MiCOM
P941, P942, P943

Frequency Relays

Software Version 05

Technical Guide

P94x/EN T/D11

MiCOM P941, P942, P943 Guides
Frequency Relays

This version of the Technical Guide is specific to the following models

Model Number	**Software Number**
P941------0050A	P941------0050-A/B
P942------0050A	P942------0050-A/B
P943------0050A	P943------0050-A/B

For other models / software versions, please contact ALSTOM T&D – Energy, Automation & Information for the relevant information.

(Software versions P94*------0010*, P94*------0020*, P94*------0030* and P94*------0040* are not supported by this menu database. See TG8611A (0010 – 0020) and TG8611B (0030 – 0040) for information on the menu database for these software versions).

Technical Guide
MiCOM P941, P942, P943
Frequency Relays

Volume 1

FREQUENCY RELAYS

MiCOM P941, P942, P943

CONTENT

Manual Issue D11			Amendments completed 20.08.2003
Doc. Ref.	Section	Page	Description
-	-	-	**Front Cover** Software version details added to back of front cover
-	-	-	**Issue Control** New section added
-	2.	-	**Safety Section:** **Installing, commissioning and servicing** Before energising the equipment, the following should be checked: 2 new points added at the end of the list
-	6.	-	**Technical specifications** Heading : Installation category amended to Insulation category Insulation category : in 1st sentence installation amended to insulation
IT	Throughout		Section brought into line with corporate standard All references to chapters and appendices replaced with new subdocument references Company name amended RS232 amended to EIA(RS)232 and RS485 amended to EIA(RS)485
IT	3.2	9	**Introduction to the user interfaces and setting options** Table 1: DNP3.0 column added Bullet point added for Time synchronisation
AP	Throughout		All references to chapters and appendices replaced with new subdocument references Company name amended RS232 amended to EIA(RS)232 and RS485 amended to EIA(RS)485
AP	1.1	5	**Frequency protection** Paragraph 1: 2nd sentence amended Paragraph 2: minor amendments Paragraph 4: re-written
AP	1.2	5 - 6	**MiCOM frequency relay** Section re-written
AP	1.2.1	6	**Protection features** Paragraph 1: re-written Bullet point 1: re-written Bullet points 2 and 3: added Bullet point 4: minor amendments
AP	1.2.3	6 7	**Other non-protection features** Heading: amended 1st sentence amended Bullet point 5: minor amendments

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Doc. Ref.	Section	Page	Description
AP	2.1	7 7 - 8 8	**Configuration column** Data in table amended Paragraph below table: deleted
AP	2.2	9	**CT & VT ratios** New section added
AP	2.3	9 - 10	**Common settings** New section added
AP	2.4	10 10 - 11 11	**Underfrequency “f+t” protection [81U]** Heading: amended Paragraph 1: 1st sentence re-written and minor amendments to rest of paragraph Paragraph 2: minor amendments Paragraph 3: rewritten Paragraphs 4 & 5: added Table and note added to end of section
AP	2.4.1	11 - 12 12	**Setting guidelines** Paragraphs 1 – 3: re-written Data in table amended Paragraph 4: minor amendments Paragraph 5: added
AP	2.5	12 - 13	**Overfrequency “f+t” protection [810]** Section moved and re-written
AP	2.5.1	13 - 15	**Setting guidelines** Section moved and re-written
AP	2.6	15 - 17	**Frequency supervised rate of change frequency “f+df/dt” protection [81RF]** Section re-written
AP	2.6.1	17 - 18	**Setting guidelines** Section re-written
AP	2.7	18 - 19	**Independent rate of change of frequency “df/dt+t” protection [81R]** Section moved and re-written
AP	2.7.1	20	**Setting guidelines** Section moved and re-written
AP	2.8	20 - 22	**Average rate of change of frequency “f+Df/DT” protection [81RAV]** Section moved and re-written
AP	2.8.1	22 - 23	**Setting guidelines** Section moved and re-written
AP	2.9	23 - 24	**Calculating the rate of change of frequency for load**

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			shedding New section added
AP	2.10	24 - 26	**Generator abnormal protection [81AB]** Section re-written
AP	2.11	26 - 30	**Load restoration** Section moved and re-written
AP	2.11.1	30 - 31	**Setting guidelines** Section moved and re-written
AP	2.12	31 - 32	**Undervoltage protection [27]** Section moved and re-written
AP	2.12.1	32 - 33	**Setting guidelines** Section moved and re-written
AP	2.13	33 - 34	**Overvoltage protection [59]** Heading: amended Paragraphs 4 & 5: added Note: added Paragraph after note: re-written Data in table amended Equations after table re-written
AP	2.13.1	34 - 35	**Setting guidelines** Paragraphs 1 – 3: added
AP	2.13	35 - 37	**Wrong settings** Section moved and re-written
AP	3.1	38	**Event and fault records** Paragraph 1: minor amendment Paragraph 4: minor amendment Table: minor amendment Paragraphs 5 & 6: minor amendments
AP	3.2	39	**Types of event** 1st line: control replaced by digital
AP	3.2.3	40	**Relay alarm conditions** Table: Data in table amended and last row added
AP	3.2.4	40	**Protection element starts and trips** 3rd sentence: minor amendment
AP	3.2.5	40	**Protection element starts and trips** Data in table amended Sentence below table: minor amendment
AP	3.2.6	41	**Fault records** Paragraph 3: added
AP	3.2.7	41	**Maintenance reports** Paragraph 2: minor amendment

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AP	3.2.8	41	**Setting changes** Data in table amended
AP	3.2.10	42 - 43 43	**Viewing event records via MiCOM S1 support software** Data in examples amended Minor amendments made in last 2 paragraphs
AP	3.2.11	43	**Event filtering** Table: General Event heading changed to System Event, and note has been deleted
AP	3.3	44 - 45 45 - 46	**Disturbance recorder** Paragraph 3: minor amendments Data in table amended Paragraphs 5, 7 & 8: minor amendments
AP	3.4	46	**Measurements** New section added
AP	3.4.1	46	**Measured voltages** New section added
AP	3.4.2	46	**Sequence voltages** New section added
AP	3.4.3	46	**Rms. Voltages and currents** New section added
AP	3.4.4	46 - 47	**Settings** New section added
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AP	3.6	47	**Generator abnormal timers** New section added
AP	3.7	47 - 48	**Changing setting groups** New section added
AP	3.8	48	**VT connections** New section added
AP	3.8.1	48	**Open delta (vee connected) VT's** New section added
AP	3.8.2	48	**VT single point earthing** New section added
AP	4.	48	**Programmable scheme logic default settings** Bullet points 3 & 4: added
AP	4.1	49	**Logic input mapping** Data in table amended Note below table: added

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AP	4.2	49 - 50	**Relay output contact mapping** Data in table amended
AP	4.3	50	**Relay output conditioning** Data in table amended
AP	4.4	50 - 51	**Programmable LED output mapping** Data in table amended
AP	4.5	51	**Fault recorder start mapping** New section added New Feature
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AP	5.	52	**Commissioning test menu** New section added
AP	5.1	52	**Opto I/P status** New section added
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AP	5.3	53	**Test port status** New section added
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AP	5.5	53	**Monitor bits 1 to 8** New section added
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AP	5.8	54	**Contact test** New section added
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HW	Throughout		All references to chapters and appendices replaced with new subdocument references Company name amended RS232 amended to EIA(RS)232 and RS485 amended to EIA(RS)485
HW	2.3.2	6	**Input board** Figure 2: updated
HW	4.2	15	**Continuous self-testing** Bullet point 4: deleted

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TD	Throughout		All references to chapters and appendices replaced with new subdocument references Company name amended RS232 amended to EIA(RS)232 and RS485 amended to EIA(RS)485
TD	1.1	5	**Voltages** Nominal voltage column in 1st table: amended Withstand column in 2nd table: amended
TD	1.2	5	**Auxiliary voltage** Data in table amended
TD	1.3	5	**Frequency** Minor amendments
TD	1.4	5	**Logic inputs** Data in table amended Paragraph below table: minor amendments Note: added
TD	1.5	6	**Output relay contacts** 2nd Table: AC data added
TD	1.6	6	**Field voltage** Minor amendments
TD	1.7	6	**Loop through connections** New section added
TD	1.8	6	**Wiring requirements** New section added
TD	2.1	6	**Voltage circuit** Data in table amended
TD	2.2	6	**Auxiliary supply** 1st Table: data in table amended Note below 1st table: amended 2nd Table: added
TD	2.3	7	**Optically isolated inputs** Minor amendment
TD	3.	7	**Accuracy** Section moved: originally section 6.
TD	3.1	7	**Reference conditions** Section moved and data in table amended

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TD	3.2	7	**Influencing quantities**
TD	4.	8	**High voltage withstand** Heading: amended
TD	4.1	8	**Dielectric withstand** Section moved and amended
TD	4.2	8	**Impulse** Section moved and amended
TD	4.3	8	**Insulation resistance** Section moved and amended
TD	4.4	8	**ANSI dielectric withstand** New section added
TD	5.	8	**Electrical environment** New section added
TD	5.1	8	**Performance criteria** New section added
TD	5.1.1	9	**Class A** New section added
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TD	5.1.3	9	**Class C** New section added
TD	5.2	9	**Auxiliary supply tests, dc interruption, etc.** New section added
TD	5.2.1	9	**DC voltage interruptions** New section added
TD	5.2.2	9	**DC voltage fluctuations** New section added
TD	5.3	10	**AC voltage dips and short interruptions** New section added
TD	5.3.1	10	**AC voltage short interruptions** New section added
TD	5.3.2	10	**AC voltage dips** New section added
TD	5.4	10	**High frequency disturbance** New section added
TD	5.5	11	**Fast transients** New section added
TD	5.6	11	**Conducted/radiated emissions** New section added

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TD	5.6.1	11	**Conducted emissions**
TD	5.6.2	11	**Radiated emissions** New section added
TD	5.7	11	**Conducted/radiated immunity** New section added
TD	5.7.1	11	**Conducted immunity** New section added
TD	5.7.2	11	**Radiated immunity** New section added
TD	5.7.3	11	**Radiated immunity from digital radio telephones** New section added
TD	5.8	12	**Electrostatic discharge** New section added
TD	5.9	12	**Surge immunity** New section added
TD	5.10	12	**Power frequency magnetic field** New section added
TD	5.11	12	**Power frequency interference** New section added
TD	5.12	12 - 13	**Surge withstand capability (SWC)** New section added
TD	5.13	13	**Radiated immunity** New section added
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TD	6.1	13	**Temperature** New section added
TD	6.2	13	**Humidity** New section added
TD	6.3	13	**Enclosure protection** New section added
TD	7.	14	**Mechanical environment** New section added
TD	7.1	14	**Test severity classes** New section added
TD	7.2	14	**Mechanical tests** New section added
TD	7.2.1	14	**Vibration (sinusoidal)** New section added

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TD	7.2.2	14	**Shock and bump**
TD	7.2.3	15	**Seismic** New section added
TD	8.	15	**EC EMC compliance** New section added
TD	9.	15	**EC LVD compliance** New section added
TD	10.	15	**Protection functions** Heading: amended
TD	10.1	15	**Common settings** Heading: amended
TD	10.1.1	15	**Undervoltage blocking** Heading: amended 1st paragraph: deleted Data in table amended
TD	10.1.2	15	**Pick-up and drop-off cycles** 1st paragraph: deleted Data in table amended
TD	10.1.3	16	**Load restoration reset holding timer** 1st paragraph: deleted Data in table amended
TD	10.1.4	16	**Accuracy** New section added
TD	10.2	16	**Under/over frequency “f+t” protection [81U/81O]** New section added
TD	10.2.1	16	**Settings** New section added
TD	10.2.2	16	**Accuracy** New section added
TD	10.3	16	**Frequency supervised rate of change of frequency “f+df/dt” protection [81RF]** New section added
TD	10.3.1	16	**Settings** New section added
TD	10.3.2	16 - 17	**Accuracy** New section added
TD	10.4	17	**Rate of change of frequency “df/dt+t” protection [81R]** New section added

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TD	10.4.1	17	**Settings**
TD	10.4.2	16 - 17	**Accuracy** New section added
TD	10.5	17	**Frequency supervised average rate of change of frequency "f+Df/Dt" protection [81RAV]** New section added
TD	10.5.1	17	**Settings** New section added
TD	10.5.2	17	**Accuracy** New section added
TD	10.6	18	**Generator abnormal protection [81AB]** Section moved and heading amended
TD	10.6.1	18	**Settings** Section moved and re-written
TD	10.6.2	18	**Accuracy** New section added
TD	10.7	18	**Load restoration** Section moved
TD	10.7.1	18	**Settings** Section moved and re-written
TD	10.7.2	18	**Accuracy** New section added
TD	10.8	18	**Undervoltage protection [27]** Section moved
TD	10.8.1	18	**Level settings** Section moved and re-written
TD	10.8.2	18 - 19	**Time delay characteristics** New section added
TD	10.8.3	19	**Accuracy** New section added
TD	10.9	19	**Overvoltage protection [59]** Section moved
TD	10.9.1	19	**Level settings** Section moved and re-written
TD	10.9.2	19	**Time delay characteristics** New section added
TD	10.9.3	20	**Time delay characteristics** New section added
TD	10.10	20	**Effect of frequency tracking on operating time** New section added
TD	10.10.1	21 - 23	**Extension of P94x operating times due to step**

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			changes New section added
TD	11.	23	**Programmable scheme logic** New section added
TD	11.1	23	**Level settings** New section added
TD	11.2	23	**Accuracy** New section added
TD	12.	23	**Measurements and recording facilities** New section added
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TD	12.2	23	**IRIG-B and real time clock** New section added
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TD	13.2	24	**Accuracy** New section added
TD	14.	24	**Input and output setting ranges** New section added
TD	14.1	24	**VT ratio settings** Section moved and re-written
TD	15.	24	**Battery life** New section added
TD	16.	25	**Frequency response** New section added
TD	17.	25	**Local and remote communications** Section moved and re-named
TD	17.1	25	**Front port (SK1)** Section moved, re-named and re-written
TD	17.2	26	**Rear port** Section moved, re-named and re-written
TD	17.2.1	26	**Performance** New section added
TD	17.3	-	**Programmable logic** Section deleted

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Doc. Ref.	Section	Page	Description
TD	17.4	-	**Protection accuracy** Section deleted
TD	18.	-	**Environment Compliance** Complete section deleted
TD	19.	-	**ANSI test requirements** Complete section deleted
TD	20.	-	**Safety** Complete section deleted
CT	Throughout		Section brought into line with corporate standard All references to chapters and appendices replaced with new subdocument references Company name amended RS232 amended to EIA(RS)232 and RS485 amended to EIA(RS)485
GC	-	-	**Relay menu database** All references to chapters and appendices replaced with new subdocument references Amended to reflect latest relay software
CO	-	-	**External connection diagrams** New diagrams
VC	-	-	**Hardware/software version history and compatibility** New section added
HI	-	-	**Menu content tables** New section added

HANDLING OF ELECTRONIC EQUIPMENT

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semiconductor devices when handling circuits can cause serious damage, which often may not be immediately apparent but the reliability of the circuit will have been reduced.

The electronic circuits of AREVA T&D products are immune to the relevant levels of electrostatic discharge when housed in their cases. Do not expose them to the risk of damage by withdrawing modules unnecessarily.

Each module incorporates the highest practicable protection for its semiconductor devices. However, if it becomes necessary to withdraw a module, the following precautions should be taken to preserve the high reliability and long life for which the equipment has been designed and manufactured.

1. Before removing a module, ensure that you are a same electrostatic potential as the equipment by touching the case.

2. Handle the module by its front-plate, frame, or edges of the printed circuit board. Avoid touching the electronic components, printed circuit track or connectors.

3. Do not pass the module to any person without first ensuring that you are both at the same electrostatic potential. Shaking hands achieves equipotential.

4. Place the module on an antistatic surface, or on a conducting surface which is at the same potential as yourself.

5. Store or transport the module in a conductive bag.

More information on safe working procedures for all electronic equipment can be found in BS5783 and IEC 60147-0F.

If you are making measurements on the internal electronic circuitry of an equipment in service, it is preferable that you are earthed to the case with a conductive wrist strap.

Wrist straps should have a resistance to ground between 500k – 10M ohms. If a wrist strap is not available you should maintain regular contact with the case to prevent the build up of static. Instrumentation which may be used for making measurements should be earthed to the case whenever possible.

AREVA T&D strongly recommends that detailed investigations on the electronic circuitry, or modification work, should be carried out in a Special Handling Area such as described in BS5783 or IEC 60147-0F.

SAFETY SECTION

CONTENTS

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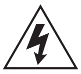
1. INTRODUCTION

This guide and the relevant operating or service manual documentation for the equipment provide full information on safe handling, commissioning and testing of this equipment and also includes descriptions of equipment label markings.

Documentation for equipment ordered from AREVA Energy Automation & Information is despatched separately from manufactured goods and may not be received at the same time. Therefore this guide is provided to ensure that printed information normally present on equipment is fully understood by the recipient.



Before carrying out any work on the equipment the user should be familiar with the contents of this Safety Guide.

Reference should be made to the external connection diagram before the equipment is installed, commissioned or serviced.

Language specific, self-adhesive User Interface labels are provided in a bag for some equipment.

2. HEALTH AND SAFETY

The information in the Safety Section of the equipment documentation is intended to ensure that equipment is properly installed and handled in order to maintain it in a safe condition.

It is assumed that everyone who will be associated with the equipment will be familiar with the contents of that Safety Section, or this Safety Guide.

When electrical equipment is in operation, dangerous voltages will be present in certain parts of the equipment. Failure to observe warning notices, incorrect use, or improper use may endanger personnel and equipment and cause personal injury or physical damage.

Before working in the terminal strip area, the equipment must be isolated.

Proper and safe operation of the equipment depends on appropriate shipping and handling, proper storage, installation and commissioning, and on careful operation, maintenance and servicing. For this reason only qualified personnel may work on or operate the equipment.

Qualified personnel are individuals who

- are familiar with the installation, commissioning, and operation of the equipment and of the system to which it is being connected;
- are able to safely perform switching operations in accordance with accepted safety engineering practices and are authorised to energize and de-energize equipment and to isolate, ground, and label it;
- are trained in the care and use of safety apparatus in accordance with safety engineering practices;
- are trained in emergency procedures (first aid).

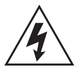
The operating manual for the equipment gives instructions for its installation, commissioning, and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate AREVA technical sales office and request the necessary information.

3. SYMBOLS AND EXTERNAL LABELS ON THE EQUIPMENT

For safety reasons the following symbols and external labels, which may be used on the equipment or referred to in the equipment documentation, should be understood before the equipment is installed or commissioned.

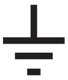
3.1 Symbols

Caution: refer to equipment documentation



Caution: risk of electric shock

Protective Conductor (*Earth) terminal.



Functional/Protective Conductor Earth terminal
Note – This symbol may also be used for a Protective Conductor (Earth) terminal if that terminal is part of a terminal block or sub-assembly e.g. power supply.

*NOTE: THE TERM EARTH USED THROUGHOUT THIS GUIDE IS THE DIRECT EQUIVALENT OF THE NORTH AMERICAN TERM GROUND.

3.2 Labels

See "Safety Guide" (SFTY/4L M) for equipment labelling information.

4. INSTALLING, COMMISSIONING AND SERVICING

Equipment connections

Personnel undertaking installation, commissioning or servicing work for this equipment should be aware of the correct working procedures to ensure safety.

The equipment documentation should be consulted before installing, commissioning or servicing the equipment.

Terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated.

Any disassembly of the equipment may expose parts at hazardous voltage, also electronic parts may be damaged if suitable electrostatic voltage discharge (ESD) precautions are not taken.

If there is unlocked access to the rear of the equipment, care should be taken by all personnel to avoid electric shock or energy hazards.

Voltage and current connections should be made using insulated crimp terminations to ensure that terminal block insulation requirements are maintained for safety.
To ensure that wires are correctly terminated the correct crimp terminal and tool for the wire size should be used.

The equipment must be connected in accordance with the appropriate connection diagram.

Protection Class I Equipment

- Before energising the equipment it must be earthed using the protective conductor terminal, if provided, or the appropriate termination of the supply plug in the case of plug connected equipment.
- The protective conductor (earth) connection must not be removed since the protection against electric shock provided by the equipment would be lost.

The recommended minimum protective conductor (earth) wire size is 2.5 mm² (3.3 mm² for North America) unless otherwise stated in the technical data section of the equipment documentation, or otherwise required by local or country wiring regulations.

The protective conductor (earth) connection must be low-inductance and as short as possible.

All connections to the equipment must have a defined potential. Connections that are pre-wired, but not used, should preferably be grounded when binary inputs and output relays are isolated. When binary inputs and output relays are connected to common potential, the pre-wired but unused connections should be connected to the common potential of the grouped connections.

Before energising the equipment, the following should be checked:

- Voltage rating/polarity (rating label/equipment documentation);
- CT circuit rating (rating label) and integrity of connections;
- Protective fuse rating;
- Integrity of the protective conductor (earth) connection (where applicable);
- Voltage and current rating of external wiring, applicable to the application.

Equipment Use

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Removal of the equipment front panel/cover

Removal of the equipment front panel/cover may expose hazardous live parts which must not be touched until the electrical power is removed.

UL and CSA Listed or Recognized Equipment

To maintain UL and CSA approvals the equipment should be installed using UL and/or CSA Listed or Recognized parts of the following type: connection cables, protective fuses/fuseholders or circuit breakers, insulation crimp terminals, and replacement internal battery, as specified in the equipment documentation.

Equipment operating conditions

The equipment should be operated within the specified electrical and environmental limits.

Current transformer circuits

Do not open the secondary circuit of a live CT since the high voltage produced may be lethal to personnel and could damage insulation.
Generally, for safety, the secondary of the line CT must be shorted before opening any connections to it.

For most equipment with ring-terminal connections, the threaded terminal block for current transformer termination has automatic CT shorting on removal of the module. Therefore external shorting of the CTs may not be required, the equipment documentation should be checked to see if this applies.

For equipment with pin-terminal connections, the threaded terminal block for current transformer termination does NOT have automatic CT shorting on removal of the module.

External resistors, including voltage dependent resistors (VDRs)

Where external resistors, including voltage dependent resistors (VDRs), are fitted to the equipment, these may present a risk of electric shock or burns, if touched.

Battery replacement

Where internal batteries are fitted they should be replaced with the recommended type and be installed with the correct polarity to avoid possible damage to the equipment, buildings and persons.

Insulation and dielectric strength testing

Insulation testing may leave capacitors charged up to a hazardous voltage. At the end of each part of the test, the voltage should be gradually reduced to zero, to discharge capacitors, before the test leads are disconnected.

Insertion of modules and pcb cards

Modules and pcb cards must not be inserted into or withdrawn from the equipment whilst it is energised, since this may result in damage.

Insertion and withdrawal of extender cards

Extender cards are available for some equipment. If an extender card is used, this should not be inserted or withdrawn from the equipment whilst it is energised. This is to avoid possible shock or damage hazards. Hazardous live voltages may be accessible on the extender card.

Insertion and withdrawal of integral heavy current test plugs

It is possible to use an integral heavy current test plug with some equipment. CT shorting links must be in place before insertion or removal of heavy current test plugs, to avoid potentially lethal voltages.

External test blocks and test plugs

Great care should be taken when using external test blocks and test plugs such as the MMLG, MMLB and MiCOM P990 types, hazardous voltages may be accessible when using these. *CT shorting links must be in place before the insertion or removal of MMLB test plugs, to avoid potentially lethal voltages.

*Note – when a MiCOM P992 Test Plug is inserted into the MiCOM P991 Test Block, the secondaries of the line CTs are automatically shorted, making them safe.

Fibre optic communication

Where fibre optic communication devices are fitted, these should not be viewed directly. Optical power meters should be used to determine the operation or signal level of the device.

Cleaning

The equipment may be cleaned using a lint free cloth dampened with clean water, when no connections are energised. Contact fingers of test plugs are normally protected by petroleum jelly which should not be removed.

5. DECOMMISSIONING AND DISPOSAL

Decommissioning:

The supply input (auxiliary) for the equipment may include capacitors across the supply or to earth. To avoid electric shock or energy hazards, after completely isolating the supplies to the equipment (both poles of any dc supply), the capacitors should be safely discharged via the external terminals prior to decommissioning.

Disposal:

It is recommended that incineration and disposal to water courses is avoided. The equipment should be disposed of in a safe manner. Any equipment containing batteries should have them removed before disposal, taking precautions to avoid short circuits. Particular regulations within the country of operation, may apply to the disposal of batteries.

6. EQUIPMENT WHICH INCLUDES ELECTROMECHANICAL ELEMENTS

Electrical adjustments

It is possible to change current or voltage settings on some equipment by direct physical adjustment e.g. adjustment of a plug-bridge setting. The electrical power should be removed before making any change, to avoid the risk of electric shock.

Exposure of live parts

Removal of the cover may expose hazardous live parts such as relay contacts, these should not be touched before removing the electrical power.

7. TECHNICAL SPECIFICATIONS FOR SAFETY

7.1 Protective fuse rating

The recommended maximum rating of the external protective fuse for equipments is 16A, high rupture capacity (HRC) Red Spot type NIT, or TIA, or equivalent, unless otherwise stated in the technical data section of the equipment documentation. The protective fuse should be located as close to the unit as possible.

DANGER - CTs must NOT be fused since open circuiting them may produce lethal hazardous voltages.

7.2 Protective Class

IEC 61010-1: 2001 EN 61010-1: 2001	Class I (unless otherwise specified in the equipment documentation). This equipment requires a protective conductor (earth) connection to ensure user safety.

7.3 Installation Category

IEC 61010-1: 2001 EN 61010-1: 2001	Installation Category III (Overvoltage Category III): Distribution level, fixed installation. Equipment in this category is qualification tested at 5kV peak, 1.2/50μs, 500Ω, 0.5J, between all supply circuits and earth and also between independent circuits

7.4 Environment

The equipment is intended for indoor installation and use only. If it is required for use in an outdoor environment then it must be mounted in a specific cabinet or housing which will enable it to meet the requirements of IEC 60529 with the classification of degree of protection IP54 (dust and splashing water protected).

Pollution Degree – Pollution Degree 2 Altitude – operation up to 2000 m IEC 61010-1: 2001 EN 61010-1: 2001	Compliance is demonstrated by reference to safety standards.

8. CE MARKING

CE Marking	Compliance with all relevant European Community directives:
Product safety: Low Voltage Directive - 73/23/EEC amended by 93/68/EEC EN 61010-1: 2001 EN 60950-1: 2001 EN 60255-5: 2001 IEC 60664-1: 2001	Compliance demonstrated by reference to safety standards.
Electromagnetic Compatibility Directive (EMC) 89/336/EEC amended by 93/68/EEC. The following Product Specific Standard was used to establish conformity: EN 50263 : 2000	Compliance demonstrated via the Technical Construction File route.

Where applicable :

Ex II (2) G	The equipment is compliant with Article 1(2) of European directive 94/9/EC. It is approved for operation outside an ATEX hazardous area. It is however approved for connection to Increased Safety, “Ex e”, motors with rated ATEX protection, Equipment Category 2, to ensure their safe operation in gas Zones 1 and 2 hazardous areas.
ATEX Potentially Explosive Atmospheres directive 94/9/EC, for equipment.	CAUTION – Equipment with this marking is not itself suitable for operation within a potentially explosive atmosphere. Compliance demonstrated by Notified Body certificates of compliance.
Radio and Telecommunications Terminal Equipment (R & TTE) directive 95/5/EC.	Compliance demonstrated by compliance to the Low Voltage Directive, 73/23/EEC amended by 93/68/EEC, down to zero volts, by reference to safety standards.

9. RECOGNIZED AND LISTED MARKS FOR NORTH AMERICA

CSA - Canadian Standards Association

UL - Underwriters Laboratory of America

– UL Recognized to UL (USA) requirements

– UL Recognized to UL (USA) and CSA (Canada) requirements

– UL Listed to UL (USA) requirements

– UL Listed to UL (USA) and CSA (Canada) requirements

– Certified to CSA (Canada) requirements

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INTRODUCTION

CONTENT

1. INTRODUCTION TO MiCOM

MiCOM is a comprehensive solution capable of meeting all electricity supply requirements. It comprises a range of components, systems and services from AREVA T&D.

Central to the MiCOM concept is flexibility.

MiCOM provides the ability to define an application solution and, through extensive communication capabilities, to integrate it with your power supply control system.

The components within MiCOM are:

– P range protection relays;

– C range control products;

– M range measurement products for accurate metering and monitoring;

– S range versatile PC support and substation control packages.

MiCOM products include extensive facilities for recording information on the state and behaviour of the power system using disturbance and fault records. They can also provide measurements of the system at regular intervals to a control centre enabling remote monitoring and control to take place.

For up-to-date information on any MiCOM product, visit our website:

www.areva-td.com

2. INTRODUCTION TO MiCOM GUIDES

The guides provide a functional and technical description of the MiCOM protection relay and a comprehensive set of instructions for the relay's use and application.

Divided into two volumes, as follows:

Volume 1 – Technical Guide, includes information on the application of the relay and a technical description of its features. It is mainly intended for protection engineers concerned with the selection and application of the relay for the protection of the power system.

Volume 2 – Operation Guide, contains information on the installation and commissioning of the relay, and also a section on fault finding. This volume is intended for site engineers who are responsible for the installation, commissioning and maintenance of the relay.

The section content within each volume is summarised below:

Volume 1 Technical Guide

Handling of Electronic Equipment

Safety Section

P94x/EN IT Introduction

A guide to the different user interfaces of the protection relay describing how to start using the relay.

P94x/EN AP Application Notes

Comprehensive and detailed description of the features of the relay including both the protection elements and the relay's other functions such as event and disturbance recording, fault location and programmable scheme logic. This section includes a description of common power system applications of the relay, calculation of suitable settings, some typical worked examples, and how to apply the settings to the relay.

P94x/EN HW Relay Description

Overview of the operation of the relay's hardware and software. This section includes information on the self-checking features and diagnostics of the relay.

P94x/EN TD Technical Data

Technical data including setting ranges, accuracy limits, recommended operating conditions, ratings and performance data. Compliance with technical standards is quoted where appropriate.

P94x/EN CT SCADA Communications

This section provides detailed information regarding the communication interfaces of the relay, including a detailed description of how to access the settings database stored within the relay. The section also gives information on each of the communication protocols that can be used with the relay, and is intended to allow the user to design a custom interface to a SCADA system.

P94x/EN GC Relay Menu Database

User interface/Courier/MODBUS/IEC 60870-5-103/DNP 3.0. Listing of all of the settings contained within the relay together with a brief description of each.

P94x/EN CO External Connection Diagrams

All external wiring connections to the relay.

P94x/EN VC Hardware / Software Version History and Compatibility

Volume 2 Operation Guide

Handling of Electronic Equipment

Safety Section

P94x/EN IT Introduction

A guide to the different user interfaces of the protection relay describing how to start using the relay.

P94x/EN IN Installation

Recommendations on unpacking, handling, inspection and storage of the relay. A guide to the mechanical and electrical installation of the relay is provided incorporating earthing recommendations.

P94x/EN CM Commissioning and Maintenance

Instructions on how to commission the relay, comprising checks on the calibration and functionality of the relay. A general maintenance policy for the relay is outlined.

P94x/EN PR Problem Analysis

Advice on how to recognise failure modes and the recommended course of action.

P94x/EN GC Relay Menu Database

User interface/Courier/MODBUS/IEC 60870-5-103/DNP 3.0. Listing of all of the settings contained within the relay together with a brief description of each.

P94x/EN CO External Connection Diagrams

All external wiring connections to the relay.

P94x/EN VC Hardware / Software Version History and Compatibility

Repair Form

3. USER INTERFACES AND MENU STRUCTURE

The settings and functions of the MiCOM protection relay can be accessed both from the front panel keypad and LCD, and via the front and rear communication ports. Information on each of these methods is given in this section to describe how to get started using the relay.

3.1 Introduction to the relay

3.1.1 Front panel

The front panel of the relay is shown in Figure 1, with the hinged covers at the top and bottom of the relay shown open. Extra physical protection for the front panel can be provided by an optional transparent front cover. With the cover in place read only access to the user interface is possible. Removal of the cover does not compromise the environmental withstand capability of the product, but allows access to the relay settings. When full access to the relay keypad is required, for editing the settings, the transparent cover can be unclipped and removed when the top and bottom covers are open. If the lower cover is secured with a wire seal, this will need to be removed. Using the side flanges of the transparent cover, pull the bottom edge away from the relay front panel until it is clear of the seal tab. The cover can then be moved vertically down to release the two fixing lugs from their recesses in the front panel.

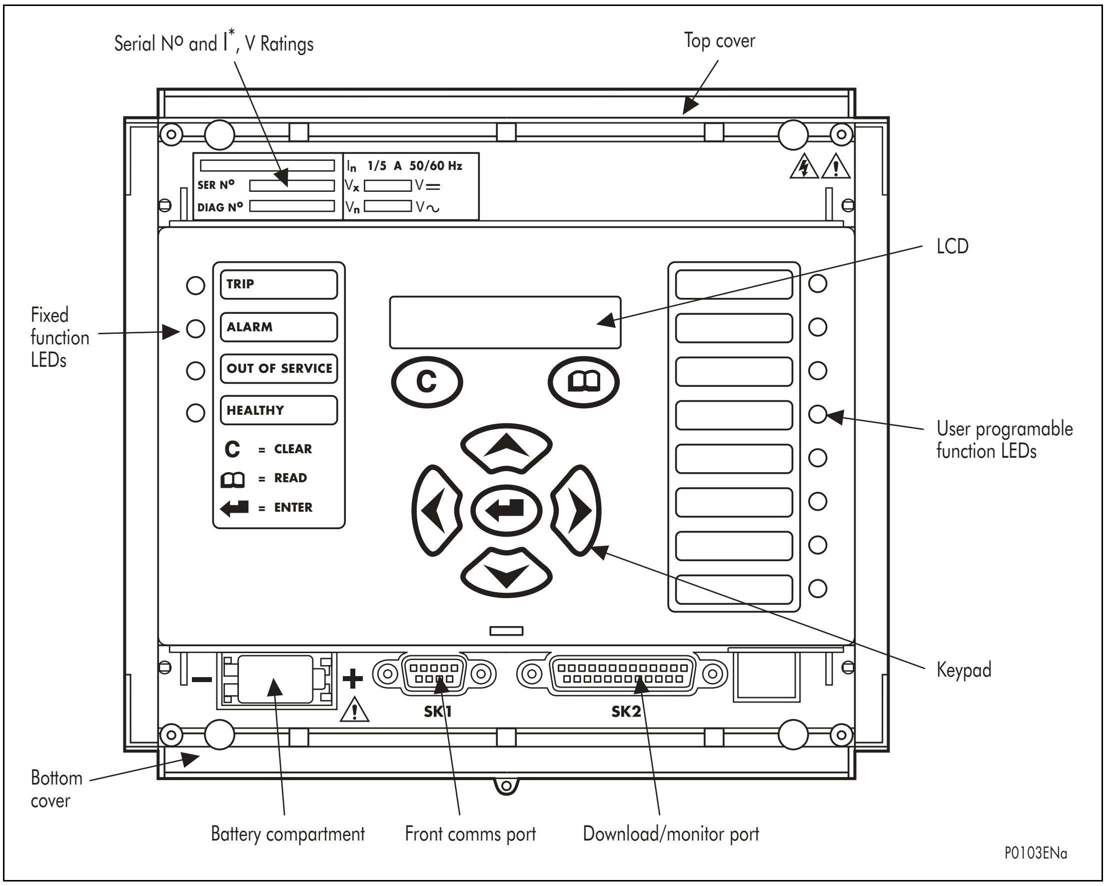


Figure 1: Relay front view

The front panel of the relay includes the following, as indicated in Figure 1:

– a 16-character by 2-line alphanumeric liquid crystal display (LCD).

– a 7-key keypad comprising 4 arrow keys •©••◊, ⌃ and ⌄), an enter key (↵), a clear key (©), and a read key (⊚).

– 12 LEDs; 4 fixed function LEDs on the left hand side of the front panel and 8 programmable function LEDs on the right hand side.

Under the top hinged cover:

– the relay serial number, and the relay's current and voltage rating information*.

Under the bottom hinged cover:

– battery compartment to hold the $^1/_2$ AA size battery which is used for memory back-up for the real time clock, event, fault and disturbance records.

– a 9-pin female D-type front port for communication with a PC locally to the relay (up to 15m distance) via an EIA(RS)232 serial data connection.

– a 25-pin female D-type port providing internal signal monitoring and high speed local downloading of software and language text via a parallel data connection.

The fixed function LEDs on the left hand side of the front panel are used to indicate the following conditions:

Trip (Red) indicates that the relay has issued a trip signal. It is reset when the associated fault record is cleared from the front display. (Alternatively the trip LED can be configured to be self-resetting)*.

Alarm (Yellow) flashes to indicate that the relay has registered an alarm. This may be triggered by a fault, event or maintenance record. The LED will flash until the alarms have been accepted (read), after which the LED will change to constant illumination, and will extinguish when the alarms have been cleared.

Out of service (Yellow) indicates that the relay's protection is unavailable.

Healthy (Green) indicates that the relay is in correct working order, and should be on at all times. It will be extinguished if the relay's self-test facilities indicate that there is an error with the relay's hardware or software. The state of the healthy LED is reflected by the watchdog contact at the back of the relay.

3.1.2 Relay rear panel

The rear panel of the relay is shown in Figure 2. All current and voltage signals*, digital logic input signals and output contacts are connected at the rear of the relay. Also connected at the rear is the twisted pair wiring for the rear EIA(RS)485 communication port, the IRIG-B time synchronising input and the optical fibre rear communication port which are both optional.

Note: *May vary according to relay type/model

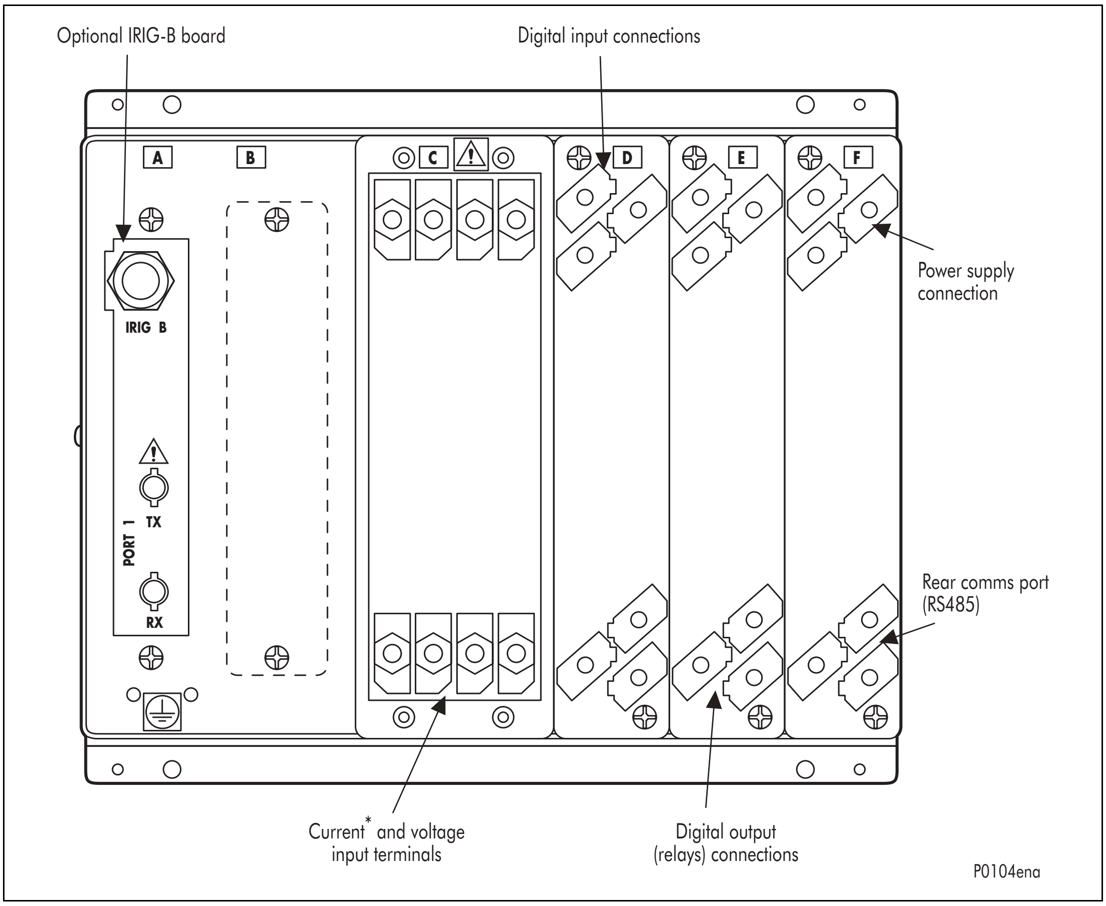


Figure 2: Relay rear view

Refer to the wiring diagram in section P94x/EN CO/D11 for complete connection details.

3.2 Introduction to the user interfaces and settings options

The relay has three user interfaces:

– the front panel user interface via the LCD and keypad.

– the front port which supports Courier communication.

– the rear port which supports one protocol of either Courier, MODBUS, IEC 60870-5-103 or DNP3.0. The protocol for the rear port must be specified when the relay is ordered.

The measurement information and relay settings which can be accessed from the three interfaces are summarised in Table 1.

	Keypad/ LCD	Courier	MODBUS	IEC870-5-103	DNP3.0
Display & modification of all settings	•	•	•		
Digital I/O signal status	•	•	•	•	•
Display/extraction of measurements	•	•	•	•	•
Display/extraction of fault records	•	•	•		
Display/extraction of event & alarm records	•	•	•	•	
Extraction of disturbance records		•	•		
Programmable scheme logic settings		•			
Reset of fault & alarm records	•	•	•	•	•
Clear event & fault records	•	•	•		•
Time synchronisation		•	•	•	•
Control commands	•	•	•	•	•

Table 1

3.3 Menu structure

The relay's menu is arranged in a tabular structure. Each setting in the menu is referred to as a cell, and each cell in the menu may be accessed by reference to a row and column address. The settings are arranged so that each column contains related settings, for example all of the disturbance recorder settings are contained within the same column. As shown in Figure 3, the top row of each column contains the heading which describes the settings contained within that column. Movement between the columns of the menu can only be made at the column heading level. A complete list of all of the menu settings is given in section P94x/EN GC/D11 of the manual.

Note: *May vary according to relay type/model

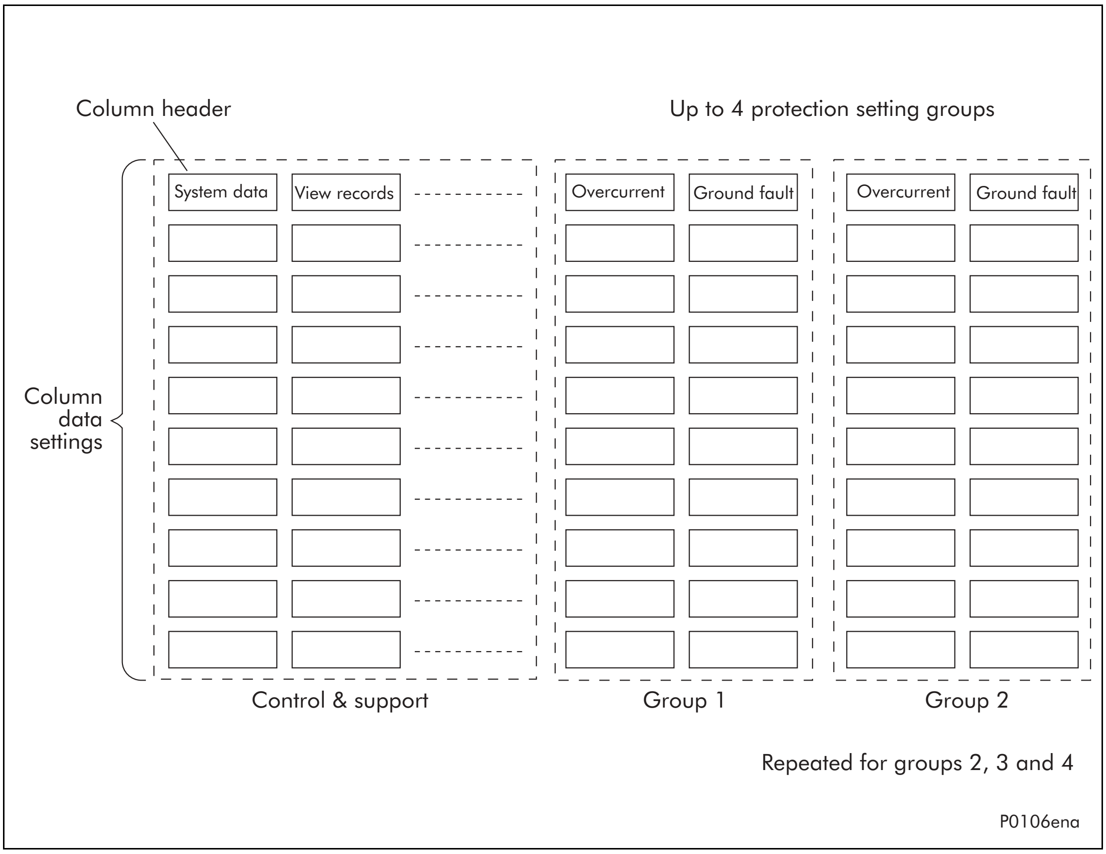


Figure 3: Menu structure

All of the settings in the menu fall into one of three categories: protection settings, disturbance recorder settings, or control and support (C&S) settings. One of two different methods is used to change a setting depending on which category the setting falls into. Control and support settings are stored and used by the relay immediately after they are entered. For either protection settings or disturbance recorder settings, the relay stores the new setting values in a temporary ‘scratchpad’. It activates all the new settings together, but only after it has been confirmed that the new settings are to be adopted. This technique is employed to provide extra security, and so that several setting changes that are made within a group of protection settings will all take effect at the same time.

3.3.1 Protection settings

The protection settings include the following items:

– protection element settings

– scheme logic settings

– auto-reclose and check synchronisation settings (where appropriate)*

– fault locator settings (where appropriate)*

There are four groups of protection settings, with each group containing the same setting cells. One group of protection settings is selected as the active group, and is used by the protection elements.

3.3.2 Disturbance recorder settings

The disturbance recorder settings include the record duration and trigger position, selection of analogue and digital signals to record, and the signal sources that trigger the recording.

3.3.3 Control and support settings

The control and support settings include:

- relay configuration settings
- open/close circuit breaker*
- CT & VT ratio settings*
- reset LEDs
- active protection setting group
- password & language settings
- circuit breaker control & monitoring settings*
- communications settings
- measurement settings
- event & fault record settings
- user interface settings
- commissioning settings

3.4 Password protection

The menu structure contains three levels of access. The level of access that is enabled determines which of the relay's settings can be changed and is controlled by entry of two different passwords. The levels of access are summarised in Table 2.

Access level	Operations enabled
Level 0 No password required	Read access to all settings, alarms, event records and fault records
Level 1 Password 1 or 2	As level 0 plus: Control commands, e.g. circuit breaker open/close. Reset of fault and alarm conditions. Reset LEDs. Clearing of event and fault records.
Level 2 As level 1 plus:	Password 2 required All other settings

Table 2

Each of the two passwords are 4 characters of upper case text. The factory default for both passwords is AAAA. Each password is user-changeable once it has been correctly entered. Entry of the password is achieved either by a prompt when a setting change is attempted, or by moving to the 'Password' cell in the 'System data'

Note: *May vary according to relay type/model

column of the menu. The level of access is independently enabled for each interface, that is to say if level 2 access is enabled for the rear communication port, the front panel access will remain at level 0 unless the relevant password is entered at the front panel. The access level enabled by the password entry will time-out independently for each interface after a period of inactivity and revert to the default level. If the passwords are lost an emergency password can be supplied - contact AREVA with the relay's serial number. The current level of access enabled for an interface can be determined by examining the 'Access level' cell in the 'System data' column, the access level for the front panel User Interface (UI), can also be found as one of the default display options.

The relay is supplied with a default access level of 2, such that no password is required to change any of the relay settings. It is also possible to set the default menu access level to either level 0 or level1, preventing write access to the relay settings without the correct password. The default menu access level is set in the 'Password control' cell which is found in the 'System data' column of the menu (note that this setting can only be changed when level 2 access is enabled).

3.5 Relay configuration

The relay is a multi-function device which supports numerous different protection, control and communication features. In order to simplify the setting of the relay, there is a configuration settings column which can be used to enable or disable many of the functions of the relay. The settings associated with any function that is disabled are made invisible, i.e. they are not shown in the menu. To disable a function change the relevant cell in the 'Configuration' column from 'Enabled' to 'Disabled'.

The configuration column controls which of the four protection settings groups is selected as active through the 'Active settings' cell. A protection setting group can also be disabled in the configuration column, provided it is not the present active group. Similarly, a disabled setting group cannot be set as the active group.

The column also allows all of the setting values in one group of protection settings to be copied to another group.

To do this firstly set the 'Copy from' cell to the protection setting group to be copied, then set the 'Copy to' cell to the protection group where the copy is to be placed. The copied settings are initially placed in the temporary scratchpad, and will only be used by the relay following confirmation.

To restore the default values to the settings in any protection settings group, set the 'Restore defaults' cell to the relevant group number. Alternatively it is possible to set the 'Restore defaults' cell to 'All settings' to restore the default values to all of the relay's settings, not just the protection groups' settings. The default settings will initially be placed in the scratchpad and will only be used by the relay after they have been confirmed. Note that restoring defaults to all settings includes the rear communication port settings, which may result in communication via the rear port being disrupted if the new (default) settings do not match those of the master station.

3.6 Front panel user interface (keypad and LCD)

When the keypad is exposed it provides full access to the menu options of the relay, with the information displayed on the LCD.

The ⓒ••◊, ⌃ and ⌄ keys which are used for menu navigation and setting value changes include an auto-repeat function that comes into operation if any of these keys are held continually pressed. This can be used to speed up both setting value changes and menu navigation; the longer the key is held depressed, the faster the rate of change or movement becomes.

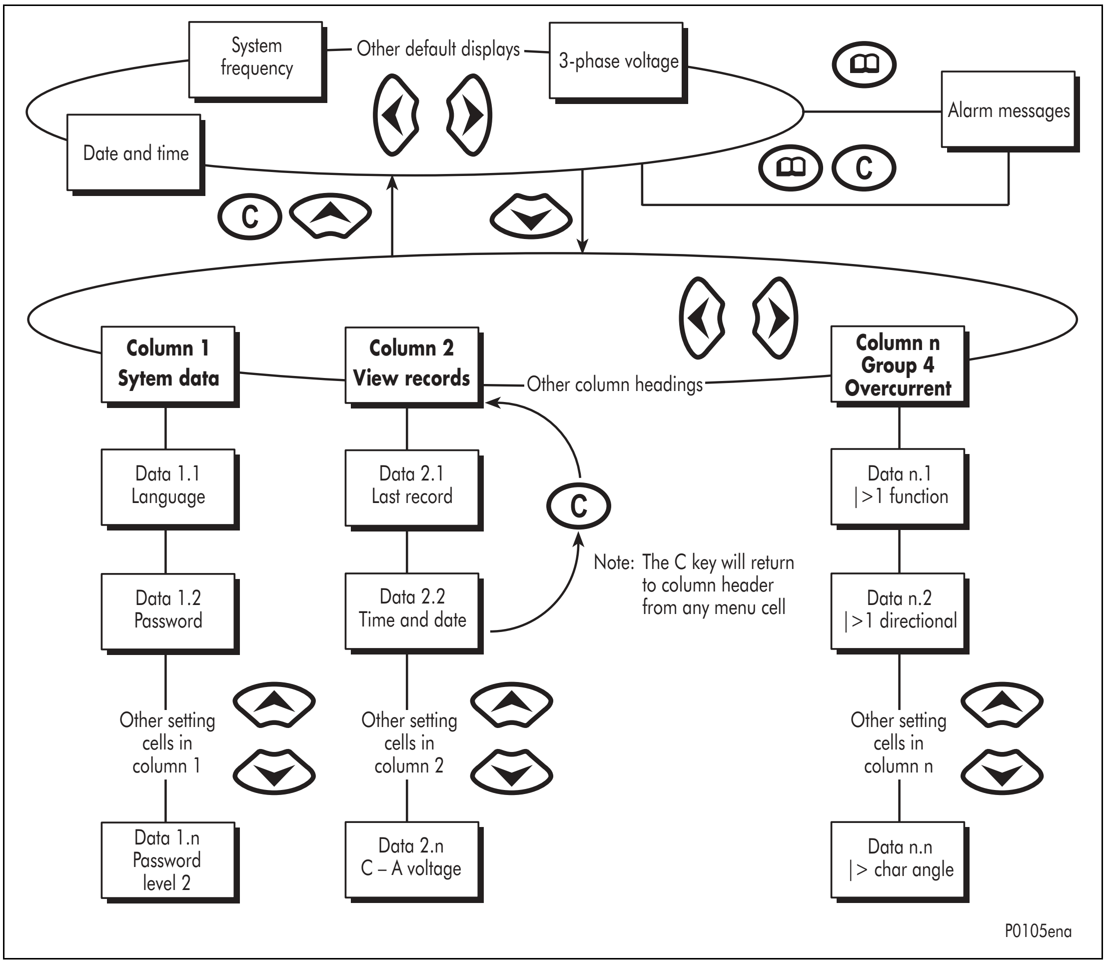


Figure 4: Front panel user interface

3.6.1 Default display and menu time-out

The front panel menu has a selectable default display. The relay will time-out and return to the default display and turn the LCD backlight off after 15 minutes of keypad inactivity. If this happens any setting changes which have not been confirmed will be lost and the original setting values maintained.

The contents of the default display can be selected from the following options: 3-phase and neutral current, 3-phase voltage, power, system frequency, date and time, relay description, or a user-defined plant reference*. The default display is selected with the 'Default display' cell of the 'Measure't setup' column. Also, from the default display the different default display options can be scrolled through using the and keys. However the menu selected default display will be restored following the menu time-out elapsing. Whenever there is an uncleared alarm present in the relay (e.g. fault record, protection alarm, control alarm etc.) the default display will be replaced by:

Alarms/Faults Present

Note: *May vary according to relay type/model

Entry to the menu structure of the relay is made from the default display and is not affected if the display is showing the 'Alarms/Faults present' message.

3.6.2 Menu navigation and setting browsing

The menu can be browsed using the four arrow keys, following the structure shown in Figure 4. Thus, starting at the default display the key will display the first column heading. To select the required column heading use the and keys. The setting data contained in the column can then be viewed by using the and keys. It is possible to return to the column header either by holding the [up arrow symbol] key down or by a single press of the clear key . It is only possible to move across columns at the column heading level. To return to the default display press the key or the clear key from any of the column headings. It is not possible to go straight to the default display from within one of the column cells using the auto-repeat facility of the key, as the auto-repeat will stop at the column heading. To move to the default display, the key must be released and pressed again.

3.6.3 Password entry

When entry of a password is required the following prompt will appear:

Enter password **** Level 1

Note: The password required to edit the setting is the prompt as shown above

A flashing cursor will indicate which character field of the password may be changed. Press the and keys to vary each character between A and Z. To move between the character fields of the password, use the •and keys. The password is confirmed by pressing the enter key •••The display will revert to 'Enter Password' if an incorrect password is entered. At this point a message will be displayed indicating whether a correct password has been entered and if so what level of access has been unlocked. If this level is sufficient to edit the selected setting then the display will return to the setting page to allow the edit to continue. If the correct level of password has not been entered then the password prompt page will be returned to. To escape from this prompt press the clear key . Alternatively, the password can be entered using the 'Password' cell of the 'System data' column.

For the front panel user interface the password protected access will revert to the default access level after a keypad inactivity time-out of 15 minutes. It is possible to manually reset the password protection to the default level by moving to the 'Password' menu cell in the 'System data' column and pressing the clear key instead of entering a password.

3.6.4 Reading and clearing of alarm messages and fault records

The presence of one or more alarm messages will be indicated by the default display and by the yellow alarm LED flashing. The alarm messages can either be self-resetting or latched, in which case they must be cleared manually. To view the alarm messages press the read key•. When all alarms have been viewed, but not cleared, the alarm LED will change from flashing to constant illumination and the latest fault record will be displayed (if there is one). To scroll through the pages of this use the key. When all pages of the fault record have been viewed, the following prompt will appear:

Press clear to reset alarms

To clear all alarm messages press ; to return to the alarms/faults present display and leave the alarms uncleared, press . Depending on the password configuration settings, it may be necessary to enter a password before the alarm messages can be cleared (see section on password entry). When the alarms have been cleared the yellow alarm LED will extinguish, as will the red trip LED if it was illuminated following a trip.

Alternatively it is possible to accelerate the procedure, once the alarm viewer has been entered using the• key, the key can be pressed, this will move the display straight to the fault record. Pressing again will move straight to the alarm reset prompt where pressing once more will clear all alarms.

3.6.5 Setting changes

To change the value of a setting, first navigate the menu to display the relevant cell. To change the cell value press the enter key ••which will bring up a flashing cursor on the LCD to indicate that the value can be changed. This will only happen if the appropriate password has been entered, otherwise the prompt to enter a password will appear. The setting value can then be changed by pressing the or keys. If the setting to be changed is a binary value or a text string, the required bit or character to be changed must first be selected using the•and keys. When the desired new value has been reached it is confirmed as the new setting value by pressing •••Alternatively, the new value will be discarded either if the clear button is pressed or if the menu time-out occurs.

For protection group settings and disturbance recorder settings, the changes must be confirmed before they are used by the relay. To do this, when all required changes have been entered, return to the column heading level and press the key. Prior to returning to the default display the following prompt will be given:

Update settings? Enter or clear

Pressing • will result in the new settings being adopted, pressing will cause the relay to discard the newly entered values. It should be noted that, the setting values will also be discarded if the menu time out occurs before the setting changes have been confirmed. Control and support settings will be updated immediately after they are entered, without ‘Update settings?’ prompt.

3.7 Front communication port user interface

The front communication port is provided by a 9-pin female D-type connector located under the bottom hinged cover. It provides EIA(RS)232 serial data communication and is intended for use with a PC locally to the relay (up to 15m distance) as shown in Figure 5. This port supports the Courier communication protocol only. Courier is the communication language developed by AREVA T&D to allow communication with its range of protection relays. The front port is particularly

Note: *May vary according to relay type/model

designed for use with the relay settings program MiCOM S1 which is a Windows 98/NT based software package.

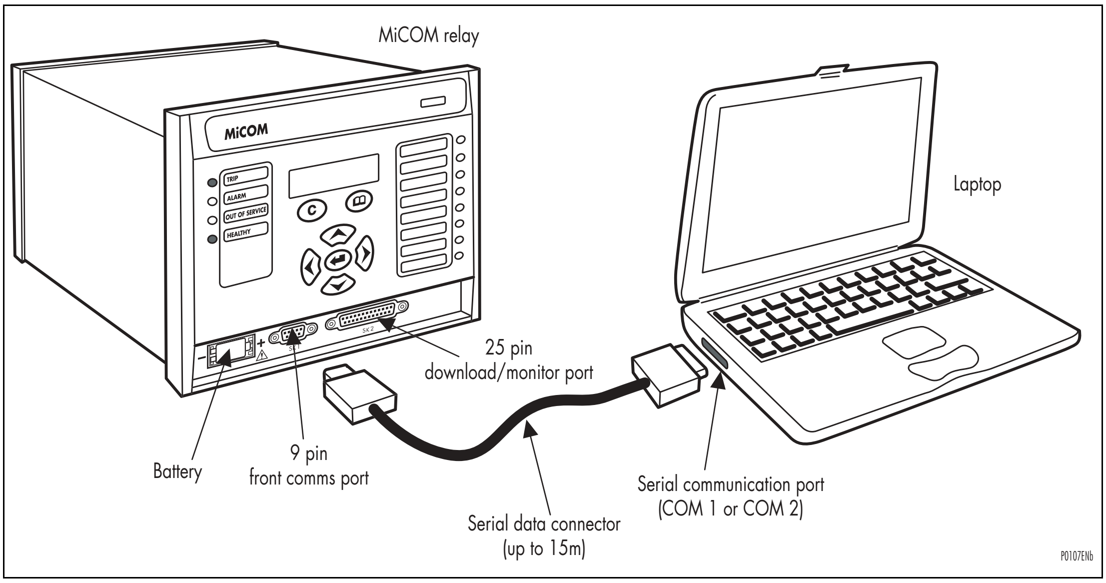


Figure 5: Front port connection

The relay is a Data Communication Equipment (DCE) device. Thus the pin connections of the relay's 9-pin front port are as follows:

Pin no. 2	Tx Transmit data
Pin no. 3	Rx Receive data
Pin no. 5	0V Zero volts common

None of the other pins are connected in the relay. The relay should be connected to the serial port of a PC, usually called COM1 or COM2. PCs are normally Data Terminal Equipment (DTE) devices which have a serial port pin connection as below (if in doubt check your PC manual):

	25 Way	9 Way	
Pin no.	3	2	Rx Receive data
Pin no.	2	3	Tx Transmit data
Pin no.	7	5	0V Zero volts common

For successful data communication, the Tx pin on the relay must be connected to the Rx pin on the PC, and the Rx pin on the relay must be connected to the Tx pin on the PC, as shown in Figure 6. Therefore, providing that the PC is a DTE with pin connections as given above, a 'straight through' serial connector is required, i.e. one that connects pin 2 to pin 2, pin 3 to pin 3, and pin 5 to pin 5. Note that a common cause of difficulty with serial data communication is connecting Tx to Tx and Rx to Rx. This could happen if a 'cross-over' serial connector is used, i.e. one that connects pin 2 to pin 3, and pin 3 to pin 2, or if the PC has the same pin configuration as the relay.

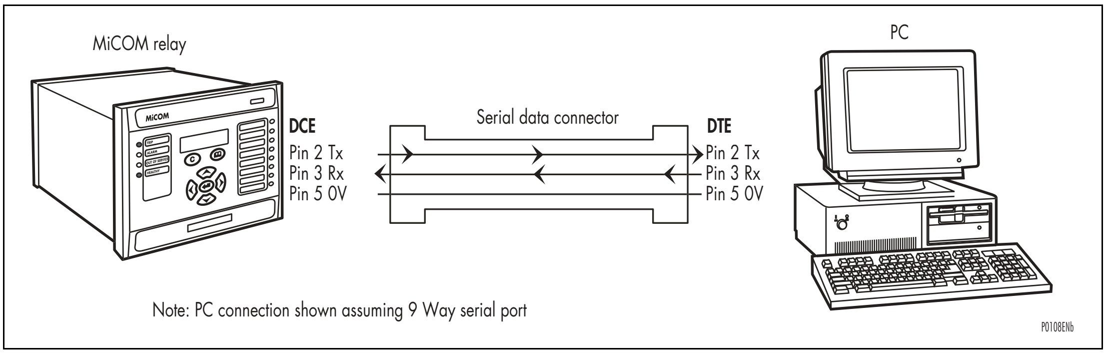


Figure 6: PC – relay signal connection

Having made the physical connection from the relay to the PC, the PC's communication settings must be configured to match those of the relay. The relay's communication settings for the front port are fixed as shown in the table below:

Protocol	Courier
Baud rate	19,200 bits/s
Courier address	1
Message format	11 bit - 1 start bit, 8 data bits, 1 parity bit (even parity), 1 stop bit

The inactivity timer for the front port is set at 15 minutes. This controls how long the relay will maintain its level of password access on the front port. If no messages are received on the front port for 15 minutes then any password access level that has been enabled will be revoked.

3.8 Rear communication port user interface

The rear port can support one of four communication protocols (Courier, MODBUS, DNP3.0, IEC 60870-5-103), the choice of which must be made when the relay is ordered. The rear communication port is provided by a 3-terminal screw connector located on the back of the relay. See section P94x/EN CO/D11 for details of the connection terminals. The rear port provides K-Bus/EIA(RS)485 serial data communication and is intended for use with a permanently-wired connection to a remote control centre. Of the three connections, two are for the signal connection, and the other is for the earth shield of the cable. When the K-Bus option is selected for the rear port, the two signal connections are not polarity conscious, however for MODBUS, IEC 60870-5-103 and DNP3.0 care must be taken to observe the correct polarity.

The protocol provided by the relay is indicated in the relay menu in the 'Communications' column. Using the keypad and LCD, firstly check that the 'Comms settings' cell in the 'Configuration' column is set to 'Visible', then move to the 'Communications' column. The first cell down the column shows the communication protocol being used by the rear port.

3.8.1 Courier communication

Courier is the communication language developed by AREVA T&D to allow remote interrogation of its range of protection relays. Courier works on a master/slave basis where the slave units contain information in the form of a database, and respond with information from the database when it is requested by a master unit.

The relay is a slave unit which is designed to be used with a Courier master unit such as MiCOM S1, MiCOM S10, PAS&T or a SCADA system. MiCOM S1 is a Windows NT4.0/98/2000 compatible software package which is specifically designed for setting changes with the relay.

To use the rear port to communicate with a PC-based master station using Courier, a KITZ K-Bus to EIA(RS)232 protocol converter is required. This unit is available from AREVA T&D. A typical connection arrangement is shown in Figure 7. For more detailed information on other possible connection arrangements refer to the manual for the Courier master station software and the manual for the KITZ protocol converter. Each spur of the K-Bus twisted pair wiring can be up to 1000m in length and have up to 32 relays connected to it.

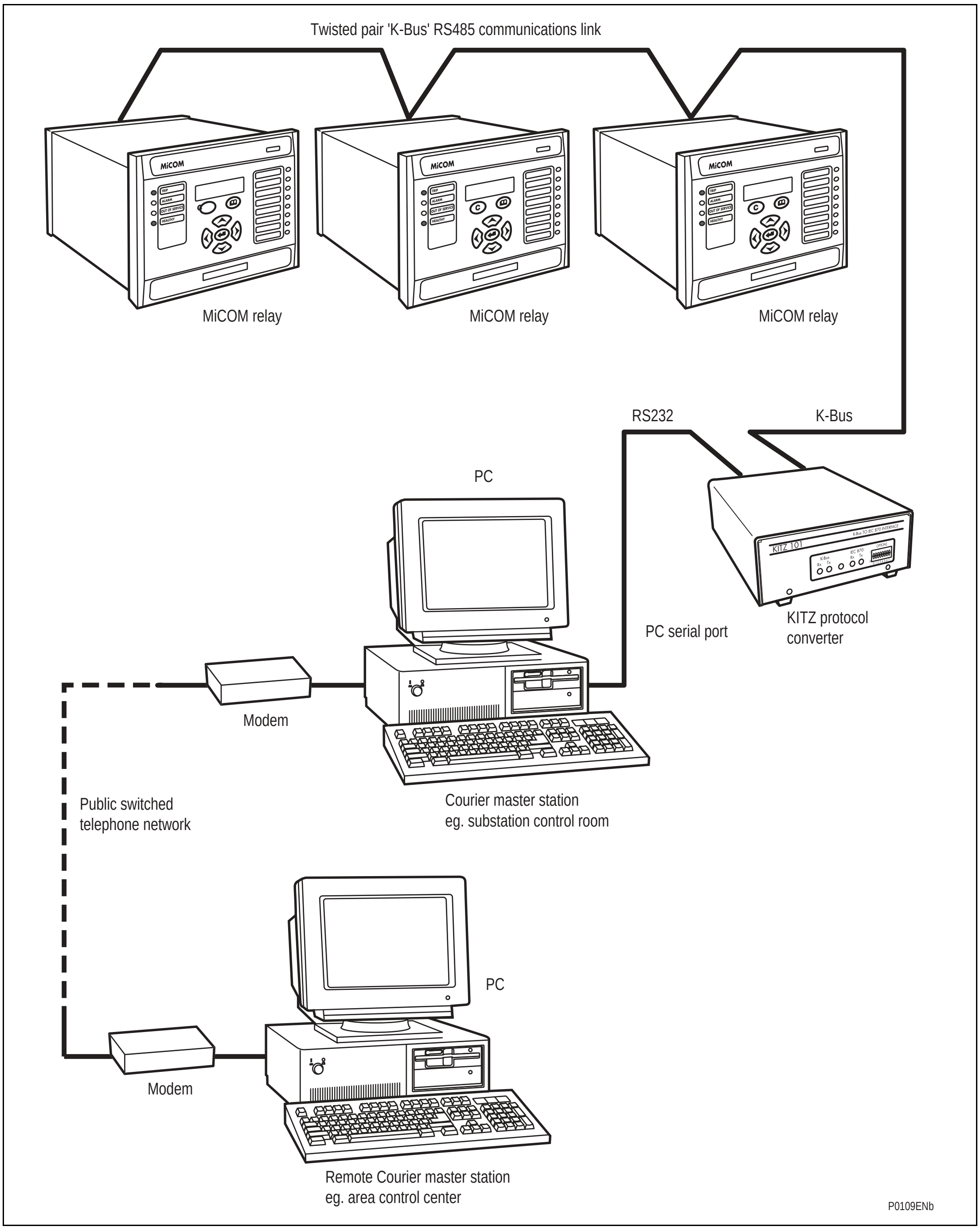


Figure 7: Remote communication connection arrangements

Having made the physical connection to the relay, the relay's communication settings must be configured. To do this use the keypad and LCD user interface. In the relay menu firstly check that the 'Comms settings' cell in the 'Configuration' column is set to 'Visible', then move to the 'Communications' column. Only two settings apply to the rear port using Courier, the relay's address and the inactivity timer. Synchronous communication is used at a fixed baud rate of 64kbits/s.

Move down the 'Communications' column from the column heading to the first cell down which indicates the communication protocol:

Note: *May vary according to relay type/model

Protocol Courier

The next cell down the column controls the address of the relay:

Remote address 1

Since up to 32 relays can be connected to one K-bus spur, as indicated in Figure 7, it is necessary for each relay to have a unique address so that messages from the master control station are accepted by one relay only. Courier uses an integer number between 0 and 254 for the relay address which is set with this cell. It is important that no two relays have the same Courier address. The Courier address is then used by the master station to communicate with the relay.

The next cell down controls the inactivity timer:

Inactivity timer 10.00 mins

The inactivity timer controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes.

Note that protection and disturbance recorder settings that are modified using an on-line editor such as PAS&T must be confirmed with a write to the 'Save changes' cell of the 'Configuration' column. Off-line editors such as MiCOM S1 do not require this action for the setting changes to take effect.

3.8.2 MODBUS communication

MODBUS is a master/slave communication protocol which can be used for network control. In a similar fashion to Courier, the system works by the master device initiating all actions and the slave devices, (the relays), responding to the master by supplying the requested data or by taking the requested action. MODBUS communication is achieved via a twisted pair connection to the rear port and can be used over a distance of 1000m with up to 32 slave devices.

To use the rear port with MODBUS communication, the relay's communication settings must be configured. To do this use the keypad and LCD user interface. In the relay menu firstly check that the 'Comms settings' cell in the 'Configuration' column is set to 'Visible', then move to the 'Communications' column. Four settings apply to the rear port using MODBUS which are described below. Move down the 'Communications' column from the column heading to the first cell down which indicates the communication protocol:

The next cell down controls the MODBUS address of the relay:

MODBUS address
23

Up to 32 relays can be connected to one MODBUS spur, and therefore it is necessary for each relay to have a unique address so that messages from the master control station are accepted by one relay only. MODBUS uses an integer number between 1 and 247 for the relay address. It is important that no two relays have the same MODBUS address. The MODBUS address is then used by the master station to communicate with the relay.

The next cell down controls the inactivity timer:

Inactivity timer
10.00 mins

The inactivity timer controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes.

The next cell down the column controls the baud rate to be used:

Baud rate
9600 bits/s

MODBUS communication is asynchronous. Three baud rates are supported by the relay, ‘9600 bits/s’, ‘19200 bits/s’ and ‘38400 bits/s’. It is important that whatever baud rate is selected on the relay is the same as that set on the MODBUS master station.

The next cell down controls the parity format used in the data frames:

Parity
None

The parity can be set to be one of ‘None’, ‘Odd’ or ‘Even’. It is important that whatever parity format is selected on the relay is the same as that set on the MODBUS master station.

Note: *May vary according to relay type/model

3.8.3 IEC 60870-5 CS 103 communication

The IEC specification IEC 60870-5-103: Telecontrol Equipment and Systems, Part 5: Transmission Protocols Section 103 defines the use of standards IEC 60870-5-1 to IEC 60870-5-5 to perform communication with protection equipment. The standard configuration for the IEC 60870-5-103 protocol is to use a twisted pair connection over distances up to 1000m. As an option for IEC 60870-5-103, the rear port can be specified to use a fibre optic connection for direct connection to a master station. The relay operates as a slave in the system, responding to commands from a master station. The method of communication uses standardised messages which are based on the VDEW communication protocol.

To use the rear port with IEC 60870-5-103 communication, the relay's communication settings must be configured. To do this use the keypad and LCD user interface. In the relay menu firstly check that the 'Comms settings' cell in the 'Configuration' column is set to 'Visible', then move to the 'Communications' column. Four settings apply to the rear port using IEC 60870-5-103 which are described below. Move down the 'Communications' column from the column heading to the first cell which indicates the communication protocol:

Protocol IEC 60870-5-103

The next cell down controls the IEC 60870-5-103 address of the relay:

Remote address 162

Up to 32 relays can be connected to one IEC 60870-5-103 spur, and therefore it is necessary for each relay to have a unique address so that messages from the master control station are accepted by one relay only. IEC 60870-5-103 uses an integer number between 0 and 254 for the relay address. It is important that no two relays have the same IEC 60870-5-103 address. The IEC 60870-5-103 address is then used by the master station to communicate with the relay.

The next cell down the column controls the baud rate to be used:

Baud rate 9600 bits/s

IEC 60870-5-103 communication is asynchronous. Two baud rates are supported by the relay, '9600 bits/s' and '19200 bits/s'. It is important that whatever baud rate is selected on the relay is the same as that set on the IEC 60870-5-103 master station.

The next cell down controls the period between IEC 60870-5-103 measurements:

Measure't period 30.00 s

The IEC 60870-5-103 protocol allows the relay to supply measurements at regular intervals. The interval between measurements is controlled by this cell, and can be set between 1 and 60 seconds.

The next cell down the column controls the physical media used for the communication:

Physical link EIA(RS)485

The default setting is to select the electrical EIA(RS)485 connection. If the optional fibre optic connectors are fitted to the relay, then this setting can be changed to 'Fibre optic'.

The next cell down can be used to define the primary function type for this interface, where this is not explicitly defined for the application by the IEC 60870-5-103 protocol*.

Function type 226

3.8.4 DNP 3.0 communication

The DNP 3.0 protocol is defined and administered by the DNP User Group. Information about the user group, DNP 3.0 in general and protocol specifications can be found on their website: www.dnp.org

The relay operates as a DNP 3.0 slave and supports subset level 2 of the protocol plus some of the features from level 3. DNP 3.0 communication is achieved via a twisted pair connection to the rear port and can be used over a distance of 1000m with up to 32 slave devices.

To use the rear port with DNP 3.0 communication, the relay's communication settings must be configured. To do this use the keypad and LCD user interface. In the relay menu firstly check that the 'Comms setting' cell in the 'Configuration' column is set to 'Visible', then move to the 'Communications' column. Four settings apply to the rear port using DNP 3.0, which are described below. Move down the 'Communications' column from the column heading to the first cell which indicates the communications protocol:

Protocol DNP 3.0

The next cell controls the DNP 3.0 address of the relay:

DNP 3.0 address 232

Upto 32 relays can be connected to one DNP 3.0 spur, and therefore it is necessary for each relay to have a unique address so that messages from the master control station are accepted by only one relay. DNP 3.0 uses a decimal number between 1 and 65519 for the relay address. It is important that no two relays have the same DNP 3.0 address. The DNP 3.0 address is then used by the master station to communicate with the relay.

Note: *May vary according to relay type/model

The next cell down the column controls the baud rate to be used:

Baud rate 9600 bits/s

DNP 3.0 communication is asynchronous. Six baud rates are supported by the relay ‘1200bits/s’, ‘2400bits/s’, ‘4800bits/s’, ’9600bits/s’, ‘19200bits/s’ and ‘38400bits/s’. It is important that whatever baud rate is selected on the relay is the same as that set on the DNP 3.0 master station.

The next cell down the column controls the parity format used in the data frames:

Parity None

The parity can be set to be one of ‘None’, ‘Odd’ or ‘Even’. It is important that whatever parity format is selected on the relay is the same as that set on the DNP 3.0 master station.

The next cell down the column sets the time synchronisation request from the master by the relay:

Time Synch Enabled

The time synch can be set to either enabled or disabled. If enabled it allows the DNP 3.0 master to synchronise the time.

APPLICATION NOTES

CONTENT

1. INTRODUCTION

1.1 Frequency protection

Generation and utilisation need to be well balanced in any industrial, distribution or transmission network. As load increases, the generation needs to be stepped up to maintain frequency of the supply because there are many frequency sensitive electrical apparatus that can be damaged when network frequency departs from the allowed band for safe operation. At times, when sudden overloads occur, the frequency drops at a rate decided by the system inertia constant, magnitude of overload, system damping constant and various other parameters. Unless corrective measures are taken at the appropriate time, frequency decay can go beyond the point of no return and cause widespread network collapse. In a wider scenario, this can result in “Blackouts”. To put the network back in healthy condition, considerable amount of time and effort is required to re-synchronise and re-energise.

Protective relays that can detect a low frequency condition are generally used in such cases to disconnect unimportant loads in order to save the network, by re-establishing the “generation-load equation”. However, with such devices, the action is initiated only after the event and while some salvaging of the situation can be achieved, this form of corrective action may not be effective enough and cannot cope with sudden load increases, causing large frequency decays in very short times. In such cases a device that can anticipate the severity of frequency decay and act to disconnect loads before the frequency actually reaches dangerously low levels, can become very effective in containing damage.

During severe disturbances, the frequency of the system oscillates as various generators try to synchronise on to a common frequency. The measurement of instantaneous rate of change of frequency can be misleading during such a disturbance. The frequency decay needs to be monitored over a longer period of time to make the correct decision for load shedding.

Normally, generators are rated for a lifetime operation in a particular band of frequency and operation outside this band can cause mechanical damage to the turbine blades. Protection against such contingencies is required when frequency does not improve even after load shedding steps have been taken and can be used for operator alarms or turbine trips in case of severe frequency decay.

Whilst load shedding leads to an improvement in the system frequency, the disconnected loads need to be reconnected after the system is stable again. Loads should only be restored if the frequency remains stable for some period of time, but minor frequency excursions can be ignored during this time period. The number of load restoration steps are normally less than the load shedding steps to reduce repeated disturbances while restoring load.

1.2 MiCOM frequency relay

MiCOM relays are a new range of products from AREVA T&D. Using the latest numerical technology the range includes devices designed for application to a wide range of power system equipment such as motors, generators, feeders, overhead lines and cables.

Each relay is designed around a common hardware and software platform in order to achieve a high degree of commonality between products. One such product in the range is the P940 frequency relay. The relay has been designed to provide protection against network disruption that causes the frequency to deviate from nominal system limits, as well as providing protection for generators running outside of normal frequency limits. The relay also offers automatic load restoration facilities once the system frequency has recovered after load shedding.

A comprehensive range of non-protection features are included to aid with power system diagnosis and fault analysis which can be accessed remotely from one of the relays serial communication options.

1.2.1 Protection features

The P940 frequency relays contain a wide variety of protection features designed to provide protection against network disruption. All three models have the same protection, control and monitoring features, with only the configuration of digital inputs and outputs providing any differentiation. The protection features available are summarised below.

- Frequency based protection - six (6) independent stages, each stage containing four elements.

  f+t – frequency

  f+df/dt – frequency supervised rate of change of frequency

  df/dt +t – rate of change of frequency

  f+Df/Dt – frequency supervised average rate of change of frequency

Each element can be independently configured in all respects for use as an over frequency element or an under frequency element.

- Undervoltage protection - Two stage, configurable as either phase to phase or phase to neutral measuring. Stage 1 may be selected as either IDMT or DT and stage 2 is DT only.
- Overvoltage protection - Two stage, configurable as either phase to phase or phase to neutral measuring. Stage 1 may be selected as either IDMT or DT and stage 2 is DT only.
- Generator abnormal protection - four (4) independent bands for the protection of generators against prolonged abnormal frequency operation. Each band can be set for independent frequency and time settings.

1.2.2 Control features

- Load restoration - Load restoration stages (maximum six) for automatic load restoration. Each stage has independent time settings for restoration and holding band timers.

1.2.3 Other non-protection features

A summary of the P940 non-protection features is given below:

- Measurements - various measurement values are available for display on the relay or may be accessed via serial communication.
- Fault/Event/Disturbance records - available from serial communications or on the relay display (fault and event records only).
- Real time clock/Time synchronisation - time synchronisation possible from relay IRIG - B input.
- Four setting groups - independent setting groups to cater for alternative power system arrangements or customer specific applications.
- Remote serial communications - to allow remote access to the relays. The following communication protocols are supported; Courier, MODBUS, IEC870 –5-103 (VDEW) and DNP3.0.

- Continuous self monitoring - power on diagnostics and self checking routines to provide maximum relay reliability.
- Commissioning test facilities

2. APPLICATION OF INDIVIDUAL PROTECTION FUNCTIONS

The following sections detail the individual protection functions in addition to where and how they may be applied. Each section also gives an extract from the respective menu columns to demonstrate how the settings are applied to the relay.

2.1 Configuration column

The P940 relay includes a column in the menu called the "CONFIGURATION" column that affects the operation of the individual protection functions. The aim of this column is to allow general configuration of the relay from a single point in the menu. Any of the functions that are disabled or made invisible from this column do not appear within the main relay menu.

The following table shows the relay menu for the configuration column, with default settings. A brief description of the function of each setting is also provided.

Menu Text	Default Setting	Available Settings	Function
CONFIGURATION			
Restore defaults	No operation	No operation All settings Setting group 1 Setting group 2 Setting group 3 Setting group 4	Restore default settings to any or all groups of settings
Setting group	Select via menu	Select via menu Select via optos	Change setting group by?
Active settings	Group 1	Group 1 Group 2 Group 3 Group 4	Select active setting group used for protection settings
Save changes	No operation	No operation Save Abort	Saves all setting changes from buffer memory into stored settings
Copy from	Group 1	Group 1, 2, 3 or 4	Selects a group of settings to copy to the group designated in "Copy to" cell
Copy to	No Operation	No operation Group 1, 2, 3 or 4	Copies the group of settings selected in the "Copy from" cell to the selected setting group
Setting group 1	Enabled	Enabled or disabled	Selects if Group 1 settings are available on the relay

Menu Text	Default Setting	Available Settings	Function
Setting group 2	Disabled	Enabled or disabled	Selects if Group 2 settings are available on the relay
Setting group 3	Disabled	Enabled or disabled	Selects if Group 3 settings are available on the relay
Setting group 4	Disabled	Enabled or disabled	Selects if Group 4 settings are available on the relay
Load restoration	Disabled	Enabled or disabled	Enables protection element in the relay
Genr abn prom	Disabled	Enabled or disabled	“
Volt protection	Enabled	Enabled or disabled	“
Input labels	Visible	Visible or invisible	Makes settings visible in the relay menu
Output labels	Visible	Visible or invisible	“
CT & VT ratios	Visible	Visible or invisible	“
Event recorder	Visible	Visible or invisible	“
Disturb recorder	Visible	Visible or invisible	“
Measure’t setup	Visible	Visible or invisible	“
Comms settings	Visible	Visible or invisible	“
Commission test	Visible	Visible or invisible	“
Setting values	Primary	Primary or secondary	Selects if relay protection settings are displayed in primary or secondary values

2.2 CT & VT ratios

The P940 relays allow the voltage setting to be applied to the relay in either primary or secondary quantities. This is done by programming the “Setting Values” cell of the “CONFIGURATION” column to either ‘Primary’ or ‘Secondary’. When this cell is set to ‘Primary’, all voltage setting values are scaled by the programmed VT ratios. These are found in the “CT AND VT Ratios” column, settings for which are shown below:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
CT AND VT RATIOS				
Main VT Primary	110V (Vn = 100/120V) 440 (Vn = 380/480V)	100V	1000000V	1V
Main VT Sec’y	110V (Vn = 100/120V) 440 (Vn = 380/480V)	80V (Vn = 100/120V) 320V (Vn = 380/480V)	140V (Vn = 100/120V) 560V (Vn = 380/480V)	1V (Vn = 100/120V) 4V (Vn = 380/480V)

2.3 Common settings

The frequency based protection features on the P940 are controlled by a number of general features which can be found in the “Common Settings” relay menu column and are shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
COMMON SETTINGS				
V<B Status	Enabled	Disabled, Enabled		
V<B Voltage Set	25V (Vn = 100/120V) 100V (Vn = 380/480V)	20V (Vn = 100/120V) 80V (Vn = 380/480V)	120V (Vn = 100/120V) 480V (Vn = 380/480V)	1V (Vn = 100/120V) 4V (Vn = 380/480V)
Pick Up Cycles	5	1	12	1
Drop Off Cycles	3	1	3	1
Holding Timer	5.0s	1.0s	300.0s	1.0s

Within the P940 relay, the frequency is tracked between 40Hz and 70Hz based upon the voltage signals presented to the relay. If the system frequency exceeds these limits, all frequency protection elements (except the under/overfrequency “f+t” element) are prevented from operating. Signals are available within the Programmable Scheme Logic (PSL) to indicate that the system frequency is outside these limits and preventing relay operation (Frequency less than 40Hz is indicated by DDB 296 whereas frequency above 70Hz is indicated by DDB 295).

Similarly, an undervoltage blocking facility with user selectable settings is provided to block the frequency protection elements if severe undervoltage conditions are experienced.

The undervoltage blocking facility on the relay is enabled or disabled in the “V<B Status” cell of the menu. When the element is enabled and any phase-phase voltage falls below the “V<B Voltage Set” setting, all the frequency based protection elements (including the under/overfrequency “f+t” element) are prevented from operating. The frequency elements will only be permitted to start operation again when all the phase-phase voltages are more than 5% above the “V<B Voltage Set” setting. A signal is available within the Programmable Scheme Logic (PSL) to indicate that undervoltage blocking is active and preventing relay operation (DDB 301).

As well as providing undervoltage blocking facilities, the “Common Settings” menu also provides the ability to de-sensitise the independent rate of change of frequency (df/dt+t) and the frequency supervised rate of change of frequency (f+df/dt) elements against oscillations in the power system frequency. The “Pick Up Cycles” cell selects the number of consecutive cycles for which the rate of change element must exceed its set threshold before a valid fault condition is recognised. The “Drop Off Cycles” cell selects the number of consecutive cycles for which the rate of change element must be below its set threshold before the element can reset.

Note: The “Pick Up Cycles” and “Drop Off Cycles” settings are common for all stages of independent rate of change of frequency (df/dt+t) and frequency supervised rate of change of frequency (f+df/dt) elements.

The final setting in the “Common Settings” menu column, is the “Holding Timer” cell which is used for the load restoration element. The setting defines the holding band reset criteria and is common to all stages of load restoration. See section 2.11 for a detailed explanation of the Load Restoration facilities and the use of this timer setting.

2.4 Underfrequency “f+t” protection [81U]

Frequency variations on a power system are an indication that the power balance between generation and load has been lost. In particular, under-frequency implies that the net load is in excess of the available generation. Such a condition can arise, when an interconnected system splits, and the load left connected to one of the subsystems is in excess of the capacity of the generators in that particular subsystem. Industrial plants which are dependent on utilities to supply part of their loads will experience under-frequency conditions when the incoming lines are lost.

An underfrequency condition at nominal voltage can result in over-fluxing of generators and transformers and many types of industrial loads have limited tolerances on the operating frequency and running speeds e.g. synchronous motors. Sustained underfrequency has implications on the stability of the system, whereby any subsequent disturbance may lead to damage to frequency sensitive equipment and even blackouts, if the underfrequency condition is not corrected sufficiently fast.

The P940 provides six independent definite time delayed stages of frequency protection (f+t). Depending upon whether the threshold is set above or below the system nominal frequency, each stage can respond to either under or over frequency conditions. The relay will also indicate that an incorrect setting has been applied if the frequency threshold is set to the nominal system frequency. Although the elements are described as definite time delayed, by setting the time delay to zero, the element will operate instantaneously.

Within the Programmable Scheme Logic (PSL), signals are available to indicate the start and trip of each frequency stage (Starts: DDB 132, DDB 141, DDB 150, DDB 159, DDB 168, DDB 177; Trips: DDB 133, DDB 142, DDB 151, DDB 160, DDB 169, DDB 178). Signals are also available to indicate when any of the six stages have started or tripped (Any f+t Start = DDB242; Any f+t Trip = DDB 245). The state of the DDB signals can be programmed to be viewed in the “Monitor Bit x” cells of the “COMMISSION TESTS” column in the relay.

Both the under and overfrequency protection functions are found in the “f+t Settings” relay menu column and are shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
f+t SETTINGS				
Stage1 f+t	Enabled	Disabled, Enabled		
1(f+t) f	49.00Hz	40.00Hz	70.00Hz	0.01Hz
1(f+t) t	20.00s	0.00s	100.00s	0.01s
Stage2 f+t	Enabled	Disabled, Enabled		
2(f+t) f	48.60Hz	40.00Hz	70.00Hz	0.01Hz
2(f+t) t	20.00s	0.00s	100.00s	0.01s
Stage3 f+t	Enabled	Disabled, Enabled		
3(f+t) f	48.20Hz	40.00Hz	70.00Hz	0.01Hz
3(f+t) t	10.00s	0.00s	100.00s	0.01s
Stage4 f+t	Enabled	Disabled, Enabled		
4(f+t) f	47.80Hz	40.00Hz	70.00Hz	0.01Hz
4(f+t) t	10.00s	0.00s	100.00s	0.01s
Stage5 f+t	Enabled	Disabled, Enabled		
5(f+t) f	50.50Hz	40.00Hz	70.00Hz	0.01Hz
5(f+t) t	30.00s	0.00s	100.00s	0.01s
Stage6 f+t	Enabled	Disabled, Enabled		
6(f+t) f	51.00Hz	40.00Hz	70.00Hz	0.01Hz
6(f+t) t	20.00s	0.00s	100.00s	0.01s

Note: The default settings of the “f+t” protection provide 4 underfrequency and 2 overfrequency stages assuming a 50Hz nominal frequency.

2.4.1 Setting guidelines

In order to minimise the effects of underfrequency on a system, a multi stage load shedding scheme may be used with the plant loads prioritised and grouped. During an underfrequency condition, the load groups are disconnected sequentially depending on the level of underfrequency, with the highest priority group being the last one to be disconnected.

The effectiveness of each stage of load shedding depends on what proportion of the power deficiency it represents. If the load shedding stage is too small compared to the prevailing generation deficiency, then the improvement in frequency may be non-existent. This aspect should be taken into account when forming the load groups.

Time delays should be sufficient to override any transient dips in frequency, as well as to provide time for the frequency controls in the system to respond. This should be balanced against the system survival requirement since excessive time delays may cause the system stability to be in jeopardy. Time delay settings of 5 – 20s are typical.

An example of a four-stage load shedding scheme for 50Hz systems is shown below:

Stage	Element	Frequency Setting (Hz)	Time Setting (Sec)
1	1(f+t)	49.0	20s
2	2(f+t)	48.6	20s
3	3(f+t)	48.2	10s
4	4(f+t)	47.8	10s

The relatively long time delays are intended to provide time for the system controls to respond and will work well in a situation where the decline of system frequency is slow. For situations where rapid decline of frequency is expected, the load shedding scheme above should be supplemented by rate of change of frequency protection elements.

It may be noted that the protection package for generators at site may include underfrequency relays. The settings made on the P940 should be co-ordinated with the generator protection frequency relays.

2.5 Overfrequency “f+t” protection [81O]

Over frequency running of a generator arises when the mechanical power input to the machine exceeds the electrical output. This could happen, for instance, when there is a sudden loss of load due to tripping of an outgoing feeder from the plant to a load centre. Under such over speed conditions, the governor should respond quickly so as to obtain a balance between the mechanical input and electrical output, thereby restoring normal frequency. Over frequency protection is required as a back-up to cater for slow response of frequency control equipment.

The P940 provides six independent definite time delayed stages of frequency protection (f+t). Depending upon whether the threshold is set above or below the system nominal frequency, each stage can respond to either under or over frequency conditions. The relay will also indicate that an incorrect setting has been applied if the frequency threshold is set to the nominal system frequency. Although the elements are described as definite time delayed, by setting the time delay to zero, the element will operate instantaneously.

Within the Programmable Scheme Logic (PSL), signals are available to indicate the start and trip of each frequency stage (Starts: DDB 132, DDB 141, DDB 150, DDB 159, DDB 168, DDB 177; Trips: DDB 133, DDB 142, DDB 151, DDB 160, DDB 169, DDB 178). Signals are also available to indicate when any of the six stages have started or tripped (Any f+t Start = DDB 242; Any f+t Trip = DDB 245). The state of the DDB signals can be programmed to be viewed in the “Monitor Bit x” cells of the “COMMISSION TESTS” column in the relay.

Both the under and overfrequency protection functions are found in the “f+t Settings” relay menu column and are shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
f+t SETTINGS				
Stage1 f+t	Enabled	Disabled, Enabled		
1(f+t) f	49.00Hz	40.00Hz	70.00Hz	0.01Hz
1(f+t) t	20.00s	0.00s	100.00s	0.01s
Stage2 f+t	Enabled	Disabled, Enabled		
2(f+t) f	48.60Hz	40.00Hz	70.00Hz	0.01Hz
2(f+t) t	20.00s	0.00s	100.00s	0.01s
Stage3 f+t	Enabled	Disabled, Enabled		
3(f+t) f	48.20Hz	40.00Hz	70.00Hz	0.01Hz
3(f+t) t	10.00s	0.00s	100.00s	0.01s
Stage4 f+t	Enabled	Disabled, Enabled		
4(f+t) f	47.80Hz	40.00Hz	70.00Hz	0.01Hz
4(f+t) t	10.00s	0.00s	100.00s	0.01s
Stage5 f+t	Enabled	Disabled, Enabled		
5(f+t) f	50.50Hz	40.00Hz	70.00Hz	0.01Hz
5(f+t) t	30.00s	0.00s	100.00s	0.01s
Stage6 f+t	Enabled	Disabled, Enabled		
6(f+t) f	51.00Hz	40.00Hz	70.00Hz	0.01Hz
6(f+t) t	20.00s	0.00s	100.00s	0.01s

Note: The default settings of the “f+t” protection provide 4 underfrequency and 2 overfrequency stages assuming a 50Hz nominal frequency.

2.5.1 Setting guidelines

Following faults on the network, or other operational requirements, it is possible that various subsystems will be formed within the power network and it is likely that each of these subsystems will suffer from a generation to load imbalance. The “islands” where generation exceeds the existing load will be subject to over frequency conditions, the level of frequency being a function of the percentage of excess generation. Severe over frequency conditions may be unacceptable to many industrial loads, since running speeds of motors will be affected. The ”f+t” element of the MiCOM P940 can be suitably set to sense this contingency.

An example of two-stage over frequency protection is shown below using stages 5 and 6 of the “f+t” element. However, it should be considered that settings for a real system will depend upon the maximum frequency that equipment can tolerate for a given period of time.

Stage	Element	Frequency Setting (Hz)	Time Setting (Sec)
1	< f + t >5(f+t)	50.5	30
2	< f+t >6(f+t)	51.0	20

The relatively long time delays are intended to provide time for the system controls to respond and will work well in a situation where the increase of system frequency is slow. For situations where rapid increase of frequency is expected, the protection scheme above could be supplemented by rate of change of frequency protection elements, possibly utilised to split the system further. For example, in the system shown below the generation in the MV bus is sized according to the loads on that bus, whereas the generators linked to the HV bus produce energy for export to utility. If the links to the grid are lost, the IPP generation will cause the system frequency to rise. This rate of rise can be used to isolate the MV bus from the HV system, if operationally acceptable.

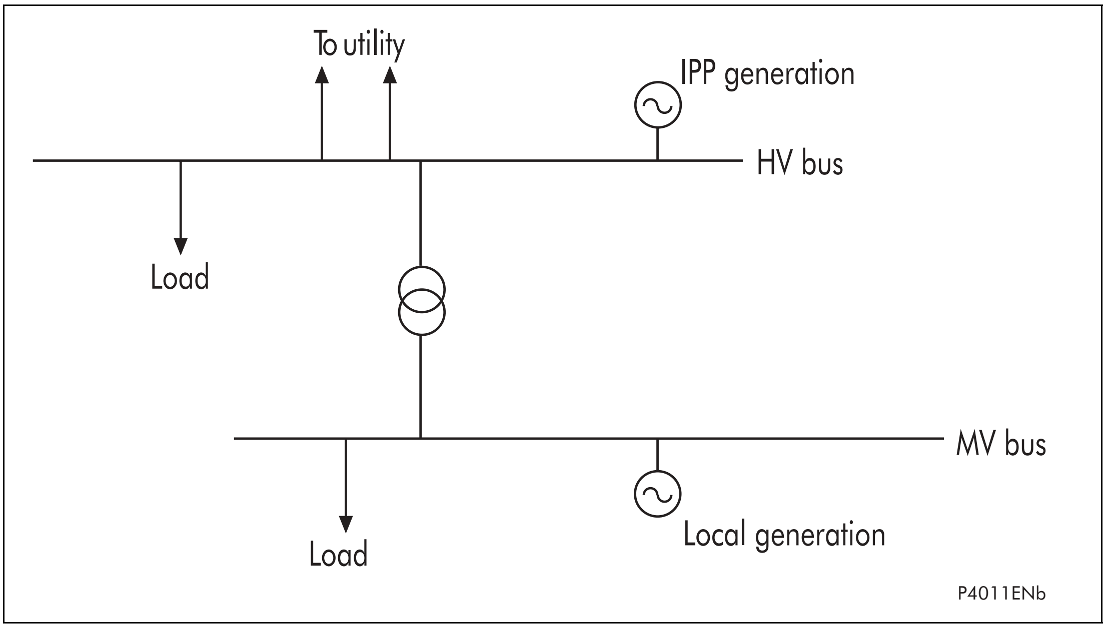


Figure 1: Power system segregation based upon frequency measurements

The following tables give possible settings that could be used to speed up the process of segregating the system as outlined above, in conjunction with the overfrequency element:

Stage	Frequency “f+t” Elements		Frequency Supervised Rate of Change of Frequency “f+df/dt” Elements	
	Frequency Setting (Hz)	Time Setting (Sec)	Frequency Setting (Hz)	Rate of Change of Frequency Setting (Hz/Sec)
1	50.5	30	50.5	1.0
2	51	20	51	1.0

Table 1: Typical settings for over frequency with frequency supervised rate of change of frequency

Stage	Frequency "f+t" Elements		Average Rate of Change of Frequency "f+Df/Dt" Elements		
	Frequency Setting (Hz)	Time Setting (Sec)	Frequency Setting (Hz)	Frequency Difference Setting, Df (Hz)	Time Period, Dt (Sec)
1	50.5	30	50.5	0.5	0.5
2	51	20	51	0.5	0.5

Table 2: Overfrequency protection with average rate of change of frequency

Stage	Frequency "f+t" Elements		Rate of Change of Frequency "df/dt+t" Elements	
	Frequency Setting (Hz)	Time Setting (Sec)	Rate of Change of Frequency Setting (Hz/sec)	Time Setting (Sec)
1	50.5	30	3.0	0.5
2	51	20	2.0	0.5

Table 3: Overfrequency protection with independent rate of change of frequency

It may be noted that the protection package for generators at site may include overfrequency relays. The settings made on the P940 should be co-ordinated with the generator protection frequency relays.

2.6 Frequency supervised rate of change of frequency "f+df/dt" protection [81RF]

Conditions may arise in an electrical network where the load to generation imbalance is considerable and this may result in relatively rapid changes of the system frequency. In such a case, maintaining the system stability is an onerous task, and calls for quick corrective action.

High speed load shedding cannot be achieved by monitoring the system frequency alone and the rate of change of system frequency becomes an equally critical parameter to use.

In the load shedding scheme below, it is assumed under falling frequency conditions that by shedding a stage of load, the system can be stabilised at frequency f_2. For slow rates of decay, this can be achieved using the underfrequency protection element set at frequency f_1 with a suitable time delay. However, if the generation deficit is substantial, the frequency will rapidly decrease and it is possible that the time delay imposed by the underfrequency protection will not allow for frequency stabilisation. In this case, the chance of system recovery will be enhanced by disconnecting the load stage based upon a measurement of rate of change of frequency and bypassing the time delay.

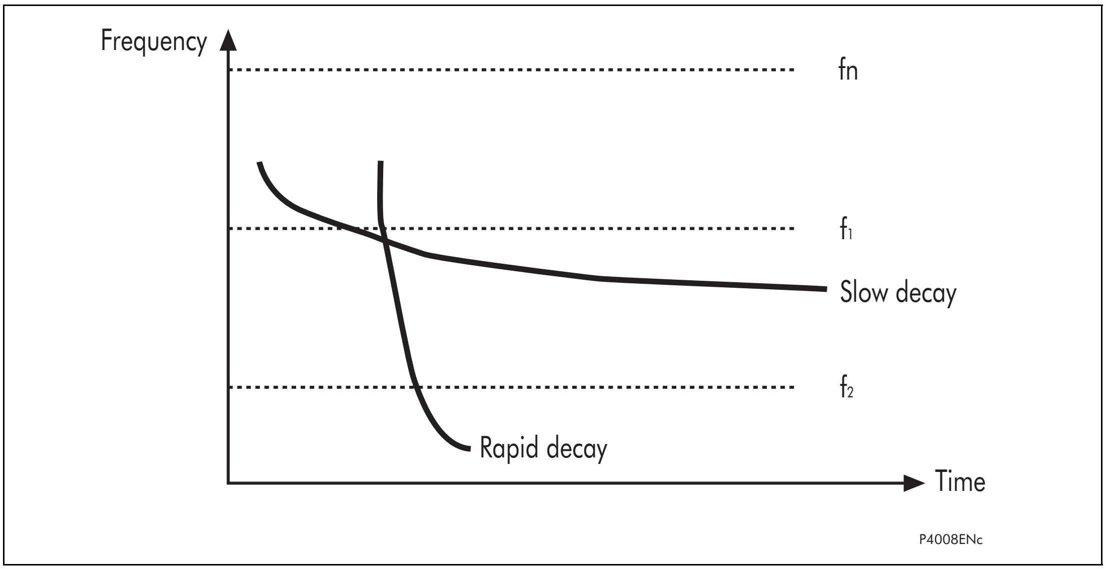


Figure 2: Frequency supervised rate of change of frequency protection

With the frequency supervised rate of change of frequency element, the basic rate of change of frequency measurement is supervised by an additional frequency measurement. As such, the rate of change of frequency AND the frequency must exceed the set thresholds before an output can be given.

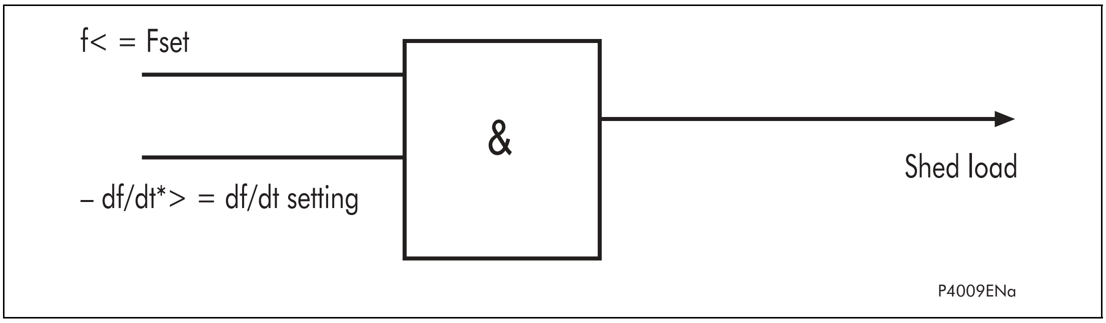


Figure 3: Frequency supervised rate of change of frequency protection logic

The P940 provides six independent stages of frequency supervised rate of change of frequency protection (f+df/dt). Depending upon whether the frequency threshold is set above or below the system nominal frequency, each stage can respond to either rising or falling frequency conditions. For example, if the frequency threshold is set above nominal frequency, the df/dt setting is considered as positive and the element will operate for rising frequency conditions. If the frequency threshold is set below nominal frequency, the df/dt setting is considered as negative and the element will operate for falling frequency conditions. The relay will also indicate that an incorrect setting has been applied if the frequency threshold is set to the nominal system frequency. There is no intentional time delay associated with this element although using the Programmable Scheme Logic (PSL), time delays could be applied if required.

Within the PSL, signals are available to indicate the trip of each frequency supervised rate of change of frequency stage (DDB 134, DDB 143, DDB 152, DDB 161, DDB 170, DDB 179). Signals are also available to indicate when any of the six stages have tripped (Any f+df/dt Trip = DDB 246). The state of the DDB signals can be programmed to be viewed in the “Monitor Bit x” cells of the “COMMISSION TESTS” column in the relay.

The frequency supervised rate of change of frequency protection function is found in the “f+df/dt Settings” relay menu column and are shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
f+df/dt SETTINGS				
Stage1 f+df/dt	Enabled	Disabled, Enabled		
1(f+df/dt) f	49.00Hz	40.00Hz	70.00Hz	0.01Hz
1(f+df/dt) df/dt	1.00Hz/s	0.1Hz/s	10.0Hz/s	0.1Hz/s
Stage2 f+df/dt	Enabled	Disabled, Enabled		
2(f+df/dt) f	48.60Hz	40.00Hz	70.00Hz	0.01Hz
2(f+df/dt) df/dt	1.00Hz/s	0.1Hz/s	10.0Hz/s	0.1Hz/s
Stage3 f+df/dt	Enabled	Disabled, Enabled		
3(f+df/dt) f	48.20Hz	40.00Hz	70.00Hz	0.01Hz
3(f+df/dt) df/dt	1.00Hz/s	0.1Hz/s	10.0Hz/s	0.1Hz/s
Stage4 f+df/dt	Enabled	Disabled, Enabled		
4(f+df/dt) f	47.80Hz	40.00Hz	70.00Hz	0.01Hz
4(f+df/dt) df/dt	1.00Hz/s	0.1Hz/s	10.0Hz/s	0.1Hz/s
Stage5 f+df/dt	Enabled	Disabled, Enabled		
5(f+df/dt) f	50.50Hz	40.00Hz	70.00Hz	0.01Hz
5(f+df/dt) df/dt	1.00Hz/s	0.1Hz/s	10.0Hz/s	0.1Hz/s
Stage6 f+df/dt	Enabled	Disabled, Enabled		
6(f+df/dt) f	51.00Hz	40.00Hz	70.00Hz	0.01Hz
6(f+df/dt) df/dt	1.00Hz/s	0.1Hz/s	10.0Hz/s	0.1Hz/s

Note: The default settings of the “f+df/dt” protection provide 4 stages of falling frequency protection and 2 stages of rising frequency protection assuming a 50Hz nominal frequency.

2.6.1 Setting guidelines

It is recommended that the frequency supervised rate of change of frequency protection (f+df/dt) element be used in conjunction with the time delayed frequency protection (f+t) elements.

A four stage high speed load shedding scheme may be configured as indicated below, noting that in each stage, both the ”f+t” and the “f+df/dt” elements are enabled.

Stage	Frequency "f+t" Elements		Frequency Supervised Rate of Change of Frequency "f+df/dt" Elements	
	Frequency Setting (Hz)	Time Setting (Sec)	Frequency Setting (Hz)	Rate of Change of Frequency Setting (Hz/sec)
1	49	20	49	1.0
2	48.6	20	48.6	1.0
3	48.2	10	48.2	1.0
4	47.8	10	47.8	1.0

It may be possible to further improve the speed of load shedding in critical cases by changing the frequency setting on the frequency supervised rate of change of frequency element. In the settings outlined below, the frequency settings for the "f+df/dt" element have been set slightly higher than the frequency settings for the "f+t" element. This difference will allow for the measuring time of the relay, assuming the set rate of frequency change, and will result in the tripping of the two elements at approximately the same frequency value. Thus, with this scheme, the slow frequency decline and fast frequency decline scenarios are independently monitored and optimised without sacrificing system security.

Stage	Frequency "f+t" Elements		Frequency Supervised Rate of Change of Frequency "f+df/dt" Elements	
	Frequency Setting (Hz)	Time Setting (Sec)	Frequency Setting (Hz)	Rate of Change of Frequency Setting (Hz/sec)
1	49	20	49.2	1.0
2	48.6	20	48.8	1.0
3	48.2	10	48.4	1.0
4	47.8	10	48.0	1.0

2.7 Independent rate of change of frequency "df/dt+t" protection [81R]

This element is a plain rate of change of frequency monitoring element, and is not supervised by a frequency setting as per the "f+df/dt" element. However, a timer is included to provide a time delayed operation. The element can be utilised to provide extra flexibility to a load shedding scheme in dealing with severe load to generation imbalances.

As mentioned in other sections, conditions involving very large load – generation imbalances may occur, accompanied by rapid decline in system frequency. Shedding of one or two stages of load is unlikely to stop the decline in frequency, if the discrepancy is still large. In such a situation, it is advantageous to have an element which identifies the high rate of decline of frequency, and adapts the load shedding scheme accordingly.

Since the rate of change monitoring is independent of frequency, the element can identify frequency variations occurring close to nominal frequency and thus provide early warning to the operator on a developing frequency problem. Additionally, the element could also be used as an alarm to warn operators of unusually high system frequency variations.

The P940 provides six independent stages of rate of change of frequency protection (df/dt+t). Depending upon whether the rate of change of frequency setting is set positive or negative, the element will react to rising or falling frequency conditions respectively, with an incorrect setting being indicated if the threshold is set to zero. The output of the element would normally be given a user-selectable time delay, although it is possible to set this to zero and create an instantaneous element.

Within the Programmable Scheme Logic (PSL), signals are available to indicate the start and trip of each rate of change of frequency stage. (Starts: DDB 135, DDB 144, DDB 153, DDB 162, DDB 171, DDB 180; Trips: DDB 136, DDB 145, DDB 154, DDB 163, DDB 172, DDB 181). Signals are also available to indicate when any of the six stages have started or tripped (Any df/dt+t Start = DDB 243; Any df/dt+t Trip = DDB 247). The state of the DDB signals can be programmed to be viewed in the “Monitor Bit x” cells of the “COMMISSION TESTS” column in the relay.

The rate of change of frequency protection function is found in the “df/dt+t Settings” relay menu column and are shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
df/dt+t SETTINGS				
Stage1 df/dt+t	Enabled	Disabled, Enabled		
1(df/dt+t) df/dt	-2.000Hz/s	-10.00Hz/s	+10.00Hz/s	0.1Hz/s
1(df/dt+t) t	0.50s	0.00s	100.00s	0.01s
Stage2 df/dt+t	Enabled	Disabled, Enabled		
2(df/dt+t) df/dt	-2.000Hz/s	-10.00Hz/s	+10.00Hz/s	0.1Hz/s
2(df/dt+t) t	1.00s	0.00s	100.00s	0.01s
Stage3 df/dt+t	Enabled	Disabled, Enabled		
3(df/dt+t) df/dt	-2.000Hz/s	-10.00Hz/s	+10.00Hz/s	0.1Hz/s
3(df/dt+t) t	2.00s	0.00s	100.00s	0.01s
Stage4 df/dt+t	Enabled	Disabled, Enabled		
4(df/dt+t) df/dt	-2.000Hz/s	-10.00Hz/s	+10.00Hz/s	0.1Hz/s
4(df/dt+t) t	3.00s	0.00s	100.00s	0.01s
Stage5 df/dt+t	Enabled	Disabled, Enabled		
5(df/dt+t) df/dt	2.000Hz/s	-10.00Hz/s	+10.00Hz/s	0.1Hz/s
5(df/dt+t) t	0.50s	0.00s	100.00s	0.01s
Stage6 df/dt+t	Enabled	Disabled, Enabled		
6(df/dt+t) df/dt	2.000Hz/s	-10.00Hz/s	+10.00Hz/s	0.1Hz/s
6(df/dt+t) t	1.0s	0.00s	100.00s	0.01s

Note: The default settings of the “df/dt+t” protection provide 4 stages of falling frequency protection and 2 stages of rising frequency protection.

2.7.1 Setting guidelines

Considerable care should be taken when setting this element because it is not supervised by a frequency setting. Setting of the time delay will lead to a more stable element but this should be considered against the loss of fast tripping capability as the time delay is extended.

It is likely that this element would be used in conjunction with other frequency based protection elements to provide a scheme that accounts for severe frequency fluctuations. An example scheme is shown below:

Stage	Frequency “f+t” Elements		Frequency Supervised Rate of Change of Frequency “f+df/dt” Elements	
	Frequency Setting (Hz)	Time Setting (Sec)	Frequency Setting (Hz)	Rate of Change of Frequency Setting (Hz/Sec)
1	49	20	49.2	1.0
2	48.6	20	48.8	1.0
3	48.2	10	48.4	1.0
4	47.8	10	48.0	1.0
5	-	-	-	-

Stage	Rate of Change of Frequency “df/dt+t” Elements	
	Rate of Change of Frequency Setting (Hz/Sec)	Time Setting (Sec)
1	-	-
2	-	-
3	-3.0	0.5
4	-3.0	0.5
5	-3.0	0.1

In the above scheme, tripping of the last two stages is accelerated by using the independent rate of change of frequency element. If the frequency starts falling at a high rate (> 3Hz/s in this example), then stages 3 & 4 are shed at around 48.5Hz, with the objective of a better chance of system stability. Stage 5 serves as an alarm and gives operators advance warning that the situation is critical and if it persists, there is the likelihood for all stages of load being shed.

2.8 Average rate of change of frequency “f+Df/Dt” protection [81RAV]

Owing to the complex dynamics of power systems, variations in frequency during times of generation – load imbalance do not follow any regular patterns and are highly non-linear. Oscillations will occur as the system seeks to address the imbalance, resulting in frequency oscillations typically in the order of 0.1Hz to 1Hz, in addition to the basic change in frequency.

The rate of change of frequency elements discussed in sections 2.6 and 2.7 both use an “instantaneous” measurement of “df/dt” based upon a fixed, 3 cycle measurement. Due to the oscillatory nature of frequency excursions, this instantaneous value can sometimes be misleading, either causing unexpected operation or excessive stability. For this reason, the P940 relays also provide an element for monitoring the longer term frequency trend, thereby reducing the effects of non-linearities in the system and providing increased security to the rate of change of frequency decision.

Using the average rate of change of frequency element “f+Df/Dt”, when the measured frequency crosses the supervising frequency threshold a timer is initiated. At the end of this time period, •t, the frequency difference, •f, is evaluated and if this exceeds the setting, a trip output is given.

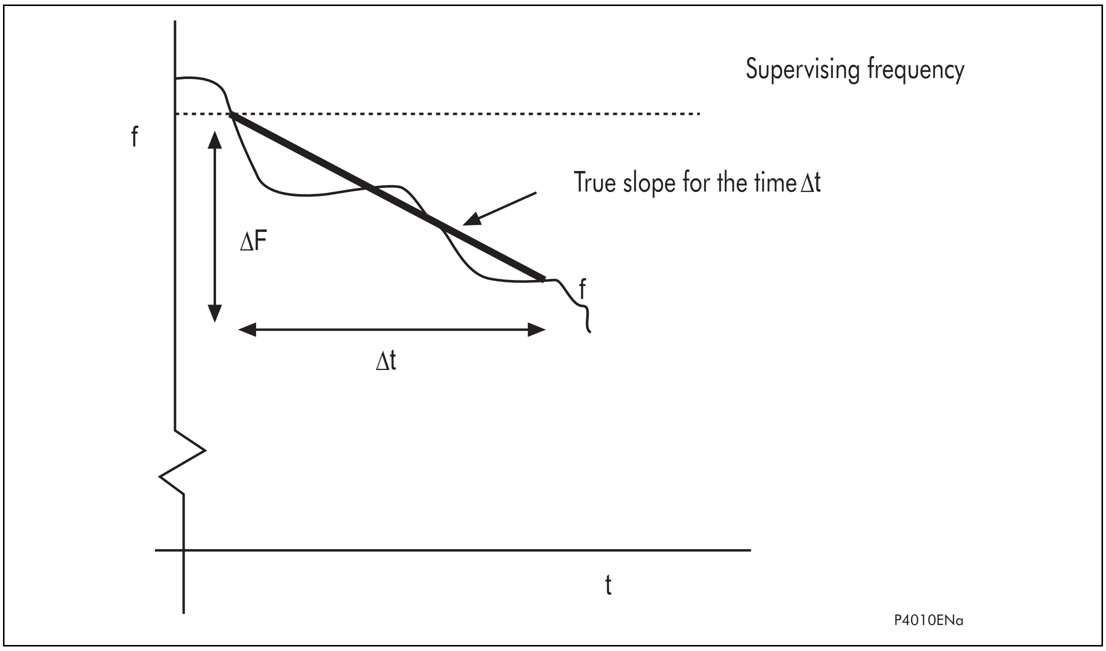


Figure 4: Average rate of change of frequency protection

After time Δt, regardless of the outcome of the comparison, the element is blocked from further operation until the frequency recovers to a value above the supervising frequency threshold (or below in the case where the element is configured for overfrequency operation).

The P940 provides six stages of average rate of change of frequency protection (f+Df/Dt). Depending upon whether the frequency threshold is set above or below the system nominal frequency, each stage can respond to either rising or falling frequency conditions. For example, if the frequency threshold is set above nominal frequency, the element will operate for rising frequency conditions. The average rate of change of frequency is then measured based upon the frequency difference, Df over the settable time period, Dt. The relay will also indicate that an incorrect setting has been applied if the frequency threshold is set to the nominal system frequency.

Within the Programmable Scheme Logic (PSL), signals are available to indicate the start and trip of each average rate of change of frequency stage. (Starts: DDB 137, DDB 146, DDB 155, DDB 164, DDB 173, DDB 182; Trips: DDB 138, DDB 147, DDB 156, DDB 165, DDB 174, DDB 183). Signals are also available to indicate when any of the six stages have started or tripped (Any f+Df/Dt Start = DDB 244; Any f+Dt/Dt Trip = DDB 248). The state of the DDB signals can be programmed to be viewed in the “Monitor Bit x” cells of the “COMMISSION TESTS” column in the relay.

The average rate of change of frequency protection function is found in the “f+Df/Dt Settings” relay menu column and are shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
f+Df/Dt SETTINGS				
Stage1 f+Df/Dt	Enabled	Disabled, Enabled		
1(f+Df/Dt) f	49.00Hz	40.00Hz	70.00Hz	0.01Hz
1(f+Df/Dt) Df	0.50Hz	0.2Hz	10.0Hz	0.1Hz
1(f+Df/Dt) Dt	0.50s	0.02s	2.00s	0.02s
Stage2 f+Df/Dt	Enabled	Disabled, Enabled		
2(f+Df/Dt) f	49.00Hz	40.00Hz	70.00Hz	0.01Hz
2(f+Df/Dt) Df	1.00Hz	0.2Hz	10.0Hz	0.1Hz
2(f+Df/Dt) Dt	1.00s	0.02s	2.00s	0.02s
Stage3 f+Df/Dt	Enabled	Disabled, Enabled		
3(f+Df/Dt) f	48.50Hz	40.00Hz	70.00Hz	0.01Hz
3(f+Df/Dt) Df	0.50Hz	0.2Hz	10.0Hz	0.1Hz
3(f+Df/Dt) Dt	0.50s	0.02s	2.00s	0.02s
Stage4 f+Df/Dt	Enabled	Disabled, Enabled		
4(f+Df/Dt) f	48.50Hz	40.00Hz	70.00Hz	0.01Hz
4(f+Df/Dt) Df	1.00Hz	0.2Hz	10.0Hz	0.1Hz
4(f+Df/Dt) Dt	1.00s	0.02s	2.00s	0.02s
Stage5 f+Df/Dt	Enabled	Disabled, Enabled		
5(f+Df/Dt) f	50.50Hz	40.00Hz	70.00Hz	0.01Hz
5(f+Df/Dt) Df	0.50Hz	0.2Hz	10.0Hz	0.1Hz
5(f+Df/Dt) Dt	0.50s	0.02s	2.00s	0.02s
Stage6 f+Df/Dt	Enabled	Disabled, Enabled		
6(f+Df/Dt) f	51.00Hz	40.00Hz	70.00Hz	0.01Hz
6(f+Df/Dt) Df	0.50Hz	0.2Hz	10.0Hz	0.1Hz
6(f+Df/Dt) Dt	0.50s	0.02s	2.00s	0.02s

Note: The default settings of the “f+Df/Dt” protection provide 4 stages of falling frequency protection and 2 stages of rising frequency protection assuming a 50Hz nominal frequency.

2.8.1 Setting guidelines

As for the other rate of change of frequency elements, it is recommended that the ”f+Df/Dt” element is used in conjunction with the ”f+t” element. The average rate of change of frequency element can be set to measure the rate of change over a short period as low as 20ms, or 1 cycle @ 50Hz) or a relatively long period up to 2s, or 100 cycles @ 50Hz). With a time setting, Dt, towards the lower end of this range, the element becomes similar to the frequency supervised rate of change function, “f+df/dt”. With high Dt settings, the element acts as a frequency trend monitor.

A possible four stage load shedding scheme using the average rate of change frequency element is shown below:

Stage	Frequency "f+t" Elements		Average Rate of Change of Frequency "f+Df/Dt" Elements		
	(f+t) f Frequency Setting (Hz)	(f+t) t Time Setting (Sec)	(f+Df/Dt) f Frequency Setting (Hz)	(f+Df/Dt) Frequency Difference Setting, Df (Hz)	(f+Df/Dt) Time Period, Dt (Sec)
1	49	20	49	0.5	0.5
2	48.6	20	48.6	0.5	0.5
3	48.2	10	48.2	0.5	0.5
4	47.8	10	47.8	0.5	0.5

In the above scheme, the faster load shed decisions are made by monitoring the frequency change over 500ms. Hence tripping takes place slower than in schemes employing the frequency supervised rate of change element (f+df/dt), but the difference is not very much at this setting. If the delay is unacceptable for system stability, then the scheme can be improved by increasing the independent "f" setting of the element. Depending upon how much this value is increased, the frequency at which the "f+Df/Dt" element will trip also increases and hence reduces the time delay to load shedding under more severe frequency fluctuations. For example, with the settings shown below and assuming the set average rate of frequency decline, the first stage of load shedding would be tripped approximately 300msecs after 49.0Hz had been reached and at a frequency of approximately 48.7Hz.

Stage	Frequency "f+t" Elements		Average Rate of Change of Frequency "f+Df/Dt" Elements		
	(f+t) f Frequency Setting (Hz)	(f+t) t Time Setting (Sec)	(f+Df/Dt) f Frequency Setting (Hz)	(f+Df/Dt) Frequency Difference Setting, Df (Hz)	(f+Df/Dt) Time Period, Dt (Sec)
1	49	20	49.2	0.5	0.5 s
2	48.6	20	48.8	0.5	0.5 s
3	48.2	10	48.4	0.5	0.5 s
4	47.8	10	48.0	0.5	0.5 s

2.9 Calculating the rate of change of frequency for load shedding

In the event of severe system overload or loss of generation conditions, the system frequency will decline exponentially and theoretically stabilise at a steady state level somewhere below the nominal frequency. The time constant of the exponential decay as well as the steady state level is governed by certain parameters such as the system inertia constant, system damping constant etc. The following definitions and equations are valid:

f = theoretical steady state frequency at which generators would stabilise if there were a generation loss of a certain percentage (Hz)

f_o = nominal system frequency (50/60Hz)

ΔP = (pu) overload (Load - Generation)/Generation

d = percent change in load for 1% change in frequency (damping constant)

H = Combined inertia constant of the power system (MW.sec/MVA)

H = (H1 MVA1 + ... + Hn MVAn/(MVA1 + ...+ MVAn) [1]

where n subscripts 1, 2, ..., n refer to individual generating units.

The following is an available theory for calculating the rate of change of frequency for a particular system contingency.

Instantaneous rate of change of frequency at the time of a overload is given by:

$$df/dt = -\ \underline{\Delta P f_0}\ ,,\ 2H \qquad [2]$$

Taking the damping constant into account, the frequency deviation from nominal is given by:

$$\Delta f = \frac{\Delta P f_0 \left(1-e^{-(td/2H)}\right)}{d} \qquad [3]$$

The above equations are a result of vast simplifications. The actual frequency change will be influenced by governor droop characteristics, load dynamics, interconnections between various generators, system stabilisers etc. However the calculated df/dt may be a good measure of the rate of change of frequency for the purpose of setting the relay.

It may be noted that the rate of change of frequency is system and situation specific; a good knowledge of the system behaviour is essential for arriving at the settings for this parameter.

2.10 Generator abnormal protection [81AB]

Generator sets are normally rated for a lifetime of operation within a defined operating frequency band. Operation outside of this “normal” region can produce mechanical stress in the turbine blades and reduce the useful life of the generator. In order to protect against this condition, it is useful to monitor the time spent running at abnormal frequencies to indicate when maintenance may be required.

Four bands of generator abnormal protection are provided within the P940 relays. Operation within each of these bands is monitored and the time added to a cumulative timer, stored within the battery backed RAM. This ensures that on loss of auxiliary supply to the relay, the information is not lost. The amount of time spent in each band can be viewed in the “GENR ABN TIMERS” column in the relay.

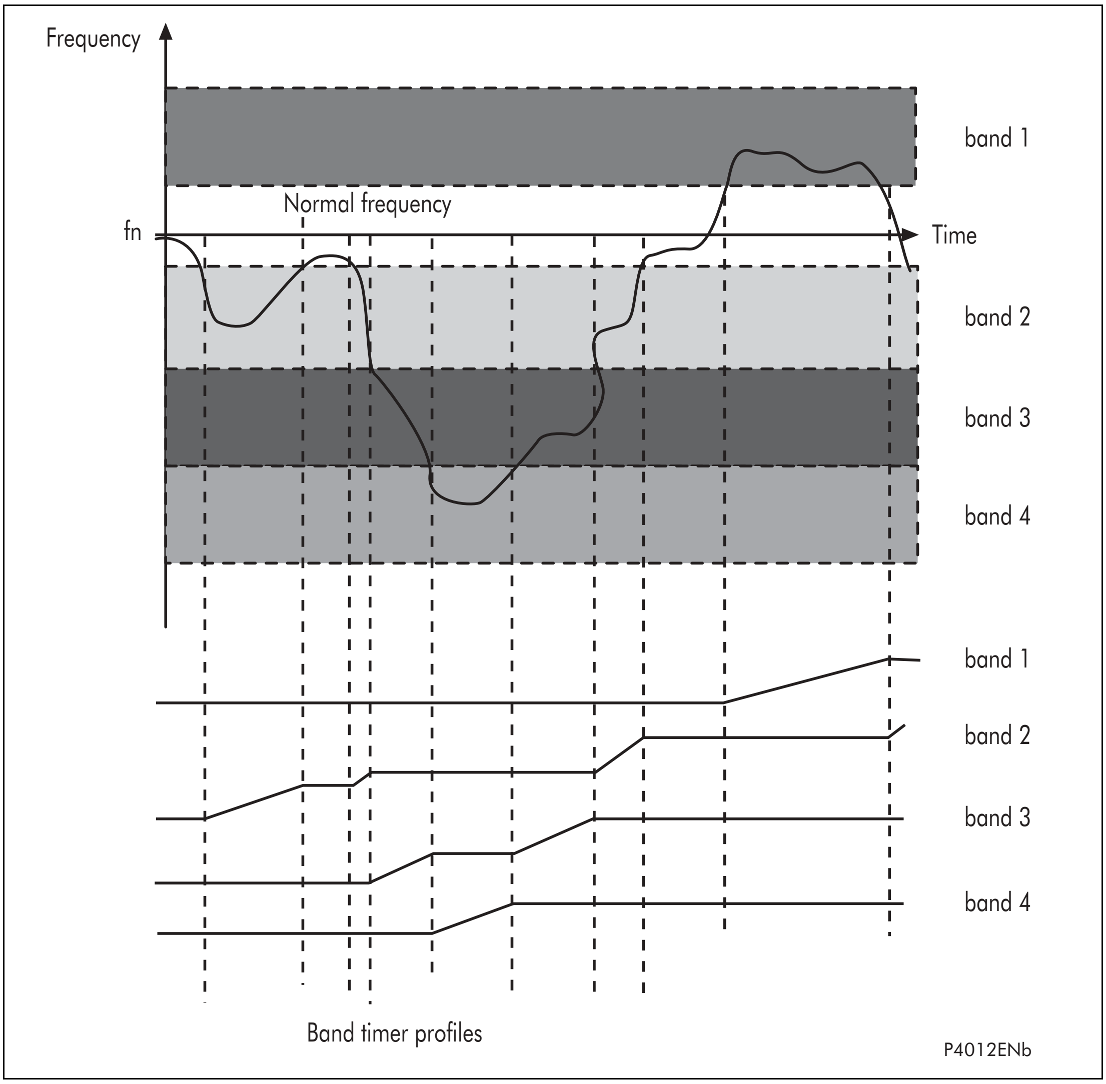


Figure 5: Generator abnormal frequency protection

Figure 5 shows the integrating timer behaviour for abnormal frequency conditions over a long period of time. The timer for a particular band is incremented as long as the frequency is within the band lower and upper frequency settings. If two bands have overlapping frequency settings and the system frequency happens to be within both bands then the timers for both bands are incremented.

DDB signals are available in the PSL to indicate when the generator is currently operating in each band (DDB 218, DDB 220, DDB 222, DDB 224) and when the cumulative timer has reached its setting limit in each band (DDB 219, DDB 221, DDB 223, DDB 225). In addition, DDB 226 will operate when the generator is currently operating in any of the four bands and DDB 227 will operate when any of the four generator abnormal timers have exceeded their setting. The state of the DDB signals can be programmed to be viewed in the “Monitor Bit x” cells of the “COMMISSION TETS” column in the relay.

The setting ranges for the generator abnormal protection are shown in the table below:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
GENR ABN PROTECTION				
Band1 Freq Low	48.50Hz	40Hz	70Hz	0.01Hz
Band1 Freq High	49.00Hz	40Hz	70Hz	0.01Hz
Band1 Delay	180.0min	0.0min	240.0min	0.5min
Band2 Freq Low	48.00Hz	40Hz	70Hz	0.01Hz
Band2 Freq High	48.50Hz	40Hz	70Hz	0.01Hz
Band2 Delay	120.0min	0.0min	240.0min	0.5min
Band3 Freq Low	47.50Hz	40Hz	70Hz	0.01Hz
Band3 Freq High	48.00Hz	40Hz	70Hz	0.01Hz
Band3 Delay	60.0min	0.0min	240.0min	0.5min
Band4 Freq Low	50.50Hz	40Hz	70Hz	0.01Hz
Band4 Freq High	53.00Hz	40Hz	70Hz	0.01Hz
Band4 Delay	60.0min	0.0min	240.0min	0.5min

2.10.1 Setting guidelines

The withstand of the generator for abnormal speeds is normally given by the generator manufacturer. Default settings have been provided as a guide for setting the relay.

The output of the element can be used as either as an operator alarm or for shutting down the generator.

2.11 Load restoration

It is the goal of load shedding to stabilise the frequency on a system and to re-establish the load to generation imbalance that initially caused the frequency to decline. As the system stabilises and the generation capability improves, the system frequency will recover to near normal levels and after some time delay it is possible to consider the restoration of load onto the healthy system. However, load restoration needs to be performed carefully and systematically so that system stability is not jeopardised again. A careful balance needs to be sought to minimise the length of time that the loads are disconnected but at the same time, not re-connect loads that will cause the problem to immediately re-occur.

In the case of industrial plants with captive generation, restoration should be linked to the available generation since connecting additional load when the generation is still inadequate, will only result in declining frequency and consequent load shedding. If the in-plant generation is insufficient to meet the load requirements, then load restoration should be interlocked with recovery of the utility supply.

The P940 uses the measurement of system frequency as its main criteria for load restoration. For each stage of restoration, it is necessary that the same stage of load shedding has occurred previously and that no elements within that stage are configured for overfrequency or rising frequency conditions. If load shedding has not occurred based upon the frequency protection elements, the load restoration for that stage is inactive.

Load restoration for a given stage begins when the system frequency rises above the “RestoreX Freq” setting for that stage and the stage restoration timer “RestoreX Time” is initiated. If the system frequency remains above the frequency setting for the set time delay, load restoration of that stage will be triggered. Unfortunately, frequency recovery profiles are highly non-linear and it would be reasonably common for the system frequency to transiently fall below the restoration frequency threshold. If the restoration timer immediately reset whenever a frequency dip occurred, it is likely that load restoration would be never be successful and for this reason a “holding band” is also implemented on the relay. The holding band is a region defined by the restoration frequency and the highest frequency setting used in the load shedding elements for that stage. The difference between these two settings must always be greater than 0.02Hz, otherwise a “Wrong Setting” alarm will be generated. Whenever the system frequency dips into the holding band, operation of the stage restoration timer is suspended until the frequency rises above the restoration frequency setting, at which point timing will continue. If the system frequency dip is sufficiently large to cause any frequency element to start or trip in this stage i.e. if the frequency falls below the lower limit of the holding band, the restoration timer will immediately be reset.

The diagram below illustrates the operation of the load restoration facility and holding band.

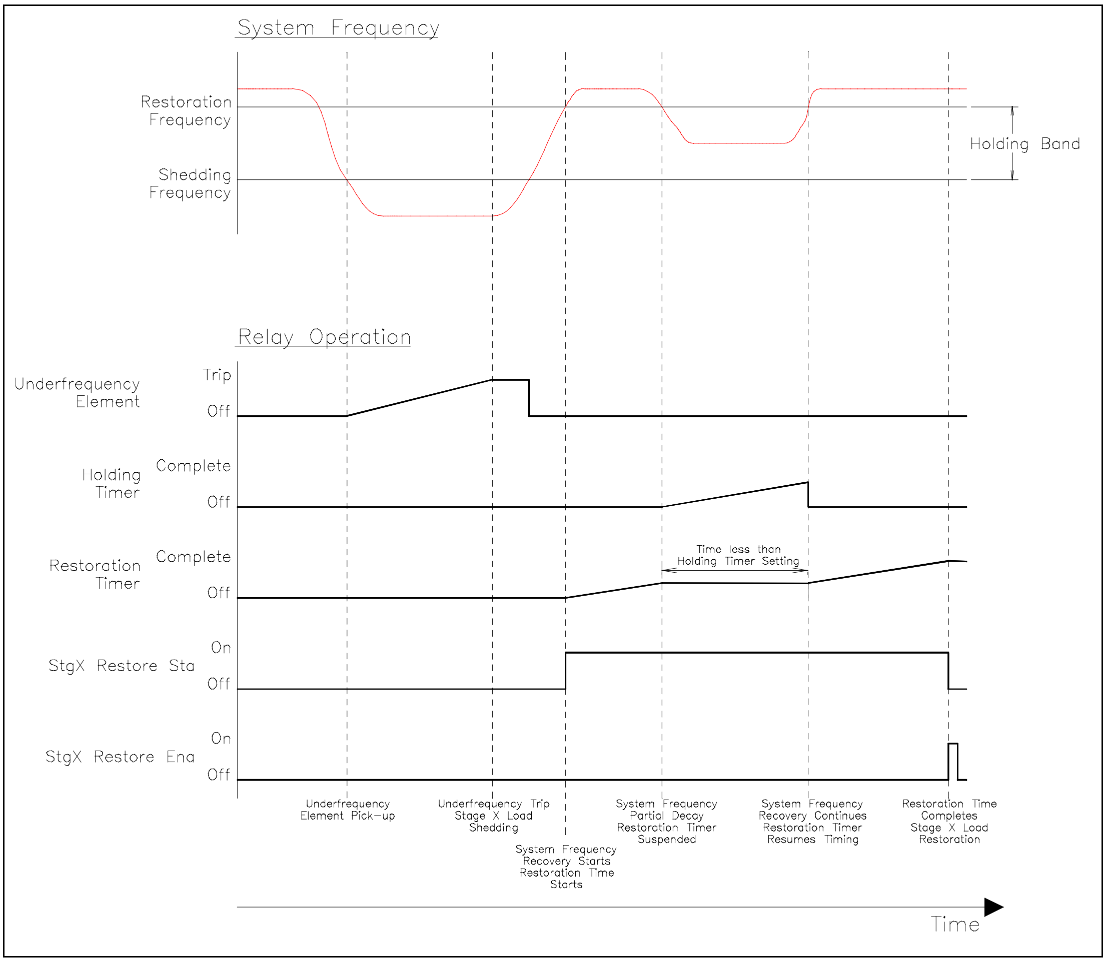


Figure 6: Load restoration with short deviation into holding band

If the system frequency remains in the holding band for too long it is likely that other system frequency problems are occurring and it would be prudent to reset the restoration timer for that stage. For this reason, as soon as the system frequency is measured to be within the holding band, the "Holding Timer" is initiated (see section 2.3). If the system frequency doesn't leave the holding band before the holding timer setting has been exceeded, the load restoration time delay for that stage is immediately reset. It should be noted that the holding timer has a common setting for all stages of load restoration.

An example of the case when the time in the holding band is excessive is shown below:

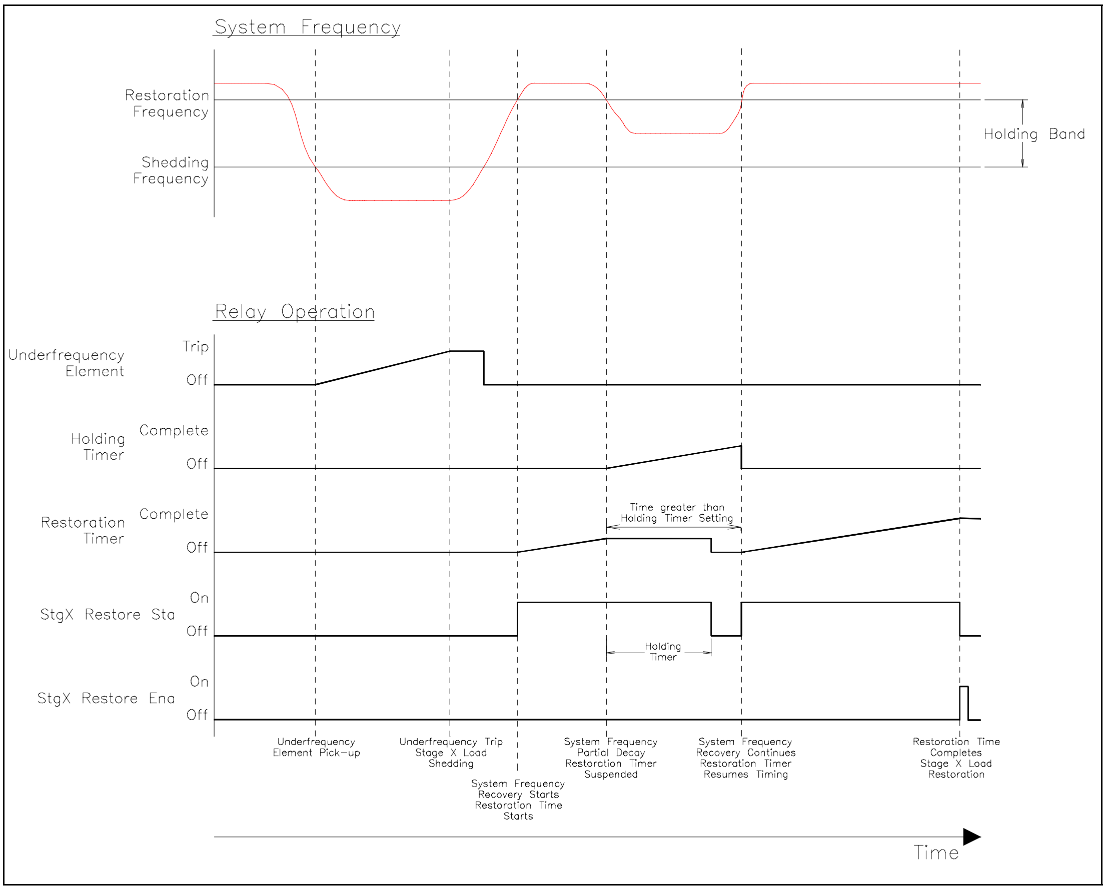


Figure 7: Load restoration with long deviation into holding band

The P940 provides up to six stages of load restoration with individual restoration frequency and time delays. Each stage of load restoration can be enabled or disabled but operation is also linked to the number of load shedding stages that have been configured using the frequency protection elements. Within a stage, if any frequency protection element is set for overfrequency operation or has a positive rate of change of frequency setting, the load restoration for that stage is automatically inhibited and a wrong setting alarm will be raised. For example, if stage 5 frequency protection "f+t" was set above nominal frequency, it would not be possible to use the stage 5 load restoration facility, even if other stage 5 frequency protection elements were set for load shedding. This means that the number of load restoration stages is always less than or equal to the number of load shedding stages. In addition, the stage load restoration can only occur if that stage of load shedding has been tripped from any of the frequency protection elements. For example, for stage 5 load restoration to occur, a stage 5 frequency protection element must have previously operated to shed load. Although the load restoration on the P940 is based upon frequency measurement, it is possible to use the Programmable Scheme Logic (PSL) of the relay to interlock with other plant items.

Within the Programmable Scheme Logic (PSL), signals are available to indicate when the stage load restoration frequency has been reached (start) and when the restoration timer for that stage has completed thereby enabling a close command to be given (ena). (Starts: DDB 228, DDB 230, DDB 232, DDB 234, DDB 236, DDB 238; Ena: DDB 229, DDB 231, DDB 233, DDB 235, DDB 237, DDB 239). The state of the DDB signals can be programmed to be viewed in the “Monitor Bit x” cells of the “COMMISSION TESTS” column in the relay.

The load restoration settings are found in the “Load Restoration” relay menu column and are shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
LOAD RESTORATION				
Restore1 Status	Disabled	Disabled, Enabled		
Restore1 Freq	49.50Hz	40.00Hz	70.00Hz	0.01Hz
Restore1 Time	240s	1s	7200s	1s
Restore2 Status	Disabled	Disabled, Enabled		
Restore2 Freq	49.50Hz	40.00Hz	70.00Hz	0.01Hz
Restore2 Time	180s	1s	7200s	1s
Restore3 Status	Disabled	Disabled, Enabled		
Restore3 Freq	49.50Hz	40.00Hz	70.00Hz	0.01Hz
Restore3 Time	120s	1s	7200s	1s
Restore4 Status	Disabled	Disabled, Enabled		
Restore4 Freq	49.00Hz	40.00Hz	70.00Hz	0.01Hz
Restore4 Time	240s	1s	7200s	1s
Restore5 Status	Disabled	Disabled, Enabled		
Restore5 Freq	49.00Hz	40.00Hz	70.00Hz	0.01Hz
Restore5 Time	180s	1s	7200s	1s
Restore6 Status	Disabled	Disabled, Enabled		
Restore6 Freq	49.00Hz	40.00Hz	70.00Hz	0.01Hz
Restore6 Time	120s	1s	7200s	1s

Note: The default settings of the “Load Restoration” facility assumes a 50Hz nominal frequency.

Although six stages of load restoration are available, using the Programmable Scheme Logic (PSL), it is possible to increase the effective number of restoration stages. This will enhance the stability of the system during load restoration by restoring the load in smaller sections. For example, assume that two feeders are tripped when a single stage of load shedding operates. The restoration of this single stage may be split using the PSL as shown below:

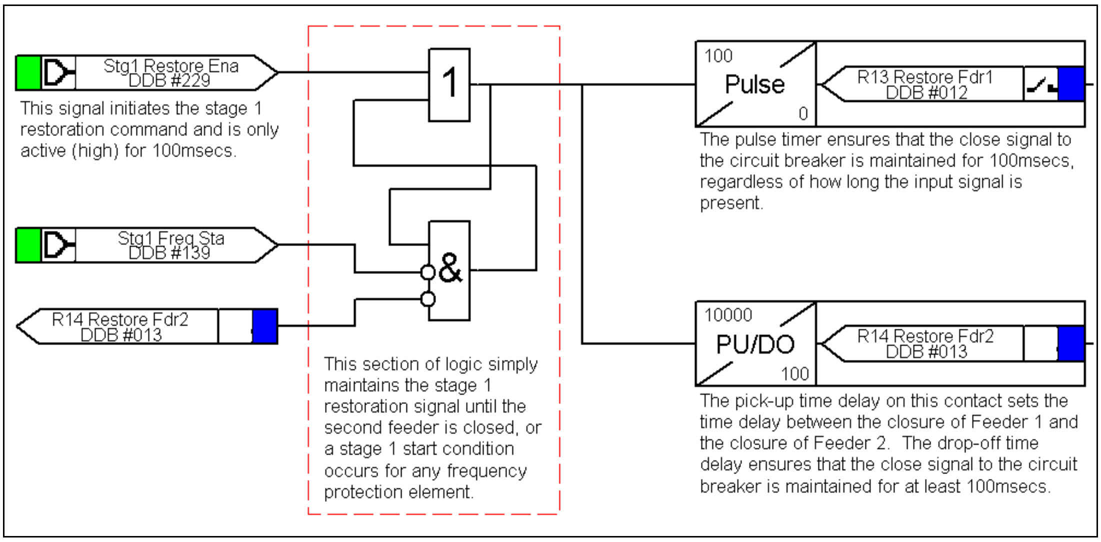


Figure 8: Example PSL for segregating a single stage of load shedding

The contact conditioners (timers) available in the PSL can be used along with the restoration timer of a stage to smooth the impact of sudden load restoration, provided sufficient output relays are available.

2.11.1 Setting guidelines

A four stage, single frequency load restoration scheme is illustrated below. The frequency setting has been chosen such that there is sufficient separation between the highest load shed frequency (49.0 Hz from the underfrequency protection elements – see section 2.4.1) and the restoration frequency to prevent any possible hunting. A restoration frequency setting closer to nominal frequency may be chosen if an operating frequency of 49.3 Hz is unacceptable.

Stage	Restoration Frequency Setting (Hz)	Restoration Time Delay (S)	Holding Time Delay (S)
1	49.3Hz	240 sec	20 sec
2	49.3Hz	180 sec	20 sec
3	49.3Hz	120 sec	20 sec
4	49.3Hz	60 sec	20 sec

In this scheme, the time delays ensure that the most critical loads are reconnected first assuming that the higher stages refer to more important loads. By sequentially restoring the load, it is also hoped that system stability is maintained and that the frequency problems are not re-instated. These time settings are system dependent; higher or lower settings may be required depending on the particular application.

It is possible to set up restoration schemes involving multiple frequencies. This allows faster restoration of loads, but the possibility of continuous system operation at frequencies far removed from the nominal must be considered in this case. A typical scheme using two frequencies is illustrated below:

Stage	Restore FreqRestoration Frequency Setting (Hz)	Restore DelayRestoration Time Delay (S)	Holding Time Delay (S)
1	49.5Hz	120 sec	20 sec
2	49.5Hz	60 sec	20 sec
3	49.0Hz	120 sec	20 sec
4	49.0Hz	60 sec	20 sec

Staggered time settings may be used in this scheme as well, but the time separation among the restoration of stages will be a function of the frequency recovery pattern. Time co-ordinated restoration can only be guaranteed for those stages with a common restoration frequency setting.

2.12 Undervoltage protection [27]

Undervoltage conditions may occur on a power system for a variety of reasons, some of which are outlined below:

- Increased system loading. Generally, some corrective action would be taken by voltage regulating equipment such as AVR's or On Load Tap Changers, in order to bring the system voltage back to its nominal value. If the regulating equipment is unsuccessful in restoring healthy system voltage, then tripping by means of an undervoltage relay will be required following a suitable time delay.
- Faults occurring on the power system result in a reduction in voltage of the phases involved in the fault. The proportion by which the voltage decreases is directly dependent upon the type of fault, method of system earthing and its location with respect to the relaying point. Consequently, co-ordination with other voltage and current-based protection devices is essential in order to achieve correct discrimination.
- Complete loss of busbar voltage. This may occur due to fault conditions present on the incomer or busbar itself, resulting in total isolation of the incoming power supply. For this condition, it may be a requirement for each of the outgoing circuits to be isolated, such that when supply voltage is restored, the load is not connected. Hence, the automatic tripping of a feeder upon detection of complete loss of voltage may be required. This may be achieved by a three phase undervoltage element.
- Where outgoing feeders from a busbar are supplying induction motor loads, excessive dips in the supply may cause the connected motors to stall, and should be tripped for voltage reductions which last longer than a pre-determined time. Such undervoltage protection may be present in the protective device on the motor feeder itself. However, if it is not, the inclusion of this functionality within the feeder protection relay on the incomer may prove beneficial.

Two stage undervoltage protection is provided which can be set to operate from phase-phase or phase-neutral voltages. Each stage has an independent time delay which can be set to zero to permit instantaneous operation. The first stage also has an option to operate according to an inverse time characteristic.

Each stage of undervoltage protection can be blocked by energising the relevant DDB signal via the PSL (DDB 251, DDB 252), and DDB signals are also available to indicate 3 phase and per phase start and trips (Starts: DDB 186-193, Trips: DDB 194-201). The state of each of these DDB signals can be programmed to be viewed in the "Monitor Bit x" cells of the "COMMISSION TEST" column in the relay menu.

Note: Each of the start and trip DDB signals is qualified by a phase indication, A/AB, B/BC or C/CA. If the undervoltage protection is set for phase-phase operation then the phase indicators should be referred as AB, BC or CA. If the undervoltage protection is set for phase-neutral operation then the phase indicators should be referred as A, B or C.

Both the under and overvoltage protection functions can be found in the “Volt Protection” relay menu column. The following table shows the undervoltage section of this menu along with the available setting ranges and factory defaults.

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
VOLT PROTECTION				
UNDER VOLTAGE	Sub Heading			
V< Measur't Mode	Phase-Phase	Phase-Phase, Phase-Neutral		
V< Operate Mode	Any Phase	Any Phase, Three Phase		
V<1 Function	DT	Disabled, DT, IDMT		
V<1 Voltage Set	80V (Vn = 100/120V) 320V (Vn = 380/480V)	10V (Vn = 100/120V) 40V (Vn = 380/480V)	120V (Vn = 100/120V) 480V (Vn = 380/480V)	1V (Vn = 100/120V) 4V (Vn = 380/480V)
V<1 Time Delay	10s	0	100	0.01s
V<1 TMS	1	0.5	100	0.5
V<2 Status	Enabled	Enabled, Disabled		
V<2 Voltage Set	60V (Vn = 100/120V) 240V (Vn = 380/480V)	10V (Vn = 100/120V) 40V (Vn = 380/480V)	120V (Vn = 100/120V) 480V (Vn = 380/480V)	1V (Vn = 100/120V) 4V (Vn = 380/480V)
V<2 Time Delay	5s	0	100	0.01s

The IDMT characteristic available on the first stage is defined by the following formula:

$t = TMS / (1 - M)$

where

t = Operating time in seconds

TMS = Time multiplier setting (V<1 TMS)

M = Measured voltage/relay setting voltage (Vs)

2.12.1 Setting guidelines

The undervoltage protection can be set to operate from phase-phase or phase-neutral voltage as selected by the “V< Measur’t Mode” cell in the menu. In the majority of applications, undervoltage protection is not required to operate during system earth fault conditions and therefore “Phase-Phase” should be selected as this is less affected by single phase voltage depressions. Additionally, the “V< Operate Mode” setting allows for single or three phase operation to be selected. If “Any Phase” is selected, the element will operate if any voltage falls below threshold and if “Three Phase” is selected, the element will only operate when all three voltages are below setting.

Stage 1 may be selected as either “IDMT” for inverse time delayed operation, “DT” for definite time delayed operation or “Disabled”, within the “V<1 Function” cell. Stage 2 is definite time only and is enabled or disabled in the “V<2 Status” cell. The time delays (“V<1 TMS” for IDMT operation, “V<1 Time Delay” and “V<2 Time Delay” for DT operation) should be set according to the application and will be dependent upon the time for which the system is able to withstand a depressed voltage. For majority motor loads, this may typically be in the order of ½ second.

The voltage setting (“V<1 Voltage Set” and “V<2 Voltage Set”) for the undervoltage protection should be set at some value below the voltage excursions which may be expected under normal system operating conditions. This is dependent upon the system in question but typical healthy system voltage excursions may be in the order of 10% below nominal voltage.

To prevent unwanted operation when the feeder is de-energised or the circuit breaker is open, blocking signals are available within the PSL for each stage (DDB 251 and DDB 252).

2.13 Overvoltage protection [59]

Undervoltage conditions are relatively common, as they are related to fault conditions etc. However, overvoltage conditions are also a possibility and are generally related to loss of load conditions as described below;

Under conditions of load rejection, the supply voltage will increase in magnitude. This situation would normally be rectified by voltage regulating equipment such as AVR’s or on-load tap changers. However, failure of this equipment to bring the system voltage back within prescribed limits leaves the system with an overvoltage condition which must be cleared in order to preserve the life of the system insulation. Hence, overvoltage protection which is suitably time delayed to allow for normal regulator action, may be applied.

During earth fault conditions on a power system there may be an increase in the healthy phase voltages. Ideally, the system should be designed to withstand such overvoltages for a defined period of time. Normally, there will be a primary protection element employed to detect the earth fault condition and to issue a trip command if the fault is uncleared after a nominal time. However, it would be possible to use an overvoltage element as a back-up protection in this instance. A single stage of protection would be sufficient, having a definite time delay.

Two stage overvoltage protection is provided which can be set to operate from phase-phase or phase-neutral voltages. Each stage has an independent time delay which can be set to zero to permit instantaneous operation. The first stage also has an option to operate according to an inverse time characteristic.

Each stage of overvoltage protection can be blocked by energising the relevant DDB signal via the PSL (DDB 253, DDB 254), and DDB signals are also available to indicate 3 phase and per phase start and trips (Starts: DDB 202-209, Trips: DDB 210-217). The state of each of these DDB signals can be programmed to be viewed in the “Monitor Bit x” cellls of the “COMMISSION TEST” column in the relay menu.

Note: Each of the start and trip DDB signals is qualified by a phase indication, A/AB, B/BC or C/CA. If the overvoltage protection is set for phase-phase operation then the phase indicators should be referred as AB, BC or CA. If the overvoltage protection is set for phase-neutral operation then the phase indicators should be referred as A, B or C.

As previously stated, both the under and overvoltage protection functions can be found in the “Volt Protection” relay menu column. Setting ranges for the overvoltage elements are shown in the following table:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
VOLT PROTECTION				
OVER VOLTAGE	Sub Heading			
V> Measur't Mode	Phase-Phase	Phase-Phase, Phase-Neutral		
V> Operate Mode	Any Phase	Any Phase, Three Phase		
V>1 Function	DT	Disabled, DT, IDMT		
V>1 Voltage Set	130V (Vn = 100/120V) 520V (Vn = 380/480V)	60V (Vn = 100/120V) 240V (Vn = 380/480V)	185V (Vn = 100/120V) 740V (Vn = 380/480V)	1V (Vn = 100/120V) 4V (Vn = 380/480V)
V>1 Time Delay	10s	0	100	0.01s
V>1 TMS	1	0.5	100	0.5
V>2 Status	Disabled	Enabled, Disabled		
V>2 Voltage Set	150V (Vn = 100/120V) 600V (Vn = 380/480V)	60V (Vn = 100/120V) 240V (Vn = 380/480V)	185V (Vn = 100/120V) 740V (Vn = 380/480V)	1V (Vn = 100/120V) 4V (Vn = 380/480V)
V>2 Time Delay	0.5s	0	100	0.01s

The IDMT characteristic available on the first stage is defined by the following formula:

$t = TMS / (M - 1)$

where

t = Operating time in seconds

TMS = Time multiplier setting (V>1 TMS)

M = Measured voltage/relay setting voltage (Vs)

2.13.1 Setting guidelines

The overvoltage protection can be set to operate from phase-phase or phase-neutral voltage as selected by the “V> Measur’t Mode” cell in the menu. In the majority of applications, overvoltage protection is not required to operate during system earth fault conditions and therefore “Phase-Phase” should be selected as this is less affected by single phase voltage depressions. Additionally, the “V> Operate Mode” setting allows for single or three phase operation to be selected. If “Any Phase” is selected, the element will operate if any voltage falls below threshold and if “Three Phase” is selected, the element will only operate when all three voltages are below setting.

Stage 1 may be selected as either “IDMT” for inverse time delayed operation, “DT” for definite time delayed operation or “Disabled”, within the “V>1 Function” cell. Stage 2 is definite time only and is enabled or disabled in the “V>2 Status” cell. The time delays (“V>1 TMS” for IDMT operation, “V>1 Time Delay” and “V>2 Time Delay” for DT operation) should be set according to the application and will be dependent upon the time for which the system is able to withstand an increased voltage.

The voltage setting (“V>1 Voltage Set” and “V>2 Voltage Set”) for the overvoltage protection should be set at some value above the voltage excursions which may be expected under normal system operating conditions. This is dependent upon the system in question but typical healthy system voltage excursions may be in the order of 10% - 20% above nominal voltage.

The inclusion of the two stages and their respective operating characteristics allows for a number of possible applications:

- Use of the IDMT characteristic gives the option of a longer time delay if the overvoltage condition is only slight but results in a fast trip for a severe overvoltage. As the voltage settings for both of the stages are independent, the second stage could then be set lower than the first to provide a time delayed alarm stage if required.
- Alternatively, if preferred, both stages could be set to definite time and configured to provide the required alarm and trip stages.
- If only one stage of overvoltage protection is required, or if the element is required to provide an alarm only, the remaining stage may be disabled within the relay menu.
- This type of protection must be co-ordinated with any other overvoltage relays at other locations on the system.

2.14 Wrong settings

As stated in the previous sections, it is possible for the relay to identify certain settings errors. These ‘wrong settings’ can be labelled according to the setting that is considered incorrect, are notified by a text alarm “Wrong Setting” on the LCD and accompanied by operation of the amber Alarm LED. The actual alarm doesn’t state which setting is incorrect, but within the event records of the relay each wrong setting is given a number that can be examined to identify its cause. Each event record can be individually viewed on the LCD display of the relay by use of the “VIEW RECORDS” menu column, or via a PC running appropriate software such as MiCOM S1.

The complete list of causes of wrong setting alarms is given below:

Wrong Setting Number	Effected Element	Cause
Wrong Setting 01	Stage 1 f+t	Frequency setting = system nominal frequency
Wrong Setting 02	Stage 2 f+t	Frequency setting = system nominal frequency
Wrong Setting 03	Stage 3 f+t	Frequency setting = system nominal frequency
Wrong Setting 04	Stage 4 f+t	Frequency setting = system nominal frequency
Wrong Setting 05	Stage 5 f+t	Frequency setting = system nominal frequency
Wrong Setting 06	Stage 6 f+t	Frequency setting = system nominal frequency

Wrong Setting Number	Effected Element	Cause
Wrong Setting 07	Stage 1 f+df/dt	Frequency setting = system nominal frequency
Wrong Setting 08	Stage 2 f+df/dt	Frequency setting = system nominal frequency
Wrong Setting 09	Stage 3 f+df/dt	Frequency setting = system nominal frequency
Wrong Setting 10	Stage 4 f+df/dt	Frequency setting = system nominal frequency
Wrong Setting 11	Stage 5 f+df/dt	Frequency setting = system nominal frequency
Wrong Setting 12	Stage 6 f+df/dt	Frequency setting = system nominal frequency
Wrong Setting 13	Stage 1 df/dt+t	Rate of change of frequency setting = 0 Hz/s
Wrong Setting 14	Stage 2 df/dt+t	Rate of change of frequency setting = 0 Hz/s
Wrong Setting 15	Stage 3 df/dt+t	Rate of change of frequency setting = 0 Hz/s
Wrong Setting 16	Stage 4 df/dt+t	Rate of change of frequency setting = 0 Hz/s
Wrong Setting 17	Stage 5 df/dt+t	Rate of change of frequency setting = 0 Hz/s
Wrong Setting 18	Stage 6 df/dt+t	Rate of change of frequency setting = 0 Hz/s
Wrong Setting 19	Stage 1 f+Df/Dt	Frequency setting = system nominal frequency
Wrong Setting 20	Stage 2 f+Df/Dt	Frequency setting = system nominal frequency
Wrong Setting 21	Stage 3 f+Df/Dt	Frequency setting = system nominal frequency
Wrong Setting 22	Stage 4 f+Df/Dt	Frequency setting = system nominal frequency
Wrong Setting 23	Stage 5 f+Df/Dt	Frequency setting = system nominal frequency
Wrong Setting 24	Stage 6 f+Df/Dt	Frequency setting = system nominal frequency
Wrong Setting 25	Band1 Generator Abnormal Protn	Low frequency setting > High frequency setting
Wrong Setting 26	Band2 Generator Abnormal Protn	Low frequency setting > High frequency setting
Wrong Setting 27	Band3 Generator Abnormal Protn	Low frequency setting > High frequency setting
Wrong Setting 28	Band4 Generator Abnormal Protn	Low frequency setting > High frequency setting
Wrong Setting 29	Stage 1 Load Restoration	Any of the following conditions; Stage 1 df/dt+t df/dt setting is greater than 0Hz/s Stage 1 f+t, f+df/dt or f+Df/Dt is configured for overfrequency protection Stage 1 restoration frequency is less than 0.015Hz above the stage 1 f+t or stage 1 f+Df/Dt setting
Wrong Setting 30	Stage 2 Load Restoration	Any of the following conditions; Stage 2 df/dt+t df/dt setting is greater than 0Hz/s Stage 2 f+t, f+df/dt or f+Df/Dt is configured for overfrequency protection Stage 2 restoration frequency is less than 0.015Hz above the stage 1 f+t or stage 1 f+Df/Dt setting
Wrong Setting 31	Stage 3 Load	Any of the following conditions;

Wrong Setting Number	Effected Element	Cause
	Restoration	Stage 3 df/dt+t df/dt setting is greater than 0Hz/s Stage 3 f+t, f+df/dt or f+Df/Dt is configured for overfrequency protection Stage 3 restoration frequency is less than 0.015Hz above the stage 1 f+t or stage 1 f+Df/Dt setting
Wrong Setting 32	Stage 4 Load Restoration	Any of the following conditions; Stage 4 df/dt+t df/dt setting is greater than 0Hz/s Stage 4 f+t, f+df/dt or f+Df/Dt is configured for overfrequency protection Stage 4 restoration frequency is less than 0.015Hz above the stage 1 f+t or stage 1 f+Df/Dt setting
Wrong Setting 33	Stage 5 Load Restoration	Any of the following conditions; Stage 5 df/dt+t df/dt setting is greater than 0Hz/s Stage 5 f+t, f+df/dt or f+Df/Dt is configured for overfrequency protection Stage 5 restoration frequency is less than 0.015Hz above the stage 1 f+t or stage 1 f+Df/Dt setting
Wrong Setting 34	Stage 6 Load Restoration	Any of the following conditions; Stage 6 df/dt+t df/dt setting is greater than 0Hz/s Stage 6 f+t, f+df/dt or f+Df/Dt is configured for overfrequency protection Stage 6 restoration frequency is less than 0.015Hz above the stage 1 f+t or stage 1 f+Df/Dt setting

Note: When an incorrect setting is identified by the relay, the appropriate stage is automatically prevented from operating.

3. APPLICATION OF NON-PROTECTION FUNCTIONS

3.1 Event and fault records

The relays records and time tags up to 250 events and stores them in non-volatile (battery backed) memory. This enables the system operator to establish the sequence of events that occurred within the relay following a particular power system condition, switching sequence etc. When the available space is exhausted, the oldest event is automatically overwritten by the new one.

The real time clock within the relay provides the time tag to each event, to a resolution of 1 ms.

The event records are available for viewing either via the front plate LCD or remotely, via the communications ports.

Local viewing on the LCD is achieved in the menu column entitled "VIEW RECORDS'. This column allows viewing of event, fault and maintenance records and is shown below:

VIEW RECORDS	
LCD Reference	Description
Select event Time & date Event text Event value	Setting range from 0 to 249. This selects the required event record from the possible 250 that may be stored. A value of 0 corresponds to the latest event and so on. Time & date stamp for the event given by the internal real time clock. Up to 32 character description of the event (refer to following sections). Up to 32 bit binary flag or integer representative of the event (refer to following sections).
Select fault	Setting range from 0 to 4. This selects the required fault record from the possible 5 that may be stored. A value of 0 corresponds to the latest fault and so on. The following cells show all the fault flags, protection starts, protection trips, fault location, measurements etc. associated with the fault, i.e. The complete fault record.
Select maint Maint text Maint type Maint data	Setting range from 0 to 4. This selects the required maintenance report from the possible 5 that may be stored. A value of 0 corresponds to the latest report and so on. Up to 32 character description of the occurrence (refer to following sections). These cells are numbers representative of the occurrence. They form a specific error code which should be quoted in any related correspondence to AREVA T&D.
Reset indication	Either yes or no. This serves to reset the trip LED indications provided that the relevant protection element has reset.

For extraction from a remote source via communications, refer to P94x/EN CT/D11, where the procedure is fully explained.

Note that a full list of all the event types and the meaning of their values is given in document P94x/EN GC/D11.

3.2 Types of event

An event may be a change of state of a digital input or output relay, an alarm condition, setting change etc. The following sections show the various items that constitute an event.

3.2.1 Change of state of opto-isolated inputs

If one or more of the opto (logic) inputs has changed state since the last time that the protection algorithm ran, then the new status is logged as an event. When this event is selected to be viewed on the LCD, three applicable cells will become visible as shown below:

Time & Date of Event
“LOGIC INPUTS”
“Event Value 0101010101010101”

The Event Value is an 8 or 16 bit word showing the status of the opto inputs, where the least significant bit (extreme right) corresponds to opto input 1 etc. The same information is present if the event is extracted and viewed via PC.

3.2.2 Change of state of one or more output relay contacts

If one or more of the output relay contacts has changed state since the last time that the protection algorithm ran, then the new status is logged as an event. When this event is selected to be viewed on the LCD, three applicable cells will become visible as shown below:

Time & Date of Event
“OUTPUT CONTACTS”
“Event Value 010101010101010101010”

The Event Value is a 7, 14 or 21 bit word showing the status of the output contacts, where the least significant bit (extreme right) corresponds to output contact 1 etc. The same information is present if the event is extracted and viewed via PC.

3.2.3 Relay alarm conditions

Any alarm conditions generated by the relays will also be logged as individual events. The following table shows examples of some of the alarm conditions and how they appear in the event list:

Alarm Condition	Resulting Event	
	Event Text	Event Value
Battery fail	Battery Fail ON/OFF	Bit position 0 in 32 bit field (1 if ON, 0 if OFF)
Field voltage fail	Field V Fail ON/OFF	Bit position 1 in 32 bit field (1 if ON, 0 if OFF)
Setting group via opto invalid	Setting Grp Invalid ON/OFF	Bit position 2 in 32 bit field (1 if ON, 0 if OFF)
Protection disabled	Prot' n Disabled ON/OFF	Bit position 3 in 32 bit field (1 if ON, 0 if OFF)
Frequency out of range	Freq. out of Range ON/OFF	Bit position in 32 bit field (1 if ON, 0 if OFF)
Frequency >70Hz	Freq. High	Bit position 4 in 32 bit field (1 if ON, 0 if OFF)

The previous table shows the abbreviated description that is given to the various alarm conditions and also a corresponding value between 0 and 31. This value is appended to each alarm event in a similar way as for the input and output events previously described. It is used by the event extraction software, such as MiCOM S1, to identify the alarm and is therefore invisible if the event is viewed on the LCD. Either ON or OFF is shown after the description to signify whether the particular condition has become operated or has reset.

3.2.4 Protection element starts and trips

Any operation of protection elements, (either a start or a trip condition), will be logged as an event record, consisting of a text string indicating the operated element and an event value. The event value is displayed as a bit position in a 32 bit field. The bit will be set to 1 if the element turns on or 0 if it turns off. See document P94x/EN GC/D11, Event record data format, for the bit positions corresponding to each element. Again, this value is intended for use by the event extraction software, such as MiCOM S1, rather than for the user, and is therefore invisible when the event is viewed on the LCD.

3.2.5 General events

A number of events come under the heading of ‘General Events’ - an example is shown below:

Nature of Event	Displayed Text in Event Record	Displayed Value
Level 1 password modified Either from user interface, front or rear port	PW1 Modified UI, F or R	6, 11 and 16 respectively

A complete list of the ‘General Events’ is given in document P94x/EN GC/D11.

3.2.6 Fault records

Each time a fault record is generated, an event is also created. The event simply states that a fault record was generated, with a corresponding time stamp.

Note that viewing of the actual fault record is carried out in the ‘Select Fault’ cell further down the ‘VIEW RECORDS’ column, which is selectable from up to 5 records. These records consist of fault flags, fault measurements etc. Also note that the time stamp given in the fault record itself will be more accurate than the corresponding stamp given in the event record as the event is logged some time after the actual fault record is generated.

The fault record is triggered from the ‘Fault REC TRIG’ signal assigned in the programmable scheme logic (PSL). Note the fault measurements in the fault record are given at the time the ‘Fault REC TRIG’ signal is asserted high and that before any new data or record can be stored, the ‘Fault REC TRIG’ signal must be allowed to reset.

3.2.7 Maintenance reports

Internal failures detected by the self monitoring circuitry, such as watchdog failure, field voltage failure etc. are logged into a maintenance report. The maintenance report holds up to 5 such ‘events’ and is accessed from the ‘Select Report’ cell at the bottom of the ‘VIEW RECORDS’ column.

Each entry consists of a self explanatory text string and a ‘Type’ and ‘Data’ cell, which are explained in the menu extract at the beginning of this section and in further detail in document P94x/EN GC/D11.

Each time a maintenance report is generated, an event is also created. The event simply states that a report was generated, with a corresponding time stamp.

3.2.8 Setting changes

Changes to any setting within the relay are logged as an event. Two examples are shown in the following table:

Type of Setting Change	Displayed Text in Event Record	Displayed Value
Control/support setting	CS Changed	22
Group 1 change	Group 1 Changed	24

Note: Control & support support settings (C&S) are communications, measurement, VT ratio settings etc, which are not duplicated within the four setting groups.
When any of these settings are changed, the event record is created simultaneously. However, changes to protection or disturbance recorder settings will only generate an event once the settings have been confirmed at the 'setting trap'.

3.2.9 Resetting of event/fault records

If it is required to delete either the event, fault or maintenance reports, this may be done from within the ‘RECORD CONTROL’ column.

3.2.10 Viewing event records via MiCOM S1 support software

When the event records are extracted and viewed on a PC they look slightly different than when viewed on the LCD. The following shows an example of how various events appear when displayed using MiCOM S1

Example 1 - Setting change

+ Wednesday 02 January 1992 03:00:00.177 GMT PW Unlocked R
When double clicked the display will expand to:

– Wednesday 02 January 1992 03:00:00.177 GMT PW Unlocked R
AREVA: MiCOM P943
Model Number: P943114A1A0050A
Address: 001 Column: 00 Row: 02
Event Type: Setting event
Event Value 14

Example 2 - Protection event

+ Wednesday 02 January 1992 02:08:25.229 GMT V < 1 Trip ON
expands to:

– Wednesday 02 January 1992 02:08:25.229 GMT V < 1 Trip ON
AREVA: MiCOM P943
Model Number: P943114A1A0050A
Address: 001 Column: 0F Row: 26
Event Type: Setting event
Event Value 00000000000000000000000000000100

Example 3 - Output relay change of state

+ Friday 29 September 2000 12:03:55.025 GMT Output Contacts

– AREVA: MiCOM P943
Model Number: P943114A1A0050A
Address: 001 Column: 00 Row: 21
Event Type: Device output changed state

Event Value	00000000000001	
ON	0	Relay Label 01
OFF	1	Relay Label 02
OFF	2	Relay Label 03
OFF	3	Relay Label 04
OFF	4	Relay Label 05
OFF	5	Relay Label 06
OFF	6	Relay Label 07
OFF	7	Relay Label 08
OFF	8	Relay Label 09
OFF	9	Relay Label 10
OFF	10	Relay Label 11
OFF	11	Relay Label 12
OFF	12	Relay Label 13
OFF	13	Relay Label 14

Example 4 - Alarm event

+ Wednesday 02 January 1992 22:40:27.756 GMT Battery Fail ON

– AREVA: MiCOM P943
Model Number: P943114A1A0050A
Address: 001 Column: 00 Row: 22
Event Type: Alarm event

Event Value	00000000000000000000000000000001	
ON	0	Battery Fail
OFF	1	Field Volt Fail
OFF	2	SG-opto Invalid
OFF	3	Prot'n Disabled
OFF	4	Freq High

OFF	5	Freq Low
OFF	6	Freq Not Found
OFF	7	Wrong Setting
OFF	8	Stats Corrupt
OFF	9	Gen Timers Bad
OFF	10	UV Block
OFF	11	Trip LED Enabled
OFF	12	SR User Alarm 1
OFF	13	SR User Alarm 2
OFF	14	SR User Alarm 3
OFF	15	SR User Alarm 4
OFF	16	SR User Alarm 5
OFF	17	SR User Alarm 6
OFF	18	SR User Alarm 7
OFF	19	SR User Alarm 8
OFF	20	SR User Alarm 9
OFF	21	SR User Alarm 10
OFF	22	MR User Alarm 11
OFF	23	MR User Alarm 12
OFF	24	MR User Alarm 13
OFF	25	MR User Alarm 14
OFF	26	MR User Alarm 15
OFF	27	MR User Alarm 16
OFF	28	MR User Alarm 17
OFF	29	MR User Alarm 18
OFF	30	MR User Alarm 19
OFF	31	MR User Alarm 20

As can be seen, the first line gives the description and time stamp for the event, whilst the additional information that is displayed below may be collapsed via the + / - symbol.

For further information regarding events and their specific meaning, refer to document P94x/EN GC/D11.

3.2.11 Event filtering

It is possible to disable the reporting of events from any user interface that supports setting changes. The settings which control the various types of events are in the Record Control column. The effect of setting each to disabled is as follows:

Alarm Event	None of the occurrences that produce an alarm will result in an event being generated. The presence of any alarms is still reported by the alarm LED flashing and the alarm bit being set in the communications status byte. Alarms can still be read using the Read key on the relay front panel.
Relay O/P Event	No event will be generated for any change in relay output state.
Opto Input Event	No event will be generated for any change in logic input state.
System Event	No General Events will be generated.

Fault Rec Event	No event will be generated for any fault that produces a fault record. The fault records can still be viewed by operating the ”Select Fault” setting in column 0100.
Maint Rec Event	No event will be generated for any occurrence that produces a maintenance record. The maintenance records can still be viewed by operating the “Select Maint” setting in column 0100.
Protection Event	Any operation of protection elements will not be logged as an event.

Note that some occurrences will result in more than one type of event, e.g. a battery failure will produce an alarm event and a maintenance record event.

If the Protection Event setting is Enabled a further set of settings is revealed which allow the event generation by individual DDB signals to be enabled or disabled.

3.3 Disturbance recorder

The integral disturbance recorder has an area of memory specifically set aside for record storage. The number of records that may be stored is dependent upon the selected recording duration but the relays typically have the capability of storing a minimum of 20 records, each of 10.5 second duration. Disturbance records continue to be recorded until the available memory is exhausted, at which time the oldest record(s) are overwritten to make space for the newest one.

The recorder stores actual samples which are taken at a rate of 24 samples per cycle.

Each disturbance record consists of four analogue data channels and thirty-two digital data channels. The relevant VT ratios for the analogue channels are also extracted to enable scaling to primary quantities.

The ‘DISTURBANCE RECORDER’ menu column is shown below:

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
DISTURB RECORDER				
Duration	10s	0.1s	10.5 s	0.01s
Trigger position	70%	0	100%	0.1
Trigger mode	Single	Single or extended		
Analog channel 1	Frequency	FREQ		
Analog channel 2	VAN	VAN, VBN, VCN		
Analog channel 3	VBN	VAN, VBN, VCN		
Analog channel 4	VCN	VAN, VBN, VCN		

Menu Text	Default Setting	Setting Range		Step Size
		Min	Max	
Digital inputs 1 to 32	StgI Freq Sta Stg2 Freq Sta Stg3 Freq Sta Stg4 Freq Sta Stg5 Freq Sta Stg6 Freq Sta StgI Freq Trp Stg2 Freq Trp Stg3 Freq Trp Stg4 Freq Trp Stg5 Freq Trp Stg6 Freq Trp V<1 Start V<2 Start V>1 Start V>2 Start V<1 Trip V<2 Trip V>1 Trip V>2 Trip Freq High Freq Low Freq Not Found Unused Unused Unused Unused Unused Unused Unused	Any of 7 or 14 O/P contacts or Any of 8 or 16 opto inputs or Internal Digital signals		
Inputs 1 to 32 Trigger	Trigger L/H	No Trigger, Trigger L/H, Trigger H/L		

The pre and post fault recording times are set by a combination of the 'Duration' and 'Trigger Position' cells. 'Duration' sets the overall recording time and the 'Trigger Position' sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 10s with the trigger point being at 70% of this, giving 7s pre-fault and 3s post fault recording times.

If a further trigger occurs whilst a recording is taking place, the recorder will ignore the trigger if the 'Trigger Mode' has been set to 'Single'. However, if this has been set to 'Extended', the post trigger timer will be reset to zero, thereby extending the recording time.

As can be seen from the menu, each of the analogue channels is selectable from the available analogue inputs to the relay. The digital channels may be mapped to any of the opto isolated inputs or output contacts, in addition to a number of internal relay digital signals, such as protection starts, etc. The complete list of these signals may be found by viewing the available settings in the relay menu or via a setting file in MiCOM S1. Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition, via the 'Input Trigger' cell.

It is not possible to view the disturbance records locally via the LCD; they must be extracted using suitable software such as MiCOM S1. This process is fully explained in P94x/EN CT/D11.

3.4 Measurements

The relay produces a variety of both directly measured and calculated power system quantities. These measurement values are updated on a per second basis and are summarised below:

- Phase Voltages
- Phase to Phase Voltage
- Sequence Voltages
- Rms. Voltages
- Frequency

3.4.1 Measured voltages

The relay produces both phase to ground and phase to phase voltage values. They are produced directly from the DFT (Discrete Fourier Transform) used by the relay protection functions and present both magnitude and phase angle measurement.

3.4.2 Sequence voltages

Sequence quantities are produced by the relay from the measured Fourier values; these are displayed as magnitude values.

3.4.3 Rms. voltages and currents

Rms. Phase voltage values are calculated by the relay using the sum of the samples squared over a cycle of sampled data.

3.4.4 Settings

The following settings under the heading Measurement Setup can be used to configure the relay measurement function.

Menu Text	Default Value	Options/Limits
MEASUREMENT SETUP		
Default Display	Date and Time	Plant Reference / Description / Date and Time / Access Level / 3Ph Voltage / Frequency
Local Values	Primary	Primary / Secondary
Remote Values	Primary	Primary / Secondary
Measurement Ref	VA	VA / VB / VC

Default display

This setting can be used to select the default display from a range of options, noting that it is also possible to view the other default displays whilst at the default level using the and keys. However once the 15 minute timeout elapses the default display will revert to that selected by this setting.

Local values

This setting controls whether measured values via the front panel user interface and the front Courier port are displayed as primary or secondary quantities.

Remote values

This setting controls whether measured values via the rear communication port are displayed as primary or secondary quantities.

Measurement ref.

Using this setting the phase reference for all angular measurements by the relay can be selected.

3.5 Stage statistics

The “STAGE STATISTICS” menu column of the relay provides information on the number of starts and trips that have occurred for each stage of each of the frequency protection elements. In addition to the start and trip statistics a revision date is given for each stage of frequency protection that will record the date and time that the last change of setting was made in any of the frequency protection elements. For example, the “Stg1 Revn Date” cell will record the date and time that the most recent setting change took place in stage 1 of any of the “f+t”, “df/dt+t”, “f+df/dt” or “f+Df/Dt” protection elements.

Each of the counters in the stage statistics simply accumulates until they are reset back to zero using the “Reset Timers” cell located at the end of the column. When the statistics are reset, all the revision dates will also be reset to the current date and time.

3.6 Generator abnormal timers

When the generator abnormal protection is enabled within the “CONFIGURATION” column of the relay, an additional “GENR ABN TIMERS” column will appear in the relay menu, to display the time spent in each of the generator abnormal frequency bands. It is also possible to reset the generator abnormal timers back to zero using the “Reset Timers” cell within this column.

3.7 Changing setting groups

The setting groups can be changed either via opto inputs or via a menu selection. In the Configuration column if 'Setting Group- select via optos' is selected, optos 1 and 2 which are dedicated for setting group selection, can be used to select the setting group as shown in the table below. If 'Setting Group- select via menu' is selected in the Configuration column, the 'Active Settings - Group1/2/3/4' can be used to select the setting group. If this option is used, opto inputs 1 and 2 can be used for other functions in the programmable scheme logic.

OPTO 1	OPTO 2	Selected Setting Group
0 (de-energised)	0 (de-energised)	1
1 (energised)	0 (de-energised)	2
0 (de-energised)	1 (energised)	3
1 (energised)	1 (energised)	4

Note: Each setting group has its own PSL. Once a PSL has been designed it can be sent to any one of 4 setting groups within the relay. When downloading a PSL to the relay the user will be prompted to enter the desired setting group to which it will be sent. This is also the case when extracting a PSL from the relay.

3.8 VT connections

3.8.1 Open delta (vee connected) VT's

The P940 range can be used with vee connected VTs by connecting the VT secondaries to C19, C20 and C21 input terminals, with the C22 input left unconnected. This type of VT arrangement cannot pass zero-sequence (residual) voltage to the relay, or provide any phase to neutral voltage quantities. Therefore any protection that is dependent upon phase to neutral voltage measurements should be disabled. The under and over voltage protection can be set as phase-to-phase measurement with vee connected VTs.

The accuracy of the single phase voltage measurements can be impaired when using vee connected VT's because the relay attempts to derive the phase to neutral voltages from the phase to phase voltage vectors. If the impedance of the voltage inputs were perfectly matched the phase to neutral voltage measurements would be correct, provided the phase to phase voltage vectors were balanced. However, in practice there are small differences in the impedance of the voltage inputs, which can cause small errors in the phase to neutral voltage measurements. The phase to neutral voltage measurement accuracy can be improved by connecting 3, well matched, load resistors between the phase voltage inputs (C19, C20, C21) and neutral C22, thus creating a 'virtual' neutral point. The load resistor values must be chosen so that their power consumption is within the limits of the VT. It is recommended that 10k ±1% (6W) resistors are used for the 110V (Vn) rated relay, assuming the VT can supply this burden.

3.8.2 VT single point earthing

The P940 range will function correctly with conventional 3 phase VT's earthed at any one point on the VT secondary circuit. Typical earthing examples being neutral earthing or yellow (B) phase earthing.

4. PROGRAMMABLE SCHEME LOGIC DEFAULT SETTINGS

The relay includes programmable scheme logic (PSL). The purpose of this logic is multi-functional and includes the following:

- Enables the mapping of opto-isolated inputs, relay output contacts and the programmable LED's
- Provides relay output conditioning (delay on pick-up/drop-off, dwell time, latching or self-reset)
- Fault Recorder start mapping, i.e. which internal signals initiate a fault record
- Trip LED illumination mapping, i.e. which internal signals cause the Trip LED to switch on
- Enables customer specific scheme logic to be generated through the use of the PSL editor inbuilt into the MiCOM S1 support software

Further information regarding editing and the use of PSL can be found in the MiCOM S1 user manual. The following section details the default settings of the PSL. Note that changes to these defaults can only be carried out using the PSL editor and not via the relay front-plate.

4.1 Logic input mapping

The default mappings for each of the opto-isolated inputs are as shown in the following table:

Opto Input No.	P941 Relay Text	P942 Relay Text	P943 Relay Text
1	L1 Setting Group	L1 Setting Group	L1 Setting Group
2	L2 Setting Group	L2 Setting Group	L2 Setting Group
3	L3 Stg1 f+t Block	L3 Stg1 f+t Block	L3 Stg1 f+t Block
4	L4 Stg2 f+t Block	L4 Stg2 f+t Block	L4 Stg2 f+t Block
5	L5 Stg3 f+t Block	L5 Stg3 f+t Block	L5 Stg3 f+t Block
6	L6 Stg4 f+t Block	L6 Stg4 f+t Block	L6 Stg4 f+t Block
7	L7 Stg6 f+t Block	L7 Stg6 f+t Block	L7 Stg6 f+t Block
8	L8 Voltage Block	L8 Voltage Block	L8 Voltage Block
9			L9 Not Used
10			L10 Not Used
11			L11 Not Used
12			L12 Not Used
13			L13 Not Used
14			L14 Not Used
15			L15 Not Used
16			L16 Not Used

Note: If the "Setting Group" cell in the "CONFIGURATION" column is set to "Select via Opto", the opto's that are used for changing setting groups are always opto's 1 and 2. This mapping is effectively hardwired and does not therefore need to be mapped within the PSL.

4.2 Relay output contact mapping

The default mappings for each of the relay output contacts are as shown in the following table:

Relay Contact No.	P941 Relay Text	P942 Relay Text	P943 Relay Text
1	R1 Stg1 f+t Trip	R1 Stg1 f+t Trip	R1 Stg1 f+t Trip
2	R2 Stg2 f+t Trip	R2 Stg2 f+t Trip	R2 Stg2 f+t Trip
3	R3 Stg3 f+t Trip	R3 Stg3 f+t Trip	R3 Stg3 f+t Trip
4	R4 Stg4 f+t Trip	R4 Stg4 f+t Trip	R4 Stg4 f+t Trip
5	R5 Stg6 f+t Trip	R5 Stg6 f+t Trip	R5 Stg6 f+t Trip
6	R6 Voltage Start	R6 Stg1f+Df/Dt T	R6 Stg1f+Df/Dt T

Relay Contact No.	P941 Relay Text	P942 Relay Text	P943 Relay Text
7	R7 Voltage Trips	R7 Stg2f+df/dt T	R7 Stg2f+df/dt T
8		R8 Stg3f+df/dt T	R8 Stg3f+df/dt T
9		R9 Stg4f+df/dt T	R9 Stg4f+df/dt T
10		R10 Voltage Strt	R10 Voltage Strt
11		R11 Voltage Trip	R11 Voltage Trip
12		R12 Gen Abn Trip	R12 Gen Abn Trip
13		R13 Stg1 Restore	R13 Stg1 Restore
14		R14 Stg2 Restore	R14 Stg2 Restore

4.3 Relay output conditioning

The default conditioning of each of the output contacts is as shown in the following table:

Relay Contact No.	P941 Relay	P942 Relay	P943 Relay
1	Dwell 100ms	Dwell 100ms	Dwell 100ms
2	Dwell 100ms	Dwell 100ms	Dwell 100ms
3	Dwell 100ms	Dwell 100ms	Dwell 100ms
4	Dwell 100ms	Dwell 100ms	Dwell 100ms
5	Dwell 100ms	Dwell 100ms	Dwell 100ms
6	Straight	Dwell 100ms	Dwell 100ms
7	Dwell 100ms	Dwell 100ms	Dwell 100ms
8		Dwell 100ms	Dwell 100ms
9		Dwell 100ms	Dwell 100ms
10		Straight	Straight
11		Dwell 100ms	Dwell 100ms
12		Dwell 100ms	Dwell 100ms
13		Dwell 100ms	Dwell 100ms
14		Dwell 100ms	Dwell 100ms

4.4 Programmable LED output mapping

The default mappings for each of the programmable LED's are as shown in the following table:

LED Number	P941 Relay	P942 Relay	P943 Relay
1	Stage 1 Freq Start	Stage 1 Freq Start	Stage 1 Freq Start
2	Stage 2 Freq Start	Stage 2 Freq Start	Stage 2 Freq Start
3	Stage 3 Freq Start	Stage 3 Freq Start	Stage 3 Freq Start
4	Stage 4 Freq Start	Stage 4 Freq Start	Stage 4 Freq Start
5	Stage 5 Freq Start	Stage 5 Freq Start	Stage 5 Freq Start
6	Voltage Start	Voltage Start	Voltage Start
7	Voltage Trip	Load Restoration	Load Restoration
8	Undervoltage Block	Undervoltage Block	Undervoltage Block

4.5 Fault recorder start mapping

The default mapping for the signal which initiates a fault record is shown in the following table:

P941 Relay	P942 Relay	P943 Relay
R1 Stg1 f+t Trip R2 Stg2 f+t Trip R3 Stg3 f+t Trip R4 Stg4 f+t Trip R5 Stg6 f+t Trip R7 Voltage Trips	R1 Stg1 f+t Trip R2 Stg2 f+t Trip R3 Stg3 f+t Trip R4 Stg4 f+t Trip R5 Stg6 f+t Trip R6 Stg1f+Df/Dt T R7 Stg2f+df/dt T R8 Stg3f+df/dt T R9 Stg4f+df/dt T R11 Voltage Trip R12 Gen Abn Trip	R1 Stg1 f+t Trip R2 Stg2 f+t Trip R3 Stg3 f+t Trip R4 Stg4 f+t Trip R5 Stg6 f+t Trip R6 Stg1f+Df/Dt T R7 Stg2f+df/dt T R8 Stg3f+df/dt T R9 Stg4f+df/dt T R11 Voltage Trip R12 Gen Abn Trip

The fault record trigger (DDB 128) requires a rising edge for operation. In other words, the input to the FRT signal must go from a low (de-energised) to a high (energised) state. When the rising edge occurs, a fault record is generated and the amber Alarm LED is illuminated (flashing). When a fault record is generated, the data can be viewed on the LCD using the key, and reset by the key if the correct password level is active. Any subsequent fault record will only be generated on a new rising edge of the fault recorder trigger DDB signal. It is therefore recommended that all the initiating signals to the fault recorder trigger are self-resetting.

Note: Since the data is captured on the rising edge, it is possible to clear the record on the default display even though the initiating signals are still active. However, the information may still be viewed in the "VIEW RECORDS" column of the menu.

4.6 Trip LED illumination mapping

The default mapping for the signal which illuminates the trip LED is shown in the following table:

P941 Relay	P942 Relay	P943 Relay
R1 Stg1 f+t Trip R2 Stg2 f+t Trip R3 Stg3 f+t Trip R4 Stg4 f+t Trip R5 Stg6 f+t Trip R7 Voltage Trips	R1 Stg1 f+t Trip R2 Stg2 f+t Trip R3 Stg3 f+t Trip R4 Stg4 f+t Trip R5 Stg6 f+t Trip R6 Stg1f+Df/Dt T R7 Stg2f+df/dt T R8 Stg3f+df/dt T R9 Stg4f+df/dt T R11 Voltage Trip R12 Gen Abn Trip	R1 Stg1 f+t Trip R2 Stg2 f+t Trip R3 Stg3 f+t Trip R4 Stg4 f+t Trip R5 Stg6 f+t Trip R6 Stg1f+Df/Dt T R7 Stg2f+df/dt T R8 Stg3f+df/dt T R9 Stg4f+df/dt T R11 Voltage Trip R12 Gen Abn Trip

As soon as the Trip LED Enabled signal (DDB 302) is energised the red Trip LED and the amber Alarm LED will be illuminated. These LED's can only be reset when the initiating condition has been removed which implies that all the initiating signals to the Trip LED Enabled DDB must be self-resetting. After the initiating signal has been removed, the Trip LED will remain lit until reset using the ⓒ key.

5. COMMISSIONING TEST MENU

To help minimise the time required to test MiCOM relays the relay provides several test facilities under the 'COMMISSION TESTS' menu heading. There are menu cells which allow the status of the opto-isolated inputs, output relay contacts, internal digital data bus (DDB) signals and user-programmable LEDs to be monitored. Additionally there are cells to test the operation of the output contacts and user-programmable LEDs.

The following table shows the relay menu of commissioning tests, including the available setting ranges and factory defaults:

Menu Text	Default Setting	Settings
COMMISSION TESTS		
Opto I/P Status		
Relay O/P Status		
Test Port Status		
LED Status	-	-
Monitor Bit 1	64 (LED 1)	0 to 511 See P94x/EN GC/C11 for details of Digital Data Bus (DDB) signals
Monitor Bit 2	65 (LED 2)	0 to 511
Monitor Bit 3	66 (LED 3)	0 to 511
Monitor Bit 4	67 (LED 4)	0 to 511
Monitor Bit 5	68 (LED 5)	0 to 511
Monitor Bit 6	69 (LED 6)	0 to 511

Menu Text	Default Setting	Settings
COMMISSION TESTS		
Monitor Bit 7	70 (LED 7)	0 to 511
Monitor Bit 8	71 (LED 8)	0 to 511
Test Mode	Disabled	Disabled / Test Mode / Contacts Blocked
Test Pattern	All bits set to 0	0 = Not operated 1 = Operated
Contact Test	No Operation	No Operation / Apply Test / Remove Test
Test LEDs	No Operation	No Operation / Apply Test

5.1 Opto I/P status

This menu cell displays the status of the relay's opto-isolated inputs as a binary string, a '1' indicating an energised opto-isolated input and a '0' a de-energised one. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each logic input. It can be used during commissioning or routine testing to monitor the status of the opto-isolated inputs whilst they are sequentially energised with a suitable dc voltage.

5.2 Relay O/P status

This menu cell displays the status of the digital data bus (DDB) signals that result in energisation of the output relays as a binary string, a '1' indicating an operated state and '0' a non-operated state. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each relay output.

The information displayed can be used during commissioning or routine testing to indicate the status of the output relays when the relay is 'in service'. Additionally fault finding for output relay damage can be performed by comparing the status of the output contact under investigation with it's associated bit.

Note: When the 'Test Mode' cell is set to 'Contacts Disabled' this cell will continue to indicate which contacts would operate if the relay was in-service, but does not show the actual status of the output relays.

5.3 Test port status

This menu cell displays the status of the eight digital data bus (DDB) signals that have been allocated in the 'Monitor Bit' cells. If the cursor is moved along the binary number the corresponding DDB signal text string will be displayed for each monitor bit.

By using this cell with suitable monitor bit settings, the state of the DDB signals can be displayed as various operating conditions or sequences are applied to the relay. Thus the programmable scheme logic can be tested.

As an alternative to using this cell, the optional monitor/download port test box can be plugged into the monitor/download port located behind the bottom access cover. Details of the monitor/download port test box can be found in section 5.10 of P94x/EN AP/C11.

5.4 LED status

The ‘LED Status’ cell is an eight bit binary string that indicates which of the user-programmable LEDs on the relay are illuminated, a ‘1’ indicating a particular LED is lit and a ‘0’ not lit.

5.5 Monitor bits 1 to 8

The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.

Each ‘Monitor Bit’ is set by entering the required digital data bus (DDB) signal number (0 – 511) from the list of available DDB signals in section P94x/EN GC/C11 of this guide. The pins of the monitor/download port used for monitor bits are given in the table below. The signal ground is available on pins 18, 19, 22 and 25.

Monitor bit	1	2	3	4	5	6	7	8
Monitor/download port pin	11	12	15	13	20	21	23	24

THE MONITOR/DOWNLOAD PORT IS NOT ELECTRICALLY ISOLATED AGAINST INDUCED VOLTAGES ON THE COMMUNICATIONS CHANNEL. IT SHOULD THEREFORE ONLY BE USED FOR LOCAL COMMUNICATIONS.

5.6 Test mode

This menu cell is to allow secondary injection testing to be performed on the relay. It also enables a facility to directly test the output contacts by applying menu controlled test signals. To select test mode the option ‘Test Mode’ should be selected. This takes the relay out of service causing an alarm condition to be recorded and the yellow ‘Out of Service’ LED to illuminate and in relays using IEC60870-5-103 protocol, changes the Cause of Transmission, COT, to Test Mode. (Test mode can also be selected by energising an opto mapped to the Test Mode signal in the programmable scheme logic). If it is required to disable the output contacts in addition to the above, the test mode should be set to ‘Contacts Blocked’.

Once testing is complete the cell must be set back to ‘Disabled’ to restore the relay back to service.

5.7 Test pattern

The ‘Test Pattern’ cell is used to select the output relay contacts that will be tested when the ‘Contact Test’ cell is set to ‘Apply Test’. The cell has a binary string with one bit for each user-configurable output contact which can be set to ‘1’ to operate the output under test conditions and ‘0’ to not operate it. This cell is only visible if the ‘Test Mode’ cell is set to ‘Contacts Blocked’.

5.8 Contact test

When the ‘Apply Test’ command in this cell is issued the contacts set for operation (set to ‘1’) in the ‘Test Pattern’ cell change state. After the test has been applied the command text on the LCD will change to ‘No Operation’ and the contacts will remain in the Test State until reset by issuing the ‘Remove Test’ command. The command text on the LCD will again revert to ‘No Operation’ after the ‘Remove Test’ command has been issued.

Note: When the 'Test Mode' cell is set to 'Contacts Blocked' the 'Relay O/P Status' cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.

5.9 Test LEDs

When the 'Apply Test' command in this cell is issued the eight user-programmable LED's will illuminate for approximately 2 seconds before they extinguish and the command text on the LCD reverts to 'No Operation'.

5.10 Using a monitor/download port test box

A monitor/download port test box (part no. ZG1094 001) containing 8 LED's and a switchable audible indicator is available from AREVA T&D, or one of their regional sales offices. It is housed in a small plastic box with a 25-pin male D-connector that plugs directly into the relay's monitor/download port. There is also a 25-pin female D-connector which allows other connections to be made to the monitor/download port whilst the monitor/download port test box is in place. Each LED corresponds to one of the monitor bit pins on the monitor/download port with 'Monitor Bit 1' being on the left hand side when viewing from the front of the relay. The audible indicator can either be selected to sound if a voltage appears on any of the eight monitor pins or remain silent so that indication of state is by LED alone.

RELAY DESCRIPTION

CONTENT

1. RELAY SYSTEM OVERVIEW

1.1 Hardware overview

The relay hardware is based on a modular design whereby the relay is made up of an assemblage of several modules which are drawn from a standard range. Some modules are essential while others are optional depending on the user's requirements.

The different modules that can be present in the relay are as follows:

1.1.1 Processor board

The processor board performs all calculations for the relay and controls the operation of all other modules within the relay. The processor board also contains and controls the user interfaces (LCD, LEDs, keypad and communication interfaces).

1.1.2 Input module

The input module converts the information contained in the analogue and digital input signals into a format suitable for processing by the processor board. The standard input module consists of two boards: a transformer board to provide electrical isolation and a main input board which provides analogue to digital conversion and the isolated digital inputs.

1.1.3 Power supply module

The power supply module provides a power supply to all of the other modules in the relay, at three different voltage levels. The power supply board also provides the EIA(RS)485 electrical connection for the rear communication port. On a second board the power supply module contains the relays which provide the output contacts.

1.1.4 IRIG-B board

This board, which is optional, can be used where an IRIG-B signal is available to provide an accurate time reference for the relay. There is also an option on this board to specify a fibre optic rear communication port, for use with IEC 60870 communication only.

All modules are connected by a parallel data and address bus which allows the processor board to send and receive information to and from the other modules as required. There is also a separate serial data bus for conveying sample data from the input module to the processor. Figure 1 shows the modules of the relay and the flow of information between them.

1.2 Software overview

The software for the relay can be conceptually split into four elements: the real-time operating system, the system services software, the platform software and the protection and control software. These four elements are not distinguishable to the user, and are all processed by the same processor board. The distinction between the four parts of the software is made purely for the purpose of explanation here:

1.2.1 Real-time operating system

The real time operating system is used to provide a framework for the different parts of the relay's software to operate within. To this end the software is split into tasks. The real-time operating system is responsible for scheduling the processing of these tasks such that they are carried out in the time available and in the desired order of priority. The operating system is also responsible for the exchange of information between tasks, in the form of messages.

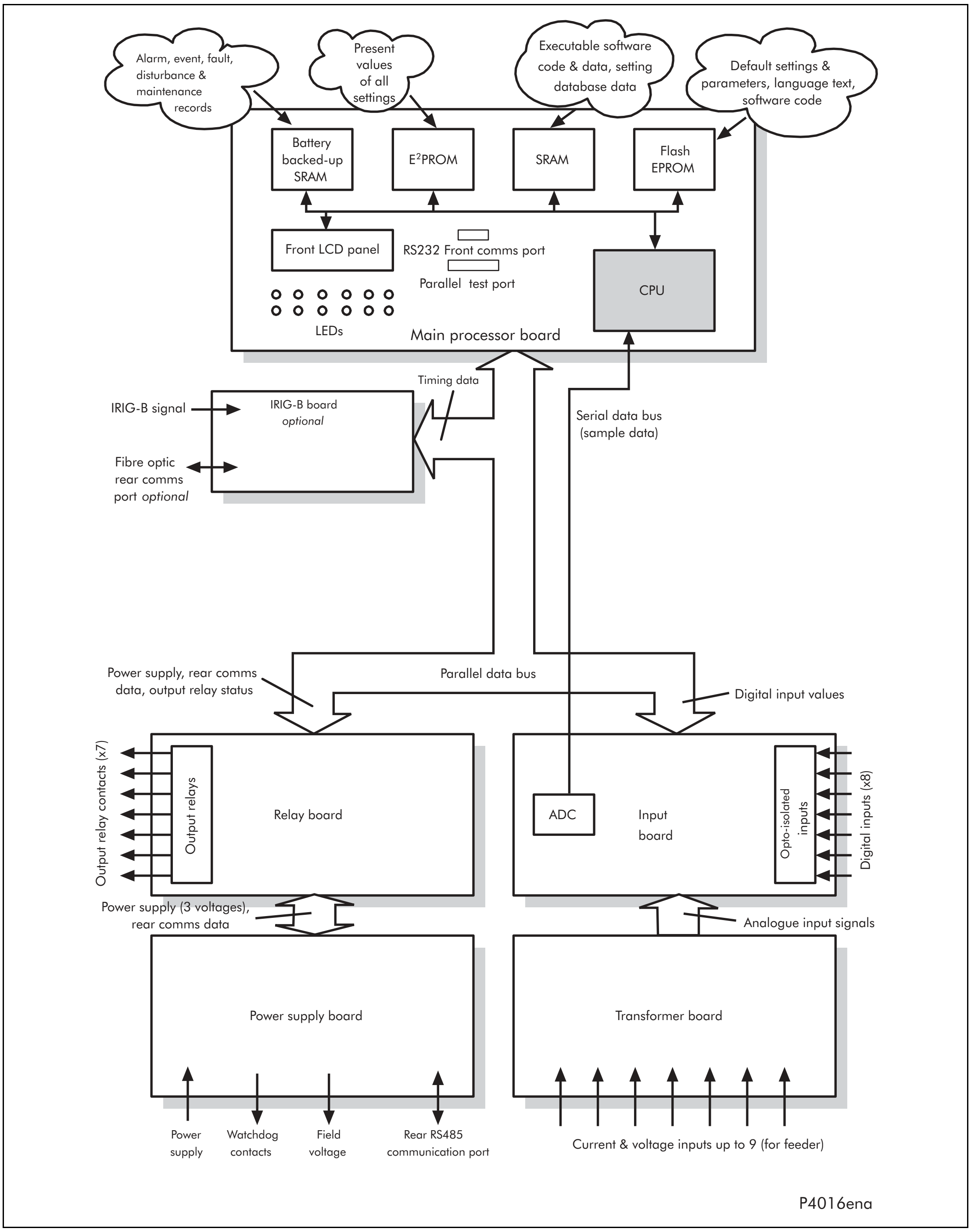


Figure 1: Relay modules and information flow

1.2.2 System services software

The system services software provides the low-level control of the relay hardware. For example, the system services software controls the boot of the relay's software from the non-volatile flash EPROM memory at power-on, and provides driver software for the user interface via the LCD and keypad, and via the serial communication ports. The system services software provides an interface layer between the control of the relay's hardware and the rest of the relay software.

1.2.3 Platform software

The platform software deals with the management of the relay settings, the user interfaces and logging of event, alarm, fault and maintenance records. All of the relay settings are stored in a database within the relay which provides direct compatibility with Courier communications. For all other interfaces (i.e. the front panel keypad and LCD interface, Modbus, IEC 60870-5-103 and DNP3.0) the platform software converts the information from the database into the format required. The platform software notifies the protection & control software of all settings changes and logs data as specified by the protection & control software.

1.2.4 Protection & control software

The protection and control software performs the calculations for all of the protection algorithms of the relay. This includes digital signal processing such as Fourier filtering and ancillary tasks such as the measurements. The protection & control software interfaces with the platform software for settings changes and logging of records, and with the system services software for acquisition of sample data and access to output relays and digital opto-isolated inputs.

1.2.5 Disturbance recorder

The disturbance recorder software is passed the sampled analogue values and logic signals from the protection and control software. This software compresses the data to allow a greater number of records to be stored. The platform software interfaces to the disturbance recorder to allow extraction of the stored records.

2. HARDWARE MODULES

The relay is based on a modular hardware design where each module performs a separate function within the relay operation. This section describes the functional operation of the various hardware modules.

2.1 Processor board

The relay is based around a TMS320C32 floating point, 32-bit digital signal processor (DSP) operating at a clock frequency of 20MHz. This processor performs all of the calculations for the relay, including the protection functions, control of the data communication and user interfaces including the operation of the LCD, keypad and LEDs.

The processor board is located directly behind the relay's front panel which allows the LCD and LEDs to be mounted on the processor board along with the front panel communication ports. These comprise the 9-pin D-connector for EIA(RS)232 serial communications (e.g. using MiCOM S1 and Courier communications) and the 25-pin D-connector relay test port for parallel communication. All serial communication is handled using a two-channel 85C30 serial communications controller (SCC).

The memory provided on the main processor board is split into two categories, volatile and non-volatile: the volatile memory is fast access (zero wait state) SRAM which is used for the storage and execution of the processor software, and data storage as required during the processor's calculations. The non-volatile memory is sub-divided into 3 groups: 2MB of flash memory for non-volatile storage of software code and text together with default settings, 256kB of battery backed-up SRAM for the storage of disturbance, event, fault and maintenance record data, and 32kB of E^2PROM memory for the storage of configuration data, including the present setting values.

2.2 Internal communication buses

The relay has two internal buses for the communication of data between different modules. The main bus is a parallel link which is part of a 64-way ribbon cable. The ribbon cable carries the data and address bus signals in addition to control signals and all power supply lines. Operation of the bus is driven by the main processor board which operates as a master while all other modules within the relay are slaves.

The second bus is a serial link which is used exclusively for communicating the digital sample values from the input module to the main processor board. The DSP processor has a built-in serial port which is used to read the sample data from the serial bus. The serial bus is also carried on the 64-way ribbon cable.

2.3 Input module

The input module provides the interface between the relay processor board and the analogue and digital signals coming into the relay. The input module consists of two PCBs; the main input board and a transformer board. The P941, P942 and P943 relays provide three voltage inputs.

2.3.1 Transformer board

The transformer board holds three voltage transformers (VTs) and can be specified for either 110V or 440V nominal voltage (order option). The transformers are used both to step-down the voltages to levels appropriate to the relay's electronic circuitry and to provide effective isolation between the relay and the power system. The connection arrangements of voltage transformer secondaries provide differential input signals to the main input board to reduce noise.

2.3.2 Input board

The main input board is shown as a block diagram in Figure 2. It provides the circuitry for the digital input signals and the analogue-to-digital conversion for the analogue signals. Hence it takes the differential analogue signals from the VTs on the transformer board(s), converts these to digital samples and transmits the samples to the processor board via the serial data bus. On the input board the analogue signals are passed through an anti-alias filter before being multiplexed into a single analogue-to-digital converter chip. The A-D converter provides 16-bit resolution and a serial data stream output. The digital input signals are opto isolated on this board to prevent excessive voltages on these inputs causing damage to the relay's internal circuitry.

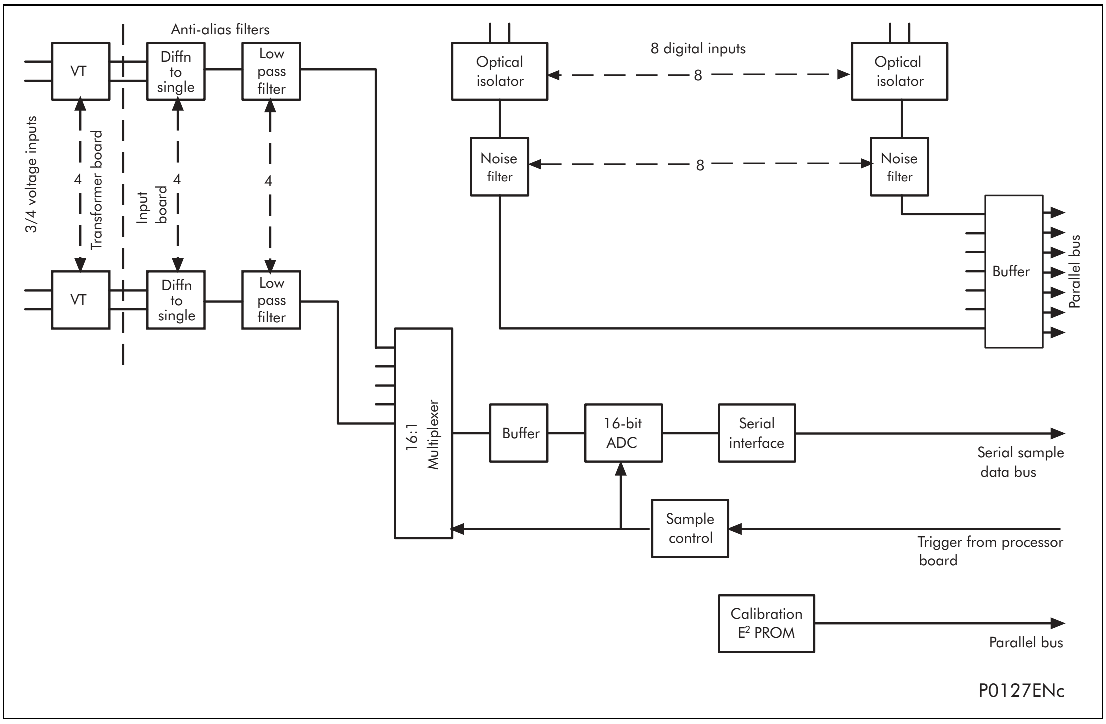


Figure 2: Main input board

The signal multiplexing arrangement provides for 16 analogue channels to be sampled. The P940 range of products provide 3 voltage inputs. 3 spare channels are used to sample 3 different reference voltages for the purpose of continually checking the operation of the multiplexer and the accuracy of the A-D converter. The sample rate is maintained at 24 samples per cycle of the power waveform by a logic control circuit which is driven by the frequency tracking function on the main processor board. The calibration E^2PROM holds the calibration coefficients which are used by the processor board to correct for any amplitude or phase errors introduced by the transformers and analogue circuitry.

The other function of the input board is to read the state of the signals present on the digital inputs and present this to the parallel data bus for processing. The input board holds 8 optical isolators for the connection of up to eight digital input signals. The opto-isolators are used with the digital signals for the same reason as the transformers with the analogue signals; to isolate the relay's electronics from the power system environment. A 48V ‘field voltage’ supply is provided at the back of the relay for use in driving the digital opto-inputs. The input board provides some hardware filtering of the digital signals to remove unwanted noise before buffering the signals for reading on the parallel data bus. Depending on the relay model, more than 8 digital input signals can be accepted by the relay. This is achieved by the use of an additional opto-board which contains the same provision for 8 isolated digital inputs as the main input board, but does not contain any of the circuits for analogue signals which are provided on the main input board.

2.4 Power supply module (including output relays)

The power supply module contains two PCBs, one for the power supply unit itself and the other for the output relays. The power supply board also contains the input and output hardware for the rear communication port which provides an EIA(RS)485 communication interface.

2.4.1 Power supply board (including EIA(RS)485 communication interface)

One of three different configurations of the power supply board can be fitted to the relay. This will be specified at the time of order and depends on the nature of the supply voltage that will be connected to the relay. The three options are shown in Table 1 below.

Nominal dc Range	Nominal ac Range
24/54V	dc only
48/125V	30/100 Vrms
110/250V	100/240 Vrms

Table 1: Power supply options

The output from all versions of the power supply module are used to provide isolated power supply rails to all of the other modules within the relay. Three voltage levels are used within the relay, 5.1V for all of the digital circuits, ±16V for the analogue electronics, e.g. on the input board, and 22V for driving the output relay coils. All power supply voltages including the 0V earth line are distributed around the relay via the 64-way ribbon cable. One further voltage level is provided by the power supply board which is the field voltage of 48V. This is brought out to terminals on the back of the relay so that it can be used to drive the optically isolated digital inputs.

The two other functions provided by the power supply board are the EIA(RS)485 communications interface and the watchdog contacts for the relay. The EIA(RS)485 interface is used with the relay’s rear communication port to provide communication using one of either Courier, Modbus, IEC 60870-5-103 or DNP3.0 protocols.

The EIA(RS)485 hardware supports half-duplex communication and provides optical isolation of the serial data being transmitted and received. All internal communication of data from the power supply board is conducted via the output relay board which is connected to the parallel bus.

The watchdog facility provides two output relay contacts, one normally open and one normally closed which are driven by the processor board. These are provided to give an indication that the relay is in a healthy state.

2.4.2 Output relay board

The output relay board holds seven relays, three with normally open contacts and four with changeover contacts. The relays are driven from the 22V power supply line. The relays’ state is written to or read from using the parallel data bus. Depending on the relay model seven additional output contacts may be provided, through the use of up to three extra relay boards.

2.5 IRIG-B board

The IRIG-B board is an order option which can be fitted to provide an accurate timing reference for the relay. This can be used wherever an IRIG-B signal is available. The IRIG-B signal is connected to the board via a BNC connector on the back of the relay. The timing information is used to synchronise the relay's internal real-time clock to an accuracy of 1ms. The internal clock is then used for the time tagging of the event, fault maintenance and disturbance records.

The IRIG-B board can also be specified with a fibre optic transmitter/receiver which can be used for the rear communication port instead of the EIA(RS)485 electrical connection (IEC 60870 only).

2.6 Mechanical layout

The case materials of the relay are constructed from pre-finished steel which has a conductive covering of aluminium and zinc. This provides good earthing at all joints giving a low impedance path to earth which is essential for performance in the presence of external noise. The boards and modules use a multi-point earthing strategy to improve the immunity to external noise and minimise the effect of circuit noise. Ground planes are used on boards to reduce impedance paths and spring clips are used to ground the module metalwork.

Heavy duty terminal blocks are used at the rear of the relay for the current and voltage signal connections. Medium duty terminal blocks are used for the digital logic input signals, the output relay contacts, the power supply and the rear communication port. A BNC connector is used for the optional IRIG-B signal. 9-pin and 25-pin female D-connectors are used at the front of the relay for data communication.

Inside the relay the PCBs plug into the connector blocks at the rear, and can be removed from the front of the relay only.

The front panel consists of a membrane keypad with tactile dome keys, an LCD and 12 LEDs mounted on an aluminium backing plate.

3. RELAY SOFTWARE

The relay software was introduced in the overview of the relay at the start of **P94x/EN HW/C11**. The software can be considered to be made up of four sections:

- the real-time operating system
- the system services software
- the platform software
- the protection & control software

This section describes in detail the latter two of these, the platform software and the protection & control software, which between them control the functional behaviour of the relay. Figure 3 shows the structure of the relay software.

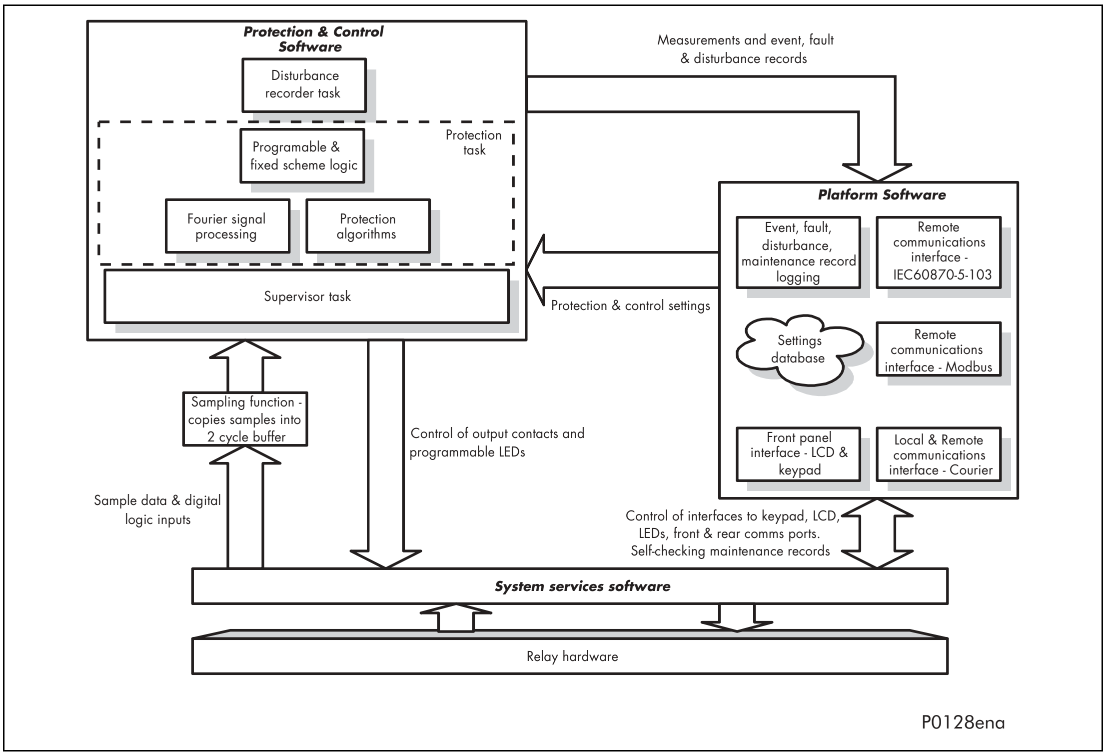


Figure 3: Relay software structure

3.1 Real-time operating system

The software is split into tasks; the real-time operating system is used to schedule the processing of the tasks to ensure that they are processed in the time available and in the desired order of priority. The operating system is also responsible in part for controlling the communication between the software tasks through the use of operating system messages.

3.2 System services software

As shown in Figure 3, the system services software provides the interface between the relay's hardware and the higher-level functionality of the platform software and the protection & control software. For example, the system services software provides drivers for items such as the LCD display, the keypad and the remote communication ports, and controls the boot of the processor and downloading of the processor code into SRAM from non-volatile flash EPROM at power up.

3.3 Platform software

The platform software has three main functions:

- to control the logging of records that are generated by the protection software, including alarms and event, fault, and maintenance records.
- to store and maintain a database of all of the relay's settings in non-volatile memory.
- to provide the internal interface between the settings database and each of the relay's user interfaces, i.e. the front panel interface and the front and rear communication ports, using whichever communication protocol has been specified (Courier, Modbus, IEC 60870-5-103 or DNP3.0).

3.3.1 Record logging

The logging function is provided to store all alarms, events, faults and maintenance records. The records for all of these incidents are logged in battery backed-up SRAM in order to provide a non-volatile log of what has happened. The relay maintains four logs: one each for up to 32 alarms, 250 event records, 5 fault records and 5 maintenance records. The logs are maintained such that the oldest record is overwritten with the newest record. The logging function can be initiated from the protection software or the platform software is responsible for logging of a maintenance record in the event of a relay failure. This includes errors that have been detected by the platform software itself or error that are detected by either the system services or the protection software function. See also the section on supervision and diagnostics later in P94x/EN HW/D11.

3.3.2 Settings database

The settings database contains all of the settings and data for the relay, including the protection, disturbance recorder and control & support settings. The settings are maintained in non-volatile E^2PROM memory. The platform software's management of the settings database includes the responsibility of ensuring that only one user interface modifies the settings of the database at any one time. This feature is employed to avoid conflict between different parts of the software during a setting change. For changes to protection settings and disturbance recorder settings, the platform software operates a 'scratchpad' in SRAM memory. This allows a number of setting changes to be applied to the protection elements, disturbance recorder and saved in the database in E^2PROM. (See also P94x/EN IT/D11 on the user interface). If a setting change affects the protection & control task, the database advises it of the new values.

3.3.3 Database interface

The other function of the platform software is to implement the relay's internal interface between the database and each of the relay's user interfaces. The database of settings and measurements must be accessible from all of the relay's user interfaces to allow read and modify operations. The platform software presents the data in the appropriate format for each user interface.

3.4 Protection and control software

The protection and control software task is responsible for processing all of the protection elements and measurement functions of the relay. To achieve this it has to communicate with both the system services software and the platform software as well as organise its own operations. The protection software has the highest priority of any of the software tasks in the relay in order to provide the fastest possible protection response. The protection & control software has a supervisor task which controls the start-up of the task and deals with the exchange of messages between the task and the platform software.

3.4.1 Overview - protection and control scheduling

After initialisation at start-up, the protection and control task is suspended until there are sufficient samples available for it to process. The acquisition of samples is controlled by a 'sampling function' which is called by the system services software and takes each set of new samples from the input module and stores them in a two-cycle buffer. The protection and control software resumes execution when the number of unprocessed samples in the buffer reaches a certain number. For the P940 frequency protection relays, the protection task is executed four times per cycle, i.e. after every 6 samples for the sample rate of 24 samples per power cycle used by the relay. The protection and control software is suspended again when all of its processing on a set of samples is complete. This allows operations by other software tasks to take place.

3.4.2 Signal processing

The sampling function provides filtering of the digital input signals from the opto-isolators and frequency tracking of the analogue signals. The digital inputs are checked against their previous value over a period of half a cycle. Hence a change in the state of one of the inputs must be maintained over at least half a cycle before it is registered with the protection and control software.

The frequency tracking of the analogue input signals is achieved by a recursive Fourier algorithm which is applied to one of the input signals, and works by detecting a change in the measured signal's phase angle. The calculated value of the frequency is used to modify the sample rate being used by the input module so as to achieve a constant sample rate of 24 samples per cycle of the power waveform. The value of the frequency is also stored for use by the protection and control task. The measured frequency is averaged over three cycles to provide a stable input to the protection functions. Rate of change of frequency is measured over three cycles of averaged frequency.

When the protection and control task is re-started by the sampling function, it calculates the Fourier components for the analogue signals. The Fourier components are calculated using a one-cycle, 24-sample Discrete Fourier Transform (DFT). The DFT is always calculated using the last cycle of samples from the 2-cycle buffer, i.e. the most recent data is used. The DFT used in this way extracts the power frequency fundamental component from the signal and produces the magnitude and phase angle of the fundamental in rectangular component format. The DFT provides an accurate measurement of the fundamental frequency component, and effective filtering of harmonic frequencies and noise. This performance is achieved in conjunction with the relay input module which provides hardware anti-alias filtering to attenuate frequencies above the half sample rate, and frequency tracking to maintain a sample rate of 24 samples per cycle. The Fourier components of the input current and voltage signals are stored in memory so that they can be accessed by all of the protection elements' algorithms. The samples from the input module are also used in an unprocessed form by the disturbance recorder for waveform recording and to calculate true rms values of voltage for metering purposes.

3.4.3 Programmable scheme logic

The purpose of the programmable scheme logic (PSL) is to allow the relay user to configure an individual protection scheme to suit their own particular application. This is achieved through the use of programmable logic gates and delay timers.

The input to the PSL is any combination of the status of the digital input signals from the opto-isolators on the input board, the outputs of the protection elements, e.g. protection starts and trips, and the outputs of the fixed protection scheme logic. The fixed scheme logic provides the relay's standard protection schemes. The PSL itself consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay, and/or to condition the logic outputs, e.g. to create a pulse of fixed duration on the output regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

The execution of the PSL logic is event driven; the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals or a trip output from a protection element. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL.

The protection and control software updates the logic delay timers and checks for a change in the PSL input signals every time it runs.

This system provides flexibility for the user to create their own scheme logic design. However, it also means that the PSL can be configured into a very complex system, and because of this setting of the PSL is implemented through the PC support package MiCOM S1.

3.4.4 Event and fault recording

A change in any digital input signal or protection element output signal causes an event record to be created. When this happens, the protection and control task sends a message to the supervisor task to indicate that an event is available to be processed and writes the event data to a fast buffer in SRAM which is controlled by the supervisor task. When the supervisor task receives either an event or fault record message, it instructs the platform software to create the appropriate log in battery backed-up SRAM. The operation of the record logging to battery backed-up SRAM is slower than the supervisor's buffer. This means that the protection software is not delayed waiting for the records to be logged by the platform software. However, in the rare case when a large number of records to be logged are created in a short period of time, it is possible that some will be lost if the supervisor's buffer is full before the platform software is able to create a new log in battery backed-up SRAM. If this occurs then an event is logged to indicate this loss of information.

3.4.5 Disturbance recorder

The disturbance recorder operates as a separate task from the protection and control task. It can record the waveforms for up to 4 analogue channels and the values of up to 32 digital signals. The recording time is user selectable up to a maximum of 10 seconds. The disturbance recorder is supplied with data by the protection and control task once per cycle. The disturbance recorder collates the data that it receives into the required length disturbance record. It attempts to limit the demands it places on memory space by saving the analogue data in compressed format whenever possible. This is done by detecting changes in the analogue input signals and compressing the recording of the waveform when it is in a steady-state condition. The compressed disturbance records can be decompressed by MiCOM S1 which can also store the data in COMTRADE format, thus allowing the use of other packages to view the recorded data.

4. SELF TESTING & DIAGNOSTICS

The relay includes a number of self-monitoring functions to check the operation of its hardware and software when it is in service. These are included so that if an error or fault occurs within the relay’s hardware or software, the relay is able to detect and report the problem and attempt to resolve it by performing a re-boot. This involves the relay being out of service for a short period of time which is indicated by the ‘Healthy’ LED on the front of the relay being extinguished and the watchdog contact at the rear operating. If the restart fails to resolve the problem, then the relay will take itself permanently out of service. Again this will be indicated by the LED and watchdog contact.

If a problem is detected by the self-monitoring functions, the relay attempts to store a maintenance record in battery backed-up SRAM to allow the nature of the problem to be notified to the user.

The self-monitoring is implemented in two stages: firstly a thorough diagnostic check which is performed when the relay is booted-up, e.g. at power-on, and secondly a continuous self-checking operation which checks the operation of the relay's critical functions whilst it is in service.

4.1 Start-up self-testing

The self-testing which is carried out when the relay is started takes a few seconds to complete, during which time the relay's protection is unavailable. This is signalled by the 'Healthy' LED on the front of the relay which will illuminate when the relay has passed all of the tests and entered operation. If the testing detects a problem, the relay will remain out of service until it is manually restored to working order.

The operations that are performed at start-up are as follows:

4.1.1 System boot

The integrity of the flash EPROM memory is verified using a checksum before the program code and data stored in it is copied into SRAM to be used for execution by the processor. When the copy has been completed the data then held in SRAM is compared to that in the flash EPROM to ensure that the two are the same and that no errors have occurred in the transfer of data from flash EPROM to SRAM. The entry point of the software code in SRAM is then called which is the relay initialisation code.

4.1.2 Initialisation software

The initialisation process includes the operations of initialising the processor registers and interrupts, starting the watchdog timers (used by the hardware to determine whether the software is still running), starting the real-time operating system and creating and starting the supervisor task. In the course of the initialisation process the relay checks:

- the status of the battery.
- the integrity of the battery backed-up SRAM that is used to store event, fault and disturbance records.
- the voltage level of the field voltage supply which is used to drive the opto-isolated inputs.
- the operation of the LCD controller.
- the watchdog operation.

At the conclusion of the initialisation software the supervisor task begins the process of starting the platform software.

4.1.3 Platform software initialisation & monitoring

In starting the platform software, the relay checks the integrity of the data held in E^2PROM with a checksum, the operation of the real-time clock, and the IRIG-B board if fitted. The final test that is made concerns the input and output of data; the presence and healthy condition of the input board is checked and the analogue data acquisition system is checked through sampling the reference voltage.

At the successful conclusion of all of these tests the relay is entered into service and the protection started-up.

4.2 Continuous self-testing

When the relay is in service, it continually checks the operation of the critical parts of its hardware and software. The checking is carried out by the system services software (see section on relay software earlier in P94x/EN HW/D11) and the results reported to the platform software. The functions that are checked are as follows:

- the flash EPROM containing all program code and language text is verified by a checksum
- the code and constant data held in SRAM is checked against the corresponding data in flash EPROM to check for data corruption
- the SRAM containing all data other than the code and constant data is verified with a checksum
- the battery status
- the level of the field voltage
- the integrity of the digital signal I/O data from the opto-isolated inputs and the relay contacts is checked by the data acquisition function every time it is executed. The operation of the analogue data acquisition system is continuously checked by the acquisition function every time it is executed, by means of sampling the reference voltages
- the operation of the IRIG-B board is checked, where it is fitted, by the software that reads the time and date from the board

In the unlikely event that one of the checks detects an error within the relay's subsystems, the platform software is notified and it will attempt to log a maintenance record in battery backed-up SRAM. If the problem is with the battery status or the IRIG-B board, the relay will continue in operation. However, for problems detected in any other area the relay will initiate a shutdown and re-boot. This will result in a period of up to 5 seconds when the protection is unavailable, but the complete restart of the relay including all initialisations should clear most problems that could occur. As described above, an integral part of the start-up procedure is a thorough diagnostic self-check. If this detects the same problem that caused the relay to restart, i.e. the restart has not cleared the problem, then the relay will take itself permanently out of service. This is indicated by the 'Healthy' LED on the front of the relay, which will extinguish, and the watchdog contact which will operate.

TECHNICAL DATA

CONTENTS

1. RATINGS

1.1 Voltages

Nominal Voltage	Operating Range
100 - 120V $_{ph-ph}$rms	0 to 200V $_{ph-ph}$rms
380 - 480V $_{ph-ph}$rms	0 to 800V $_{ph-ph}$rms

Duration	Withstand (Vn = 100/ 120V)	Withstand (Vn = 380/480V)
Continuous rating (2Vn)	240V $_{ph-ph}$rms	880V $_{ph-ph}$rms
10 seconds (2.6Vn)	312V $_{ph-ph}$rms	1144V$_{ph-ph}$rms

1.2 Auxiliary voltage

The relay is available in three auxiliary voltage versions, these are specified in the table below:

Nominal Ranges	Operative dc Range	Operative ac Range
24/54V dc	19 to 65V	-
48/125V dc (30/100V ac rms) **	37 to 150V	24 to 110V
110/250V dc (I00/240V ac rms) **	87 to 300V	80 to 265V

** rated for ac or dc operation.

1.3 Frequency

The nominal frequency (fn) is dual rated at 50 and 60Hz, the operating range is 40Hz to 70Hz.

1.4 Logic inputs

All the logic inputs are independent and isolated, relay types P941 and P942 provide 8 inputs, 16 inputs are provided by the P943.

	Rating	Range
Logical “off”	0V dc	0 to 12V dc
Logical “on”	50V dc	25 to 60V dc

Higher voltages can be used in conjunction with an external resistor, with the value of the resistor determined by the following equation:

Resistor = (Required input level – 50) x 200Ω.

Note: All opto isolated inputs include a ½ cycle filter to ensure that they are immune to transient conditions. This linked with the input recognition time, give an overall operation time of typically ¾ cycle.

1.5 Output relay contacts

Relay types P942 and P943 provide 14 outputs, 7 outputs are provided by the P941.

Make & carry	30A for 3s
Carry	250A for 30ms 5A continuous
Break	DC: 50W resistive DC: 25W inductive (L/R = 40ms) AC: 1250VA
Maxima:	5A and 300V
Loaded contact:	10,000 operation minimum
Unloaded contact:	100,000 operations minimum

Watchdog contact	
Break	DC: 30W resistive DC: 15W inductive (L/R = 40ms) AC: 375VA inductive (p.f. = 0.7)

1.6 Field voltage

The field voltage provided by the relay is nominally 48V dc with a current limit of 112mA. The operating range shall be 40V to 60V with an alarm raised at <35V.

1.7 Loop through connections

Terminals D17 – D18 (and F17 – F18 on the P943) are internally connected together for convenience when wiring, maxima 5A and 300V.

1.8 Wiring requirements

The requirements for the wiring of the relay and cable specifications are detailed in the installation section of the Operation Guide (P94x/EN IN/C11).

2. BURDENS

2.1 Voltage circuit

Reference Voltage (Vn)	
Vn = 100 - 120V	<0.02VA at 110V
Vn = 380 - 480V	<0.15VA at 440V

2.2 Auxiliary supply

Case Size	Minimum*
Size 8 / 40TE	11W or 24VA
Size 12 / 60TE	11W or 24VA

Note*: No output contacts or optically isolated inputs energised

Each additional opto input	0.26W or 0.35VA
Each additional output relay	0.55W or 0.70VA

2.3 Optically isolated inputs

DC supply 5mA burden. (Current drawn at rated voltage)
2.5mA burden at minimum voltage (30V)

3. ACCURACY

For all accuracies specified, the repeatability is ±2.5% unless otherwise specified.

If no range is specified for the validity of the accuracy, then the specified accuracy shall be valid over the full setting range.

3.1 Reference conditions

Quantity	Reference Conditions	Test Tolerance
General		
Ambient temperature	20°C	±2°C
Atmospheric pressure	86kPa to 106kPa	-
Relative humidity	45 to 75%	-
Input energising quantity		
Voltage	Vn	±5%
Frequency	50 or 60Hz	±0.5%
Auxiliary supply	DC 48 V or 110V AC 63.5 V or 110V	±5%

3.2 Influencing quantities

No additional errors will be incurred for any of the following influencing quantities:

Quantity	Operative Range (Typical Only)
Environmental	
Temperature	-25°C to +55°C
Mechanical (vibration, shock, bump, seismic)	According to IEC 60255-21-1:1988 IEC 60255-21-2:1988 IEC 60255-21-3:1995
Electrical	
Frequency	45Hz to 65Hz
Harmonics (single)	5% over the range 2nd to 17th
Auxiliary voltage range	0.8 LV to 1.2HV (dc) 0.8 LV to 1.1HV (ac)
Aux. supply ripple	12 % Vn with a frequency of 2.f_n
Point on wave of fault waveform	0 - 360^0
DC offset of fault waveform	No offset to fully offset
Phase angle	-90° to +90°
Magnetising inrush	No operation with OC elements set to 35% of peak anticipated inrush level.

4. HIGH VOLTAGE WITHSTAND

4.1 Dielectric withstand

IEC60255-5:1997.

2.0kV rms for one minute between all terminals and case earth.

2.0kV rms for one minute between all terminals each independent circuit grouped together, and all other terminals. This includes the output contacts and loop through connections D17-D18 (and F17-F18 on P943).

1.5kV rms for one minute across dedicated normally open contacts of output relays.

1.0kV rms for 1 minute across normally open contacts of changeover pairs and watchdog outputs.

1.0kV rms for 1 minute for all D-type connections between line and ground.

4.2 Impulse

IEC60255-5:1997.

The product will withstand without damage impulses of 5kV peak, 1.2/50µs, 0.5J across:

Each independent circuit and the case with the terminals of each independent circuit connected together.

Independent circuits with the terminals of each independent circuit connected together.

Terminals of the same circuit except normally open metallic contacts.

4.3 Insulation resistance

IEC60255-5:1997.

The insulation resistance is greater than 100MΩ at 500Vdc.

4.4 ANSI dielectric withstand

ANSI/IEEE C37.90.(1989)(Reaff. 1994).

1kV rms for 1 minute across open contacts of the watchdog contacts.

1kV rms for 1 minute across open contacts of changeover output contacts.

1.5kV rms for 1 minute across normally open output contacts.

5. ELECTRICAL ENVIRONMENT

5.1 Performance criteria

The following three classes of performance criteria are used within sections 5.2 to 5.13 (where applicable) to specify the performance of the MiCOM relay when subjected to the electrical interference. The performance criteria are based on the performace criteria specified in EN 50082-2:1995.

5.1.1 Class A

During the testing the relay will not maloperate, upon completion of the testing the relay will function as specified. A maloperation will include a transient operation of the output contacts, operation of the watchdog contacts, reset of any of the relays microprocessors or an alarm indication.

The relay communications and IRIG-B signal must continue uncorrupted via the communications ports and IRIG-B port respectively during the test, however relay communications and the IRIG-B signal may be momentarily interrupted during the tests, provided that they recover with no external intervention.

5.1.2 Class B

During the testing the relay will not maloperate, upon completion of the testing the relay will function as specified. A maloperation will include a transient operation of the output contacts, operation of the watchdog contacts, reset of any of the relays microprocessors or an alarm indication. A transitory operation of the output LEDs is acceptable provided no permanent false indications are recorded.

The relay communications and IRIG-B signal must continue uncorrupted via the communications ports and IRIG-B port respectively during the test, however relay communications and the IRIG-B signal may be momentarily interrupted during the tests, provided that they recover with no external intervention.

5.1.3 Class C

The relay will power down and power up again in a controlled manner within 5 seconds. The output relays are permitted to change state during the test as long as they reset once the relay powers up. Communications to relay may be suspended during the testing as long as communication recovers with no external intervention after the testing.

5.2 Auxiliary supply tests, dc interruption, etc.

5.2.1 DC voltage interruptions

IEC 60255-11:1979.

DC Auxiliary Supply Interruptions 2, 5, 10, 20ms.

Performance criteria - Class A.

DC Auxiliary Supply Interruptions 50, 100, 200ms, 40s.

Performance criteria - Class C.

5.2.2 DC voltage fluctuations

IEC 60255-11:1979.

AC 100Hz ripple superimposed on DC max. and min. auxiliary supply at 12% of highest rated DC.

Performance criteria - Class A.

5.3 AC voltage dips and short interruptions

5.3.1 AC voltage short interruptions

IEC 61000-4-11:1994.

AC Auxiliary Supply Interruptions 2, 5, 10, 20ms.

Performance criteria - Class A.

AC Auxiliary Supply Interruptions 50, 100, 200ms, 1s, 40s.

Performance criteria - Class C.

5.3.2 AC voltage dips

IEC 61000-4-11:1994.

AC Auxiliary Supply 100% Voltage Dips 2, 5, 10, 20ms.

Performance criteria –Class A.

AC Auxiliary Supply 100% Voltage Dips 50, 100, 200ms, 1s, 40s.

Performance criteria - Class C.

AC Auxiliary Supply 60% Voltage Dips 2, 5, 10, 20ms.

Performance criteria - Class A.

AC Auxiliary Supply 60% Voltage Dips 50, 100, 200ms, 1s, 40s.

Performance criteria - Class C.

AC Auxiliary Supply 30% Voltage Dips 2, 5, 10, 20ms.

Performance criteria - Class A.

AC Auxiliary Supply 30% Voltage Dips 50, 100, 200ms, 1s, 40s.

Performance criteria - Class C.

5.4 High frequency disturbance

IEC 60255-22-1:1988 Class III.

1MHz burst disturbance test.

2.5kV common mode.

Power supply, field voltage, VTs, opto inputs, output contacts, IRIG-B and terminal block communications connections.

1kV differential mode.

Power supply, field voltage, VTs, opto inputs and output contacts.

Performance criteria Class A.

5.5 Fast transients

IEC 60255-22-4:1992 (EN 61000-4-4:1995), Class III and Class IV.

2kV 5kHz (Class III) and 4kV 2.5kHz (Class IV) direct coupling.

Power supply, field voltage, opto inputs, output contacts, VTs.

2kV 5kHz (Class III) and 4kV 2.5kHz (Class IV) capacitive clamp.

IRIG-B and terminal block communications connections.

Performance criteria Class A.

5.6 Conducted/radiated emissions

5.6.1 Conducted emissions

EN 55011:1998 Class A, EN 55022:1994 Class A.

0.15 - 0.5MHz, 79dBμV (quasi peak) 66dBμV (average).

0.5 - 30MHz, 73dBμV (quasi peak) 60dBμV (average).

5.6.2 Radiated emissions

EN 55011:1998 Class A, EN 55022:1994 Class A.

30 - 230MHz, 40dBμV/m at 10m measurement distance.

230 - 1000MHz, 47dBμV/m at 10m measurement distance.

5.7 Conducted/radiated immunity

5.7.1 Conducted immunity

EN 61000-4-6:1996 Level 3.

10V emf @ 1kHz 80% am, 150kHz to 80MHz. Spot tests at 27MHz, 68MHz.

Performance criteria Class A.

5.7.2 Radiated immunity

IEC 60255-22-3:1989 Class III (EN 61000-4-3:1997 Level 3).

10 V/m 80MHz - 1GHz @ 1kHz 80% am.

Spot tests at 80MHz, 160MHz, 450MHz, 900MHz.

Performance criteria Class A.

5.7.3 Radiated immunity from digital radio telephones

ENV 50204:1995.

10 V/m 900MHz ± 5 MHz and 1.89GHz ±5MHz, 200Hz rep. Freq., 50% duty cycle pulse modulated.

Performance criteria Class A.

5.8 Electrostatic discharge

IEC 60255-22-2:1996 Class 3 & Class 4.

Class 4: 15kV air discharge.
Class 3: 6kV contact discharge.
Tests carried out both with and without cover fitted.

Performance criteria Class A.

5.9 Surge immunity

IEC 61000-4-5:1995 Level 4.

4kV common mode 12Ω source impedance, 2kV differential mode 2Ω source impedance.

Power supply, field voltage, VTs.

4kV common mode 42Ω source impedance, 2kV differential mode 42Ω source impedance.

Opto inputs, output contacts.

4kV common mode 2Ω source impedance applied to cable screen.

Terminal block communications connections and IRIG-B.

Performance criteria Class A under reference conditions.

5.10 Power frequency magnetic field

IEC 61000-4-8:1994 Level 5.

100A/m field applied continuously in all planes for the EUT in a quiescent state and tripping state.

1000A/m field applied for 3s in all planes for the EUT in a quiescent state and tripping state.

Performance criteria Class A.

5.11 Power frequency interference

NGTS* 2.13 Issue 3 April 1998, section 5.5.6.9.

500V rms. common mode.
250V rms. differential mode.

Voltage applied to all non-mains frequency inputs. Permanently connected communications circuits tested to Class 3 (100-1000m) test level 50mV.

Performance criteria Class A.

* National Grid Technical Specification.

5.12 Surge withstand capability (SWC)

ANSI/IEEE C37.90.1 (1990) (Reaff. 1994)

Oscillatory SWC Test.

2.5kV – 3kV, 1 - 1.5MHz - common and differential mode – applied to all circuits except for IRIG-B and terminal block communications, which are tested common mode only via the cable screen.

Fast Transient SWC Test.

4 - 5kV crest voltage - common and differential mode - applied to all circuits except for IRIG-B and terminal block communications, which are tested common mode only via the cable screen.

Performance criteria Class A.

5.13 Radiated immunity

ANSI/IEEE C37.90.2 1995.

35 V/m 25MHz - 1GHz no modulation applied to all sides.

35 V/m 25MHz - 1GHz, 100% pulse modulated, front only.

Performance criteria Class A.

6. ATMOSPHERIC ENVIRONMENT

6.1 Temperature

IEC 60068-2-1:1990/A2:1994 - Cold.

IEC 60068-2-2:1974/A2:1994 - Dry heat.

IEC 60255-6:1988.

Operating Temperature Range °C (Time Period in Hours)		Storage Temperature Range °C (Time Period in Hours)	
Cold Temperature	Dry Heat Temperature	Cold Temperature	Dry Heat Temperature
-25 (96)	55 (96)	-25 (96)	70 (96)

6.2 Humidity

IEC 60068-2-3:1969.

Damp heat, steady state, 40° C ± 2° C and 93% relative humidity (RH) +2% -3%, duration 56 days.

IEC 60068-2-30:1980.

Damp heat cyclic, six (12 + 12 hour cycles) of 55°C ±2°C 93% ±3% RH and 25°C ±3°C 93% ±3% RH.

6.3 Enclosure protection

IEC 60529:1989.

IP52 Category 2.

IP5x – Protected against dust, limited ingress permitted.

IPx2 – Protected against vertically falling drops of water with the product in 4 fixed positions of 15° tilt with a flow rate of 3mm/minute for 2.5 minutes.

7. MECHANICAL ENVIRONMENT

7.1 Test severity classes

The following table details the Test Severity Class and Typical Applications of the vibration, shock bump and seismic tests that are applied to protection relays.

Class	Typical Application
1	Measuring relays and protection equipment for normal use in power plants, substations and industrial plants and for normal transportation conditions
2	Measuring relays and protection equipment for which a very high security margin is required or where the vibration (shock and bump) (seismic shock) levels are very high, e.g. shipboard application and for severe transportation conditions.

7.2 Mechanical tests

The following sections detail the mechnical tests applied to the MiCOM P94x series relays:

7.2.1 Vibration (sinusoidal)

IEC 60255-21-1:1988.

Cross over frequency - 58 to 60Hz.

Vibration response

Severity Class	Peak Displacement Below Cross Over Frequency (mm)	Peak Acceleration Above Cross Over Frequency (g_n)	Number of Sweeps in Each Axis	Frequency Range (Hz)
2	0.075	1	1	10 – 150

Vibration endurance

Severity Class	Peak Acceleration (g_n)	Number of Sweeps in Each Axis	Frequency Range (Hz)
2	2.0	20	10 – 150

7.2.2 Shock and bump

IEC 60255-21-2:1988.

IEC 60255-21-2:1988.

Type of Test	Severity Class	Peak Acceleration (g_n)	Duration of Pulse (ms)	Number of Pulses in Each Direction
Shock Response	2	10	11	3
Shock withstand	1	15	11	3
Bump	1	10	16	1000

7.2.3 Seismic

IEC 60255-21-3:1993.

Cross over frequency - 8 to 9Hz.

x = horizontal axis, y = vertical axis.

Severity Class	Peak Displacement Below Cross Over Frequency (mm)		Peak Acceleration Above Cross Over Frequency (g_n)		Number of Sweep Cycles in Each Axis	Frequency Range (Hz)
	x	y	x	y		
2	7.5	3.5	2.0	1.0	1	1- 35

8. EC EMC COMPLIANCE

Compliance to the European Community Directive 89/336/EEC amended by 93/68/EEC is claimed via the Technical Construction File route.

The Competent Body has issued a Technical Certificate and a Declaration of Conformity has been completed.

The following Generic Standards used to establish conformity:

EN 50081-2:1994.

EN 50082-2:1995.

9. EC LVD COMPLIANCE

Compliance with European Community Directive on Low Voltage 73/23/EEC is demonstrated by reference to generic safety standards:

EN 61010-1:1993/A2:1995.

EN 60950:1992/A11:1997.

10. PROTECTION FUNCTIONS

10.1 Common settings

10.1.1 Undervoltage blocking

Setting	Range	Step Size	Affected Elements
V<B voltage set (V_n = 100/ 120V)	20 – 120V	1V	All frequency based protection elements
V<B voltage set (V_n = 380/480V)	80 – 480V	4V	

10.1.2 Pick-up and drop-off cycles

Setting	Range	Step Size	Affected Elements
Pick-up cycles	1 - 12	1	All f+df/dt and df/dt+t elements
Drop-off cycles	1 - 3	1	

10.1.3 Load restoration reset holding timer

Setting	Range	Step Size	Affected Elements
Holding timer	1 - 300s	1s	All load restoration stages

10.1.4 Accuracy

Undervoltage blocking	Pick up at setting ±5%
	Drop off at 1.05 x setting ±5%
Holding timer	2% of setting or 20ms, whichever is greater

10.2 Under/Over frequency "f+t" protection [81U/81O]

10.2.1 Settings

Number of Stages	Up to 6	
Setting	Range	Step Size
(f+t) f (each stage)	40.00 - 70.00Hz	0.01Hz
(f+t) t (each stage)	0 – 100s	0.01s

10.2.2 Accuracy

Pick-up	Setting ±0.01Hz
Drop-off (underfrequency)	Setting + 0.02Hz,±0.01Hz
Drop-off (overfrequency)	Setting - 0.02Hz, ±0.01Hz
Operating timer	±2% of setting or 30ms whichever is greater
Instantaneous operating time	Typically <4 cycles *
Reset time	Typically <4 cycles *

Note*: Operation time is dependent upon the relays ability to track the system frequency. To stabilise the relay, the frequency tracking can only change value at a maximum rate of 20Hz per second. Hence, for large step changes in frequency, longer operation times will be experienced.

10.3 Frequency supervised rate of change of frequency "f+df/dt" protection [81RF]

10.3.1 Settings

Number of Stages	Up to 6	
Setting	Range	Step Size
(f+df/dt) f (each stage)	40.00 - 70.0Hz	0.01Hz
(f+df/dt) df/dt (each stage)	0.1 – 10.0Hz/s	0.1Hz/s

10.3.2 Accuracy

Pick-up (frequency)	Setting ±0.01Hz
Pick-up (df/dt)	Setting ±0.1Hz/sec
Drop-off (underfrequency)	Setting + 0.02Hz,±0.01Hz
Drop-off (overfrequency)	Setting - 0.02Hz,±0.01Hz

Note: Operation time is effected by the number of pick-up cycles set in the Common settings, averaging techniques of the df/dt algorithm and also the tracking limit of 20Hz/s.

10.4 Rate of change of frequency “df/dt+t” protection [81R]

10.4.1 Settings

Number of Stages	Up to 6	
Setting	Range	Step Size
(df/dt+t) df/dt (each stage)	-10.00 to +10.00Hz/s	0.1Hz/s
(df/dt+t) t (each stage)	0 – 100s	0.01s

10.4.2 Accuracy

Pick-up	Setting ±0.1Hz/s
Operating timer	±2% of setting or 30ms whichever is greater
Instantaneous operating time	Typically <10 cycles*
Reset time	Typically <10 cycles*

Note*: Operation time is effected by the number of pick-up cycles set in the Common settings and the averaging technique used. Additional delays can be anticipated due to these two factors.

10.5 Frequency supervised average rate of change of frequency “f+Df/Dt” protection [81RAV]

10.5.1 Settings

Number of Stages	Up to 6	
Setting	Range	Step Size
(f+Df/Dt) f (each stage)	40.00 - 70.00Hz	0.01Hz
(f+Df/Dt) Df (each stage)	0.2 – 10.0Hz	0.1Hz
(f+Df/Dt) Dt (each stage)	0.02 – 2.00s	0.02s

10.5.2 Accuracy

Pick-up (frequency)	Setting ±0.01Hz
Pick-up (Df/Dt)	Setting ±0.1Hz/sec
Drop-off (underfrequency)	Setting + 0.02Hz,±0.01Hz
Drop-off (overfrequency)	Setting - 0.02Hz,±0.01Hz
Operating timer	±2% of setting or 30ms whichever is greater

Note: Operation time is dependent upon the relays ability to track the system frequency. To stabilise the relay, the frequency tracking can only change value at a maximum rate of 20Hz per second. Hence, for large step changes in frequency, longer operation times will be experienced.

10.6 Generator abnormal protection [81AB]

10.6.1 Settings

Number of Stages	4	
Setting	Range	Step Size
Band freq low (each stage)	40.00 - 70.00Hz	0.01Hz
Band freq high (each stage)	40.00 - 70.00Hz	0.01Hz
Band delay	00.00 - 240.00mins	0.5mins

10.6.2 Accuracy

Pick-up	Setting ±0.01Hz
Drop-off	Setting ±0.01Hz
Operating timer	±2% of setting or 50ms whichever is greater

10.7 Load restoration

10.7.1 Settings

Number of Stages	Up to 6	
Setting	Range	Step Size
Restore freq (each stage)	40.00 - 70.00Hz	0.01Hz
Restore time	1 – 7200s	1s

10.7.2 Accuracy

Pick-up	Setting ±0.01Hz
Drop-off	Setting – 0.02Hz, ±0.01Hz
Operating timer	±2% of setting or 50ms whichever is greater

10.8 Undervoltage protection (27)

10.8.1 Level settings

Setting	Range	Step Size
V<1 & V<2 (V_n = 100/ 120V)	10 – 120V	1V
V<1 & V<2 (V_n = 380/ 480V)	40 – 480V	4V

10.8.2 Time delay characteristics

The undervoltage measuring elements are followed by an independently selectable time delay. The first stage has a time delay characteristics selectable as either inverse time or definite time. The second stage has an associated definite time delay setting.

The inverse characteristic is defined by the following formula:

$$t = \frac{K}{(1-M)}$$

where

K = time multiplier setting

t = operating time in seconds

M = applied input voltage/relay setting voltage (Vs)

Stage	Range	Step Size
DT setting	0 – 100s	0.1s
TMS setting (K)	0.5 - 100	0.5

10.8.3 Accuracy

Pick-up (definite time)	Setting ±5%
Pick-up (IDMT)	Setting ±5%
Drop-off	1.05 x Setting ±5%
IDMT or DT timer	±2% of setting or 60ms whichever is greater
Instantaneous operation time	<60ms
Reset	<75ms

10.9 Overvoltage protection [59]

10.9.1 Level settings

Setting	Range	Step Size
V>1 & V>2 (V_n = 100/ 120V)	60 – 185V	1V
V>1 & V>2 (V_n = 380/ 480V)	240 – 740V	4V

10.9.2 Time delay characteristics

The overvoltage measuring elements are followed by an independently selectable time delay. The first stage has a time delay characteristics selectable as either inverse time or definite time. The second stage has an associated definite time delay setting.

The inverse characteristic is defined by the following formula

$$t = \frac{K}{(M-1)}$$

where

K = time multiplier setting

t = operating time in seconds

M = applied input voltage/relay setting voltage (Vs)

Stage	Range	Step Size
DT setting	0 - 100s	0.1s
TMS setting (K)	0.5 – 100s	0.5

10.9.3 Accuracy

Pick-up (definite time)	Setting ±5%
Pick-up (IDMT)	Setting ±5%
Drop-off	0.95 x Setting ±5%
IDMT or DT timer	±2% of setting or 60ms whichever is greater
Instantaneous operation time	<60ms
Reset	<75ms

10.10 Effect of frequency tracking on operating time

Section 16 discusses the use of frequency tracking to ensure that the relay only responds to the fundamental frequency component and rejects harmonics. The method of frequency tracking used by the MiCOM Px40 relays is based upon a rate of change of phase angle and to ensure stability during fault conditions, where sudden changes of phase angle can occur, it is limited so that the frequency can only change at a rate equivalent to 20Hz/sec. On most power systems, the frequency is unlikely to experience such rapid changes of frequency, but under test conditions it is possible that the relay will be presented with step changes of frequency. In fact, it is common to test frequency elements by applying these relatively unrealistic step changes in frequency. With the tracking limit of 20Hz/sec, the relay will not see the step change and will track to the new frequency over a period of time that varies according to the start and end frequency of the step change. Theoretical examples of the time taken to respond to step changes are shown below:

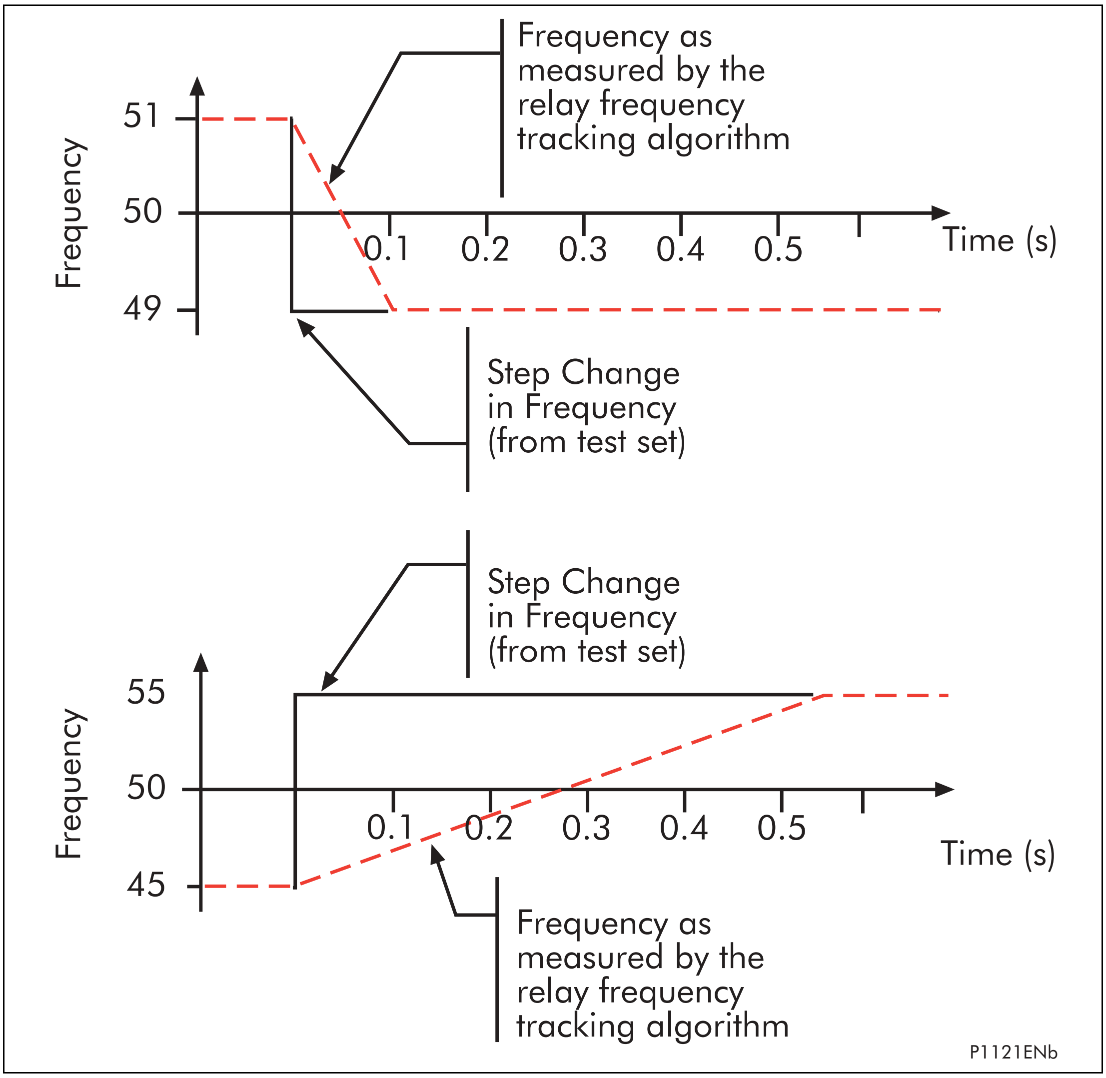


Figure 1: Relay reaction to step changes in frequency

From Figure 1 it can be seen that the larger the step in frequency, the longer the relay will take to achieve the final frequency value as a result of the tracking limit. In the second case above, it would take the relay ½ a second to actually measure the final frequency as a result of the 10Hz step change. This clearly will have a significant effect upon the operating times measured as a result of applying step changes in frequency. For example, in the second case above, if we set an overfrequency element to 51Hz with 100msec delay, it would take 300msec for the relay to start measuring 51Hz and the final trip time would be in the order of 400msec (plus inherent algorithm delays). This apparent “slow” operation is due to the step change in frequency applied and should not be considered as a faulty relay.

10.10.1 Extension of P94x operating times due to step changes

The figures below show actual test results and the delays incurred as a result of the frequency tracking limit imposed on the MiCOM P940.

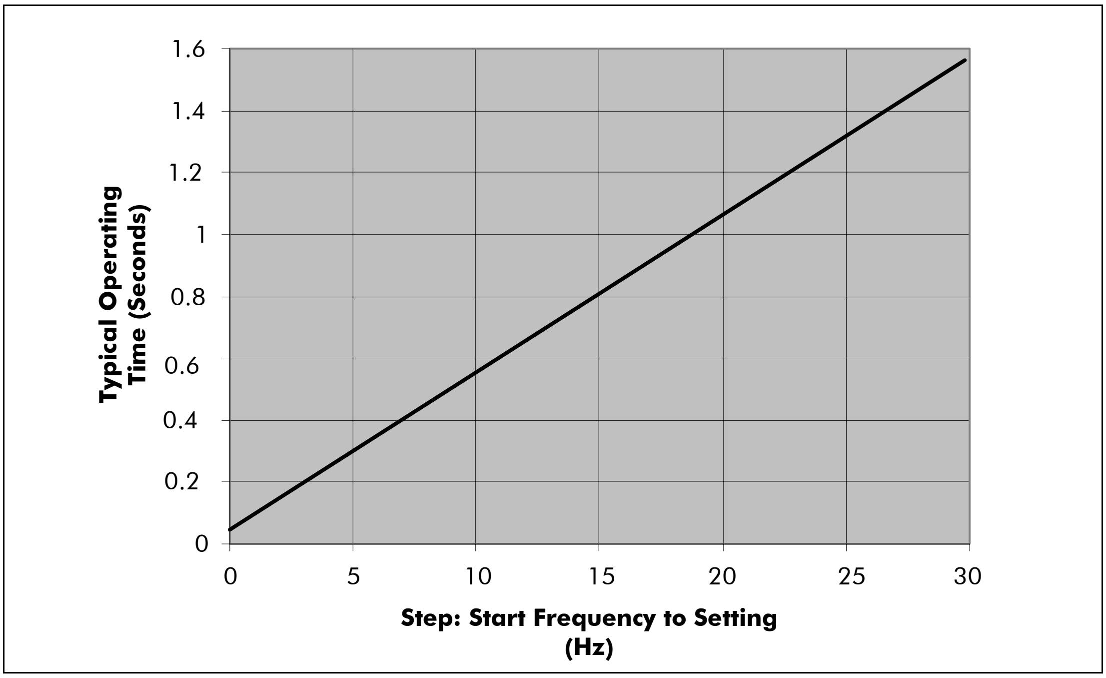


Figure 2: Typical instantaneous operating times for various step changes in frequency

In Figure 2 under and overfrequency elements were tested with no intentional time delay set. The relay was presented with a variable step change in frequency and operating times were plotted against the difference in starting frequency in relation to setting. (The end frequency was also varied i.e. the diagram doesn't show the complete frequency step change). Operation in less than 4 cycles was seen when the difference in start frequency to setting was less than approximately 0.6Hz.

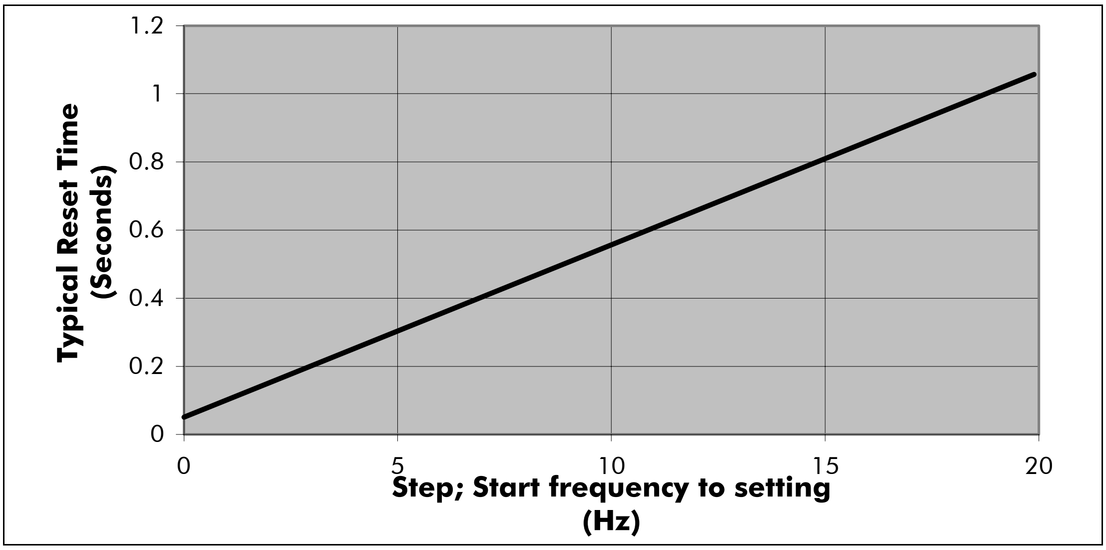


Figure 3: Typical reset times for various step changes in frequency

In Figure 3 under and overfrequency elements were initially operated and then checked for resetting. The relay was presented with a variable step change in frequency and reset times were plotted against the difference in starting frequency in relation to setting. (The end frequency was also varied i.e. the diagram doesn't show the complete frequency step change). Reset in less than 4 cycles was seen when the difference in start frequency to setting was less than approximately 0.6Hz.

10.10.2 Operation on real power systems

As highlighted previously, most areas of the power system do not experience step changes in frequency as this would require instantaneous changes in generator rotational speed. It is therefore incorrect to consider that operating times on real power systems will be significantly effected by the limitation in tracking speed. Under normal power system conditions it should be expected that the frequency detection algorithm will give an instantaneous output in typically less than 2 cycles from the time the power system frequency actually crosses the setting point.

11. PROGRAMMABLE SCHEME LOGIC

Each P940 frequency protection relay has an area of programmable scheme logic to allow users to customise the functionality of the relay. This logic cannot be programmed from the relay menu and requires the use of a dedicated support package that is part of the MiCOM S1 software. The graphical interface for this package includes 8 timers as well as conditioning/timing facilities for each programmable output. Each timer/conditioner has the following setting ranges.

11.1 Level settings

Settings	Range	Step Size
Time delay t	0-14400000ms (4 hrs)	1ms

11.2 Accuracy

Output conditioner timer	Setting ±2% or 50ms whichever is greater
Dwell conditioner timer	Setting ±2% or 50ms whichever is greater
Pulse conditioner timer	Setting ±2% or 50ms whichever is greater

12. MEASUREMENTS AND RECORDING FACILITIES

12.1 Measurements

Typically ±1.0%, but ±0.5% between 0.2 – 2Vn. Accuracy under reference conditions.

Measurand	Range	Accuracy
Voltage	0.05 to 2Vn	±1.0% of reading
Frequency	45 – 65Hz	±0.01Hz
Phase	0 – 360°	±0.5°

12.2 IRIG-B and real time clock

12.2.1 Features

Real time 24 hour clock settable in hours, minutes and seconds
Calendar settable from January 1994 to December 2092
Clock and calendar maintained via battery after loss of auxiliary supply
Internal clock synchronisation using IRIG-B
Interface for IRIG-B signal is BNC

12.2.2 Performance

Year 2000	Compliant
Real time clock accuracy	< ±2 seconds / day
Modulation ratio	1/3 or 1/6
Input signal peak-peak amplitude	200 mV to 20 V
Input impedance at 1000 Hz	6000 Ω
External clock synchronisation	Conforms to IRIG standard 200-98, format B

13. DISTURBANCE RECORDER

13.1 Level settings

Setting	Range	Step
Record length	0 - 10.5s	0.1s
Trigger position	0 - 100%	0.1%
Trigger mode	Single/extended	
Sample rate	24 Samples/cycle	Fixed
Digital signals	32 channels selectable from logic inputs, outputs and internal signals	
Trigger logic	Each of the digital channels can be selected to trigger a record	
Analogue signals	4 channels ($V_{A-N,}$ $V_{B-N,}$ $V_{C-N,}$ f)	

13.2 Accuracy

Magnitude and relative phases	±5% of applied quantities
Duration	±2%
Trigger position	±2% (minimum trigger 100ms)

14. INPUT AND OUTPUT SETTING RANGES

14.1 VT ratio settings

The primary and secondary rating can be independently set for the VT input.

	Primary Range	Secondary Range
Voltage transformer	100V - 1000kV step size 1V	80 to 140V (Vn = 100/120V) 320 to 560V (Vn = 380/480V)

15. BATTERY LIFE

Battery life (assuming relay energised for 90% of time) > 10 years.

½ AA size 3.6V lithium thionyl chloride battery (SAFT advanced battery reference LS14250).

16. FREQUENCY RESPONSE

With the exception of the RMS measurements all other measurements and protection functions are based on the Fourier derived fundamental component. The fundamental component is extracted by using a 24 sample Discrete Fourier Transform (DFT). This gives good harmonic rejection for frequencies up to the 23rd harmonic. The 23rd is the first predominant harmonic that is not attenuated by the Fourier filter and this is known as an 'Alias'. However, the Alias is attenuated by approximately 85% by an additional, analogue, 'anti-aliasing' filter (low pass filter). The combined affect of the anti-aliasing and Fourier filters is shown below:

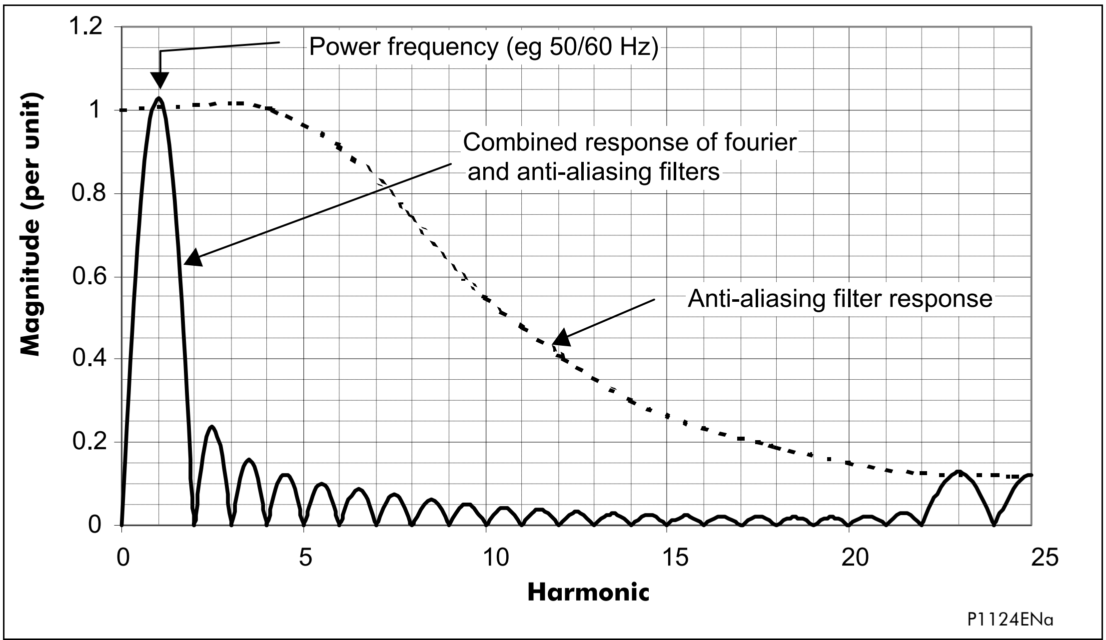


Figure 4: Frequency response

For power frequencies that are not equal to the selected rated frequency the harmonics would not be attenuated to zero amplitude. For small deviations of ±1Hz, this is not a problem but to allow for larger deviations, an improvement is obtained by the addition of frequency tracking.

With frequency tracking the sampling rate of the analogue/digital conversion is automatically adjusted to match the applied signal. In the absence of a suitable signal to amplitude track, the sample rate defaults to the selected rated frequency (fn). In the presence of a signal within the tracking range (40 to 70Hz), the relay will lock on to the signal and the measured frequency will coincide with the power frequency as labelled in the diagram above. The resulting outputs for harmonics up to the 23rd will be zero.

17. LOCAL AND REMOTE COMMUNICATIONS

17.1 Front port (SK1)

Physical Link	EIA (RS)232
Protocol	Courier
Address	1
Message format	IEC 60870FT1.2
Baud rate	19200 bits/s

17.2 Rear port

Rear Port Settings	Setting Options	Setting Available For:
Physical links	EIA(RS)485 or fibre optic	IEC60870-5-103 only
	EIA(RS)485 only	Courier, MODBUS and DNP3.0
Remote address	0 - 255 (step 1)	Courier only
	1 - 247 (step 1)	MODBUS only
	0 - 254 (step 1)	IEC60870-5-103 only
	0 - 65519 (step 1)	DNP3.0 only
Baud rate	64000 bits/s	Courier
	9600, 19200 or 38400 bits/s	MODBUS only
	9600 or 19200 bits/s	IEC60870-5-103 only
	1200, 2400, 4800, 9600, 19200, 38400 bits/s	DNP3.0 only
Inactivity timer	1 - 30 minutes (step 1)	Courier, MODBUS and IEC60870-5-103 only
Parity	“Odd”, “Even” or “None”	MODBUS and DNP3.0 only
Measurement period	1 - 60 minutes (step 1)	IEC60870-5-103 only
Time sync	“Disabled, “Enabled”	DNP3.0 only
Function type	0 - 255 (step 1)	IEC only

17.2.1 Performance

Front and rear ports conforming to courier protocol	Compliant
Rear port conforming to MODBUS protocol	Compliant
Rear port conforming to IEC60870-5-103 protocol	Compliant to Level 2
Rear port conforming to DNP3.0 protocol	Compliant to Level 2

SCADA COMMUNICATIONS

CONTENTS

1. INTRODUCTION

This section describes the remote interfaces of the MiCOM relay in enough detail to allow integration within a substation communication network. As has been outlined in earlier sections, the relay supports a choice of one of four protocols via the rear communication interface. This is in addition to the front serial interface, which supports the Courier protocol only.

The rear EIA(RS)485 interface is isolated and is suitable for permanent connection whichever protocol is selected. The advantage of this type of connection is that up to 32 relays can be ‘daisy chained’ together using a simple twisted pair electrical connection.

For each of the protocol options, the supported functions/commands will be listed together with the database definition. The operation of standard procedures such as extraction of event, fault and disturbance records, or setting changes, will also be described.

It should be noted that the descriptions contained within this section do not aim to fully detail the protocol itself. The relevant documentation for the protocol should be referred to for this information. This section serves to describe the specific implementation of the protocol in the relay.

2. COURIER INTERFACE

2.1 Courier protocol

Courier is an AREVA T&D communication protocol. The concept of the protocol is that a standard set of commands are used to access a database of settings and data within the relay. This allows a generic master to be able to communicate with different slave devices. The application specific aspects are contained within the database itself rather than the commands used to interrogate it, i.e. the master station does not need to be pre-configured.

The same protocol can be used via two physical links K-Bus or EIA(RS)232.

K-Bus is based on EIA(RS)485 voltage levels with HDLC FM0 encoded synchronous signalling and its own frame format. The K-Bus twisted pair connection is unpolarised, whereas the EIA(RS)485 and EIA(RS)232 interfaces are polarised.

The EIA(RS)232 interface uses the IEC60870-5 FT1.2 frame format.

The relay supports an IEC60870-5 FT1.2 connection on the front-port. This is intended for temporary local connection and is not suitable for permanent connection. This interface uses a fixed baud rate, 11-bit frame, and a fixed device address.

The rear interface is used to provide a permanent connection for K-Bus and allows multi-drop connection. It should be noted that although K-Bus is based on EIA(RS)485 voltage levels it is a synchronous HDLC protocol using FM0 encoding. It is not possible to use a standard EIA(RS)232 to EIA(RS)485 converter to convert IEC60870-5 FT1.2 frames to K-Bus. Nor is it possible to connect K-Bus to an EIA(RS)485 computer port. A protocol converter, such as the KITZ101, should be employed for this purpose.

The following documentation should be referred to for a detailed description of the Courier protocol, command-set and link description.

R6509	K-Bus Interface Guide
R6510	IEC60870 Interface Guide
R6511	Courier Protocol
R6512	Courier User Guide

2.2 Front courier port

The front EIA(RS)232 9 pin port supports the Courier protocol for one to one communication. It is designed for use during installation and commissioning / maintenance and is not suitable for permanent connection. Since this interface will not be used to link the relay to a substation communication system, some of the features of Courier are not implemented. These are as follows:

Automatic extraction of Event Records:

- Courier Status byte does not support the Event flag
- Send Event/Accept Event commands are not implemented

Automatic extraction of Disturbance records:

- Courier Status byte does not support the Disturbance flag

Busy Response Layer:

- Courier Status byte does not support the Busy flag, the only response to a request will be the final data

Fixed Address:

- The address of the front Courier port is always 1, the Change Device address command is not supported.

Fixed Baud rate:

- 19200 bps

It should be noted that although automatic extraction of event and disturbance records is not supported it is possible to manually access this data via the front port.

2.3 Supported command set

The following Courier commands are supported by the relay:

Protocol Layer

Reset Remote Link

Poll Status

Poll Buffer*

Low Level Commands

Send Event*

Accept Event*

Send Block

Store Block Identifier

Store Block Footer

Menu Browsing

Get Column Headings

Get Column Text

Get Column Values

Get Strings

Get Text

Get Value

Get Column Setting Limits

Setting Changes

Enter Setting Mode

Preload Setting

Abort Setting

Execute Setting

Reset Menu Cell

Set Value

Control Commands

Select Setting Group

Change Device Address*

Set Real Time

Note: Commands indicated with a * are not supported via the front Courier port.

2.4 Relay courier database

The Courier database is a two dimensional structure with each cell in the database being referenced by a row and column address. Both the column and the row can take a range from 0 to 255. Addresses in the database are specified as hexadecimal values, e.g. 0A02 is column 0A (10 decimal) row 02. Associated settings/data will be part of the same column, row zero of the column contains a text string to identify the contents of the column, i.e. a column heading.

P94x/EN GC contains the complete database definition for the relay. For each cell location the following information is stated:

– Cell Text

– Cell Datatype

– Cell value

– Whether the cell is settable, if so

- Minimum value
- Maximum value
- Step size
- Password Level required to allow setting changes

- String information (for Indexed String or Binary flag cells)

2.5 Setting changes

(See R6512, Courier User Guide - Chapter 9)

Courier provides two mechanisms for making setting changes, both of these are supported by the relay. Either method can be used for editing any of the settings within the relay database.

2.5.1 Method 1

This uses a combination of three commands to perform a settings change:

Enter Setting Mode - checks that the cell is settable and returns the limits

Preload Setting - Places a new value to the cell, this value is echoed to ensure that setting corruption has not taken place, the validity of the setting is not checked by this action.

Execute Setting - Confirms the setting change, if the change is valid then a positive response will be returned, if the setting change fails then an error response will be returned.

Abort Setting - This command can be used to abandon the setting change.

This is the most secure method and is ideally suited to on-line editors as the setting limits are taken from the relay before the setting change is made. However this method can be slow if many settings are being changed as three commands are required for each change.

2.5.2 Method 2

The Set Value command can be used to directly change a setting, the response to this command will be either a positive confirm or an error code to indicate the nature of a failure. This command can be used to implement a setting more rapidly then the previous method, however the limits are not extracted from the relay. This method is most suitable for off-line setting editors such as MiCOM S1, or for the issuing of pre-configured (SCADA) control commands.

2.5.3 Relay settings

There are three categories of settings within the relay database

– Control and Support

– Disturbance Recorder

– Protection Settings Group

Setting changes made to the control and support settings are implemented immediately and stored in non-volatile memory. Changes made to either the Disturbance recorder settings or the Protection Settings Groups are stored in a ‘scratchpad’ memory and are not immediately implemented by the relay.

To action setting changes stored in the scratchpad the Save Changes cell in the Configuration column must be written to. This allows the changes to either be confirmed and stored in non-volatile memory, or the setting changes to be aborted.

2.5.4 Setting transfer mode

If it is necessary to transfer all of the relay settings to or from the relay a cell within the Communication System Data column can be used. This cell (location BF03) when set to 1 makes all of the relay settings visible. Any setting changes made, with the relay set in this mode, are stored in scratchpad memory (including control and support settings). When the value of BF03 is set back to 0 any setting changes are verified and stored in non-volatile memory.

2.6 Event extraction

Events can be extracted either automatically (rear port only) or manually (either Courier port). For automatic extraction all events are extracted in sequential order using the standard Courier event mechanism, this includes fault/maintenance data if appropriate. The manual approach allows the user to select events, faults, or maintenance data at random from the stored records.

2.6.1 Automatic event extraction

(See Chapter 7 - Courier User Guide, publication R6512)

This method is intended for continuous extraction of event and fault information as it is produced. It is only supported via the rear Courier port.

When new event information is created the Event bit is set within the Status byte, this indicates to the Master device that event information is available. The oldest, unextracted event can be extracted from the relay using the Send Event command. The relay will respond with the event data, which will be either a Courier Type 0 or Type 3 event. The Type 3 event is used for fault records and maintenance records.

Once an event has been extracted from the relay, the Accept Event can be used to confirm that the event has been successfully extracted. If all events have been extracted then the event bit will reset, if there are more events still to be extracted the next event can be accessed using the Send Event command as before.

2.6.2 Event types

Events will be created by the relay under the following circumstances:

- Change of state of output contact
- Change of state of opto input
- Protection element operation
- Alarm condition
- Setting Change
- Password entered/timed-out
- Fault Record (Type 3 Courier Event)
- Maintenance record (Type 3 Courier Event)

2.6.3 Event format

The Send Event command results in the following fields being returned by the relay:

- Cell Reference
- Timestamp
- Cell Text
- Cell Value

The menu database, P94x/EN GC, contains a table of the events created by the relay and indicates how the contents of the above fields are interpreted. Fault records and Maintenance records will return a Courier Type 3 event, which contains the above fields together with two additional fields:

- Event extraction column
- Event number

These events contain additional information that is extracted from the relay using the referenced extraction column. Row 01 of the extraction column contains a setting that allows the fault/maintenance record to be selected. This setting should be set to the event number value returned within the record, the extended data can be extracted from the relay by uploading the text and data from the column.

2.6.4 Manual event record extraction

Column 01 of the database can be used for manual viewing of event, fault, and maintenance records. The contents of this column will depend on the nature of the record selected. It is possible to select events by event number and to directly select a fault record or maintenance record by number.

Event Record selection (Row 01) - This cell can be set to a value between 0 to 249 to select which of the 250 stored events is selected, 0 will select the most recent record; 249 the oldest stored record. For simple event records, (Type 0) cells 0102 to 0105 contain the event details. A single cell is used to represent each of the event fields. If the event selected is a fault or maintenance record (Type 3) then the remainder of the column will contain the additional information.

Fault Record Selection (Row 05) – This cell can be used to directly select a fault record using a value between 0 and 4 to select one of up to five stored fault records. (0 will be the most recent fault and 4 will be the oldest). The column will then contain the details of the fault record selected.

Maintenance Record Selection (Row F0) – This cell can be used to select a maintenance record using a value between 0 and 4 and operates in a similar way to the fault record selection.

It should be noted that if this column is used to extract event information from the relay the number associated with a particular record will change when a new event or fault occurs.

2.7 Disturbance record extraction

The stored disturbance records within the relay are accessible in a compressed format via the Courier interface. The records are extracted using column B4. It should be noted that cells required for extraction of uncompressed disturbance records are not supported.

Select Record Number (Row 01) - This cell can be used to select the record to be extracted. Record 0 will be the oldest unextracted record, already extracted older records will be assigned positive values, and negative values will be used for more recent records. To facilitate automatic extraction via the rear port the Disturbance bit of the Status byte is set by the relay whenever there are unextracted disturbance records.

Once a record has been selected, using the above cell, the time and date of the record can be read from cell 02. The disturbance record itself can be extracted using the block transfer mechanism from cell B00B. It should be noted that the file extracted from the relay is in a compressed format. It will be necessary to use MiCOM S1 to de-compress this file and save the disturbance record in the COMTRADE format.

As has been stated, the rear Courier port can be used to automatically extract disturbance records as they occur. This operates using the standard Courier mechanism defined in Chapter 8 of the Courier User Guide. The front Courier port does not support automatic extraction although disturbance record data can be extracted manually from this port.

2.8 Programmable scheme logic settings

The programmable scheme logic (PSL) settings can be uploaded from and downloaded to the relay using the block transfer mechanism defined in Chapter 12 of the Courier User Guide.

The following cells are used to perform the extraction:

– B204 Domain: Used to select either PSL settings (Upload or download) or PSL configuration data (Upload only)

– B208 Sub-Domain: Used to select the Protection Setting Group to be uploaded/downloaded.

– B20C Version: Used on a download to check the compatibility of the file to be downloaded with the relay.

– B21C Transfer Mode: Used to set-up the transfer process

– B120 Data Transfer Cell: Used to perform upload/download.

The Programmable scheme-logic settings can be uploaded and downloaded to and from the relay using this mechanism. If it is necessary to edit the settings MiCOM S1 must be used as the data format is compressed. MiCOM S1 also performs checks on the validity of the settings before they are downloaded to the relay.

3. MODBUS INTERFACE

The MODBUS interface is a master/slave protocol and it is defined by MODBUS.org: See

www.modbus.org

MODBUS Serial Protocol Reference Guide PI-MBUS-300 Rev. E

3.1 Communication link

This interface also uses the rear EIA(RS)485 port for communication using ‘RTU’ mode communication rather than ‘ASCII’ mode as this provides more efficient use of the communication bandwidth. This mode of communication is defined by the MODBUS standard.

In summary, the character framing is 1 start bit, 8 bit data, either 1 parity bit and 1 stop bit, or two stop bits. This gives 11 bits per character.

The following parameters can be configured for this port using either the front panel interface or the front Courier port:

– Baud Rate
– Device Address
– Parity
– Inactivity Time

3.2 MODBUS functions

The following MODBUS function codes are supported by the relay:

01 Read Coil Status
02 Read Input Status
03 Read Holding Registers
04 Read Input Registers
06 Preset Single Register
08 Diagnostics
11 Fetch Communication Event Counter
12 Fetch Communication Event Log
16 Preset Multiple Registers 127 max

These are interpreted by the MiCOM relay in the following way:

01 Read status of output contacts (0xxxx addresses)
02 Read status of opto inputs (1xxxx addresses)
03 Read Setting values (4xxxx addresses)
04 Read Measured values (3xxxx addresses
06 Write single setting value (4xxxx addresses)
16 Write multiple setting values (4xxxx addresses)

3.3 Response codes

Code	MODBUS Description	MiCOM Interpretation
01	Illegal Function Code	The function code transmitted is not supported by the slave
02	Illegal Data Address	The start data address in the request is not an allowable value. If any of the addresses in the range cannot be accessed due to password protection then all changes within the request are discarded and this error response will be returned. Note: If the start address is correct but the range includes non - implemented addresses this response is not produced
03	Illegal Value	A value referenced in the data field transmitted by the master is not within range. Other values transmitted within the same packet will be executed if inside range.
06	Slave Device Busy	The write command cannot be implemented due to the database being locked by another interface. This response is also produced if the relay software is busy executing a previous request.

3.4 Register mapping

The relay supports the following memory page references:

Memory Page	Interpretation
0xxxx	Read and write access of the output relays.
1xxxx	Read only access of the opto inputs.
3xxxx	Read only access of data.
4xxxx	Read and write access of settings.

Where xxxx represents the addresses available in the page (0 to 9999)

Note that the “extended memory file” (6xxxx) is not supported.

A complete map of the MODBUS addresses supported by the relay is contained in menu database, P94x/EN GC, of this service manual.

Note that MODBUS convention is to document register addresses as ordinal values whereas the actual protocol addresses are literal values. The Micom relays begin their register addresses at zero. Thus, the first register in a memory page is register address zero. The second register is register address 1 and so on. Note that the page number notation is not part of the address.

3.5 Event extraction

The relay supports two methods of event extraction providing either automatic or manual extraction of the stored event, fault, and maintenance records.

3.5.1 Manual selection

There are three registers available to manually select stored records, there are also three read only registers allowing the number of stored records to be determined.

40100 - Select Event, 0 to 249

40101 - Select Fault, 0 to 4

40102 - Select Maintenance Record, 0 to 4

For each of the above registers a value of 0 represents the most recent stored record. The following registers can be read to indicate the numbers of the various types of record stored.

30100 - Number of stored records

30101 - Number of stored fault records

30102 - Number of stored maintenance records

Each fault or maintenance record logged causes an event record to be created by the relay. If this event record is selected the additional registers allowing the fault or maintenance record details will also become populated.

3.5.2 Automatic extraction

The automatic extraction facilities allow all types of record to be extracted as they occur. Event records are extracted in sequential order including any fault or maintenance data that may be associated with the event.

The MODBUS master can determine whether the relay has any events stored that have not yet been extracted. This is performed by reading the relay status register 30001 (G26 data type). If the event bit of this register is set then the relay has unextracted events available. To select the next event for sequential extraction the master station writes a value of 1 to the record selection register 40400 (G18 data type). The event data together with any fault/maintenance data can be read from the registers specified below. Once the data has been read the event record can be marked as having been read by writing a value of 2 to register 40400.

3.5.3 Record data

The location and format of the registers used to access the record data is the same whether they have been selected using either of the two mechanisms detailed above.

Event Description	MODBUS Address	Length	Comments
Time and Date	30103	4	See G12 data type description in section 3.8
Event Type	30107	1	See G13 data type. Indicates type of event
Event Value	30108	2	Nature of Value depends on Event Type. This will contain the status as a binary flag for Contact, Opto, Alarm, and protection events.

Event Description	MODBUS Address	Length	Comments
MODBUS Address	30110	1	This indicates the MODBUS Register address where the change occurred. Alarm 30011 Relays 30723 Optos 30725 Protection events – Like the Relay and Opto addresses this will map onto the MODBUS address of the appropriate DDB status register depending on which bit of the DDB the change occurred. These will range from 30727 to 30785. For Platform events, Fault events and Maintenance events the default is 0.
Event Index	30111	1	This register will contain the DDB ordinal for protection events or the bit number for alarm events. The direction of the change will be indicated by the most significant bit; 1 for 0 – 1change and 0 for 1 – 0 change.
Additional Data Present	30112	1	0 means that there is no additional data 1 means fault record data can be read from 30113 to 30199 (number of registers depends on the product) 2 means maintenance record data can be read from 30036 to 30039

If a fault record or maintenance record is directly selected using the manual mechanism then the data can be read from the register ranges specified above. The event record data in registers 30103 to 30111 will not be available.

It is possible using register 40401(G6 data type) to clear independently the stored relay event/fault and maintenance records. This register also provides an option to reset the relay indications which has the same effect on the relay as pressing the clear key within the alarm viewer using the front panel menu.

3.6 Disturbance record extraction

The relay provides facilities for both manual and automatic extraction of disturbance records. The two methods differ only in the mechanism for selecting a disturbance record, the method for extracting the data and the format of the data are identical.

3.6.1 Manual selection

Each disturbance record has a unique identifier which increments for each stored record and resets at a value of 65535. The following registers can be used to determine the identifiers for the stored records

30800 - The number of stored disturbance records

30801 - The identifier for the oldest stored record

A record can be selected by writing the required record identifier to register 40250. It is possible to read the timestamp of the selected record and in this way produce a chronological list of all the stored records.

3.6.2 Automatic extraction

The MODBUS master station can determine the presence of unread disturbance records by polling register 30001 (G26 data type). When the disturbance bit of this register is set, disturbance records are available for extraction. To select the next disturbance record, write a value of 4 to register 40400 (G18 data type). Once the disturbance record data has been read by the master station this record can be marked as having been read by writing a value of 8 to register 40400.

3.6.3 Record data

The timestamp for a record selected using either of the above means can be read from registers 30390 to 30393. The disturbance record data itself is stored in a compressed format, due to the size of the disturbance record it must be read using a paging system.

The number of pages required to extract a record will depend on the configured size of the record.

When a record is first selected, the first page of data will be available in registers 30803 to 30929. (The number of registers required for the current page can be read from register 30802. It will have a value of 127 for all but the last page in the record). Once the first page has been read, the next page can be selected by writing a value of 5 to register 40400. If this action is performed after the last page for the disturbance record has been selected an illegal value error response will be returned. This error response can be used by the MODBUS master to indicate that the last page of the disturbance record has been read.

3.7 Setting changes

The relay settings can be split into two categories:

– control and support settings

– disturbance record settings and protection setting groups

Changes to settings within the control and support area are executed immediately. Changes to the protection setting groups or the disturbance recorder settings are stored in a temporary ‘scratchpad’ area and must be confirmed before they are implemented. All the relay settings are 4xxxx page addresses. The following points should be noted when changing settings:

– Settings implemented using multiple registers must be written to using a multi-register write operation.

– The first address for a multi-register write must be a valid address, if there are unmapped addresses within the range being written to then the data associated with these addresses will be discarded.

– If a write operation is performed with values that are out of range then the illegal data response will be produced. Valid setting values within the same write operation will be executed.

– If a write operation is performed attempting to change registers that require a higher level of password access than is currently enabled then all setting changes in the write operation will be discarded.

3.7.1 Password protection

As described in the introduction to this service manual, the relay settings can be subject to Password protection. The level of password protection required to change a setting is indicated in the relay setting database (P94x/EN GC). Level 2 is the highest level of password access, level 0 indicates that no password is required.

The following registers are available to control Password protection:

40001&40002	Password entry
40022	Default password level
40023&40024	Setting to change password level 1
40025&40026	Setting to change password level 2
30010	Can be read to indicate current access level

3.7.2 Control and support settings

Control and support settings are executed immediately on the write operation.

3.7.3 Protection and disturbance recorder settings

Setting changes to either of these areas are stored in a scratchpad area and will not be used by the relay unless a confirm or an abort operation is performed. Register 40405 can be used either to confirm or abort the setting changes within the scratchpad area. It should be noted that the relay supports four groups of protection settings. The MODBUS addresses for each of the four groups are repeated within the following address ranges:

- Group 1 41000-42999
- Group 2 43000-44999
- Group 3 45000-46999
- Group 4 47000-48999

In addition to the basic editing of the protection setting groups, the following functions are provided:

- Default values can be restored to a setting group or to all of the relay settings by writing to register 40402.
- It is possible to copy the contents of one setting group to another by writing the source group to register 40406 and the target group to 40407.

It should be noted that the setting changes performed by either of the two operations defined above are made to the scratchpad area. These changes must be confirmed by writing to register 40405.

The active protection setting groups can be selected by writing to register 40404. An illegal data response will be returned if an attempt is made to set the active group to one that has been disabled.

3.8 Date and time format (data type G12)

The date-time data type G12 allows *real* date and time information to be conveyed down to a resolution of 1ms. The structure of the data type is shown in Table 3-1 and is compliant with the IEC60870-5-4 “Binary Time 2a” format.

The seven bytes of the structure are packed into four 16-bit registers, such that byte 1 is transmitted first, followed by byte 2 through to byte 7, followed by a null (zero) byte to make eight bytes in total. Since register data is usually transmitted in big-endian format (high order byte followed by low order byte), byte 1 will be in the high-order byte position followed by byte 2 in the low-order position for the first register. The last register will contain just byte 7 in the high order position and the low order byte will have a value of zero.

	Bit Position							
Byte	7	6	5	4	3	2	1	0
1	m^7	m^6	m^5	m^4	m^3	m^2	m^1	m^0
2	m^{15}	m^{14}	m^{13}	m^{12}	m^{11}	m^{10}	m^9	m^8
3	IV	R	I^5	I^4	I^3	I^2	I^1	I^0
4	SU	R	R	H^4	H^3	H^2	H^1	H^0
5	W^2	W^1	W^0	D^4	D^3	D^2	D^1	D^0
6	R	R	R	R	M^3	M^2	M^1	M^0
7	R	Y^6	Y^5	Y^4	Y^3	Y^2	Y^1	Y^0

Where:
- m = 0…59,999ms
- I = 0…59 minutes
- H = 0…23 Hours
- W = 1…7 Day of week; Monday to Sunday, 0 for not calculated
- D = 1…31 Day of Month
- M = 1…12 Month of year; January to December
- Y = 0…99 Years (year of century)
- R = Reserved bit = 0
- SU = summertime: 0=standard time, 1=summer time
- IV = invalid value: 0=valid, 1=invalid
- range = 0ms…99 years

Table 3-1: G12 date & time data type structure

Since the range of the data type is only 100 years, the century must be deduced. The century is calculated as the one that will produce the nearest time value to the current date. For example: 30-12-99 is 30-12-1999 when received in 1999 & 2000, but is 30-12-2099 when received in 2050. This technique allows 2 digit years to be accurately converted to 4 digits in a ±50 year window around the current datum.

The invalid bit has two applications:

1. It can indicate that the date-time information is considered inaccurate, but is the best information available.

2. Date-time information is not available.

The summertime bit is used to indicate that summertime (day light saving) is being used and, more importantly, to resolve the alias and time discontinuity which occurs when summertime starts and ends. This is important for the correct time correlation of time stamped records.

The day of the week field is optional and if not calculated will be set to zero.

The concept of time zone is not catered for by this data type and hence by the relay. It is up to the end user to determine the time zone utilised by the relay. Normal practise is to use UTC (universal co-ordinated time), which avoids the complications with day light saving time-stamp correlation's.

4. IEC60870-5-103 INTERFACE

The IEC60870-5-103 interface is a master/slave interface with the relay as the slave device. The relay conforms to compatibility level 2, compatibility level 3 is not supported.

The following IEC60870-5-103 facilities are supported by this interface:

– Initialisation (Reset)

– Time Synchronisation

– Event Record Extraction

– General Interrogation

– Cyclic Measurements

– General Commands

– Disturbance Record Extraction

4.1 Physical connection and link layer

Two connection options are available for IEC60870-5-103, either the rear EIA(RS)485 port or an optional rear fibre optic port. Should the fibre optic port be fitted the selection of the active port can be made via the front panel menu or the front Courier port, however the selection will only be effective following the next relay power up.

For either of the two modes of connection it is possible to select both the relay address and baud rate using the front panel menu/front Courier. Following a change to either of these two settings a reset command is required to re-establish communications, see reset command description below.

4.2 Initialisation

Whenever the relay has been powered up, or if the communication parameters have been changed a reset command is required to initialise the communications. The relay will respond to either of the two reset commands (Reset CU or Reset FCB), the difference being that the Reset CU will clear any unsent messages in the relay's transmit buffer.

The relay will respond to the reset command with an identification message ASDU 5, the Cause Of Transmission COT of this response will be either Reset CU or Reset FCB depending on the nature of the reset command. The content of ASDU 5 is described in the IEC60870-5-103 section of the menu database, P94x /EN GC.

In addition to the above identification message, if the relay has been powered up it will also produce a power up event.

4.3 Time synchronisation

The relay time and date can be set using the time synchronisation feature of the IEC60870-5-103 protocol. The relay will correct for the transmission delay as specified in IEC60870-5-103. If the time synchronisation message is sent as a send/confirm message then the relay will respond with a confirm. Whether the time-synchronisation message is sent as a send confirm or a broadcast (send/no reply) message, a time synchronisation Class 1 event will be generated/produced.

If the relay clock is being synchronised using the IRIG-B input then it will not be possible to set the relay time using the IEC60870-5-103 interface. An attempt to set the time via the interface will cause the relay to create an event with the current date and time taken from the IRIG-B synchronised internal clock.

4.4 Spontaneous events

Events are categorised using the following information:

- Function Type
- Information Number

The IEC60870-5-103 profile in the menu database, P94x/EN GC, contains a complete listing of all events produced by the relay.

4.5 General interrogation

The GI request can be used to read the status of the relay, the function numbers, and information numbers that will be returned during the GI cycle are indicated in the IEC60870-5-103 profile in the menu database, P94x/EN GC.

4.6 Cyclic measurements

The relay will produce measured values using ASDU 9 on a cyclical basis, this can be read from the relay using a Class 2 poll (note ADSU 3 is not used). The rate at which the relay produces new measured values can be controlled using the Measurement Period setting. This setting can be edited from the front panel menu/front Courier port and is active immediately following a change.

It should be noted that the measurands transmitted by the relay are sent as a proportion of 2.4 times the rated value of the analogue value.

4.7 Commands

A list of the supported commands is contained in the menu database, P94x/EN GC. The relay will respond to other commands with an ASDU 1, with a cause of transmission (COT) indicating ‘negative acknowledgement’.

4.8 Test mode

It is possible using either the front panel menu or the front Courier port to disable the relay output contacts to allow secondary injection testing to be performed. This is interpreted as ‘test mode’ by the IEC60870-5-103 standard. An event will be produced to indicate both entry to and exit from test mode. Spontaneous events and cyclic measured data transmitted whilst the relay is in test mode will have a COT of ‘test mode’.

4.9 Disturbance records

The disturbance records stored by the relay cannot be extracted using the mechanism defined in the IEC60870-5-103 standard. The relay maintains compatability with the VDEW control system by transmitting an ASDU23 with no disturbance records at the start of every GI cycle.

Any attempt to extract disturbance record data from the relay (using ASU 24) will result in the relay responding with ASDU31 end of transmission of disturbance record with a Type of Order of abortion by the protection equipment.

4.10 Blocking of monitor direction

The relay does not support a facility to block messages in the Monitor.

5. DNP3 INTERFACE

5.1 DNP3 protocol

The DNP3 protocol is defined and administered by the DNP Users Group. Information about the user group, DNP3 in general and the protocol specifications can be found on their Internet site:

www.dnp.org

The descriptions given here are intended to accompany the device profile document which is included in the menu database, P94x/EN GC. The DNP3 protocol is not described here, please refer to the documentation available from the user group. The device profile document specifies the full details of the DNP3 implementation for the relay. This is the standard format DNP3 document that specifies which objects, variations and qualifiers are supported. The device profile document also specifies what data is available from the relay via DNP3. The relay operates as a DNP3 slave and supports subset level 2 of the protocol, plus some of the features from level 3.

DNP3 communication uses the EIA(RS)485 communication port at the rear of the relay. The data format is 1 start bit, 8 data bits, an optional parity bit and 1 stop bit. Parity is configurable (see menu settings below).

5.2 DNP3 menu setting

The settings shown below are available in the menu for DNP3 in the 'Communications' column.

Setting	Range	Description
Remote Address	0 – 65534	DNP3 address of relay (decimal)
Baud Rate	1200, 2400, 4800, 9600, 19200, 38400	Selectable baud rate for DNP3 communication
Parity	None, Odd, Even	Parity setting
Time Sync	Enabled, Disabled	Enables or disables the relay requesting time sync from the master via IIN bit 4 word 1

5.3 Object 1 binary inputs

Object 1, binary inputs, contains information describing the state of signals within the relay which mostly form part of the digital data bus (DDB). In general these include the state of the output contacts and input optos, alarm signals and protection start and trip signals. The 'DDB number' column in the device profile document provides the DDB numbers for the DNP3 point data. These can be used to cross-reference to the DDB definition list which is also found in the menu database, P94x/EN GC. The binary input points can also be read as change events via object 2 and object 60 for class 1-3 event data.

5.4 Object 10 binary outputs

Object 10, binary outputs, contains commands which can be operated via DNP3. As such the points accept commands of type pulse on [null, trip, close] and latch on/off as detailed in the device profile in the menu database, P94x/EN GC and execute the command once for either command. The other fields are ignored (queue, clear, trip/close, in time and off time).

Due to that fact that many of the relay's functions are configurable, it may be the case that some of the object 10 commands described below are not available for operation. In the case of a read from object 10 this will result in the point being reported as off-line and an operate command to object 12 will generate an error response.

Examples of object 10 points that maybe reported as off-line are:

– Activate Setting Groups - Ensure setting groups are enabled

– Reset Gen. Abnormal Timers - Ensure gen. abnormal protection is enabled

5.5 Object 20 binary counters

Object 20, binary counters, contains cumulative counters and measurements. The binary counters can be read as their present 'running' value from object 20, or as a 'frozen' value from object 21. The running counters of object 20 accept the read, freeze and clear functions. The freeze function takes the current value of the object 20 running counter and stores it in the corresponding object 21 frozen counter. The freeze and clear function resets the object 20 running counter to zero after freezing its value.

5.6 Object 30 analogue input

Object 30, analogue inputs, contains information from the relay's measurements columns in the menu. All object 30 points are reported as fixed-point values although they are stored inside the relay in a floating point format. The conversion to fixed point format requires the use of a scaling factor, which differs for the various types of data within the relay e.g. current, voltage, phase angle etc. The data types supported are listed at the end of the device profile document with each type allocated a 'D number', i.e. D1, D2, etc. In the object 30 point list each data point has a D number data type assigned to it which defines the scaling factor, default deadband setting and the range and resolution of the deadband setting. The deadband is the setting used to determine whether a change event should be generated for each point. The change events can be read via object 32 or object 60 and will be generated for any point whose value has changed by more than the deadband setting since the last time the data value was reported.

Any analogue measurement that is unavailable at the time it is read will be reported as offline, e.g. the frequency when the voltage frequency is outside the tracking range of the relay. Note that all object 30 points are reported as secondary values in DNP3 (with respect to VT ratios).

5.7 DNP3 configuration using MiCOM S1

A PC support package for DNP3 is available as part of the Settings and Records module of MiCOM S1. The S1 module allows configuration of the relay's DNP3 response. The PC is connected to the relay via a serial cable to the 9-pin front part of the relay – see section P94x/EN IT/D11, Introduction. The configuration data is uploaded from the relay to the PC in a block of compressed format data and downloaded to the relay in a similar manner after modification. The new DNP3 configuration takes effect in the relay after the download is complete. The default configuration can be restored at any time by choosing 'All Settings' from the 'Restore Defaults' cell in the menu 'Configuration' column. In S1, the DNP3 data is displayed on a three tabbed screen, one screen each for object1, 20 and 30. Object 10 is not configurable.

5.7.1 Object 1

For every point included in the device profile document there is a check box for membership of class 0 and radio buttons for class 1, 2 or 3 membership. Any point that is in class 0 must be a member of one of the change event classes, 1, 2 or 3.

Points that are configured out of class 0 are by default not capable of generating change events. Furthermore, points that are not part of class 0 are effectively removed from the DNP3 response by renumbering the points that are in class 0 into a contiguous list starting at point number 0. The renumbered point numbers are shown at the left hand side of the screen in S1 and can be printed out to form a revised device profile for the relay. This mechanism allows best use of available bandwidth by only reporting the data points required by the user when a poll for all points is made.

5.7.2 Object 20

The running counter value of object 20 points can be configured to be in or out of class 0. Any running counter that is in class 0 can have its frozen value selected to be in or out of the DNP3 response, but a frozen counter cannot be included without the corresponding running counter. As with object 1, the class 0 response will be renumbered into a contiguous list of points based on the selection of running counters. The frozen counters will also be renumbered based on the selection; note that if some of the counters that are selected as running are not also selected as frozen then the renumbering will result in the frozen counters having different point numbers to their running counterparts. For example, object 20 point 3 (running counter) might have its frozen value reported as object 21 point 1.

5.7.3 Object 30

For the analogue inputs, object 30, the same selection options for classes 0, 1, 2 and 3 are available as for object 1. In addition to these options, which behave in exactly the same way as for object 1, it is possible to change the deadband setting for each point. The minimum and maximum values and the resolution of the deadband settings are defined in the device profile document; MiCOM S1 will allow the deadband to be set to any value within these constraints.

RELAY MENU DATABASE

MiCOM P941, P942, P943 Guides

Frequency Relays

Relay Menu Database

This version of the Relay Menu Database is specific to the following models

Model Number	**Software Number**
P941------0050A	P941------0050-A/B
P942------0050A	P942------0050-A/B
P943------0050A	P943------0050-A/B

For other models / software versions, please contact AREVA T&D – for the relevant information.

(Software versions P94*------0010*, P94*------0020*, P94*------0030* and P94*------0040* are not supported by this menu database. See TG8611A (0010 – 0020) and TG8611B (0030 - 0040) for information on the menu database for these software versions).

RELAY MENU DATABASE

This Relay Menu Database is split into several sections, these are as follows:

- Menu Database for Courier, User Interface and MODBUS
- Menu Datatype Definition
- Event Data for Courier, User Interface and MODBUS
- IEC60870-5-103 Interoperability Guide
- Internal Digital Signals
- DNP3.0 Device Profile Document
- Default Programmable Logic

Menu database

This database defines the structure of the relay menu for the Courier interface, the front panel user interface and the MODBUS interface. This includes all the relay settings and measurements. Datatypes for MODBUS and indexed strings for Courier and the user interface are cross-referenced to the Menu Datatype Definition section (using a G Number). For all settable cells the setting limits and default value are also defined within this database.

Note: The following labels are used within the database

Label	Description	Value
V1	Main VT Rating	1 (100/110V) or 4 (380/440V)

Menu datatype definition

This table defines the datatypes used for MODBUS (the datatypes for the Courier and user interface are defined within the Menu Database itself using the standard Courier Datatypes). This section also defines the indexed string setting options for all interfaces. The datatypes defined within this section are cross-referenced to from the menu Database using a G number.

Event data

This section specifies all the event information that can be produced by the relay. It details exactly how each event will be presented via the Courier, User and MODBUS interfaces.

IEC60870-5-103 interoperability guide

This table fully defines the operation of the IEC60870-5-103 (VDEW) interface for the relay it should be read in conjunction with the relevant section of the SCADA Communications section of this manual (P94x/EN CT/C11).

Internal digital signals

This table defines all of the relay internal digital signals (opto inputs, output contacts and protection inputs and outputs). A relay may have up to 512 internal signals each referenced by a numeric index as shown in this table. This numeric index is used to select a signal for the commissioning monitor port. It is also used to explicitly define protection events produced by the relay (see the Event Data section).

DNP3.0 device profile document

This table defines all of the objects, functions and/or qualifiers supported.

Default programmable logic

This section documents the default programmable logic for the various models of the relay. This default logic for each model of the relay is supplied with the MiCOM S1 Scheme Logic Editor PC support software.

References

Introduction (P94x/EN IT/D11): User Interface operation and connections to the relay

SCADA Communications (P94x/EN CT/D11): Overview of communication interfaces

Courier User Guide R6512

Modicon MODBUS Protocol Reference Guide PI-MBUS-300 Rev E

IEC60870-5-103 Telecontrol Equipment and Systems – Transmission Protocols – Companion Standard for the informative interface of Protection Equipment

Courier Text	UI	Courier		Data Type	Strings	Modbus Address		Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model			Comment
		Col	Row			Start	End								P941	P942	P943	
SYSTEM DATA		00	00												*	*	*	
Language		00	01	Indexed String	G19			G19	English	Setting	0	3	1	2	*	*	*	Sets only for interface being used
Password		00	02	ASCII Password(4 chars)	G20	40001	40002	G20	AAAA	Setting	65	90	1	0	*	*	*	Sets only for interface being used
Description		00	04	ASCII Text(16 chars)		40003	40010	G3	MiCOM P941	Setting	32	163	1	2	*			
									MiCOM P942	Setting	32	163	1			*		
									MiCOM P943	Setting	32	163	1				*	
Plant Reference		00	05	ASCII Text(16 chars)		40011	40018	G3	ALSTOM	Setting	32	163	1	2	*	*	*	
Model Number		00	06	ASCII Text(32 chars)		30020	30035	G3		Data					*	*	*	
Serial Number		00	08	ASCII Text(7 chars)		30044	30051	G3		Data					*	*	*	
Frequency		00	09	Unsigned Integer(16 bits)		40019		G1	50	Setting	50	60	10	2	*	*	*	
Comms Level		00	0A	Unsigned Integer(16 bits)					2	Data					*	*	*	
Relay Address		00	0B	Unsigned Integer(16 bits)				G1	255	Setting	0	255	1	1	*	*	*	Address of interface Rear Courier
									1	Setting	1	247	1	1	*	*	*	Address of interface Rear Modbus
									1	Setting	0	254	1	1	*	*	*	Address of interface Rear IEC60870 -5-103
									1	Setting	0	65534	1	1	*	*	*	Address of interface Rear DNP 3
																		Address available via LCD
	N/A	N/A				30001		G1		Data					*	*	*	Relay status (Modbus Only)
Active Group		00	0E	Unsigned Integer(16 bits)		30006		G1		Data					*	*	*	
Software Ref. 1		00	11	ASCII Text(16 chars)		30052	30059	G3		Data					*	*	*	
Opto I/P Status		00	20	Binary Flag(8 bits)		30007		G8		Data					*	*		
				Binary Flag(16 bits)						Data							*	
				Indexed String														
Relay O/P Status		00	21	Binary Flag(7 bits)		30008	30009	G9		Data					*			
				Binary Flag(14 bits)						Data						*	*	
				Indexed String														
Alarm Status		00	22	Binary Flag(32 bits) Indexed String		30011	30012	G96		Data					*	*	*	
Access Level		00	D0	Unsigned Integer(16 bits)	G1	30010		G1	2	Data					*	*	*	
Password Control		00	D1	Unsigned Integer(16 bits)	G22	40022		G22	2	Setting	0	2	1	2	*	*	*	Sets only for interface being used
Password Level 1		00	D2	ASCII Password(4 chars)	G20	40023	40024	G20	AAAA	Setting	65	90	1	1	*	*	*	Sets only for interface being used
Password Level 2		00	D3	ASCII Password(4 chars)	G20	40025	40026	G20	AAAA	Setting	65	90	1	2	*	*	*	Sets only for interface being used
VIEW RECORDS		01	00												*	*	*	
						30100		G1							*	*	*	No of event records stored
						30101		G1							*	*	*	No of Fault records stored
						30102		G1							*	*	*	No of maintenance records stored
						30107		G1							*	*	*	Event record type
Select Event		01	01	Unsigned Integer(16 bits)		40100			0	Setting	0	Oldest Record	1	0	*	*	*	Max value is oldest record
Menu Cell Ref	N/A	01	02	Cell Reference				G13	(From Record)	Data					*	*	*	Indicates type of event. See Event sheet
Time & Date		01	03	IEC870 Date & Time		30103	30106	G12	(From Record)	Data					*	*	*	
Event Text		01	04	ASCII Text(32 chars)						Data					*	*	*	See Event sheet
Event Value		01	05	Unsigned Integer(32 bits)		30108	30109	G27		Data					*	*	*	Note DTL depends on event type
						30110		G1										Modbus address where change occurred
						30111												Event Index (DDB Number causing event)
						30112												Indicates additional data (e.g. a fault record) is present

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
Select Fault		01	06	Unsigned Integer (16 bits)		40101		G1	0	Setting	0	4	1	0	*	*	*	Allows Fault Record to be selected
						30110		G1										Modbus address where change occurred
f+t Start 1 2 3 4 5 6		N/A								Data					*	*	*	Indicates started stage(s)
df/dt+t Start 1 2 3 4 5 6		N/A								Data					*	*	*	Indicates started stage(s)
f_Df/Dt Start 1 2 3 4 5 6		N/A								Data					*	*	*	Indicates started stage(s)
V < 1 Start A B C 3		N/A								Data					*	*	*	Indicates started phases(s) and 3 phase
V < 2 Start A B C 3		N/A								Data					*	*	*	Indicates started phases(s) and 3 phase
V > 1 Start A B C 3		N/A								Data					*	*	*	Indicates started phases(s) and 3 phase
V > 2 Start A B C 3		N/A								Data					*	*	*	Indicates started phases(s) and 3 phase
Gen Abn Start 1 2 3 4		N/A								Data					*	*	*	Indicates started stage(s)
f+t trip 1 2 3 4 5 6		N/A								Data					*	*	*	Indicates tripped stage(s)
f+df/dt trip 1 2 3 4 5 6		N/A								Data					*	*	*	Indicates tripped stage(s)
df/dt+t trip 1 2 3 4 5 6		N/A								Data					*	*	*	Indicates tripped stage(s)
f+DF/DT trip 1 2 3 4 5 6		N/A								Data					*	*	*	Indicates tripped stage(s)
V < 1 Trip A B C 3		N/A								Data					*	*	*	Indicates tripped phases(s) and 3 phase
V < 2 Trip A B C 3		N/A								Data					*	*	*	Indicates tripped phases(s) and 3 phase
V > 1 Trip A B C 3		N/A								Data					*	*	*	Indicates tripped phases(s) and 3 phase
V > 2 Trip A B C 3		N/A								Data					*	*	*	Indicates tripped phases(s) and 3 phase
Gen Abn Trip 1 2 3 4		N/A								Data					*	*	*	Indicates tripped stage(s)
Start Elements 1	N/A		08	Binary Flags (18 Bits) Indexed String	G84	30113	30114	G84		Data					*	*	*	Started Elements for f+t, df/dt+t, f+DelF/Dt
Start Elements 2	N/A		09	Binary Flags (20 Bits) Indexed String	G102	30115	30116	G102		Data					*	*	*	Started Elements for V,1,2, V.1,2, Gen Abn.
Trip Elements 1	N/A		0A	Binary Flags (24 Bits) Indexed String	G85	30117	30118	G85		Data					*	*	*	Started Elements for f+t, f+df/dt, df/dt+t, f+DelF/Dt
Trip Elements 2	N/A		0B	Binary Flags (20 Bits) Indexed String	G86	30119	30120	G86		Data					*	*	*	Tripped Elements for V,1,2, V.1,2, Gen Abn.
Date & Time	N/A		0D	IEC870 Date & Time		30121	30124	G12		Data					*	*	*	
Active Group	N/A		0E	Unsigned Integer		30125		G1		Data					*	*	*	
System Frequency	N/A		0F	Courier Number (frequency)		30126		G25		Data					*	*	*	

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
VAB	N/A		19	Courier Number (voltage)		30127	30128	G24		Data					*	*	*	
VBC	N/A		1A	Courier Number (voltage)		30129	30130	G24		Data					*	*	*	
VCA	N/A		1B	Courier Number (voltage)		30131	30132	G24		Data					*	*	*	
df/dt	N/A		1C	Courier Number (Hz/s)		30133		G30		Data					*	*	*	
Select Maint			F0	Unsigned Integer(16 bits)		40102		G1	0	Setting	0	4	1	2	*	*	*	Allows Self Test Report to be selected
Maint Text			F1	ASCII Text (32 Characters)						Data					*	*	*	Description of failure
Maint Type			F2	Unsigned Integer (32 bits)		30036	30037	G27		Data					*	*	*	???
Maint Data			F3	Unsigned Integer (32 bits)		30038	30039	G27		Data					*	*	*	???
Reset Indication			FF	Indexed String	G11			G11	No	Command	0	1	1	1	*	*	*	
MEASUREMENTS 1		02	00												*	*	*	
VAB Magnitude			14	Courier Number (voltage)		30200	30201	G24		Data					*	*	*	
VAB Phase Angle			15	Courier Number (angle)		30202		G30		Data					*	*	*	
VBC Magnitude			16	Courier Number (voltage)		30203	30204	G24		Data					*	*	*	
VBC Phase Angle			17	Courier Number (angle)		30205		G30		Data					*	*	*	
VCA Magnitude			18	Courier Number (voltage)		30206	30207	G24		Data					*	*	*	
VCA Phase Angle			19	Courier Number (angle)		30208		G30		Data					*	*	*	
VAN Magnitude			1A	Courier Number (voltage)		30209	30210	G24		Data					*	*	*	
VAN Phase Angle			1B	Courier Number (angle)		30211		G30		Data					*	*	*	
VBN Magnitude			1C	Courier Number (voltage)		30212	30213	G24		Data					*	*	*	
VBN Phase Angle			1D	Courier Number (angle)		30214		G30		Data					*	*	*	
VCN Magnitude			1E	Courier Number (voltage)		30215	30216	G24		Data					*	*	*	
VCN Phase Angle			1F	Courier Number (angle)		30217		G30		Data					*	*	*	
V1 Magnitude			24	Courier Number (voltage)		30218	30219	G24		Data					*	*	*	
V2 Magnitude			25	Courier Number (voltage)		30220	30221	G24		Data					*	*	*	
V0 Magnitude			26	Courier Number (voltage)		30222	30223	G24		Data					*	*	*	
VAN RMS			27	Courier Number (voltage)		30224	30225	G24		Data					*	*	*	
VBN RMS			28	Courier Number (voltage)		30226	30227	G24		Data					*	*	*	
VCN RMS			29	Courier Number (voltage)		30228	30229	G24		Data					*	*	*	
Frequency			2A	Courier Number (frequency)		30230		G30		Data					*	*	*	
STAGE STATISTICS		04	00												*	*	*	MEASUREMENTS 3 modified
Stg1 f+t Sta			01	Unsigned Integer		30400		G1		Data					*	*	*	Number of f+t starts for Stage 1
Stg1 f+t Trp			02	Unsigned Integer		30401		G1		Data					*	*	*	Number of f+t trips for Stage 1
Stg1 f+df/dt Trp			03	Unsigned Integer		30402		G1		Data					*	*	*	Number of f+df/dt trips for Stage 1
Stg1 df/dt+t Sta			04	Unsigned Integer		30403		G1		Data					*	*	*	Number of df/dt+t starts for Stage 1
Stg1 df/dt+t Trp			05	Unsigned Integer		30404		G1		Data					*	*	*	Number of df/dt trips for Stage 1
Stg1 f+Df/Dt Sta			06	Unsigned Integer		30405		G1		Data					*	*	*	Number of f+DF/DT starts for Stage 1
Stg1 f+Df/Dt Trp			07	Unsigned Integer		30406		G1		Data					*	*	*	Number of f+DF/DT trips for Stage 1
Stg1 Revn Date			N/A	(Sub Heading)											*	*	*	
Stg1 Revn Date	N/A		09	IEC870 Date & Time		30407	30410	G12		Data					*	*	*	Date and Time of last revn of Stg1 setting
12_Jan_98 12:00:00.000			N/A												*	*	*	Front Panel Menu only
Stg2 f+t Sta			0A	Unsigned Integer		30411		G1		Data					*	*	*	Number of f+t starts for Stage 2
Stg2 f+t Trp			0B	Unsigned Integer		30412		G1		Data					*	*	*	Number of f+t trips for Stage 2
Stg2 f+df/dt Trp			0C	Unsigned Integer		30413		G1		Data					*	*	*	Number of f+df/dt trips for Stage 2
Stg2 df/dt+t Sta			0D	Unsigned Integer		30414		G1		Data					*	*	*	Number of df/dt+t starts for Stage 2
Stg2 df/dt+t Trp			0E	Unsigned Integer		30415		G1		Data					*	*	*	Number of df/dt trips for Stage 2
Stg2 f+Df/Dt Sta			0F	Unsigned Integer		30416		G1		Data					*	*	*	Number of f+DF/DT starts for Stage 2

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
Stg2 f+Df/Dt Trp			10	Unsigned Integer		30417		G1		Data					*	*	*	Number of f+DF/DT trips for Stage 2
Stg2 Revn Date			N/A	(Sub Heading)											*	*	*	
Stg2 Revn Date	N/A		12	IEC870 Date & Time		30418	30421	G12		Data					*	*	*	Date and Time of last revn of Stg2 setting
12_Jan_98 12:00:00.000			N/A												*	*	*	
Stg3 f+t Sta			13	Unsigned Integer		30422		G1		Data					*	*	*	Number of f+t starts for Stage 3
Stg3 f+t Trp			14	Unsigned Integer		30423		G1		Data					*	*	*	Number of f+t trips for Stage 3
Stg3 f+df/dt Trp			15	Unsigned Integer		30424		G1		Data					*	*	*	Number of f+df/dt trips for Stage 3
Stg3 df/dt+t Sta			16	Unsigned Integer		30425		G1		Data					*	*	*	Number of df/dt+t starts for Stage 3
Stg3 df/dt+t Trp			17	Unsigned Integer		30426		G1		Data					*	*	*	Number of df/dt trips for Stage 3
Stg3 f+Df/Dt Sta			18	Unsigned Integer		30427		G1		Data					*	*	*	Number of f+DF/DT starts for Stage 3
Stg3 f+Df/Dt Trp			19	Unsigned Integer		30428		G1		Data					*	*	*	Number of f+DF/DT trips for Stage 3
Stg3 Revn Date			N/A	(Sub Heading)											*	*	*	
Stg3 Revn Date	N/A		1B	IEC870 Date & Time		30429	30432	G12		Data					*	*	*	Date and Time of last revn of Stg3 setting
12_Jan_98 12:00:00.000			N/A												*	*	*	Front Panel Menu only
Stg4 f+t Sta			1C	Unsigned Integer		30433		G1		Data					*	*	*	Number of f+t starts for Stage 4
Stg4 f+t Trp			1D	Unsigned Integer		30434		G1		Data					*	*	*	Number of f+t trips for Stage 4
Stg4 f+df/dt Trp			1E	Unsigned Integer		30435		G1		Data					*	*	*	Number of f+df/dt trips for Stage 4
Stg4 df/dt+t Sta			1F	Unsigned Integer		30436		G1		Data					*	*	*	Number of df/dt+t starts for Stage 4
Stg4 df/dt+t Trp			20	Unsigned Integer		30437		G1		Data					*	*	*	Number of df/dt trips for Stage 4
Stg4 f+Df/Dt Sta			21	Unsigned Integer		30438		G1		Data					*	*	*	Number of f+DF/DT starts for Stage 4
Stg4 f+Df/Dt Trp			22	Unsigned Integer		30439		G1		Data					*	*	*	Number of f+DF/DT trips for Stage 4
Stg4 Revn Date			N/A	(Sub Heading)											*	*	*	
Stg4 Revn Date	N/A		24	IEC870 Date & Time		30440	30443	G12		Data					*	*	*	Date and Time of last revn of Stg4 setting
12_Jan_98 12:00:00.000			N/A												*	*	*	Front Panel Menu only
Stg5 f+t Sta			25	Unsigned Integer		30444		G1		Data					*	*	*	Number of f+t starts for Stage 5
Stg5 f+t Trp			26	Unsigned Integer		30445		G1		Data					*	*	*	Number of f+t trips for Stage 5
Stg5 f+df/dt Trp			27	Unsigned Integer		30446		G1		Data					*	*	*	Number of f+df/dt trips for Stage 5
Stg5 df/dt+t Sta			28	Unsigned Integer		30447		G1		Data					*	*	*	Number of df/dt+t starts for Stage 5
Stg5 df/dt+t Trp			29	Unsigned Integer		30448		G1		Data					*	*	*	Number of df/dt trips for Stage 5
Stg5 f+Df/Dt Sta			2A	Unsigned Integer		30449		G1		Data					*	*	*	Number of f+DF/DT starts for Stage 5
Stg5 f+Df/Dt Trp			2B	Unsigned Integer		30450		G1		Data					*	*	*	Number of f+DF/DT trips for Stage 5
Stg5 Revn Date			N/A	(Sub Heading)											*	*	*	
Stg5 Revn Date	N/A		2D	IEC870 Date & Time		30451	30454	G12		Data					*	*	*	Date and Time of last revn of Stg5 setting
12_Jan_98 12:00:00.000			N/A												*	*	*	Front Panel Menu only
Stg6 f+t Sta			2E	Unsigned Integer		30455		G1		Data					*	*	*	Number of f+t starts for Stage 6
Stg6 f+t Trp			2F	Unsigned Integer		30456		G1		Data					*	*	*	Number of f+t trips for Stage 6
Stg6 f+df/dt Trp			30	Unsigned Integer		30457		G1		Data					*	*	*	Number of f+df/dt trips for Stage 6
Stg6 df/dt+t Sta			31	Unsigned Integer		30458		G1		Data					*	*	*	Number of df/dt+t starts for Stage 6
Stg6 df/dt+t Trp			32	Unsigned Integer		30459		G1		Data					*	*	*	Number of df/dt trips for Stage 6
Stg6 f+Df/Dt Sta			33	Unsigned Integer		30460		G1		Data					*	*	*	Number of f+DF/DT starts for Stage 6
Stg6 f+Df/Dt Trp			34	Unsigned Integer		30461		G1		Data					*	*	*	Number of f+DF/DT trips for Stage 6
Stg6 Revn Date			N/A	(Sub Heading)											*	*	*	
Stg6 Revn Date	N/A		36	IEC870 Date & Time		30462	30465	G12		Data					*	*	*	Date and Time of last revn of Stg6 setting

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
12_Jan_98 12:00:00.000			N/A												*	*	*	Front Panel Menu only
Reset Statistics			37	Indexed String	G11	40103		G11	No	Command	0	1	1	2	*	*	*	Reset all Stage statistics
GENR ABN TIMERS		05	00												*	*	*	
Freq Band1 Timer			01	Courier Number (Time-minutes)		30500		G25		Data					*	*	*	Displays current timer value for band1
Freq Band2 Timer			02	Courier Number (Time-minutes)		30501		G25		Data					*	*	*	Displays current timer value for band2
Freq Band3 Timer			03	Courier Number (Time-minutes)		30502		G25		Data					*	*	*	Displays current timer value for band3
Freq Band4 Timer			04	Courier Number (Time-minutes)		30503		G25		Data					*	*	*	Displays current timer value for band4
Reset Timers			05	Indexed String	G11	40104		G11	No	Command	0	1	1	2	*	*	*	
DATE AND TIME		08	00												*	*	*	
Date/Time	N/A		01	IEC870 Date & Time		40300	40303	G12		Setting				2	*	*	*	
Date 12_Jan_98			N/A												*	*	*	Front Panel Menu only
Time 12:00			N/A												*	*	*	Front Panel Menu only
IRIG-B Sync			04	Indexed String	G37	40304		G37	Disabled	Setting	0	1	1	2	*	*	*	
IRIG-B Status			05	Indexed String	G17	30090		G17		Data					*	*	*	
Battery Status			06	Indexed String	G59	30091		G59		Data					*	*	*	
Battery Alarm			07	Indexed String	G37	40305		G37	Enabled	Setting	0	1	1	2	*	*	*	
CONFIGURATION		09	00												*	*	*	
Restore Defaults			01	Indexed String	G53	40402		G53	No Operation	Command	0	5	1	2	*	*	*	
Setting Group			02	Indexed String	G61	40403		G61	Select via Menu	Setting	0	1	1	2	*	*	*	
Save Changes			04	Indexed String	G62	40405		G62	No Operation	Command	0	2	1	2	*	*	*	
Copy From			05	Indexed String	G90	40406		G90	Group 1	Setting	0	3	1	2	*	*	*	
Copy To			06	Indexed String	G98	40407		G98	No Operation	Command	0	3	1	2	*	*	*	
Setting Group 1			07	Indexed String	G37	40408		G37	Enabled	Setting	0	1	1	2	*	*	*	
Setting Group 2			08	Indexed String	G37	40409		G37	Disabled	Setting	0	1	1	2	*	*	*	
Setting Group 3			09	Indexed String	G37	40410		G37	Disabled	Setting	0	1	1	2	*	*	*	
Setting Group 4			0A	Indexed String	G37	40411		G37	Disabled	Setting	0	1	1	2	*	*	*	
Load Restoration			0B	Indexed String	G37	40412		G37	Disabled	Setting	0	1	1	2	*	*	*	Enable/Disable Load restoration feature
Genr Abn Protn			0C	Indexed String	G37	40413		G37	Disabled	Setting	0	1	1	2	*	*	*	Enable/Disable Gen abn protn
Volt Protection			1D	Indexed String	G37	40414		G37	Enabled	Setting	0	1	1	2	*	*	*	
Input Labels			25	Indexed String	G80				Visible	Setting	0	1	1	1	*	*	*	
Output Labels			26	Indexed String	G80				Visible	Setting	0	1	1	1	*	*	*	
CT & VT Ratios			28	Indexed String	G80				Visible	Setting	0	1	1	1	*	*	*	
Record Control			29	Indexed String	G80				Visible	Setting	0	1	1	1	*	*	*	Disturbance recorder
Disturb Recorder			2A	Indexed String	G80				Visible	Setting	0	1	1	1	*	*	*	Disturbance recorder
Measure't Setup			2B	Indexed String	G80				Visible	Setting	0	1	1	1	*	*	*	
Comms Settings			2C	Indexed String	G80				Visible	Setting	0	1	1	1	*	*	*	
Commission Test			2D	Indexed String	G80				Visible	Setting	0	1	1	1	*	*	*	
Setting Values			2E	Indexed String	G54				Secondary	Setting	0	1	1	1	*	*	*	Sets only for interface being used
						40400 40401		G18 G6										Record Selection Command register Record Control Command register
CT AND VT RATIOS		0A	00												*	*	*	

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
Main VT Primary			01	Courier Number (Voltage)		40500	40501	G35	110	Setting	100	1000000	1	2	*	*	*	Label V1=Main VT Rating/110
Main VT Sec'y			02	Courier Number (Voltage)		40502		G2	110	Setting	80	140	1	2	*	*	*	
RECORD CONTROL		0B	00												*	*	*	
Clear Events			01	Indexed String	G11				No	Command	0	1	1	1	*	*	*	
Clear Faults			02	Indexed String	G11				No	Command	0	1	1	1	*	*	*	
Clear Maint			03	Indexed String	G11				No	Command	0	1	1	1	*	*	*	
Alarm Event			04	Indexed String	G37	40520		G37	Enabled	Setting	0	1	1	2	*	*	*	
Relay O/P Event			05	Indexed String	G37	40521		G37	Enabled	Setting	0	1	1	2	*	*	*	
Opto Input Event			06	Indexed String	G37	40522		G37	Enabled	Setting	0	1	1	2	*	*	*	
System Event			07	Indexed String	G37	40523		G37	Enabled	Setting	0	1	1	2	*	*	*	
Fault Rec Event			08	Indexed String	G37	40524		G37	Enabled	Setting	0	1	1	2	*	*	*	
Maint Rec Event			09	Indexed String	G37	40525		G37	Enabled	Setting	0	1	1	2	*	*	*	
Protection Event			0A	Indexed String	G37	40526		G37	Enabled	Setting	0	1	1	2	*	*	*	
DDB 31 - 0			0B	Binary Flag (32 bits)	G27	40527	40528	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 63 - 32			0C	Binary Flag (32 bits)	G27	40529	40530	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 95 - 64			0D	Binary Flag (32 bits)	G27	40531	40532	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 127 - 96			0E	Binary Flag (32 bits)	G27	40533	40534	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 159 - 128			0F	Binary Flag (32 bits)	G27	40535	40536	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 191 - 160			10	Binary Flag (32 bits)	G27	40537	40538	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 223 - 192			11	Binary Flag (32 bits)	G27	40539	40540	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 255 - 224			12	Binary Flag (32 bits)	G27	40541	40542	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 287 - 256			13	Binary Flag (32 bits)	G27	40543	40544	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 319 - 288			14	Binary Flag (32 bits)	G27	40545	40546	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 351 - 320			15	Binary Flag (32 bits)	G27	40547	40548	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 383 - 352			16	Binary Flag (32 bits)	G27	40549	40550	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 415 - 384			17	Binary Flag (32 bits)	G27	40551	40552	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 447 - 416			18	Binary Flag (32 bits)	G27	40553	40554	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 479 - 448			19	Binary Flag (32 bits)	G27	40555	40556	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DDB 511 - 480			1A	Binary Flag (32 bits)	G27	40557	40558	G27	0xFFFFFFFF	Setting	0xFFFFFFFF	32	1	2	*	*	*	
DISTURB RECORDER		0C	00												*	*	*	DISTURBANCE RECORDER
Duration			01	Courier Number (Time)		40600		G2	10	Setting	0,1	10,5	0,01	2	*	*	*	
Trigger Position			02	Courier Number (Percentage)		40601		G2	70	Setting	0	100	0,1	2	*	*	*	
Trigger Mode			03	Indexed String	G34	40602		G34	Single	Setting	0	1	1	2	*	*	*	
Analog Channel 1			04	Indexed String	G101	40603		G101	Frequency	Data	0	0	0	2	*	*	*	Must be frequency for MiCOM S1
Analog Channel 2			05	Indexed String	G101	40604		G101	VAN	Setting	0	2	1	2	*	*	*	
Analog Channel 3			06	Indexed String	G101	40605		G101	VBN	Setting	0	2	1	2	*	*	*	
Analog Channel 4			07	Indexed String	G101	40606		G101	VCN	Setting	0	2	1	2	*	*	*	
Digital Input 1			0C	Indexed String	G32	40607		G32	Stg1 Freq Sta	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 1 Trigger			0D	Indexed String	G66	40608		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 2			0E	Indexed String	G32	40609		G32	Stg2 Freq Sta	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 2 Trigger			0F	Indexed String	G66	40610		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 3			10	Indexed String	G32	40611		G32	Stg3 Freq Sta	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 3 Trigger			11	Indexed String	G66	40612		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 4			12	Indexed String	G32	40613		G32	Stg4 Freq Sta	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 4 Trigger			13	Indexed String	G66	40614		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 5			14	Indexed String	G32	40615		G32	Stg5 Freq Sta	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 5 Trigger			15	Indexed String	G66	40616		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	

Courier Text	UI	Courier		Data Type	Strings	Modbus Address		Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model			Comment
		Col	Row			Start	End								P941	P942	P943	
Digital Input 6			16	Indexed String	G32	40617		G32	Stg6 Freq Sta	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 6 Trigger			17	Indexed String	G66	40618		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 7			18	Indexed String	G32	40619		G32	Stg1 Freq Trp	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 7 Trigger			19	Indexed String	G66	40620		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 8			1A	Indexed String	G32	40621		G32	Stg2 Freq Trp	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 8 Trigger			1B	Indexed String	G66	40622		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 9			1C	Indexed String	G32	40623		G32	Stg3 Freq Trp	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 9 Trigger			1D	Indexed String	G66	40624		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 10			1E	Indexed String	G32	40625		G32	Stg4 Freq Trp	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 10 Trigger			1F	Indexed String	G66	40626		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 11			20	Indexed String	G32	40627		G32	Stg5 Freq Trp	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 11 Trigger			21	Indexed String	G66	40628		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 12			22	Indexed String	G32	40629		G32	Stg6 Freq Trp	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 12 Trigger			23	Indexed String	G66	40630		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 13			24	Indexed String	G32	40631		G32	V < 1 Start	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 13 Trigger			25	Indexed String	G66	40632		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 14			26	Indexed String	G32	40633		G32	V < 2 Start	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 14 Trigger			27	Indexed String	G66	40634		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 15			28	Indexed String	G32	40635		G32	V > 1 Start	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 15 Trigger			29	Indexed String	G66	40636		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 16			2A	Indexed String	G32	40637		G32	V > 2 Start	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 16 Trigger			2B	Indexed String	G66	40638		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 17			2C	Indexed String	G32	40639		G32	V < 1 Trip	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 17 Trigger			2D	Indexed String	G66	40640		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 18			2E	Indexed String	G32	40641		G32	V < 2 Trip	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 18 Trigger			2F	Indexed String	G66	40642		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 19			30	Indexed String	G32	40643		G32	V > 1 Trip	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 19 Trigger			31	Indexed String	G66	40644		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 20			32	Indexed String	G32	40645		G32	V > 2 Trip	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 20 Trigger			33	Indexed String	G66	40646		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 21			34	Indexed String	G32	40647		G32	Freq High	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 21 Trigger			35	Indexed String	G66	40648		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 22			36	Indexed String	G32	40649		G32	Freq Low	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 22 Trigger			37	Indexed String	G66	40650		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 23			38	Indexed String	G32	40651		G32	Freq Not Found	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 23 Trigger			39	Indexed String	G66	40652		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 24			3A	Indexed String	G32	40653		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 24 Trigger			3B	Indexed String	G66	40654		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 25			3C	Indexed String	G32	40655		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 25 Trigger			3D	Indexed String	G66	40656		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 26			3E	Indexed String	G32	40657		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 26 Trigger			3F	Indexed String	G66	40658		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 27			40	Indexed String	G32	40659		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 27 Trigger			41	Indexed String	G66	40660		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 28			42	Indexed String	G32	40661		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 28 Trigger			43	Indexed String	G66	40662		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 29			44	Indexed String	G32	40663		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
Input 29 Trigger			45	Indexed String	G66	40664		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 30			46	Indexed String	G32	40665		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 30 Trigger			47	Indexed String	G66	40666		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 31			48	Indexed String	G32	40667		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 31 Trigger			49	Indexed String	G66	40668		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
Digital Input 32			4A	Indexed String	G32	40669		G32	Unused	Setting	0	DDB Size	1	2	*	*	*	DDB Size different for each model
Input 32 Trigger			4B	Indexed String	G66	40670		G66	Trigger L/H	Setting	0	2	1	2	*	*	*	
MEASURE'T SETUP		0D	00												*	*	*	MEASUREMENT SETTINGS
Default Display			01	Indexed String	G52	40700		G52	Date and Time	Setting	0	5	1	2	*	*	*	
Local Values			02	Indexed String	G54	40701		G54	Primary	Setting	0	1	1	2	*	*	*	Local Measurement Values
Remote Values			03	Indexed String	G54	40702		G54	Primary	Setting	0	1	1	2	*	*	*	Remote Measurement Values
Measurement Ref			04	Indexed String	G100	40703		G100	VA	Setting	0	2	1	1	*	*	*	Measurement Phase Reference
COMMUNICATIONS		0E	00												*	*	*	
Rear Protocol			01	Indexed String	G71					Data					*	*	*	
Remote Address			02	Unsigned Integer(16 bits)					255	Setting	0	255	1	1	*	*	*	Rear port = Courier
									1	Setting	1	247	1	1	*	*	*	Rear port = Modbus
									1	Setting	0	254	1	1	*	*	*	Rear port = IEC60870-5-103
									3	Setting	0	65519	1		*	*	*	Rear port = DNP 3
Inactivity Timer			03	Courier Number (Time-minutes)					15	Setting	1	30	1	2	*	*	*	Rear poer not DNP 3
Baud Rate			04	Indexed String	G38V				19200	Setting	0	1	1	2	*	*	*	Rear port = IEC60870-5-103
					G38M				19200	Setting	0	2	1	2	*	*	*	Rear port = Modbus
					G38D				19200	Setting	0	5	1	2	*	*	*	Rear port = DNP 3
Parity			05	Indexed String	G39				None	Setting	0	2	1	2	*	*	*	Rear port = Modbus
										Setting	0	2	1		*	*	*	Rear port = DNP 3
Measure't Period			06	Courier Number (Time)					15	Setting	1	60	1	2	*	*	*	Rear port = IEC60870-5-103
Physical Link			07	Indexed String	G21				RS485	Setting	0	1	1	2	*	*	*	Rear port = IEC60870-5-103
Time Sync			08	indexed string	G37				Disabled	Setting	0	1	1		*	*	*	Rear port = DNP 3
Function Type			09	Unsigned Integer (2 bytes)					226	Setting	0	255	1	2	*	*	*	Build = IEC60870-5-103
COMMISSION TESTS		0F	00												*	*	*	
Opto I/P Status			01	binary flag(8 bits)				G8		Data					*	*		
				binary flag(16 bits)						Data							*	
				Indexed String														
Relay O/P Status			02	binary flag(7 bits)				G9		Data					*			
				binary flag(14 bits)						Data						*	*	
				Indexed String														
Test Port Status			03	Binary Flags(8 bits)		30709		G1		Data					*	*	*	
				Indexed String														
LED Status			04	Binary Flags(8 bits)				G10		Data					*	*	*	
Monitor Bit 1			05	Unsigned Integer (16 bits)		40850		G1	64	Setting	0	511	1	1	*	*	*	Default LED 1
Monitor Bit 2			06	Unsigned Integer (16 bits)		40851		G1	65	Setting	0	511	1	1	*	*	*	Default LED 2
Monitor Bit 3			07	Unsigned Integer (16 bits)		40852		G1	66	Setting	0	511	1	1	*	*	*	Default LED 3
Monitor Bit 4			08	Unsigned Integer (16 bits)		40853		G1	67	Setting	0	511	1	1	*	*	*	Default LED 4
Monitor Bit 5			09	Unsigned Integer (16 bits)		40854		G1	68	Setting	0	511	1	1	*	*	*	Default LED 5
Monitor Bit 6			0A	Unsigned Integer (16 bits)		40855		G1	69	Setting	0	511	1	1	*	*	*	Default LED 6
Monitor Bit 7			0B	Unsigned Integer (16 bits)		40856		G1	70	Setting	0	511	1	1	*	*	*	Default LED 7
Monitor Bit 8			0C	Unsigned Integer (16 bits)		40857		G1	71	Setting	0	511	1	1	*	*	*	Default LED 8

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
Test mode			0D	Indexed String	G119	40858		G119	Disabled	Setting	0	2	1	2	*	*	*	
Test Pattern			0E	binary flags (7 bits)	G27	40859	40860	G27	0	Setting	127	7	1	2	*			
				binary flags (14 bits)						Setting	16383	14	1			*	*	
				Indexed String							0	13	1	2				
Contact Test			0F	Indexed String	G93	40861		G93	No Operation	Command	0	2	1	2	*	*	*	
Test LEDs			10	Indexed String	G94	40862		G94	No Operation	Command	0	1	1	2	*	*	*	
DDB 31 - 0	N/A		20	Binary Flags (32 Bits)		30723	30724	G27		Data					*	*	*	
				Indexed String														
DDB 63 - 32	N/A		21	Binary Flags (32 Bits)		30725	30726	G27		Data					*	*	*	
				Indexed String														
DDB 95 - 64	N/A		22	Binary Flags (32 Bits)		30727	30728	G27		Data					*	*	*	
				Indexed String														
DDB 127 - 96	N/A		23	Binary Flags (32 Bits)		30729	30730	G27		Data					*	*	*	
				Indexed String														
DDB 159 - 128	N/A		24	Binary Flags (32 Bits)		30731	30732	G27		Data					*	*	*	
				Indexed String														
DDB 191 - 160	N/A		25	Binary Flags (32 Bits)		30733	30734	G27		Data					*	*	*	
				Indexed String														
DDB 223 - 192	N/A		26	Binary Flags (32 Bits)		30735	30736	G27		Data					*	*	*	
				Indexed String														
DDB 255 - 224	N/A		27	Binary Flags (32 Bits)		30737	30738	G27		Data					*	*	*	
				Indexed String														
DDB 287 - 256	N/A		28	Binary Flags (32 Bits)		30739	30740	G27		Data					*	*	*	
				Indexed String														
DDB 319 - 288	N/A		29	Binary Flags (32 Bits)		30741	30742	G27		Data					*	*	*	
				Indexed String														
DDB 351 - 320	N/A		2A	Binary Flags (32 Bits)		30743	30744	G27		Data					*	*	*	
				Indexed String														
DDB 383 - 352	N/A		2B	Binary Flags (32 Bits)		30745	30746	G27		Data					*	*	*	
				Indexed String														
DDB 415 - 384	N/A		2C	Binary Flags (32 Bits)		30747	30748	G27		Data					*	*	*	
				Indexed String														
DDB 447 - 416	N/A		2D	Binary Flags (32 Bits)		30749	30750	G27		Data					*	*	*	
				Indexed String														
DDB 479 - 448	N/A		2E	Binary Flags (32 Bits)		30751	30752	G27		Data					*	*	*	
				Indexed String														
DDB 511 - 480	N/A		2F	Binary Flags (32 Bits)		30753	30754	G27		Data					*	*	*	
				Indexed String														
	N/A		N/A	Binary Flag (16 bits)		30701		G1		Data					*	*	*	Relay Status (repeat of Courier status)
	N/A		N/A	Courier Number (voltage)		30702	30703	G24		Data					*	*	*	VAB Magnitude
	N/A		N/A	Courier Number (voltage)		30704	30705	G24		Data					*	*	*	VBC Magnitude
	N/A		N/A	Courier Number (voltage)		30706	30707	G24		Data					*	*	*	VCA Magnitude
	N/A		N/A	Courier Number (frequency)		30708		G25		Data					*	*	*	Frequency
	N/A		N/A	Time synchronisation		42049	42052	G12		Setting					*	*	*	
GROUP 1		30	00												*	*	*	
COMMON SETTINGS																		
V<B Status			01	Indexed String	G37	41000		G37	Enabled	Setting	0	1	1	2	*	*	*	Undervoltage blocking

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
V<B Voltage Set			02	Courier Number (Voltage)		41001		G2	25	Setting	20*V1	120*V1	1*V1	2	*	*	*	Range covers Ph-Ph & Ph-N for 2 VT rat
Pick Up Cycles			03	Unsigned Integer(2 chars)		41002		G1	5	Setting	1	12	1	2	*	*	*	
Drop Off Cycles			04	Unsigned Integer(2 chars)		41003		G1	3	Setting	1	3	1	2	*	*	*	
Holding Timer			05	Courier Number (Time)		41004		G2	5	Setting	1	300	1	2	*	*	*	
GROUP 1		31	00												*	*	*	
f+t SETTINGS																		
Stage1 f+t			01	Indexed String	G37	41050		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
1(f+t) f			02	Courier Number (Frequency)		41051		G2	49	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+t element - Stg1
1(f+t) t			03	Courier Number (Time)		41052		G2	20	Setting	0	100	0,01	2	*	*	*	Time setting for the f+t element - Stg1
Stage2 f+t			04	Indexed String	G37	41053		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
2(f+t) f			05	Courier Number (Frequency)		41054		G2	48,6	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+t element - Stg2
2(f+t) t			06	Courier Number (Time)		41055		G2	20	Setting	0	100	0,01	2	*	*	*	Time setting for the f+t element - Stg2
Stage3 f+t			07	Indexed String	G37	41056		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
3(f+t) f			08	Courier Number (Frequency)		41057		G2	48,2	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+t element - Stg3
3(f+t) t			09	Courier Number (Time)		41058		G2	10	Setting	0	100	0,01	2	*	*	*	Time setting for the f+t element - Stg3
Stage4 f+t			0A	Indexed String	G37	41059		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
4(f+t) f			0B	Courier Number (Frequency)		41060		G2	47,8	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+t element - Stg4
4(f+t) t			0C	Courier Number (Time)		41061		G2	10	Setting	0	100	0,01	2	*	*	*	Time setting for the f+t element - Stg4
Stage5 f+t			0D	Indexed String	G37	41062		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
5(f+t) f			0E	Courier Number (Frequency)		41063		G2	50,5	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+t element - Stg5
5(f+t) t			0F	Courier Number (Time)		41064		G2	30	Setting	0	100	0,01	2	*	*	*	Time setting for the f+t element - Stg5
Stage6 f+t			10	Indexed String	G37	41065		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
6(f+t) f			11	Courier Number (Frequency)		41066		G2	51	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+t element - Stg6
6(f+t) t			12	Courier Number (Time)		41067		G2	20	Setting	0	100	0,01	2	*	*	*	Time setting for the f+t element - Stg6
GROUP 1		32	00												*	*	*	
f+df/dt SETTINGS																		
Stage1 f+df/dt			01	Indexed String	G37	41100		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
1(f+df/dt) f			02	Courier Number (Frequency)		41101		G2	49	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+df/dt element - Stg1
1(f+df/dt) df/dt			03	Courier Number (Hz/s)		41102		G2	1	Setting	0,1	10	0,1	2	*	*	*	df/dt setting for the f+df/dt element - Stg1
Stage2 f+df/dt			04	Indexed String	G37	41103		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
2(f+df/dt) f			05	Courier Number (Frequency)		41104		G2	48,6	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+df/dt element - Stg2
2(f+df/dt) df/dt			06	Courier Number (Hz/s)		41105		G2	1	Setting	0,1	10	0,1	2	*	*	*	df/dt setting for the f+df/dt element - Stg2
Stage3 f+df/dt			07	Indexed String	G37	41106		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
3(f+df/dt) f			08	Courier Number (Frequency)		41107		G2	48,2	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+df/dt element - Stg3
3(f+df/dt) df/dt			09	Courier Number (Hz/s)		41108		G2	1	Setting	0,1	10	0,1	2	*	*	*	df/dt setting for the f+df/dt element - Stg3
Stage4 f+df/dt			0A	Indexed String	G37	41109		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
4(f+df/dt) f			0B	Courier Number (Frequency)		41110		G2	47,8	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+df/dt element - Stg4
4(f+df/dt) df/dt			0C	Courier Number (Hz/s)		41111		G2	1	Setting	0,1	10	0,1	2	*	*	*	df/dt setting for the f+df/dt element - Stg4
Stage5 f+df/dt			0D	Indexed String	G37	41112		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
5(f+df/dt) f			0E	Courier Number (Frequency)		41113		G2	50,5	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+df/dt element - Stg5
5(f+df/dt) df/dt			0F	Courier Number (Hz/s)		41114		G2	1	Setting	0,1	10	0,1	2	*	*	*	df/dt setting for the f+df/dt element - Stg5
Stage6 f+df/dt			10	Indexed String	G37	41115		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
6(f+df/dt) f			11	Courier Number (Frequency)		41116		G2	51	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+df/dt element - Stg6
6(f+df/dt) df/dt			12	Courier Number (Hz/s)		41117		G2	1	Setting	0,1	10	0,1	2	*	*	*	df/dt setting for the f+df/dt element - Stg6
GROUP 1		33	00												*	*	*	
df/dt+t SETTINGS																		
Stage1 df/dt+t			01	Indexed String	G37	41150		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
1(df/dt+t) df/dt			02	Courier Number (Hz/s)		41151		G2	-2	Setting	-10	10	0,1	2	*	*	*	df/dt setting for the df/dt+t element - Stg1
1(df/dt+t) t			03	Courier Number (Time)		41152		G2	0,5	Setting	0	100	0,01	2	*	*	*	Time setting for the df/dt+t element - Stg1
Stage2 df/dt+t			04	Indexed String	G37	41153		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
2(df/dt+t) df/dt			05	Courier Number (Hz/s)		41154		G2	-2	Setting	-10	10	0,1	2	*	*	*	df/dt setting for the df/dt+t element - Stg2
2(df/dt+t) t			06	Courier Number (Time)		41155		G2	1	Setting	0	100	0,01	2	*	*	*	Time setting for the df/dt+t element - Stg2
Stage3 df/dt+t			07	Indexed String	G37	41156		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
3(df/dt+t) df/dt			08	Courier Number (Hz/s)		41157		G2	-2	Setting	-10	10	0,1	2	*	*	*	df/dt setting for the df/dt+t element - Stg3
3(df/dt+t) t			09	Courier Number (Time)		41158		G2	2	Setting	0	100	0,01	2	*	*	*	Time setting for the df/dt+t element - Stg3
Stage4 df/dt+t			0A	Indexed String	G37	41159		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
4(df/dt+t) df/dt			0B	Courier Number (Hz/s)		41160		G2	-2	Setting	-10	10	0,1	2	*	*	*	df/dt setting for the df/dt+t element - Stg4
4(df/dt+t) t			0C	Courier Number (Time)		41161		G2	3	Setting	0	100	0,01	2	*	*	*	Time setting for the df/dt+t element - Stg4
Stage5 df/dt+t			0D	Indexed String	G37	41162		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
5(df/dt+t) df/dt			0E	Courier Number (Hz/s)		41163		G2	2	Setting	-10	10	0,1	2	*	*	*	df/dt setting for the df/dt+t element - Stg5
5(df/dt+t) t			0F	Courier Number (Time)		41164		G2	0,5	Setting	0	100	0,01	2	*	*	*	Time setting for the df/dt+t element - Stg5
Stage6 df/dt+t			10	Indexed String	G37	41165		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
6(df/dt+t) df/dt			11	Courier Number (Hz/s)		41166		G2	2	Setting	-10	10	0,1	2	*	*	*	df/dt setting for the df/dt+t element - Stg6
6(df/dt+t) t			12	Courier Number (Time)		41167		G2	1	Setting	0	100	0,01	2	*	*	*	Time setting for the df/dt+t element - Stg6
GROUP 1		34	00												*	*	*	
f+Df/Dt SETTINGS																		
Stage1 f+Df/Dt			01	Indexed String	G37	41200		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
1(f+Df/Dt) f			02	Courier Number (Frequency)		41201		G2	49	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+DF/DT element - Stg1
1(f+Df/Dt) Df			03	Courier Number (Frequency)		41202		G2	0,5	Setting	0,2	10	0,1	2	*	*	*	Df setting for the f+DF/DT element - Stg1
1(f+Df/Dt) Dt			04	Courier Number (Time)		41203		G2	0,5	Setting	0,02	2	0,02	2	*	*	*	Dt setting for the f+DF/DT element - Stg1
Stage2 f+Df/Dt			05	Indexed String	G37	41204		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
2(f+Df/Dt) f			06	Courier Number (Frequency)		41205		G2	49	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+DF/DT element - Stg2
2(f+Df/Dt) Df			07	Courier Number (Frequency)		41206		G2	1	Setting	0,2	10	0,1	2	*	*	*	Df setting for the f+DF/DT element - Stg2
2(f+Df/Dt) Dt			08	Courier Number (Time)		41207		G2	1	Setting	0,02	2	0,02	2	*	*	*	Dt setting for the f+DF/DT element - Stg2
Stage3 f+Df/Dt			09	Indexed String	G37	41208		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
3(f+Df/Dt) f			0A	Courier Number (Frequency)		41209		G2	48,5	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+DF/DT element - Stg3
3(f+Df/Dt) Df			0B	Courier Number (Frequency)		41210		G2	0,5	Setting	0,2	10	0,1	2	*	*	*	Df setting for the f+DF/DT element - Stg3
3(f+Df/Dt) Dt			0C	Courier Number (Time)		41211		G2	0,5	Setting	0,02	2	0,02	2	*	*	*	Dt setting for the f+DF/DT element - Stg3
Stage4 f+Df/Dt			0D	Indexed String	G37	41212		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
4(f+Df/Dt) f			0E	Courier Number (Frequency)		41213		G2	48,5	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+DF/DT element - Stg4
4(f+Df/Dt) Df			0F	Courier Number (Frequency)		41214		G2	1	Setting	0,2	10	0,1	2	*	*	*	Df setting for the f+DF/DT element - Stg4
4(f+Df/Dt) Dt			10	Courier Number (Time)		41215		G2	1	Setting	0,02	2	0,02	2	*	*	*	Dt setting for the f+DF/DT element - Stg4
Stage5 f+Df/Dt			11	Indexed String	G37	41216		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
5(f+Df/Dt) f			12	Courier Number (Frequency)		41217		G2	50,5	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+DF/DT element - Stg5
5(f+Df/Dt) Df			13	Courier Number (Frequency)		41218		G2	0,5	Setting	0,2	10	0,1	2	*	*	*	Df setting for the f+DF/DT element - Stg5
5(f+Df/Dt) Dt			14	Courier Number (Time)		41219		G2	0,5	Setting	0,02	2	0,02	2	*	*	*	Dt setting for the f+DF/DT element - Stg5
Stage6 f+Df/Dt			15	Indexed String	G37	41220		G37	Enabled	Setting	0	1	1	2	*	*	*	Status of the element
6(f+Df/Dt) f			16	Courier Number (Frequency)		41221		G2	51	Setting	40	70	0,01	2	*	*	*	Frq setting for the f+DF/DT element - Stg6
6(f+Df/Dt) Df			17	Courier Number (Frequency)		41222		G2	0,5	Setting	0,2	10	0,1	2	*	*	*	Df setting for the f+DF/DT element - Stg6
6(f+Df/Dt) Dt			18	Courier Number (Time)		41223		G2	0,5	Setting	0,02	2	0,02	2	*	*	*	Dt setting for the f+DF/DT element - Stg6
GROUP 1		39	00												*	*	*	
GENR ABN PROTN																		
Band1 Freq Low			01	Courier Number (Frequency)		41450		G2	48,5	Setting	40	70	0,01	2	*	*	*	
Band1 Freq High			02	Courier Number (Frequency)		41451		G2	49	Setting	40	70	0,01	2	*	*	*	

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
Band1 Delay			03	Courier Number (Time-minutes)		41452		G2	180	Setting	0	240	0,5	2	*	*	*	
Band2 Freq Low			04	Courier Number (Frequency)		41453		G2	48	Setting	40	70	0,01	2	*	*	*	
Band2 Freq High			05	Courier Number (Frequency)		41454		G2	48,5	Setting	40	70	0,01	2	*	*	*	
Band2 Delay			06	Courier Number (Time-minutes)		41455		G2	120	Setting	0	240	0,5	2	*	*	*	
Band3 Freq Low			07	Courier Number (Frequency)		41456		G2	47,5	Setting	40	70	0,01	2	*	*	*	
Band3 Freq High			08	Courier Number (Frequency)		41457		G2	48	Setting	40	70	0,01	2	*	*	*	
Band3 Delay			09	Courier Number (Time-minutes)		41458		G2	60	Setting	0	240	0,5	2	*	*	*	
Band4 Freq Low			0A	Courier Number (Frequency)		41459		G2	50,5	Setting	40	70	0,01	2	*	*	*	
Band4 Freq High			0B	Courier Number (Frequency)		41460		G2	53	Setting	40	70	0,01	2	*	*	*	
Band4 Delay			0C	Courier Number (Time-minutes)		41461		G2	60	Setting	0	240	0,5	2	*	*	*	
GROUP 1		3C	00												*	*	*	
LOAD RESTORATION																		
Restore1 Status			01	Indexed String	G37	41600		G37	Disabled	Setting	0	1	1	2	*	*	*	
Restore1 Freq			02	Courier Number (Frequency)		41601		G2	49,5	Setting	40	70	0,01	2	*	*	*	
Restore1 Time			03	Courier Number (Time)		41602		G2	240	Setting	1	7200	1	2	*	*	*	
Restore2 Status			04	Indexed String	G37	41603		G37	Disabled	Setting	0	1	1	2	*	*	*	
Restore2 Freq			05	Courier Number (Frequency)		41604		G2	49,5	Setting	40	70	0,01	2	*	*	*	
Restore2 Time			06	Courier Number (Time)		41605		G2	180	Setting	1	7200	1	2	*	*	*	
Restore3 Status			07	Indexed String	G37	41606		G37	Disabled	Setting	0	1	1	2	*	*	*	
Restore3 Freq			08	Courier Number (Frequency)		41607		G2	49,5	Setting	40	70	0,01	2	*	*	*	
Restore3 Time			09	Courier Number (Time)		41608		G2	120	Setting	1	7200	1	2	*	*	*	
Restore4 Status			0A	Indexed String	G37	41609		G37	Disabled	Setting	0	1	1	2	*	*	*	
Restore4 Freq			0B	Courier Number (Frequency)		41610		G2	49	Setting	40	70	0,01	2	*	*	*	
Restore4 Time			0C	Courier Number (Time)		41611		G2	240	Setting	1	7200	1	2	*	*	*	
Restore5 Status			0D	Indexed String	G37	41612		G37	Disabled	Setting	0	1	1	2	*	*	*	
Restore5 Freq			0E	Courier Number (Frequency)		41613		G2	49	Setting	40	70	0,01	2	*	*	*	
Restore5 Time			0F	Courier Number (Time)		41614		G2	180	Setting	1	7200	1	2	*	*	*	
Restore6 Status			10	Indexed String	G37	41615		G37	Disabled	Setting	0	1	1	2	*	*	*	
Restore6 Freq			11	Courier Number (Frequency)		41616		G2	49	Setting	40	70	0,01	2	*	*	*	
Restore6 Time			12	Courier Number (Time)		41617		G2	120	Setting	1	7200	1	2	*	*	*	
GROUP 1		42	00												*	*	*	
VOLT PROTECTION																		
UNDER VOLTAGE			01	(Sub Heading)											*	*	*	
V< Measur't Mode			02	Indexed String	G47	41950		G47	Phase-Phase	Setting	0	1	1	2	*	*	*	
V< Operate Mode			03	Indexed String	G48	41951		G48	Any Phase	Setting	0	1	1	2	*	*	*	
V<1 Function			04	Indexed String	G23	41952		G23	DT	Setting	0	2	1	2	*	*	*	
V<1 Voltage Set			05	Courier Number (Voltage)		41953		G2	80	Setting	10*V1	120*V1	1*V1	2	*	*	*	Range covers Ph-N & Ph-Ph
V<1 Time Delay			06	Courier Number (Time)		41954		G2	10	Setting	0	100	0,01	2	*	*	*	
V<1 TMS			07	Courier Number (Decimal)		41955		G2	1	Setting	0,5	100	0,5	2	*	*	*	
V<2 Status			09	Indexed String	G37	41956		G37	Enabled	Setting	0	1	1	2	*	*	*	
V<2 Voltage Set			0A	Courier Number (Voltage)		41957		G2	60	Setting	10 * V1	120 * V1	1 * V1	2	*	*	*	Phase-Neutral
V<2 Time Delay			0B	Courier Number (Time)		41958		G2	5	Setting	0	100	0,01	2	*	*	*	
OVERVOLTAGE			0D	(Sub Heading)											*	*	*	

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
V> Measur't Mode			0E	Indexed String	G47	41959		G47	Phase-Phase	Setting	0	1	1	2	*	*	*	
V> Operate Mode			0F	Indexed String	G48	41960		G48	Any Phase	Setting	0	1	1	2	*	*	*	
V>1 Function			10	Indexed String	G23	41961		G23	DT	Setting	0	2	1	2	*	*	*	
V>1 Voltage Set			11	Courier Number (Voltage)		41962		G2	130	Setting	60	185	1	2	*	*	*	
V>1 Time Delay			12	Courier Number (Time)		41963		G2	10	Setting	0	100	0,01	2	*	*	*	
V>1 TMS			13	Courier Number (Decimal)		41964		G2	1	Setting	0,5	100	0,5	2	*	*	*	
V>2 Status			14	Indexed String	G37	41965		G37	Disabled	Setting	0	1	1	2	*	*	*	
V>2 Voltage Set			15	Courier Number (Voltage)		41966		G2	150	Setting	60	185	1	2	*	*	*	
V>2 Time Delay			16	Courier Number (Time)		41967		G2	0,5	Setting	0	100	0,01	2	*	*	*	
GROUP 1		4A	00												*	*	*	
INPUT LABELS																		
Opto Input 1			01	ASCII Text (16 chars)		42400	42407	G3	L1 Setting Group	Setting	32	163	1	2	*	*	*	
Opto Input 2			02	ASCII Text (16 chars)		42408	42415	G3	L2 Setting Group	Setting	32	163	1	2	*	*	*	
Opto Input 3			03	ASCII Text (16 chars)		42416	42423	G3	L3 Stg1f+t Block	Setting	32	163	1	2	*	*	*	
Opto Input 4			04	ASCII Text (16 chars)		42424	42431	G3	L4 Stg2f+t Block	Setting	32	163	1	2	*	*	*	
Opto Input 5			05	ASCII Text (16 chars)		42432	42439	G3	L5 Stg3f+t Block	Setting	32	163	1	2	*	*	*	
Opto Input 6			06	ASCII Text (16 chars)		42440	42447	G3	L6 Stg4f+t Block	Setting	32	163	1	2	*	*	*	
Opto Input 7			07	ASCII Text (16 chars)		42448	42455	G3	L7 Stg6f+t Block	Setting	32	163	1	2	*	*	*	
Opto Input 8			08	ASCII Text (16 chars)		42456	42463	G3	L8 Voltage Block	Setting	32	163	1	2	*	*	*	
Opto Input 9			09	ASCII Text (16 chars)		42464	42471	G3	L9 Not Used	Setting	32	163	1	2			*	
Opto Input 10			0A	ASCII Text (16 chars)		42472	42479	G3	L10 Not Used	Setting	32	163	1	2			*	
Opto Input 11			0B	ASCII Text (16 chars)		42480	42487	G3	L11 Not Used	Setting	32	163	1	2			*	
Opto Input 12			0C	ASCII Text (16 chars)		42488	42495	G3	L12 Not Used	Setting	32	163	1	2			*	
Opto Input 13			0D	ASCII Text (16 chars)		42496	42503	G3	L13 Not Used	Setting	32	163	1	2			*	
Opto Input 14			0E	ASCII Text (16 chars)		42504	42511	G3	L14 Not Used	Setting	32	163	1	2			*	
Opto Input 15			0F	ASCII Text (16 chars)		42512	42519	G3	L15 Not Used	Setting	32	163	1	2			*	
Opto Input 16			10	ASCII Text (16 chars)		42520	42527	G3	L16 Not Used	Setting	32	163	1	2			*	
GROUP 1		4B	00												*	*	*	
OUTPUT LABELS																		
Relay 1			01	ASCII Text (16 chars)		42550	42557	G3	R1 Stg1 f+t Trip	Setting	32	163	1	2	*	*	*	
Relay 2			02	ASCII Text (16 chars)		42558	42565	G3	R2 Stg2 f+t Trip	Setting	32	163	1	2	*	*	*	
Relay 3			03	ASCII Text (16 chars)		42566	42573	G3	R3 Stg3 f+t Trip	Setting	32	163	1	2	*	*	*	
Relay 4			04	ASCII Text (16 chars)		42574	42581	G3	R4 Stg4 f+t Trip	Setting	32	163	1	2	*	*	*	
Relay 5			05	ASCII Text (16 chars)		42582	42589	G3	R5 Stg6 f+t Trip	Setting	32	163	1	2	*	*	*	
Relay 6			06	ASCII Text (16 chars)		42590	42597	G3	R6 Voltage Start R6 Stg1f+Df/Dt T	Setting	32	163	1	2	*	 *	 *	
Relay 7			07	ASCII Text (16 chars)		42598	42605	G3	R7 Voltage Trips R7 Stg2f+df/dt T	Setting	32	163	1	2	*	 *	 *	
Relay 8			08	ASCII Text (16 chars)		42606	42613	G3	R8 Stg3f+df/dt T	Setting	32	163	1	2		*	*	
Relay 9			09	ASCII Text (16 chars)		42614	42621	G3	R9 Stg4f+df/dt T	Setting	32	163	1	2		*	*	
Relay 10			0A	ASCII Text (16 chars)		42622	42629	G3	R10 Voltage Strt	Setting	32	163	1	2		*	*	
Relay 11			0B	ASCII Text (16 chars)		42630	42637	G3	R11 Voltage Trip	Setting	32	163	1	2		*	*	
Relay 12			0C	ASCII Text (16 chars)		42638	42645	G3	R12 Gen Abn Trip	Setting	32	163	1	2		*	*	
Relay 13			0D	ASCII Text (16 chars)		42646	42653	G3	R13 Stg1 Restore	Setting	32	163	1	2		*	*	

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
Relay 14			0E	ASCII Text (16 chars)		42654	42661	G3	R14 Stg2 Restore	Setting	32	163	1	2		*	*	
GROUP 2 PROTECTION SETTINGS															*	*	*	
Repeat of Group 1		50	00			43000	44999								*	*	*	
GROUP 3 PROTECTION SETTINGS															*	*	*	
Repeat of Group 1		70	00			45000	46999								*	*	*	
GROUP 4 PROTECTION SETTINGS															*	*	*	
Repeat of Group 1		90	00			47000	48999								*	*	*	
(No Header)	N/A	B0	00	Auto extraction Event Record Column											*	*	*	
Select Record			01	Unsigned Integer (16 bits)						Setting	0	65535	1		*	*	*	Unique cyclical fault number(from event)
Start Elements 1			02	Binary Flags (18 Bits) Indexed String	G84					Data					*	*	*	
Start Elements 2			03	Binary Flags (20 Bits) Indexed String	G102					Data					*	*	*	Product Specific Bit Flags Targeting
Trip Elements 1			04	Binary Flags (24 Bits) Indexed String	G85					Data					*	*	*	Product Specific Bit Flags Targeting
Trip Elements 2			05	Binary Flags (20 Bits) Indexed String	G86					Data					*	*	*	Product Specific Bit Flags Targeting
Date & Time			06	IEC870 Date & Time						Data					*	*	*	
Active Group			07	Unsigned Integer						Data					*	*	*	
System Frequency			08	Courier Number (frequency)						Data					*	*	*	
VAB			09	Courier Number (voltage)						Data					*	*	*	
VBC			0A	Courier Number (voltage)						Data					*	*	*	
VCA			0B	Courier Number (voltage)						Data					*	*	*	
df/dt			0C	Courier Number (Hz/s)						Data					*	*	*	
No Header	N/A	B1	00	Auto extraction Maintenance record column											*	*	*	
Select Record			01	Unsigned integer (16 bits)						Setting	0	65535	1		*	*	*	
Time and Date			02	IEC Date and Time						Data					*	*	*	
Record Text			03	ASCII Text (32 chars)						Data					*	*	*	
Record Type			04	Unsigned Integer (32 bits)						Data					*	*	*	
Record Data			05	Unsigned Integer (32 bits)						Data					*	*	*	
No Header	N/A	B2	00												*	*	*	
Domain			04	Indexed String				G57	PSL Settings	Setting	0	2	1	2	*	*	*	
Sub-Domain			08	Indexed String				G90	PSL Setting Grp1	Setting	0	3	1	2	*	*	*	
Version			0C	Unsigned Integer (16 bits)					256	Setting	0	65535	1	2	*	*	*	
Start			10	Not Used											*	*	*	
Length			14	Not Used											*	*	*	
Reference			18	Not Used											*	*	*	
Transfer Mode			1C	Indexed String	G76			G76	ok	Setting	0	7	1	2	*	*	*	
Data Transfer			20	Repeated groups of Unsigned Integers						Setting					*	*	*	Only settable if Domain = PSL Settings
No Header	N/A	B3	00	Disturbance Recorder Control														
UNUSED			01												*	*	*	
Recorder Source			02	Indexed String	0			0	Samples	Data					*	*	*	
No Header	N/A	B4	00	Disturbance Record Extraction											*	*	*	
Select Record			01	Unsigned Integer					0	Setting	-199	199	1	0	*	*	*	

Courier Text	UI	Courier Col	Courier Row	Data Type	Strings	Modbus Address Start	Modbus Address End	Modbus Database	Default Setting	Cell Type	Min	Max	Step	Password Level	Model P941	Model P942	Model P943	Comment
Trigger Time			02	IEC870 Date & Time						Data					*	*	*	
Format			0A	Unsigned Integer (16 bits)					1	Data					*	*	*	
Upload			0B	Unsigned Integer (16 bits)						Data					*	*	*	
						30800		G1		Data					*	*	*	Number of Disturbance Records
						30801		G1		Data					*	*	*	Oldest Stored Disturbance Record
						30802		G1		Data					*	*	*	Number of Registers in Current Page
						30803	30929	G1		Data					*	*	*	Disturbance Record Page
						30930	30933	G12		Data					*	*	*	Time Stamp of selected Record
						40250		G1		Setting	1	65535	1	2	*	*	*	Select Disturbance Record
(No Header)	N/A	B5	00															Calibration Coefficients - Hidden
Cal Software Version		B5	01	ASCII Text (16 chars)											*	*	*	
Cal Date and Time		B5	02	IEC870 Date & Time											*	*	*	
Channel Types		B5	03	Repeated Group 16 * Binary Flag 8 bits											*	*	*	
Cal Coeffs		B5	04	Block transfer Repeated Group of UINT32 (4 coeffs voltage channel, 8 coeffs current channel)											*	*	*	
(No Header)	N/A	B6	00												*	*	*	Comms Diagnostics - Hidden
Bus Comms Err Count Front			01	Unsigned Integer (32 bits)											*	*	*	
Bus Message Count Front			02	Unsigned Integer (32 bits)											*	*	*	
Protocol Err Count Front			03	Unsigned Integer (32 bits)											*	*	*	
Busy Count Front			04	Unsigned Integer (32 bits)											*	*	*	
Reset front count			05	(Reset Menu Cell cmd only)											*	*	*	
Bus Comms Err Count Rear			06	Unsigned Integer (32 bits)											*	*	*	
Bus Message Count Rear			07	Unsigned Integer (32 bits)											*	*	*	
Protocol Err Count Rear			08	Unsigned Integer (32 bits)											*	*	*	
Busy Count Rear			09	Unsigned Integer (32 bits)											*	*	*	
Reset rear count			0A	(Reset Menu Cell cmd only)											*	*	*	
COMMS SYS DATA	N/A	BF	00												*	*	*	
Record Cntrl Ref			01	Menu Cell(2)					B300	Data					*	*	*	Disturbance Record Control Reference
Record Ext Ref			02	Menu Cell(2)					B400	Data					*	*	*	Disturbance Record Extraction Reference
Setting Transfer			03	Unsigned Integer (16 bits)						Setting					*	*	*	
Block Transfer Ref			06	Menu Cell(2)					B200	Data					*	*	*	Block Transfer Reference

Data Types and Indexed String Settings

TYPE	VALUE/BIT MASK	DESCRIPTION		
G1	1 Register	UNSIGNED INTEGER		
		Range 0 to 65535		
G2	1 Register	NUMERIC SETTING		
		Value = (Setting - Minimum) / Step Size		
G3		ASCII TEXT CHARACTERS (Modbus)		
	0x00FF	Second character		
	0xFF00	First character		
G6	1 Register	Record Control Command Register		
	0	No Operation		
	1	Clear Event Records		
	2	Clear Fault Records		
	3	Clear Maintenence Records		
	4	Reset Indications		
G8		LOGIC INPUT STATUS		
		P941	P942	P943
	0x0001	Opto 1 Input State (0=Off, 1=On)	Opto 1 Input State (0=Off, 1=On)	Opto 1 Input State (0=Off, 1=On)
	0x0002	Opto 2 Input State (0=Off, 1=On)	Opto 2 Input State (0=Off, 1=On)	Opto 2 Input State (0=Off, 1=On)
	0x0004	Opto 3 Input State (0=Off, 1=On)	Opto 3 Input State (0=Off, 1=On)	Opto 3 Input State (0=Off, 1=On)
	0x0008	Opto 4 Input State (0=Off, 1=On)	Opto 4 Input State (0=Off, 1=On)	Opto 4 Input State (0=Off, 1=On)
	0x0010	Opto 5 Input State (0=Off, 1=On)	Opto 5 Input State (0=Off, 1=On)	Opto 5 Input State (0=Off, 1=On)
	0x0020	Opto 6 Input State (0=Off, 1=On)	Opto 6 Input State (0=Off, 1=On)	Opto 6 Input State (0=Off, 1=On)
	0x0040	Opto 7 Input State (0=Off, 1=On)	Opto 7 Input State (0=Off, 1=On)	Opto 7 Input State (0=Off, 1=On)
	0x0080	Opto 8 Input State (0=Off, 1=On)	Opto 8 Input State (0=Off, 1=On)	Opto 8 Input State (0=Off, 1=On)
	0x0100			Opto 9 Input State (0=Off, 1=On)
	0x0200			Opto 10 Input State (0=Off, 1=On)
	0x0400			Opto 11 Input State (0=Off, 1=On)
	0x0800			Opto 12 Input State (0=Off, 1=On)
	0x1000			Opto 13 Input State (0=Off, 1=On)

TYPE	VALUE/BIT MASK	DESCRIPTION		
	0x2000			Opto 14 Input State (0=Off, 1=On)
	0x4000			Opto 15 Input State (0=Off, 1=On)
	0x8000			Opto 16 Input State (0=Off, 1=On)
G9		RELAY OUTPUT STATUS		
	(2nd Reg, 1st Reg)	P941	P942	P943
	0x0000,0x0001	Relay 1 (0=Off, 1=On)	Relay 1 (0=Off, 1=On)	Relay 1 (0=Off, 1=On)
	0x0000,0x0002	Relay 2 (0=Off, 1=On)	Relay 2 (0=Off, 1=On)	Relay 2 (0=Off, 1=On)
	0x0000,0x0004	Relay 3 (0=Off, 1=On)	Relay 3 (0=Off, 1=On)	Relay 3 (0=Off, 1=On)
	0x0000,0x0008	Relay 4 (0=Off, 1=On)	Relay 4 (0=Off, 1=On)	Relay 4 (0=Off, 1=On)
	0x0000,0x0010	Relay 5 (0=Off, 1=On)	Relay 5 (0=Off, 1=On)	Relay 5 (0=Off, 1=On)
	0x0000,0x0020	Relay 6 (0=Off, 1=On)	Relay 6 (0=Off, 1=On)	Relay 6 (0=Off, 1=On)
	0x0000,0x0040	Relay 7 (0=Off, 1=On)	Relay 7 (0=Off, 1=On)	Relay 7 (0=Off, 1=On)
	0x0000,0x0080		Relay 8 (0=Off, 1=On)	Relay 8 (0=Off, 1=On)
	0x0000,0x0100		Relay 9 (0=Off, 1=On)	Relay 9 (0=Off, 1=On)
	0x0000,0x0200		Relay 10 (0=Off, 1=On)	Relay 10 (0=Off, 1=On)
	0x0000,0x0400		Relay 11 (0=Off, 1=On)	Relay 11 (0=Off, 1=On)
	0x0000,0x0800		Relay 12 (0=Off, 1=On)	Relay 12 (0=Off, 1=On)
	0x0000,0x1000		Relay 13 (0=Off, 1=On)	Relay 13 (0=Off, 1=On)
	0x0000,0x2000		Relay 14 (0=Off, 1=On)	Relay 14 (0=Off, 1=On)
G10		LED Text		
		See DDB 64		
		See DDB 65		
		See DDB 66		
		See DDB 67		
		See DDB 68		
		See DDB 69		
		See DDB 70		
		See DDB 71		
G11		YES/NO		

TYPE	VALUE/BIT MASK	DESCRIPTION
	0	No
	1	Yes
G12		TIME AND DATE (4 REGISTERS)
	(bit mask)	IEC60870-5-4 "Binary Time 2A" format - see Technical Guide
	0xFFFF	First Register - Milli-seconds
	0x9FBF	Second Register - Summertime and hours / Validity and minutes
	0x0FFF	Third register - Month of year / Day of month / Day of week
	0x007F	Fourth Register - Years
G13		EVENT RECORD TYPE
	0	Latched alarm active
	1	Latched alarm inactive
	2	Self reset alarm active
	3	Self reset alarm inactive
	4	Relay event
	5	Opto event
	6	Protection event
	7	Platform event
	8	Fault logged event
	9	Maintanence logged event
G15		DISTURBANCE RECORD INDEX STATUS
	0	No Record
	1	Un-extracted
	2	Extracted
G17		IRIG-B STATUS
	0	Card Not Fitted
	1	Card Failed
	2	Signal Healthy
	3	No signal
G18	Record Selection Command Register	
	0x0000	No Operation

TYPE	VALUE/BIT MASK	DESCRIPTION
	0x0001	Select Next Event
	0x0002	Accept Event
	0x0004	Select Next Disturbance Record
	0x0008	Accept Disturbance Record
	0x0010	Select Next Disturbance Record Page
G19		LANGUAGE
	0	English
	1	Francais
	2	Deutsch
	3	Espanol
G20	(Second reg, First Reg)	PASSWORD (2 REGISTERS)
	0x0000, 0x00FF	First password character
	0x0000, 0xFF00	Second password character
	0x00FF, 0x0000	Third password character
	0xFF00, 0x0000	Fourth password character
		NOTE THAT WHEN REGISTERS OF THIS TYPE ARE READ THE
		SLAVE WILL ALWAYS INDICATE AN "*" IN EACH CHARACTER
		POSITION TO PRESERVE THE PASSWORD SECURITY.
G21		IEC870 Interface
	0	RS485
	1	Fibre Optic
G22		PASSWORD CONTROL ACCESS LEVEL
	0	Level 0 - Passwords required for levels 1 & 2.
	1	Level 1 - Password required for level 2.
	2	Level 2 - No passwords required.
G23		Voltage Curve selection
	0	Disabled
	1	DT
	2	IDMT
G24	2 REGISTERS	UNSIGNED LONG VALUE, 3 DECIMAL PLACES

TYPE	VALUE/BIT MASK	DESCRIPTION		
		High order word of long stored in 1st register		
		Low order word of long stored in 2nd register		
		Example 123456.789 stored as 123456789		
G25	1 REGISTER	UNSIGNED VALUE, 3 DECIMAL PLACES		
		Example 50.050 stored as 50050		
		Range 0 to 65.535		
G26		RELAY STATUS		
	0x0001	Event		
	0x0002	Disturbance		
	0x0004	Alarm		
	0x0008	Trip		
	0x0010	Out of Service		
	0x0020	Plant		
	0x0040	Control		
	0x0080	Unused		
	0x0100	Unused		
	0x0200	Unused		
	0x0400	Unused		
	0x0800	Unused		
	0x1000	Unused		
	0x2000	Unused		
	0x4000	Unused		
	0x8000	Unused		
G27	2 REGISTERS	UNSIGNED LONG VALUE		
		High order word of long stored in 1st register		
		Low order word of long stored in 2nd register		
		Range -2.147E9 to 2.147E9		
G30	1 REGISTER	SIGNED VALUE, 2 DECIMAL PLACES		

TYPE	VALUE/BIT MASK	DESCRIPTION		
		Range -327.68 to 327.67		
G32		DIGITAL CHANNEL ASSIGNMENT SELECTOR		
		P941	P942	P943
	0	Unused	Unused	Unused
	1	R1 Stg1 f+t Trip	R1 Stg1 f+t Trip	R1 Stg1 f+t Trip
	2	R2 Stg2 f+t Trip	R2 Stg2 f+t Trip	R2 Stg2 f+t Trip
	3	R3 Stg3 f+t Trip	R3 Stg3 f+t Trip	R3 Stg3 f+t Trip
	4	R4 Stg4 f+t Trip	R4 Stg4 f+t Trip	R4 Stg4 f+t Trip
	5	R5 Stg6 f+t Trip	R5 Stg6 f+t Trip	R5 Stg6 f+t Trip
	6	R6 Voltage Start	R6 Stg1f+Df/Dt T	R6 Stg1f+Df/Dt T
	7	R7 Voltage Trips	R7 Stg2f+df/dt T	R7 Stg2f+df/dt T
	8	L1 Setting Group	R8 Stg3f+df/dt T	R8 Stg3f+df/dt T
	9	L2 Setting Group	R9 Stg4f+df/dt T	R9 Stg4f+df/dt T
	10	L3 Stg1f+t Block	R10 Voltage Strt	R10 Voltage Strt
	11	L4 Stg2f+t Block	R11 Voltage Trip	R11 Voltage Trip
	12	L5 Stg3f+t Block	R12 Gen Abn Trip	R12 Gen Abn Trip
	13	L6 Stg4f+t Block	R13 Stg1 Restore	R13 Stg1 Restore
	14	L7 Stg6f+t Block	R14 Stg2 Restore	R14 Stg2 Restore
	15	L8 Voltage Block	L1 Setting Group	L1 Setting Group
	16	Stg1 f+t Sta	L2 Setting Group	L2 Setting Group
	17	Stg1 f+t Trp	L3 Stg1f+t Block	L3 Stg1f+t Block
	18	Stg1 f+df/dt Trp	L4 Stg2f+t Block	L4 Stg2f+t Block
	19	Stg1 df/dt+t Sta	L5 Stg3f+t Block	L5 Stg3f+t Block
	20	Stg1 df/dt+t Trp	L6 Stg4f+t Block	L6 Stg4f+t Block
	21	Stg1 f+Df/Dt Sta	L7 Stg6f+t Block	L7 Stg6f+t Block
	22	Stg1 f+Df/Dt Trp	L8 Voltage Block	L8 Voltage Block
	23	Stg1 Freq Sta	Stg1 f+t Sta	L9 Not Used
	24	Stg1 Freq Trp	Stg1 f+t Trp	L10 Not Used
	25	Stg2 f+t Sta	Stg1 f+df/dt Trp	L11 Not Used
	26	Stg2 f+t Trp	Stg1 df/dt+t Sta	L12 Not Used

TYPE	VALUE/BIT MASK	DESCRIPTION		
	27	Stg2 f+df/dt Trp	Stg1 df/dt+t Trp	L13 Not Used
	28	Stg2 df/dt+t Sta	Stg1 f+Df/Dt Sta	L14 Not Used
	29	Stg2 df/dt+t Trp	Stg1 f+Df/Dt Trp	L15 Not Used
	30	Stg2 f+Df/Dt Sta	Stg1 Freq Sta	L16 Not Used
	31	Stg2 f+Df/Dt Trp	Stg1 Freq Trp	Stg1 f+t Sta
	32	Stg2 Freq Sta	Stg2 f+t Sta	Stg1 f+t Trp
	33	Stg2 Freq Trp	Stg2 f+t Trp	Stg1 f+df/dt Trp
	34	Stg3 f+t Sta	Stg2 f+df/dt Trp	Stg1 df/dt+t Sta
	35	Stg3 f+t Trp	Stg2 df/dt+t Sta	Stg1 df/dt+t Trp
	36	Stg3 f+df/dt Trp	Stg2 df/dt+t Trp	Stg1 f+Df/Dt Sta
	37	Stg3 df/dt+t Sta	Stg2 f+Df/Dt Sta	Stg1 f+Df/Dt Trp
	38	Stg3 df/dt+t Trp	Stg2 f+Df/Dt Trp	Stg1 Freq Sta
	39	Stg3 f+Df/Dt Sta	Stg2 Freq Sta	Stg1 Freq Trp
	40	Stg3 f+Df/Dt Trp	Stg2 Freq Trp	Stg2 f+t Sta
	41	Stg3 Freq Sta	Stg3 f+t Sta	Stg2 f+t Trp
	42	Stg3 Freq Trp	Stg3 f+t Trp	Stg2 f+df/dt Trp
	43	Stg4 f+t Sta	Stg3 f+df/dt Trp	Stg2 df/dt+t Sta
	44	Stg4 f+t Trp	Stg3 df/dt+t Sta	Stg2 df/dt+t Trp
	45	Stg4 f+df/dt Trp	Stg3 df/dt+t Trp	Stg2 f+Df/Dt Sta
	46	Stg4 df/dt+t Sta	Stg3 f+Df/Dt Sta	Stg2 f+Df/Dt Trp
	47	Stg4 df/dt+t Trp	Stg3 f+Df/Dt Trp	Stg2 Freq Sta
	48	Stg4 f+Df/Dt Sta	Stg3 Freq Sta	Stg2 Freq Trp
	49	Stg4 f+Df/Dt Trp	Stg3 Freq Trp	Stg3 f+t Sta
	50	Stg4 Freq Sta	Stg4 f+t Sta	Stg3 f+t Trp
	51	Stg4 Freq Trp	Stg4 f+t Trp	Stg3 f+df/dt Trp
	52	Stg5 f+t Sta	Stg4 f+df/dt Trp	Stg3 df/dt+t Sta
	53	Stg5 f+t Trp	Stg4 df/dt+t Sta	Stg3 df/dt+t Trp
	54	Stg5 f+df/dt Trp	Stg4 df/dt+t Trp	Stg3 f+Df/Dt Sta
	55	Stg5 df/dt+t Sta	Stg4 f+Df/Dt Sta	Stg3 f+Df/Dt Trp
	56	Stg5 df/dt+t Trp	Stg4 f+Df/Dt Trp	Stg3 Freq Sta

TYPE	VALUE/BIT MASK	DESCRIPTION		
	57	Stg5 f+Df/Dt Sta	Stg4 Freq Sta	Stg3 Freq Trp
	58	Stg5 f+Df/Dt Trp	Stg4 Freq Trp	Stg4 f+t Sta
	59	Stg5 Freq Sta	Stg5 f+t Sta	Stg4 f+t Trp
	60	Stg5 Freq Trp	Stg5 f+t Trp	Stg4 f+df/dt Trp
	61	Stg6 f+t Sta	Stg5 f+df/dt Trp	Stg4 df/dt+t Sta
	62	Stg6 f+t Trp	Stg5 df/dt+t Sta	Stg4 df/dt+t Trp
	63	Stg6 f+df/dt Trp	Stg5 df/dt+t Trp	Stg4 f+Df/Dt Sta
	64	Stg6 df/dt+t Sta	Stg5 f+Df/Dt Sta	Stg4 f+Df/Dt Trp
	65	Stg6 df/dt+t Trp	Stg5 f+Df/Dt Trp	Stg4 Freq Sta
	66	Stg6 f+Df/Dt Sta	Stg5 Freq Sta	Stg4 Freq Trp
	67	Stg6 f+Df/Dt Trp	Stg5 Freq Trp	Stg5 f+t Sta
	68	Stg6 Freq Sta	Stg6 f+t Sta	Stg5 f+t Trp
	69	Stg6 Freq Trp	Stg6 f+t Trp	Stg5 f+df/dt Trp
	70	V < 1 Start	Stg6 f+df/dt Trp	Stg5 df/dt+t Sta
	71	V < 1 Start A/AB	Stg6 df/dt+t Sta	Stg5 df/dt+t Trp
	72	V < 1 Start B/BC	Stg6 df/dt+t Trp	Stg5 f+Df/Dt Sta
	73	V < 1 Start C/CA	Stg6 f+Df/Dt Sta	Stg5 f+Df/Dt Trp
	74	V < 2 Start	Stg6 f+Df/Dt Trp	Stg5 Freq Sta
	75	V < 2 Start A/AB	Stg6 Freq Sta	Stg5 Freq Trp
	76	V < 2 Start B/BC	Stg6 Freq Trp	Stg6 f+t Sta
	77	V < 2 Start C/CA	V < 1 Start	Stg6 f+t Trp
	78	V < 1 Trip	V < 1 Start A/AB	Stg6 f+df/dt Trp
	79	V < 1 Trip A/AB	V < 1 Start B/BC	Stg6 df/dt+t Sta
	80	V < 1 Trip B/BC	V < 1 Start C/CA	Stg6 df/dt+t Trp
	81	V < 1 Trip C/CA	V < 2 Start	Stg6 f+Df/Dt Sta
	82	V < 2 Trip	V < 2 Start A/AB	Stg6 f+Df/Dt Trp
	83	V < 2 Trip A/AB	V < 2 Start B/BC	Stg6 Freq Sta
	84	V < 2 Trip B/BC	V < 2 Start C/CA	Stg6 Freq Trp
	85	V < 2 Trip C/CA	V < 1 Trip	V < 1 Start
	86	V > 1 Start	V < 1 Trip A/AB	V < 1 Start A/AB

TYPE	VALUE/BIT MASK	DESCRIPTION		
	87	V > 1 Start A/AB	V < 1 Trip B/BC	V < 1 Start B/BC
	88	V > 1 Start B/BC	V < 1 Trip C/CA	V < 1 Start C/CA
	89	V > 1 Start C/CA	V < 2 Trip	V < 2 Start
	90	V > 2 Start	V < 2 Trip A/AB	V < 2 Start A/AB
	91	V > 2 Start A/AB	V < 2 Trip B/BC	V < 2 Start B/BC
	92	V > 2 Start B/BC	V < 2 Trip C/CA	V < 2 Start C/CA
	93	V > 2 Start C/CA	V > 1 Start	V < 1 Trip
	94	V > 1 Trip	V > 1 Start A/AB	V < 1 Trip A/AB
	95	V > 1 Trip A/AB	V > 1 Start B/BC	V < 1 Trip B/BC
	96	V > 1 Trip B/BC	V > 1 Start C/CA	V < 1 Trip C/CA
	97	V > 1 Trip C/CA	V > 2 Start	V < 2 Trip
	98	V > 2 Trip	V > 2 Start A/AB	V < 2 Trip A/AB
	99	V > 2 Trip A/AB	V > 2 Start B/BC	V < 2 Trip B/BC
	100	V > 2 Trip B/BC	V > 2 Start C/CA	V < 2 Trip C/CA
	101	V > 2 Trip C/CA	V > 1 Trip	V > 1 Start
	102	Gen Band1 Sta	V > 1 Trip A/AB	V > 1 Start A/AB
	103	Gen Band1 Trp	V > 1 Trip B/BC	V > 1 Start B/BC
	104	Gen Band2 Sta	V > 1 Trip C/CA	V > 1 Start C/CA
	105	Gen Band2 Trp	V > 2 Trip	V > 2 Start
	106	Gen Band3 Sta	V > 2 Trip A/AB	V > 2 Start A/AB
	107	Gen Band3 Trp	V > 2 Trip B/BC	V > 2 Start B/BC
	108	Gen Band4 Sta	V > 2 Trip C/CA	V > 2 Start C/CA
	109	Gen Band4 Trp	Gen Band1 Sta	V > 1 Trip
	110	Gen Abn Start	Gen Band1 Trp	V > 1 Trip A/AB
	111	Gen Abn Trip	Gen Band2 Sta	V > 1 Trip B/BC
	112	Stg1 Restore Sta	Gen Band2 Trp	V > 1 Trip C/CA
	113	Stg1 Restore Ena	Gen Band3 Sta	V > 2 Trip
	114	Stg2 Restore Sta	Gen Band3 Trp	V > 2 Trip A/AB
	115	Stg2 Restore Ena	Gen Band4 Sta	V > 2 Trip B/BC
	116	Stg3 Restore Sta	Gen Band4 Trp	V > 2 Trip C/CA

TYPE	VALUE/BIT MASK	DESCRIPTION		
	117	Stg3 Restore Ena	Gen Abn Start	Gen Band1 Sta
	118	Stg4 Restore Sta	Gen Abn Trip	Gen Band1 Trp
	119	Stg4 Restore Ena	Stg1 Restore Sta	Gen Band2 Sta
	120	Stg5 Restore Sta	Stg1 Restore Ena	Gen Band2 Trp
	121	Stg5 Restore Ena	Stg2 Restore Sta	Gen Band3 Sta
	122	Stg6 Restore Sta	Stg2 Restore Ena	Gen Band3 Trp
	123	Stg6 Restore Ena	Stg3 Restore Sta	Gen Band4 Sta
	124	Any Protn Start	Stg3 Restore Ena	Gen Band4 Trp
	125	Any Protn Trip	Stg4 Restore Sta	Gen Abn Start
	126	Any f+t Sta	Stg4 Restore Ena	Gen Abn Trip
	127	Any df/dt+t Sta	Stg5 Restore Sta	Stg1 Restore Sta
	128	Any f+Df/Dt Sta	Stg5 Restore Ena	Stg1 Restore Ena
	129	Any f+t Trp	Stg6 Restore Sta	Stg2 Restore Sta
	130	Any f+df/dt Trp	Stg6 Restore Ena	Stg2 Restore Ena
	131	Any df/dt+t Trp	Any Protn Start	Stg3 Restore Sta
	132	Any f+Df/Dt Trp	Any Protn Trip	Stg3 Restore Ena
	133	Freq High	Any f+t Sta	Stg4 Restore Sta
	134	Freq Low	Any df/dt+t Sta	Stg4 Restore Ena
	135	Freq Not Found	Any f+Df/Dt Sta	Stg5 Restore Sta
	136	UV Block	Any f+t Trp	Stg5 Restore Ena
	137		Any f+df/dt Trp	Stg6 Restore Sta
	138		Any df/dt+t Trp	Stg6 Restore Ena
	139		Any f+Df/Dt Trp	Any Protn Start
	140		Freq High	Any Protn Trip
	141		Freq Low	Any f+t Sta
	142		Freq Not Found	Any df/dt+t Sta
	143		UV Block	Any f+Df/Dt Sta
	144			Any f+t Trp
	145			Any f+df/dt Trp
	146			Any df/dt+t Trp

TYPE	VALUE/BIT MASK	DESCRIPTION		
	147			Any f+Df/Dt Trp
	148			Freq High
	149			Freq Low
	150			Freq Not Found
	151			UV Block
G34		TRIGGER MODE		
	0	Single		
	1	Extended		
G35		NUMERIC SETTING (AS G2 BUT 2 REGISTERS)		
		Number of steps from minimum value		
		expressed as 2 register 32 bit unsigned int		
G37		ENABLED / DISABLED		
	0	Disabled		
	1	Enabled		
G38V		COMMUNICATION BAUD RATE (IEC 60870)		
	0	9600 bits/s		
	1	19200 bits/s		
G38M		COMMUNICATION BAUD RATE (Modbus)		
	0	9600 bits/s		
	1	19200 bits/s		
	2	38400 bits/s		
G38D		COMMUNICATION BAUD RATE (DNP 3.0)		
	0	1200 bits/s		
	1	2400 bits/s		
	2	4800 bits/s		
	3	9600 bits/s		
	4	19200 bits/s		
	5	38400 bits/s		
G39		COMMUNICATIONS PARITY		
	0	Odd		

TYPE	VALUE/BIT MASK	DESCRIPTION		
	1	Even		
	2	None		
G47		MEASURING MODE		
	0	Phase-Phase		
	1	Phase-Neutral		
G48		OPERATION MODE		
	0	Any Phase		
	1	Three Phase		
G52		DEFAULT DISPLAY		
	0	Date and Time		
	1	Description		
	2	Plant Reference		
	3	Frequency		
	4	3Ph Voltage		
	5	Access Level		
G53		SELECT FACTORY DEFAULTS		
	0	No Operation		
	1	All Settings		
	2	Setting Group 1		
	3	Setting Group 2		
	4	Setting Group 3		
	5	Setting Group 4		
G54		SELECT PRIMARY SECONDARY MEASUREMENTS		
	0	Primary		
	1	Secondary		
G57		Data Transfer Domain		
	0	PSL Settings		
	1	PSL Config		
	2	DNP Settings		
G59		BATTERY STATUS		

TYPE	VALUE/BIT MASK	DESCRIPTION		
	0	Dead		
	1	Healthy		
G61		ACTIVE GROUP CONTROL		
	0	Select via Menu		
	1	Select via Opto		
G62		SAVE AS		
	0	No Operation		
	1	Save		
	2	Abort		
G66		TRIGGER LEVEL		
	0	No Trigger		
	1	Trigger L/H		
	2	Trigger H/L		
G71		PROTOCOL		
	0	Courier		
	1	Modbus		
	2	IEC60870-5-103		
	3	DNP 3.0		
G76		TRANSFER MODE		
	0	Prepare Rx		
	1	Complete Rx		
	2	Prepare Tx		
	3	Complete Tx		
	4	Rx Prepared		
	5	Tx Prepared		
	6	OK		
	7	Error		
G80		Visible/Invisible		
	0	Invisible		

TYPE	VALUE/BIT MASK	DESCRIPTION		
	1	Visible		
G84	Modbus value+bit pos	Started Elements 1		
	(Second reg, First Reg)			
	0x0000,0x0001	Stg1 f+t Sta		
	0x0000,0x0002	Stg2 f+t Sta		
	0x0000,0x0004	Stg3 f+t Sta		
	0x0000,0x0008	Stg4 f+t Sta		
	0x0000,0x0010	Stg5 f+t Sta		
	0x0000,0x0020	Stg6 f+t Sta		
	0x0000,0x0040	Stg1 df/dt+t Sta		
	0x0000,0x0080	Stg2 df/dt+t Sta		
	0x0000,0x0100	Stg3 df/dt+t Sta		
	0x0000,0x0200	Stg4 df/dt+t Sta		
	0x0000,0x0400	Stg5 df/dt+t Sta		
	0x0000,0x0800	Stg6 df/dt+t Sta		
	0x0000,0x1000	Stg1 f+Df/Dt Sta		
	0x0000,0x2000	Stg2 f+Df/Dt Sta		
	0x0000,0x4000	Stg3 f+Df/Dt Sta		
	0x0000,0x8000	Stg4 f+Df/Dt Sta		
	0x0001,0x0000	Stg5 f+Df/Dt Sta		
	0x0002,0x0000	Stg6 f+Df/Dt Sta		
G85	Modbus value+bit pos	Tripped Elements(1)		
	(Second reg, First Reg)			
	0x0000,0x0001	Stg1 f+t Trp		
	0x0000,0x0002	Stg2 f+t Trp		
	0x0000,0x0004	Stg3 f+t Trp		
	0x0000,0x0008	Stg4 f+t Trp		
	0x0000,0x0010	Stg5 f+t Trp		
	0x0000,0x0020	Stg6 f+t Trp		
	0x0000,0x0040	Stg1 f+df/dt Trp		

TYPE	VALUE/BIT MASK	DESCRIPTION		
	0x0000,0x0080	Stg2 f+df/dt Trp		
	0x0000,0x0100	Stg3 f+df/dt Trp		
	0x0000,0x0200	Stg4 f+df/dt Trp		
	0x0000,0x0400	Stg5 f+df/dt Trp		
	0x0000,0x0800	Stg6 f+df/dt Trp		
	0x0000,0x1000	Stg1 df/dt+t Trp		
	0x0000,0x2000	Stg2 df/dt+t Trp		
	0x0000,0x4000	Stg3 df/dt+t Trp		
	0x0000,0x8000	Stg4 df/dt+t Trp		
	0x0001,0x0000	Stg5 df/dt+t Trp		
	0x0002,0x0000	Stg6 df/dt+t Trp		
	0x0004,0x0000	Stg1 f+Df/Dt Trp		
	0x0008,0x0000	Stg2 f+Df/Dt Trp		
	0x0010,0x0000	Stg3 f+Df/Dt Trp		
	0x0020,0x0000	Stg4 f+Df/Dt Trp		
	0x0040,0x0000	Stg5 f+Df/Dt Trp		
	0x0080,0x0000	Stg6 f+Df/Dt Trp		
G86	Modbus value+bit pos	Tripped Elements(2)		
	(Second reg, First Reg)			
	0x0000,0x0001	V < 1 Trip A/AB		
	0x0000,0x0002	V < 1 Trip B/BC		
	0x0000,0x0004	V < 1 Trip C/CA		
	0x0000,0x0008	V < 1 Trip		
	0x0000,0x0010	V < 2 Trip A/AB		
	0x0000,0x0020	V < 2 Trip B/BC		
	0x0000,0x0040	V < 2 Trip C/CA		
	0x0000,0x0080	V < 2 Trip		
	0x0000,0x0100	V > 1 Trip A/AB		
	0x0000,0x0200	V > 1 Trip B/BC		
	0x0000,0x0400	V > 1 Trip C/CA		

TYPE	VALUE/BIT MASK	DESCRIPTION		
	0x0000,0x0800	V > 1 Trip		
	0x0000,0x1000	V > 2 Trip A/AB		
	0x0000,0x2000	V > 2 Trip B/BC		
	0x0000,0x4000	V > 2 Trip C/CA		
	0x0000,0x8000	V > 2 Trip		
	0x0001,0x0000	Gen Band1 Trp		
	0x0002,0x0000	Gen Band2 Trp		
	0x0004,0x0000	Gen Band3 Trp		
	0x0008,0x0000	Gen Band4 Trp		
G90		Active Settings		
	0	Group 1		
	1	Group 2		
	2	Group 3		
	3	Group 4		
G93		Commission Test		
	0	No Operation		
	1	Apply Test		
	2	Remove Test		
G94		Commission Test		
	0	No Operation		
	1	Apply Test		
G96	Bit Position	Indexed Strings		
	0	Battery Fail		
	1	Field Volt Fail		
	2	SG-opto Invalid		
	3	Prot'n Disabled		
	4	Freq High		
	5	Freq Low		
	6	Freq Not Found		
	7	Wrong Setting		

TYPE	VALUE/BIT MASK	DESCRIPTION		
	8	Stats Corrupt		
	9	Gen Timers Bad		
	10	UV Block		
	11	Trip LED Enabled		
	12	SR User Alarm 1		
	13	SR User Alarm 2		
	14	SR User Alarm 3		
	15	SR User Alarm 4		
	16	SR User Alarm 5		
	17	SR User Alarm 6		
	18	SR User Alarm 7		
	19	SR User Alarm 8		
	20	SR User Alarm 9		
	21	SR User Alarm 10		
	22	MR User Alarm 11		
	23	MR User Alarm 12		
	24	MR User Alarm 13		
	25	MR User Alarm 14		
	26	MR User Alarm 15		
	27	MR User Alarm 16		
	28	MR User Alarm 17		
	29	MR User Alarm 18		
	30	MR User Alarm 19		
	31	MR User Alarm 20		
G98		Copy to		
	0	No Operation		
	1	Group 1		
	2	Group 2		
	3	Group 3		

TYPE	VALUE/BIT MASK	DESCRIPTION		
	4	Group 4		
G100		PHASE MEASUREMENT REFERENCE		
	0	VA		
	1	VB		
	2	VC		
G101		ANALOG CHANNEL ASSIGNMENT SELECTOR FOR DIST REC		
	0	VAN		
	1	VBN		
	2	VCN		
G102	Modbus value+bit pos	Started Elements 2		
	(Second reg, First Reg)			
	0x0000,0x0001	V < 1 Start A/AB		
	0x0000,0x0002	V < 1 Start B/BC		
	0x0000,0x0004	V < 1 Start C/CA		
	0x0000,0x0008	V < 1 Start		
	0x0000,0x0010	V < 2 Start A/AB		
	0x0000,0x0020	V < 2 Start B/BC		
	0x0000,0x0040	V < 2 Start C/CA		
	0x0000,0x0080	V < 2 Start		
	0x0000,0x0100	V > 1 Start A/AB		
	0x0000,0x0200	V > 1 Start B/BC		
	0x0000,0x0400	V > 1 Start C/CA		
	0x0000,0x0800	V > 1 Start		
	0x0000,0x1000	V > 2 Start A/AB		
	0x0000,0x2000	V > 2 Start B/BC		
	0x0000,0x4000	V > 2 Start C/CA		
	0x0000,0x8000	V > 2 Start		
	0x0001,0x0000	Gen Band1 Sta		
	0x0002,0x0000	Gen Band2 Sta		
	0x0004,0x0000	Gen Band3 Sta		

TYPE	VALUE/BIT MASK	DESCRIPTION		
	0x0008,0x0000	Gen Band4 Sta		
G119		Test Mode		
	0	Disabled		
	1	Test Mode		
	2	Contacts Blocked		

IEC60870-5-103: Interoperability

Vendor Name:	Alstom T&D - Energy Automation & Information
Device Name:	P940 Frequency Protection
Models Covered:	P941****3**05**
	P942****3**05**
	P943****3**05**
Compatibility Level:	2
Physical Layer	
Electrical Interface:	EIA(RS)485
Number of Loads:	1 for one protection equipment
Optical Interface (Order Option)	Plastic fibre BFOC/2.5 type connector
Transmission Speed:	9600 or 19200bps (User Setting)
Application Layer	
More than one COMMON ADDRESS of ASDU	

Standard Information Numbers in Monitor Direction

ASDU TYPE	COT	FUN	INF NO.	Description	GI	Model Number			Address*	Interpretation
						P941	P942	P943		
System Functions (Monitor)										
8	10	255	0	End of General Interrogration		*	*			
6	8	255	0	Time Syncronisation		*	*			
5	3	160	2	Reset FCB		*	*			
5	4	160	3	Reset CU		*	*			
5	5	160	4	Start/Restart		*	*			
5	6	160	5	Power On		*	*			
Note: Indenfication message in ASDU 5: ALSTOM, Software ref P94x										
Status Indications										
1	1,7,9,11,12,20,21	160	16	Auto-recloser active						
1	1,7,9,11,12,20,21		17	Tele-protection active						
1	1,7,9,11,12,20,21		18	Protection active						
1	1,7,9,11,12,20,21	160	19	LED Reset		*	*	*	0	Reset Indication
1	9,11		20	Monitor direction blocked						
1	9,11	160	21	Test mode	*	*	*	*	0	Protection Disabled
1	9,11		22	Local parameter setting						
1	1,7,9,11,12,20,21	160	23	Characteristic 1	*	*	*	*	0	Group 1 Active
1	1,7,9,11,12,20,21	160	24	Characteristic 2	*	*	*	*	0	Group 2 Active
1	1,7,9,11,12,20,21	160	25	Characteristic 3	*	*	*	*	0	Group 3 Active
1	1,7,9,11,12,20,21	160	26	Characteristic 4	*	*	*	*	0	Group 4 Active
1	1,7,9,11	160	27	Auxillary input 1	*	*	*	*	0	Opto Input 1
1	1,7,9,11	160	28	Auxillary input 2	*	*	*	*	0	Opto Input 2
1	1,7,9,11	160	29	Auxillary input 3	*	*	*	*	0	Opto Input 3
1	1,7,9,11	160	30	Auxillary input 4	*	*	*	*	0	Opto Input 4
1	1,7,9,11	160	27	Auxillary input 5	*	*	*	*	1	Opto Input 5
1	1,7,9,11	160	28	Auxillary input 6	*	*	*	*	1	Opto Input 6
1	1,7,9,11	160	29	Auxillary input 7	*	*	*	*	1	Opto Input 7
1	1,7,9,11	160	30	Auxillary input 8	*	*	*	*	1	Opto Input 8
1	1,7,9,11	160	27	Auxillary input 9	*			*	2	Opto Input 9
1	1,7,9,11	160	28	Auxillary input 10	*			*	2	Opto Input 10
1	1,7,9,11	160	29	Auxillary input 11	*			*	2	Opto Input 11
1	1,7,9,11	160	30	Auxillary input 12	*			*	2	Opto Input 12
1	1,7,9,11	160	27	Auxillary input 13	*			*	3	Opto Input 13
1	1,7,9,11	160	28	Auxillary input 14	*			*	3	Opto Input 14
1	1,7,9,11	160	29	Auxillary input 15	*			*	3	Opto Input 15
1	1,7,9,11	160	30	Auxillary input 16	*			*	3	Opto Input 16
Supervision Indications										
1	1,7,9		32	Measurand supervision I						
1	1,7,9		33	Measurand supervision V						
1	1,7,9		35	Phase sequence supervision						
1	1,7,9		36	Trip circuit supervision						
1	1,7,9		37	I>> back-up supervision						
1	1,7,9	160	38	VT fuse failure						
1	1,7,9		39	Teleprotection disturbed						
1	1,7,9		46	Group warning						

ASDU TYPE	COT	FUN	INF NO.	Description	GI	Model Number			Address*	Interpretation
						P941	P942	P943		
1	1,7,9		47	Group alarm						
Earth Fault Indications										
1	1,7,9		48	Earth Fault L1						
1	1,7,9		49	Earth Fault L2						
1	1,7,9		50	Earth Fault L3						
1	1,7,9		51	Earth Fault Fwd						
1	1,7,9		52	Earth Fault Rev						
Fault Indications										
2	1,7,9		64	Start /pickup L1						
2	1,7,9		65	Start /pickup L2						
2	1,7,9		66	Start /pickup L3						
2	1,7,9		67	Start /pickup N						
2	1,7		68	General Trip		*	*	*	0	Any Trip
2	1,7		68	General Trip		*	*	*	1	Any Load Shedding Element Stage 1 Trip
2	1,7		68	General Trip		*	*	*	2	Any Load Shedding Element Stage 2 Trip
2	1,7		68	General Trip		*	*	*	3	Any Load Shedding Element Stage 3 Trip
2	1,7		68	General Trip		*	*	*	4	Any Load Shedding Element Stage 4 Trip
2	1,7		68	General Trip		*	*	*	5	Any Load Shedding Element Stage 5 Trip
2	1,7		68	General Trip		*	*	*	6	Any Load Shedding Element Stage 6 Trip
2	1,7		68	General Trip		*	*	*	7	1st Stage Phase U/V Trip 3ph
2	1,7		68	General Trip		*	*	*	8	2nd Stage Phase U/V Trip 3ph
2	1,7		68	General Trip		*	*	*	9	1st Stage Phase O/V Trip 3ph
2	1,7		68	General Trip		*	*	*	10	2nd Stage Phase O/V Trip 3ph
2	1,7		68	General Trip		*	*	*	11	Any Generator Abnormal Trip
2	1,7		68	General Trip		*	*	*	12	Any F + T Trip
2	1,7		68	General Trip		*	*	*	13	Any F + df/dt Trip
2	1,7		68	General Trip		*	*	*	14	Any df/dt + T Trip
2	1,7		68	General Trip		*	*	*	15	Any F + DelF/DelT Trip
2	1,7		68	General Trip		*	*	*	16	Stage 1 F+T trip
2	1,7		68	General Trip		*	*	*	17	Stage 1 F+df/dt trip
2	1,7		68	General Trip		*	*	*	18	Stage 1 df/dt+t trip
2	1,7		68	General Trip		*	*	*	19	Stage 1 F + DelF/DelT trip
2	1,7		68	General Trip		*	*	*	20	Stage 2 F+T trip
2	1,7		68	General Trip		*	*	*	21	Stage 2 F+df/dt trip
2	1,7		68	General Trip		*	*	*	22	Stage 2 df/dt+t trip
2	1,7		68	General Trip		*	*	*	23	Stage 2 F + DelF/DelT trip
2	1,7		68	General Trip		*	*	*	24	Stage 3 F+T trip
2	1,7		68	General Trip		*	*	*	25	Stage 3 F+df/dt trip
2	1,7		68	General Trip		*	*	*	26	Stage 3 df/dt+t trip
2	1,7		68	General Trip		*	*	*	27	Stage 3 F + DelF/DelT Trip
2	1,7		68	General Trip		*	*	*	28	Stage 4 F+T trip
2	1,7		68	General Trip		*	*	*	29	Stage 4 F+df/dt trip
2	1,7		68	General Trip		*	*	*	30	Stage 4 df/dt+t trip
2	1,7		68	General Trip		*	*	*	31	Stage 4 F + DelF/DelT trip
2	1,7		68	General Trip		*	*	*	32	Stage 5 F+T trip
2	1,7		68	General Trip		*	*	*	33	Stage 5 F+df/dt trip
2	1,7		68	General Trip		*	*	*	34	Stage 5 df/dt+t trip
2	1,7		68	General Trip		*	*	*	35	Stage 5 F + DelF/DelT trip
2	1,7		68	General Trip		*	*	*	36	Stage 6 F+T trip
2	1,7		68	General Trip		*	*	*	37	Stage 6 F+df/dt trip
2	1,7		68	General Trip		*	*	*	38	Stage 6 df/dt+t trip
2	1,7		68	General Trip		*	*	*	39	Stage 6 F + DelF/DelT trip
2	1,7		68	General Trip		*	*	*	40	1st Stage Phase U/V Trip A/AB
2	1,7		68	General Trip		*	*	*	41	1st Stage Phase U/V Trip B/BC
2	1,7		68	General Trip		*	*	*	42	1st Stage Phase U/V Trip C/CA
2	1,7		68	General Trip		*	*	*	43	2nd Stage Phase U/V Trip A/AB
2	1,7		68	General Trip		*	*	*	44	2nd Stage Phase U/V Trip B/BC
2	1,7		68	General Trip		*	*	*	45	2nd Stage Phase U/V Trip C/CA
2	1,7		68	General Trip		*	*	*	46	1st Stage Phase O/V Trip A/AB
2	1,7		68	General Trip		*	*	*	47	1st Stage Phase O/V Trip B/BC
2	1,7		68	General Trip		*	*	*	48	1st Stage Phase O/V Trip C/CA
2	1,7		68	General Trip		*	*	*	49	2nd Stage Phase O/V Trip A/AB

ASDU TYPE	COT	FUN	INF NO.	Description	GI	Model Number			Address*	Interpretation
						P941	P942	P943		
2	1,7		68	General Trip		*	*	*	50	2nd Stage Phase O/V Trip B/BC
2	1,7		68	General Trip		*	*	*	51	2nd Stage Phase O/V Trip C/CA
2	1,7		68	General Trip		*	*	*	52	Generator Abnormal Band 1 Trip
2	1,7		68	General Trip		*	*	*	53	Generator Abnormal Band 2 Trip
2	1,7		68	General Trip		*	*	*	54	Generator Abnormal Band 3 Trip
2	1,7		68	General Trip		*	*	*	55	Generator Abnormal Band 4 Trip
2	1,7		69	Trip L1						
2	1,7		70	Trip L2						
2	1,7		71	Trip L3						
2	1,7		72	Trip I>>						
4	1,7		73	Fault Location in ohms						
2	1,7		74	Fault forward						
2	1,7		75	Fault reverse						
2	1,7		76	Teleprotection signal sent						
2	1,7		77	Teleprotection signal received						
2	1,7		78	Zone 1						
2	1,7		79	Zone 2						
2	1,7		80	Zone 3						
2	1,7		81	Zone 4						
2	1,7		82	Zone 5						
2	1,7		83	Zone 6						
2	1,7,9		84	General Start	*	*	*	*	0	Any Start
2	1,7,9		84	General Start	*	*	*	*	1	Any Load Shedding Element Stage 1 Start
2	1,7,9		84	General Start	*	*	*	*	2	Any Load Shedding Element Stage 2 Start
2	1,7,9		84	General Start	*	*	*	*	3	Any Load Shedding Element Stage 3 Start
2	1,7,9		84	General Start	*	*	*	*	4	Any Load Shedding Element Stage 4 Start
2	1,7,9		84	General Start	*	*	*	*	5	Any Load Shedding Element Stage 5 Start
2	1,7,9		84	General Start	*	*	*	*	6	Any Load Shedding Element Stage 6 Start
2	1,7,9		84	General Start	*	*	*	*	7	1st Stage Phase U/V Start 3ph
2	1,7,9		84	General Start	*	*	*	*	8	2nd Stage Phase U/V Start 3ph
2	1,7,9		84	General Start	*	*	*	*	9	1st Stage Phase O/V Start 3ph
2	1,7,9		84	General Start	*	*	*	*	10	2nd Stage Phase O/V Start 3ph
2	1,7,9		84	General Start	*	*	*	*	11	Any Generator Abnormal Start
2	1,7,9		84	General Start	*	*	*	*	12	Any F + T Start
2	1,7,9		84	General Start	*	*	*	*	13	Any df/dt + T Start
2	1,7,9		84	General Start	*	*	*	*	14	Any F + DelF/DelT Start
2	1,7,9		84	General Start	*	*	*	*	15	Stage 1 F+T start
2	1,7,9		84	General Start	*	*	*	*	16	Stage 1 df/dt+t start
2	1,7,9		84	General Start	*	*	*	*	17	Stage 1 F + DelF/DelT start
2	1,7,9		84	General Start	*	*	*	*	18	Stage 2 F+T start
2	1,7,9		84	General Start	*	*	*	*	19	Stage 2 df/dt+t start
2	1,7,9		84	General Start	*	*	*	*	20	Stage 2 F + DelF/DelT start
2	1,7,9		84	General Start	*	*	*	*	21	Stage 3 F+T start
2	1,7,9		84	General Start	*	*	*	*	22	Stage 3 df/dt+t start
2	1,7,9		84	General Start	*	*	*	*	23	Stage 3 F + DelF/DelT start
2	1,7,9		84	General Start	*	*	*	*	24	Stage 4 F+T start
2	1,7,9		84	General Start	*	*	*	*	25	Stage 4 df/dt+t start
2	1,7,9		84	General Start	*	*	*	*	26	Stage 4 F + DelF/DelT start
2	1,7,9		84	General Start	*	*	*	*	27	Stage 5 F+T start
2	1,7,9		84	General Start	*	*	*	*	28	Stage 5 df/dt+t start
2	1,7,9		84	General Start	*	*	*	*	29	Stage 5 F + DelF/DelT start
2	1,7,9		84	General Start	*	*	*	*	30	Stage 6 F+T start
2	1,7,9		84	General Start	*	*	*	*	31	Stage 6 df/dt+t start
2	1,7,9		84	General Start	*	*	*	*	32	Stage 6 F + DelF/DelT start
2	1,7,9		84	General Start	*	*	*	*	33	1st Stage Phase U/V Start A/AB
2	1,7,9		84	General Start	*	*	*	*	34	1st Stage Phase U/V Start B/BC
2	1,7,9		84	General Start	*	*	*	*	35	1st Stage Phase U/V Start C/CA
2	1,7,9		84	General Start	*	*	*	*	36	2nd Stage Phase U/V Start A/AB
2	1,7,9		84	General Start	*	*	*	*	37	2nd Stage Phase U/V Start B/BC
2	1,7,9		84	General Start	*	*	*	*	38	2nd Stage Phase U/V Start C/CA
2	1,7,9		84	General Start	*	*	*	*	39	1st Stage Phase O/V Start A/AB
2	1,7,9		84	General Start	*	*	*	*	40	1st Stage Phase O/V Start B/BC

ASDU TYPE	COT	FUN	INF NO.	Description	GI	Model Number			Address*	Interpretation
						P941	P942	P943		
2	1,7,9		84	General Start	*	*	*	*	41	1st Stage Phase O/V Start C/CA
2	1,7,9		84	General Start	*	*	*	*	42	2nd Stage Phase O/V Start A/AB
2	1,7,9		84	General Start	*	*	*	*	43	2nd Stage Phase O/V Start B/BC
2	1,7,9		84	General Start	*	*	*	*	44	2nd Stage Phase O/V Start C/CA
2	1,7,9		84	General Start	*	*	*	*	45	Generator Abnormal Band 1 Start
2	1,7,9		84	General Start	*	*	*	*	46	Generator Abnormal Band 2 Start
2	1,7,9		84	General Start	*	*	*	*	47	Generator Abnormal Band 3 Start
2	1,7,9		84	General Start	*	*	*	*	48	Generator Abnormal Band 4 Start
2	1,7		85	Breaker Failure						
2	1,7		86	START measuring system L1						
2	1,7		87	Trip measuring system L2						
2	1,7		88	Trip measuring system L3						
2	1,7		89	Trip measuring system E						
2	1,7		90	Trip I>						
2	1,7		91	Trip I>>						
2	1,7		92	Trip IN>						
2	1,7		93	Trip IN>>						
Auto-Reclose Indications (Monitor)										
1	1,7		128	CB 'on' by A/R						
1	1,7		129	CB 'on' by long time A/R						
1	1,7,9		130	AR blocked						
Measurands (Monitor)										
3,1	2,7		144	Measurand I						
3,2	2,7		145	Measurands I,V						
3,3	2,7		146	Measurands I,V,P,Q						
3,4	2,7		147	Measurands IN,VEN						
9	2,7		148	Measurands IL1, 2, 3, VL1, 2, 3, P, Q, f		*	*	*	0	Invalid bit set for IL1, 2, 3 and P, Q
Generic Functions (Monitor)										
10	42,43		240	Read Headings						
10	42,43		241	Read attributes of all entries of a group						
10	42,43		243	Read directory of entry						
10	1,2,7, 9,11,12,42,43		244	Real attribute of entry						
10	10		245	End of GGI						
10	41,44		249	Write entry with confirm						
10	40,41		250	Write entry with execute						
10	40		251	Write entry aborted						

Standard Information Numbers in Control Direction

ASDU TYPE	COT	FUN	INF NO.	Description	GI	Model Number			Address*	Interpretation
						P941	P942	P943		
System Functions (Control)										
7	9	255	0	Init General Interrogation		*	*	*	0	
6	8			Time Syncronisation		*	*	*	255	
General Commands										
20	20		16	Auto-recloser on/off						
20	20		17	Teleprotection on/off						
20	20		18	Protection on/off						
20	20		19	LED Reset		*	*	*	0	Reset Indications and Latches
20	20		23	Activate characteristic 1		*	*	*	0	Group 1 Active
20	20		24	Activate characteristic 2		*	*	*	0	Group 2 Active
20	20		25	Activate characteristic 3		*	*	*	0	Group 3 Active
20	20		26	Activate characteristic 4		*	*	*	0	Group 4 Active
Generic Functions										
21	42		240	Read headings of all defined groups						
21	42		241	Read single attribute of all entries of a group						
21	42		243	Read directory of single entry						

ASDU TYPE	COT	FUN	INF NO.	Description	GI	Model Number			Address*	Interpretation
						P941	P942	P943		
21	42		244	Read attribute of sngle entry						
21	9		245	Generic General Interrogation (GGI)						
10	40		248	Write entry						
10	40		249	Write with confirm						
10	40		250	Write with execute						
10	40		251	Write entry abort						
* Note the value in this column is added to the station address to produce the common address of the ASDU										
Basic Application Functions										
Test Mode			✓							
Blocking of monitor direction			×							
Disturbance data			×							
Generic services			×							
Private data			×							
Miscellaneous										
					Max .MVAL = times rated value					
Measurand					1,2		2,4			
Voltage L1-E					✓					
Voltage L2-E					✓					
Voltage L3-E					✓					
Frequency f					✓					

Digital Data Bus

DDB No.	Source	Description	English Text	P941	P942	P943
0	Output Condition	Output Relay 1	Output Label 1 (Setting)	*	*	*
1	Output Condition	Output Relay 2	Output Label 2 (Setting)	*	*	*
2	Output Condition	Output Relay 3	Output Label 3 (Setting)	*	*	*
3	Output Condition	Output Relay 4	Output Label 4 (Setting)	*	*	*
4	Output Condition	Output Relay 5	Output Label 5 (Setting)	*	*	*
5	Output Condition	Output Relay 6	Output Label 6 (Setting)	*	*	*
6	Output Condition	Output Relay 7	Output Label 7 (Setting)	*	*	*
7	Output Condition	Output Relay 8	Output Label 8 (Setting)		*	*
8	Output Condition	Output Relay 9	Output Label 9 (Setting)		*	*
9	Output Condition	Output Relay 10	Output Label 10 (Setting)		*	*
10	Output Condition	Output Relay 11	Output Label 11 (Setting)		*	*
11	Output Condition	Output Relay 12	Output Label 12 (Setting)		*	*
12	Output Condition	Output Relay 13	Output Label 13 (Setting)		*	*
13	Output Condition	Output Relay 14	Output Label 14 (Setting)		*	*
14		Unused		*	*	*
15		Unused		*	*	*
16		Unused		*	*	*
17		Unused		*	*	*
18		Unused		*	*	*
19		Unused		*	*	*
20		Unused		*	*	*
21		Unused		*	*	*
22		Unused		*	*	*
23		Unused		*	*	*
24		Unused		*	*	*
25		Unused		*	*	*
26		Unused		*	*	*
27		Unused		*	*	*
28		Unused		*	*	*
29		Unused		*	*	*
30		Unused		*	*	*
31		Unused		*	*	*
32	Opto	Opto Input 1	Opto Label 1 (Setting)	*	*	*
33	Opto	Opto Input 2	Opto Label 2 (Setting)	*	*	*
34	Opto	Opto Input 3	Opto Label 3 (Setting)	*	*	*
35	Opto	Opto Input 4	Opto Label 4 (Setting)	*	*	*
36	Opto	Opto Input 5	Opto Label 5 (Setting)	*	*	*
37	Opto	Opto Input 6	Opto Label 6 (Setting)	*	*	*
38	Opto	Opto Input 7	Opto Label 7 (Setting)	*	*	*
39	Opto	Opto Input 8	Opto Label 8 (Setting)	*	*	*
40	Opto	Opto Input 9	Opto Label 9 (Setting)			*
41	Opto	Opto Input 10	Opto Label 10 (Setting)			*
42	Opto	Opto Input 11	Opto Label 11 (Setting)			*
43	Opto	Opto Input 12	Opto Label 12 (Setting)			*
44	Opto	Opto Input 13	Opto Label 13 (Setting)			*
45	Opto	Opto Input 14	Opto Label 14 (Setting)			*
46	Opto	Opto Input 15	Opto Label 15 (Setting)			*
47	Opto	Opto Input 16	Opto Label 16 (Setting)			*
48		Unused		*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
49		Unused		*	*	*
50		Unused		*	*	*
51		Unused		*	*	*
52		Unused		*	*	*
53		Unused		*	*	*
54		Unused		*	*	*
55		Unused		*	*	*
56		Unused		*	*	*
57		Unused		*	*	*
58		Unused		*	*	*
59		Unused		*	*	*
60		Unused		*	*	*
61		Unused		*	*	*
62		Unused		*	*	*
63		Unused		*	*	*
64	Output Condition	Programmable LED 1	Led 1	*	*	*
65	Output Condition	Programmable LED 2	Led 2	*	*	*
66	Output Condition	Programmable LED 3	Led 3	*	*	*
67	Output Condition	Programmable LED 4	Led 4	*	*	*
68	Output Condition	Programmable LED 5	Led 5	*	*	*
69	Output Condition	Programmable LED 6	Led 6	*	*	*
70	Output Condition	Programmable LED 7	Led 7	*	*	*
71	Output Condition	Programmable LED 8	Led 8	*	*	*
72	PSL	Input to Relay Output Condition	Relay Cond 1	*	*	*
73	PSL	Input to Relay Output Condition	Relay Cond 2	*	*	*
74	PSL	Input to Relay Output Condition	Relay Cond 3	*	*	*
75	PSL	Input to Relay Output Condition	Relay Cond 4	*	*	*
76	PSL	Input to Relay Output Condition	Relay Cond 5	*	*	*
77	PSL	Input to Relay Output Condition	Relay Cond 6	*	*	*
78	PSL	Input to Relay Output Condition	Relay Cond 7	*	*	*
79	PSL	Input to Relay Output Condition	Relay Cond 8		*	*
80	PSL	Input to Relay Output Condition	Relay Cond 9		*	*
81	PSL	Input to Relay Output Condition	Relay Cond 10		*	*
82	PSL	Input to Relay Output Condition	Relay Cond 11		*	*
83	PSL	Input to Relay Output Condition	Relay Cond 12		*	*
84	PSL	Input to Relay Output Condition	Relay Cond 13		*	*
85	PSL	Input to Relay Output Condition	Relay Cond 14		*	*
86		Unused		*	*	*
87		Unused		*	*	*
88		Unused		*	*	*
89		Unused		*	*	*
90		Unused		*	*	*
91		Unused		*	*	*
92		Unused		*	*	*
93		Unused		*	*	*
94		Unused		*	*	*
95		Unused		*	*	*
96		Unused		*	*	*
97		Unused		*	*	*
98		Unused		*	*	*
99		Unused		*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
100		Unused		*	*	*
101		Unused		*	*	*
102		Unused		*	*	*
103		Unused		*	*	*
104	PSL	Input to LED Output Condition	LED Cond IN 1	*	*	*
105	PSL	Input to LED Output Condition	LED Cond IN 2	*	*	*
106	PSL	Input to LED Output Condition	LED Cond IN 3	*	*	*
107	PSL	Input to LED Output Condition	LED Cond IN 4	*	*	*
108	PSL	Input to LED Output Condition	LED Cond IN 5	*	*	*
109	PSL	Input to LED Output Condition	LED Cond IN 6	*	*	*
110	PSL	Input to LED Output Condition	LED Cond IN 7	*	*	*
111	PSL	Input to LED Output Condition	LED Cond IN 8	*	*	*
112	PSL	Input to Auxiliary Timer 1	Timer in 1	*	*	*
113	PSL	Input to Auxiliary Timer 2	Timer in 2	*	*	*
114	PSL	Input to Auxiliary Timer 3	Timer in 3	*	*	*
115	PSL	Input to Auxiliary Timer 4	Timer in 4	*	*	*
116	PSL	Input to Auxiliary Timer 5	Timer in 5	*	*	*
117	PSL	Input to Auxiliary Timer 6	Timer in 6	*	*	*
118	PSL	Input to Auxiliary Timer 7	Timer in 7	*	*	*
119	PSL	Input to Auxiliary Timer 8	Timer in 8	*	*	*
120	Auxiliary Timer	Output from Auxiliary Timer 1	Timer out 1	*	*	*
121	Auxiliary Timer	Output from Auxiliary Timer 2	Timer out 2	*	*	*
122	Auxiliary Timer	Output from Auxiliary Timer 3	Timer out 3	*	*	*
123	Auxiliary Timer	Output from Auxiliary Timer 4	Timer out 4	*	*	*
124	Auxiliary Timer	Output from Auxiliary Timer 5	Timer out 5	*	*	*
125	Auxiliary Timer	Output from Auxiliary Timer 6	Timer out 6	*	*	*
126	Auxiliary Timer	Output from Auxiliary Timer 7	Timer out 7	*	*	*
127	Auxiliary Timer	Output from Auxiliary Timer 8	Timer out 8	*	*	*
128	PSL	Fault recorder trigger	Fault REC TRIG	*	*	*
129		Unused		*	*	*
130		Unused		*	*	*
131		Unused		*	*	*
132	F+T	Stage 1 f+t element start	Stg1 f+t Sta	*	*	*
133	F+T	Stage 1 f+t element trip	Stg1 f+t Trp	*	*	*
134	F + df/dt	Stage 1 f+df/dt element trip	Stg1 f+df/dt Trp	*	*	*
135	df/dt + T	Stage 1 df/dt+t element start	Stg1 df/dt+t Sta	*	*	*
136	df/dt + T	Stage 1 df/dt+t element trip	Stg1 df/dt+t Trp	*	*	*
137	F + DelF/DelT	Stage 1 f + DeltaF/DeltaT element start	Stg1 f+Df/Dt Sta	*	*	*
138	F + DelF/DelT	Stage 1 f + DeltaF/DeltaT element trip	Stg1 f+Df/Dt Trp	*	*	*
139	Fixed Logic	Stage 1 any freq element start	Stg1 Freq Sta	*	*	*
140	Fixed Logic	Stage 1 any freq element trip	Stg1 Freq Trp	*	*	*
141	F+T	Stage 2 f+t element start	Stg2 f+t Sta	*	*	*
142	F+T	Stage 2 f+t element trip	Stg2 f+t Trp	*	*	*
143	F + df/dt	Stage 2 f+df/dt element trip	Stg2 f+df/dt Trp	*	*	*
144	df/dt + T	Stage 2 df/dt+t element start	Stg2 df/dt+t Sta	*	*	*
145	df/dt + T	Stage 2 df/dt+t element trip	Stg2 df/dt+t Trp	*	*	*
146	F + DelF/DelT	Stage 2 f + DeltaF/DeltaT element start	Stg2 f+Df/Dt Sta	*	*	*
147	F + DelF/DelT	Stage 2 f + DeltaF/DeltaT element trip	Stg2 f+Df/Dt Trp	*	*	*
148	Fixed Logic	Stage 2 any freq element start	Stg2 Freq Sta	*	*	*
149	Fixed Logic	Stage 2 any freq element trip	Stg2 Freq Trp	*	*	*
150	F+T	Stage 3 f+t element start	Stg3 f+t Sta	*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
151	F+T	Stage 3 f+t element trip	Stg3 f+t Trp	*	*	*
152	F + df/dt	Stage 3 f+df/dt element trip	Stg3 f+df/dt Trp	*	*	*
153	df/dt + T	Stage 3 df/dt+t element start	Stg3 df/dt+t Sta	*	*	*
154	df/dt + T	Stage 3 df/dt+t element trip	Stg3 df/dt+t Trp	*	*	*
155	F + DelF/DelT	Stage 3 f + DeltaF/DeltaT element start	Stg3 f+Df/Dt Sta	*	*	*
156	F + DelF/DelT	Stage 3 f + DeltaF/DeltaT element trip	Stg3 f+Df/Dt Trp	*	*	*
157	Fixed Logic	Stage 3 any freq element start	Stg3 Freq Sta	*	*	*
158	Fixed Logic	Stage 3 any freq element trip	Stg3 Freq Trp	*	*	*
159	F+T	Stage 4 f+t element start	Stg4 f+t Sta	*	*	*
160	F+T	Stage 4 f+t element trip	Stg4 f+t Trp	*	*	*
161	F + df/dt	Stage 4 f+df/dt element trip	Stg4 f+df/dt Trp	*	*	*
162	df/dt + T	Stage 4 df/dt+t element start	Stg4 df/dt+t Sta	*	*	*
163	df/dt + T	Stage 4 df/dt+t element trip	Stg4 df/dt+t Trp	*	*	*
164	F + DelF/DelT	Stage 4 f + DeltaF/DeltaT element start	Stg4 f+Df/Dt Sta	*	*	*
165	F + DelF/DelT	Stage 4 f + DeltaF/DeltaT element trip	Stg4 f+Df/Dt Trp	*	*	*
166	Fixed Logic	Stage 4 any freq element start	Stg4 Freq Sta	*	*	*
167	Fixed Logic	Stage 4 any freq element trip	Stg4 Freq Trp	*	*	*
168	F+T	Stage 5 f+t element start	Stg5 f+t Sta	*	*	*
169	F+T	Stage 5 f+t element trip	Stg5 f+t Trp	*	*	*
170	F + df/dt	Stage 5 f+df/dt element trip	Stg5 f+df/dt Trp	*	*	*
171	df/dt + T	Stage 5 df/dt+t element start	Stg5 df/dt+t Sta	*	*	*
172	df/dt + T	Stage 5 df/dt+t element trip	Stg5 df/dt+t Trp	*	*	*
173	F + DelF/DelT	Stage 5 f + DeltaF/DeltaT element start	Stg5 f+Df/Dt Sta	*	*	*
174	F + DelF/DelT	Stage 5 f + DeltaF/DeltaT element trip	Stg5 f+Df/Dt Trp	*	*	*
175	Fixed Logic	Stage 5 any freq element start	Stg5 Freq Sta	*	*	*
176	Fixed Logic	Stage 5 any freq element trip	Stg5 Freq Trp	*	*	*
177	F+T	Stage 6 f+t element start	Stg6 f+t Sta	*	*	*
178	F+T	Stage 6 f+t element trip	Stg6 f+t Trp	*	*	*
179	F + df/dt	Stage 6 f+df/dt element trip	Stg6 f+df/dt Trp	*	*	*
180	df/dt + T	Stage 6 df/dt+t element start	Stg6 df/dt+t Sta	*	*	*
181	df/dt + T	Stage 6 df/dt+t element trip	Stg6 df/dt+t Trp	*	*	*
182	F + DelF/DelT	Stage 6 f + DeltaF/DeltaT element start	Stg6 f+Df/Dt Sta	*	*	*
183	F + DelF/DelT	Stage 6 f + DeltaF/DeltaT element trip	Stg6 f+Df/Dt Trp	*	*	*
184	Fixed Logic	Stage 6 any freq element start	Stg6 Freq Sta	*	*	*
185	Fixed Logic	Stage 6 any freq element trip	Stg6 Freq Trp	*	*	*
186	Undervoltage	1st Stage Phase U/V Start 3ph	V < 1 Start	*	*	*
187	Undervoltage	1st Stage Phase U/V Start A/AB	V < 1 Start A/AB	*	*	*
188	Undervoltage	1st Stage Phase U/V Start B/BC	V < 1 Start B/BC	*	*	*
189	Undervoltage	1st Stage Phase U/V Start C/CA	V < 1 Start C/CA	*	*	*
190	Undervoltage	2nd Stage Phase U/V Start 3ph	V < 2 Start	*	*	*
191	Undervoltage	2nd Stage Phase U/V Start A/AB	V < 2 Start A/AB	*	*	*
192	Undervoltage	2nd Stage Phase U/V Start B/BC	V < 2 Start B/BC	*	*	*
193	Undervoltage	2nd Stage Phase U/V Start C/CA	V < 2 Start C/CA	*	*	*
194	Undervoltage	1st Stage Phase U/V Trip 3ph	V < 1 Trip	*	*	*
195	Undervoltage	1st Stage Phase U/V Trip A/AB	V < 1 Trip A/AB	*	*	*
196	Undervoltage	1st Stage Phase U/V Trip B/BC	V < 1 Trip B/BC	*	*	*
197	Undervoltage	1st Stage Phase U/V Trip C/CA	V < 1 Trip C/CA	*	*	*
198	Undervoltage	2nd Stage Phase U/V Trip 3ph	V < 2 Trip	*	*	*
199	Undervoltage	2nd Stage Phase U/V Trip A/AB	V < 2 Trip A/AB	*	*	*
200	Undervoltage	2nd Stage Phase U/V Trip B/BC	V < 2 Trip B/BC	*	*	*
201	Undervoltage	2nd Stage Phase U/V Trip C/CA	V < 2 Trip C/CA	*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
202	Overvoltage	1st Stage Phase O/V Start 3ph	V > 1 Start	*	*	*
203	Overvoltage	1st Stage Phase O/V Start A/AB	V > 1 Start A/AB	*	*	*
204	Overvoltage	1st Stage Phase O/V Start B/BC	V > 1 Start B/BC	*	*	*
205	Overvoltage	1st Stage Phase O/V Start C/CA	V > 1 Start C/CA	*	*	*
206	Overvoltage	2nd Stage Phase O/V Start 3ph	V > 2 Start	*	*	*
207	Overvoltage	2nd Stage Phase O/V Start A/AB	V > 2 Start A/AB	*	*	*
208	Overvoltage	2nd Stage Phase O/V Start B/BC	V > 2 Start B/BC	*	*	*
209	Overvoltage	2nd Stage Phase O/V Start C/CA	V > 2 Start C/CA	*	*	*
210	Overvoltage	1st Stage Phase O/V Trip 3ph	V > 1 Trip	*	*	*
211	Overvoltage	1st Stage Phase O/V Trip A/AB	V > 1 Trip A/AB	*	*	*
212	Overvoltage	1st Stage Phase O/V Trip B/BC	V > 1 Trip B/BC	*	*	*
213	Overvoltage	1st Stage Phase O/V Trip C/CA	V > 1 Trip C/CA	*	*	*
214	Overvoltage	2nd Stage Phase O/V Trip 3ph	V > 2 Trip	*	*	*
215	Overvoltage	2nd Stage Phase O/V Trip A/AB	V > 2 Trip A/AB	*	*	*
216	Overvoltage	2nd Stage Phase O/V Trip B/BC	V > 2 Trip B/BC	*	*	*
217	Overvoltage	2nd Stage Phase O/V Trip C/CA	V > 2 Trip C/CA	*	*	*
218	Generator Abnormal	Generator Abnormal Band 1 Start	Gen Band1 Sta	*	*	*
219	Generator Abnormal	Generator Abnormal Band 1 Trip	Gen Band1 Trp	*	*	*
220	Generator Abnormal	Generator Abnormal Band 2Start	Gen Band2 Sta	*	*	*
221	Generator Abnormal	Generator Abnormal Band 2 Trip	Gen Band2 Trp	*	*	*
222	Generator Abnormal	Generator Abnormal Band 3 Start	Gen Band3 Sta	*	*	*
223	Generator Abnormal	Generator Abnormal Band 3 Trip	Gen Band3 Trp	*	*	*
224	Generator Abnormal	Generator Abnormal Band 4 Start	Gen Band4 Sta	*	*	*
225	Generator Abnormal	Generator Abnormal Band 4 Trip	Gen Band4 Trp	*	*	*
226	Fixed Logic	Any Generator Abnormal Start	Gen Abn Start	*	*	*
227	Fixed Logic	Any Generator Abnormal Trip	Gen Abn Trip	*	*	*
228	Load Restoration	Stage 1 Load Restoration Start	Stg1 Restore Sta	*	*	*
229	Load Restoration	Stage 1 Load Restoration Enable	Stg1 Restore Ena	*	*	*
230	Load Restoration	Stage 2 Load Restoration Start	Stg2 Restore Sta	*	*	*
231	Load Restoration	Stage 2 Load Restoration Enable	Stg2 Restore Ena	*	*	*
232	Load Restoration	Stage 3 Load Restoration Start	Stg3 Restore Sta	*	*	*
233	Load Restoration	Stage 3 Load Restoration Enable	Stg3 Restore Ena	*	*	*
234	Load Restoration	Stage 4 Load Restoration Start	Stg4 Restore Sta	*	*	*
235	Load Restoration	Stage 4 Load Restoration Enable	Stg4 Restore Ena	*	*	*
236	Load Restoration	Stage 5 Load Restoration Start	Stg5 Restore Sta	*	*	*
237	Load Restoration	Stage 5 Load Restoration Enable	Stg5 Restore Ena	*	*	*
238	Load Restoration	Stage 6 Load Restoration Start	Stg6 Restore Sta	*	*	*
239	Load Restoration	Stage 6 Load Restoration Enable	Stg6 Restore Ena	*	*	*
240	Fixed Logic	Any Start for all the protection elements	Any Protn Start	*	*	*
241	Fixed Logic	Any Trip for all the protection elements	Any Protn Trip	*	*	*
242	Fixed Logic	Any f+t element start for all the Stages	Any f+t Sta	*	*	*
243	Fixed Logic	Any df/dt+t element start for all the Stages	Any df/dt+t Sta	*	*	*
244	Fixed Logic	Any f+delf/delt element start for all the Stages	Any f+Df/Dt Sta	*	*	*
245	Fixed Logic	Any f+t element Trip for all the Stages	Any f+t Trp	*	*	*
246	Fixed Logic	Any f+df/dt element Trip for all the Stages	Any f+df/dt Trp	*	*	*
247	Fixed Logic	Any df/dt+t element Trip for all the Stages	Any df/dt+t Trp	*	*	*
248	Fixed Logic	Any f+delf/delt element Trip for all the Stages	Any f+Df/Dt Trp	*	*	*
249	Field Voltage Monitor	Field Voltage Failure Indication	Field Volt Fail	*	*	*
250	PSL	Reset Latched Relays & LED's	Reset Relays/LED	*	*	*
251	PSL	Block Undervoltage Stage 1 time delay	V<1 Timer Block	*	*	*
252	PSL	Block Phase Underrvoltage Stage2 time delay	V<2 Timer Block	*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
253	PSL	Block Phase Overvoltage Stage 1 time delay	V>1 Timer Block	*	*	*
254	PSL	Block Phase Overvoltage Stage 2 time delay	V>2 Timer Block	*	*	*
255	Frequency Tracking	Frequency out of range	Freq Invalid	*	*	*
256	Frequency Tracking	Stop Freq Track	Stop Freq Track	*	*	*
257	PSL	Statistics Cleared	Stats Cleared	*	*	*
258	PSL	Generator Abnormal Timers Cleared	Timers Cleared	*	*	*
259	F+T Configuration	Stage 1 f+t Fequency set to Nominal	Wrong Setting 01	*	*	*
260	F+T Configuration	Stage 2 f+t Fequency set to Nominal	Wrong Setting 02	*	*	*
261	F+T Configuration	Stage 3 f+t Fequency set to Nominal	Wrong Setting 03	*	*	*
262	F+T Configuration	Stage 4 f+t Fequency set to Nominal	Wrong Setting 04	*	*	*
263	F+T Configuration	Stage 5 f+t Fequency set to Nominal	Wrong Setting 05	*	*	*
264	F+T Configuration	Stage 6 f+t Fequency set to Nominal	Wrong Setting 06	*	*	*
265	F+df/dt Configuration	Stage 1 f+df/dt Frequency set to Nominal	Wrong Setting 07	*	*	*
266	F+df/dt Configuration	Stage 2 f+df/dt Frequency set to Nominal	Wrong Setting 08	*	*	*
267	F+df/dt Configuration	Stage 3 f+df/dt Frequency set to Nominal	Wrong Setting 09	*	*	*
268	F+df/dt Configuration	Stage 4 f+df/dt Frequency set to Nominal	Wrong Setting 10	*	*	*
269	F+df/dt Configuration	Stage 5 f+df/dt Frequency set to Nominal	Wrong Setting 11	*	*	*
270	F+df/dt Configuration	Stage 6 f+df/dt Frequency set to Nominal	Wrong Setting 12	*	*	*
271	df/dt + T Configuration	Stage 1 df/dt setting is 0	Wrong Setting 13	*	*	*
272	df/dt + T Configuration	Stage 2 df/dt setting is 0	Wrong Setting 14	*	*	*
273	df/dt + T Configuration	Stage 3 df/dt setting is 0	Wrong Setting 15	*	*	*
274	df/dt + T Configuration	Stage 4 df/dt setting is 0	Wrong Setting 16	*	*	*
275	df/dt + T Configuration	Stage 5 df/dt setting is 0	Wrong Setting 17	*	*	*
276	df/dt + T Configuration	Stage 6 df/dt setting is 0	Wrong Setting 18	*	*	*
277	F + DelF/DelT Configurati	Stage 1 f+Df/Dt Frequency set to Nominal	Wrong Setting 19	*	*	*
278	F + DelF/DelT Configurati	Stage 2 f+Df/Dt Frequency set to Nominal	Wrong Setting 20	*	*	*
279	F + DelF/DelT Configurati	Stage 3 f+Df/Dt Frequency set to Nominal	Wrong Setting 21	*	*	*
280	F + DelF/DelT Configurati	Stage 4 f+Df/Dt Frequency set to Nominal	Wrong Setting 22	*	*	*
281	F + DelF/DelT Configurati	Stage 5 f+Df/Dt Frequency set to Nominal	Wrong Setting 23	*	*	*
282	F + DelF/DelT Configurati	Stage 6 f+Df/Dt Frequency set to Nominal	Wrong Setting 24	*	*	*
283	Generator Abnormal Confi	Band 1 Low Frequency greater then high	Wrong Setting 25	*	*	*
284	Generator Abnormal Confi	Band 2 Low Frequency greater then high	Wrong Setting 26	*	*	*
285	Generator Abnormal Confi	Band 3 Low Frequency greater then high	Wrong Setting 27	*	*	*
286	Generator Abnormal Confi	Band 4 Low Frequency greater then high	Wrong Setting 28	*	*	*
287	Load Restoration Configura	Wrong Stage 1 Load Restoration Setting	Wrong Setting 29	*	*	*
288	Load Restoration Configura	Wrong Stage 2 Load Restoration Setting	Wrong Setting 30	*	*	*
289	Load Restoration Configura	Wrong Stage 3 Load Restoration Setting	Wrong Setting 31	*	*	*
290	Load Restoration Configura	Wrong Stage 4 Load Restoration Setting	Wrong Setting 32	*	*	*
291	Load Restoration Configura	Wrong Stage 5 Load Restoration Setting	Wrong Setting 33	*	*	*
292	Load Restoration Configura	Wrong Stage 6 Load Restoration Setting	Wrong Setting 34	*	*	*
293	Group Selection	Setting Group via opto invalid Alarm	SG-opto Invalid	*	*	*
294	Commission Test	Test Mode Enabled Alarm	Prot'n Disabled	*	*	*
295	Frequency Tracking	Freq out of Range High	Freq High	*	*	*
296	Frequency Tracking	Freq out of Range Low	Freq Low	*	*	*
297	Frequency Tracking	Frequency Not found	Freq Not Found	*	*	*
298	Configuration	Indication for wrong setting	Wrong Setting	*	*	*
299	Statistics	Indication for corrupted checksum for Statistics	Stats Corrupt	*	*	*
300	Generator Abnormal	Indication for corrupted checksum for Timers	Gen Timers Bad	*	*	*
301	Undervoltage	Undervoltage block for 3 Phase	UV Block	*	*	*
302	PSL	Turns trip led on	Trip LED Enabled	*	*	*
303	PSL	User definable Alarm 1	SR User Alarm 1	*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
304	PSL	User definable Alarm 2	SR User Alarm 2	*	*	*
305	PSL	User definable Alarm 3	SR User Alarm 3	*	*	*
306	PSL	User definable Alarm 4	SR User Alarm 4	*	*	*
307	PSL	User definable Alarm 5	SR User Alarm 5	*	*	*
308	PSL	User definable Alarm 6	SR User Alarm 6	*	*	*
309	PSL	User definable Alarm 7	SR User Alarm 7	*	*	*
310	PSL	User definable Alarm 8	SR User Alarm 8	*	*	*
311	PSL	User definable Alarm 9	SR User Alarm 9	*	*	*
312	PSL	User definable Alarm 10	SR User Alarm 10	*	*	*
313	PSL	User definable Alarm 11	MR User Alarm 11	*	*	*
314	PSL	User definable Alarm 12	MR User Alarm 12	*	*	*
315	PSL	User definable Alarm 13	MR User Alarm 13	*	*	*
316	PSL	User definable Alarm 14	MR User Alarm 14	*	*	*
317	PSL	User definable Alarm 15	MR User Alarm 15	*	*	*
318	PSL	User definable Alarm 16	MR User Alarm 16	*	*	*
319	PSL	User definable Alarm 17	MR User Alarm 17	*	*	*
320	PSL	User definable Alarm 18	MR User Alarm 18	*	*	*
321	PSL	User definable Alarm 19	MR User Alarm 19	*	*	*
322	PSL	User definable Alarm 20	MR User Alarm 20	*	*	*
323	PSL	Initiate Test Mode	Test Mode	*	*	*
324		Unused		*	*	*
325		Unused		*	*	*
326		Unused		*	*	*
327		Unused		*	*	*
328		Unused		*	*	*
329		Unused		*	*	*
330		Unused		*	*	*
331		Unused		*	*	*
332		Unused		*	*	*
333		Unused		*	*	*
334		Unused		*	*	*
335		Unused		*	*	*
336		Unused		*	*	*
337		Unused		*	*	*
338		Unused		*	*	*
339		Unused		*	*	*
340		Unused		*	*	*
341		Unused		*	*	*
342		Unused		*	*	*
343		Unused		*	*	*
344		Unused		*	*	*
345		Unused		*	*	*
346		Unused		*	*	*
347		Unused		*	*	*
348		Unused		*	*	*
349		Unused		*	*	*
350		Unused		*	*	*
351		Unused		*	*	*
352		Unused		*	*	*
353		Unused		*	*	*
354		Unused		*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
355		Unused		*	*	*
356		Unused		*	*	*
357		Unused		*	*	*
358		Unused		*	*	*
359		Unused		*	*	*
360		Unused		*	*	*
361		Unused		*	*	*
362		Unused		*	*	*
363		Unused		*	*	*
364		Unused		*	*	*
365		Unused		*	*	*
366		Unused		*	*	*
367		Unused		*	*	*
368		Unused		*	*	*
369		Unused		*	*	*
370		Unused		*	*	*
371		Unused		*	*	*
372		Unused		*	*	*
373		Unused		*	*	*
374		Unused		*	*	*
375		Unused		*	*	*
376		Unused		*	*	*
377		Unused		*	*	*
378		Unused		*	*	*
379		Unused		*	*	*
380		Unused		*	*	*
381		Unused		*	*	*
382		Unused		*	*	*
383		Unused		*	*	*
384		Unused		*	*	*
385		Unused		*	*	*
386		Unused		*	*	*
387		Unused		*	*	*
388		Unused		*	*	*
389		Unused		*	*	*
390		Unused		*	*	*
391		Unused		*	*	*
392		Unused		*	*	*
393		Unused		*	*	*
394		Unused		*	*	*
395		Unused		*	*	*
396		Unused		*	*	*
397		Unused		*	*	*
398		Unused		*	*	*
399		Unused		*	*	*
400		Unused		*	*	*
401		Unused		*	*	*
402		Unused		*	*	*
403		Unused		*	*	*
404		Unused		*	*	*
405		Unused		*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
406		Unused		*	*	*
407		Unused		*	*	*
408		Unused		*	*	*
409		Unused		*	*	*
410		Unused		*	*	*
411		Unused		*	*	*
412	PSL	PSL Internal Node 1	PSL Internal 000	*	*	*
413	PSL	PSL Internal Node 2	PSL Internal 001	*	*	*
414	PSL	PSL Internal Node 3	PSL Internal 002	*	*	*
415	PSL	PSL Internal Node 4	PSL Internal 003	*	*	*
416	PSL	PSL Internal Node 5	PSL Internal 004	*	*	*
417	PSL	PSL Internal Node 6	PSL Internal 005	*	*	*
418	PSL	PSL Internal Node 7	PSL Internal 006	*	*	*
419	PSL	PSL Internal Node 8	PSL Internal 007	*	*	*
420	PSL	PSL Internal Node 9	PSL Internal 008	*	*	*
421	PSL	PSL Internal Node 10	PSL Internal 009	*	*	*
422	PSL	PSL Internal Node 11	PSL Internal 010	*	*	*
423	PSL	PSL Internal Node 12	PSL Internal 011	*	*	*
424	PSL	PSL Internal Node 13	PSL Internal 012	*	*	*
425	PSL	PSL Internal Node 14	PSL Internal 013	*	*	*
426	PSL	PSL Internal Node 15	PSL Internal 014	*	*	*
427	PSL	PSL Internal Node 16	PSL Internal 015	*	*	*
428	PSL	PSL Internal Node 17	PSL Internal 016	*	*	*
429	PSL	PSL Internal Node 18	PSL Internal 017	*	*	*
430	PSL	PSL Internal Node 19	PSL Internal 018	*	*	*
431	PSL	PSL Internal Node 20	PSL Internal 019	*	*	*
432	PSL	PSL Internal Node 21	PSL Internal 020	*	*	*
433	PSL	PSL Internal Node 22	PSL Internal 021	*	*	*
434	PSL	PSL Internal Node 23	PSL Internal 022	*	*	*
435	PSL	PSL Internal Node 24	PSL Internal 023	*	*	*
436	PSL	PSL Internal Node 25	PSL Internal 024	*	*	*
437	PSL	PSL Internal Node 26	PSL Internal 025	*	*	*
438	PSL	PSL Internal Node 27	PSL Internal 026	*	*	*
439	PSL	PSL Internal Node 28	PSL Internal 027	*	*	*
440	PSL	PSL Internal Node 29	PSL Internal 028	*	*	*
441	PSL	PSL Internal Node 30	PSL Internal 029	*	*	*
442	PSL	PSL Internal Node 31	PSL Internal 030	*	*	*
443	PSL	PSL Internal Node 32	PSL Internal 031	*	*	*
444	PSL	PSL Internal Node 33	PSL Internal 032	*	*	*
445	PSL	PSL Internal Node 34	PSL Internal 033	*	*	*
446	PSL	PSL Internal Node 35	PSL Internal 034	*	*	*
447	PSL	PSL Internal Node 36	PSL Internal 035	*	*	*
448	PSL	PSL Internal Node 37	PSL Internal 036	*	*	*
449	PSL	PSL Internal Node 38	PSL Internal 037	*	*	*
450	PSL	PSL Internal Node 39	PSL Internal 038	*	*	*
451	PSL	PSL Internal Node 40	PSL Internal 039	*	*	*
452	PSL	PSL Internal Node 41	PSL Internal 040	*	*	*
453	PSL	PSL Internal Node 42	PSL Internal 041	*	*	*
454	PSL	PSL Internal Node 43	PSL Internal 042	*	*	*
455	PSL	PSL Internal Node 44	PSL Internal 043	*	*	*
456	PSL	PSL Internal Node 45	PSL Internal 044	*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
457	PSL	PSL Internal Node 46	PSL Internal 045	*	*	*
458	PSL	PSL Internal Node 47	PSL Internal 046	*	*	*
459	PSL	PSL Internal Node 48	PSL Internal 047	*	*	*
460	PSL	PSL Internal Node 49	PSL Internal 048	*	*	*
461	PSL	PSL Internal Node 50	PSL Internal 049	*	*	*
462	PSL	PSL Internal Node 51	PSL Internal 050	*	*	*
463	PSL	PSL Internal Node 52	PSL Internal 051	*	*	*
464	PSL	PSL Internal Node 53	PSL Internal 052	*	*	*
465	PSL	PSL Internal Node 54	PSL Internal 053	*	*	*
466	PSL	PSL Internal Node 55	PSL Internal 054	*	*	*
467	PSL	PSL Internal Node 56	PSL Internal 055	*	*	*
468	PSL	PSL Internal Node 57	PSL Internal 056	*	*	*
469	PSL	PSL Internal Node 58	PSL Internal 057	*	*	*
470	PSL	PSL Internal Node 59	PSL Internal 058	*	*	*
471	PSL	PSL Internal Node 60	PSL Internal 059	*	*	*
472	PSL	PSL Internal Node 61	PSL Internal 060	*	*	*
473	PSL	PSL Internal Node 62	PSL Internal 061	*	*	*
474	PSL	PSL Internal Node 63	PSL Internal 062	*	*	*
475	PSL	PSL Internal Node 64	PSL Internal 063	*	*	*
476	PSL	PSL Internal Node 65	PSL Internal 064	*	*	*
477	PSL	PSL Internal Node 66	PSL Internal 065	*	*	*
478	PSL	PSL Internal Node 67	PSL Internal 066	*	*	*
479	PSL	PSL Internal Node 68	PSL Internal 067	*	*	*
480	PSL	PSL Internal Node 69	PSL Internal 068	*	*	*
481	PSL	PSL Internal Node 70	PSL Internal 069	*	*	*
482	PSL	PSL Internal Node 71	PSL Internal 070	*	*	*
483	PSL	PSL Internal Node 72	PSL Internal 071	*	*	*
484	PSL	PSL Internal Node 73	PSL Internal 072	*	*	*
485	PSL	PSL Internal Node 74	PSL Internal 073	*	*	*
486	PSL	PSL Internal Node 75	PSL Internal 074	*	*	*
487	PSL	PSL Internal Node 76	PSL Internal 075	*	*	*
488	PSL	PSL Internal Node 77	PSL Internal 076	*	*	*
489	PSL	PSL Internal Node 78	PSL Internal 077	*	*	*
490	PSL	PSL Internal Node 79	PSL Internal 078	*	*	*
491	PSL	PSL Internal Node 80	PSL Internal 079	*	*	*
492	PSL	PSL Internal Node 81	PSL Internal 080	*	*	*
493	PSL	PSL Internal Node 82	PSL Internal 081	*	*	*
494	PSL	PSL Internal Node 83	PSL Internal 082	*	*	*
495	PSL	PSL Internal Node 84	PSL Internal 083	*	*	*
496	PSL	PSL Internal Node 85	PSL Internal 084	*	*	*
497	PSL	PSL Internal Node 86	PSL Internal 085	*	*	*
498	PSL	PSL Internal Node 87	PSL Internal 086	*	*	*
499	PSL	PSL Internal Node 88	PSL Internal 087	*	*	*
500	PSL	PSL Internal Node 89	PSL Internal 088	*	*	*
501	PSL	PSL Internal Node 90	PSL Internal 089	*	*	*
502	PSL	PSL Internal Node 91	PSL Internal 090	*	*	*
503	PSL	PSL Internal Node 92	PSL Internal 091	*	*	*
504	PSL	PSL Internal Node 93	PSL Internal 092	*	*	*
505	PSL	PSL Internal Node 94	PSL Internal 093	*	*	*
506	PSL	PSL Internal Node 95	PSL Internal 094	*	*	*
507	PSL	PSL Internal Node 96	PSL Internal 095	*	*	*

DDB No.	Source	Description	English Text	P941	P942	P943
508	PSL	PSL Internal Node 97	PSL Internal 096	*	*	*
509	PSL	PSL Internal Node 98	PSL Internal 097	*	*	*
510	PSL	PSL Internal Node 99	PSL Internal 098	*	*	*
511	PSL	PSL Internal Node 100	PSL Internal 099	*	*	*

Event Record Data Format

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
Logic Inputs		**Changes in opto input status**	5	0020	Binary Flag (8 bits) Binary Flag (16 bits) Value contains new opto input status		*	*	*
Output Contacts		**Changes in output contact status**	4	0021	Binary Flag (7 bits) Binary Flag (14 bits) Value contains new output contact status		*	*	*
		Alarm Events:			Unsigned Integer (32 bits) Bit position for alarm Direction 1=ON, 0=OFF				
Battery Fail	ON/OFF	Battery Fail	2/3	0022	0		*	*	*
Field Voltage Fail	ON/OFF	Field Voltage Fail	2/3	0022	1		*	*	*
SG-opto invalid	ON/OFF	Setting Group via opto invalid	2/3	0022	2		*	*	*
Prot'n Disabled	ON/OFF	Protection Disabled	2/3	0022	3		*	*	*
Freq High	ON/OFF	Frequency is > 70 Hz	2/3	0022	4		*	*	*
Freq Low	ON/OFF	Frequency is < 40 Hz	2/3	0022	5		*	*	*
Freq Not Found	ON/OFF	Frequency is not measureable	2/3	0022	6		*	*	*
Wrong Setting	ON/OFF	An invalid setting has been entered	2/3	0022	7		*	*	*
Stats Corrupt	ON/OFF	Bad statistics checksum	0/1	0022	8		*	*	*
Gen Timers Bad	ON/OFF	Bad Generator abnormal timer checksum	0/1	0022	9		*	*	*
UV Block	ON/OFF	Undervoltage Block	0/1	0022	10		*	*	*
User Alarm 1	ON/OFF	User Definable Alarm 1 (Self Reset)	0/1	0022	11				
User Alarm 2	ON/OFF	User Definable Alarm 2 (Self Reset)	2/3	0022	12				
User Alarm 3	ON/OFF	User Definable Alarm 3 (Self Reset)	2/3	0022	13				
User Alarm 4	ON/OFF	User Definable Alarm 4 (Self Reset)	2/3	0022	14				
User Alarm 5	ON/OFF	User Definable Alarm 5 (Self Reset)	2/3	0022	15				
User Alarm 6	ON/OFF	User Definable Alarm 6 (Self Reset)	2/3	0022	16				

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
User Alarm 7	ON/OFF	User Definable Alarm 7 (Self Reset)	2/3	0022	17				
User Alarm 8	ON/OFF	User Definable Alarm 8 (Self Reset)	2/3	0022	18				
User Alarm 9	ON/OFF	User Definable Alarm 9 (Self Reset)	2/3	0022	19				
User Alarm 10	ON/OFF	User Definable Alarm 10 (Self Reset)	2/3	0022	20				
User Alarm 11	ON/OFF	User Definable Alarm 11 (Latched)	0/1	0022	21				
User Alarm 12	ON/OFF	User Definable Alarm 12 (Latched)	0/1	0022	22				
User Alarm 13	ON/OFF	User Definable Alarm 13 (Latched)	0/1	0022	23				
User Alarm 14	ON/OFF	User Definable Alarm 14 (Latched)	0/1	0022	24				
User Alarm 15	ON/OFF	User Definable Alarm 15 (Latched)	0/1	0022	25				
User Alarm 16	ON/OFF	User Definable Alarm 16 (Latched)	0/1	0022	26				
User Alarm 17	ON/OFF	User Definable Alarm 17 (Latched)	0/1	0022	27				
User Alarm 18	ON/OFF	User Definable Alarm 18 (Latched)	0/1	0022	28				
User Alarm 19	ON/OFF	User Definable Alarm 19 (Latched)	0/1	0022	29				
User Alarm 20	ON/OFF	User Definable Alarm 20 (Latched)	0/1	0022	30				
User Alarm 21	ON/OFF	User Definable Alarm 21 (Latched)	0/1	0022	31				
		Protection Events:			Unsigned Integer (32 bits) Bit position for event Direction 1=ON, 0 = OFF				
Stg1 f+t Sta	ON/OFF	Stage 1 f+t element start	6	0F24	4	132	*	*	*
Stg1 f+t Trp	ON/OFF	Stage 1 f+t element trip	6	0F24	5	133	*	*	*
Stg1 f+df/dt Trp	ON/OFF	Stage 1 f+df/dt element trip	6	0F24	6	134	*	*	*
Stg1 df/dt+t Sta	ON/OFF	Stage 1 df/dt+t element start	6	0F24	7	135	*	*	*
Stg1 df/dt+t Trp	ON/OFF	Stage 1 df/dt+t element trip	6	0F24	8	136	*	*	*
Stg1 f+Df/Dt Sta	ON/OFF	Stage 1 f + DeltaF/DeltaT element start	6	0F24	9	137	*	*	*
Stg1 f+Df/Dt Trp	ON/OFF	Stage 1 f + DeltaF/DeltaT element trip	6	0F24	10	138	*	*	*
Stg2 f+t Sta	ON/OFF	Stage 2 f+t element start	6	0F24	13	141	*	*	*
Stg2 f+t Trp	ON/OFF	Stage 2 f+t element trip	6	0F24	14	142	*	*	*

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
Stg2 f+df/dt Trp	ON/OFF	Stage 2 f+df/dt element trip	6	0F24	15	143	*	*	*
Stg2 df/dt+t Sta	ON/OFF	Stage 2 df/dt+t element start	6	0F24	16	144	*	*	*
Stg2 df/dt+t Trp	ON/OFF	Stage 2 df/dt+t element trip	6	0F24	17	145	*	*	*
Stg2 f+Df/Dt Sta	ON/OFF	Stage 2 f + DeltaF/DeltaT element start	6	0F24	18	146	*	*	*
Stg2 f+Df/Dt Trp	ON/OFF	Stage 2 f + DeltaF/DeltaT element trip	6	0F24	19	147	*	*	*
Stg3 f+t Sta	ON/OFF	Stage 3 f+t element start	6	0F24	22	150	*	*	*
Stg3 f+t Trp	ON/OFF	Stage 3 f+t element trip	6	0F24	23	151	*	*	*
Stg3 f+df/dt Trp	ON/OFF	Stage 3 f+df/dt element trip	6	0F24	24	152	*	*	*
Stg3 df/dt+t Sta	ON/OFF	Stage 3 df/dt+t element start	6	0F24	25	153	*	*	*
Stg3 df/dt+t Trp	ON/OFF	Stage 3 df/dt+t element trip	6	0F24	26	154	*	*	*
Stg3 f+Df/Dt Sta	ON/OFF	Stage 3 f + DeltaF/DeltaT element start	6	0F24	27	155	*	*	*
Stg3 f+Df/Dt Trp	ON/OFF	Stage 3 f + DeltaF/DeltaT element trip	6	0F24	28	156	*	*	*
Stg4 f+t Sta	ON/OFF	Stage 4 f+t element start	6	0F24	31	159	*	*	*
Stg4 f+t Trp	ON/OFF	Stage 4 f+t element trip	6	0F25	0	160	*	*	*
Stg4 f+df/dt Trp	ON/OFF	Stage 4 f+df/dt element trip	6	0F25	1	161	*	*	*
Stg4 df/dt+t Sta	ON/OFF	Stage 4 df/dt+t element start	6	0F25	2	162	*	*	*
Stg4 df/dt+t Trp	ON/OFF	Stage 4 df/dt+t element trip	6	0F25	3	163	*	*	*
Stg4 f+Df/Dt Sta	ON/OFF	Stage 4 f + DeltaF/DeltaT element start	6	0F25	4	164	*	*	*
Stg4 f+Df/Dt Trp	ON/OFF	Stage 4 f + DeltaF/DeltaT element trip	6	0F25	5	165	*	*	*
Stg5 f+t Sta	ON/OFF	Stage 5 f+t element start	6	0F25	8	168	*	*	*
Stg5 f+t Trp	ON/OFF	Stage 5 f+t element trip	6	0F25	9	169	*	*	*
Stg5 f+df/dt Trp	ON/OFF	Stage 5 f+df/dt element trip	6	0F25	10	170	*	*	*
Stg5 df/dt+t Sta	ON/OFF	Stage 5 df/dt+t element start	6	0F25	11	171	*	*	*
Stg5 df/dt+t Trp	ON/OFF	Stage 5 df/dt+t element trip	6	0F25	12	172	*	*	*
Stg5 f+Df/Dt Sta	ON/OFF	Stage 5 f + DeltaF/DeltaT element start	6	0F25	13	173	*	*	*
Stg5 f+Df/Dt Trp	ON/OFF	Stage 5 f + DeltaF/DeltaT element trip	6	0F25	14	174	*	*	*

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
Stg6 f+t Sta	ON/OFF	Stage 6 f+t element start	6	0F25	17	177	*	*	*
Stg6 f+t Trp	ON/OFF	Stage 6 f+t element trip	6	0F25	18	178	*	*	*
Stg6 f+df/dt Trp	ON/OFF	Stage 6 f+df/dt element trip	6	0F25	19	179	*	*	*
Stg6 df/dt+t Sta	ON/OFF	Stage 6 df/dt+t element start	6	0F25	20	180	*	*	*
Stg6 df/dt+t Trp	ON/OFF	Stage 6 df/dt+t element trip	6	0F25	21	181	*	*	*
Stg6 f+Df/Dt Sta	ON/OFF	Stage 6 f + DeltaF/DeltaT element start	6	0F25	22	182	*	*	*
Stg6 f+Df/Dt Trp	ON/OFF	Stage 6 f + DeltaF/DeltaT element trip	6	0F25	23	183	*	*	*
V < 1 Start	ON/OFF	1st Stage Phase U/V Start 3ph	6	0F25	26	186	*	*	*
V < 1 Start A/AB	ON/OFF	1st Stage Phase U/V Start A/AB	6	0F25	27	187	*	*	*
V < 1 Start B/BC	ON/OFF	1st Stage Phase U/V Start B/BC	6	0F25	28	188	*	*	*
V < 1 Start C/CA	ON/OFF	1st Stage Phase U/V Start C/CA	6	0F25	29	189	*	*	*
V < 2 Start	ON/OFF	2nd Stage Phase U/V Start 3ph	6	0F25	30	190	*	*	*
V < 2 Start A/AB	ON/OFF	2nd Stage Phase U/V Start A/AB	6	0F25	31	191	*	*	*
V < 2 Start B/BC	ON/OFF	2nd Stage Phase U/V Start B/BC	6	0F26	0	192	*	*	*
V < 2 Start C/CA	ON/OFF	2nd Stage Phase U/V Start C/CA	6	0F26	1	193	*	*	*
V < 1 Trip	ON/OFF	1st Stage Phase U/V Trip 3ph	6	0F26	2	194	*	*	*
V < 1 Trip A/AB	ON/OFF	1st Stage Phase U/V Trip A/AB	6	0F26	3	195	*	*	*
V < 1 Trip B/BC	ON/OFF	1st Stage Phase U/V Trip B/BC	6	0F26	4	196	*	*	*
V < 1 Trip C/CA	ON/OFF	1st Stage Phase U/V Trip C/CA	6	0F26	5	197	*	*	*
V < 2 Trip	ON/OFF	2nd Stage Phase U/V Trip 3ph	6	0F26	6	198	*	*	*
V < 2 Trip A/AB	ON/OFF	2nd Stage Phase U/V Trip A/AB	6	0F26	7	199	*	*	*
V < 2 Trip B/BC	ON/OFF	2nd Stage Phase U/V Trip B/BC	6	0F26	8	200	*	*	*
V < 2 Trip C/CA	ON/OFF	2nd Stage Phase U/V Trip C/CA	6	0F26	9	201	*	*	*
V > 1 Start	ON/OFF	1st Stage Phase O/V Start 3ph	6	0F26	10	202	*	*	*
V > 1 Start A/AB	ON/OFF	1st Stage Phase O/V Start A/AB	6	0F26	11	203	*	*	*
V > 1 Start B/BC	ON/OFF	1st Stage Phase O/V Start B/BC	6	0F26	12	204	*	*	*

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
V > 1 Start C/CA	ON/OFF	1st Stage Phase O/V Start C/CA	6	0F26	13	205	*	*	*
V > 2 Start	ON/OFF	2nd Stage Phase O/V Start 3ph	6	0F26	14	206	*	*	*
V > 2 Start A/AB	ON/OFF	2nd Stage Phase O/V Start A/AB	6	0F26	15	207	*	*	*
V > 2 Start B/BC	ON/OFF	2nd Stage Phase O/V Start B/BC	6	0F26	16	208	*	*	*
V > 2 Start C/CA	ON/OFF	2nd Stage Phase O/V Start C/CA	6	0F26	17	209	*	*	*
V > 1 Trip	ON/OFF	1st Stage Phase O/V Trip 3ph	6	0F26	18	210	*	*	*
V > 1 Trip A/AB	ON/OFF	1st Stage Phase O/V Trip A/AB	6	0F26	19	211	*	*	*
V > 1 Trip B/BC	ON/OFF	1st Stage Phase O/V Trip B/BC	6	0F26	20	212	*	*	*
V > 1 Trip C/CA	ON/OFF	1st Stage Phase O/V Trip C/CA	6	0F26	21	213	*	*	*
V > 2 Trip	ON/OFF	2nd Stage Phase O/V Trip 3ph	6	0F26	22	214	*	*	*
V > 2 Trip A/AB	ON/OFF	2nd Stage Phase O/V Trip A/AB	6	0F26	23	215	*	*	*
V > 2 Trip B/BC	ON/OFF	2nd Stage Phase O/V Trip B/BC	6	0F26	24	216	*	*	*
V > 2 Trip C/CA	ON/OFF	2nd Stage Phase O/V Trip C/CA	6	0F26	25	217	*	*	*
Gen Band1 Sta	ON/OFF	Generator Abnormal Band 1 Start	6	0F26	26	218	*	*	*
Gen Band1 Trp	ON/OFF	Generator Abnormal Band 1 Trip	6	0F26	27	219	*	*	*
Gen Band2 Sta	ON/OFF	Generator Abnormal Band 2Start	6	0F26	28	220	*	*	*
Gen Band2 Trp	ON/OFF	Generator Abnormal Band 2 Trip	6	0F26	29	221	*	*	*
Gen Band3 Sta	ON/OFF	Generator Abnormal Band 3 Start	6	0F26	30	222	*	*	*
Gen Band3 Trp	ON/OFF	Generator Abnormal Band 3 Trip	6	0F26	31	223	*	*	*
Gen Band4 Sta	ON/OFF	Generator Abnormal Band 4 Start	6	0F27	0	224	*	*	*
Gen Band4 Trp	ON/OFF	Generator Abnormal Band 4 Trip	6	0F27	1	225	*	*	*
Stg1 Restore Sta	ON/OFF	Stage 1 Load Restoration Start	6	0F27	4	228	*	*	*
Stg1 Restore Ena	ON/OFF	Stage 1 Load Restoration Enable	6	0F27	5	229	*	*	*
Stg2 Restore Sta	ON/OFF	Stage 2 Load Restoration Start	6	0F27	6	230	*	*	*
Stg2 Restore Ena	ON/OFF	Stage 2 Load Restoration Enable	6	0F27	7	231	*	*	*
Stg3 Restore Sta	ON/OFF	Stage 3 Load Restoration Start	6	0F27	8	232	*	*	*

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
Stg3 Restore Ena	ON/OFF	Stage 3 Load Restoration Enable	6	0F27	9	233	*	*	*
Stg4 Restore Sta	ON/OFF	Stage 4 Load Restoration Start	6	0F27	10	234	*	*	*
Stg4 Restore Ena	ON/OFF	Stage 4 Load Restoration Enable	6	0F27	11	235	*	*	*
Stg5 Restore Sta	ON/OFF	Stage 5 Load Restoration Start	6	0F27	12	236	*	*	*
Stg5 Restore Ena	ON/OFF	Stage 5 Load Restoration Enable	6	0F27	13	237	*	*	*
Stg6 Restore Sta	ON/OFF	Stage 6 Load Restoration Start	6	0F27	14	238	*	*	*
Stg6 Restore Ena	ON/OFF	Stage 6 Load Restoration Enable	6	0F27	15	239	*	*	*
Stats Cleared	ON/OFF	Statistics Cleared	6	0F28	1	257	*	*	*
Timers Cleared	ON/OFF	Generator Abnormal Timers Cleared	6	0F28	2	258	*	*	*
Wrong Setting 01	ON/OFF	Stage 1 f+t Fequency set to Nominal	6	0F28	3	259	*	*	*
Wrong Setting 02	ON/OFF	Stage 2 f+t Fequency set to Nominal	6	0F28	4	260	*	*	*
Wrong Setting 03	ON/OFF	Stage 3 f+t Fequency set to Nominal	6	0F28	5	261	*	*	*
Wrong Setting 04	ON/OFF	Stage 4 f+t Fequency set to Nominal	6	0F28	6	262	*	*	*
Wrong Setting 05	ON/OFF	Stage 5 f+t Fequency set to Nominal	6	0F28	7	263	*	*	*
Wrong Setting 06	ON/OFF	Stage 6 f+t Fequency set to Nominal	6	0F28	8	264	*	*	*
Wrong Setting 07	ON/OFF	Stage 1 f+df/dt Frequency set to Nominal	6	0F28	9	265	*	*	*
Wrong Setting 08	ON/OFF	Stage 2 f+df/dt Frequency set to Nominal	6	0F28	10	266	*	*	*
Wrong Setting 09	ON/OFF	Stage 3 f+df/dt Frequency set to Nominal	6	0F28	11	267	*	*	*
Wrong Setting 10	ON/OFF	Stage 4 f+df/dt Frequency set to Nominal	6	0F28	12	268	*	*	*
Wrong Setting 11	ON/OFF	Stage 5 f+df/dt Frequency set to Nominal	6	0F28	13	269	*	*	*
Wrong Setting 12	ON/OFF	Stage 6 f+df/dt Frequency set to Nominal	6	0F28	14	270	*	*	*
Wrong Setting 13	ON/OFF	Stage 1 df/dt setting is 0	6	0F28	15	271	*	*	*
Wrong Setting 14	ON/OFF	Stage 2 df/dt setting is 0	6	0F28	16	272	*	*	*
Wrong Setting 15	ON/OFF	Stage 3 df/dt setting is 0	6	0F28	17	273	*	*	*
Wrong Setting 16	ON/OFF	Stage 4 df/dt setting is 0	6	0F28	18	274	*	*	*
Wrong Setting 17	ON/OFF	Stage 5 df/dt setting is 0	6	0F28	19	275	*	*	*

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
Wrong Setting 18	ON/OFF	Stage 6 df/dt setting is 0	6	0F28	20	276	*	*	*
Wrong Setting 19	ON/OFF	Stage 1 f+Df/Dt Frequency set to Nominal	6	0F28	21	277	*	*	*
Wrong Setting 20	ON/OFF	Stage 2 f+Df/Dt Frequency set to Nominal	6	0F28	22	278	*	*	*
Wrong Setting 21	ON/OFF	Stage 3 f+Df/Dt Frequency set to Nominal	6	0F28	23	279	*	*	*
Wrong Setting 22	ON/OFF	Stage 4 f+Df/Dt Frequency set to Nominal	6	0F28	24	280	*	*	*
Wrong Setting 23	ON/OFF	Stage 5 f+Df/Dt Frequency set to Nominal	6	0F28	25	281	*	*	*
Wrong Setting 24	ON/OFF	Stage 6 f+Df/Dt Frequency set to Nominal	6	0F28	26	282	*	*	*
Wrong Setting 25	ON/OFF	Band 1 Low Frequency greater then high	6	0F28	27	283	*	*	*
Wrong Setting 26	ON/OFF	Band 2 Low Frequency greater then high	6	0F28	28	284	*	*	*
Wrong Setting 27	ON/OFF	Band 3 Low Frequency greater then high	6	0F28	29	285	*	*	*
Wrong Setting 28	ON/OFF	Band 4 Low Frequency greater then high	6	0F28	30	286	*	*	*
Wrong Setting 29	ON/OFF	Wrong Stage 1 Load Restoration Setting	6	0F28	31	287	*	*	*
Wrong Setting 30	ON/OFF	Wrong Stage 2 Load Restoration Setting	6	0F29	0	288	*	*	*
Wrong Setting 31	ON/OFF	Wrong Stage 3 Load Restoration Setting	6	0F29	1	289	*	*	*
Wrong Setting 32	ON/OFF	Wrong Stage 4 Load Restoration Setting	6	0F29	2	290	*	*	*
Wrong Setting 33	ON/OFF	Wrong Stage 5 Load Restoration Setting	6	0F29	3	291	*	*	*
Wrong Setting 34	ON/OFF	Wrong Stage 6 Load Restoration Setting	6	0F29	4	292	*	*	*
Note: The following data were copied from the feeder spreadsheet at Manuals\50301\append\append_a.xls									
		General Events:			Unsigned Integer (32 bits)				
Alarms Cleared		Relay Alarms Cleared	7	FFFF	0		*	*	*
Events Cleared		Relay Event Records Cleared	7	0B01	1		*	*	*
Faults Cleared		Relay Fault Records Cleared	7	0B02	2		*	*	*
Maint Cleared		Relay Maintenance Records Cleared	7	0B03	3		*	*	*
PW Unlocked UI		Password Unlocked via User Interface	7	0002	4		*	*	*
PW Invalid UI		Invalid Password entered on User Interface	7	0002	5		*	*	*

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
PW1 Modified UI		Password Level 1 Modified on User Interface	7	0002	6		*	*	*
PW2 Modified UI		Password Level 2 Modified on User Interface	7	0002	7		*	*	*
PW Expired UI		Password unlock expired User Interface	7	0002	8		*	*	*
PW Unlocked F		Password Unlocked via Front Port	7	0002	9		*	*	*
PW Invalid F		Invalid Password entered on Front Port	7	0002	10		*	*	*
PW1 Modified F		Password Level 1 Modified on Front Port	7	0002	11		*	*	*
PW2 Modified F		Password Level 2 Modified on Front Port	7	0002	12		*	*	*
PW Expired F		Password unlock expired Front Port	7	0002	13		*	*	*
PW Unlocked R		Password Unlocked via Rear Port	7	0002	14		*	*	*
PW Invalid R		Invalid Password entered on Rear Port	7	0002	15		*	*	*
PW1 Modified R		Password Level 1 Modified on Rear Port	7	0002	16		*	*	*
PW2 Modified R		Password Level 2 Modified on Rear Port	7	0002	17		*	*	*
PW Expired R		Password unlock expired Rear Port	7	0002	18		*	*	*
IRIG-B Active		IRIG-B Timesync Active (Valid Signal)	7	0805	19		*	*	*
IRIG-B Inactive		IRIG-B Timesync Inactive (No Signal)	7	0805	20		*	*	*
Time Synch		Relay Clock Adjusted	7	0801	21		*	*	*
C&S Changed		Control and Support Settings Changed	7	FFFF	22		*	*	*
Dist Changed		Disturbance Recorder Settings Changed	7	0904	23		*	*	*
Group 1 Changed		Change to Protection Setting Group 1	7	0904	24		*	*	*
Group 2 Changed		Change to Protection Setting Group 2	7	0904	25		*	*	*
Group 3 Changed		Change to Protection Setting Group 3	7	0904	26		*	*	*
Group 4 Changed		Change to Protection Setting Group 4	7	0904	27		*	*	*
Act Grp Changed		Active Group Selection Changed	7	0903	28		*	*	*
Indication Reset		Relay Indications Reset	7	01FF	29		*	*	*

Event Text	Additional Text	Event Description	Modbus Event Type G13	Courier Cell Ref	Value	DDB No.	P941	P942	P943
Power On		Relay Powered Up	7	FFFF	30		*	*	*
Text		**Fault Recorder**		**Cell Ref**	**Value**	**Extraction Column**		**Record No.**	
Fault Recorded		Fault Recorded	8	0100	0	B000		16bit UINT	
Text		**Self Monitoring**		**Cell Ref**	**Value**	**Extraction Column**		**Record No.**	
Maint Recorded		Maintenance Records	9	FFFF	0	B100		16bit UINT	
Maintenance Record Text		**Description**			**Continuous**				
Fast W'Dog Error		Fast Watchdog Error					*	*	*
Battery Failure		Battery Failure			*		*	*	*
BBRAM Failure		Battery Back RAM Failure			*		*	*	*
Field Volt Fail		Field Voltage Failure			*		*	*	*
Bus Reset Error		Bus Error					*	*	*
Slow W'Dog Error		Slow Watchdog Error					*	*	*
SRAM Failure Bus		SRAM Bus Failure			*		*	*	*
SRAM Failure Blk		SRAM Block Failure			*		*	*	*
FLASH Failure		Flash checksum Error			*		*	*	*
Code Verify Fail		Software Code Verification Failure			*		*	*	*
EEPROM Failure		EEPROM Failure			*		*	*	*
Software Failure		Software Error			*		*	*	*
Hard Verify Fail		Hardware Verification Error					*	*	*
Non Standard		General Error			*		*	*	*

DNP 3.0
DEVICE PROFILE DOCUMENT

Vendor Name: **AREVA T&D**
Device Name: **P940 FREQUENCY PROTECTION Relay**, Model No's: **P941xxxx4xx050A** **P942xxxx4xx050A** **P943xxxx4xx050A**

Highest DNP Level Supported: For Requests: Level 2 For Responses: Level 2	Device Function: Master ✔ Slave

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the DNP V3.0 Implementation table):

For static (non-change-event) object requests, request qualifier codes 00 and 01 (start-stop), 07 and 08 (limited quantity), and 17 and 28 (index) are supported in addition to request qualifier code 06 (no range).

Static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01.

Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28.

For change-event object requests, qualifiers 17 or 28 are always responded.
16-bit and 32-bit Analog Change Events with Time may be requested.
The read function code for Object 50 (Time and Date), variation 1, is supported.

Maximum Data Link Frame Size (octets): Transmitted: **292** Received: **292**	Maximum Application Fragment Size (octets): Transmitted: **2048** Received: **249**
Maximum Data Link Re-tries: None ✔ **Fixed at 2** Configurable	Maximum Application Layer Re-tries: ✔ **None** Configurable

Requires Data Link Layer Confirmation:
- ✔ **Never**
- Always
- Sometimes
- Configurable

Requires Application Layer Confirmation:
- Never
- Always
- ✔ **When reporting Event Data**
- ✔ **When sending multi-fragment responses**
- Sometimes
- Configurable

Timeouts while waiting for:

Data Link Confirm:	None	✔ **Fixed at 100ms**	Variable	Configurable
Complete Appl. Fragment:	✔ **None**	Fixed at	Variable	Configurable
Application Confirm:	None	✔ **Fixed at 1s**	Variable	Configurable
Complete Appl. Response:	✔ **None**	Fixed at	Variable	Configurable

Others:

Inter-character Delay:	**4 character times at selected baud rate.**
Select/Operate Arm Timeout:	**default 10s.**
Need Time Interval:	**configurable, 0 or 30min.**

DNP 3.0
DEVICE PROFILE DOCUMENT

Sends/Executes Control Operations:

WRITE Binary Outputs	✔ **Never**	Always	Sometimes	Configurable
SELECT/OPERATE	Never	✔ **Always**	Sometimes	Configurable
DIRECT OPERATE	Never	✔ **Always**	Sometimes	Configurable
DIRECT OPERATE – NO ACK	Never	✔ **Always**	Sometimes	Configurable
Count > 1	✔ **Never**	Always	Sometimes	Configurable
Pulse On	Never	✔ **Always**	Sometimes	Configurable
Pulse Off	✔ **Never**	Always	Sometimes	Configurable
Latch On	Never	✔ **Always**	Sometimes	Configurable
Latch Off	Never	✔ **Always**	Sometimes	Configurable
Queue	✔ **Never**	Never	Sometimes	Configurable
Clear Queue	✔ **Never**	Never	Sometimes	Configurable

Reports Binary Input Change Events when no specific variation requested:

- Never
- ✔ **Only time-tagged, var 2**
- Only non-time-tagged
- Configurable

Reports time-tagged Binary Input Change Events when no specific variation requested:

- Never
- ✔ **Binary Input Change With Time**
- Binary Input Change With Relative Time
- Configurable

Sends Unsolicited Responses:

- ✔ **Never**
- Configurable
- Only certain Objects
- Sometimes

ENABLE/DISABLE UNSOLICITED
Function codes supported

Sends Static Data in Unsolicited Responses:

- ✔ **Never**
- When Device Restarts
- When Status Flags Change

No other options are permitted.

Default Counter Object/Variation:

- No Counters Reported
- Configurable
- ✔ **Default Object: 20**
  Default Variation: 5
- ✔ **Point-by-point list attached**

Counters Roll Over at:

- No Counters Reported
- Configurable
- 16 Bits
- ✔ **32 Bits**
- Other Value:____
- ✔ **Point-by-point list attached**

Sends Multi-Fragment Responses:

- ✔ **Yes**
- No

Object			REQUEST		RESPONSE	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
1	0	Binary Input - Any Variation	1	00,01,06,07, 08,17,28		
1	1	Binary Input	1	00,01,06,07, 08,17,28	129	00,01,17,28
2	0	Binary Input Change - Any Variation	1	06,07,08	129	
2	1	Binary Input Change without Time	1	06,07,08	129	17,28
2	2	Binary Input Change with Time	1	06,07,08	129	17,28
10	0	Binary Output - All Variations	1	00,01,06,07, 08,17,28		
10	2	Binary Output Status	1	00,01,06,07, 08,17,28	129	00,01,17,28
12	1	Control Relay Output Block	3,4,5,6	00,01,07,08, 17,28	129	echo
20	0	Binary Counter	1,7,8,9,10	00,01,06,07, 08,17,28		
20	1	32-Bit Binary Counter with Flag	1,7,8,9,10	00,01,06,07, 08,17,28	129	00,01,17,28
20	2	16-Bit Binary Counter with Flag	1,7,8,9,10	00,01,06,07, 08,17,28	129	00,01,17,28
20	5	32-Bit Binary Counter without Flag	1,7,8,9,10	00,01,06,07, 08,17,28	129	00,01,17,28
20	6	16 Bit Binary Counter Without Flag	1,7,8,9,10	00,01,06,07, 08,17,28	129	00,01,17,28
21	0	Frozen Counter	1	00,01,06,07, 08,17,28		
21	1	32-Bit Frozen Counter with Flag	1	00,01,06,07, 08,17,28	129	00,01,17,28
21	2	16-Bit Frozen Counter with Flag	1	00,01,06,07, 08,17,28	129	00,01,17,28
21	9	32-Bit Frozen Counter without Flag	1	00,01,06,07, 08,17,28	129	00,01,17,28
21	10	16-Bit Frozen Counter without Flag	1	00,01,06,07, 08,17,28	129	00,01,17,28
30	0	Analog Input - All Variations	1	00,01,06,07, 08,17,28		
30	1	32 Bit Analog Input	1	00,01,06,07, 08,17,28	129	00,01,17,28
30	2	16-Bit Analog Input	1	00,01,06,07, 08,17,28	129	00,01,17,28
30	3	32-Bit Analog Input without Flag	1	00,01,06,07, 08,17,28	129	00,01,17,28
30	4	16-Bit Analog Input without Flag	1	00,01,06,07, 08,17,28	129	00,01,17,28
32	0	Analog Change Event - All Variations	1	06,07,08		
32	1	32-Bit Analog Change Event without Time	1	06,07,08	129	17,28
32	2	16-Bit Analog Change Event without Time	1	06,07,08	129	17,28

Object			REQUEST		RESPONSE	
Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
32	3	32-Bit Analog Change Event with Time	1	06,07,08	129	17,28
32	4	16-Bit Analog Change Event with Time	1	06,07,08	129	17,28
50	0	Time and Date - All Variations	1	00,01,06,07, 08,17,28		00,01,17,28
50	1	Time and Date	1,2	00,01,06,07, 08,17,28	129	00,01,17,28
52	2	Time Delay Fine			129	7
60	0	Class 0,1,2,3 Data	1	06		
60	1	Class 0 Data	1	06	129	00,01
60	2	Class 1 Data	1	06,07,08	129	17,28
60	3	Class 2 Data	1	06,07,08	129	17,28
60	4	Class 3 Data	1	06,07,08	129	17,28
80	1	Internal Indications	2	00 (index = 7)		
		No Object (function code only)	13			
		No Object (function code only)	14			
		No Object (function code only)	23			

Binary Input Points
Static (Steady State) Object Number: **1**
Change Event Object Number: **2**
Request Function Code supported: **1(read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Event Variation reported when variation 0 requested: **2 (Binary Input Change with Time)**

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	DDB Number	Change Event Assigned Class (1,2,3 or none)	Initial Value
			Output Relay Status			
0	0	0	Output Relay 1	0	2	FAUX
1	1	1	Output Relay 2	1	2	FAUX
2	2	2	Output Relay 3	2	2	FAUX
3	3	3	Output Relay 4	3	2	FAUX
4	4	4	Output Relay 5	4	2	FAUX
5	5	5	Output Relay 6	5	2	FAUX
6	6	6	Output Relay 7	6	2	FAUX
	7	7	Output Relay 8	7	2	FAUX
	8	8	Output Relay 9	8	2	FAUX
	9	9	Output Relay 10	9	2	FAUX
	10	10	Output Relay 11	10	2	FAUX
	11	11	Output Relay 12	11	2	FAUX
	12	12	Output Relay 13	12	2	FAUX
	13	13	Output Relay 14	13	2	FAUX
			Opto Isolator Status			
7	14	14	Opto Isolator 1	32	2	FAUX
8	15	15	Opto Isolator 2	33	2	FAUX
9	16	16	Opto Isolator 3	34	2	FAUX
10	17	17	Opto Isolator 4	35	2	FAUX
11	18	18	Opto Isolator 5	36	2	FAUX
12	19	19	Opto Isolator 6	37	2	FAUX
13	20	20	Opto Isolator 7	38	2	FAUX
14	21	21	Opto Isolator 8	39	2	FAUX
		22	Opto Isolator 9	40	2	FAUX

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	DDB Number	Change Event Assigned Class (1,2,3 or none)	Initial Value
		23	Opto Isolator 10	41	2	FAUX
		24	Opto Isolator 11	42	2	FAUX
		25	Opto Isolator 12	43	2	FAUX
		26	Opto Isolator 13	44	2	FAUX
		27	Opto Isolator 14	45	2	FAUX
		28	Opto Isolator 15	46	2	FAUX
		29	Opto Isolator 16	47	2	FAUX
			Alarm Indications			
15	22	30	Field Voltage Fail	249	2	FAUX
16	23	31	Setting Group Via Opto Invalid	293	2	FAUX
17	24	32	Protection Disabled	294	2	FAUX
18	25	33	Frequency High	295	2	FAUX
19	26	34	Frequency Low	296	2	FAUX
20	27	35	Frequency Not Found	297	2	FAUX
21	28	36	Wrong Setting	298	2	FAUX
22	29	37	Statistics Corrupt	299	2	FAUX
23	30	38	Generator Abnormal Timers Corrupt/Bad	300	2	FAUX
24	31	39	Under Voltage Block	301	2	FAUX
25	32	40	Trip LED Enabled	302	2	FAUX
26	33	41	User Definable Alarm 1 (Self Reset)	303	2	FAUX
27	34	42	User Definable Alarm 2 (Self Reset)	304	2	FAUX
28	35	43	User Definable Alarm 3 (Self Reset)	305	2	FAUX
29	36	44	User Definable Alarm 4 (Self Reset)	306	2	FAUX
30	37	45	User Definable Alarm 5 (Self Reset)	307	2	FAUX
31	38	46	User Definable Alarm 6 (Self Reset)	308	2	FAUX
32	39	47	User Definable Alarm 7 (Self Reset)	309	2	FAUX
33	40	48	User Definable Alarm 8 (Self Reset)	310	2	FAUX
34	41	49	User Definable Alarm 9 (Self Reset)	311	2	FAUX

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	DDB Number	Change Event Assigned Class (1,2,3 or none)	Initial Value
35	42	50	User Definable Alarm 10 (Self Reset)	312	2	FAUX
36	43	51	User Definable Alarm 11 (Latched)	313	2	FAUX
37	44	52	User Definable Alarm 12 (Latched)	314	2	FAUX
38	45	53	User Definable Alarm 13 (Latched)	315	2	FAUX
39	46	54	User Definable Alarm 14 (Latched)	316	2	FAUX
40	47	55	User Definable Alarm 15 (Latched)	317	2	FAUX
41	48	56	User Definable Alarm 16 (Latched)	318	2	FAUX
42	49	57	User Definable Alarm 17 (Latched)	319	2	FAUX
43	50	58	User Definable Alarm 18 (Latched)	320	2	FAUX
44	51	59	User Definable Alarm 19 (Latched)	321	2	FAUX
45	52	60	User Definable Alarm 20 (Latched)	322	2	FAUX
			Miscellaneous Indications			
46	53	61	Battery Status	N/A	2	FAUX
47	54	62	IRIG-B Status	N/A	2	FAUX
			Protection Events (Digital Databus Signals)			
48	55	63	Stage 1 f + t Start	132	2	FAUX
49	56	64	Stage 1 f + t Trip	133	2	FAUX
50	57	65	Stage 1 f + df/dt Trip	134	2	FAUX
51	58	66	Stage 1 df/dt + t Start	135	2	FAUX
52	59	67	Stage 1 df/dt + t Trip	136	2	FAUX
53	60	68	Stage 1 f + Df/Dt Start	137	2	FAUX
54	61	69	Stage 1 f + Df/Dt Trip	138	2	FAUX
55	62	70	Stage 1 Frequency Start	139	2	FAUX
56	63	71	Stage 1 Frequency Trip	140	2	FAUX
57	64	72	Stage 2 f + t Start	141	2	FAUX
58	65	73	Stage 2 f + t Trip	142	2	FAUX
59	66	74	Stage 2 f + df/dt Trip	143	2	FAUX
60	67	75	Stage 2 df/dt + t Start	144	2	FAUX

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	DDB Number	Change Event Assigned Class (1,2,3 or none)	Initial Value
61	68	76	Stage 2 df/dt + t Trip	145	2	FAUX
62	69	77	Stage 2 f + Df/Dt Start	146	2	FAUX
63	70	78	Stage 2 f + Df/Dt Trip	147	2	FAUX
64	71	79	Stage 2 Frequency Start	148	2	FAUX
65	72	80	Stage 2 Frequency Trip	149	2	FAUX
66	73	81	Stage 3 f + t Start	150	2	FAUX
67	74	82	Stage 3 f + t Trip	151	2	FAUX
68	75	83	Stage 3 f + df/dt Trip	152	2	FAUX
69	76	84	Stage 3 df/dt + t Start	153	2	FAUX
70	77	85	Stage 3 df/dt + t Trip	154	2	FAUX
71	78	86	Stage 3 f + Df/Dt Start	155	2	FAUX
72	79	87	Stage 3 f + Df/Dt Trip	156	2	FAUX
73	80	88	Stage 3 Frequency Start	157	2	FAUX
74	81	89	Stage 3 Frequency Trip	158	2	FAUX
75	82	90	Stage 4 f + t Start	159	2	FAUX
76	83	91	Stage 4 f + t Trip	160	2	FAUX
77	84	92	Stage 4 f + df/dt Trip	161	2	FAUX
78	85	93	Stage 4 df/dt + t Start	162	2	FAUX
79	86	94	Stage 4 df/dt + t Trip	163	2	FAUX
80	87	95	Stage 4 f + Df/Dt Start	164	2	FAUX
81	88	96	Stage 4 f + Df/Dt Trip	165	2	FAUX
82	89	97	Stage 4 Frequency Start	166	2	FAUX
83	90	98	Stage 4 Frequency Trip	167	2	FAUX
84	91	99	Stage 5 f + t Start	168	2	FAUX
85	92	100	Stage 5 f + t Trip	169	2	FAUX
86	93	101	Stage 5 f + df/dt Trip	170	2	FAUX
87	94	102	Stage 5 df/dt + t Start	171	2	FAUX
88	95	103	Stage 5 df/dt + t Trip	172	2	FAUX

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	DDB Number	Change Event Assigned Class (1,2,3 or none)	Initial Value
89	96	104	Stage 5 f + Df/Dt Start	173	2	FAUX
90	97	105	Stage 5 f + Df/Dt Trip	174	2	FAUX
91	98	106	Stage 5 Frequency Start	175	2	FAUX
92	99	107	Stage 5 Frequency Trip	176	2	FAUX
93	100	108	Stage 6 f + t Start	177	2	FAUX
94	101	109	Stage 6 f + t Trip	178	2	FAUX
95	102	110	Stage 6 f + df/dt Trip	179	2	FAUX
96	103	111	Stage 6 df/dt + t Start	180	2	FAUX
97	104	112	Stage 6 df/dt + t Trip	181	2	FAUX
98	105	113	Stage 6 f + Df/Dt Start	182	2	FAUX
99	106	114	Stage 6 f + Df/Dt Trip	183	2	FAUX
100	107	115	Stage 6 Frequency Start	184	2	FAUX
101	108	116	Stage 6 Frequency Trip	185	2	FAUX
102	109	117	Stage 1 Under Voltage 3 Phase Start	186	2	FAUX
103	110	118	Stage 1 Under Voltage Phase A Start	187	2	FAUX
104	111	119	Stage 1 Under Voltage Phase B Start	188	2	FAUX
105	112	120	Stage 1 Under Voltage Phase C Start	189	2	FAUX
106	113	121	Stage 2 Under Voltage 3 Phase Start	190	2	FAUX
107	114	122	Stage 2 Under Voltage Phase A Start	191	2	FAUX
108	115	123	Stage 2 Under Voltage Phase B Start	192	2	FAUX
109	116	124	Stage 2 Under Voltage Phase C Start	193	2	FAUX
110	117	125	Stage 1 Under Voltage 3 Phase Trip	194	2	FAUX
111	118	126	Stage 1 Under Voltage Phase A Trip	195	2	FAUX
112	119	127	Stage 1 Under Voltage Phase B Trip	196	2	FAUX
113	120	128	Stage 1 Under Voltage Phase C Trip	197	2	FAUX
114	121	129	Stage 2 Under Voltage 3 Phase Trip	198	2	FAUX
115	122	130	Stage 2 Under Voltage Phase A Trip	199	2	FAUX
116	123	131	Stage 2 Under Voltage Phase B Trip	200	2	FAUX

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	DDB Number	Change Event Assigned Class (1,2,3 or none)	Initial Value
117	124	132	Stage 2 Under Voltage Phase C Trip	201	2	FAUX
118	125	133	Stage 1 Over Voltage 3 Phase Start	202	2	FAUX
119	126	134	Stage 1 Over Voltage Phase A Start	203	2	FAUX
120	127	135	Stage 1 Over Voltage Phase B Start	204	2	FAUX
121	128	136	Stage 1 Over Voltage Phase C Start	205	2	FAUX
122	129	137	Stage 2 Over Voltage 3 Phase Start	206	2	FAUX
123	130	138	Stage 2 Over Voltage Phase A Start	207	2	FAUX
124	131	139	Stage 2 Over Voltage Phase B Start	208	2	FAUX
125	132	140	Stage 2 Over Voltage Phase C Start	209	2	FAUX
126	133	141	Stage 1 Over Voltage 3 Phase Trip	210	2	FAUX
127	134	142	Stage 1 Over Voltage Phase A Trip	211	2	FAUX
128	135	143	Stage 1 Over Voltage Phase B Trip	212	2	FAUX
129	136	144	Stage 1 Over Voltage Phase C Trip	213	2	FAUX
130	137	145	Stage 2 Over Voltage 3 Phase Trip	214	2	FAUX
131	138	146	Stage 2 Over Voltage Phase A Trip	215	2	FAUX
132	139	147	Stage 2 Over Voltage Phase B Trip	216	2	FAUX
133	140	148	Stage 2 Over Voltage Phase C Trip	217	2	FAUX
134	141	149	Generator Abnormal Band 1 Start	218	2	FAUX
135	142	150	Generator Abnormal Band 1 Trip	219	2	FAUX
136	143	151	Generator Abnormal Band 2 Start	220	2	FAUX
137	144	152	Generator Abnormal Band 2 Trip	221	2	FAUX
138	145	153	Generator Abnormal Band 3 Start	222	2	FAUX
139	146	154	Generator Abnormal Band 3 Trip	223	2	FAUX
140	147	155	Generator Abnormal Band 4 Start	224	2	FAUX
141	148	156	Generator Abnormal Band 4 Trip	225	2	FAUX
142	149	157	Generator Abnormal Start	226	2	FAUX
143	150	158	Generator Abnormal Trip	227	2	FAUX
144	151	159	Stage 1 Restoration Start	228	2	FAUX

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	DDB Number	Change Event Assigned Class (1,2,3 or none)	Initial Value
145	152	160	Stage 1 Restoration Complete/Enable	229	2	FAUX
146	153	161	Stage 2 Restoration Start	230	2	FAUX
147	154	162	Stage 2 Restoration Complete/Enable	231	2	FAUX
148	155	163	Stage 3 Restoration Start	232	2	FAUX
149	156	164	Stage 3 Restoration Complete/Enable	233	2	FAUX
150	157	165	Stage 4 Restoration Start	234	2	FAUX
151	158	166	Stage 4 Restoration Complete/Enable	235	2	FAUX
152	159	167	Stage 5 Restoration Start	236	2	FAUX
153	160	168	Stage 5 Restoration Complete/Enable	237	2	FAUX
154	161	169	Stage 6 Restoration Start	238	2	FAUX
155	162	170	Stage 6 Restoration Complete/Enable	239	2	FAUX
156	163	171	Any Start	240	2	FAUX
157	164	172	Any f + t Start	241	2	FAUX
158	165	173	Any df/dt + t Start	242	2	FAUX
159	166	174	Any f + Df/Dt Start	243	2	FAUX
160	167	175	Any Trip	244	2	FAUX
161	168	176	Any f + t Trip	245	2	FAUX
162	169	177	Any f + df/dt Trip	246	2	FAUX
163	170	178	Any df/dt + t Trip	247	2	FAUX
164	171	179	Any f + Df/Dt Trip	248	2	FAUX

Binary Output Status Points
Object Number: **10**
Request Function Code supported: **1(read)**
Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**
Request Function Code supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, noack)**

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	Supported Control Relay Output Block Fields
			Activate Setting Groups	
0	0	0	Activate Setting Group 1	Note 1
1	1	1	Activate Setting Group 2	Note 1
2	2	2	Activate Setting Group 3	Note 1
3	3	3	Activate Setting Group 4	Note 1
			Controls	
4	4	4	Reset Indications	Note 1
5	5	5	Reset Statistics	Note 1
6	6	6	Reset Generator Abnormal Timers	Note 1
7	7	7	Clear Event Log	Note 1
8	8	8	Clear Fault Log	Note 1
9	9	9	Clear Maintenance Log	Note 1
10	10	10	Test LEDs	Note 1

Note 1 - LATCH_ON and PULSE_ON operations are supported, although both have the same effect for these data points; the operation is carried out once. The queue, clear, trip/close, on time and off time fields are ignored. A read of these points through object 10 will always return zero.

Binary Counter Points
Static (Steady-State) Object Number: **20**
Request Function Code supported: **1(read), 7(freeze), 8(freeze noack)**
9(freeze and clear), 10(freeze and clear, noack)
Static Variation reported when variation 0 requested: 5 **(32-Bit Binary Counter without Flag)**
Change Event Variation reported when variation 0 requested: none-not supported
Frozen Counter Points
Static (Steady State) Object Number: **21**
Request Function Code supported: **1 (read)**
Static Variation reported when variation 0 requested: 9 **(32-Bit Binary Counter without Flag)**
Change Event Variation reported when variation 0 requested: none-not supported

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	Data Type
0	0	0	Stage 1 f + t Starts	D9
1	1	1	Stage 1 f + t Trips	D9
2	2	2	Stage 1 f + df/dt Trips	D9
3	3	3	Stage 1 df/dt + t Starts	D9
4	4	4	Stage 1 df/dt + t Trips	D9
5	5	5	Stage 1 f + Df/Dt Starts	D9
6	6	6	Stage 1 f + Df/Dt Trips	D9
7	7	7	Stage 2 f + t Starts	D9
8	8	8	Stage 2 f + t Trips	D9
9	9	9	Stage 2 f + df/dt Trips	D9
10	10	10	Stage 2 df/dt + t Starts	D9
11	11	11	Stage 2 df/dt + t Trips	D9
12	12	12	Stage 2 f + Df/Dt Starts	D9
13	13	13	Stage 2 f + Df/Dt Trips	D9
14	14	14	Stage 3 f + t Starts	D9
15	15	15	Stage 3 f + t Trips	D9
16	16	16	Stage 3 f + df/dt Trips	D9
17	17	17	Stage 3 df/dt + t Starts	D9
18	18	18	Stage 3 df/dt + t Trips	D9
19	19	19	Stage 3 f + Df/Dt Starts	D9
20	20	20	Stage 3 f + Df/Dt Trips	D9
21	21	21	Stage 4 f + t Starts	D9
22	22	22	Stage 4 f + t Trips	D9
23	23	23	Stage 4 f + df/dt Trips	D9

P941 Point Index	P942 Point Index	P943 Point Index	Name/Description	Data Type
24	24	24	Stage 4 df/dt + t Starts	D9
25	25	25	Stage 4 df/dt + t Trips	D9
26	26	26	Stage 4 f + Df/Dt Starts	D9
27	27	27	Stage 4 f + Df/Dt Trips	D9
28	28	28	Stage 5 f + t Starts	D9
29	29	29	Stage 5 f + t Trips	D9
30	30	30	Stage 5 f + df/dt Trips	D9
31	31	31	Stage 5 df/dt + t Starts	D9
32	32	32	Stage 5 df/dt + t Trips	D9
33	33	33	Stage 5 f + Df/Dt Starts	D9
34	34	34	Stage 5 f + Df/Dt Trips	D9
35	35	35	Stage 6 f + t Starts	D9
36	36	36	Stage 6 f + t Trips	D9
37	37	37	Stage 6 f + df/dt Trips	D9
38	38	38	Stage 6 df/dt + t Starts	D9
39	39	39	Stage 6 df/dt + t Trips	D9
40	40	40	Stage 6 f + Df/Dt Starts	D9
41	41	41	Stage 6 f + Df/Dt Trips	D9

Note 1 - Freeze and clear operations on individual counters will cause the revision date for the stage containing the counter to be reset to the current date and time..

Analog Inputs
Static (Steady State) Object Number: 30
Change Event Object Number: 32
Request Function Codes supported: 1 (read)
Static Variation reported when variation 0 requested: 2 (16-Bit Analog Input)
Change Event Variation reported when variation 0 requested: 2 (Analog Change Event without Time)

P141 Point Index	P142 Point Index	P143 Point Index	Name/Description	Data Type	Valid Range	Change Event Deadband	Changed Event Assigned Class	Initial Value
0	0	0	Active Group	D9	1 … 4	Note 1	3	1
			Measurements 1					
1	1	1	VAB Magnitude	D3	0.00…220.00	Note 1	3	0
2	2	2	VAB Phase Angle	D4	-180.00…+180.00	Note 1	3	0
3	3	3	VBC Magnitude	D3	0.00…220.00	Note 1	3	0
4	4	4	VBC Phase Angle	D4	-180.00…+180.00	Note 1	3	0
5	5	5	VCA Magnitude	D3	0.00…220.00	Note 1	3	0
6	6	6	VCA Phase Angle	D4	-180.00…+180.00	Note 1	3	0
7	7	7	VAN Magnitude	D3	0.00…220.00	Note 1	3	0
8	8	8	VAN Phase Angle	D4	-180.00…+180.00	Note 1	3	0
9	9	9	VBN Magnitude	D3	0.00…220.00	Note 1	3	0
10	10	10	VBN Phase Angle	D4	-180.00…+180.00	Note 1	3	0
11	11	11	VCN Magnitude	D3	0.00…220.00	Note 1	3	0
12	12	12	VCN Phase Angle	D4	-180.00…+180.00	Note 1	3	0
13	13	13	V1 Magnitude	D3	0.00…220.00	Note 1	3	0
14	14	14	V2 Magnitude	D3	0.00…220.00	Note 1	3	0
15	15	15	V0 Magnitude	D3	0.00…220.00	Note 1	3	0
16	16	16	VAN RMS	D3	0.00…220.00	Note 1	3	0
17	17	17	VBN RMS	D2	0.00…220.00	Note 1	3	0
18	18	18	VCN RMS	D3	0.00…220.00	Note 1	3	0
19	19	19	Frequency	D5	40.00…70.00	Note 1	3	0
22	20	20	Band1 Generator Abnormal Timer	D13	0.00…240.00	Note 1	3	0
23	21	21	Band2 Generator Abnormal Timer	D13	0.00…240.00	Note 1	3	0
24	22	22	Band3 Generator Abnormal Timer	D13	0.00…240.00	Note 1	3	0

P141 Point Index	P142 Point Index	P143 Point Index	Name/Description	Data Type	Valid Range	Change Event Deadband	Changed Event Assigned Class	Initial Value
25	23	23	Band4 Generator Abnormal Timer	D13	0.00…240.00	Note 1	3	0

Data Types

Notes:

1 Type D6 can represent Watts, VArs or VA; the exact unit applied depends on the description of the item.

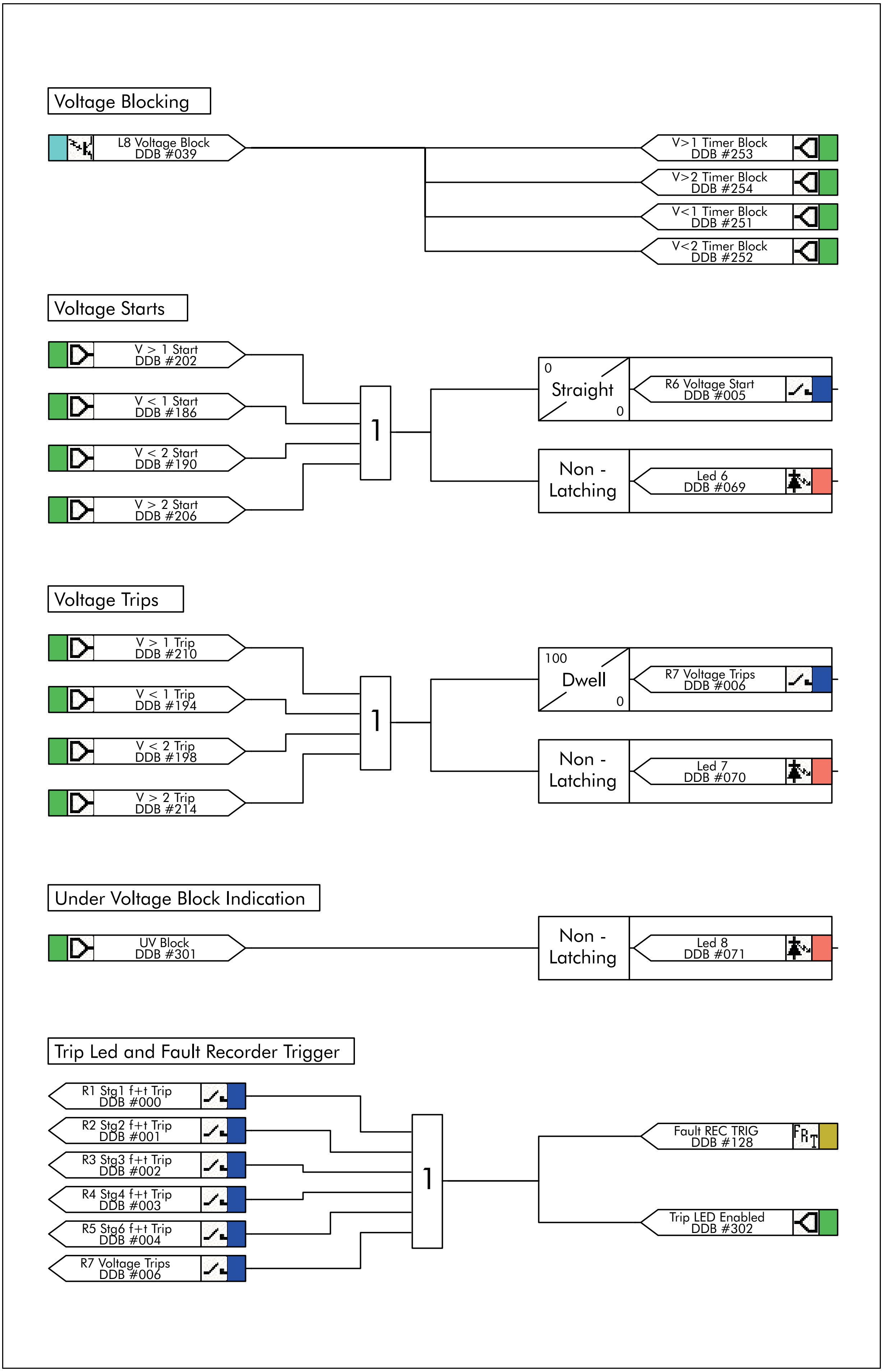
2 The default change event deadband is used unless specified otherwise in the point list.

3 The scaling value represents the multiplier required at the master station.

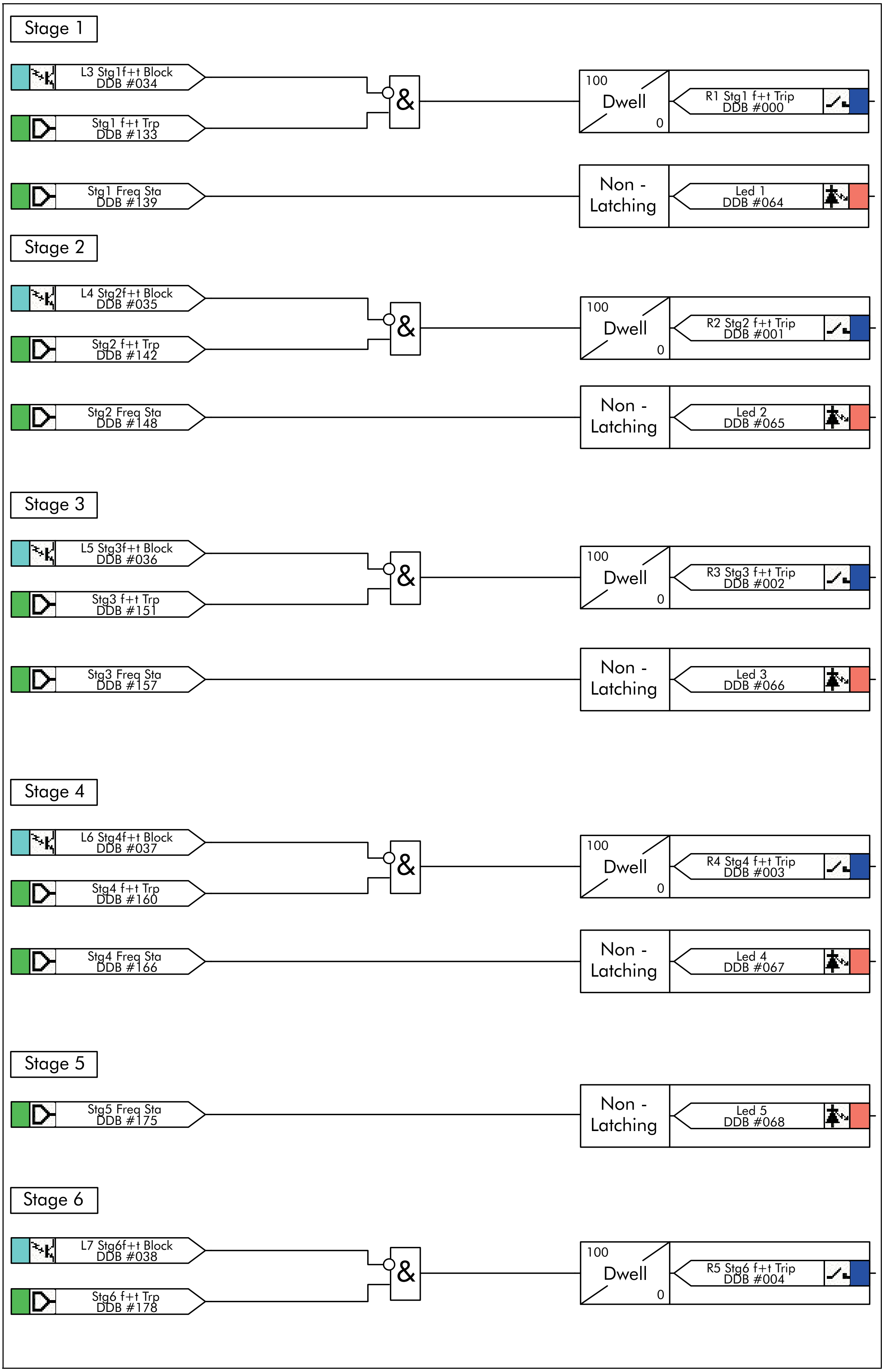
4 In and Vn represent the rated current and rated voltage respectively.

Data Type	Name/Description	Scaling	DEFAULT Change Event Deadband	Change Event Deadband MIN	Change Event Deadband MAX	Change Event Deadband STEP	Units
D1	Phase, RMS, & sequence currents	x In / 500	0.1 In	0.05 In	64 In	0.01 In	A
D2	Sensitive neutral currents	x In / 10,000	0.01 In	0.01 In	2 In	0.001 In	A
D3	Voltages	x Vn /(110 x 100)	5 Vn / 110	0.1 Vn / 110	220 Vn / 110	0.1 Vn / 110	V
D4	Angles	x 0.01	1	0,1	180	0,1	°
D5	Frequency	x 0.01	0,5	0,1	70	0,1	Hz
D6	Power	x 0.1In .Vn / 110	In .Vn / 110	0.1In .Vn / 110	3200 In .Vn / 110	0.1In .Vn / 110	W/Var/VA
D7	Percentage	x 0.01	10	0,1	320	0,1	%
D8	Power Factor	x 0.001	0.10	0,01	1	0,01	[None]
D9	Setting Group	x 1	1	1	4	1	[None]
D10	Energy	x In .Vn / 110	n/a	In .Vn / 110	32000 In .Vn / 110	In .Vn / 110	Whr/Varhr/VAhr
D11	Admittance (I Earth Fault)	x (In / 1000).(110 / Vn)	(0.1 In).(110 / Vn)	(0.01 In).(110 / Vn)	32 In .(110 / Vn)	(0.01 In).(110 / Vn)	S
D12	Admittance (I SEF)	x (In / 10000).(110 / Vn)	(0.01 In).(110 / Vn)	(0.001 In).(110 / Vn)	2 In .(110 / Vn)	(0.001 In).(110 / Vn)	S
D13	Time (minutes)	x 0.01	5	1	30	0,5	Minutes
D14	Temperature	x 0.1	1	0,1	300	0,1	C

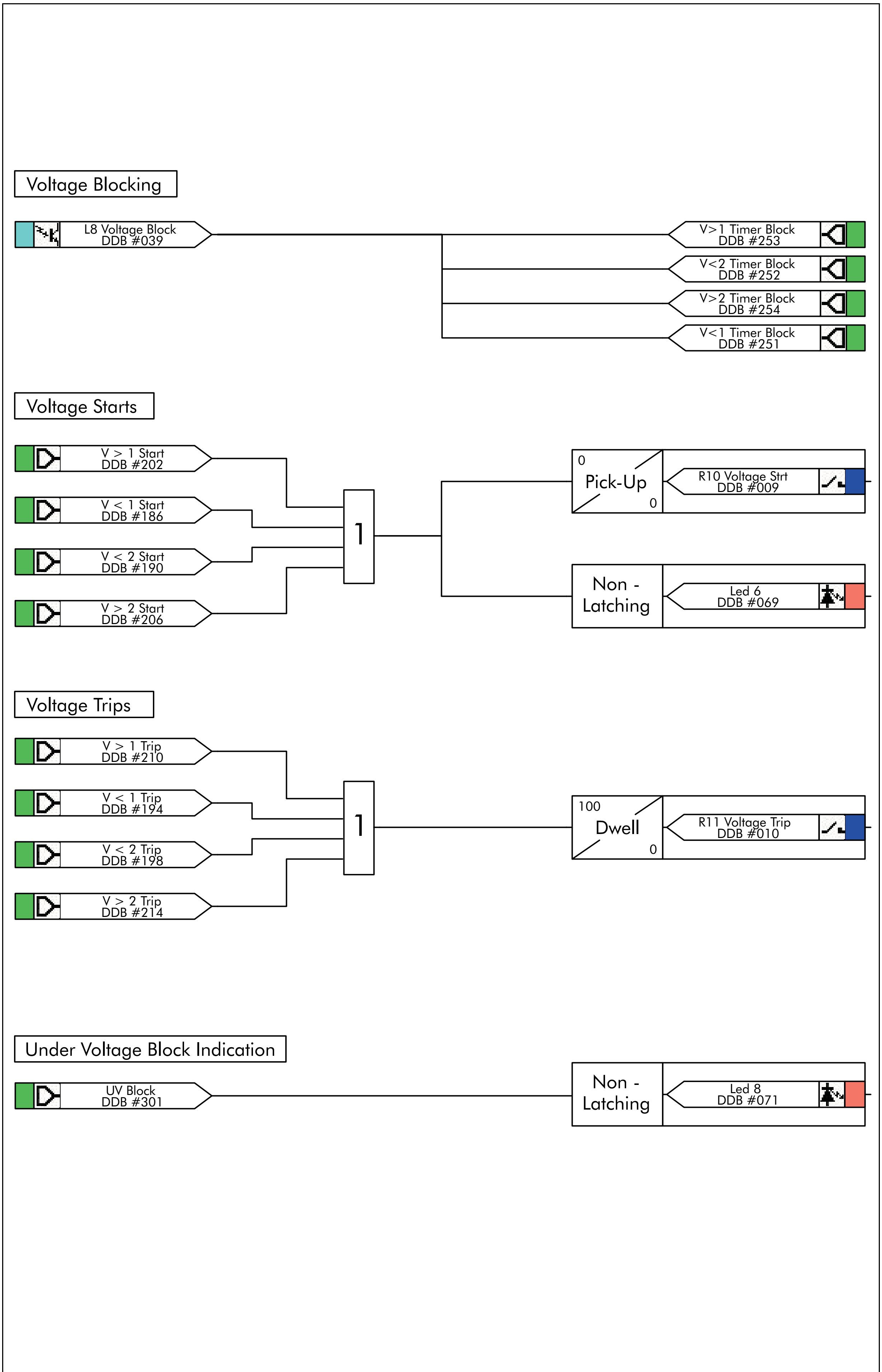
MiCOM P941 DEFAULT PROGRAMMABLE SCHEME LOGIC



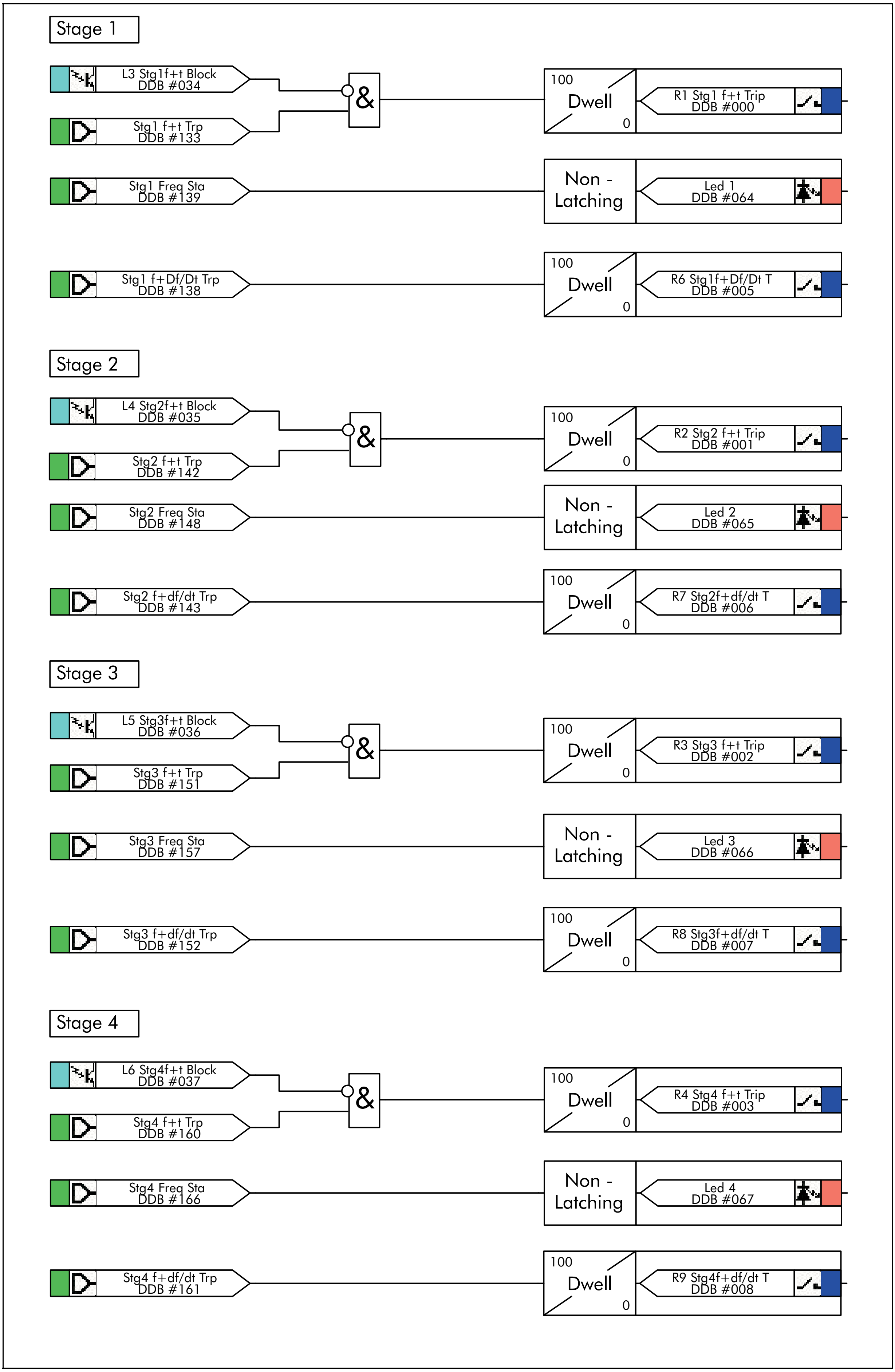
MiCOM P941 DEFAULT PROGRAMMABLE SCHEME LOGIC



MiCOM P942 DEFAULT PROGRAMMABLE SCHEME LOGIC



MiCOM P942 DEFAULT PROGRAMMABLE SCHEME LOGIC



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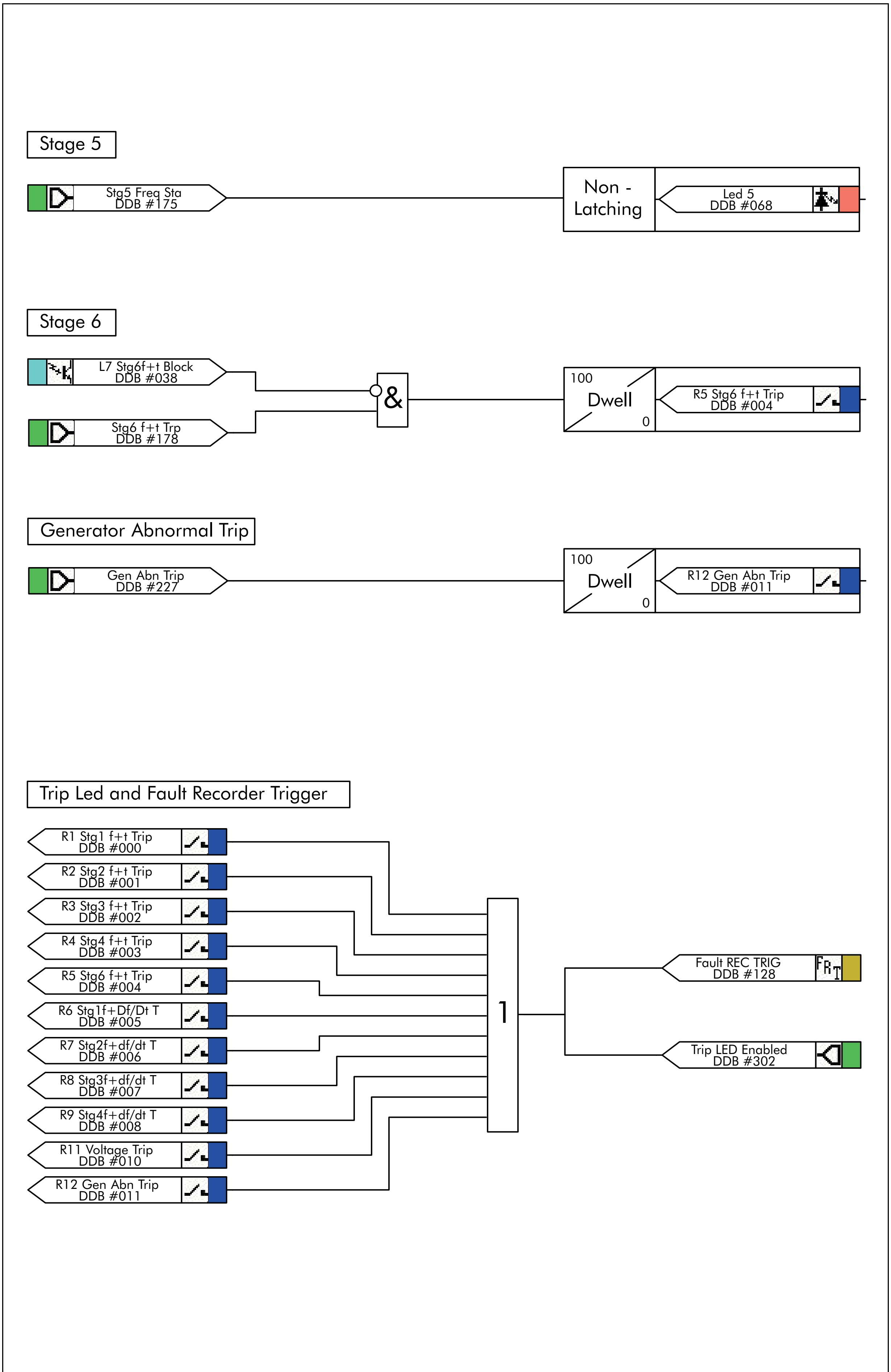

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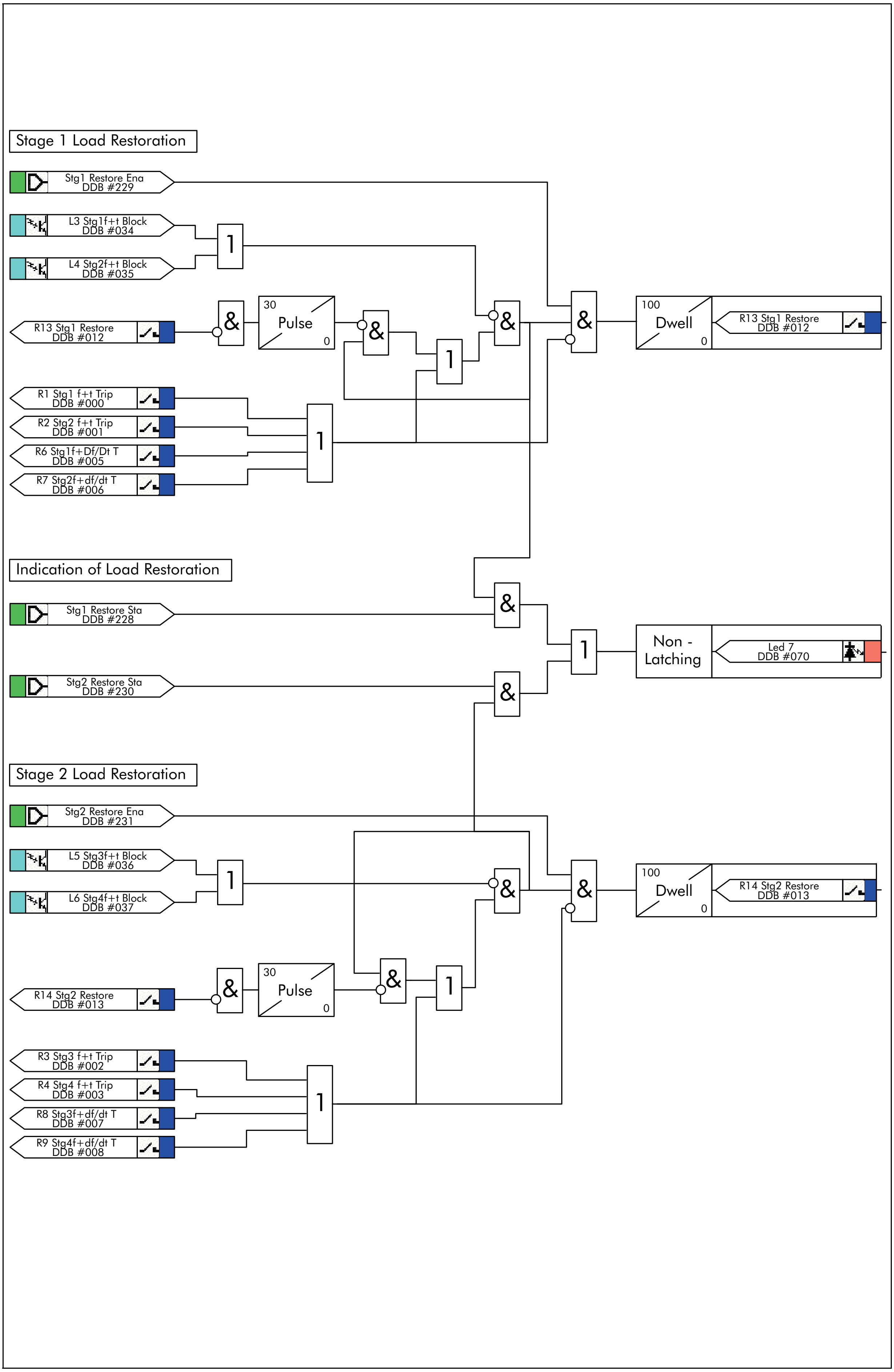

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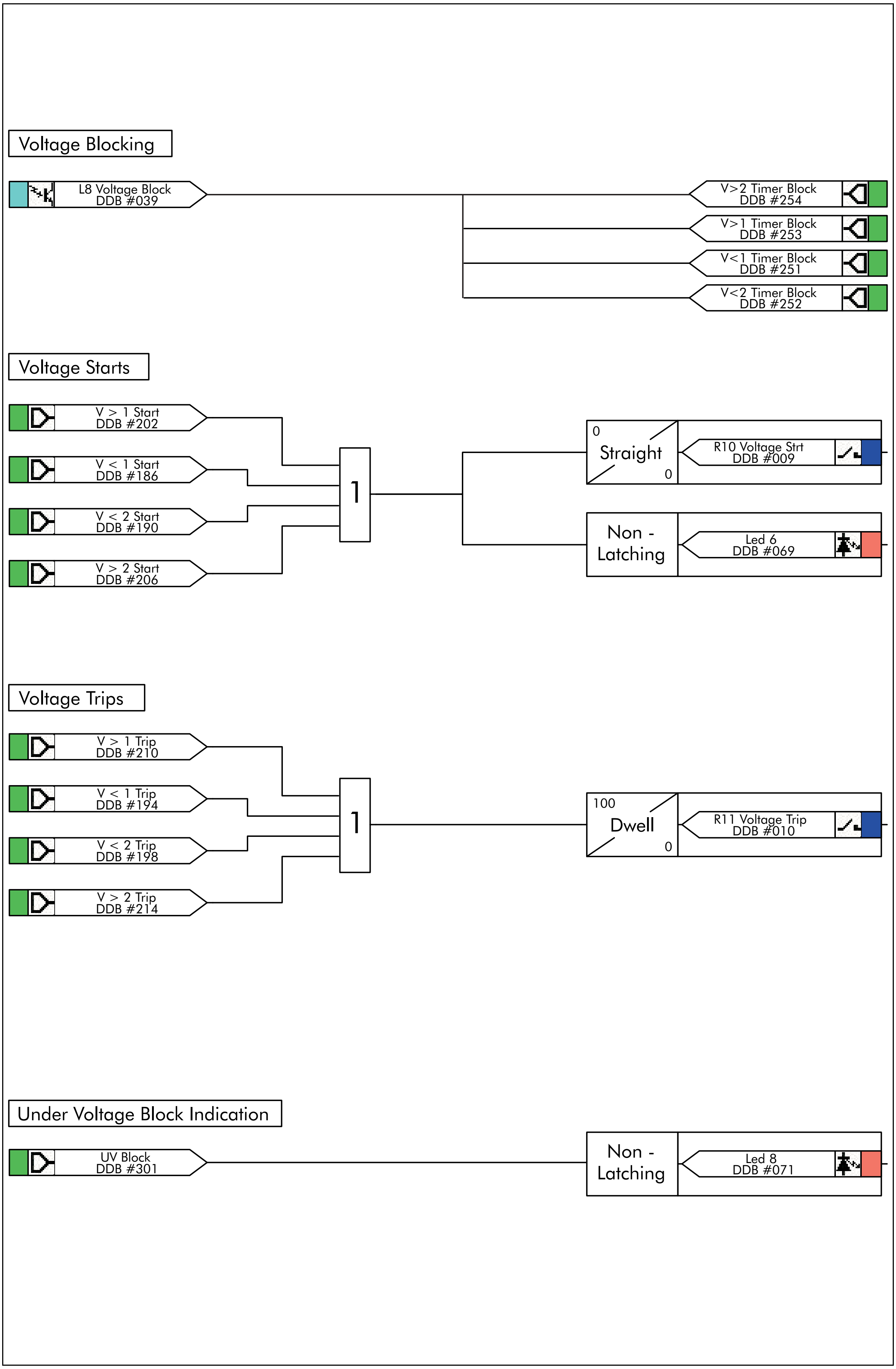

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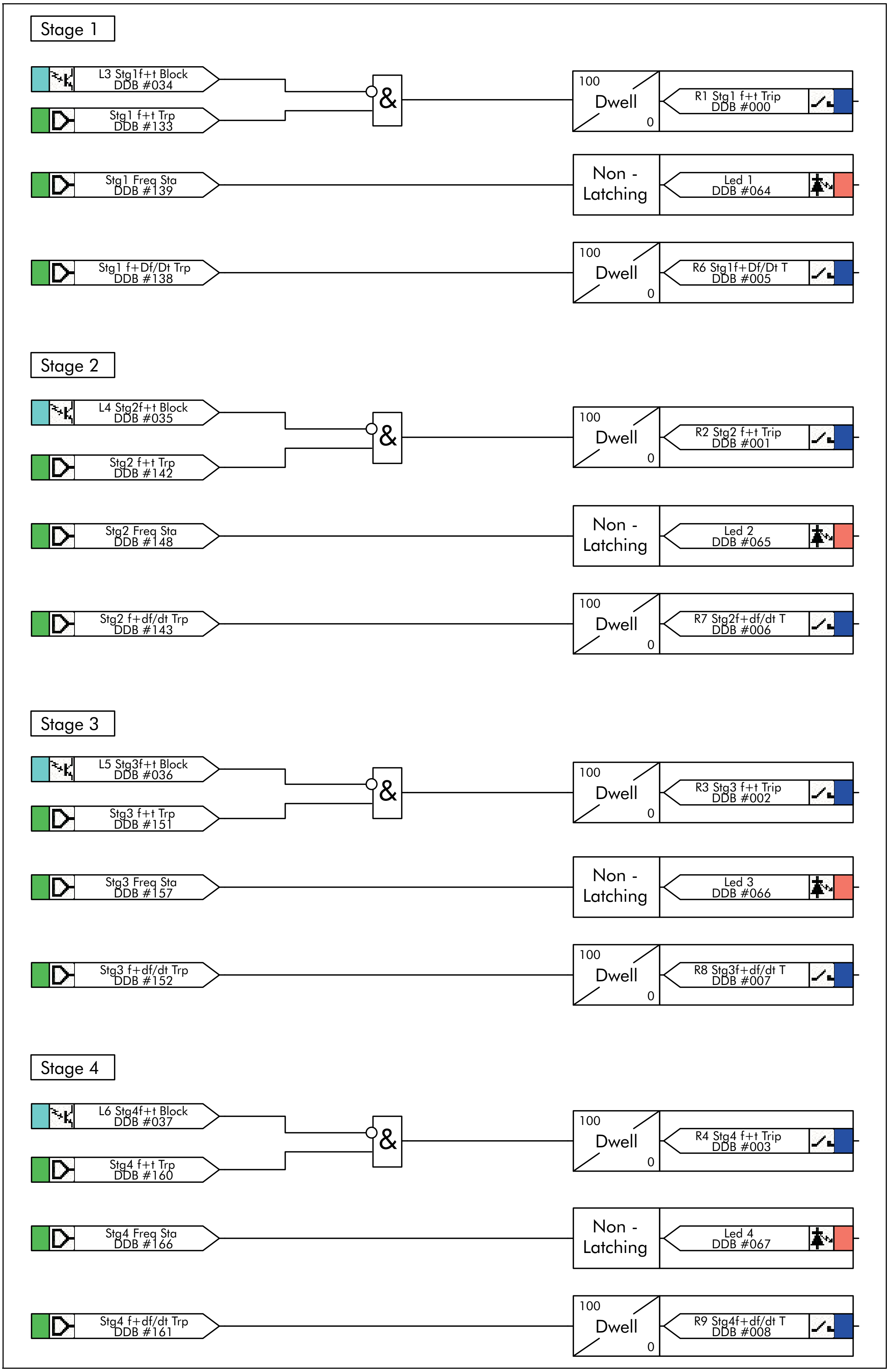

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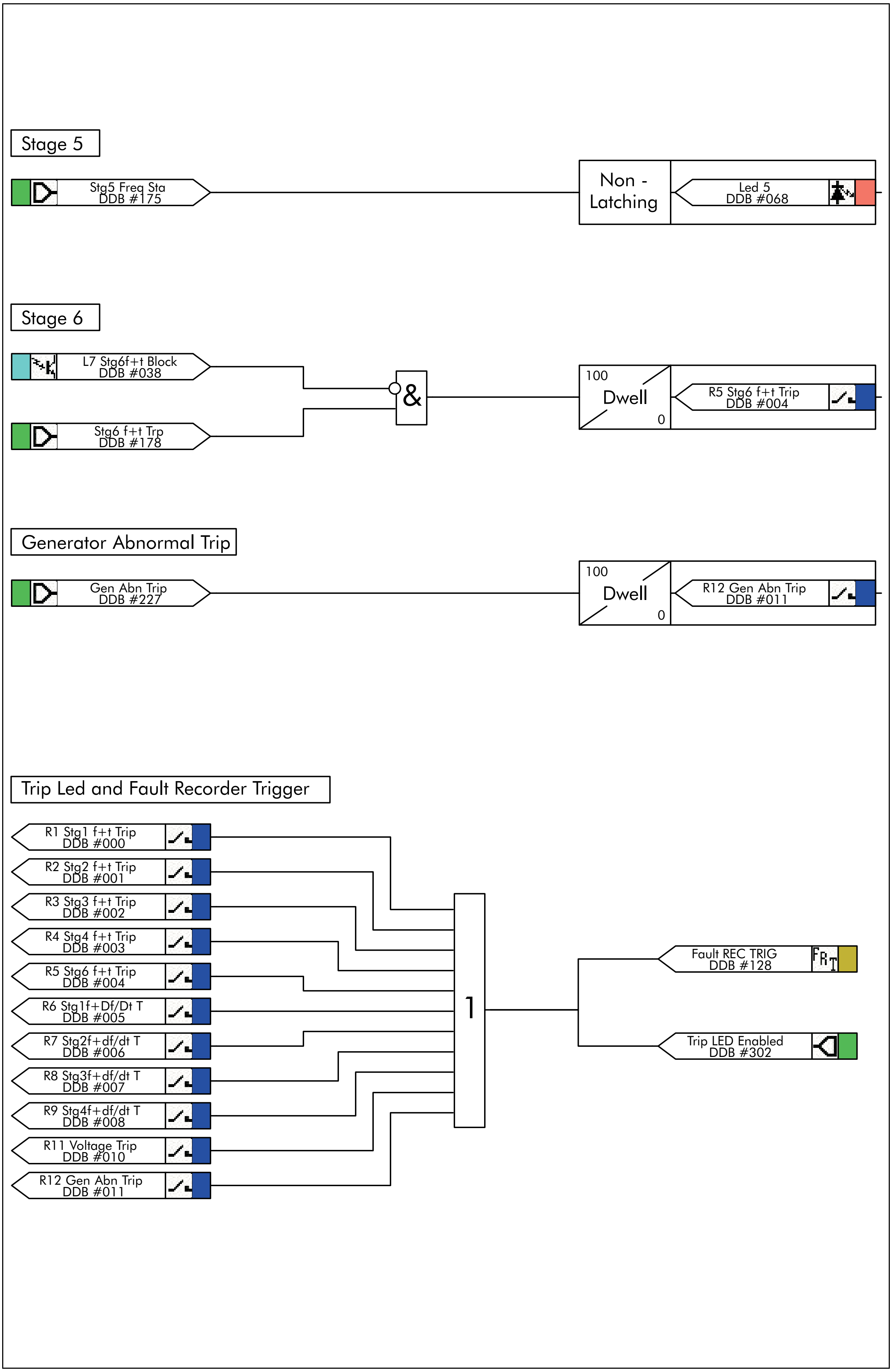

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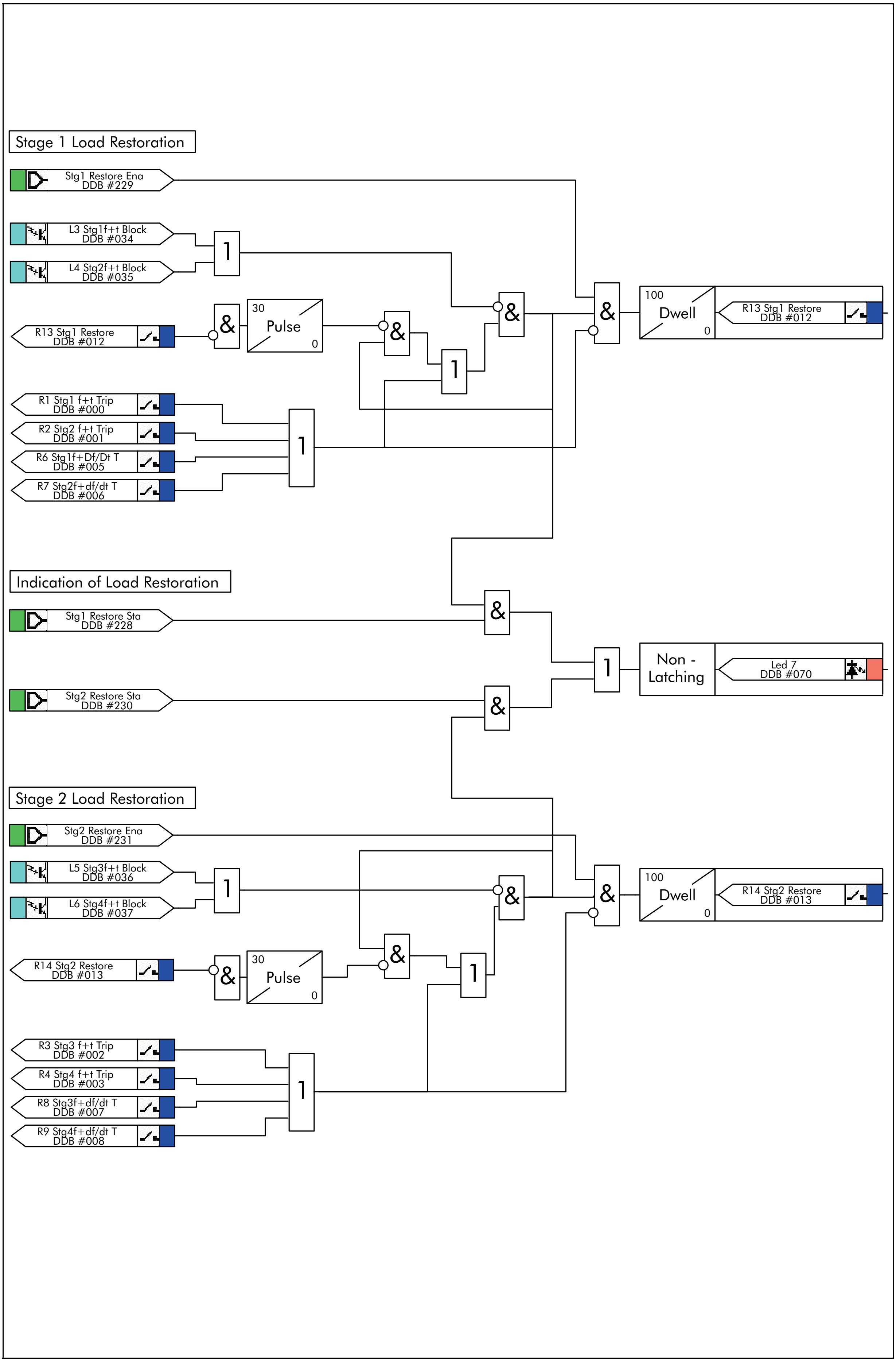
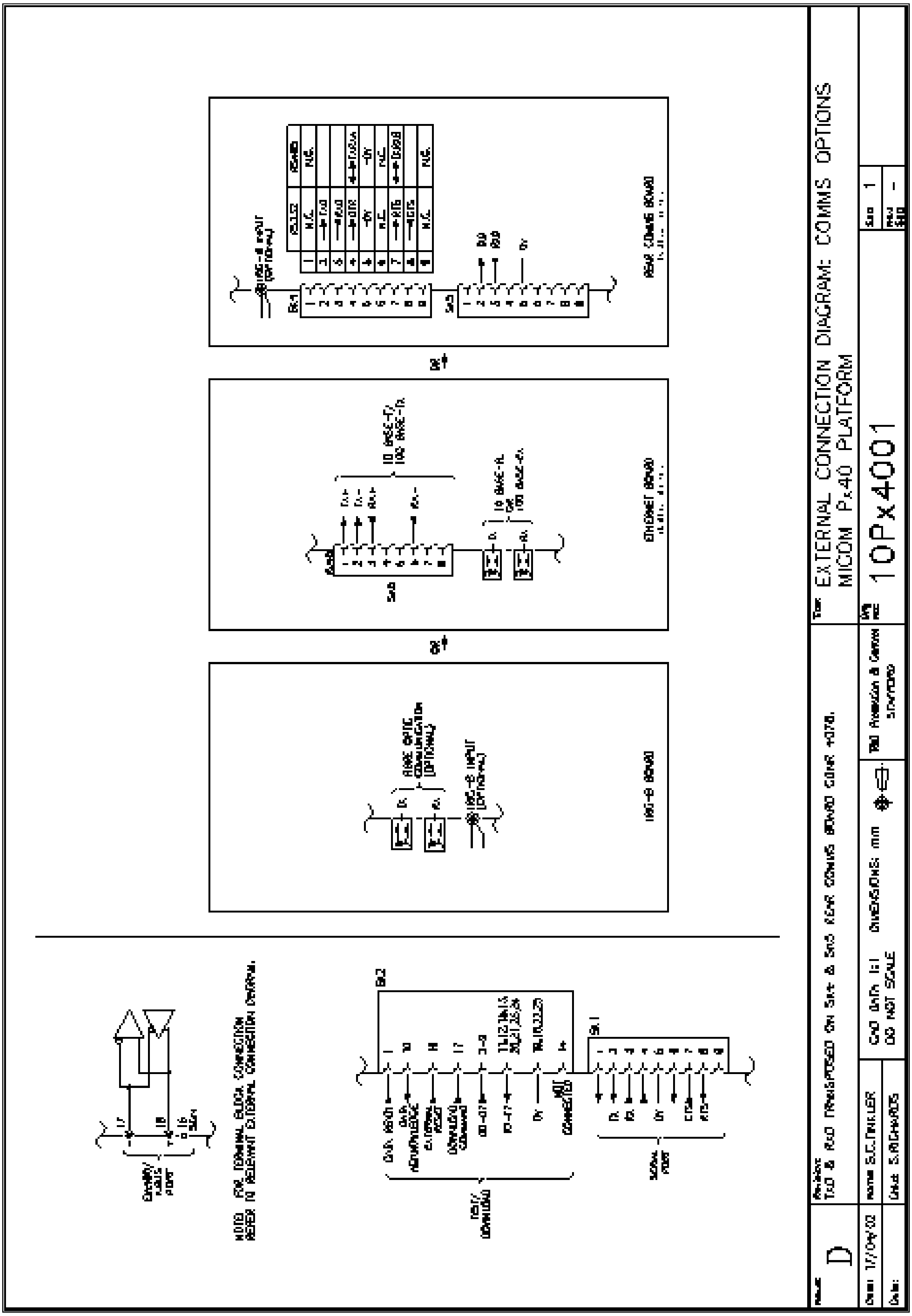
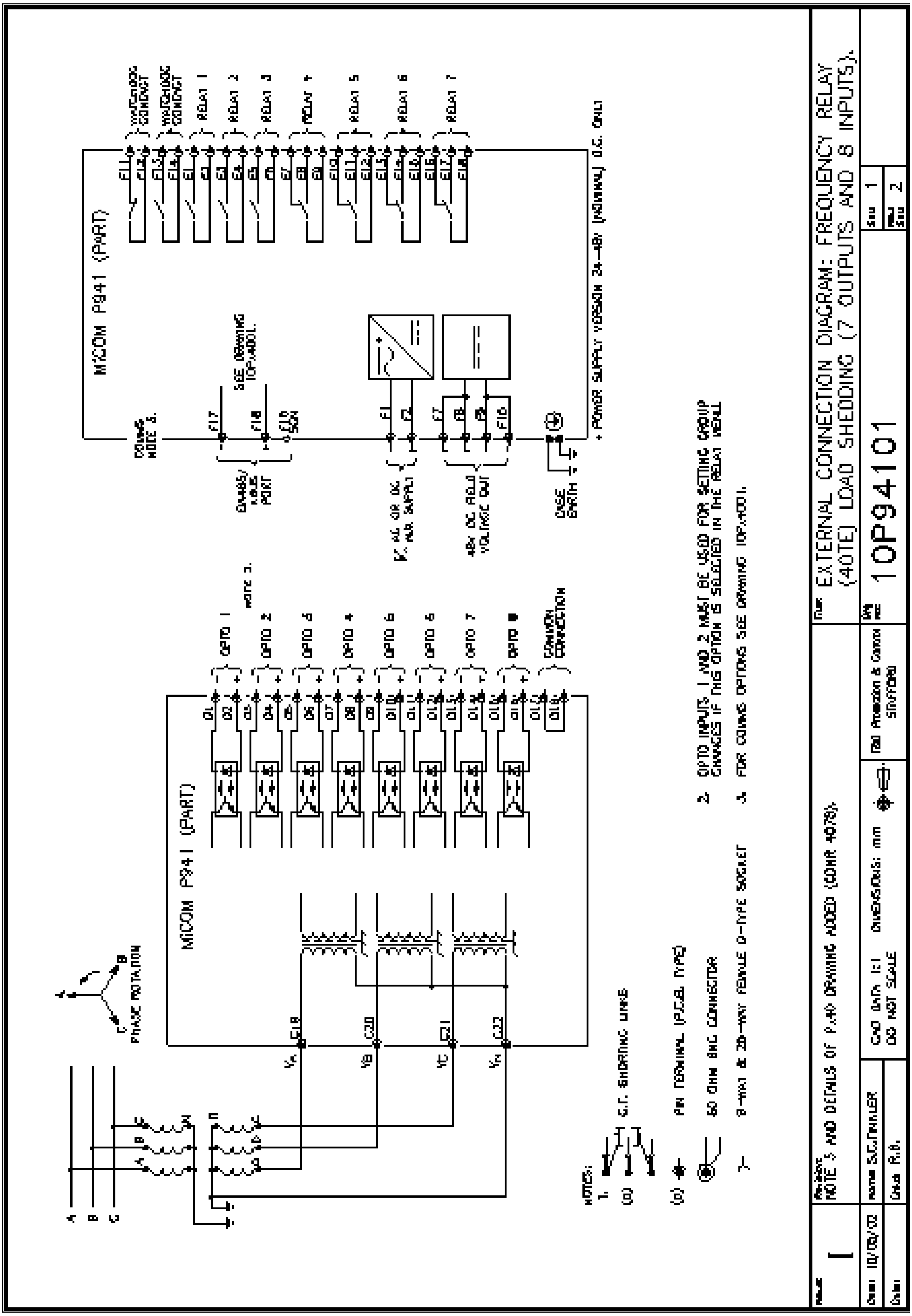
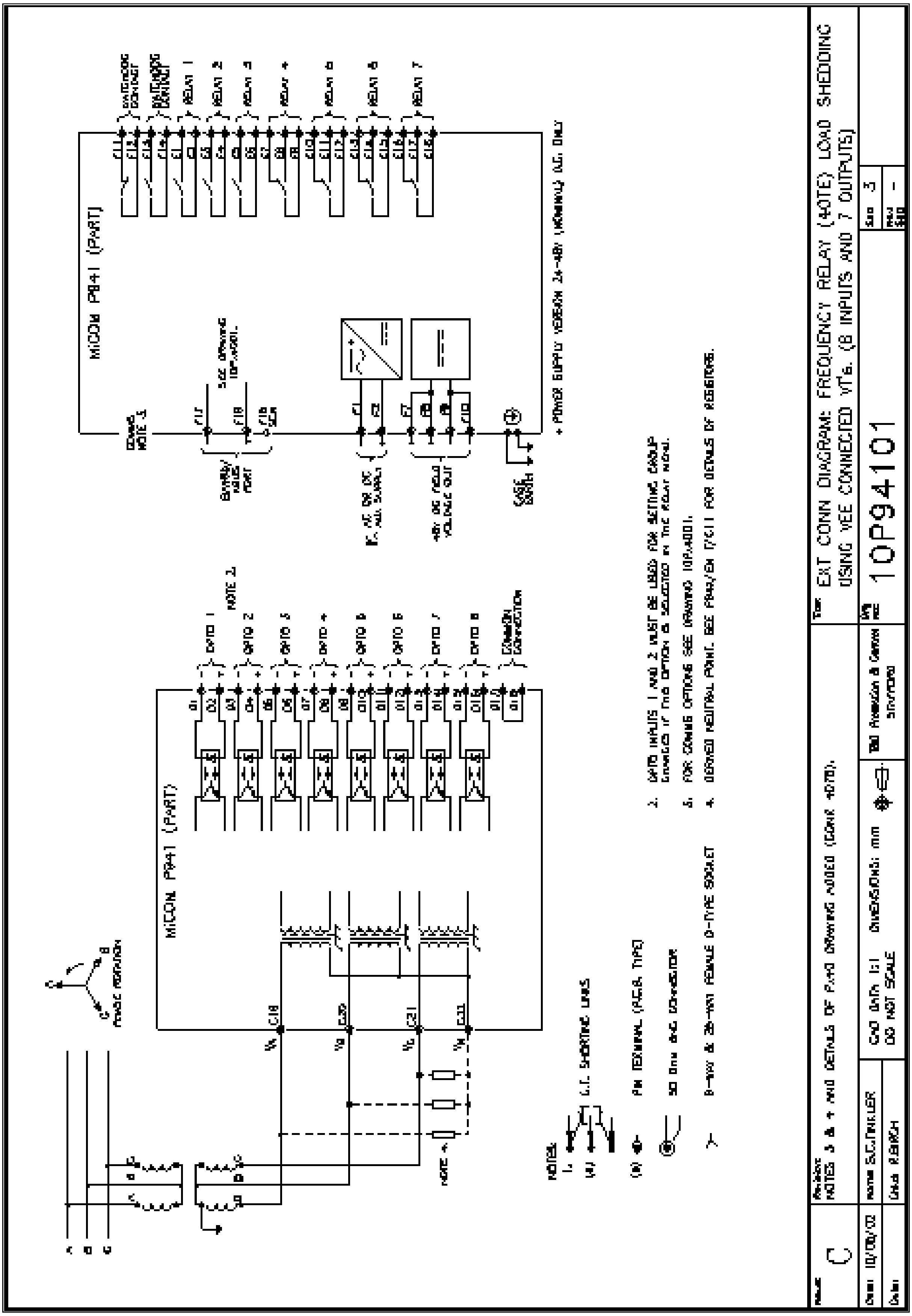
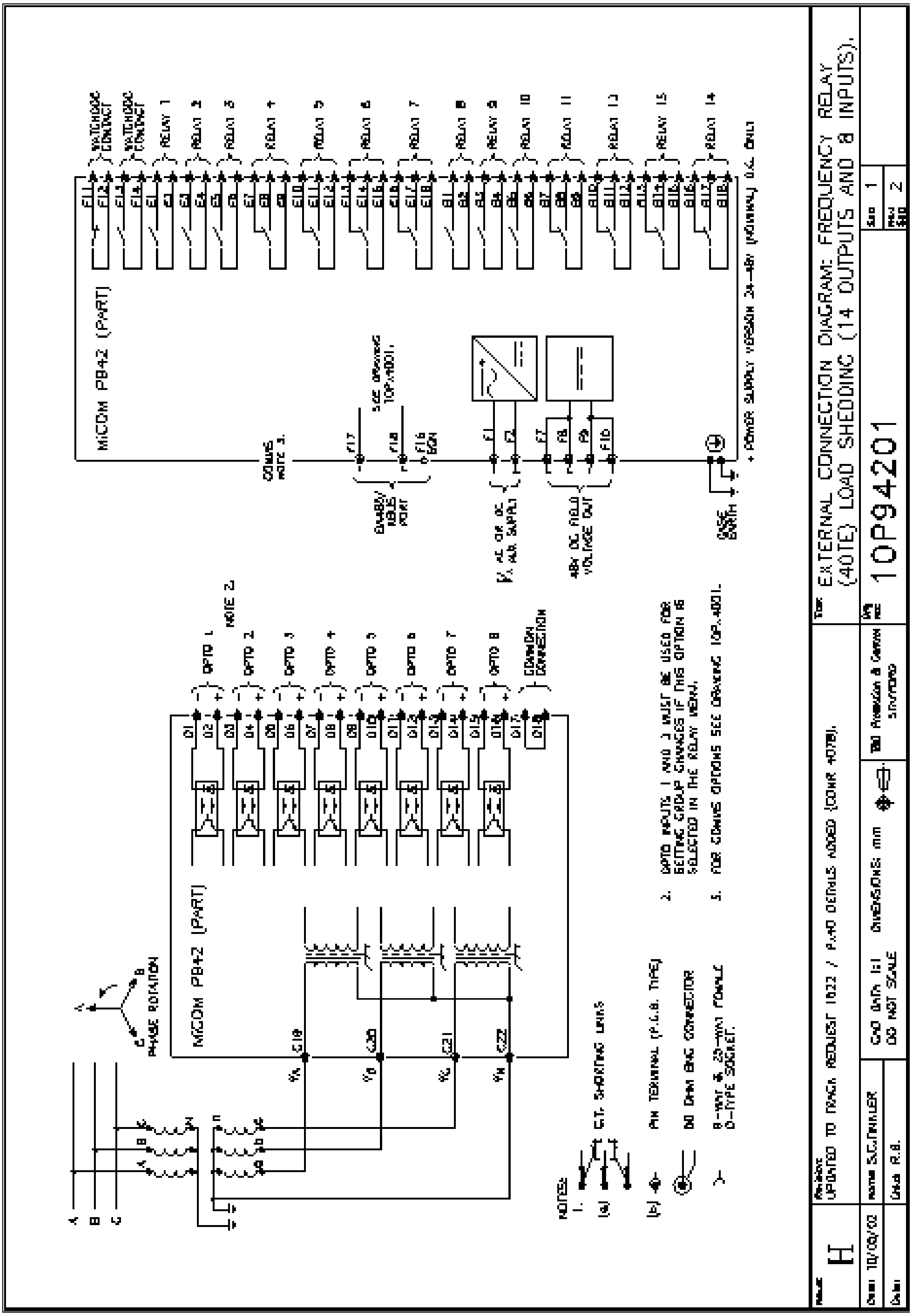


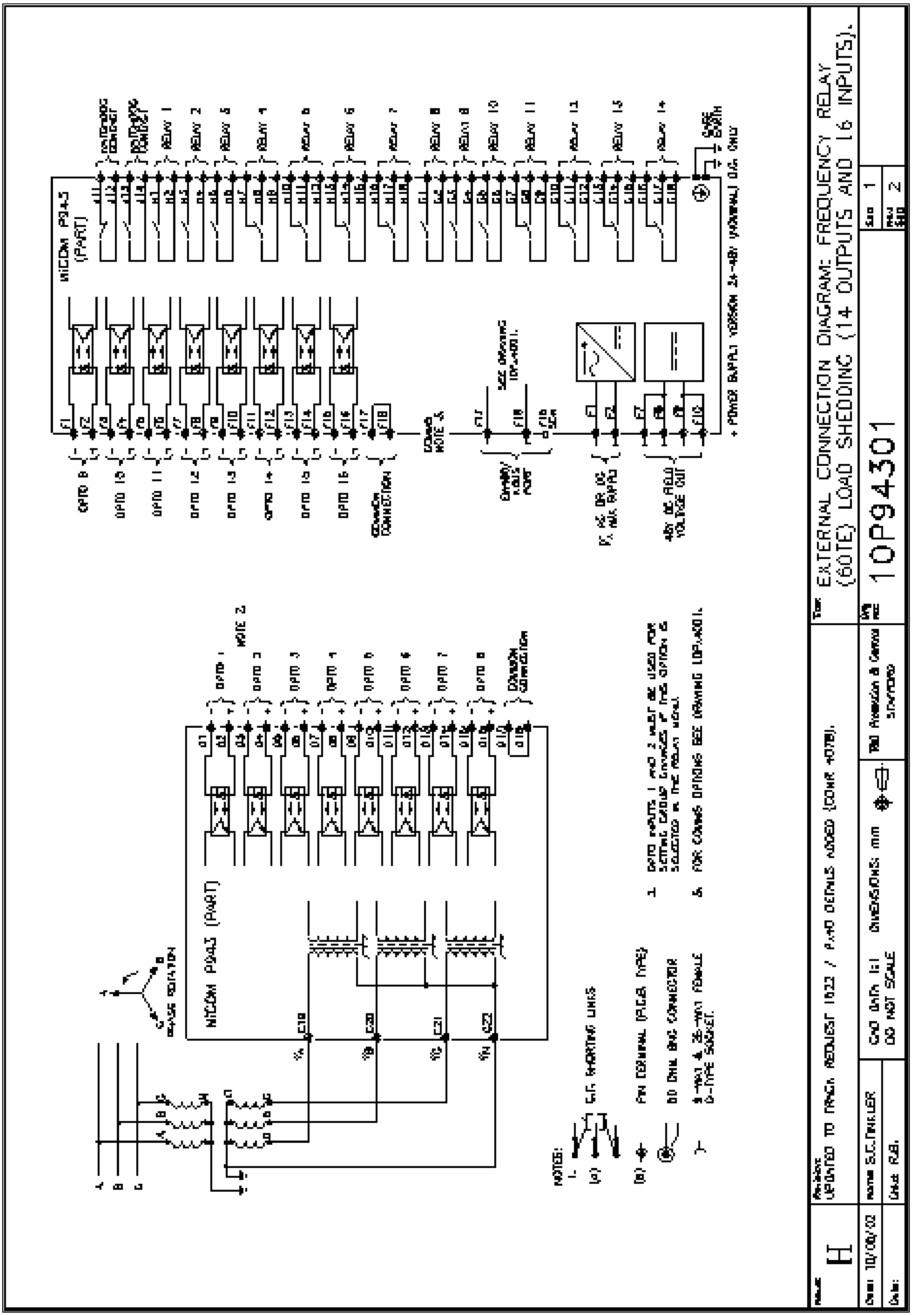
EXTERNAL CONNECTION DIAGRAMS


EXTERNAL CONNECTION DIAGRAM: COMMS OPTIONS
MICOM Px40 PLATFORM
10Px4001
D
DO NOT SCALE


EXTERNAL CONNECTION DIAGRAM: FREQUENCY RELAY
(40TE) LOAD SHEDDING (7 OUTPUTS AND 8 INPUTS).
10P94101
MiCOM P941 (PART)
MiCOM P941 (PART)
WATCHDOG CONTACT
WATCHDOG CONTACT
RELAY 1
RELAY 2
RELAY 3
RELAY 4
RELAY 5
RELAY 6
RELAY 7
OPTO 1
OPTO 2
OPTO 3
OPTO 4
OPTO 5
OPTO 6
OPTO 7
OPTO 8
COMMON CONNECTION
NOTE 3.
PHASE ROTATION
CASE EARTH
+ POWER SUPPLY VERSION 24-48V (NOMINAL) D.C. ONLY
2. OPTO INPUTS 1 AND 2 MUST BE USED FOR SETTING GROUP CHANGES IF THIS OPTION IS SELECTED IN THE RELAY MENU.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
NOTES: 1. (a) C.T. SHORTING LINKS
(b) PIN TERMINAL (P.C.B. TYPE)
50 OHM BNC CONNECTOR
9-WAY & 25-WAY FEMALE D-TYPE SOCKET
NOTE 3 AND DETAILS OF Px40 DRAWING ADDED
DIMENSIONS: mm
DO NOT SCALE


EXT CONN DIAGRAM: FREQUENCY RELAY (40TE) LOAD SHEDDING
USING VEE CONNECTED VTs. (8 INPUTS AND 7 OUTPUTS)
10P94101
MiCOM P941 (PART)
DO NOT SCALE


EXTERNAL CONNECTION DIAGRAM: FREQUENCY RELAY
(40TE) LOAD SHEDDING (14 OUTPUTS AND 8 INPUTS).
10P94201


EXTERNAL CONNECTION DIAGRAM: FREQUENCY RELAY (60TE) LOAD SHEDDING (14 OUTPUTS AND 16 INPUTS).
10P94301
H
MiCOM P943 (PART)

HARDWARE / SOFTWARE VERSION HISTORY AND COMPATIBILITY

(Note: Includes versions released and supplied to customers only)

Relay type: P94x …						
Software Version		Hardware Suffix	Original Date of Issue	Description of Changes	S1 Compatibility	Technical Documentation
Major	Minor					
A	1	A	Feb 1999	Original Issue	V1.00 or Later	TG8611A
B	1	A	Apr 1999	✓ f+t element modified so that it is blocked when frequency out of range ✓ Generator abnormal timers now updated every cycle ✓ Setting ranges corrected for Vn=440V models	V1.06 or Later	TG8611A
01	A	A	Oct 1999	✓ Software reference aligned with PCS procedure ✓ Corrections to French language text ✓ Improvements to IEC60870-5-103 protocol implementation to improve operation during heavy event load	V1.06 or Later	TG8611A
	B	A	Dec 1999	✓ Opto-input sampling modified	V1.06 or Later	TG8611A
02	A	A	Jan 2000	✓ Trip LED status saved during power cycle ✓ Software and hardware compatibility checked on power-up (as per P14x relays)	V1.06 or Later	TG8611A
	B	A	Feb 2002	✓ Resolved possible reboot caused by invalid MODBUS requests ✓ Prevention of software errors causing event log from being erased ✓ IDMT curve improvements ✓ Modification to prevent possible f+t trip contact operation at start-up when the delay is set to <60ms ✓ Resolved possible reboot caused by disturbance recorder	V1.06 or Later	TG8611A

Relay type: P94x …

Software Version Major	Software Version Minor	Hardware Suffix	Original Date of Issue	Description of Changes	S1 Compatibility	Technical Documentation
03	A	A	Sept 2002	✓ DNP3.0 protocol added ✓ Resolved MODBUS compatibility issues with Px2x products	V2.00 or Later	TG8611B
	B	A	Feb 2002	✓ Resolved possible reboot caused by invalid MODBUS requests ✓ Prevention of software errors causing event log from being erased ✓ IDMT curve improvements ✓ Modification to prevent possible f+t trip contact operation at start-up when the delay is set to <60ms ✓ Resolved possible reboot caused by disturbance recorder	V2.00 or Later	TG8611B
04	A	A	Jan 2001	✓ Event filtering added ✓ Menu text modifications	V2.00 or Later	TG8611B
	B	A	Jan 2002	✓ Modification to prevent possible f+t trip contact operation at start-up when the time delay is set to <60ms	V2.00 or Later	TG8611B
	C	A	Feb 2002	✓ Resolved possible reboot caused by disturbance recorder	V2.00 or Later	TG8611B
	D	A	Feb 2002	✓ Resolved possible reboot caused by invalid MODBUS requests ✓ Prevention of software errors causing event log from being erased ✓ IDMT curve improvements	V2.00 or Later	TG8611B

Relay type: P94x …						
Software Version		**Hardware Suffix**	**Original Date of Issue**	**Description of Changes**	**S1 Compatibility**	**Technical Documentation**
Major	Minor					
05	A	A	Jan 2003	✓ User alarms added (10 self-reset, 10 manual reset) ✓ Fault Record Trigger DDB signal added ✓ Operation of Trip LED removed from fixed code and replaced by trip LED DDB signal ✓ Fault record text change for 3 phase conditions (removed ‘3’) ✓ Improved UV blocking of elements to function during settings changes ✓ Improved operation of ‘Frequency not found’ alarm to function correctly during changes in the tracking phase	V2.07 + Patch	P94x/EN T/C11
	B	A	Feb 2003	✓ Measurements refresh rate improved to once per second via communications	V2.07 + Patch	P94x/EN T/C11

Setting File Software Version	Relay Software Version: A1	B1	01	02	03	04	05
A1	✓	×	×	×	×	×	×
B1	×	✓	×	×	×	×	×
01	×	×	✓	✓	✓	❶	❶
02	×	×	✓	✓	✓	❶	❶
03	×	×	✓	✓	✓	❶	❶
04	×	×	×	×	×	✓	✓
05	×	×	×	×	×	✓	✓

❶ Additional functionality was added in 04 software such that setting files from earlier software versions will need additional settings to be made.

PSL File Software Version \ Relay Software Version	A1	B1	01	02	03	04	05
A1	✓	×	×	×	×	×	×
B1	×	✓	×	×	×	×	×
01	×	×	✓	✓	❶	❶	×
02	×	×	✓	✓	❶	❶	×
03	×	×	✓	✓	✓	✓	×
04	×	×	×	×	✓	✓	×
05	×	×	×	×	×	×	✓

❶ Additional functionality was added in 03 software such that PSL files from earlier software versions may need additional logic. 05 software includes trip LED and FRT control and is not compatible with earlier versions.

Menu Text File Software Version	Relay Software Version: A1	B1	01	02	03	04	05
A1	✓	×	×	×	×	×	×
B1	×	✓	×	×	×	×	×
01	×	×	✓	×	×	×	×
02	×	×	×	✓	×	×	×
03	×	×	×	×	✓	×	×
04	×	×	×	×	×	✓	×
05	×	×	×	×	×	×	✓

❶ Menu text remains compatible within each software version but is NOT compatible across different versions.

Information Required with Order

Relay Type	P94				A		A	0			0	A

Frequency Relay

Option	Code
Version with 7 contacts & 8 digital inputs	1
Version with 14 contacts & 8 digital inputs	2
Version with 14 contacts & 16 digital outputs	3

Auxiliary Voltage Rating

Option	Code
24 – 48V dc only	1
48 – 125V dc (30 – 110V ac)	2
110 – 250V dc (100 – 240V ac)	3

Vn rating

Option	Code
100 – 120V ac	1
380 – 480V ac	2

Hardware Options

Option	Code
Nothing	1
IRIG-B only	2
Fibre optic converter only (IEC60870-5-103)	3
IRIG-B & Fibre optic converter (IEC60870-5-103)	4

Product Specific

Option	Code
None available	A

Protocol Options

Option	Code
K-Bus/Courier	1
Modbus	2
IEC60870-5-103	3
DNP3.0	4

Mounting

Option	Code
Panel Mounting	A

Software Version

See version history – unless specified the latest version (05) will be delivered

Hardware Suffix

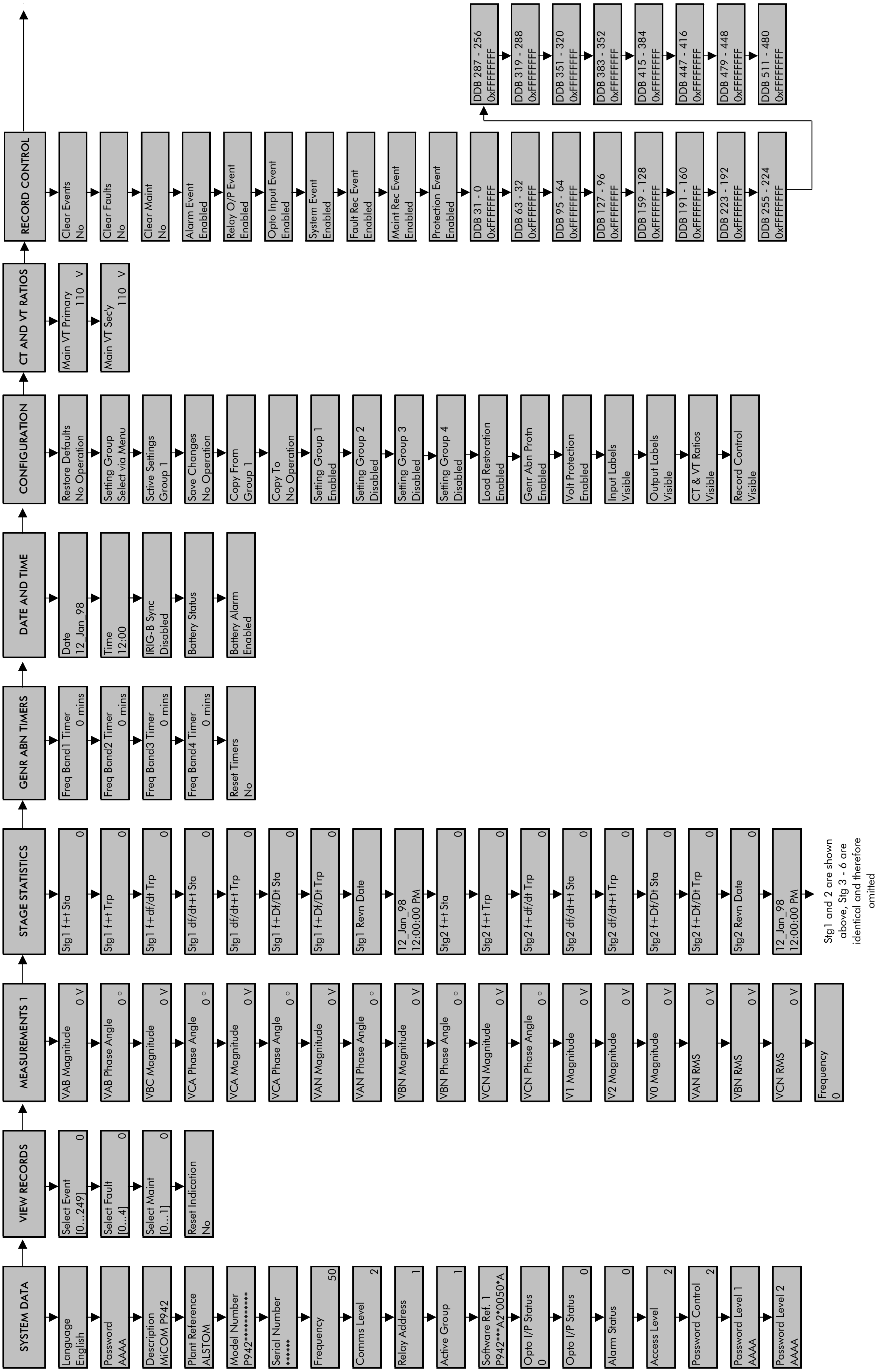
Option	Code
Original	A

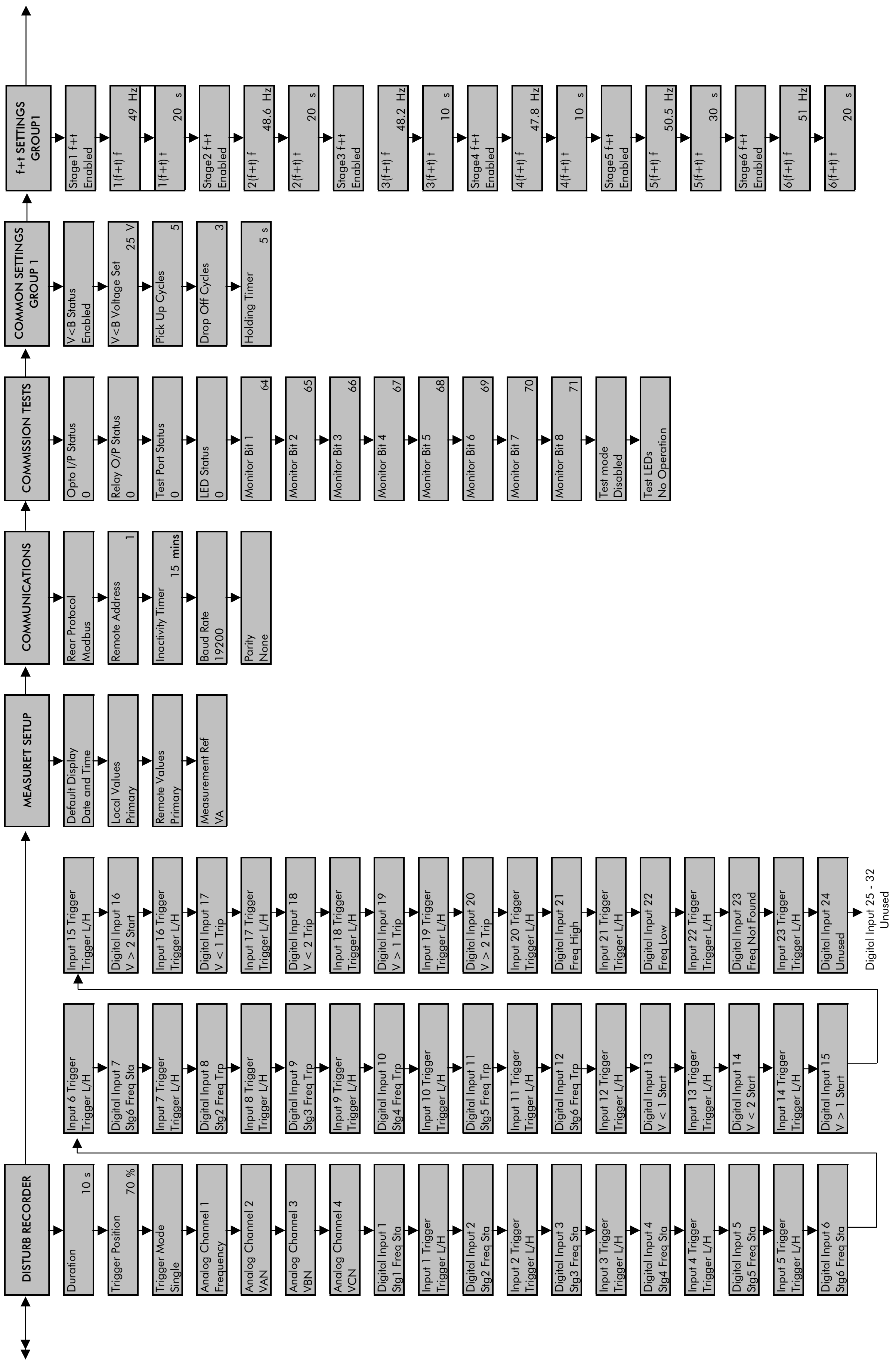
Accessories	Please quote on order
Rack frame (in accordance with IEC60297)	FX0021 001
Case to rack sealing gaskets are available to improve the overall IP rating of the panel, (10 per order)	GN2044 001
M4 90° pre-insulated ring terminals: Blue – Wire size 1.04 – 2.63mm2 (100 per order) Red – Wire size 0.25 – 1.65mm2 (100 per order)	 ZB9124 900 ZB9124 901
Secondary Cover: P941, P942 Size 40TE P943 Size 60TE	GN0037 001 GN0038 001
Blanking Plates: Size 10TE Size 20TE Size 30TE Size 40TE	GJ2028 002 GJ2028 004 GJ2028 006 GJ2028 008

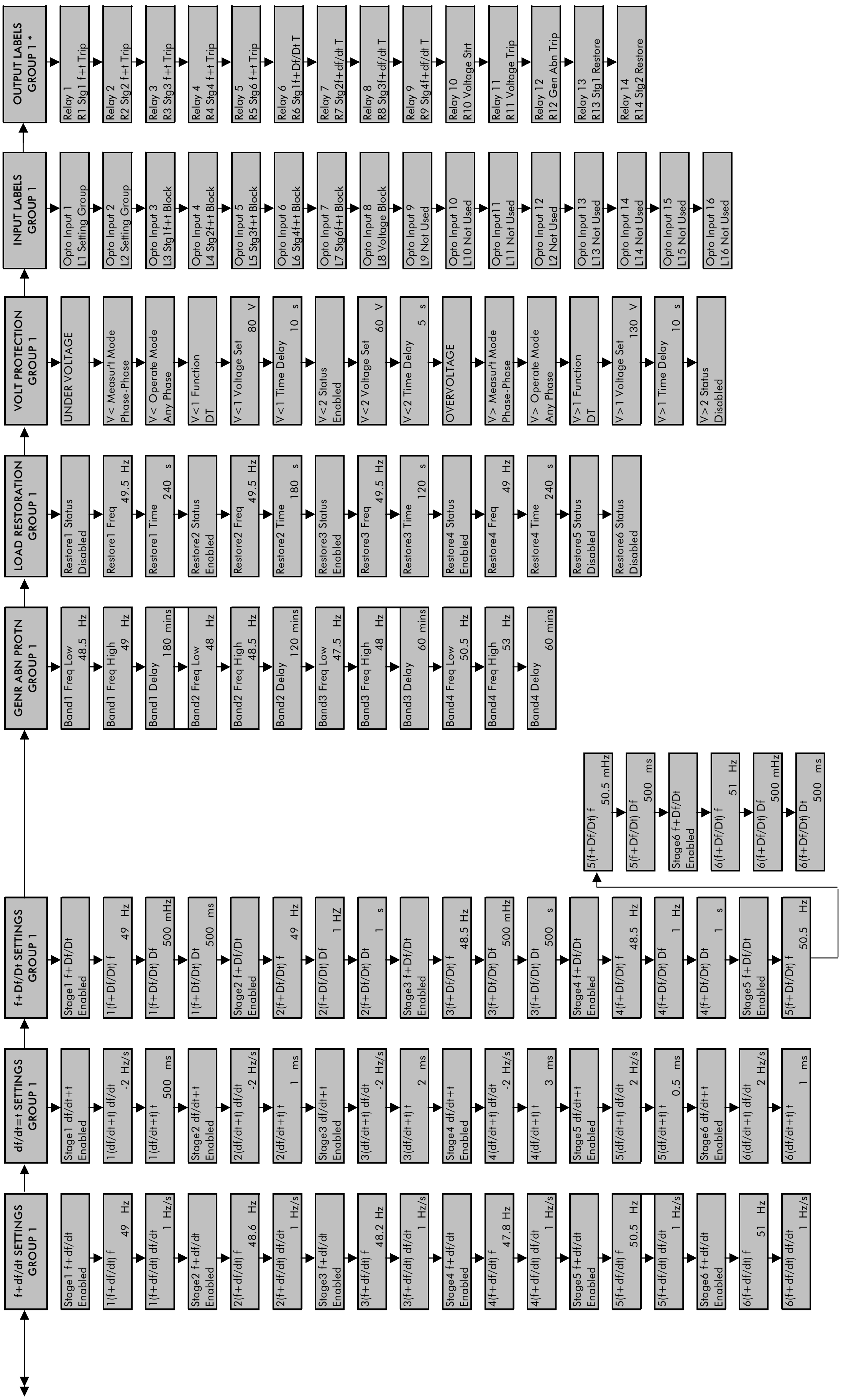
MENU CONTENT TABLES

Note 1: * Group 1 is shown on the Menu Map, Groups 2, 3 and 4 are identical to Group 1 and therefore omitted.

Note 2: This specific Menu Map relates to the MiCOM P943. For other models, the number of opto inputs and relay outputs vary and hence the menu slightly changes. Please make reference to the Relay Menu Database (P94x/EN GC).


SYSTEM DATA
Language English
Password AAAA
Description MiCOM P942
Plant Reference ALSTOM
Model Number P942**********
Serial Number ******
Frequency 50
Comms Level 2
Relay Address 1
Active Group 1
Software Ref. 1 P942***A2*0050*A
Opto I/P Status 0
Opto I/P Status 0
Alarm Status 0
Access Level 2
Password Control 2
Password Level 1 AAAA
Password Level 2 AAAA
VIEW RECORDS
Select Event [0...249] 0
Select Fault [0...4] 0
Select Maint [0...1] 0
Reset Indication No
MEASUREMENTS 1
VAB Magnitude 0 V
VAB Phase Angle 0 °
VBC Magnitude 0 V
VCA Phase Angle 0 °
VCA Magnitude 0 V
VCA Phase Angle 0 °
VAN Magnitude 0 V
VAN Phase Angle 0 °
VBN Magnitude 0 V
VBN Phase Angle 0 °
VCN Magnitude 0 V
VCN Phase Angle 0 °
V1 Magnitude 0 V
V2 Magnitude 0 V
V0 Magnitude 0 V
VAN RMS 0 V
VBN RMS 0 V
VCN RMS 0 V
Frequency 0
STAGE STATISTICS
Stg1 f+t Sta 0
Stg1 f+t Trp 0
Stg1 f+df/dt Trp 0
Stg1 df/dt+t Sta 0
Stg1 df/dt+t Trp 0
Stg1 f+Df/Dt Sta 0
Stg1 f+Df/Dt Trp 0
Stg1 Revn Date
12_Jan_98 12:00:00 PM
Stg2 f+t Sta 0
Stg2 f+t Trp 0
Stg2 f+df/dt Trp 0
Stg2 df/dt+t Sta 0
Stg2 df/dt+t Trp 0
Stg2 f+Df/Dt Sta 0
Stg2 f+Df/Dt Trp 0
Stg2 Revn Date 0
12_Jan_98 12:00:00 PM
Stg1 and 2 are shown above, Stg 3 - 6 are identical and therefore omitted
GENR ABN TIMERS
Freq Band1 Timer 0 mins
Freq Band2 Timer 0 mins
Freq Band3 Timer 0 mins
Freq Band4 Timer 0 mins
Reset Timers No
DATE AND TIME
Date 12_Jan_98
Time 12:00
IRIG-B Sync Disabled
Battery Status
Battery Alarm Enabled
CONFIGURATION
Restore Defaults No Operation
Setting Group Select via Menu
Sctive Settings Group 1
Save Changes No Operation
Copy From Group 1
Copy To No Operation
Setting Group 1 Enabled
Setting Group 2 Disabled
Setting Group 3 Disabled
Setting Group 4 Disabled
Load Restoration Enabled
Genr Abn Protn Enabled
Volt Protection Enabled
Input Labels Visible
Output Labels Visible
CT & VT Ratios Visible
Record Control Visible
CT AND VT RATIOS
Main VT Primary 110 V
Main VT Sec'y 110 V
RECORD CONTROL
Clear Events No
Clear Faults No
Clear Maint No
Alarm Event Enabled
Relay O/P Event Enabled
Opto Input Event Enabled
System Event Enabled
Fault Rec Event Enabled
Maint Rec Event Enabled
Protection Event Enabled
DDB 31 - 0 0xFFFFFFFF
DDB 63 - 32 0xFFFFFFFF
DDB 95 - 64 0xFFFFFFFF
DDB 127 - 96 0xFFFFFFFF
DDB 159 - 128 0xFFFFFFFF
DDB 191 - 160 0xFFFFFFFF
DDB 223 - 192 0xFFFFFFFF
DDB 255 - 224 0xFFFFFFFF
DDB 287 - 256 0xFFFFFFFF
DDB 319 - 288 0xFFFFFFFF
DDB 351 - 320 0xFFFFFFFF
DDB 383 - 352 0xFFFFFFFF
DDB 415 - 384 0xFFFFFFFF
DDB 447 - 416 0xFFFFFFFF
DDB 479 - 448 0xFFFFFFFF
DDB 511 - 480 0xFFFFFFFF


DISTURB RECORDER
Duration 10 s
Trigger Position 70 %
Trigger Mode Single
Analog Channel 1 Frequency
Analog Channel 2 VAN
Analog Channel 3 VBN
Analog Channel 4 VCN
Digital Input 1 Stg1 Freq Sta
Input 1 Trigger Trigger L/H
Digital Input 2 Stg2 Freq Sta
Input 2 Trigger Trigger L/H
Digital Input 3 Stg3 Freq Sta
Input 3 Trigger Trigger L/H
Digital Input 4 Stg4 Freq Sta
Input 4 Trigger Trigger L/H
Digital Input 5 Stg5 Freq Sta
Input 5 Trigger Trigger L/H
Digital Input 6 Stg6 Freq Sta
Input 6 Trigger Trigger L/H
Digital Input 7 Stg6 Freq Sta
Input 7 Trigger Trigger L/H
Digital Input 8 Stg2 Freq Trp
Input 8 Trigger Trigger L/H
Digital Input 9 Stg3 Freq Trp
Input 9 Trigger Trigger L/H
Digital Input 10 Stg4 Freq Trp
Input 10 Trigger Trigger L/H
Digital Input 11 Stg5 Freq Trp
Input 11 Trigger Trigger L/H
Digital Input 12 Stg6 Freq Trp
Input 12 Trigger Trigger L/H
Digital Input 13 V < 1 Start
Input 13 Trigger Trigger L/H
Digital Input 14 V < 2 Start
Input 14 Trigger Trigger L/H
Digital Input 15 V > 1 Start
Input 15 Trigger Trigger L/H
Digital Input 16 V > 2 Start
Input 16 Trigger Trigger L/H
Digital Input 17 V < 1 Trip
Input 17 Trigger Trigger L/H
Digital Input 18 V < 2 Trip
Input 18 Trigger Trigger L/H
Digital Input 19 V > 1 Trip
Input 19 Trigger Trigger L/H
Digital Input 20 V > 2 Trip
Input 20 Trigger Trigger L/H
Digital Input 21 Freq High
Input 21 Trigger Trigger L/H
Digital Input 22 Freq Low
Input 22 Trigger Trigger L/H
Digital Input 23 Freq Not Found
Input 23 Trigger Trigger L/H
Digital Input 24 Unused
Digital Input 25 - 32 Unused
MEASURET SETUP
Default Display Date and Time
Local Values Primary
Remote Values Primary
Measurement Ref VA
COMMUNICATIONS
Rear Protocol Modbus
Remote Address 1
Inactivity Timer 15 mins
Baud Rate 19200
Parity None
COMMISSION TESTS
Opto I/P Status 0
Relay O/P Status 0
Test Port Status 0
LED Status 0
Monitor Bit 1 64
Monitor Bit 2 65
Monitor Bit 3 66
Monitor Bit 4 67
Monitor Bit 5 68
Monitor Bit 6 69
Monitor Bit 7 70
Monitor Bit 8 71
Test mode Disabled
Test LEDs No Operation
COMMON SETTINGS GROUP 1
V<B Status Enabled
V<B Voltage Set 25 V
Pick Up Cycles 5
Drop Off Cycles 3
Holding Timer 5 s
f+t SETTINGS GROUP1
Stage1 f+t Enabled
1(f+t) f 49 Hz
1(f+t) t 20 s
Stage2 f+t Enabled
2(f+t) f 48.6 Hz
2(f+t) t 20 s
Stage3 f+t Enabled
3(f+t) f 48.2 Hz
3(f+t) t 10 s
Stage4 f+t Enabled
4(f+t) f 47.8 Hz
4(f+t) t 10 s
Stage5 f+t Enabled
5(f+t) f 50.5 Hz
5(f+t) t 30 s
Stage6 f+t Enabled
6(f+t) f 51 Hz
6(f+t) t 20 s


f+df/dt SETTINGS GROUP 1
Stage1 f+df/dt Enabled
1(f+df/dt) f 49 Hz
1(f+df/dt) df/dt 1 Hz/s
Stage2 f+df/dt Enabled
2(f+df/dt) f 48.6 Hz
2(f+df/dt) df/dt 1 Hz/s
Stage3 f+df/dt Enabled
3(f+df/dt) f 48.2 Hz
3(f+df/dt) df/dt 1 Hz/s
Stage4 f+df/dt Enabled
4(f+df/dt) f 47.8 Hz
4(f+df/dt) df/dt 1 Hz/s
Stage5 f+df/dt Enabled
5(f+df/dt) f 50.5 Hz
5(f+df/dt) df/dt 1 Hz/s
Stage6 f+df/dt Enabled
6(f+df/dt) f 51 Hz
6(f+df/dt) df/dt 1 Hz/s
df/dt+t SETTINGS GROUP 1
Stage1 df/dt+t Enabled
1(df/dt+t) df/dt -2 Hz/s
1(df/dt+t) t 500 ms
Stage2 df/dt+t Enabled
2(df/dt+t) df/dt -2 Hz/s
2(df/dt+t) t 1 ms
Stage3 df/dt+t Enabled
3(df/dt+t) df/dt -2 Hz/s
3(df/dt+t) t 2 ms
Stage4 df/dt+t Enabled
4(df/dt+t) df/dt -2 Hz/s
4(df/dt+t) t 3 ms
Stage5 df/dt+t Enabled
5(df/dt+t) df/dt 2 Hz/s
5(df/dt+t) t 0.5 ms
Stage6 df/dt+t Enabled
6(df/dt+t) df/dt 2 Hz/s
6(df/dt+t) t 1 ms
f+Df/Dt SETTINGS GROUP 1
Stage1 f+Df/Dt Enabled
1(f+Df/Dt) f 49 Hz
1(f+Df/Dt) Df 500 mHz
1(f+Df/Dt) Dt 500 ms
Stage2 f+Df/Dt Enabled
2(f+Df/Dt) f 49 Hz
2(f+Df/Dt) Df 1 HZ
2(f+Df/Dt) Dt 1 s
Stage3 f+Df/Dt Enabled
3(f+Df/Dt) f 48.5 Hz
3(f+Df/Dt) Df 500 mHz
3(f+Df/Dt) Dt 500 s
Stage4 f+Df/Dt Enabled
4(f+Df/Dt) f 48.5 Hz
4(f+Df/Dt) Df 1 Hz
4(f+Df/Dt) Dt 1 s
Stage5 f+Df/Dt Enabled
5(f+Df/Dt) f 50.5 Hz
5(f+Df/Dt) f 50.5 mHz
5(f+Df/Dt) Df 500 ms
Stage6 f+Df/Dt Enabled
6(f+Df/Dt) f 51 Hz
6(f+Df/Dt) Df 500 mHz
6(f+Df/Dt) Dt 500 ms
GENR ABN PROTN GROUP 1
Band1 Freq Low 48.5 Hz
Band1 Freq High 49 Hz
Band1 Delay 180 mins
Band2 Freq Low 48 Hz
Band2 Freq High 48.5 Hz
Band2 Delay 120 mins
Band3 Freq Low 47.5 Hz
Band3 Freq High 48 Hz
Band3 Delay 60 mins
Band4 Freq Low 50.5 Hz
Band4 Freq High 53 Hz
Band4 Delay 60 mins
LOAD RESTORATION GROUP 1
Restore1 Status Disabled
Restore1 Freq 49.5 Hz
Restore1 Time 240 s
Restore2 Status Enabled
Restore2 Freq 49.5 Hz
Restore2 Time 180 s
Restore3 Status Enabled
Restore3 Freq 49.5 Hz
Restore3 Time 120 s
Restore4 Status Enabled
Restore4 Freq 49 Hz
Restore4 Time 240 s
Restore5 Status Disabled
Restore6 Status Disabled
VOLT PROTECTION GROUP 1
UNDER VOLTAGE
V< Measur't Mode Phase-Phase
V< Operate Mode Any Phase
V<1 Function DT
V<1 Voltage Set 80 V
V<1 Time Delay 10 s
V<2 Status Enabled
V<2 Voltage Set 60 V
V<2 Time Delay 5 s
OVERVOLTAGE
V> Measur't Mode Phase-Phase
V> Operate Mode Any Phase
V>1 Function DT
V>1 Voltage Set 130 V
V>1 Time Delay 10 s
V>2 Status Disabled
INPUT LABELS GROUP 1
Opto Input 1 L1 Setting Group
Opto Input 2 L2 Setting Group
Opto Input 3 L3 Stg1f+t Block
Opto Input 4 L4 Stg2f+t Block
Opto Input 5 L5 Stg3f+t Block
Opto Input 6 L6 Stg4f+t Block
Opto Input 7 L7 Stg6f+t Block
Opto Input 8 L8 Voltage Block
Opto Input 9 L9 Not Used
Opto Input 10 L10 Not Used
Opto Input11 L11 Not Used
Opto Input 12 L2 Not Used
Opto Input 13 L13 Not Used
Opto Input 14 L14 Not Used
Opto Input 15 L15 Not Used
Opto Input 16 L16 Not Used
OUTPUT LABELS GROUP 1 *
Relay 1 R1 Stg1 f+t Trip
Relay 2 R2 Stg2 f+t Trip
Relay 3 R3 Stg3 f+t Trip
Relay 4 R4 Stg4 f+t Trip
Relay 5 R5 Stg6 f+t Trip
Relay 6 R6 Stg1f+Df/Dt T
Relay 7 R7 Stg2f+df/dt T
Relay 8 R8 Stg3f+df/dt T
Relay 9 R9 Stg4f+df/dt T
Relay 10 R10 Voltage Strt
Relay 11 R11 Voltage Trip
Relay 12 R12 Gen Abn Trip
Relay 13 R13 Stg1 Restore
Relay 14 R14 Stg2 Restore

Publication: P94x/EN T/D11

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T&D Worldwide Contact Centre online 24 hours a day: +44 (0) 1785 25 00 70 http://www.areva-td.com/contactcentre/