Numerical Check Synchronism Relay

ARGUS 7

EASUN REYROLLE

Operation & Maintenance Instruction Manual

CONTENTS

TABLE OF CONTENTS

TABLE OF FIGURES

REFERENCE MATERIAL

[1] - REYDISP EVOLUTION : is a PC based relay support package which allows local or remote access to relays for uploading settings, downloading event and disturbance records, reading real-time data and allowing control of plant. The package is available from Reyrolle Protection and is compatible with all Argus range relays.

[2] - INFORMATIVE COMMUNICATIONS INTERFACE : a report detailing all aspects of the communications protocol used in the Argus range of relays is available from Reyrolle Protection. The report reference is 434TM05B.

1 INTRODUCTION

Check Synchronising or System Synchronising is required whenever two parts of a power system network, each containing generation, have to be connected or re-connected together. To avoid shock loading and possible damage to primary electrical plant the voltage, frequency and phase angle difference between the two systems should be within acceptable limits relative to one another.

Where the two systems have been previously interconnected before a circuit breaker (CB) was opened then the frequencies of the two systems will drift apart slowly and the phase angle difference will increase. Relatively large voltage and phase angle differences can be allowed with this slow slip rate since closing the CB will merely re-configure the system to its previous state. The relay will detect these conditions and apply the Check Synchronising settings as limiting parameters.

However, if the two systems are asynchronous and one system is an 'island' of generation then a high rate of slip may result causing the two systems to pass through anti-phase conditions. The rate of slip between the frequencies of the two systems will be much higher and be outside of the Check Synchronising setting parameters. The relay will detect this system split condition, inhibit the Check Synchronising algorithms and automatically apply System Synchronising settings as limiting parameters. Typically, in this mode, there will be a narrower allowable phase angle difference and also closure of the CB will only be allowed under decreasing phase angle difference conditions.

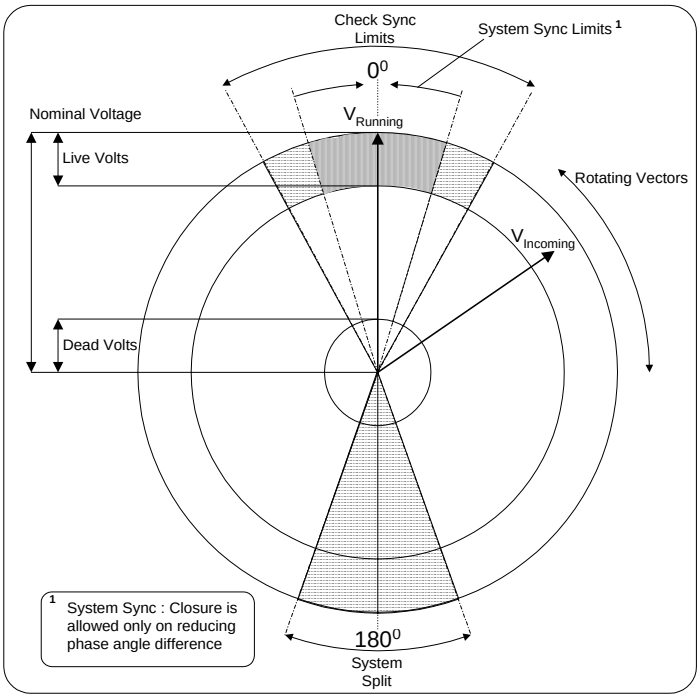


Figure 1 - Check and System Synchronising

The Argus 7 series Check and System synchronising relay is part of the comprehensive range of Argus platform based numeric relays. These relays have extensive control functions, which are supplemented by advanced metering, data storage and fibre optic communications. Supervisory and self-monitoring features give added confidence to the user as well as reduced maintenance and down time. A menu-based interface gives user-friendly access to relay settings, instrumentation and operational data.

The relay conforms to NGTS 3.7.7 and the relevant IEC255 standards.

2 HARDWARE DESCRIPTION

2.1 General

The Argus 7 series of relays are all housed in the Epsilon E4 size case. They consist of the following versions which differ only in their auxiliary and status supply voltages :

Relay Article No.	Nominal Aux. Volts	Status Volts
AG7-101	24/30/48VDC	48VDC
AG7-102	110/220VDC	48VDC
2732H30006	24/30/48VDC	30VDC

All of the Argus range of relays share common hardware components and modules. The design for the mechanical arrangement of the relays has been carefully chosen to provide a high level of EMI screening using multi-layer PCB's with ground planes, RFI suppression components and earthed metal screens. The internal arrangement has been divided into noisy and quiet areas in order to improve noise immunity and reduce RFI emissions. The only direct connection from the quiet components to the external environment is via the optical serial communications interface, which is immune to radiated or conducted interference.

2.2 Analogue Inputs

The input stage of the Argus 7 relay measures two basic quantities, V_{Line} and V_{Bus}. The voltage transformer inputs are suitable for either phase to phase or phase to neutral connections and the input stage measures over the range of 1 Vrms to 200 Vrms. It maintains accuracy within ±1% over the range 5 Vrms to 132 Vrms.

In order to ensure high accuracy true RMS measurements and accurate phase and slip frequency calculations, the voltage signals are sampled at 32 samples per cycle for both 50Hz and 60Hz system frequencies. The high sampling rate provides high accuracy and quality waveform storage records, which are stored at a rate of 16 samples per cycle.

2.3 Output Relays

The Argus 7 relay has 7 output relays in total, which are rated for handling breaker control duty. All 7 relays are fully user configurable and can be programmed to operate from any or all of the control functions. They consist of 1 C/O contact, 1 N/C contact and 5 N/O contacts.

In their normal mode of operation output relays remain energised for at least 100ms. If required, however, outputs can be programmed to operate as latching relays. These latched outputs can be reset by either pressing the TEST/RESET button, by energising a status input or by sending an appropriate communications command.

A trip test feature is provided to exercise the output contacts.

Note :- When output relays are required to perform control functions such as circuit breaker closing, care must be taken in applying relay settings to ensure that the outputs do not latch unless specifically required to do so.

2.4 Status Inputs

There are a total of 4 status inputs available in the relay. All status inputs are fully user programmable and have associated pick-up and drop-off timers. These timers allow software filtering to be applied, which provides security in the presence of any induced a.c. voltages in the external wiring. If high-speed operation is required then the pick-up delay should be set to zero.

Each of the status inputs can be programmed to perform one or more of the following functions :

- Start Check Synchronising.
- Start System Synchronising.
- Synchronising Bypass.
- Inhibit Check or System synchronising.
- Select an alternative settings group.
- Trigger storage of a waveform record.
- Synchronise the real time clock.
- Reset the Lockout condition.
- Reset latched output relays.
- Energise an output relay.
- Raise an Alarm annunciation.

Additionally, each status can have its logic inverted with the Status Invert feature.

2.5 Self Monitoring

The relay incorporates a number of self-monitoring features. Each of these features can initiate a controlled reset sequence, which can be used to generate an alarm output. In addition, the Protection Healthy LED will give visual indication.

A watchdog timer continuously monitors the microprocessor and the relay program memory is continuously checked for data corruption using a cyclic redundancy check (CRC) routine. The voltage rails are also continuously supervised and the microprocessor is reset if any of the rails falls outside of their working ranges. Any failure is detected in sufficient time so that the micro can be shut down in a safe and controlled manner.

3 CONTROL FUNCTIONS

3.1 Voltage Monitoring Elements

3.1.1 Undervoltage Detector Elements

The undervoltage detector elements, if enabled, can block a close output command if either the line or bus voltages are below the undervoltage setting value. Both line and bus voltages have their own independent settings.

Note : if any of the input voltages falls below 5Vrms all synchronising algorithms are blocked and a close will not be possible. However, a bypass close will be possible in this situation, see section 3.1.4.

3.1.2 Differential Voltage Detector Element

The differential voltage detector element, if enabled, can block a close output command if the scalar difference between the line and bus voltages is greater than the differential voltage setting value.

3.1.3 Voltage Level Elements

The voltage level elements determine the status of the line or bus. If the voltages on either the line or bus are below a set threshold level they can be considered to be ‘dead’. If the voltages are within a setting band around the nominal voltage they are classed as ‘live’. Independent voltage level elements are provided for both line and bus voltage inputs.

If a voltage is in the dead band range then it will be classed as dead until it has reached the live band area. Similarly, if a voltage is live, it continues to be live until it has reached the dead band area. This effectively allows for variable amounts of hysteresis to be set. Figure 2 illustrates the voltage detector operation.

Note : the area between the dead and live zones is not indeterminate. When any voltage is applied to the relay it will ramp up the software RMS algorithm and always pass through the dead zone first.

Although a wide range is provided for live and dead voltage level elements, these must not overlap. The relay software acts to prevent this from happening, this is to stop unusual alarm outputs and conflicts with internal logic elements. If the user attempts to increment the dead voltage level to the live voltage level, the relay will automatically increase the live voltage to be 5V above the dead voltage level. Similarly, if the live level is decremented to the dead level, the dead level will drop keeping a hysteresis gap of 5V. The two voltages are displayed simultaneously on the LCD display so that this operation is clear to the user.

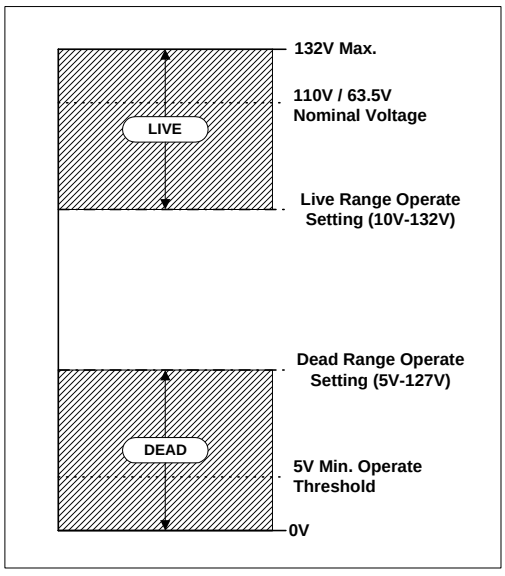


Figure 2 - Voltage Level Element Operation

3.1.4 Sync Bypass Logic

For switching operations, which involve connecting an uncharged line or bus to a live line or live bus, a means of bypassing the synchronising operation is required. This is achieved using the Sync Bypass setting. The range of setting values for this are :

- Dead Line AND Live Bus : (DL & LB)
- Live Line AND Dead Bus : (LL & DB)
- Dead Line AND Dead Bus : (DL & DB)

- Dead Line OR Dead Bus : (DL or DB)
- Dead Line Exclusive OR Dead Bus : (DL xor DB)

To bypass the synchronisation feature and issue a Bypass Close output the particular line and bus conditions have to be met and the Sync Bypass status input has to be energised. The Bypass Close output will stay on for the duration of the status input energisation and while the line and bus conditions are met.

Alarms outputs can be generated from these conditions and these are dead line (DL), dead bus (DB), DL&LB, LL&DB, and DL&DB.

3.1.5 Voltage Trim Feature

The relay incorporates a voltage trim feature, which allows small adjustments to the input voltages of the relay. For 110V nominal or 63.5V nominal connections, the relay in service may not see exactly the expected nominal voltages. This is due to losses from cable lengths and joints and also due to small inaccuracies in the voltage transformers (VT's). Sometimes, interposing VT's are used to trim the voltages seen by the relay back to their nominal values. This feature does away with the need for interposing VT's because the relay can digitally adjust the incoming samples by a scaling factor back to their expected nominal values.

Each voltage input, V_{Line} and V_{Bus}, has an independent voltage trim in the range of – 5.0V to + 5.0V with a step size of 0.1V.

Internally to the relay the voltage trim value will be turned into a multiplying factor derived from the Rated Voltage setting. Therefore on a 110V connected system with secondary losses making the system voltage e.g. 108V, a 2.0V trim could be applied. The relay will convert this to a multiplier of 110 / 108 = 1.0185 which will be applied to the sampled voltage data. An important point to note is that the accuracy of the trim feature is only guaranteed where the system voltages are either 110V or 63.5V because the internal multiplier is based on the rated voltage.

3.2 Check Synchronising (CS) Operation

For the relay to issue a Check Sync Close the following conditions have to be met :

CS PHASE ANGLE – the phase difference between the line and bus voltages has to be less than the phase angle setting value. Whilst within the limits the phase angle can be increasing or decreasing and the element will still issue a valid close signal.

CS SLIP TIMER, [If ENABLED] – the phase angle and voltage blocking features have to be within their parameters for the duration of the slip timer setting. If either the phase angle or the voltage elements fall outside of their limits the slip timer is reset. If they subsequently come back in then the slip timer has to time out before a close output is given. (This ensures that a close output will not be given if there is a transient disturbance on the system due to e.g. some remote switching operations).

CS SLIP FREQUENCY, [If ENABLED] – the frequency difference between line and bus voltages has to be less than the slip frequency setting value.

LINE U/V DETECTOR, [If ENABLED] – the line voltage has to be above the line undervoltage setting value and also above 5V for an output to be given.

BUS U/V DETECTOR, [If ENABLED] – the bus voltage has to be above the bus undervoltage setting value and also above 5V for an output to be given.

DIFFERENTIAL VOLTAGE DETECTOR, [If ENABLED] – the scalar difference between the line and bus voltages has to be less than the ΔV detector setting value for an output to be given.

The Check Synchronising operation of the relay can be initiated in two different ways.

This is set by the 'Check Sync Enable' setting which has two parameters : **AUTO** and **MANUAL**.

AUTO : The relay will issue a Check Sync Close output automatically if the relevant conditions mentioned above are met.

MANUAL : The relay will only issue a Check Sync Close output if the relevant conditions are met AND if it has received a command to do so. This command is issued via the Start Check Sync status input. (See also section 3.2.1 Close Guard Feature).

Note : the Check Sync Close output relay will stay on for a minimum time of 100ms and for the whole duration of the time that the system parameters are met.

Figure 3 illustrates the Check Sync Function logic.

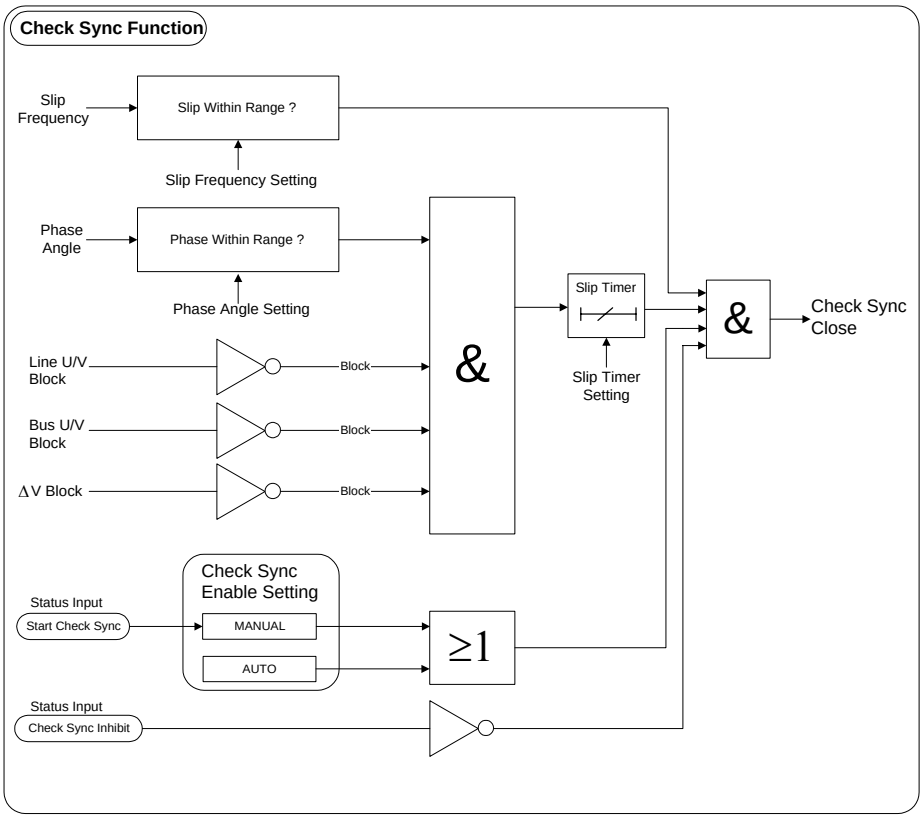


Figure 3 - Check Sync Function

3.2.1 Close Guard Feature

If manual closes are required to be carried out via an operator, the 'Close Guard' feature can be enabled which prevents the operator from initiating a CB close before the relay issues a valid Check Sync Close signal. This prevents the operator from pre-empting the relays' decision. When active and the operator is trying to pre-empt the relay the LCD will display the following message :

(The bottom line of the General Alarm screen will continuously scroll sideways with the message 'Close Guard Active'.)

To enable the feature the Close Guard setting has to be set to ON. This setting is found in the Check Sync menu. When the Start Check Sync status input is then energised the close guard feature will be active and a Check Sync Close output will not be given unless all of the relay setting parameters are met by the system.

3.3 System Split Detector

A system split occurs where the opening of a CB disconnects two separate sections of a grid network. Since the two grid sources are not coupled the frequencies can drift apart even though the independent control systems employ the same reference frequency. A small drift in frequency can lead to a major phase angle difference. The system split detector operates when the phase angle difference exceeds a pre-set value. The setting range for a system split is from 90° to 175° (setting step is 1°).

Note : the system split setting is effectively an absolute value and therefore a split will occur at the value regardless of the direction of the frequency slip e.g. if an angle of 170° is selected, then starting from 0°, a split will occur at either +170° or -170° (effectively +190°).

The system split detector has an associated timer, the Split Timer which holds the system split output on for a minimum time set by the timer setting value. This can be used when interfacing with delayed autoreclose (DAR) schemes.

If a system split occurs during a Check Sync operation and the System Split Detector has been enabled then the following events occur :

- The Check Sync function is inhibited.
- The System Sync function is started if the setting has been set to AUTO. If the System Sync function has been set to LOCKOUT, then, only a system split LED indication is given and the relay will be in lockout mode. The relay will stay in this lockout mode until one of the following methods of resetting it is performed:
  1) The AC voltage supplies are removed and re-applied.
  2) The Test/Reset button is pressed on the relay fascia.
  3) A status input command is received.
  4) An appropriate IEC870-5-103 communications command is received.
- An event is recorded.
- The split flag can be mapped to an output relay for alarm indication.
- The system split LED will stay on for the split timer delay time.

3.4 System Synchronising (SS) Operation

For the relay to issue a System Sync Close the following conditions have to be met :

SS PHASE ANGLE – the phase difference between the line and bus voltages has to be less than the phase angle setting value and the phase angle has to be decreasing before the element will issue a valid close signal.

SS SLIP TIMER, [If ENABLED] – the phase angle and voltage blocking features have to be within their parameters for the duration of the slip timer setting. If either the phase angle or the voltage elements fall outside of their limits the slip timer is reset. If they subsequently come back in then the slip timer has to time out before a close output is given. (This ensures that a close

output will not be given if there is a transient disturbance on the system due to e.g. some remote switching operations).

SS SLIP FREQUENCY, [If ENABLED] – the frequency difference between line and bus has to be less than the slip frequency setting value.

LINE U/V DETECTOR, [If ENABLED] – the line voltage has to be above the line undervoltage setting value and also above 5V for an output to be given.

BUS U/V DETECTOR, [If ENABLED] – the bus voltage has to be above the line undervoltage setting value and also above 5V for an output to be given.

DIFFERENTIAL VOLTAGE DETECTOR, [If ENABLED] – the scalar difference between the line and bus voltages has to be less than the ΔV detector setting value for an output to be given.

The System Synchronising operation of the relay can be initiated in two different ways.

This is set by the 'System Sync Enable' setting which has three parameters : **AUTO**, **MANUAL** and **LOCKOUT**.

AUTO : The relay will only start system synchronising after a split condition has occurred. It will issue a System Sync Close automatically if the relevant conditions are met.

MANUAL : The relay will only start system synchronising after a split condition has occurred. It will only issue a System Sync Close output when it has received a command to do so. This command can be issued via the Start System Sync status input or it can come via the communications interface.

(An ASDU20 general command can be used to start the System Sync function. This can be sent using REYDISP EVOLUTION [1] or via any communications network with IEC870-5-103 driver capability. For more information see [2]).

LOCKOUT : After a split has occurred the relay will go into lockout mode.(See section 3.3)

Note : the System Sync function has a close pulse timer, which is set by the SS Close Pulse setting. The System Sync Close output will be given for a minimum of 100ms or for the duration of the SS Close Pulse setting.

Figure 4 overleaf illustrates the System Sync Function logic.

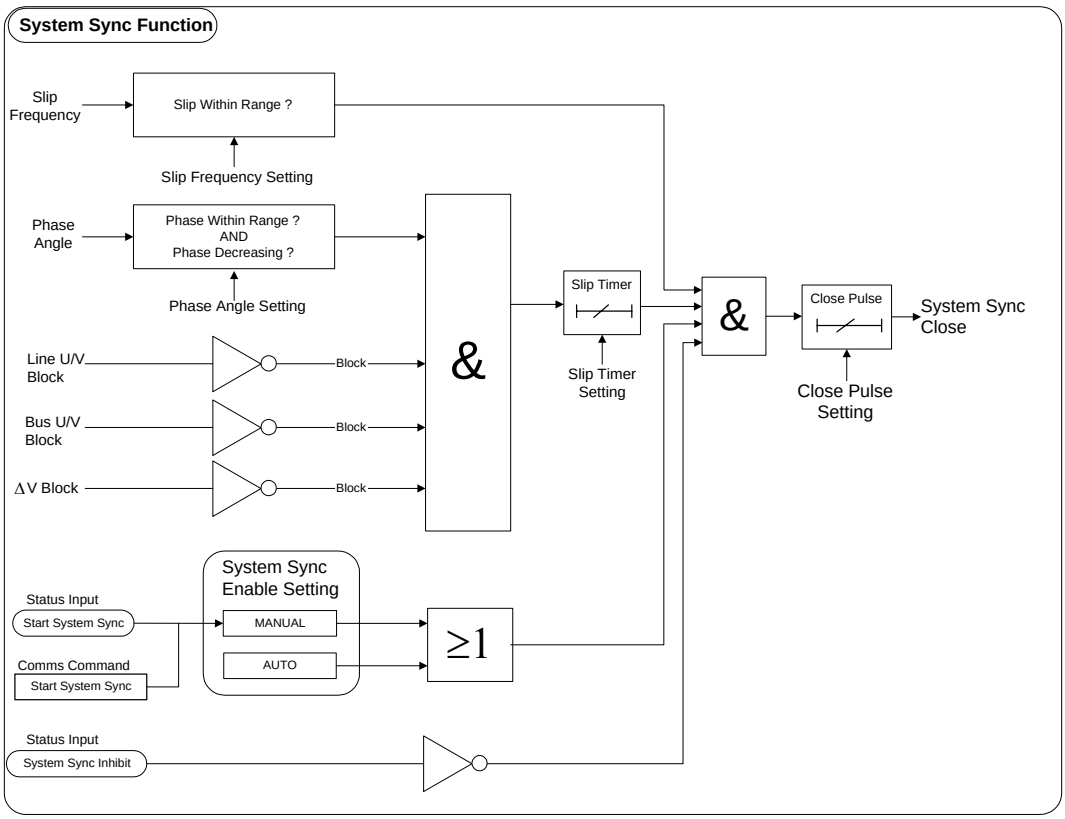


Figure 4 - System Sync Function

4 OTHER FEATURES

4.1 Instrumentation

The Argus metering feature provides real-time data available from the relay fascia in the 'Instruments Mode' or via the communications interface. The following displays are available :

- Primary RMS volts for both Line and Bus
- Secondary RMS volts for both Line and Bus
- Frequency of both Line and Bus
- Phase difference between Line and Bus
- Frequency slip between Line and Bus
- Phase - In / Out of limits
- Slip - In / Out of limits
- Line and Bus health status i.e. Live or Dead
- Voltage blocking element status
- Output relay status
- Digital input status
- General alarm screen

- Number of waveforms recorded
- Number of events stored
- Date - displayed in DD/MM/YY format
- Time - displayed in HH:MM:SS format
- Relay Mode :- This is a special instrument which shows the mode of operation of the relay and its particular state in a single display. This shows if the relay has been set as a Check synchroniser or as both a Check and System synchroniser. It also shows, in real-time, the health of the line and bus volts and the particular operational state i.e. whether it is check synchronising, system synchronising or in bypass or system split modes.

Note : while the instrument displays are updated as often the software routines can service them, some have their response time deliberately slowed down to enable them to be read. The first four displays in the list, which show the analogue measurands have a response time of approximately 500ms.

Figure 5 shows the display menu structure from where the available instruments can be accessed. Note that pressing the ⇨ Test/Reset key can clear two of the instruments, waveforms and events.

4.2 Data Storage

Details of relay operation are recorded in three forms, namely Waveform records, Event records and Close Data records. All records are time and date stamped with a year 2000 compatible real time clock which maintains the time even when the relay is de-energised [see Note]. Time and date can be set either via the relay fascia using appropriate commands in the System Config menu or via the communications interface. In the latter case, relays connected in a network can be synchronised by a global time sync command.

Alternatively, synchronising pulses can be received via a status input. To use this feature one of the status inputs has to be assigned to the 'Clock Sync' feature in the Status Config menu. Additionally the 'Clock Sync Period' setting in the System Config menu should be set to either 'seconds' or 'minutes'. If 'seconds' are selected then the energisation of the selected status input will result in the clock being synchronised to the nearest second with the milliseconds set to zero. If 'minutes' are selected, however, then the clock is synchronised to the nearest minute with both seconds and milliseconds set to zero.

Note : the real-time clock, waveform records and event records are all maintained by the backup storage capacitor. This capacitor has the ability to maintain the charges on the real-time clock IC and the SRAM memory device for typically 2-3 weeks time duration. This time, however, is influenced by factors such as temperature and the age of the capacitor and could be shorter.

4.2.1 Waveform Records.

The waveform record feature stores analogue and digital information for the voltage inputs, status inputs and output relays. A single phase waveform record for both the line and bus voltages can be stored and this shows the voltages at either side of the circuit breaker at the moment of closing of the switch. The waveform record is 1.5 second wide (1.25sec at 60Hz) with a sampling resolution of 16 samples per cycle. The recorder feature has the ability to store records for the previous five close operations of the relay. These are labelled 1-5 with 1 being the most recent record.

The waveform recorder can be triggered in the following ways ;

- Via the waveform trigger status input signal.
- If the synchronising mode is set to AUTO then on issuing a Check or System synchronising close output.

- If the synchronising mode is set to MANUAL, then on receipt of a Start Check Sync command signal, the relay will trigger the waveform recorder when it issues a Check Sync Close output signal. (Note: if the Close Guard feature is operating and blocking the close output then a waveform record will not be triggered).
- If the synchronising mode is set to MANUAL, then on receipt of a Start System Sync command signal, the relay will trigger the waveform recorder when it issues a System Sync Close output signal. (Note: the Close Guard feature is not available for system synchronising operations).
- If Sync Bypass is enabled, then, the relay will trigger the waveform recorder when it issues a Bypass Close output signal.

4.2.2 Event Records

The event recorder feature allows the time tagging of any change of state (event) of the relay. As an event occurs the actual event condition is logged as a record along with a time and date stamp to a resolution of 5ms. There is capacity for a maximum of 500 event records to be stored in the relay and when the event buffer is full any new record will over-write the oldest. The following events are logged :

- Change of setting (though not the actual setting change). Also indication of which group of settings is active.
- Change of state of each output relay.
- Change of state of each status Input.
- Change of state of any of the control functions of the relay.
- Change of state of any of the voltage elements.

For a full list of all the events available see Table 1.

4.2.3 Close Data Records

The relay has a 'Close Data Mode' display which provides information about a close decision that the relay has made. The information stored includes the date and time, the setting group used, the type of closure, the phase and slip measurands and the line and bus voltages and frequency information at the time of the close decision. There are 10 close data records stored in a cyclical buffer labelled 1-10 with record 1 being the newest. Whenever the relay issues any type of close e.g. check sync, system sync or bypass close, a record of its decision is stored off. To examine the close data records navigate the menu to the Close Data Mode and press the ⇩ arrow (See Figure 5 - Display Menu Structure). A scrolling message with the following typical information will then be displayed :-

CLOSE 1 01/01/00 00:02:09.5750 G1, SS CLOSE, PHASE= +2.3º, SLIP= -0.03Hz, BUS= 109.5V 50.01Hz, LINE= 110.7V 49.98Hz.

4.3 Communications

A fibre optic communication port is provided which gives superior EMC performance. Communication is compatible with the IEC870-5-103 FT 1.2 transmission and application standards. For communication with the relay via a PC (personal computer) a user-friendly software package, REYDISP EVOLUTION [1], is available to allow transfer of the following:

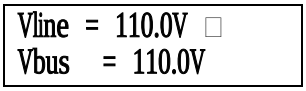
- Relay Settings
- Waveform Records

- Event Records
- Close Data Records
- Instrument and meters
- Control Functions

Communications operation is described in detail in Section 4 of this manual.

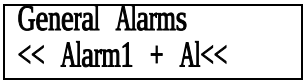
4.4 Default Displays and General Alarms

Any one or more of the Argus 7 instrument displays can be selected as a default display by pressing the ENTER key while viewing the particular display. When a display has been selected it shows a block '□' on the top line of the LCD. To de-select simply press ENTER again which toggles it between on and off.



If no keys have been pressed for a pre-determined time the relay will jump to the default instrument display regardless of where the menu system has been left by the user. It will then scroll through each of the selected default instruments and remain on each for 5 seconds. The main timer which sets the time to elapse before the relay goes into the default instruments mode is found in the System Config Menu. This is the Default Screen Timer setting and it can be set to a range of values from 10 seconds to 1 hour. See the relay settings Section 3 of this manual.

Argus 7 provides a General Alarm screen which can place user-defined messages of upto 13 characters in length onto the LCD. Alarms are triggered when a status input is energised and the display will jump to the general alarm screen automatically and display the message. The message appears on the LCD for the duration of the time that the status input is energised. The Argus 7 has 4 status inputs and so can have 4 different alarms to display. If more than one status input is energised then the alarm screen will scroll with the messages separated by a '+' sign.



To set up a general alarm requires the LCD message to be entered. This is input with the Set Alarm settings found in the System Config menu. Each general alarm screen has to then be assigned to a status input and this is done with the Alarm settings in the Status Config menu.

4.5 Multiple Settings Groups.

Argus relays provide eight alternative setting groups, making it possible to edit one group while the relay protection algorithms operate using another 'active' group. An indication of which group is being viewed is given by the 'Gn' character in the top left of the display. The relay can then be switched from one group of settings to another to cater for reconfiguration of the power system. Changeover will occur within 25 ms.

A change of group can be achieved either locally at the relay fascia, remotely via a communication interface command or by energisation of a status input. In the case of the latter method, the 'Settings Group Select' setting is used to configure any one (or more) of the status inputs to select a settings group. The selected group is then made active if the status input is energised and remains active for as long as the input remains energised.

4.6 Password Feature

The programmable password feature enables the user to enter a 4 character alpha-numeric code to secure access to the relay settings. The relay is supplied with the password set to

'NONE' which means that the password feature is not activated. Once a password has been entered then it will be required thereafter to change settings. It can, however, be de-activated by using the password to gain access and by resetting it back to 'NONE'.

As soon as the user attempts to change a setting the password is requested before any setting alterations are allowed. Once the password has been validated, the user is 'logged on' and any further changes can be made without re-entering the password. If no more changes are made within 1 hour then the user will automatically be 'logged off', re-enabling the password feature.

Note that the password validation screen also displays a numerical code. If the password is lost or forgotten, this code can be communicated to Reyrolle Protection by authorised personnel, and the password can be retrieved.

5 USER INTERFACE

The user interface is designed to provide a user-friendly method of entering settings and retrieving data from the relay. The relay fascia includes a 16 character by 2 line, backlit, liquid crystal display (LCD), 3 light emitting diodes (LED) and 5 push buttons. Figure 6 shows the Argus 7 fascia.

5.1 Liquid Crystal Display

The liquid crystal display is used to present settings, instrumentation and close data in a textual format.

To conserve power the display backlighting is turned off if no push buttons are pressed for 5 minutes. After one hour the whole display is de-activated except if the display is left in the 'Instruments Mode' where it remain visible permanently. This is so that instruments such as voltages can be displayed continuously. Also, if any default instruments have been selected then the display will not power down, only the backlight will turn off. Once the backlight is off, any following keypress will turn the backlight on without changing the display.

5.2 LED Indications

The following indications are provided :

- **Relay Healthy – Green LED.**

This LED is solidly illuminated to indicate that DC volts have been applied to the relay and that the relay is operating correctly. If the internal relay watchdog detects a permanent fault then this LED will continuously flash.

- **Check / System Sync – Yellow LED.**

This indicates that a Check Sync or System Sync output is being issued.

- **System Split – Red LED**

This LED indicates when a system split occurs, i.e. whenever the phase angles are within the system split limits. If the system split timer is set to 0 seconds, then the LED will reset as soon as the phases fall outside of the system split limits. Otherwise the LED will stay on for the system split timer setting time and reset after this.

If the relay has been set up as a Check synchroniser only and not Check and System synchroniser then, if a system split occurs, the system split LED will remain on until the Test/Reset button is pressed, or, the voltage supplies are removed and re-applied.

5.3 Keypad

Five pushbuttons are used to control the functions of the relay. They are labelled ⇧ ⇩ ⇨ ENTER and CANCEL. Note that the ⇨ button is also labelled TEST/RESET.

When the relay front cover is in place only the ⇩ and ⇨ buttons are accessible. This allows only read access to all the menu displays. It is not possible to change settings.

6 SETTINGS AND DISPLAYS

The display menu structure is shown in Figure 5. This diagram shows the three main modes of display, which are the Settings Mode, Instruments Mode and the Close Data Mode.

On initial relay start up the user is presented with a default relay identifier,

which shows that the relay has been set with the standard factory default settings. The bottom line of the LCD can be changed to some user-definable identifier or code if preferred.

Pressing the ⇨ key on this display initiates an LED test. Pressing ⇩ at this display allows access to the three display modes which are accessed in turn by pressing the ⇨ key.

The Settings Mode contains 8 setting sub-menu's. These hold all of the programmable settings of the relay in separate logical groups. The sub menu's are accessed by pressing the ⇨ key. This enters the sub menu and presents a list of all the settings within that sub menu. Pressing the ⇩ key scrolls through the settings until after the last setting in the group the next sub menu is presented. Access to this group is via the same method as before. If a particular sub menu is not required to be viewed then pressing the ⇩ key will skip past that particular menu and present the next one in the list. Note that all screens can be viewed even if the password is not known. The password only protects against unauthorised changes to settings.

While viewing an editable screen pressing the ENTER key allows the user to change the displayed data. The editable field will be indicated by a flashing character(s). Pressing ⇧ or ⇩ scrolls through the available setting values or, pressing the ⇨ key moves right through the edit fields. Note that all settings can be incremented or decremented using the ⇧ or ⇩ keys and they all wrap-around so that to go from e.g. a setting minimum value to the maximum value it is quicker to press the ⇩ key, rather than scroll up through every setting. Also, to facilitate quicker setting changes an acceleration feature is employed which if ⇧ or ⇩ are depressed and held, then the rate of scrolling through the setting values increases.

If CANCEL is pressed during a setting change operation the original setting value is restored and the display is returned to the normal view mode.

If changes are made to the setting value then pressing ENTER disables the flashing character mode and displays the new setting value. This is immediately stored in non-volatile memory.

The next sections give a description of each setting in the relay. The actual setting ranges and default values can be found in the Relay Settings section of this manual.

Note : the relay exhibits a method of hiding settings which are not relevant to a particular customer scheme which is known as setting dependencies. Some settings are dependant on others and if a function is not enabled then associated settings are not displayed e.g. if there is no requirement for sync bypass then the setting Gn Sync Bypass should be set to OFF. This automatically removes the Gn Bypass Close option from the Output Relay Config. Menu because it is not required. Another example is the System Split Detector. If this is set to OFF then the System Split Timer is not displayed as it is not required.

There are many examples of setting dependencies and care must be taken to ensure a function is enabled before looking for other associated settings which otherwise would be hidden. The following list of settings shows all possible settings that can be displayed.

6.1 System Config Menu

Active Setting Group – this setting selects the settings group that the relay will act upon.

Settings Group Edit/View – this setting selects the settings group to be displayed on the LCD.

Copy Group – this setting allows the contents of one settings group to be copied completely to another group. Note that Copy Group will not allow the copying of a group onto the currently active group.

Power System Frequency – this setting selects between 50Hz or 60Hz nominal system frequencies.

Rated Voltage – this setting sets the rated voltage of the relay, either 63.5V or 110V.

Line Voltage Trim – this setting adjusts the incoming line voltage samples to compensate for losses.

Bus Voltage Trim – this setting adjusts the incoming bus voltage samples to compensate for losses.

V.T. Ratio – this setting sets the VT ratio, which allows the relay to calculate the primary voltage quantities displayed in the instruments mode.

Set Identifier – this setting allows a 16 character alphanumeric code or unique identification reference to be entered for the relay.

Set Alarm 1 – this setting allows a 13 character alphanumeric string to be entered for the General Alarm screen. It will be displayed on the energisation of the ALARM 1 status input.

Set Alarm 2 – this setting allows a 13 character alphanumeric string to be entered for the General Alarm screen. It will be displayed on the energisation of the ALARM 2 status input.

Set Alarm 3 – this setting allows a 13 character alphanumeric string to be entered for the General Alarm screen. It will be displayed on the energisation of the ALARM 3 status input.

Set Alarm 4 – this setting allows a 13 character alphanumeric string to be entered for the General Alarm screen. It will be displayed on the energisation of the ALARM 4 status input.

Calendar – Set Date – this setting sets the current date in DD/MM/YY format.

Clock – Set Time – this setting sets the time in HH:MM:SS format. Note that only the hours and minutes can be set. The seconds default to zero on pressing the ENTER key.

Clock Sync. From Status – this setting sets the period of synchronisation of the clock to the nearest second or minute. The synchronisation occurs on energisation of the Clock Sync. Status input.

Default Screen Timer – this setting sets the time required to have elapsed before the LCD jumps to the default instruments display.

Change Password – this setting allows a 4 character alphanumeric code to be entered as the password. Note that the display shows a password dependant encrypted code on the second line of the LCD.

6.2 Voltage Setting Menu

Gn DeadL : LiveL – this setting sets the Line input dead and live voltage limits.

Gn DeadB : LiveB – this setting sets the Bus input dead and live voltage limits.

Gn Line U/V Detector – this setting sets the Line undervoltage blocking element level.

Gn Bus U/V Detector – this setting sets the Bus undervoltage blocking element level.

Gn Δ Voltage Detector – this setting sets the differential voltage blocking element level.

Gn Sync Bypass – this setting sets the synchronisation bypass logic.

6.3 Check Sync Menu

Gn Check Sync Enable – this setting sets the mode of operation of the Check Sync. element.

Gn CS Phase Angle – this setting sets the phase angle limits for the Check Sync. element.

Gn CS Slip Timer – this setting sets the Check Sync. slip timer delay time.

Gn CS Slip Freq. – this setting sets the Check Sync. slip frequency limit.

Gn System Split Detector – this setting sets the angle at which a system split will occur.

Gn System Split Timer – this setting sets the system split timer delay time. This holds the split flag on for the set value.

Gn Close Guard – this setting enables the close guard logic feature.

6.4 System Sync Menu

Gn System Sync Enable – this setting sets the mode of operation of the System Sync. element.

Gn SS Phase Angle – this setting sets the phase angle limits for the System Sync. element.

Gn SS Slip Timer – this setting sets the System Sync. slip timer delay time.

Gn SS Slip Freq. – this setting sets the System Sync. slip frequency limit.

Gn SS Close Pulse. – this setting sets the time that the System Sync. Close output relay will stay energised for.

6.5 Output Relay Config Menu

Gn Relay Healthy – this setting sets the output relay operated by the relay watchdog monitor. An output relay with a changeover or normally closed contact should be used for this function.

Gn Check Sync Close – this setting sets the output relay(s) which is operated when a check synchronising close output is given.

Gn System Sync Close – this setting sets the output relay(s) which is operated when a system synchronising close output is given.

Gn Bypass Close – this setting sets the output relay(s) which is operated when a bypass synchronising close output is given.

Gn System Split – this setting sets the output relay(s) which is operated when a system split output is given.

Gn U/V Line – this setting sets the output relay(s) which is operated when the Line undervoltage blocking element operates.

Gn U/V Bus – this setting sets the output relay(s) which is operated when the Bus undervoltage blocking element operates.

Gn ⊿Voltage – this setting sets the output relay(s) which is operated when the differential voltage blocking element operates.

Gn Live Line (LL) – this setting sets the output relay(s) which is operated when the Line voltage reaches the live range limits.

Gn Live Bus (LB) – this setting sets the output relay(s) which is operated when the Bus voltage reaches the live range limits.

Gn Dead Line (DL) – this setting sets the output relay(s) which is operated when the Line voltage reaches the dead range limits.

Gn Dead Bus (DB) – this setting sets the output relay(s) which is operated when the Bus voltage reaches the dead range limits.

Gn DLLB – this setting sets the output relay(s) which is operated when the Line voltage reaches the dead range limits AND the Bus voltage reaches the live range limits.

Gn LLDB – this setting sets the output relay(s) which is operated when the Line voltage reaches the live range limits AND the Bus voltage reaches the dead range limits.

Gn DLDB – this setting sets the output relay(s) which is operated when the Line voltage reaches the dead range limits AND the Bus voltage reaches the dead range limits.

Gn Status 1 – this setting sets the output relay(s) which is operated when status input 1 is energised.

Gn Status 2 – this setting sets the output relay(s) which is operated when status input 2 is energised.

Gn Status 3 – this setting sets the output relay(s) which is operated when status input 3 is energised.

Gn Status 4 – this setting sets the output relay(s) which is operated when status input 4 is energised.

Gn Hand Reset – this setting sets the output relay(s) which is to be latched on operation.

O/P Relay Test – this setting allows any combination of output relays to be energised. This is achieved by selecting one of the output settings defined in the above list. The software will energise the particular control function e.g. U/V Line and energise it's associated output relay for 100ms.

6.6 Status Config Menu

Settings Group Select – this setting sets the status input, required to be energised, to enable a particular active settings group. Note that the lower the number of status input, the higher precedence that it has e.g. Status 1 will take precedence over all of the rest.

Inverted Inputs – this setting sets the status input(s) which are required to have their operating logic inverted.

Gn Start Check Sync – this setting sets the status input(s) which, when energised, starts the check synchronising operation of the relay.

Gn Start System Sync – this setting sets the status input(s) which, when energised, starts the system synchronising operation of the relay.

Gn Sync Bypass – this setting sets the status input(s) which, when energised, bypasses the synchronisation operation.

Gn Check Sync Inhibit – this setting sets the status input(s) which, when energised, will inhibit the check synchronising close operation.

Gn System Sync Inhibit – this setting sets the status input(s) which, when energised, will inhibit the system synchronising close operation.

Gn ALARM 1 – this setting sets the status input which, when energised, causes the Alarm 1 character string to be displayed on the general alarm screen.

Gn ALARM 2 – this setting sets the status input which, when energised, causes the Alarm 2 character string to be displayed on the general alarm screen.

Gn ALARM 3 – this setting sets the status input which, when energised, causes the Alarm 3 character string to be displayed on the general alarm screen.

Gn ALARM 4 – this setting sets the status input which, when energised, causes the Alarm 4 character string to be displayed on the general alarm screen.

Gn Waveform Trig – this setting sets status input which, when energised, triggers a waveform record storage.

Gn Clock Sync. – this setting sets status input which, when energised, will synchronise the clock to either the nearest second or minute.

Gn Reset Lockout Mode – this setting sets status input which, when energised, will reset the relay lockout condition.

Gn Reset Outputs – this setting sets status input which, when energised, will reset all latched output relays.

Gn Status 1 P/U Delay – this setting sets the time delay to be applied to the pick-up of status input 1.

Gn Status 1 D/O Delay – this setting sets the time delay to be applied to the drop-off of status input 1.

Gn Status 2 P/U Delay – this setting sets the time delay to be applied to the pick-up of status input 2.

Gn Status 2 D/O Delay – this setting sets the time delay to be applied to the drop-off of status input 2.

Gn Status 3 P/U Delay – this setting sets the time delay to be applied to the pick-up of status input 3.

Gn Status 3 D/O Delay – this setting sets the time delay to be applied to the drop-off of status input 3.

Gn Status 4 P/U Delay – this setting sets the time delay to be applied to the pick-up of status input 4.

Gn Status 4 D/O Delay – this setting sets the time delay to be applied to the drop-off of status input 4.

6.7 Comms Interface Menu

Comms Baud Rate – this setting sets the required communications Baud rate.

Comms Parity – this setting sets the required communications parity bit.

Relay Address – this setting sets the required address of a particular relay within a network.

Line Idle – this setting sets the required communications line idle sense.

Data Echo – this setting enables data echo, which is necessary for use with relays connected in a ring.

6.8 Data Storage Menu

Gn Waveform Trig – this setting selects the control functions which trigger the storage of a waveform record.

Gn Waveform Pre-Trigger – this setting sets the percentage of pre-trigger that is required.

Clear All Waveforms – this setting clears all waveform records stored. Note that this can also be done at the instruments display. (see Figure 5).

Clear All Events – this setting clears all event records stored. Note that this can also be done at the instruments display. (see Figure 5).

Clear Close Data – this setting clears all close data records stored.

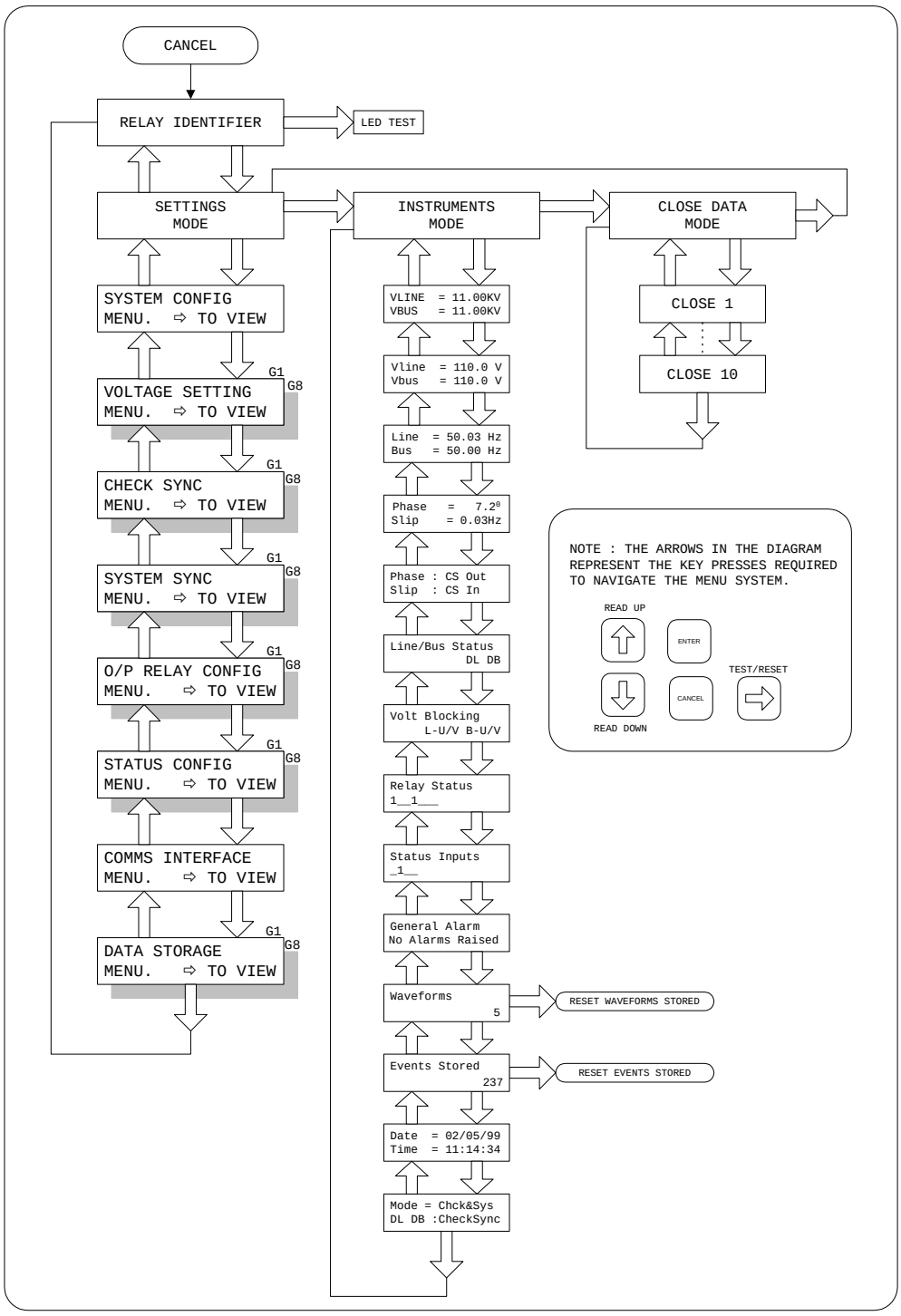


Figure 5 - Display Menu Structure

Figure 6 - Argus 7 Relay Fascia

Event Description	Event Code	GI	Frame Type
Data lost	0	✘	1
Reset FCB	2	✘	5
Reset CU	3	✘	5
Start/Restart	4	✘	5
Power On	5	✘	5
Setting G1 selected	23	✔	1
Setting G2 selected	24	✔	1
Setting G3 selected	25	✔	1
Setting G4 selected	26	✔	1
Setting G5 selected	35	✔	1
Setting G6 selected	36	✔	1
Setting G7 selected	37	✔	1
Setting G8 selected	38	✔	1
LEDs reset	19	✘	1
Trip Test	21	✘	1
Settings changed	22	✘	1
Input 1	27	✔	1
Input 2	28	✔	1
Input 3	29	✔	1
Input 4	30	✔	1
Output 1	51	✔	1
Output 2	52	✔	1
Output 3	53	✔	1
Output 4	54	✔	1
Output 5	55	✔	1
Output 6	56	✔	1
Output 7	57	✔	1
Waveform stored	80	✔	1
Remote control interrupted	81	✘	1
Lockout	83	✔	1
Reset Lockout Mode	84	✘	1

Event Description	Event Code	GI	Frame Type
Check Sync Start	90	✔	1
System Sync Start	91	✔	1
Check Sync Inhibit	92	✔	1
System Sync Inhibit	93	✔	1
Sync Bypass	94	✔	1
Check Sync Close	96	✔	1
System Sync Close	97	✔	1
Bypass Close	98	✔	1
Slip In Sync	99	✔	1
Phase In Sync	100	✔	1
Live Line	101	✔	1
Live Bus	102	✔	1
Bus U/V Detector	103	✔	1
Line U/V Detector	104	✔	1
Volts Differential	105	✔	1
System Split	106	✔	1
Alarm 1	121	✔	1
Alarm 2	122	✔	1
Alarm 3	123	✔	1
Alarm 4	124	✔	1

KEY :

Event Code – is the allocated number given to a particular event.

GI – If the relay is interrogated for its events using the general interrogation (GI) command then only those indicated with the ✔ will respond.

Frame Type – a ‘1’ indicates that the event is time tagged. A ‘5’ indicates an event which is generated only on power-on or reset of the relay.

Table 1 - Argus 7 Event Codes

TABLE OF CONTENTS

1 GENERAL

The relay complies with the relevant clauses in the following specifications :-

- IEC 255 series of standards.

2 CHARACTERISTIC ENERGIZING QUANTITY

AC Voltage (Vn)	63.5 / 110 Vrms
Frequency	50 / 60Hz

3 AUXILIARY ENERGIZING QUANTITY

3.1 DC Power Supply

	Nominal	Operating Range
V_{AUX}	24, 30, 48V	18V to 60V dc
V_{AUX}	110, 220V	88V to 280V dc

3.2 DC Status Inputs

Nominal Voltage	Operating Range
30 / 34	18V to 37.5V
48 / 54	37.5V to 60V
110 / 125	87.5V to 137.5V
220 / 250	175 to 280V

NB Status operating voltage need not be the same as the main energising voltage. For 110/125 volt or 220/250 volt working , a standard Argus relay with 48/54 volt status will be supplied for use with external dropper resistors as follows:-

Status Input External Resistances

Nominal Voltage	Resistor Value (Wattage)
110 / 125V	2k7 ± 5% ; (2.5W)
220 / 250V	8k2 ± 5% ; (6.0W)

Status Input Performance

Minimum DC current for operation	10mA
Reset/Operate Voltage Ratio	≥ 90%
Typical response time	< 5ms
Typical response time when programmed to energise an output relay contact	< 15ms
Minimum pulse duration	40ms

Each status input has an associated timer which can be programmed to give time delayed pick-up and time delayed drop-off. The pick-up timers have default settings of 20ms, thus providing immunity to an AC input signal. Status inputs will not respond to the following:

- 250V RMS 50/60Hz applied for two seconds through a 0.1μF capacitor.
- 500V RMS 50/60Hz applied between each terminal and earth.
- Discharge of a 10μF capacitor charged to maximum DC auxiliary supply voltage.

The inputs meet the requirements of ESI48-4 ESI 1.

4 SETTING RANGES

Check Synchronising Settings

CS Phase Angle	5° - 90° step 1°
CS Slip Timer	OFF, 0.1 – 100sec step 0.1sec
CS Slip Frequency	OFF, 0.02 – 2.000Hz step 5mHz
Split Detector	OFF, 90°-175° step 1°
Split Timer	OFF, 0.1 – 100sec step 0.1sec

System Synchronising Settings

SS Phase Angle	5° - 90° step 1°
SS Slip Timer	OFF, 0.1 – 100sec step 0.1sec
SS Slip Frequency	OFF, 0.02 - 2.000Hz step 5mHz

Voltage Element Settings

Bus Dead Range	5V - 127V step 0.5V
Bus Live Range	10V - 132V step 0.5V
Line Dead Range	5V - 127V step 0.5V
Line Live Range	10V - 132V step 0.5V
Bus U/V Detector	OFF, 22V-132V step 0.5V
Line U/V Detector	OFF, 22V-132V step 0.5V
ΔV Detector	OFF, 0.5V - 44 V step 0.5V

5 ACCURACY REFERENCE CONDITIONS

General	IEC255
Auxiliary Supply	Nominal
Rating	63.5 or 110 Vrms
Frequency	50 or 60Hz
Ambient Temperature	20°C

6 ACCURACY

CS and SS Phase Angle measurement	
Operate	Setting -3° + 0°
Reset	operate value -0° + 3°
CS and SS Slip Frequency	
Operate	Setting -15mHz + 0mHz
Reset	Operate value -0mHz + 15mHz
Split Detector measurement	
Operate	setting ±1.5°
Reset	Detector is latched
Line and Bus Voltage Detector Elements	
Live Operate	setting ±1%
Live Reset	dead operate setting ±1%
Dead Operate	setting ±1%
Dead Reset	live operate setting ±1%
Line and Bus U/V Detector Elements	
Operate	Setting ±1%
Reset	< 104% of operate value
ΔV Detector Element	
Operate	Setting ±2% or 0.5V whichever is greater
Reset	Typically > 90% (and always within 2V) of operate value
All Timers	
Timing Accuracy	±1% or 10ms whichever is greater

7 ACCURACY GENERAL

Measuring Accuracy

Voltage	± 1% (for range 7V-132Vrms)
Frequency	Typically ± 10mHz
Phase	Typically ± 1°

8 ACCURACY INFLUENCING FACTORS

Temperature

Ambient Range	-10°C to +55°C
Variation over range	≤ 5%

Frequency

Range (50Hz) (60Hz)	47Hz to 51Hz 57Hz to 61Hz
Setting variation	≤ 1%
Phase Angle Measurement	≤ 1%
Operating time variation	≤ 1%

Auxiliary DC Supply - IEC 255-11

Allowable superimposed ac component	≤ 12% of DC voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤ 20ms

9 THERMAL WITHSTAND

Continuous Overload

AC Voltage	250Vrms

10 BURDENS

AC Burden

	AC Burden
110Vrms Input	≤ 0.1VA
63.5Vrms Input	≤ 0.05VA

DC Burden

	DC Burden
Quiescent (Typical)	3 Watts
Max	10 Watts

11 OUTPUT CONTACTS

Contact rating to IEC255-0-20.

Carry continuously 5A ac or dc

Make and Carry
(limit L/R ≤ 40ms and V ≤ 300 volts)

For 0.5 sec	20A ac or dc
For 0.2 sec	30A ac or dc

Break
(limit ≤ 5A or ≤ 300 volts)

ac resistive	1250VA
ac inductive	250VA @ PF ≤ 0.4
dc resistive	75W
dc inductive	30W @ L/R ≤ 40 ms 50W @ L/R ≤ 10 ms

Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5W, limits 10mA or 5V

12 ENVIRONMENTAL WITHSTAND

12.1 General

Temperature - IEC 68-2-1/2

Operating range	-10°C to +55°C
Storage range	-25°C to +70°C

Humidity - IEC 68-2-3

Operational test	56 days at 40°C and 95% RH

Transient Overvoltage - IEC 255-5

Between all terminals and earth or between any two independent circuits without damage or flashover	5kV 1.2 / 50µs 0.5J

Insulation - IEC 255-5

Between all terminals and earth	2.0kV rms for 1 min
Between independent circuits	2.0kV rms for 1 min
Across normally open contacts	1.0kV rms for 1 min

12.2 Immunity

High Frequency Disturbance - IEC 255-22-1 Class III

	Variation
2.5kV Common (Longitudinal) Mode	≤ 5%
1.0kV Series (Transverse) Mode	≤ 5%

Electrostatic Discharge - IEC 255-22-2 Class III

	Variation
8kV contact discharge	≤ 5%

Radio Frequency Interference - IEC 255-22-3 Class III

	Variation
20MHz to 1000MHz, 10V/m	≤ 5%

Fast Transient – IEC 255-22-4 Class IV

	Variation
4kV 5/50ns 2.5kHz repetitive	≤ 5%

Conducted RFI – IEC 255-22-6

	Variation
0.15 to 1000MHz – 10V	≤ 5%

12.3 Emissions

Radiated Limits – IEC 255-25

Frequency Range	Limits dB (µV)	
	Quasi-peak	Average
30 to 230MHz	79	66
230 to 1000MHz	73	60

Conducted Limits – IEC 255-25

Frequency Range	Limits at 10m Quasi-peak dB (µV/m)
0.15 to 0.5MHz	40
0.5 to 30MHz	47

12.4 Mechanical

Vibration (Sinusoidal) – IEC 255-21-1 Class 1

		Variation
Vibration response	0.5gn	≤ 5%
Vibration endurance	1.0gn	≤ 5%

Shock and Bump – IEC 255-21-2 Class 1

		Variation
Shock response	5 gn 11ms	≤ 5%
Shock withstand	15 gn 11ms	≤ 5%
Bump test	10 gn 16ms	≤ 5%

Seismic – IEC 255-21-3 Class 1

		Variation
Seismic Response	1gn	≤ 5%

Mechanical Classification

Durability	In excess of 10^6 operations

TABLE OF CONTENTS

1 SYSTEM CONFIG MENU

SETTING	RANGE	DEFAULT
Active Settings Group	G1-G8	G1
Settings Group Edit/View	G1-G8	G1
Copy Group	From G1-G8 to G1-G8	From G1-G2
Power System Frequency	50 or 60 Hz	50Hz
Rated Voltage	110V or 63.5V	110V
Line Voltage Trim	- 5.0V to + 5.0V step 0.1V	0.0V
Bus Voltage Trim	- 5.0V to + 5.0V step 0.1V	0.0V
V.T. Ratio	1:1 to 99999:1	1:1
Set Identifier	Up to 16 alphanumeric characters	ARGUS 7
Set Alarm 1	Up to 13 alphanumeric characters	ALARM 1
Set Alarm 2	Up to 13 alphanumeric characters	ALARM 2
Set Alarm 3	Up to 13 alphanumeric characters	ALARM 3
Set Alarm 4	Up to 13 alphanumeric characters	ALARM 4
Calendar - Set Date	DD/MM/YY	01/01/99
Clock - Set Time	HH:MM:SS	00:00:00
Clock Sync. From Status	Seconds or Minutes	Minutes
Default Screen Timer	10sec, 60sec, 5min, 1hour	5 min
Change Password	4 alphanumeric characters	NONE

2 VOLTAGE SETTING MENU

SETTING	RANGE	DEFAULT
Gn DeadL : LiveL	Dead V : 5V to 127V step 0.5V Live V : 10V to 132V step 0.5V	30V : 80V
Gn DeadB : LiveB	As above	30V : 80V
Gn Line U/V Detector	OFF, 22 - 132V step 0.5V	80.0V
Gn Bus U/V Detector	OFF, 22 - 132V step 0.5V	80.0V
Gn ΔV Detector	OFF, 0.5 - 44V step 0.5V	20.0V
Gn Sync Bypass	OFF, DL&LB, LL&DB, DL&DB, DL or DB, DL xor DB	OFF

3 CHECK SYNC MENU

SETTING	RANGE	DEFAULT
Gn Check Sync Enable	AUTO, MANUAL	MANUAL
Gn CS Phase Angle	5° - 90° step 1°	20°
Gn CS Slip Timer	OFF, 0 - 100sec step 0.1sec	OFF
Gn CS Slip Freq.	OFF, 0.020 - 2.000Hz step 0.005Hz	0.050Hz
Gn System Split Detector	OFF, 90° - 175° step 1°	90°
Gn System Split Timer	OFF, 0 – 100sec step 0.1sec	OFF
Gn Close Guard	OFF or ON	OFF

4 SYSTEM SYNC MENU

SETTING	RANGE	DEFAULT
Gn System Sync Enable	AUTO, MANUAL, LOCKOUT	AUTO
Gn SS Phase Angle	5° - 90° step 1°	10°
Gn SS Slip Timer	OFF, 0 – 100sec step 0.1sec	OFF
Gn SS Slip Freq.	OFF, 0.020 - 2.000Hz step 0.005Hz	0.250Hz
Gn SS Close Pulse	0.1 - 2.0sec step 0.1sec	0.2sec

5 OUTPUT RELAY CONFIG MENU

SETTING	RANGE	DEFAULT
Gn Relay Healthy	RL1..RL7	RL1
Gn Check Sync Close	RL1..RL7	None
Gn System Sync Close	RL1..RL7	None
Gn Bypass Close	RL1..RL7	None
Gn System Split	RL1..RL7	None
Gn U/V Line	RL1..RL7	None
Gn U/V Bus	RL1..RL7	None
Gn ΔVoltage	RL1..RL7	None
Gn Live Line (LL)	RL1..RL7	None
Gn Live Bus (LB)	RL1..RL7	None
Gn Dead Line(DL)	RL1..RL7	None
Gn Dead Bus (DB)	RL1..RL7	None
Gn DLLB	RL1..RL7	None
Gn LLDB	RL1..RL7	None
Gn DLDB	RL1..RL7	None
Gn Status 1	RL1..RL7	None
Gn Status 2	RL1..RL7	None
Gn Status 3	RL1..RL7	None

SETTING	RANGE	DEFAULT
Gn Status 4	RL1..RL7	None
Gn Hand Reset	RL1..RL7	None
O/P Relay Test	Any O/P Relay Option	OFF

6 STATUS CONFIG MENU

SETTING	RANGE	DEFAULT
Settings Group Select	S1..S4	None
Inverted Inputs	S1..S4	None
Gn Start Check Sync	S1..S4	None
Gn Start System Sync	S1..S4	None
Gn Sync Bypass	S1..S4	None
Gn Check Sync Inhibit	S1..S4	None
Gn System Sync Inhibit	S1..S4	None
Gn ALARM 1	S1..S4	None
Gn ALARM 2	S1..S4	None
Gn ALARM 3	S1..S4	None
Gn ALARM 4	S1..S4	None
Gn Waveform Trig	S1..S4	None
Gn Clock Sync.	S1..S4	None
Gn Reset Lockout Mode	S1..S4	None
Gn Reset Outputs	S1..S4	None
Gn Status 1 P/U Delay	0 – 2.00 sec step 10ms 2.10 – 20.00 sec step 100ms 21 – 300 sec step 1 sec 360 – 3600 sec step 60 sec 3900 – 14400 sec step 300 sec	0.02sec
Gn Status 1 D/O Delay	As above	0.00sec
Gn Status 2 P/U Delay	As above	0.02sec
Gn Status 2 D/O Delay	As above	0.00sec
Gn Status 3 P/U Delay	As above	0.02sec
Gn Status 3 D/O Delay	As above	0.00sec
Gn Status 4 P/U Delay	As above	0.02sec
Gn Status 4 D/O Delay	As above	0.00sec

7 COMMS INTERFACE MENU

SETTING	RANGE	DEFAULT
Comms Baud Rate	75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200	19200
Comms Parity	NONE, EVEN	EVEN
Relay Address	0 - 254	0
Line Idle	LIGHT ON, LIGHT OFF	LIGHT OFF
Data Echo	OFF or ON	OFF

8 DATA STORAGE MENU

SETTING	RANGE	DEFAULT
Waveform Trig	OFF, CS Close, SS Close, BYPASS, STATUS	CS/SS Close
Waveform Pre-trigger	OFF, 10%-100% step 10%	80%
Clear All Waveforms	NO, YES (Confirmation required)	NO
Clear All Events	NO, YES (Confirmation required)	NO
Clear Close Data	NO, YES (Confirmation required)	NO

TABLE OF CONTENTS

GLOSSARY

Baud Rate	See *bits per second*.
Bit	The smallest measure of computer data.
Bits Per Second (BPS)	Measurement of data transmission speed.
Data Bits	A number of *bits* containing the data. Sent after the *start bit*.
Half-Duplex Asynchronous Communications	Communications in two directions, but only one direction at a time.
Hayes 'AT'	Modem command set developed by Hayes Microcomputer products, Inc.
Master Station	See *primary station*.
Modem	MOdulator / DEModulator device for connecting computer equipment to a telephone line.
Parity	Method of error checking by counting the value of the bits in a sequence, and adding a parity bit to make the outcome, for example, even.
Parity Bit	*Bit* used for implementing parity checking. Sent after the *data bits*.
Primary Station	The device controlling the communication.
PSTN	Public Switched Telephone Network
RS232C	Serial Communications Standard. Electronic Industries Association Recommended Standard Number 232, Revision C.
Secondary Station	The device being communicated with.
Slave Station	See *secondary station*.
Start Bit	*Bit* (logical 0) sent to signify the start of a byte during data transmission.
Stop Bit	*Bit* (logical 1) sent to signify the end of a byte during data transmission.

1. INTRODUCTION

This document describes how to connect the IEC870-5-103 compliant communications interface to a control system or interrogating computer.

To access the interface the user will need appropriate software within the control system or on the interrogating computer (e.g. Reydisp Evolution).

2. CONNECTION SPECIFICATION AND RELAY SETTINGS

This section defines the connection medium as defined by IEC 870-5-103. Appendix A shows some typical communication connections.

2.1. Recommended cable

Selection of fibre optic cable is critical. Fibres should be terminated with 9mm SMA connectors.

The recommended type is 200µm Plastic Coated Silica (PCS). This will allow a maximum transmission distance of 100m between Argus relays. It will also be the maximum distance between the ring network and the fibre to RS232 converter.

Alternatively, 1mm polymer cable may be used to reduce cost. This will provide transmission distances of upto 43m between relays. Note that the distance from the transmit output of the RS232 / fibre optic converter to the receive input of the first Argus relay should be not more than 6m. The distance from the transmit output of the last Argus to the receive input of the converter may be upto 43m.

No other types of cable are suitable for use with Argus relays.

2.2. Connection Method

Argus relays can be connected in either a Star or Ring fibre-optic communications network. If star connected then a passive fibre optic hub must be used. A lower cost option is the ring configuration where the Argus relays are 'daisy chained.' That is, the transmit output of the first relay is connected to the receive input of the second relay, and so on until the ring is complete.

Communication to the ring may be achieved either locally in the substation or remotely via the Public Switched Telephone Network (PSTN). If remote communication is desired, then additional modem equipment must be installed.

Reydisp Evolution is a PC based software package providing capability for both local and remote communication. It provides features such as download of disturbance and event records, upload of relay settings, real-time monitoring of measurands and remote control of plant.

2.3. Transmission Method

The transmission method is Half Duplex serial asynchronous transmission. In IEC 870-5-103 the line idle state is defined as Light ON. This can alternatively be selected as Light OFF in the Communications Interface menu of the relay if required for use with alternate hardware (See Section 2.5).

2.4. Transmission Rate

Rates of 19200, 9600, 4800, 2400, 1200, 600, 300, 150, 110 and 75 bits per second (BPS) are provided. Only 19200 and 9600 BPS are standard in IEC 870-5-103, the additional rates are provided for local or modem communications.

2.5. Line Idle Setting

The line idle setting can be set to be either ON or OFF and the setting must be compatible with the device connected to the relay. The IEC 870-5-103 standard defines a line idle state of Light On. If the device the relay is connected to does not have a compatible fibre-optic port then a suitable electrical to optical converter is required to connect it to a standard RS232C electrical interface. A suitable converter is the Sigma 4 type, which is available from Reyrolle Protection.

Alternative converters are the Reyrolle Dual RS232 Port (Sigma 3) or Reyrolle Passive Fibre-Optic Hub (Sigma 1).

1. The Sigma 3 Dual RS232 port provides a fibre-optic interface to a relay and two RS232 ports. The RS232 system port is typically connected to a control system while the second port is a local port. When the local port is in use the system port is automatically disabled. The Sigma 3 has an internal link to switch between line idle Light ON or Light OFF. The default configuration is Light OFF.
2. The Sigma 1 Passive Fibre-Optic Hub provides fibre-optic interfaces for up to 29 relays. It has a fibre-optic port to the control system and multiple relay connections. Each of the 30 fibre-optic ports can be configured for either Light ON or Light OFF operation. Default for all is OFF.

2.6. Parity Setting

IEC 870-5-103 defines the method of transmission as using EVEN Parity. However, in some instances an alternative may be required. This option allows the parity to be set to NONE.

2.7. Address Setting

The address of the relay must be set to a value between 1 and 254 inclusive before any communication can take place. Setting the address to zero disables communications to the relay, although if it is in an optical ring it will still obey the Data Echo setting. All relays in an optical ring must have a unique address. Address 255 is reserved as a global broadcast address.

3. MODEMS

The communications interface has been designed to allow data transfer via modems. However, IEC 870-5-103 defines the data transfer protocol as an 11 bit format of 1 start, 1 stop, 8 data and 1 parity bit which is a mode most commercial modems do not support. High performance modems, for example, Sonix (now 3Com), Volante and MultiTech Systems MT series will support this mode but are expensive. For this reason a parity setting (see section 2.6) to allow use of easily available and relatively inexpensive commercial modems has been provided. The downside to using no parity is that the data security will be reduced slightly and the system will not be compatible with true IEC870 control systems.

3.1 Connecting a modem to the relay(s)

The RS232C standard defines devices as being either Data Terminal Equipment (DTE) e.g. computers, or Data Communications Equipment (DCE) e.g. modems. To connect the modem to a relay requires a fibre-optic to electrical connector and a Null Terminal connector which switches various control lines. The fibre-optic converter is then connected to the relay in the following manner :

Fibre-Optic Converter	Relay Connection
Tx	**Rx**
Rx	**Tx**

3.2 Setting the Remote Modem

Most modems support the basic Hayes 'AT' command format, though, different manufacturers can use different commands for the same functions. In addition, some modems use DIP switches to set parameters while others are entirely software configured. Before applying the following settings it is necessary to return the modem to its factory default settings to ensure that it is in a known state.

The remote modem must be configured as Auto Answer, which will allow it to initiate communications with the relays. Auto answer usually requires 2 parameters to be set. One switches auto answer on and the other, the number of rings after which it will answer. The Data Terminal Ready (DTR) settings should be forced on which tells the modem that the device connected to it is ready to receive data. The parameters of the modem's RS232C port need to be set to match those set on the relay i.e. baud rate and parity to be the same as the settings on the relay, and number of data bits to be 8 and stop bits 1.

Note : although it may be possible to communicate with the modem at e.g. 19200bps, it may not be possible to transmit at this rate over the telephone system which may be limited to 14400. A baud rate setting needs to be chosen which is compatible with the telephone system. As 14400 is not available in the relay, the next lowest rate, 9600, would have to be used.

Since the modem needs to be transparent, simply passing on the data sent from the controller to the device and vice versa, the error correction and buffering must be turned off. In addition if possible force the Data Carrier Detect (DCD) setting to ON as this control line will be used by the fibre-optic converter.

Finally these settings should be stored in the modem's memory for power on defaults.

3.3 Connecting to the remote modem

Once the remote modem is configured correctly it should be possible to dial into it using the standard configuration from a local PC. As the settings on the remote modem are fixed, the local modem should negotiate with it on connecting and choose suitable matching settings. If it does not, however, set the local modem to mimic the settings of the remote modem described above.

APPENDIX A - COMMUNICATION CONNECTIONS

Figures 1 to 6 illustrate a number of methods of connecting relays in communications networks.

(Note that in the case of the optical ring configuration (figure 5), the Data Echo feature must be switched ON in the communications settings menu of the relay. In all other cases this setting should be set to OFF).

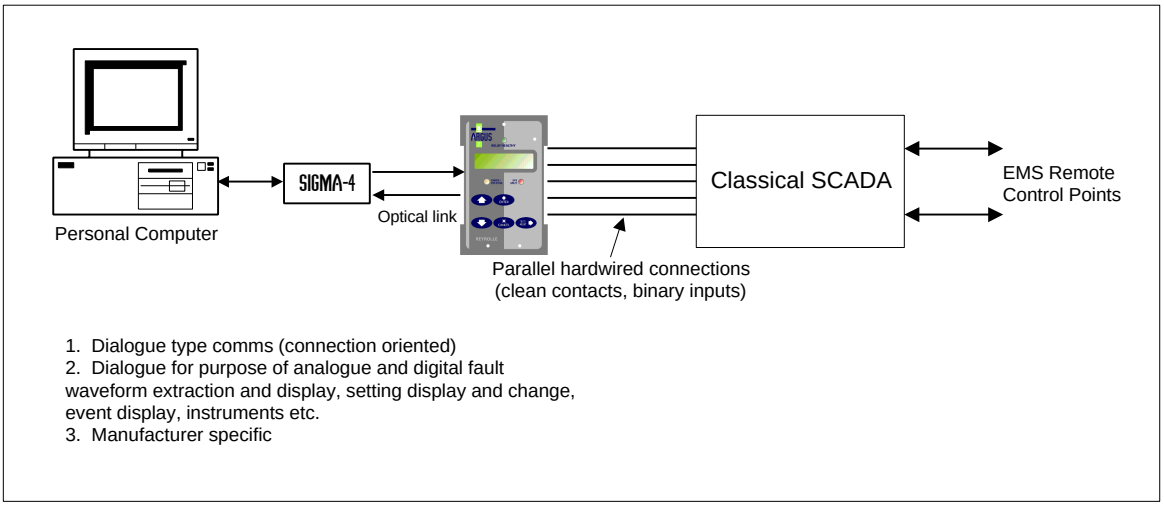


Figure 1 - Basic Communications Configuration

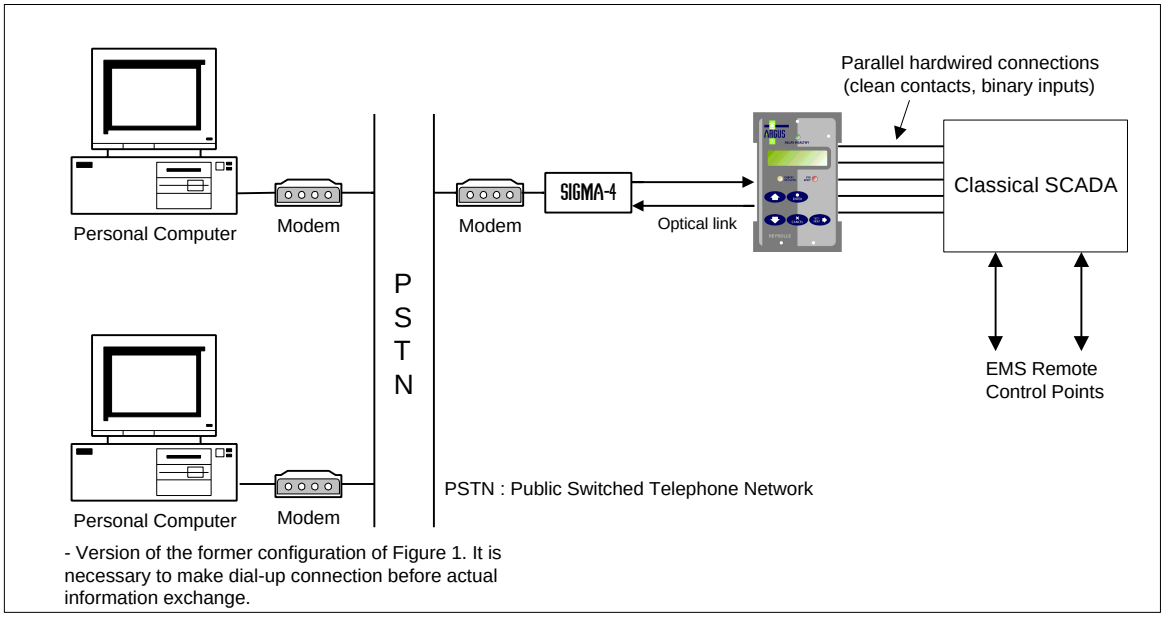


Figure 2 - Basic Communications Configuration (Remote)

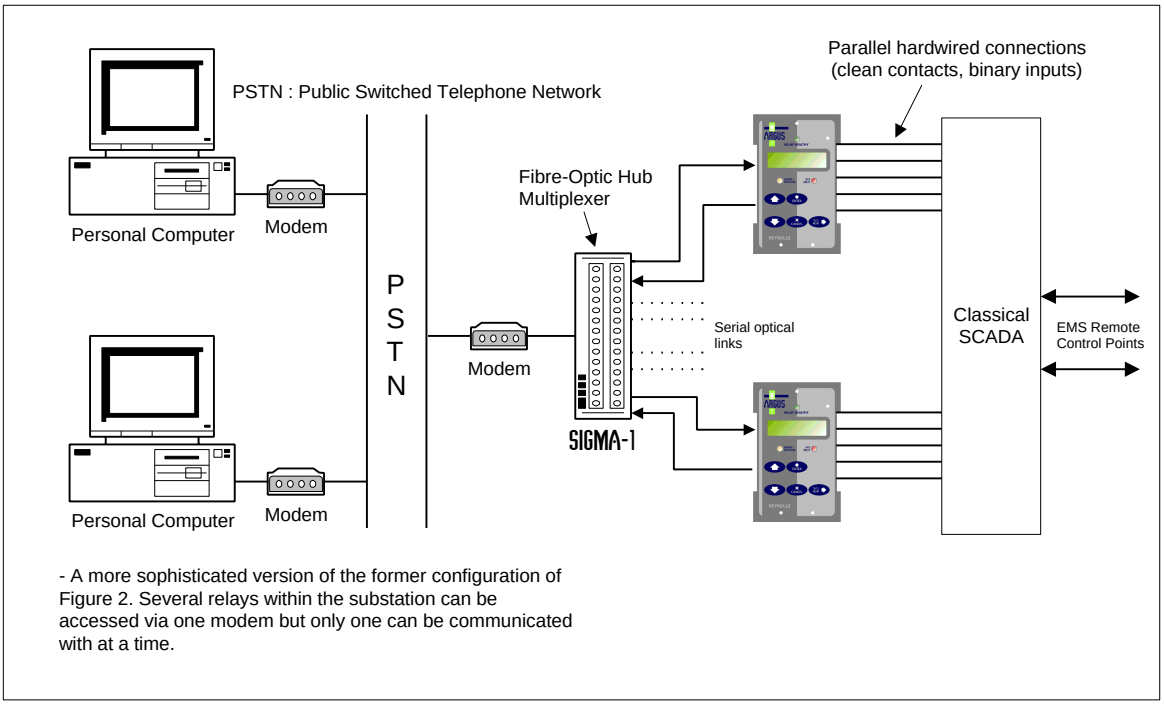


Figure 3 - Star Type Configuration (Multiplexer)

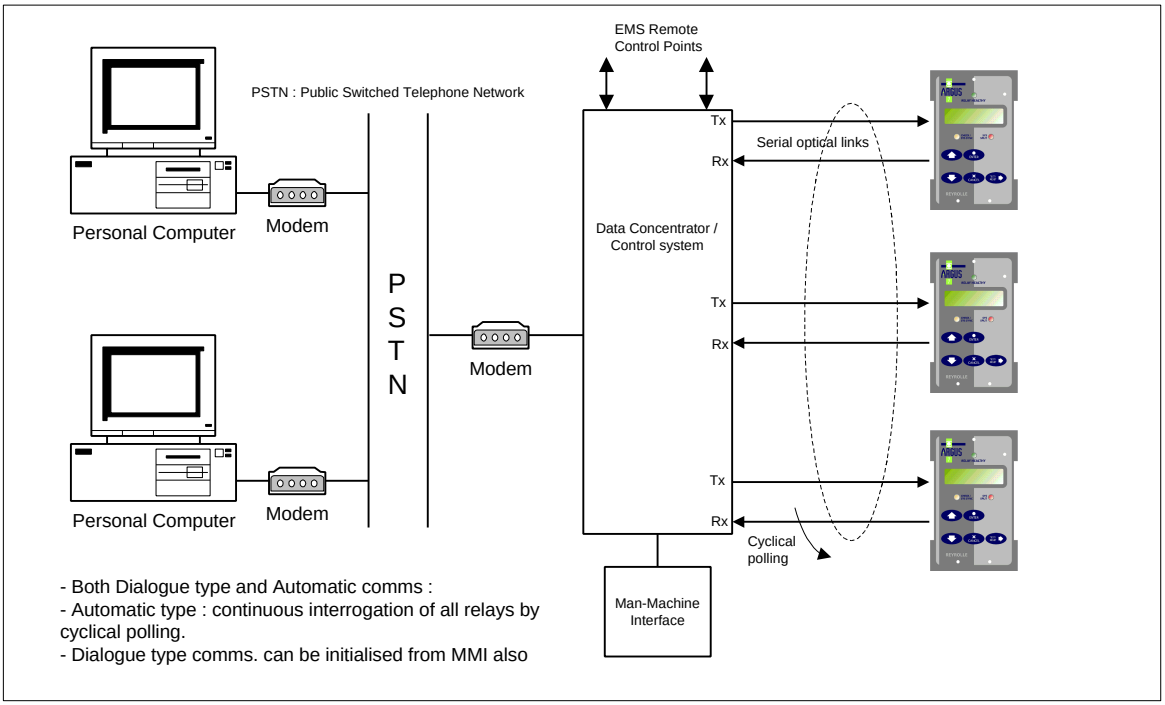


Figure 4 - Data Concentrator Configuration

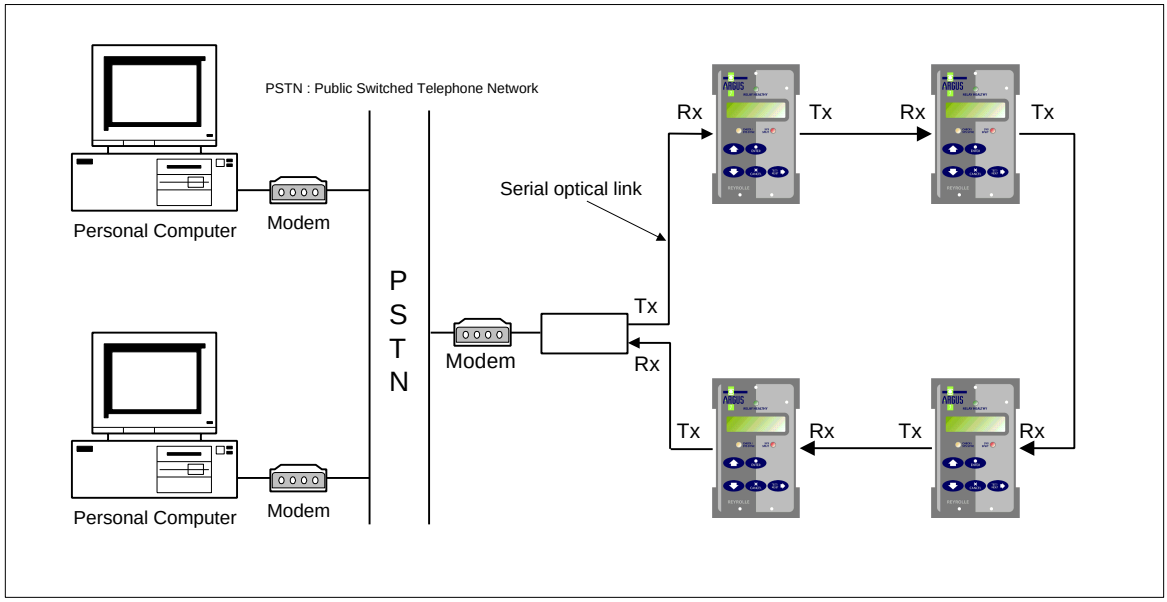


Figure 5 - Optical Ring Configuration

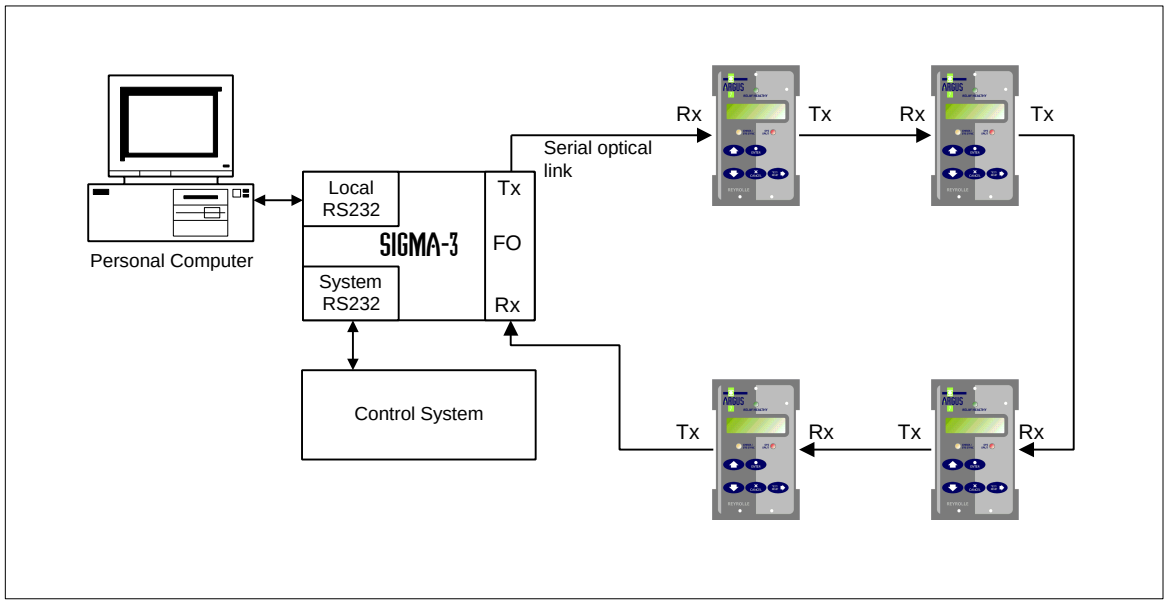


Figure 6 - Configuration using the Sigma 3 – Dual Port RS232 Device

TABLE OF CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

Argus 7 is a combined check and system synchronising relay which can automatically select check or system synchronise, as appropriate, from measurements of the relative phase angles between the line and bus voltages. The relay will prevent closure of the circuit breaker if the phase angle, slip frequency or the voltage magnitudes of the incoming and running voltages fall outside prescribed limits.

If these calculated quantities are within the relays' setting limits the relay will issue an output which can be used to close the circuit breaker directly or in conjunction with an autoreclose scheme. Both the check and system synchronise functions have independent settings and blocking features. The relay also includes split system detection with a variable time delay, which can be used for blocking purposes within delayed autoreclose (DAR) schemes.

Synchronising bypass logic is provided to connect a dead line or bus to a live line or bus. For manual synchronising the relay includes a circuit breaker close guard feature which is used to prevent the control switch being held closed during a synchronising operation. This feature is implemented using internal logic and removes the need for an external guard relay.

2 GENERAL INFORMATION

2.1 Voltage Threshold

The relay has a minimum voltage threshold below which the frequency and phase angle measurements are blocked from operation. This is preset to 5V rms and cannot be changed by the user. On initial switch on of AC volts to the relay, if both the line and bus volts exceed 5V rms, then the relay will wait for 0.96 second before any output can be given. This is to allow time for the frequency and phase measuring elements to settle and establish healthy outputs and also to allow for any transient conditions on voltage switch-on to pass.

2.2 Output Contact Delay Time

The output relay contacts have a typical close response time of 7ms.This inherent delay is not, however, the only factor determining the actual contact closure time. The relay has a main software control loop of 5ms. Any software decision or external interrupt to the microcontroller involves a maximum possible delay of 5ms while the software completes the loop. This time should be added to the contact closure time of 7ms to give a maximum closure time.

e.g. - if an energisation signal is applied to a status input which is programmed to directly operate an output relay the following delays should be added :

Status I/P response time (< 5ms) + Status PU delay setting + S/W loop (max. 5ms) + O/P contact closure (typ. 7ms).

This gives a total time of < 17ms + Status PU delay setting.

2.3 Synchronising Enable Modes

The Argus 7 relay has been designed to conform to NGTS 3.7.7 and therefore must be able to be set up as a check synchronising relay, for applications such as manually bringing a generator online, and also as a check and system synchronising relay for applications where two power systems are to be connected. The following examples show various ways that the relay can be enabled for these different applications.

The check sync (CS) and system sync (SS) functions each have independent enable modes. If the requirement is for the relay to be used as a check for manually synchronising a generator for example, then system sync is not required.

1. Set CS Enable to **MANUAL** (or **AUTO**)

   Set System Split Detector to **OFF**

Setting the split detector to OFF will ensure that the relay never goes into system synchronising mode. The relay will continue to issue a check sync close if the power system conditions fall within the relay setting parameters.

If the requirement is for a check and system synchronising scheme where a lockout of the relay is required if the system splits, then

2. Set CS Enable to **MANUAL** (or **AUTO**)

   Set System Split Detector to a suitable angle e.g. **170°**

   Set SS Enable to **LOCKOUT**

This will ensure that if the power system splits the relay will not go into system synchronising mode but revert to lockout mode. The relay will at this point issue a lockout alarm via the LCD and generate an Event Record.

If the requirement is for a check and system synchronising scheme where system synchronising is required if the system splits, then

3. Set CS Enable to **MANUAL** (or **AUTO**)

   Set System Split Detector to a suitable angle e.g. **170°**

   Set SS Enable to **MANUAL** (or **AUTO**)

   This will ensure that if the power system splits the relay will system synchronise.

It should be noted that at any time during a synchronising sequence, the relay can be inhibited from operation using the Check Sync Inhibit or System Sync Inhibit command from the control system.

Note : the relay settings groups could be used to switch between the different modes of the relay. The relay could be set up to be a check synchroniser in settings Group 1 and a check and system synchronising relay in settings Group 2. The group selection and thus the actual relay mode of operation could then be changed remotely using a status input signal or a communications command from a control system.

2.4 Manual Synchronising

In applications where the relay is used for manual synchronising of e.g. generators, a close guard feature can be used to ensure that the operator uses the relay as a check for synchronism and does not give all the responsibility for the close to the relay. Previously this functionality has been achieved using external auxiliary guard relays to prevent the operator from pre-closing the switch and waiting for the relay to issue its close signal. This can now be achieved without the external guard elements but by using a status input and internal logic.

To use the close guard feature :

- CS Enable has to be set to **MANUAL**
- Close Guard is set to **ON**

When the Check Sync close status input is received, internal logic will only allow the relay to issue a close if the system conditions were in synchronism and the relay was issuing a Check Sync close before the status input was activated.

2.5 Typical Voltage Settings

2.5.1 Rated Voltage Setting – V.T. Connection

The Argus 7 relay can be connected either single-phase (e.g. phase-neutral of a 3 phase V.T.) or phase-phase (e.g. of Vee connected or 3 phase V.T.). The same reference voltage must be employed for both Line and Bus voltages.

V.T. ratings for secondary connections are normally either 100V or 110V for phase-phase, with the associated phase-neutral ratings being 57.7V and 63.5V respectively. For phase-neutral connections the Rated Voltage setting should be set to 63.5V. For phase-phase connections the Rated Voltage setting should be set to 110V.

Where V.T.'s with 100 / 57.7V ratings are employed the 110V or 63.5V settings, as appropriate, should be chosen. It is only necessary to ensure that the associated settings e.g. V.T. ratio, dead line / bus voltage, live line / bus voltage and line / bus undervoltage detector settings are based on ratings of 100 / 57.7V and not 110 / 63.5V.

2.5.2 Undervoltage Detector Settings

The relay undervoltage blocking elements, if enabled, can be used to block the close operation if either the line (incoming) or bus (running) voltages fall below a certain percentage of rated voltage. Typically, the undervoltage elements are set somewhere between 80% and 90% of rating.

Note : when using the undervoltage elements care should be taken to ensure that the reset of the element occurs at below the expected minimum operating voltage of the system. The undervoltage elements reset at <103% of the operate level. If the system is expected to run at less than the rated voltage, the undervoltage element reset level must be set to operate at a value below this plus a discrimination margin.

e.g. - for a phase to neutral connection nominally at 63.5 Vrms but which can run as low as 59 Vrms,

the undervoltage setting should be set no higher than 59 V – 1 V (margin) = 58V / 103% = 56.31V (the actual setting would have to be 56.5V). This is equivalent to approximately 89% of rated voltage. If the setting is set higher than this then the element may never reset and will continuously block.

2.5.3 Differential Voltage Detector Settings

A differential voltage detector is incorporated and this, if enabled, blocks the synchronising function if the difference between the measured voltages is greater than the setting. This is used to prevent closing of the circuit breaker with a large voltage differential between the line (incoming) or bus (running) voltages, which could overstress the electrical systems. Typically, the differential voltage elements are set below 10% of rated voltage.

2.6 Synchronising Bypass Logic

The relay Dead and Live voltage monitors are used along with corresponding internal logic to bypass the synchronising operation of the relay. Typically, anywhere above 80% to 90% of rating can be classed as a live line or live bus. The dead voltage monitors should be set to somewhere above the expected level of induced voltages on the line or bus. It should be noted that a dead line or dead bus can have a considerable potential induced onto it from a parallel line or via capacitance across open breaker contacts. This potential can be as high as 30% of rated voltage.

The synchronising Bypass logic can be enabled, if required, to provide Dead Line and Live Bus closing, Live Line and Dead Bus closing, Dead Line and Dead Bus closing, Dead Line or Dead Bus closing and Dead Line xor Dead Bus closing. A truth table showing the close logic for all of the possible combinations is shown in Table 1.

		Sync Bypass Setting				
		DL & LB	LL & DB	DL & DB	DL or DB	DL xor DB
Line Status	Bus Status	Allow Close	Allow Close	Allow Close	Allow Close	Allow Close
Dead	Dead	No	No	Yes	Yes	No
Dead	Live	Yes	No	No	Yes	Yes
Live	Dead	No	Yes	No	Yes	Yes
Live	Live	No	No	No	No	No

Table 1 - Bypass Close Logic

2.7 Slip and Phase Angle Relationship

Slip frequency is defined as the difference between two frequencies. Where a slip frequency exists between two separate systems, during a 'slip' cycle the two voltage vectors will be in anti-phase at one point in time. The phase angle difference will vary between being in phase and anti-phase. Argus 7 relays can be set to measure slip frequency in two ways. One way is to measure the two system frequencies directly and calculate the difference. Another way is to measure the phase difference between the two systems and check that the phase angle change in a defined time period is less than a predetermined value. If F1 and F2 represent the frequencies of two systems then it can be shown that for check synchronising operation,

$$\Delta F = F1 - F2 = \frac{1}{Td} \times \frac{q}{180^\circ}$$

where Td = time delay setting and θ = phase angle setting.

For system synchronising operation the following formula is used because in this mode the relay will only issue a close signal if the phase angle is decreasing in value. It will not issue a close if the phase angle is increasing in value.

$$\Delta F = F1 - F2 = \frac{1}{Td} \times \frac{q}{360^\circ}$$

where Td = time delay setting and θ = phase angle setting.

The Argus 7 relay has both a frequency measuring element and phase detector and so can be set up to measure slip either directly or by the phase detector plus timer method. Use of either method is perfectly valid, as is use of both at the same time.

Note : if using both the slip frequency detector and the phase angle plus slip timer for a particular scheme then care has to be taken in setting selection. It is possible to set the relay up with an incorrect slip timer setting which will prevent the relay from issuing a valid close signal.

e.g. - a system with a high rate of slip which is within the allowable slip frequency limit, could be set up with too long a slip timer setting. This would mean that the incoming vector could pass through the valid close window too quickly and not allow the slip timer to time out and give a valid output.

2.8 Check Synchronising Settings

The check synchronising operation of the relay is used mainly in switching operations which link two parts of a system which are weakly tied via other paths elsewhere in the system. In this synchronous system there should be no frequency difference across the breaker but significant differences in phase angle and voltage magnitude may exist due to the transmission line characteristics such as its length and type of loading.

For check synchronising operation the relay should be set to the maximum phase angle and maximum voltage differences which still permit the circuit breaker to close without causing large disturbances to the system. For most systems the phase angle can be set between 20° and 30°. There should not be any slip frequency but a setting of 50mHz is typically applied as a check against loss of synchronism. Table 2 shows some possible check synchronising settings when using the phase detector plus time delay method. This shows a range of phase angles and the required slip timer settings to achieve a slip frequency limit of 50mHz. Note that due to the step resolution of the timer, an exact 50mHz slip limit is not always achievable.

CS Phase Angle Setting (θ°)	CS Slip Timer Setting (sec)	Slip Frequency Limit (mHz)
± 10°	1.1	50.51
± 15°	1.7	49.02
± 20°	2.2	50.51
± 25°	2.8	49.60
± 30°	3.3	50.51
± 35°	3.9	49.86
± 40°	4.4	50.51
± 45°	5.0	50.00

Table 2 - Typical Check Synchronising Settings

Alternatively, if the slip frequency detector is used and the slip timer turned OFF, a setting of 50mHz could be applied to the slip frequency detector directly to achieve the same ends.

Note : in check synchronising mode the valid phase difference window for closing is actually twice the phase angle setting value because the valid Check Sync close can be given when the phase angle is either decreasing or increasing. It should also be noted that the Check Sync close output will stay on for a minimum of 100 ms and for the whole duration of the time that the close parameters are met.

2.9 System Synchronising Settings

The system synchronising operation of the relay can automatically start if the two systems become asynchronous i.e. there are no ties between the two systems and one system is effectively ‘islanded’. If this situation occurs the frequencies will slip past each other and may cause the phase angle to come into the system split limits. The system split detector can be set anywhere from 90° to 175° and is typically set to 170°. This will start system synchronising automatically if the enable has been set to AUTO.

When there are high rates of slip between the two systems greater care is needed when closing the breaker and for this reason the system synchronising mode has independent settings from the check synchronising mode. The allowable phase angle close window is usually set much narrower than for check synchronising operation. Also, the close decision from the relay is only given in the case of the phase angle decreasing. It will not issue a close if the phase angle is increasing in value. Typically the slip frequency will be set to a limit of 250mHz or less and the phase angle to 10° or 15°. Table 3 shows some possible system synchronising settings for limits

of 100mHz and 250mHz. Note that due to the step resolution of the timer, an exact 100mHz or 250mHz slip limit is not always achievable.

SS Phase Angle Setting (θ°)	SS Slip Timer Setting (sec)	Slip Frequency Limit (mHz)
± 10°	0.3	92.59
± 15°	0.4	104.17
± 10°	0.1	277.78
± 15°	0.2	208.33

Table 3 - Typical System Synchronising Settings

Alternatively, if the slip frequency detector is used and the slip timer turned OFF, settings of 100mHz or 250mHz could be applied to the slip frequency detector directly to achieve the same ends.

Note : the system sync close output pulse is on for a minimum of 100 ms but can be extended if necessary by using the SS Close Pulse setting.

2.10 Example Setting Calculations For Slip Timer

In Check Synchronising operation the relay will issue a Check Sync close if the system conditions are such that the phase angle and slip frequency are within limits. There is a possibility, however, that a Check Sync close could be issued at a point where the phase angle is approaching the angular limits, say + 20°, and the slip frequency is at the maximum allowable value. The consequence of this is that due to the inherent closing time of the CB the actual CB close occurs outside of the phase angle limits. The angle overshoot being dependent on the actual slip frequency and the total CB closing delay.

The total delays involved in this process include the main software timing loop which issues the close command, the output relay time to pick up and the actual breaker closing time delays. To reduce the risk of a late closure it is common practice to set the slip timer setting (Td) to typically 10x the CB closing time. This will ensure that the CB will close no later than 1.2x the actual phase angle setting of the relay e.g. ± 24° for a ± 20° setting.

e.g. :-

The change in phase angle between two waveforms is directly related to the frequency difference, or slip, between them. The change in phase angle Δq for a system with 1Hz slip is 360° in 1 second. Thus,

Change in phase angle $\Delta q = (\text{Slip} \times 360)$ °/sec.

The distance the phasor can travel during the breaker close time can therefore be given by,

$\Delta q = (\text{Slip} \times 360 \times t_{CB})$ - where t_{CB} is the breaker close time in seconds.

Using the equation given in section 2.7 for check synchronising,

$\text{Slip} = \frac{1}{\text{Td}} \times \frac{q}{180°}$ and substituting this into $\Delta q = (\text{Slip} \times 360 \times t_{CB})$ gives the following,

$\Delta q = \frac{1}{\text{Td}} \times \frac{q}{180°} \times 360° \times t_{CB}$ which gives $\Delta q = 2 \times q \times \frac{t_{CB}}{\text{Td}}$

It was stated that the slip timer setting Td should be set to 10x the breaker closing time t_{CB}.

Substituting for this in the above equation gives,

$$\Delta q = \frac{(2 \times q)}{10} \quad \text{or} \quad \Delta q = 0.2 \times q$$

Thus for a slip timer setting (Td) of 10x breaker closing time (t_{CB}) the actual change in phase angle will be 20% of the phase angle setting. The maximum closing angle will be 120% of phase angle setting.

In practice, however, the relay operating times need to be taken into consideration. A typical example now follows :

- Maximum allowed phase angle for closure = 30°.

- Circuit breaker closure time = 150ms.

- Maximum relay delays : Software timing loop + Output relay delays = 5ms + 7ms = 12ms.

Therefore slip timer time delay should be set to 10x (150ms + 12ms) = 1.62sec. In practice this will have to be set to 1.6sec due to the resolution of the slip timer.

The phase angle setting should be set to 80% of the maximum allowable closing angle, which is 24°.

If the relay was to issue a close right on the boundary of 24° then the breaker will not close outside of 30°.

With an angle of 24° and a slip timer delay (Td) of 1.6sec, using the equation from section 2.7, the slip is therefore,

24 / (1.6 x 180) = 83mHz. If the relay were to close on the boundary the phase angle traversed in the 160ms total delay time is given by,

$\Delta q = (\text{Slip} \times 360) \times (t_{CB} + t_{RELAY})$ = 0.083 x 360 x 0.16 = 4.80°.

Therefore the CB will close at 24° + 4.80° = 28.80°.

2.11 Diagrams

At the back of this section Figure 1 shows a typical connection diagram for the Argus 7 check synchronising relay. Figure 2 shows a programming matrix, which is a convenient way of recording the input / output logic for the relay.

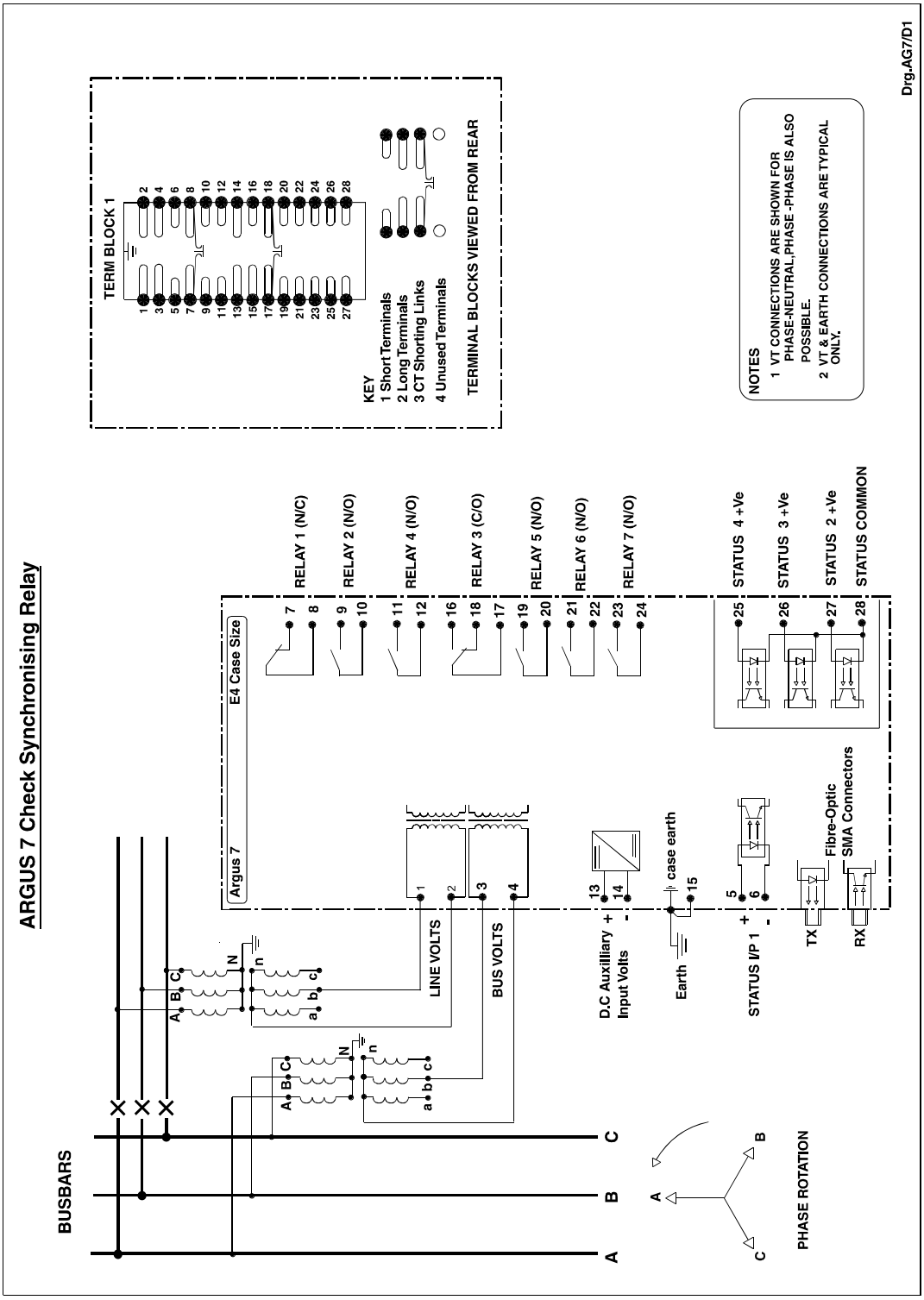


Figure 1 - Typical Connection Diagram

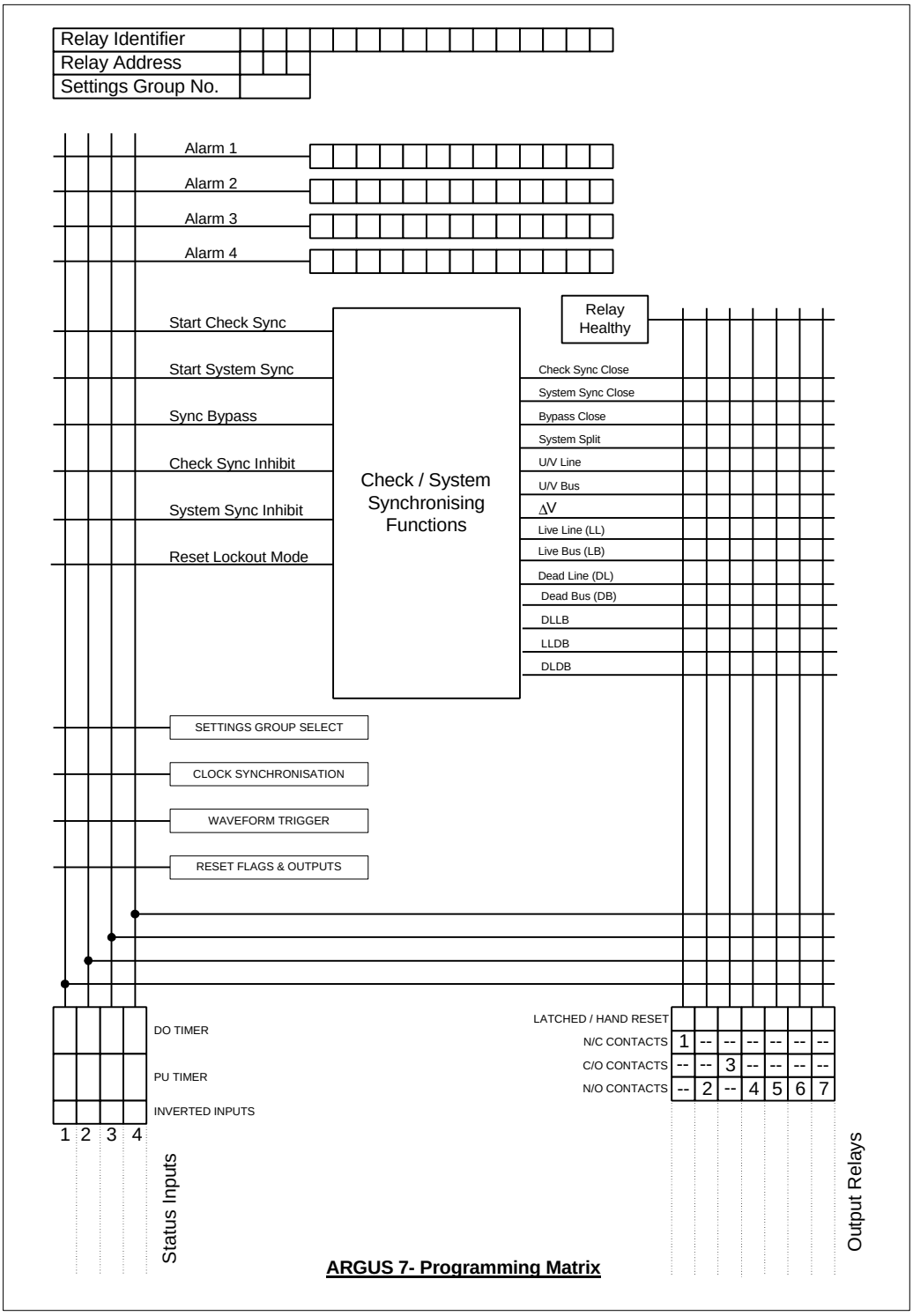


Figure 2 - Argus 7 Programming Matrix

TABLE OF CONTENTS

1 UNPACKING, STORAGE AND HANDLING

On receipt, remove the relay from the container in which it was received and inspect it for obvious damage. Check that the relay is the correct model number and the rating information is correct. It is recommended that the relay is not removed from the case. To prevent the possible ingress of dirt, the sealed polythene bag should not be opened until the relay is to be used. If damage has been sustained a claim should immediately be made against the carrier and Reyrolle Protection and the nearest Reyrolle agent should be informed.

When not required for immediate use the relay should be returned to its original carton and stored in a clean, dry place. The relay contains static sensitive devices, which are susceptible to damage due to static discharge and for this reason it is essential that the correct handling procedure is followed. The relays' electronic circuits are protected from damage by static discharge when it is housed in its case. When it has been withdrawn from the case, static handling procedures should be observed.

- Before removing the relay from its case the operator must first ensure that he is at the same potential as the relay by touching the case.
- The relay must not be handled by any of the relay terminals on the rear of the chassis.
- Relays must be packed for transport in an anti-static container.
- Ensure that anyone else handling the relays is at the same potential as the relay.

As there are no user serviceable parts in the relay, then there should be no requirement to remove any modules from the chassis. If any modules have been removed or tampered with, then the guarantee will be invalidated. Reyrolle Protection reserves the right to charge for any subsequent repairs.

2 RECOMMENDED MOUNTING POSITION

The relay uses a liquid crystal display (LCD) which displays setting and metering information. It has a viewing angle of ± 70º and an internal back light. The recommended viewing position is at eye level.

The relay should be mounted onto the circuit breaker or panel at a level which allows the user easiest access to the relay functions.

3 RELAY DIMENSIONS

The relay is supplied in the Epsilon case size E4. Mechanical diagrams of the case dimensions and panel cut-out requirements are provided in section 9 of this manual.

4 FIXINGS

4.1 Crimps

Amp Pidg or Plasti Grip Funnel entry ring tongue

Size	AMP Ref	Reyrolle Ref
0.25-1.6mm^2	342103	2109E11602
1.0-2.6mm^2	151758	2109E11264

4.2 Panel Fixing Screws

Kit – 2995G10046 comprising :

- Screw M4 X10TT 2106F14010 – 4 off
- Lock Washers 2104F70040 – 4 off
- Nut M4 2103F11040 – 4 off

4.3 Communications

9mm SMA fibre optic connections – 2 per relay.

(Refer to section 4 of this manual – Communications Interface).

5 ANCILLARY EQUIPMENT

The relay can be interrogated locally or remotely by making connection to the fibre optic terminals on the rear of the relay. For local interrogation a portable PC with a fibre to RS232 modem (Sigma 4) is required. The PC must be capable of running Microsoft Windows Ver 3.1 or greater, and it must have a standard RS232 port in order to drive the modem. For remote communications more specialised equipment is required. Refer to section 4 of this manual – Communications Interface.

TABLE OF CONTENTS

1 REQUIRED TEST EQUIPMENT

The following equipment will be required to perform commissioning tests on the Argus 7 relay.

- 500V Insulation resistance test set.
- Two variable A.C. voltage sources with a means of varying the phase relationship between them e.g. phase shifting transformer. Ideally, a portable relay test set e.g. Doble, Omicron etc.
- Time interval meter.
- Two A.C. Voltmeters.
- Phase angle meter.
- D.C. supply with nominal voltage within the working range of the relay's D.C. auxiliary supply rating.
- D.C. supply with nominal voltage within the working range of the relay's D.C. status input rating.
- Continuity tester e.g. multimeter.

Additional equipment for testing the communications channel :

- Portable PC with an electrical-to-optical RS232 converter and fibre optic connectors.
- A copy of Reydisp Evolution software installed on the PC to exercise the communications channel.

2 INSPECTION

Check that the relay has not been damaged in any way since being installed into the panel. Remove the relay from the case and check that the serial numbers of the relay and the case are all identical. Check also that the relay is the correct model and that the rating is correct.

Ensure that all connections are tight and in accordance with the relay wiring diagram or the scheme diagram. Replace the relay back into the case and check that it is fully inserted. Ensure that the relay case is solidly bonded to a local earth point by checking the earthing connection to the case.

3 APPLYING SETTINGS

Before applying settings to the relay the engineers should take time out to familiarise themselves with the relay's menu system. Section 1 and section 3 of this manual are helpful in this respect. The relay settings for the particular application should be applied before any secondary testing occurs. If they are not available then the relay has default settings which can be used for pre-commissioning tests. See section 3 of this manual for a list of the relay default settings.

Settings can be entered into the relay using the keypad on the front of the relay or they can be sent to the relay, from a file, using a portable PC and Reydisp Evolution software package.

Argus 7 relays feature eight alternative setting groups. In applications where more than one setting group is to be used then it may be necessary to test the relay in more than one configuration.

Note :- one settings group may be used to retain test settings.

When using setting groups it is important to remember that the relay may not necessarily be operating from the settings which are currently being displayed. There is an 'Active Settings Group' on which the relay operates and a 'Settings Group Edit/View' which allows the settings in one group to be viewed and altered while protection continues to operate on a different unaffected group. The 'Active Settings Group' and the 'Settings Group Edit/View' are selected in the System Configuration Menu. Settings should not be altered in the 'Active Settings Group' while the relay is in service unless other precautions, such as removing system links to prevent operation, are taken.

4 PRECAUTIONS

Before testing commences the relay should be isolated from the voltage transformers in line with the local site procedures. The closing and alarm circuits should also be isolated where practical. Ensure that the correct d.c. auxiliary voltage is applied to the circuit. See the relevant scheme diagrams for the relay connections.

5 TESTS

5.1 Insulation

When required, insulation tests to check the relay and associated wiring can be performed using a 500V electronic insulation resistance test set. The wiring may be tested between :-

1. All electrically isolated circuits.
2. All circuits to earth.

Accessible terminals of the same circuit should be connected together and deliberate circuit earthing links removed for the tests. Normal connections must be restored after testing. Satisfactory values for the various readings above depend upon the amount of wiring concerned. Where considerable multi-core wiring is involved a reading of 2.5 to 3.0 MΩ can be considered satisfactory. For short lengths of wiring higher values can be expected. A value of 1.0 MΩ should not be considered satisfactory and should be investigated.

We do not recommend a 2KV site pressure test on the secondary wiring with relays connected. If this has to be carried out then, as above, deliberate earth links must be removed. Note that both the positive and negative feeds to the relay's DC/DC converter are earthed via 5KV capacitors and the leakage current of these capacitors may trip the 2KV pressure test set. Also note that the capacitance effect of the secondary wiring may give rise to test set calibration errors that give impressed voltages higher than measured. To avoid this phenomenon, the pressure test set used should have the metering on the secondary (high voltage) side. Suitable test sets are manufactured by T&R Test Equipment (Type KV5 – 100).

All Reyrolle relays are comprehensively pressure tested during manufacture.

5.2 Commissioning Tests

Select the required relay configuration and settings for the application.

5.2.1 Status input tests

This test checks that the status input circuits are functioning correctly. The status input circuits should be energised in turn and observed to be operating using the instruments mode 'Status Inputs' display. A '1' indicates that the status circuit is energised, a '0' indicates that it is not.

Connect the correct D.C. voltage to the following terminals to energise the status inputs :

Status Input	+ DC Volts	- DC Volts
Status 1	5	6
Status 2	27	28
Status 3	26	28
Status 4	25	28

5.2.2 Output relay tests

This test checks that the output relays are functioning correctly. The output relays should be energised in turn and the contacts should be checked for correct operation using a continuity tester. The output relays can be energised in a number of ways. The following is the recommended method :

Assign each output relay in turn to 'Relay Healthy' in the output relay menu. On pressing the ENTER key the output relay selected will be energised. Check with a continuity tester that the actual contacts have operated. De-select the output relay and check that the contact returns.

Output Relay	Type	Terminal No.
Relay 1	N/C	7 – 8
Relay 2	N/O	9 – 10
Relay 3	C/O	17 (COM) 18 (N/C) 16 (N/O)
Relay 4	N/O	11 – 12
Relay 5	N/O	19 – 20
Relay 6	N/O	21 – 22
Relay 7	N/O	23 – 24

Note : when finished testing the output relays make sure that the 'Relay healthy' is re-assigned to the correct output relay given in the settings file.

5.2.3 Measurement Tests

Apply A.C.volts to both of the voltage input circuits of the relay using the A.C. variable voltage sources or portable relay test set. The relay should display the correct value of voltage ± 5% which is the tolerance of the measurement display meters. The instruments mode 'Vline' and 'Vbus' meters display the secondary voltage levels.

The applied A.C. volts can be in the range of 5 – 200Vrms. Nominal volts of 63.5V or 110V are recommended.

5.2.4 Scheme Tests

It is not necessary to perform tests on all internal elements of the relay. If the settings have been checked, the external wiring checked, the status inputs and output relays verified and the relay measures satisfactorily then the relay can be considered to be working to its design requirements. It will operate correctly, to the performance claims, and its operation under all service conditions is guaranteed.

However, if added confidence is required, then the following elements can be checked. Note that the relay should be commissioned with the actual settings calculated for the particular scheme.

1. Phase Angle Tests

The CS Phase Angle detector and the SS Phase Angle detector can be tested in the following way :

Apply nominal volts to both the line and bus input terminals of the relay. On initial turn on, the relay will start in check synchronising mode. If the voltage vectors are displaced by an amount greater than the CS Phase Angle setting but not as much as the System Split

Detector angle then the relay will stay in check synchronising mode. Using the instruments display, locate the Phase and Slip instruments as shown below :

```
Phase : CS Out
Slip  : CS In
```

Slowly decrease the phase angle difference and check the pick up where the Phase displays ‘CS In’. Then slowly increase the phase angle and check the drop off where Phase displays ‘CS Out’. The pick up and drop off values should fall within the performance claims given in Section 2 - Performance Specification. Repeat for opposite angles.

Note : the phase angle should be adjusted slowly so that the LCD has time to update. The instrument has a 0.5 sec delay on updating. Monitoring may also be done using the output contacts.

This test should be repeated for the system synchronising settings. This is best carried out by increasing the phase angle until a split occurs and then bringing the angles in. The split will cause the relay to go into system synchronising mode.

The results can be put into Table 1 at the back of this section.

2. Slip Frequency Tests

The CS Slip Frequency detector and SS Slip Frequency detector elements are more difficult to test and require variable frequency sources. A portable relay test set with fixed and variable frequency voltage source output is ideal for this.

Depending on the relay scheme settings it may be difficult to test the CS and SS slip frequency elements independently without adjusting the settings.

To test the CS Slip Frequency element turn the System Split Detector to OFF. This will ensure that a split is not initiated and the relay stays in check sync mode. Increase the frequency slip to a value outside of the slip frequency limits and then slowly reduce it until the element picks up. This will be indicated on the same instrument as above. Slip should display ‘CS In’. Gradually increase the slip until the element drops off as indicated by ‘CS Out’. Record the results in Table 2.

To test the SS Slip Frequency element turn the System Split Detector back to the value required for the scheme. Turn CS Slip Frequency element to OFF. Increase the phase angle until a split occurs and then repeat the above tests but checking for ‘SS In’ and ‘SS Out’. Record the results in Table 2.

All the results should fall within the performance claims given in Section 2 - Performance Specification section 6.

Note : remember to return all settings back to the original scheme settings if they have been changed.

3. Timer Tests

The slip timers can be tested by setting the angle between the two voltages to a value outside of the phase angle settings. Reduce the phase angle to zero and the output should not close until after the slip timer has timed out.

In practice however, the timers are difficult to test without specialist test equipment and test software. There are three recommended methods :

1. Apply in phase nominal volts to the relay. The relay will issue a close only after the slip timer has timed out. Note, however, that the relay has a start-up timer of 960ms which is the minimum time before an output is given. This start-up timer effectively runs in parallel with the slip timer. If for example a CS Slip Time of 2.0sec has been

selected then the time for close will be 2.0sec. If however, 0.5sec has been selected then the time for close will be 0.960sec.

2. Apply in phase volts to the relay at a level above the 5V blocking level but below the undervoltage blocking element level. The relay will time through the start-up timer. If the volts are then increased to nominal then the relay will close after the set slip time. If 0.5sec has been selected then the relay will close after 0.5sec.

   All results should fall within the performance claims given in Section 2 - Performance Specification.

3. Using Reydisp Evolution software the event records will give accurate times for all of the timing events within the relay. The following events were extracted from a relay which had the CS Slip Timer set to 1.0 sec. When the phase angle moved inside the close window the actual close output was given after a time of 1.005 seconds.

   00:27:41.310 , 01/01/99 Rey Raised Phase In Sync

   00:27:42.315 , 01/01/99 Rey Raised Check Sync Close

The split timer can be tested in the following way. Apply nominal in phase volts to both of the voltage inputs. Cause a system split to occur by displacing the vectors by the System Split Detector setting and then turn both volts off. The system split output contact will then stay on for a time set by the System Split Timer setting.

Record all results in Table 3.

4. Voltage Level Detectors

Check the pick up and drop off levels for the voltage level detector elements. Individually ramp up and down the line and bus volts and examine the 'Line/Bus Status' instrument to see where the elements actually operate. Record the results in Table 4.

5. Undervoltage Elements

Check the pick up and drop off levels for both the line undervoltage and bus undervoltage blocking elements. Examine the 'Volt Blocking' instrument to see where the elements actually operate. Record the results in Table 4.

6. Differential Voltage Elements

Check the pick up and drop off levels for the differential voltage blocking element. Examine the 'Volt Blocking' instrument to see where the elements actually operate. Record the results in Table 4.

All results should fall within the performance claims given in Section 2 - Performance Specification.

6 PUTTING INTO SERVICE

After the tests have been performed satisfactorily the relay should be put back into service as follows :

- Remove all test connections
- Where possible, the relay settings should be downloaded to a computer and a printout of the settings obtained. This should then be compared against the required settings. It is important that the correct settings group is active, if more than one group has been programmed.
- Replace all fuses and links.

APPENDIX 1 – Test Tables

Table 1 – Phase Angle Tests

		Positive angle		Negative angle	
Phase Element	Phase Setting (Degrees)	Pick Up (Degrees)	Drop Off (Degrees)	Pick Up (Degrees)	Drop Off (Degrees)
CS Phase Angle					
SS Phase Angle					

Table 2 – Slip Frequency Tests

		Positive Slip		Negative Slip	
Slip Element	Slip Setting (Hz)	Pick Up (Hz)	Drop Off (Hz)	Pick Up (Hz)	Drop Off (Hz)
CS Slip Freq.					
SS Slip Freq.					

Table 3 – Timer Tests

Timer Type	Timer Setting (sec)	Actual Time (sec)
CS Slip Timer		
SS Slip Timer		
Split Timer		

Table 4 – Voltage Element Tests

	Live Level			Dead Level		
Voltage Detector	Setting (V)	Pick Up (V)	Drop Off (V)	Setting (V)	Pick Up (V)	Drop Off (V)
Line						
Bus						

Voltage Element	Setting (V)	Pick Up (V)	Drop Off (V)
Line Undervoltage			
Bus Undervoltage			
Differential Element			

TABLE OF CONTENTS

APPENDIX

1 MAINTENANCE INSTRUCTIONS

The Argus 7 is a maintenance free relay, with no user serviceable parts. During the life of the relay it should be checked for operation during the normal maintenance period for the site on which the product is installed. It is recommended the following tests are carried out :

1 Visual inspection of the metering display (every year)

2 Operation of output contacts (every 2 years)

3 Secondary injection of each element (every 5 years)

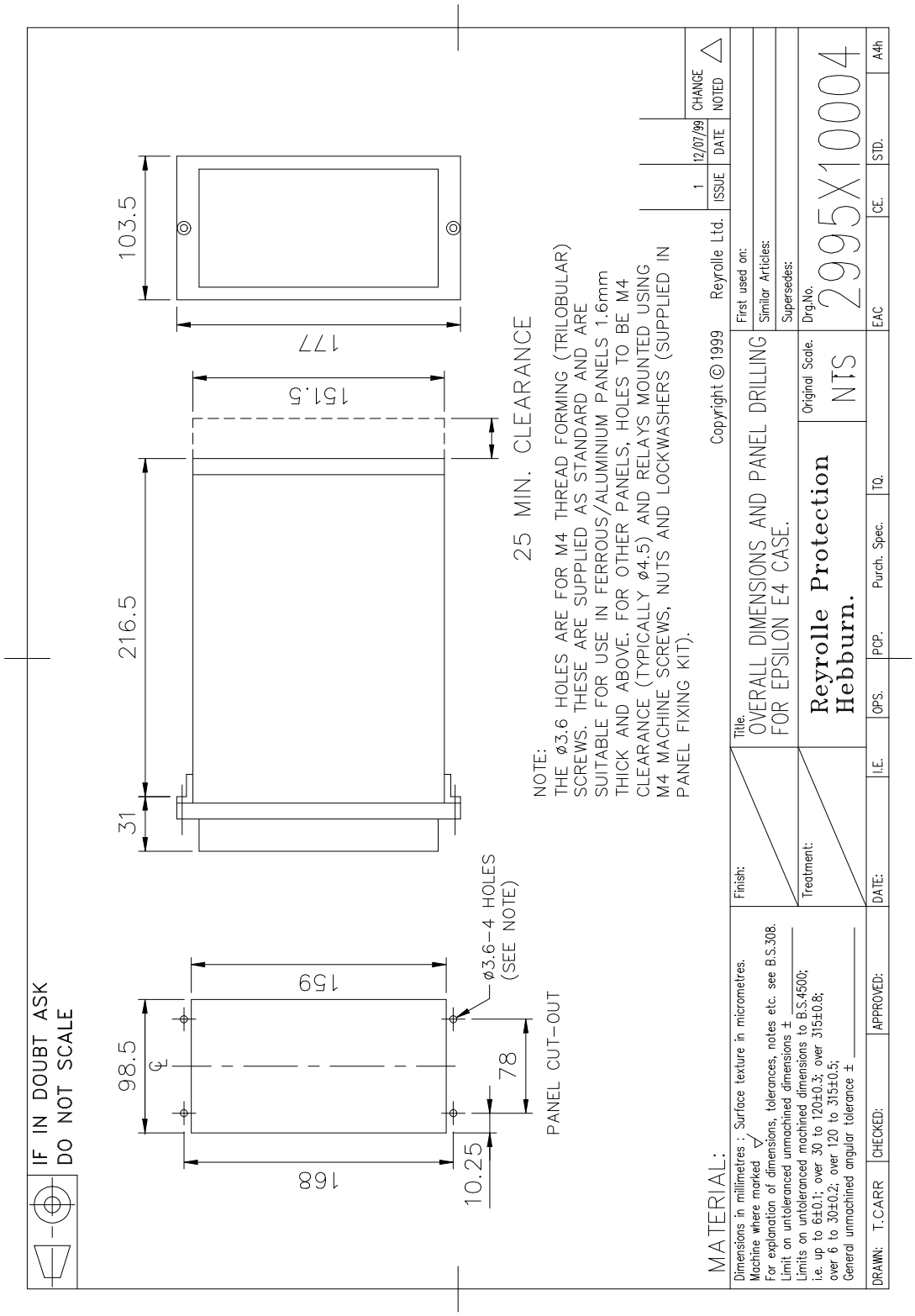
DEFECT REPORT FORM

Please copy this sheet and use it to report any defect which may occur.

<table>
<tr><td colspan="3">Customers Name & Address:</td><td colspan="3">Contact Name:</td></tr>
<tr><td colspan="3" rowspan="2"></td><td colspan="3">Telephone No:</td></tr>
<tr><td colspan="3">Fax No:</td></tr>
<tr><td colspan="3">Supplied by:</td><td colspan="3">Date when installed:</td></tr>
<tr><td colspan="3">Site:</td><td colspan="3">Circuit:</td></tr>
<tr><td>Date Found:</td><td>During Commissioning:</td><td>During Maintenance:</td><td>From a System Fault:</td><td colspan="2">Other, please state:</td></tr>
<tr><td colspan="3">Product Name:</td><td colspan="3">Article Number:</td></tr>
<tr><td colspan="3">Software Version:</td><td colspan="3">Serial Number:</td></tr>
<tr><td colspan="6">Copy any message displayed by the relay:</td></tr>
<tr><td colspan="6">Describe Defect:</td></tr>
<tr><td colspan="6">Describe any other action taken:</td></tr>
<tr><td colspan="2">Signature:</td><td colspan="2">Please print name:</td><td colspan="2">Date:</td></tr>
<tr><td colspan="6">For Reyrolle Protection use only:</td></tr>
<tr><td>Date Received:</td><td>Contact Name:</td><td>Reference No:</td><td>Date Acknowledged:</td><td>Date of Reply:</td><td>Date Cleared:</td></tr>
</table>

VA Tech Reyrolle ACP Ltd.
PO Box 8
HEBBURN
Tyne & Wear
NE31 1TZ
England
Telephone: (0191) 401 5555
Fax: (0191) 401 5575

Attached is a mechanical drawing for the Epsilon E4 case size with panel cut-out and drilling dimensions.



The policy of Easun Reyrolle is one of continuous improvement and development. The company therefore reserves the right to supply equipment which may differ slightly from described and illustrated in this publication.

HOSUR WORKS
#98, Sipcot Industrial Complex,
Hosur 635 126, India.
Tel: +91 4344 501600-602 (4 lines)
Fax: +91 4344 276397

BANGALORE WORKS
#17/3 Arakere,
Bannerghatta Road,
Bangalore-560 076, India.
Tel: +91 80 26581023 / 3268
Fax: +91 80 26580642
Email: blrworks@easunreyrolle.net

SWITCHGEAR WORKS
Ernavur,
Chennai-600 057, India.
Tel: +91 44 25733715
Fax: +91 44 25733468
Email: switchgear@easunreyrolle.net

AUTOMATION DIVISION
"Ashirwad", #25, 29th Main,
4th B Cross, BTM Layout 2nd Stage,
Bangalore-560 076, India.
Tel: +91 80 26685496
Fax: +91 80 26685446
Email: smabp@easunreyrolle.net

EXPORTS DIVISION
#17/3 Arakere,
Bannerghatta Road,
Bangalore-560 076, India.
Tel: +91 80 26581023 / 3268
Fax: +91 80 26580642
Email: exports@easunreyrolle.net

Sales Offices

Mumbai
Tel: +91 22 22855415
Fax: +91 22 22825703
Email: mumbai@easunreyrolle.net

Delhi
Tel: +91 11 25747321
Fax: +91 11 25747320
Email: delhi@easunreyrolle.net

Kolkata
Tel: +91 33 22848320
Fax: +91 33 22848326
Email: kolkata@easunreyrolle.net

Bangalore
Tel: +91 80 26685496
Fax: +91 22 26685446
Email: blroffice@easunreyrolle.net

Chennai
Tel: +91 44 24346425
Fax: +91 44 24346435
Email: chennai@easunreyrolle.net

Secunderabad
Telefax: +91 40278 17847
Email: hyderabad@easunreyrolle.net

Bhopal
Telefax: +91 755 2684221
Email: bhopal@easunreyrolle.net

EASUN REYROLLE
Corporate Office
Easun Reyrolle Limited. 98 Sipcot Industrial Complex
Hosur 635 126 India. Tel: +91 4344 501600-602 (4 Lines)
Fax: +91 4344 276397
www.easunreyrolle.com

Man/Argus 7/Rev 0/1105 IMAGIC CREATIVES