



GE Consumer & Industrial  
**Multilin**

# CIO

Remote CAN Digital I/O Module  
Instruction manual  
GEK-106465A



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<b>1.</b>	<b><u>OVERVIEW</u></b>	<b><u>3</u></b>
1.1.	<b>IMPORTANT PROCEDURES</b>	<b>3</b>
1.1.1.	INSPECTION CHECKLIST.....	4
1.1.2.	SAFETY INSTRUCTIONS.....	6
1.2.	<b>OVERVIEW</b>	<b>7</b>
1.2.1.	INTRODUCTION TO F650 AND F600 FAMILY OF RELAYS.....	7
1.2.2.	HARDWARE ARCHITECTURE.....	7
1.2.3.	SOFTWARE ARCHITECTURE.....	7
1.2.4.	COMMUNICATIONS ARCHITECTURE.....	8
<b>2.</b>	<b><u>PRODUCT DESCRIPTION</u></b>	<b><u>9</u></b>
2.1.	<b>OVERVIEW</b>	<b>9</b>
2.2.	<b>SUMMARY OF FEATURES</b>	<b>9</b>
2.3.	<b>ORDERING CODE</b>	<b>10</b>
2.4.	<b>TECHNICAL SPECIFICATIONS</b>	<b>11</b>
2.4.1.	INPUTS.....	11
2.4.2.	OUTPUTS.....	11
2.4.3.	CONTROL POWER SUPPLY.....	11
2.4.4.	CAN BUS.....	11
2.4.5.	ENVIRONMENTAL CHARACTERISTICS.....	11
2.4.6.	PACKAGING AND WEIGHT.....	12
2.4.7.	TYPE TESTS.....	12
2.4.8.	APPROVALS.....	12
<b>3.</b>	<b><u>HARDWARE</u></b>	<b><u>13</u></b>
3.1.	<b>MODULE DESCRIPTION</b>	<b>13</b>
3.2.	<b>MECHANICAL DESCRIPTION</b>	<b>14</b>
3.2.1.	MOUNTING.....	14
3.2.2.	REAR COVER DESCRIPTION.....	16
3.3.	<b>WIRING</b>	<b>17</b>
3.3.1.	EXTERNAL CONNECTIONS.....	17
3.4.	<b>BOARDS</b>	<b>19</b>
3.4.1.	BOARD OPTION 1.....	19
3.4.2.	BOARD OPTION 2.....	20
<b>4.</b>	<b><u>USER INTERFACES</u></b>	<b><u>29</u></b>
4.1.	<b>SOFTWARE</b>	<b>29</b>
4.2.	<b>FRONT INDICATORS</b>	<b>29</b>

<b>5.</b>	<b><u>INPUT/OUTPUT MODULES DESCRIPTION</u></b>	<b><u>31</u></b>
<b>5.1.</b>	<b>CIRCUIT SUPERVISION AND CONTACT SEAL-IN CIRCUITS</b>	<b>31</b>
5.1.1.	CIRCUIT SUPERVISION.....	31
5.1.2.	CONTACT SEAL-IN .....	31
<b>5.2.</b>	<b>CONTROL SETTINGS FOR INPUTS/OUTPUTS</b>	<b>32</b>
5.2.1.	INPUT/OUTPUT BOARDS SETTINGS.....	32
5.2.2.	INPUTS/OUTPUTS STATUS .....	36
<b>6.</b>	<b><u>ACCEPTANCE TESTS</u></b>	<b><u>39</u></b>
<b>6.1.</b>	<b>VISUAL INSPECTION</b>	<b>39</b>
<b>6.2.</b>	<b>GENERAL CONSIDERATIONS ON THE POWER SUPPLY NETWORK</b>	<b>39</b>
<b>6.3.</b>	<b>ISOLATION TESTS</b>	<b>40</b>
<b>6.4.</b>	<b>INDICATORS</b>	<b>40</b>
<b>6.5.</b>	<b>POWER SUPPLY TESTING</b>	<b>40</b>
<b>6.6.</b>	<b>COMMUNICATION WITH THE MASTER UNIT</b>	<b>41</b>
<b>6.7.</b>	<b>INPUTS AND OUTPUTS</b>	<b>41</b>
6.7.1.	DIGITAL INPUTS.....	41
6.7.2.	CONTACT OUTPUTS .....	42
6.7.3.	CIRCUIT CONTINUITY SUPERVISION INPUTS .....	42
6.7.4.	LATCHING CIRCUITS.....	42

## 1. OVERVIEW

### 1.1. IMPORTANT PROCEDURES

To help ensure years of trouble free operation, please read through the following chapter for information to help guide you through the initial installation procedures of your new relay.



**BEFORE ATTEMPTING TO INSTALL OR USE THE RELAY, IT IS IMPERATIVE THAT ALL WARNINGS AND CAUTIONS IN THIS MANUAL ARE REVIEWED TO HELP PREVENT PERSONAL INJURY, EQUIPMENT CAUTION: THE OPERATOR OF THIS INSTRUMENT IS ADVISED THAT IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED IN THIS MANUAL, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED**

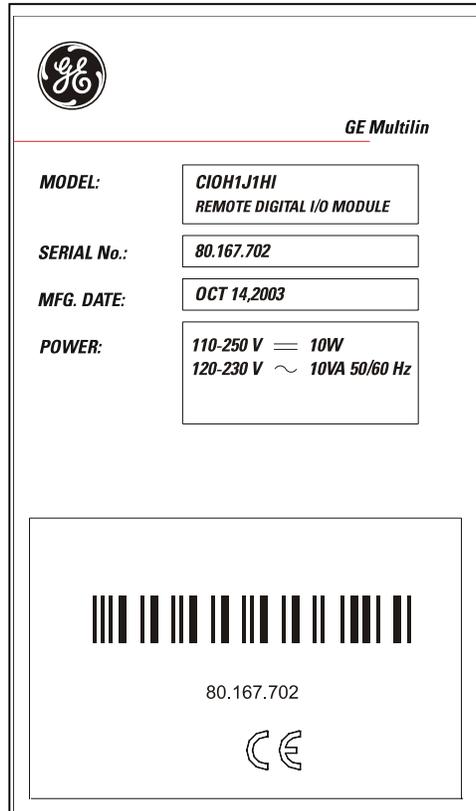


**FIGURE 1-1 CIO FRONT VIEW**

**Installation must be according to the national electric code of the appropriate country**

- Open the relay packaging and inspect the relay for physical damage.

Refer to the label on the side of the relay verifies that the model number is the correct model ordered.



**FIGURE 1-2 IDENTIFICATION LABEL (A4454P5)**

- Please ensure that you receive the following items with your CIO unit:

- Mounting screws for rear terminals and for fixing the relay to a cabinet
- Wiring diagram

For product information, instruction manual updates, and the latest software updates, please visit the GE Multilin Home Page [www.GEMultilin.com](http://www.GEMultilin.com).

**Note: If there is any physical damage detected on the relay, or any of the contents listed are missing, please contact GE Multilin immediately at:**

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The information provided herein does not intend to cover all details of variations of the equipment nor does it take into account the circumstances that may be present in your installation, operating or maintenance activities.

Should you wish to receive additional information, or for any particular problem that cannot be solved by referring to the information contained herein, please contact GENERAL ELECTRIC MULTILIN.

The CIO ground screw located on the rear of the unit must be correctly grounded.

This is required not only for personal protection, but also for avoiding a voltage difference between the CIO serial port and the master unit port, which could produce anomalies in communication.

GE Multilin will not be responsible for any damage in the relay or connected equipment whenever this elemental safety rule is not followed.

1.2. OVERVIEW

1.2.1. INTRODUCTION TO F650 AND F600 FAMILY OF RELAYS

This platform of relays has been designed to meet the goals that are appearing nowadays in the environment of new substations. Historically, protection, control and metering functions have been performed by electromechanical elements at the beginning, then static devices, and finally by digital equipment able to integrate all these functions in a single device, called IED (Intelligent Electronic Device).

Due to the huge number of signals to be controlled and monitored nowadays in a substation environment, there is a new need for a great number of digital inputs and outputs to retrieve states and to signal or perform all different operations. CIO units respond to this need, allowing connection to F650 and F600 IEDs, and increasing the number of available inputs and outputs depending on the connected equipment.

1.2.2. HARDWARE ARCHITECTURE

CIO units incorporate a series of interconnected modules to operate. These modules are a power supply and input/output boards.

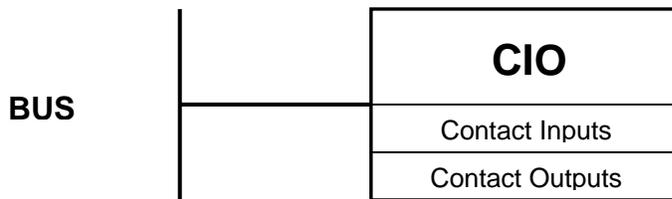


FIGURE 1-3 HARDWARE ARCHITECTURE

As shown on the diagram above, Contact Inputs/Outputs are signals associated to physical input/output contacts in the relay, and their status is sent/received through the CAN BUS of the associated equipment, F600 or F650.

This CAN connection to the master unit can be made through fiber optic cable or through copper cable.

CIO units can incorporate up to two I/O boards, each of which must have a unique address in the system. For this purpose, there is a switch at the rear of the unit with 16 positions (0 to F), that allows indicating the address for board H. The address of board J is fixed to “board H address + 1”.

1.2.3. SOFTWARE ARCHITECTURE

Each I/O board includes a microprocessor that manages communication with the master unit, as well as sampling and activation of the corresponding inputs and outputs.

The firmware (software embedded in the boards) has been designed using object oriented programming techniques (OOD/OOP). These techniques are based on the use of objects and classes, and provide the software architecture with the same characteristics as the hardware architecture, i.e., modularity and flexibility.

**1.2.4. COMMUNICATIONS ARCHITECTURE**

CIO units incorporate a CAN BUS port in two physical media: glass fiber optic and cable. The fiber optic port allows connection to the master unit for a single CIO unit. For connections including several CIO units, the cable port must be used. If the master unit is a F650, then communication must always be in fiber optic.

## **2. PRODUCT DESCRIPTION**

### **2.1. OVERVIEW**

The CIO module is an input/output extension for F650 and F600 units. Using this module, the number of available inputs/outputs can be increased, these inputs/outputs operation being identical to the one of the original I/Os in the master unit.

The CIO module has been designed to be installed close to the substation switchgear, and connected to the main unit through a CAN bus in fiber optic or cable. Fiber optic connection provides total immunity against electromagnetic disturbances, as well as simplified wiring and commissioning.

CIO module I/O configuration and management are performed exclusively from the master unit. This master unit manages the CIO inputs and outputs in the same way as its own.

### **2.2. SUMMARY OF FEATURES**

#### **INPUTS**

- Inputs programmable from the master unit.
- Programmable activation voltage level
- Programmable debounce time for each inputs group
- Possibility to select positive or negative activation logic
- Possibility to select pulse or level activation.

#### **OUTPUTS**

- Outputs programmable from the master unit
- Possibility to select positive or negative activation logic
- Selectable pulse mode activation
- Selectable latched configuration
- Breaker tripping and Closing circuits supervision

**2.3. ORDERING CODE**

CIO units are available in 1/3 19" rack, 6 units high, and it includes a power supply module and a communication module, plus a maximum of two I/O modules. Each of these modules can be supplied in different versions, which must be specified when ordering. The required information to detail the requested unit is shown on the table below:

TABLE 2-1 ORDERING CODE

CIO	H	-	J	-	-	-	DESCRIPTION
							<b>I/O board 1 in slot H</b>
		1					16 digital inputs + 8 outputs
		2					8 digital inputs + 8 outputs + 2 trip/close circuit supervision circuits
		4					32 digital inputs
		5					16 digital inputs + 8 analog inputs
							<b>I/O board 1 in slot J</b>
				0			None
				1			16 inputs + 8 outputs
				4			32 digital inputs (See Note 1)
				5			16 digital inputs + 8 analog inputs (See Note 1)
							<b>Auxiliary Voltage</b>
					LO		24-48 Vdc (range 19.2 - 57.6)
					HI		110-250 Vdc (range 88-300) 120-230 Vac (range 96-250)
							<b>Environmental Protection</b>
						H	Harsh (Chemical) environment conformal coating

(1) The digit selected for option J must be equal or higher than the digit selected for option H.  
 CIOH1J5\*\* is a valid selection  
 CIOH5J1\*\* is an invalid selection

**2.4. TECHNICAL SPECIFICATIONS**

TECHNICAL SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

**2.4.1. INPUTS**

Activation range:	Programmable from 1 up to 255 Vdc in steps of 1 V
Impedance	> 100 kOhm
Load for voltage supervision inputs	2 mA + V/100 kOhm
Acknowledgement time	<1 m
Debounce time:	1 to 50 ms in steps of 1 ms

**2.4.2. OUTPUTS**

Permanent current	16 A
Closing current	60 A during 1 second
Opening current	0.3 A with L/R = 40 ms at 125 Vdc 0.25 A with L/R = 40 ms at 250 Vdc

**2.4.3. CONTROL POWER SUPPLY**

<b>LO (low range)</b>	
Range:	24 to 48 Vdc (from 24 Vdc – 15% to 48 Vdc + 20%)
<b>HI (high range)</b>	
Range:	110 to 250 Vdc (from 110 Vdc – 15% to 250 Vdc + 20%) 110 to 240 Vac (from 110 Vac – 15% to 240 Vac + 20%)
Consumption:	5 W typical 0.25 W more per each activated output.
Interruptions:	Typical 100 ms, without unit reset.

**2.4.4. CAN BUS**

Baudrate:	125 kbits per second
Media:	Glass fiber optic multimode with ST connectors. Maximum recommended length 1Km 3 wire cable connection Maximum recommended length 500m

**2.4.5. ENVIRONMENTAL CHARACTERISTICS**

Operation temperature:	- 10°C to + 60°C
Storage temperature:	- 40°C to + 80°C
Humidity:	95% without condensing.

2.4.6. PACKAGING AND WEIGHT

Net weight: 2.5 kg  
 Packaged: 3.5 kg  
 Package dimensions (WxHxD): 30x40x40 cm

2.4.7. TYPE TESTS

CATEGORY	STANDARD	CLASS	TEST
EMC	IEC 1000-4-8 EN61000-4-8	IV	Power frequency magnetic field immunity test.
	IEC 1000-4-10 EN61000-4-10	4	Damped oscillatory field immunity test
	IEC 1000-4-3 IEC60255-22-3	III	Radiated, radio-frequency electromagnetic field immunity test
	IEC 1000-4-3	3	Digital radiofrequency electromagnetic field
	IEC 1000-4-2 EN 61000-4-2 IEC60255-22-2	III	Electrostatic discharge immunity test
	IEC 1000-4-16	4	Test for immunity to conducted common mode disturbances in the frequency range 0Hz to 150 kHz immunity test.
	IEC 1000-4-5	4	Surge immunity test
	IEC 1000-4-12 IEC 60255-22-1	III	Noise 1 MHz. Oscillatory waves immunity test.
	IEC 1000-4-4 EC 61000-4-4 IEC60255-22-4	IV	Electrical fast transient/burst immunity test
	IEC 1000-4-6 IEC60255-22-6	III	Immunity to conducted disturbances, induced by radio-frequency fields
EMC Emisivity	IEC 60255-25 EN55022	B	Conducted and radiated emissions class B
Product	IEC60255-5	2 kV	Insulation
	IEC60255-5	6kV .5J	Impulse test
	IEC60255-11; IEC61000-4-29	100 ms	Power supply interruptions

CIO has been designed to comply with the highest existing requirements. More specifically, UNIPED recommendations for high voltage substations are followed.

2.4.8. APPROVALS

ISO9001 Registered system.

CE marking: Meets the CE standards relevant for protections.

### 3. HARDWARE

#### 3.1. MODULE DESCRIPTION

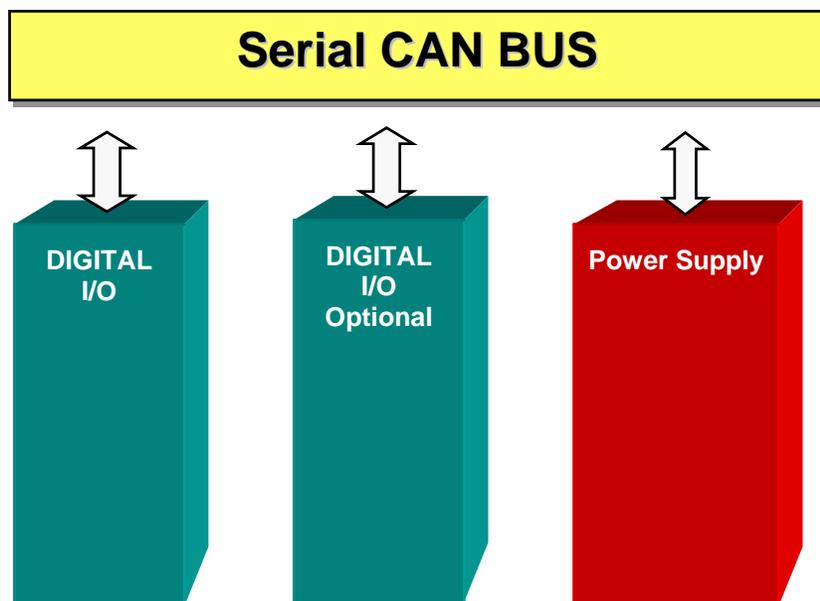


FIGURE 3-1 BLOCK DIAGRAM

F650 units incorporate the following modules:

**Power supply**

**Input/Output module**

Optionally, a **second I/O module** can be added.

A relay connected to the low voltage side of the power supply monitors this voltage. The three contact terminals, normally open, common, and normally closed, are available at the external connector terminals. This relay monitors only the power supply integrity.

This is a “fly-back” type power supply, providing high efficiency, stability and reliability thanks to the maturity of this technology. There are two available ranges, Hi and Low, in order to optimize efficiency and general performance, including the capability to tolerate auxiliary voltage interruptions (dips).

Oversized components highly resistant to temperature are used. For example, all capacitors are specified to stand up to 105°C, transformer components are specially designed to stand up to 180°C, the used MOSFET transistor is of very low resistance, supports high voltage and is refrigerated by an oversized heat sink. This allows supporting extremely high temperatures, and prolonged overloads such as the ones occurring at batteries in deep charge mode (much higher than the maximum voltage shown in the Technical Characteristics section).

High capacity capacitors are also used, providing high tolerance to prolonged dips, 100ms, even in the most unfavorable consumption conditions. This allows the relay to continue with normal operation without undesired resets, which would cause a long time of protection unavailability

### 3.2. MECHANICAL DESCRIPTION

The model number and electrical characteristics of the unit are indicated on the label located on the right side of the relay case.

The metallic case of the unit is highly resistant to corrosion. It is made of stainless steel (AISI 304), coated with an epoxy layer, and the rest of the metallic pieces are covered with a high quality resistive coating that has successfully passed at least 96 hours in the salt spray chamber (S/N ASTM B-117).

The front of the relay is made of a conductor thermoplastic, flame retardant (V0), highly resistive material, which guarantees the unit's immunity to all kinds of EMI/RFI/ESD interferences. As well, an IP51 (IEC 529) protection degree against dust and water through the front and with the relay mounted in the panel.

In order to guarantee safety and preventing access to the unit by unauthorized personnel, the front communications port and the operation mode key are protected by a sealable cover.

#### 3.2.1. MOUNTING

The unit is designed for both semi-flush mounting with the terminals on the back, and rear panel mounting, with the terminals towards the front. In both cases the relay should be secured to the panel with the M6 screws provided with the unit.

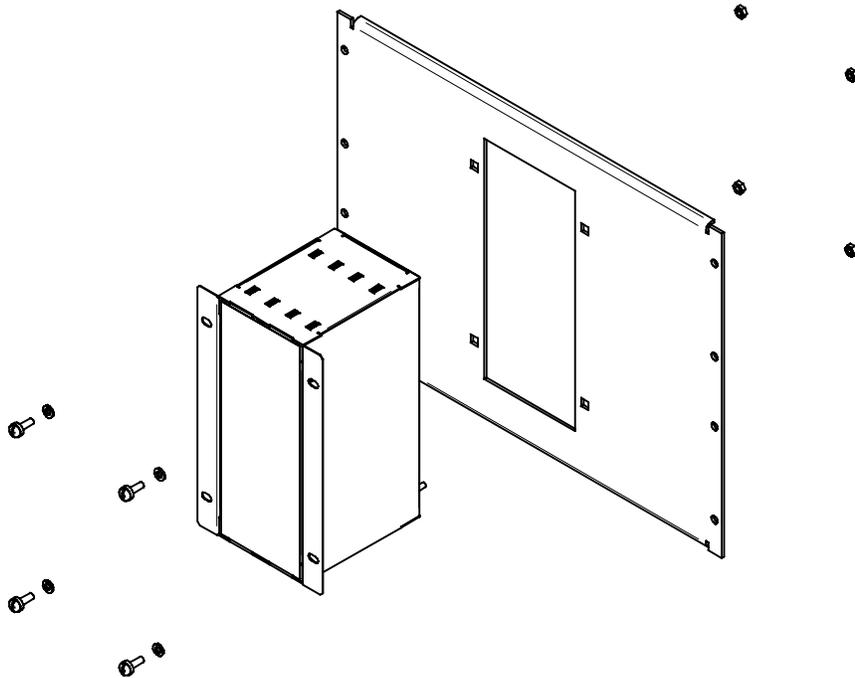


FIGURE 3-2 SEMI-FLUSH MOUNTING

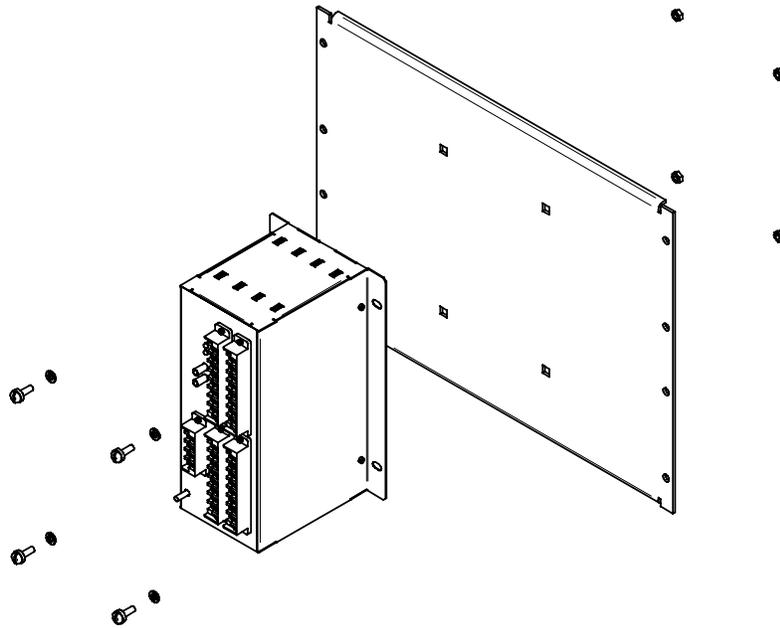


FIGURE 3-3 REAR PANEL MOUNTING

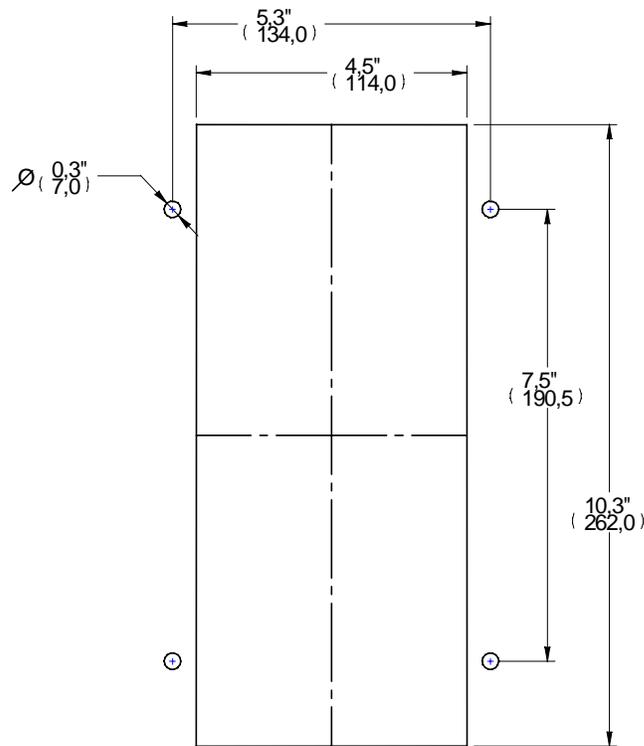


FIGURE 3-4 DRILLING DIMENSIONS

Unit wiring is performed through the terminal blocks located on the rear.

The rest of the terminal blocks for power supply, inputs/outputs, incorporate high quality connectors with the capacity to withstand a rated current of 15 A at 300 V. These terminal blocks admit a cable section of up to 2.5 mm<sup>2</sup> (AWG 12).

3.3. WIRING

3.3.1. EXTERNAL CONNECTIONS

CIO units can hold up to two I/O modules. Each of these modules can be selected between the following options:

Option 1: Board with 16 inputs and 8 outputs.

Option 2: Board with 8 digital inputs, 4 circuit supervision outputs, 6 conventional outputs, and two current sensing outputs

Each model has a different wiring diagram, as follows:

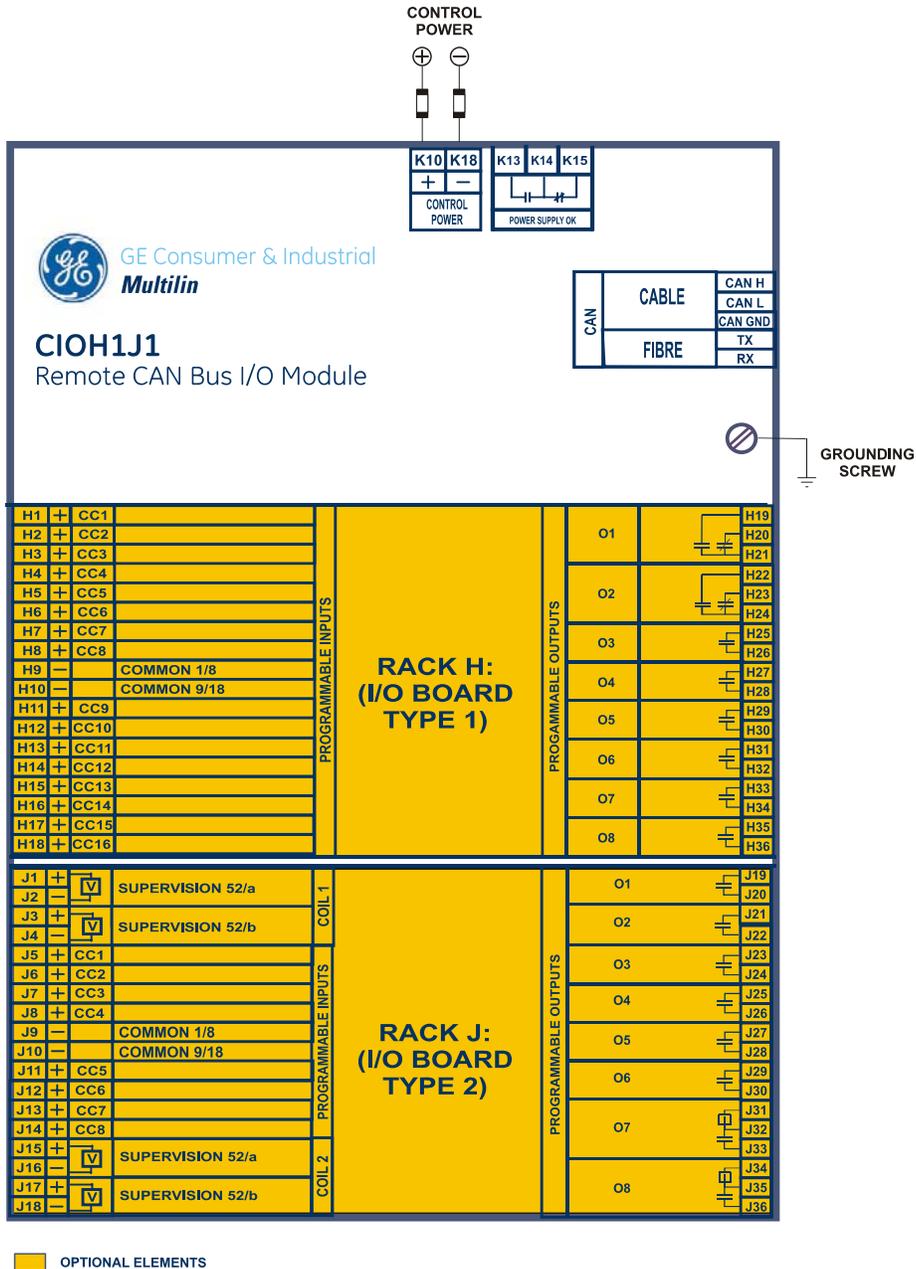


FIGURE 3-5 WIRING DIAGRAM FOR MODELS CIOH2J1 (226B5113F1)



3.4. BOARDS

3.4.1. BOARD OPTION 1

CIO I/O board option 1 includes 16 inputs grouped in two series of 8 inputs with a common, and 8 conventional inputs.

FIGURE 3-7 shows the location of terminals for both types of board:

TERMINAL	MIXED	SUPERVISION	
	1	2	
<b>INPUTS</b>			
1	CC1		COIL 1
2	CC2		52/a
3	CC3		COIL 1
4	CC4		52/b
5	CC5	CC1	
6	CC6	CC2	
7	CC7	CC3	
8	CC8	CC4	
9	COMMON 1/8	COMMON 1/4	
10	COMMON 9/16	COMMON 5/8	
11	CC9	CC5	
12	CC10	CC6	
13	CC11	CC7	
14	CC12	CC8	
15	CC13		COIL 2
16	CC14		52/a
17	CC15		COIL 2
18	CC16		52/b
<b>OUTPUTS</b>			
19			O1
20			O2
21			O3
22			O4
23			O5
24			O6
25			O7
26			O8
27			O9
28			O10
29			O11
30			O12
31			I SENS
32			O13
33			O14
34			I SENS
35			O15
36			O16

FIGURE 3-7 LOCATION OF TERMINALS

Option 2 I/O board includes two groups of 4 inputs with one common, in terminals 9 to 10. It also includes 6 auxiliary outputs, in terminals 19 to 30 with normally open contacts and two current sensing (latching) outputs.

Besides, there are 2 groups of inputs for trip circuit supervision. The first group includes two isolated digital inputs, terminals 1-2 and 3-4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs 15-16 and 17-18.

Inputs in both groups are wet contacts, this means they need to receive a positive in the terminal labeled as + coming from a power supply whose negative is connected to the terminal labelled as -.

Using voltage detectors and current sensing, it is possible to implement several trip or close circuit supervision schemes, as well as protection of the unit output contact.

In order to implement these schemes, it is not necessary to perform any setting in the unit. Internal functions are always operative and provide the following logic operands:

OPERAND		DESCRIPTION
CONTACT (Va_COIL1)	INPUT_00_08	Active when voltage is detected in terminals 1 - 2 (circuit 1)
CONTACT (Vb_COIL1)	INPUT_00_09	Active when voltage is detected in terminals 3 - 4 (circuit 1)
CONTACT (Va_COIL2)	INPUT_00_10	Active when voltage is detected in terminals 15 - 16 (circuit 2)
CONTACT (Vb_COIL1)	INPUT_00_11	Active when voltage is detected in terminals 17 - 18 (circuit 2)
CONTACT (O7_SEAL)	INPUT_00_12	Active if current is detected by sensor in output O7 (F31-F33)
CONTACT (O8_SEAL)	INPUT_00_13	Active if current is detected by sensor in output O8 (F34-F36)
CONTACT (SUP_COIL1)	INPUT_00_14	Active when continuity is detected in circuit 1
CONTACT (SUP_COIL2)	INPUT_00_15	Active when continuity is detected in circuit 2

A continuity failure is detected in a circuit when both voltage detectors (Va and Vb) detect lack of voltage during more than 500 ms. This function is not influenced by the breaker status.

These operands can be associated to internal signals (virtual outputs), LEDs or unit outputs, to issue alarm signals or to block elements, for example for blocking the Breaker close if an abnormality is detected in the trip circuit.

Available schemes are as follows:

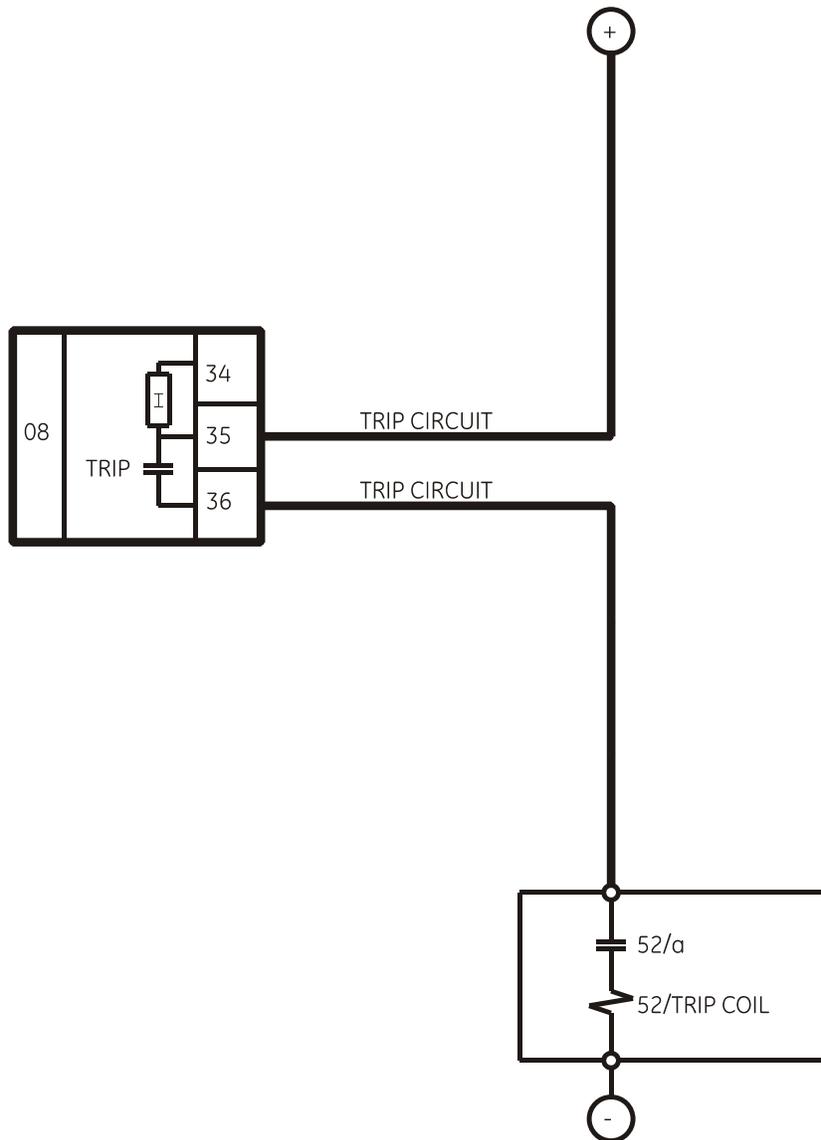
1. Without supervision
2. With current supervision (with seal-in)
3. With simple voltage supervision
4. With double voltage supervision
5. With current and simple voltage supervision (with seal-in)
6. With current and double voltage supervision (with seal-in)

The following lines describe the different types of connection to create each scheme in an easy way. As the supervision circuits are identical, we will describe connection examples for the first group. They are also applicable to the second group.

The symmetrical location of digital inputs is an optimization for ensuring a high isolation between groups that, belonging to different groups could be connected to separate batteries, and therefore a greater distance between circuits is required.

**3.4.2.1. WITHOUT SUPERVISION**

This is a very frequent case, and we must only wire the tripping circuit to terminals 35 and 36, leaving unused terminals 34, 15, 16, 17, 18.



WITHOUT TRIPPING CIRCUIT NOR TRIPPING COIL SUPERVISION

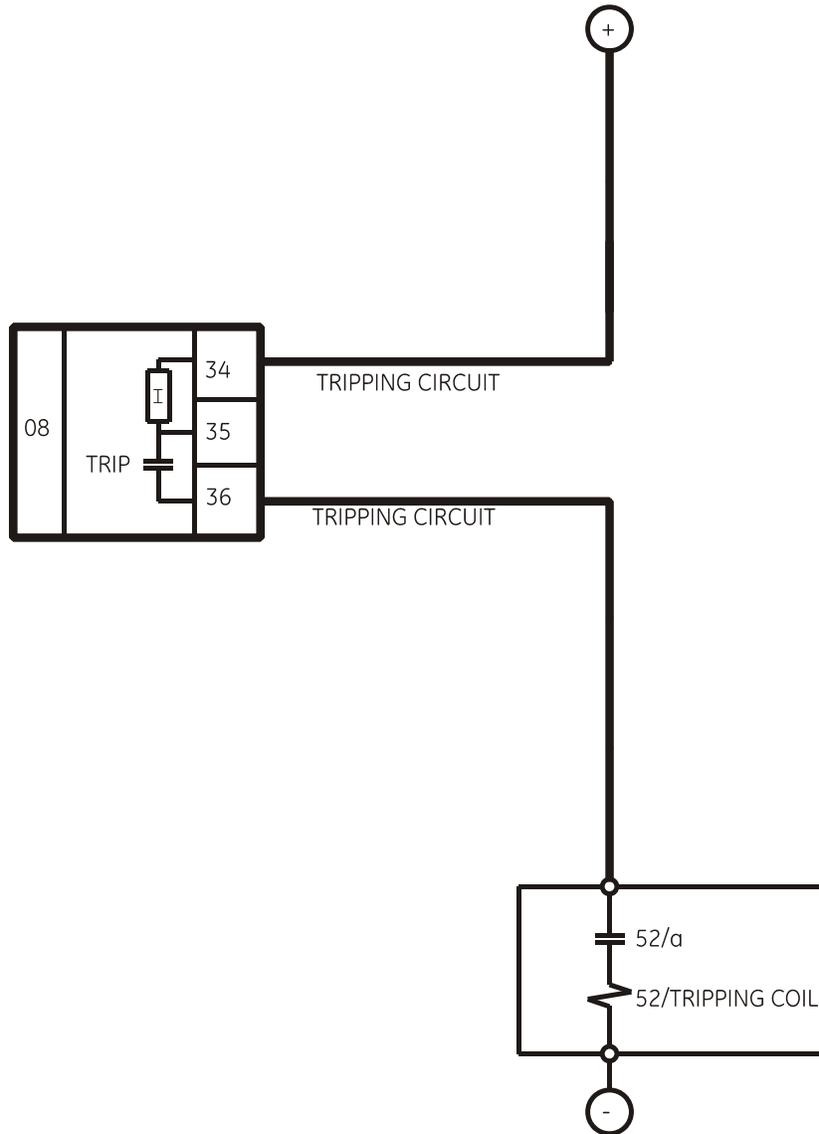
**FIGURE 3-8 CIRCUIT WITHOUT TRIPPING CIRCUIT SUPERVISION (A6631F1)**

**3.4.2.2. WITH CURRENT SUPERVISION (WITH SEAL-IN)**

In this case, as shown on FIGURE 3-9, the current supervision circuit consists in a circuit connected in series with the output contact, so that the external circuit is wired to terminals 34 and 36. This supervision circuit includes a low impedance reed relay that is activated when the current value exceeds 100 mA, and sends a signal to the main microprocessor. This indication can be used to produce a latching of the output relay, so that it will remain closed while the circulating current is over 100 mA. For this purpose we don't need to program any setting, it is enough to wire it as shown on FIGURE 3-9.

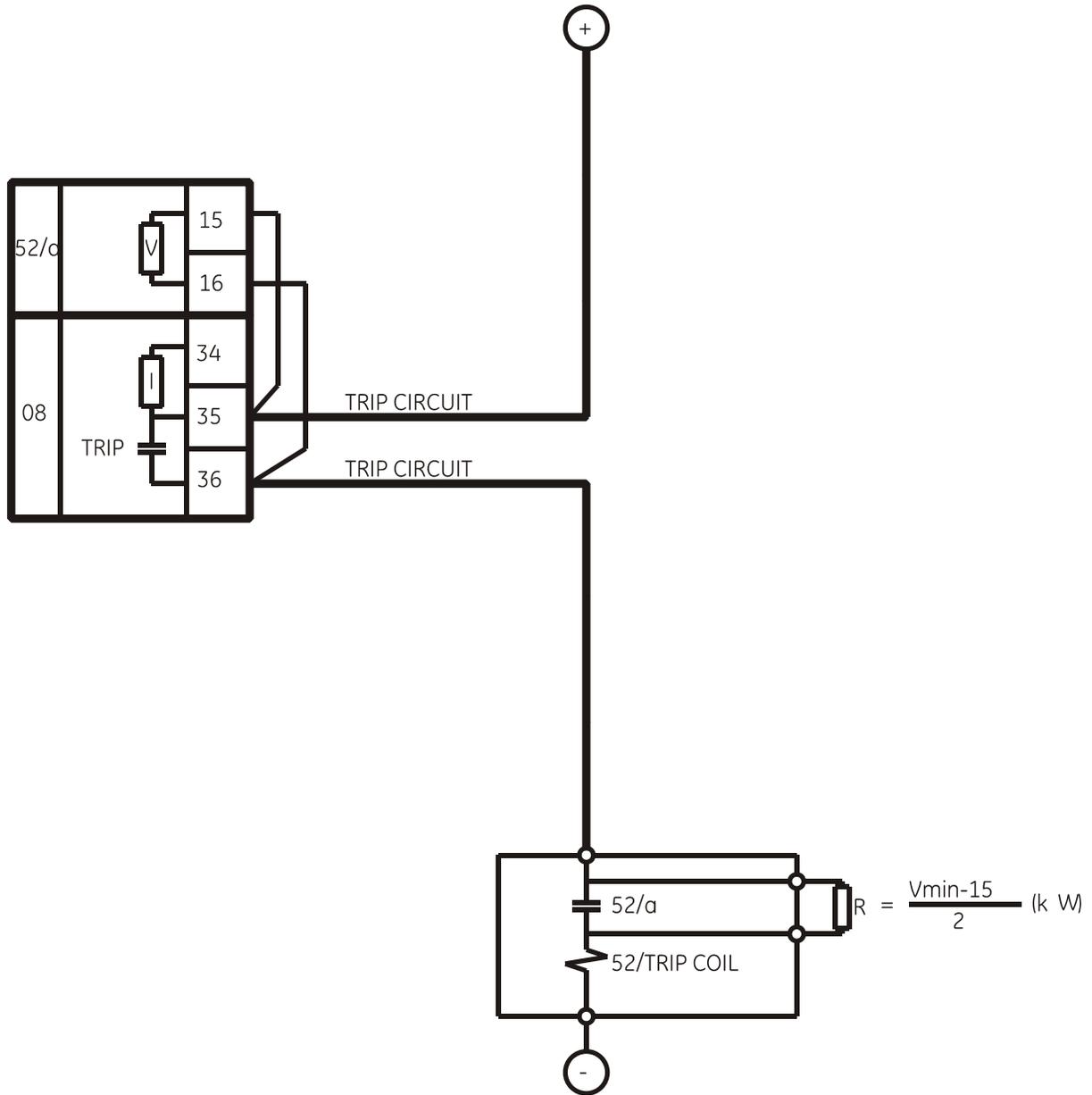
With this scheme, in the case of a failure to open from the breaker auxiliary contact, the CIO output relay will not be the one to open the tripping coil current, as in this case the contact may result damaged, as it is prepared for opening currents around 0.5 A at 125 Vdc.

This latching or memory function is only guaranteed while the unit is powered.



**FIGURE 3-9 CURRENT SUPERVISION OF THE TRIPPING CONTACT (A6631F2)**

3.4.2.3. WITH SIMPLE VOLTAGE SUPERVISION



TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACT 52/a. USE OF A RESISTOR FOR MONITORING WITH OPEN BREAKER

FIGURE 3-10 SUPERVISION APPLICATION WITH AUXILIARY CONTACT 52A AND A RESISTOR (A6631F3)

<b>INTERNAL STATE</b>	<b>V 52/a</b>	<b>SUPERVISION</b>
52 open	ON	Ok
52 closed	ON	Ok
TRIP	OFF	Ok if t < 0.5 s
TRIP with 52 open	OFF	Ok if t < 0.5 s

There is a possibility to monitor the trip circuit and trip coil continuity. This can be done by monitoring Vdc through the output contact when this is open.

As shown on FIGURE 3-10, when the relay is not tripped, trip contact 35-36 remains open. If the breaker is closed, its auxiliary contact 52a is closed. Therefore, a little current is flowing, about 2 mA, through terminals 15 and 16 through the voltage detector circuit, which flows through 52/a and the tripping coil 52TC (TC = tripping coil). Current will only circulate when there is continuity in the whole circuit, so the complete circuit is monitored, and not only the trip coil. This circuit includes auxiliary 52/a as well as the whole wiring between the battery and the relay tripping terminals, and between these and the breaker tripping circuit.

This is the first case shown on the table. With closed breaker, voltage is detected by V 52/a sensor, and this means that there is continuity in the supervised circuit.

In this table, ON means that the voltage detector V52/a is active, detecting voltage presence.

<b>Status of Involved Elements</b>			<b>Input to F650</b>	<b>Decision</b>
<b>CIRCUIT STATUS</b>	<b>OUTPUT STATUS (F35-F36)</b>	<b>BREAKER STATUS</b>	<b>OPERAND CONTACT INPUT_00_10 (Va_COIL2) V 52/a (F15-F16)</b>	<b>OPERAND CONTACT INPUT_00_15 (SUP_COIL2)</b>
Healthy	Open	52 closed	ON	ON
Healthy	Open	52 open	ON	ON
Healthy	Closed	52 closed	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Faulty	Open	52 closed	OFF	OFF (500 ms delay)
Faulty	Open	52 open	OFF	OFF (500 ms delay)
Faulty	Closed	52 closed	OFF	OFF (500 ms delay)
Faulty	Closed	52 open	OFF	OFF (500 ms delay)

For the second case shown on the table, open breaker, its auxiliary contact 52/a remains open, and current cannot flow through it for detecting continuity. In order to correctly monitor the circuit, a resistor must be used, not included in the protection, connected in parallel. The value of resistance will be selected so that the V 52/a input circuit minimum detection current flows, but not as high as to activate the breaker tripping coil. The figure shows the following equation:

$$R = \frac{V_{min} - 15}{2}$$

Where:

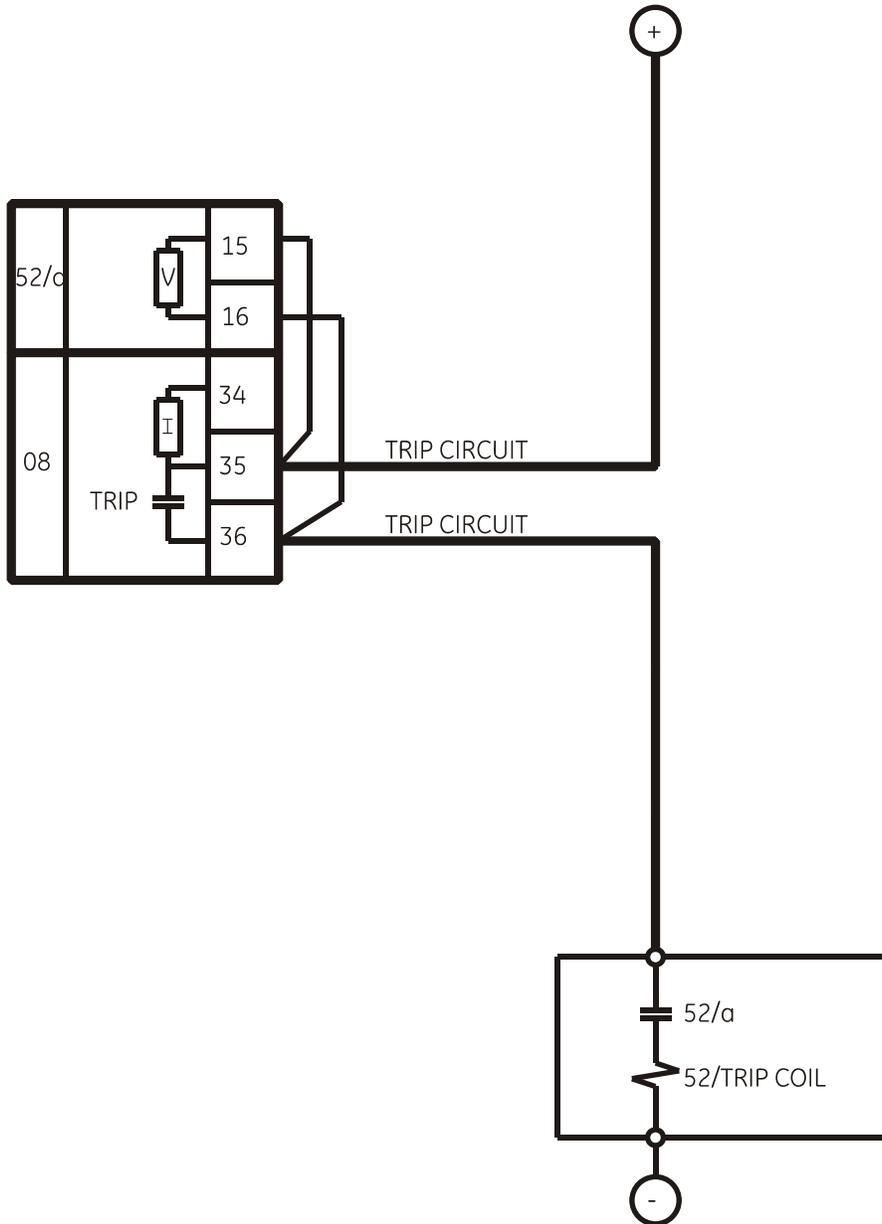
- Vmin            Is the minimum voltage, in Volts, expected in the battery (e.g. 80% of Vn)
- R                Resistance, in kilo ohms.
- 2                2 mA of approximate current flowing through input V 52/a

As shown in the second case in the table, with an open breaker, as current will flow through R if there is continuity in the WHOLE tripping circuit, voltage will be detected in input V 52/a.

This works correctly in steady state. However, if the breaker trips, while it is opening, the V 52/a input signal can be deactivated without this meaning that the circuit is not correct. This is due to the fact that the tripping relay, terminals 35-36, short circuits input V 52/a temporarily.

Therefore, if there is a trip signal, it is admitted that no signal will be detected during a period of 1 s to allow the breaker to open, and reopen the tripping relay 35-36.

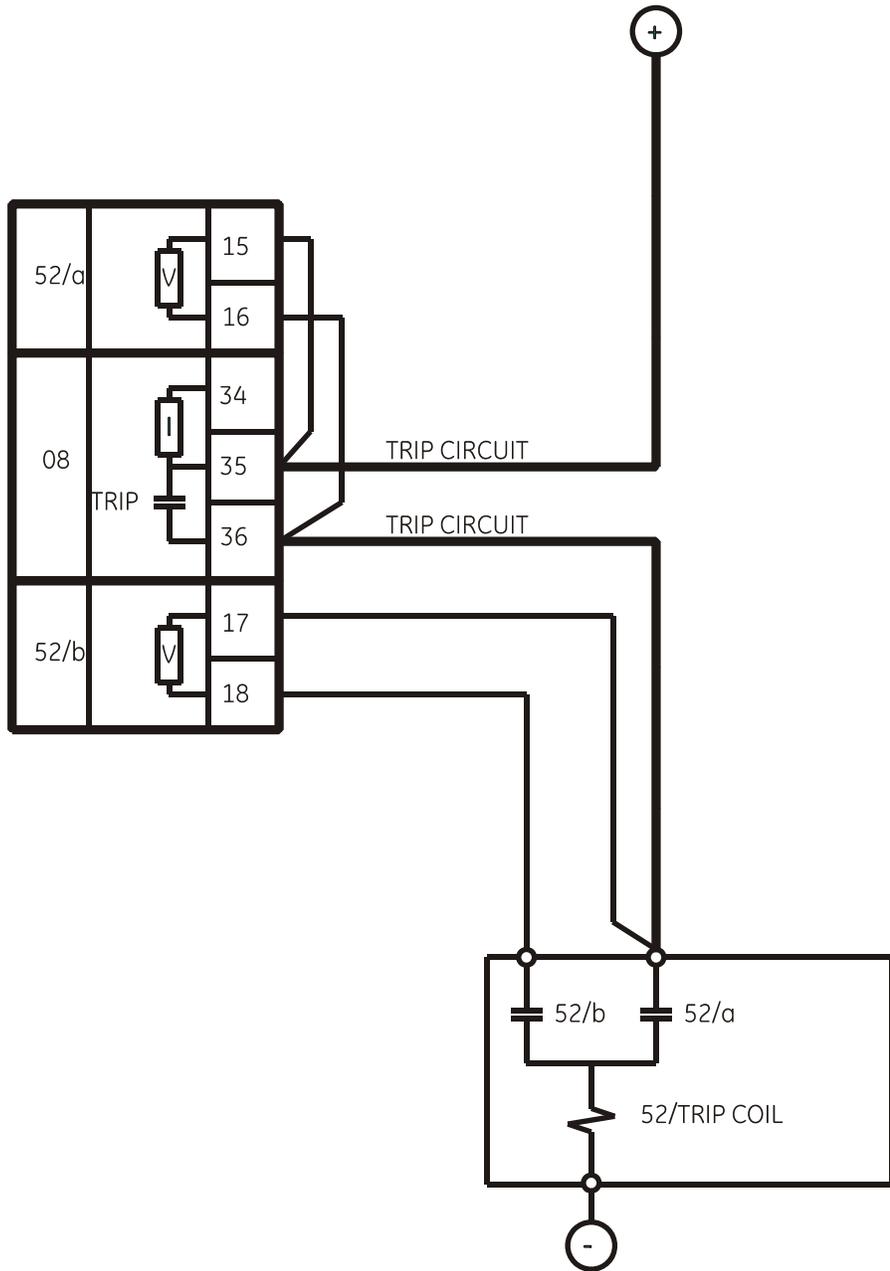
FIGURE 3-11 shows the possibility of monitoring the circuit only when the breaker is closed. In this case resistance R will not be used, but it must be observed in the unit logic, that the corresponding signal CONTACT INPUT\_00\_15 (SUP\_COIL2), will be activated showing a failure when the breaker is open, and therefore it will be required to supervise the continuity failure signalling by the breaker status information.



TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACT 52/a. ONLY WITH CLOSED BREAKER

**FIGURE 3-11 TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACT 52/A. ONLY WITH CLOSED BREAKER (A6631F5)**

3.4.2.4. WITH DOUBLE VOLTAGE SUPERVISION



TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACTS 52/a AND 52/b. FOR MONITORING WITH OPEN AND CLOSED BREAKER.

FIGURE 3-12 SUPERVISION APPLICATION WITH AUXILIARY CONTACTS 52A AND 52B (A6631F4)

INTERNAL STATE	V 52/a	V 52/b	SUPERVISION
52 open	ON	ON	OK
52 closed	ON	OFF	OK
TRIP	OFF	OFF	Ok if t < 0.5 s
TRIP with 52 open	OFF	ON	OK

Status of Involved Elements			Inputs to F650		Decision
CIRCUIT STATUS	OUTPUT STATUS (F35-F36)	BREAKER STATUS	OPERAND CONTACT INPUT_00_10 (Va_COIL2) V 52/a (15-16)	OPERAND CONTACT INPUT_00_11 (Vb_COIL2) V 52/b (17-18)	OPERAND CONTACT INPUT_00_15 (SUP_COIL2)
Healthy	Open	52 closed	ON	OFF	ON
Healthy	Open	52 open	ON	ON	ON
Healthy	Closed	52 closed	OFF	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON	ON (if t < 500 ms) OFF (if t > 500 ms)
Defective	Open	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Open	52 open	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 open	OFF	OFF	OFF (500 ms delay)

There is a possibility to monitor the trip circuit continuity not only via its auxiliary contact 52/a, but also with auxiliary contact 52/b. This avoids the need to install a resistance in parallel with auxiliary 52/a. The correct connection is shown on FIGURE 3-12.

The circuit works in a similar way to the one described in the previous section, but it uses both supervision inputs 15-16 and 17-18.

The advantage in this case is that circuit supervision with 52 open is more complete, as input V 52/b is used through contact 52/b, (that is closed when the breaker is open).

We must point out that in this scheme, the tripping contact, shown in the example as the CIO trip relay, can be the one in the relay (terminals 35 and 36), or be provided by another protection or by the parallel of several protections. This provides high flexibility in the use of this circuit.

The battery voltage can also be monitored, by using one of the standard digital inputs.

## **4. USER INTERFACES**

### **4.1. SOFTWARE**

CIO units need to be connected to a master unit, either an F650 or an F600. If the master unit is an F650, the CIO can be programmed using EnerVista F650Setup program; in case of using an F600 as master unit, the CIO can be programmed using GE-CONF software. In both cases, CIO inputs/outputs will be shown as if they were part of the master unit, with the same programming options as the master unit I/O.

EnerVista F650Setup software provides a simple way to configure, monitor and maintain operation of F650 and the connected CIO unit. Please refer to the F650 user manual for a more detailed reference about EnerVista F650Setup.

In the same way, please refer to GE-CONF software manual for details about programming a CIO unit connected to an F600 master unit.

### **4.2. FRONT INDICATORS**

CIO units incorporate 2 LEDs on the front, one of them indicates that the unit is powered, and the other indicates activity on the CAN bus.



## 5. INPUT/OUTPUT MODULES DESCRIPTION

### 5.1. CIRCUIT SUPERVISION AND CONTACT SEAL-IN CIRCUITS

#### 5.1.1. CIRCUIT SUPERVISION

CIO units can include type 2 boards. This type of board includes 4 voltage detectors for implementing tripping or opening circuit supervision control logics.

#### 5.1.2. CONTACT SEAL-IN

The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 100 mA, the function is sealed independently of the status of the function that caused the trip.

This current seal-in function in tripping circuits is mainly used in applications where auxiliary contacts 52/a (in charge of cutting the current in the tripping circuit) are very slow. This may cause that, once the function that produced the trip is reset, the relay contact will open before the breaker auxiliary 52/a, even if the time delay of the first has expired.

By using this function, we prevent the relay contact from cutting the current (basically inductive and high) from the tripping circuit, which could cause damage to the unit, as these currents exceed the nominal breaking characteristics.

The circuit and the current threshold of the function are as follows:

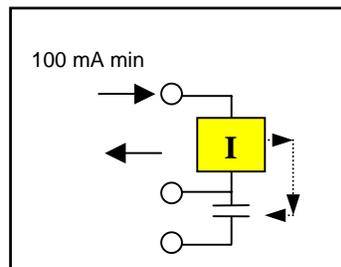


FIGURE 5-1 CURRENT SUPERVISION

**5.2. CONTROL SETTINGS FOR INPUTS/OUTPUTS**

This section explains the settings related to CIO inputs/outputs. Modification of these values is performed using the master unit communication software, EnerVista F650Setup for F650, or GE-CONF for F600.

**5.2.1. INPUT/OUTPUT BOARDS SETTINGS**

Settings relative to I/O boards are described in table 5-1:

TABLE 5-1 I/O BOARD SETTINGS

SETTING	HMI	DEFAULT	RANGE	STEP
I/O board type (available only for CIO modules)	I/O Board_X Type	NONE	16 INP + 8OUT	N/A
			8 INP + 8OUT + SUPV	
			NONE	
Input activation voltage threshold Group A	Voltage Threshold A_X	80	0 – 255 V	1 V
Input activation voltage threshold Group B	Voltage Threshold B_X	80	0 – 255 V	1 V
Debounce time Group A	Debounce Time A_X	15	1 – 50 ms	1 ms
Debounce time Group B	Debounce Time B_X	15	1 – 50 ms	1 ms
Input type	Input Type_X_CCY	POSITIVE	POSITIVE-EDGE	N/A
			NEGATIVE-EDGE	
			POSITIVE	
			NEGATIVE	
Input signal time delay	Delay Input Time_X_CCY	0	0 – 60000 ms	1 ms
Output logic type	Output Logic_X_0Z	POSITIVE	POSITIVE-NEGATIVE	N/A
Output type	Output Type_X_0Z	NORMAL	NORMAL	N/A
			PULSE	
			LATCH	
Output pulse length	Pulse Output Time_X_0Z	0	0 – 60000 ms	1 ms

Being:

**X** I/O board name, depending on the CIO model.

For the I/O board selection in the relay model, associated digits to each board type are as follows:

ASSOCIATED DIGIT	F650PC BOARD SETTINGS	BOARD TYPE
0	NONE	None
1	16 INP+ 8OUT	Mixed
2	8 INP +8 OUT +SUPV	Supervision

**CCY** Is the name used for inputs in I/O boards

**Mixed**, 16 digital inputs: CC1....CC16

**Supervision**: 8 digital inputs: CC1,...., CC8

**OZ** Is the name used for the different outputs in I/O boards, 8 outputs available for any of the two types of board (01,....., 08)

Description of I/O board settings is as follows:

**General Board Settings:**

**I/O Board Type:** Selection of the I/O board type.

**Settings relative to Inputs:**

**Input Activation Voltage Threshold:** This value can be from 0 to 255 volts. There is a single setting for all inputs in the same group (inputs sharing the same common). In mixed and supervision boards there are two groups of inputs, called A and B.

**Debounce Time:** This is the debounce time set for inputs (1 to 50 ms). The debounce time is the time window for input filtering. If an input suffers a change of level that lasts less than this set time, the change will not be considered. There is a single setting for all inputs in the same group.

**Delay Input Time:** This is the delay applied to the input signal; the default value is zero, meaning no delay; the setting range is 0 to 60000 milliseconds (1 minute). This setting is used in slow switchgear applications.

This is not a grouped setting; there is a different setting for each input. It is important not to confuse this **delay input time** with the **debounce time** used for filtering undesired transients in the input signal. The Debounce time is always added to the delay input time.

**Input Type:** Type of logic associated to the physical input. Possible settings are, positive and negative.

Positive and Negative settings correspond to signals that are activated or deactivated with the input level, considering the delay setting. Positive-edge, and Negative-edge settings correspond to signals that are activated with the change of the input signal; in this case, the Delay Input Time will not be considered, only the Debounce Time; this edge signals are deactivated automatically after one PLC scan cycle. FIGURE 5-2 shows the types of signals associated to the different input configuration types.

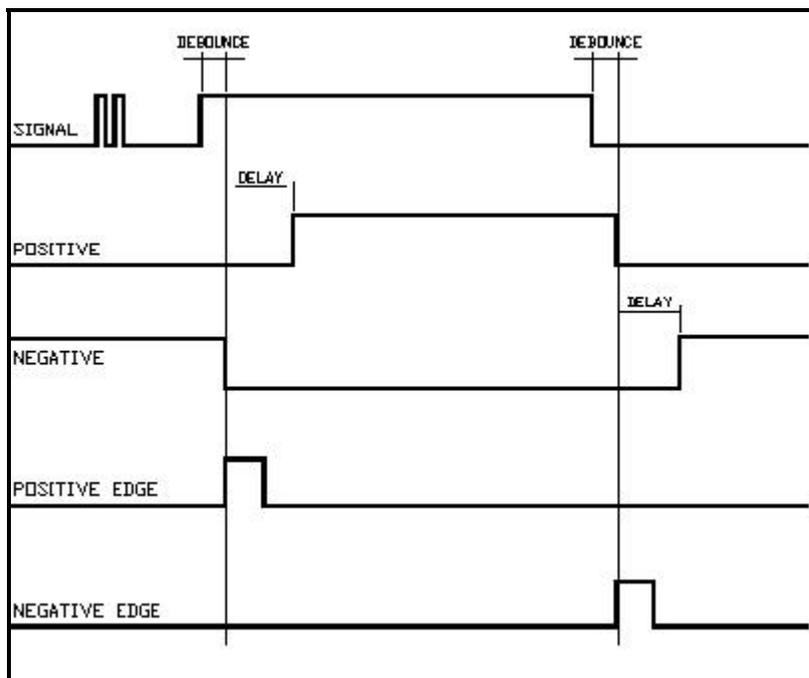


FIGURE 5-2. INPUT LOGIC

**Settings relative to Outputs:**

**Output Logic\_0X \_XX:** Type of logic applied to outputs. Possible values are *positive* and *negative*. The default value is positive.

**Output Type\_0X \_XX:** Type of output adjusted. Possible values are *normal*, *latched* or *pulse*; the default value is *Normal*.

**Pulse Output Time\_0X \_XX:** This is the output pulse length in case the output type is selected to be pulse; the default value is 10000 ms.

**Output Logic:** Type of logic applied to outputs; possible values are *Positive* and *Negative*; the default value is *Positive*. Depending on the type of setting selected, the physical output will be in the same direction (positive) or opposite (negative) the output activation command.

**Output Type:** This is the set output type. Possible values are *normal*, *latched* or *pulse*; the default value is *Normal*. *Normal* type follows the activation command. *Pulse* type delays the time, according the *Pulse Output Time* setting. *Latched* type remains active after the activation command. The physical output reset when it is configured as latched can be performed using a deactivation command. Such command must be configured at *Setpoint > Relay Configuration > Outputs > Contact Output Reset*.

**Pulse Output Time:** This is the output pulse length, applicable only to signals set as pulse type; the default value is 10000 ms and the setting range is 0 to 60000 ms (1 minute).

FIGURE 5-3 shows the types of signals associated to the different output configuration types.

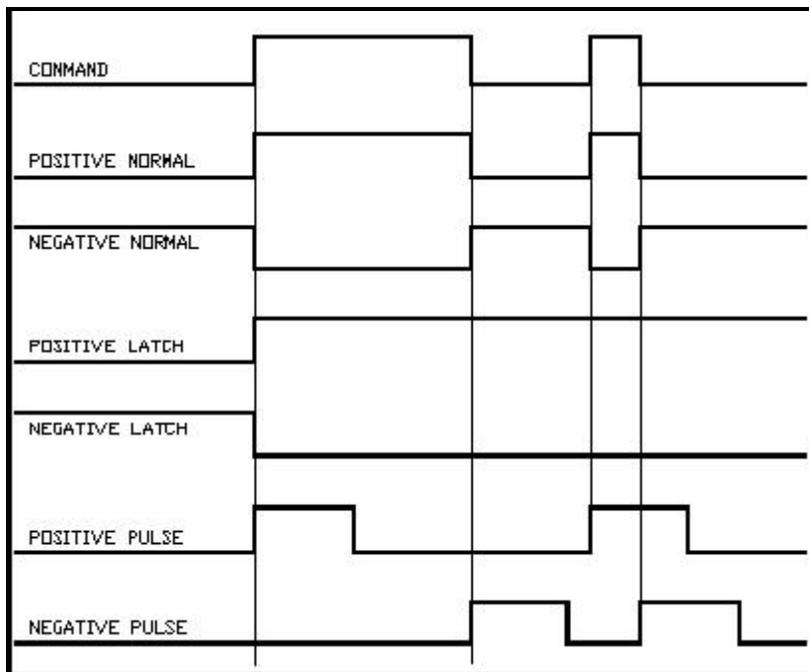


FIGURE 5-3 OUTPUT LOGIC.

Signals associated to I/O boards are divided in several groups:

**Input activation signals (Contact Inputs):**

Contact input activation signals can be obtained at **Actual > Status > Contact Inputs > Board X**, being X the corresponding I/O board. Depending on the I/O board, inputs are represented as follows:

TABLE 5-2: INPUT STATUS

INPUT STATUS (X: board F, G, H, J)	MIXED BOARD (TYPE 1)	SUPERVISION BOARD (TYPE 2)
CONT IP_X_CC1	CC1	CC1
CONT IP_X_CC2	CC2	CC2
CONT IP_X_CC3	CC3	CC3
CONT IP_X_CC4	CC4	CC4
CONT IP_X_CC5	CC5	CC5
CONT IP_X_CC6	CC6	CC6
CONT IP_X_CC7	CC7	CC7
CONT IP_X_CC8	CC8	CC8
CONT IP_X_CC9	CC9	Va_COIL1
CONT IP_X_CC10	CC10	Vb_COIL1
CONT IP_X_CC11	CC11	Va_COIL2
CONT IP_X_CC12	CC12	Vb_COIL2
CONT IP_X_CC13	CC13	O7_SEAL
CONT IP_X_CC14	CC14	O8_SEAL
CONT IP_X_CC15	CC15	SUP_COIL1
CONT IP_X_CC16	CC16	SUP_COIL2

The operation logic for supervision signals (board type 2) is detailed in section 3.3.2. in this manual.

**Contact Outputs activation signals:**

These are the signals that mark the physical activation of contact outputs, independently from their associated logic. They can be obtained at **Actual > Status > Contact Outputs > Board X**, being X the corresponding I/O board. The output name is the same both for the mixed and supervision boards; the difference will be the symbol associated to the slot where the board is located in the unit (slot F, G, H or J).

TABLE 5-3 CONTACT OUTPUT STATUS

<b>CONTACT OUTPUT STATUS (X: board F, G, H, J)</b>
CONT OP_X_01
CONT OP_X_02
CONT OP_X_03
CONT OP_X_04
CONT OP_X_05
CONT OP_X_06
CONT OP_X_07
CONT OP_X_08

**Contact Output Activation Signals (Contact Output Operates):**

These are the logic signals associated to contact outputs that produce their activation. **Actual > Status > Contact Outputs Operates > Board X**, being X the corresponding I/O board. The name of these outputs is the same for the mixed and supervision boards, the only difference will be the slot where the output is located in the relay (slot F, G, H or J). These signals can be configured at **Setpoint > Relay Configuration > Outputs > Contact Output Operate**.

TABLE 5-4 CONTACT OUTPUT OPERATES

<b>CONTACT OUTPUT OPERATES (X: board F, G, H, J)</b>
CONT OP OPER_X_01
CONT OP OPER_X_02
CONT OP OPER_X_03
CONT OP OPER_X_04
CONT OP OPER_X_05
CONT OP OPER_X_06
CONT OP OPER_X_07
CONT OP OPER_X_08

**Contact Output Reset Signals (Contact Output Resets):**

These are the logic signals associated to the contact output reset, which produce the reset of those signals previously configured as Latched. The status of these signals is obtained at **Actual > Status > Contact Outputs Resets > Board X**, being X the corresponding I/O board. The name of these outputs is the same for the mixed and supervision boards, the only difference will be the slot where the output is located in the relay (slot F, G, H or J). These signals can be configured at **Setpoint > Relay Configuration > Outputs > Contact Output Reset**

TABLE 5-5 CONTACT OUTPUT RESETS

<b>CONTACT OUTPUT RESETS (X: board F, G, H, J)</b>
CONT OP RESET_X_01
CONT OP RESET_X_02
CONT OP RESET_X_03
CONT OP RESET_X_04
CONT OP RESET_X_05
CONT OP RESET_X_06
CONT OP RESET_X_07
CONT OP RESET_X_08

**IO Board Status:**

These signals are associated to the different I/O boards. There are internal signals that provide information about the status of these boards, indicating whether there is any anomaly in the board, or whether the board is not available in the relay according to the relay model. This information can be accessed at **Actual > Status > IO Board Status**.

TABLE 5-6 I/O BOARD STATUS

<b>BOARD STATUS</b>
BOARD F STATUS
BOARD G STATUS
BOARD H STATUS
BOARD J STATUS

## 6. ACCEPTANCE TESTS

### 6.1. VISUAL INSPECTION

Verify that the relay has not suffered any damage during transportation, and that all screws are correctly fixed, and all relay terminal boards are in good condition.

### 6.2. GENERAL CONSIDERATIONS ON THE POWER SUPPLY NETWORK

All devices running on AC current are affected by frequency. As a non-senoidal wave is the result of a fundamental wave plus a series of harmonics from this fundamental wave, it can be deducted that devices running on AC current are influenced by the applied waveform.

For a correct testing of devices running on AC current, it is fundamental to use a current and/or voltage senoidal waveform. The pureness of a senoidal wave (lack of harmonics) cannot be expressed specifically for a specific device. However, any relay incorporating sintonized circuits, R-L and R-C circuits, will be affected by non-senoidal waveforms.

These devices respond to the voltage waveform in a different way to the majority of AC current voltmeters. If the power supply network used for the testing contains wide harmonics, the voltmeter and relay responses will be different.

When the device is tested, a power supply network with no harmonics in its waveform must be used.

It is important to point out that the accuracy with which the test is performed depends on the network and on the instruments used. Functional tests performed with unsuitable power supply network and instruments are useful to check that the device operates properly and therefore its operating characteristics are verified in an approximate manner.

The following sections detail the list of tests for verifying the device functionality.

### 6.3. ISOLATION TESTS

During all tests, the screw located on the rear of the relay must be grounded.

For verifying isolation, independent groups will be created, and voltage will be applied as follows:

2000 RMS volts will be applied **progressively** among all terminals in a group, short-circuited between them and the case, during one second.

2000 RMS volts will be applied **progressively** between groups, during one second.

**WARNING:** No communication circuit shall be tested for isolation.

Groups to be created will depend on the type of modules included in the CIO, selectable according to the model.

The following table shows the different groups depending on the module type:

SOURCE 1:	I/O OPTION 1	I/O OPTION 2.
<b>G1:</b> K10, K18	<b>G1:</b> (Inp. 1)1...9	<b>G1</b> (Spv 1): 1...4
<b>G2:</b> K13, K14, K15	<b>G2:</b> (Inp. 2) 10...18	<b>G2</b> (Inp. 1): 5...9
	<b>G3:</b> (Out.) 19...36	<b>G3</b> (Inp. 2): 10...14
		<b>G4</b> (Spv 2): 15...18
		<b>G5</b> (Out.): 19...30
		<b>G6</b> (Out.): 31...36

### 6.4. INDICATORS

Feed the unit and verify that the Ready LED lights up.

Communicate with the master unit and verify that the communication LED lights up showing activity on the CAN bus.

### 6.5. POWER SUPPLY TESTING

Feed the unit to the minimum and maximum voltage. For each voltage value, verify that the alarm relay is activated when there is voltage, and it is deactivated when there is no feed. If the power supply source incorporates AC feed, this test will be performed also for VAC.

Voltage values to be applied will be the ones indicated below according to the relay model:

SUPPLY	V min.	V max.
<b>HI</b>		
110-250 Vdc	88 Vdc	300 Vdc
120-230 Vac	96 Vac	250 Vac
<b>LO</b>		
24-48 Vdc	20 Vdc	57.6 Vdc

## 6.6. COMMUNICATION WITH THE MASTER UNIT

1. Connect the master unit to the CIO. Verify that the BUS LED blinks indicating communication between both units.
2. Verify, using the master unit Setup program, that the CIO boards setting options are available. For example, using an F650 as master unit, verify in EnerVista F650 Setup, that the "**Actual > Inputs/Outputs > I/O Board Status > Board H Status**" and "**Actual > Inputs/Outputs > I/O Board Status>Board J Status**" appear as active.

## 6.7. INPUTS AND OUTPUTS

During all tests, the screw on the rear of the relay must be grounded.

### 6.7.1. DIGITAL INPUTS

During this test, the user will determine the activation/deactivation points for every input in the relay for the set voltage value of 30 Volts.

Verify that the error does not exceed +/- 10% (+10% on activation, -10% on deactivation)

Default board settings for the input test are as follows:

#### Settings/Control Elements/Inputs Outputs/Board X

I/O Board Type 1	
Voltage Threshold A_01	30 V
Voltage Threshold B_01	40 V
Debounce Time A_01	15 ms
Debounce Time B_01	15 ms
Input Type 01 00 (CC1)	POSITIVE
...	...
Input Type 01 15 (CC16)	POSITIVE

The inputs test is completed by groups of 8 inputs, as this type of board has 2 groups of 8 inputs with the same common. For the first 8 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 8 inputs, the setting is Voltage Threshold B.

Inputs (or contact converters, CC1 – CC15) must also be set to POSITIVE.

I/O Board Type 2	
Voltage Threshold A_01	30 V
Voltage Threshold B_01	40 V
Debounce Time A_01	5 ms
Debounce Time B_01	5 ms
Input Type 01 00 (CC1)	POSITIVE
...	...
Input Type 01 07 (CC8)	POSITIVE

## ACCEPTANCE TESTS

The inputs test is completed by groups of 4 inputs, as this type of board has 2 groups of 4 inputs with the same common. For the first 4 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 4 inputs, the setting is Voltage Threshold B.

Inputs (or contact converters, CC1 – CC8) must also be set to POSITIVE.

### 6.7.2. CONTACT OUTPUTS

The correct activation of every output will be verified.

For every output, activation command of a single contact must be given, and then verify that only that contact is activated (**Setpoint/Force IO**)

For switched contacts, the change of state of both contacts shall be verified.

### 6.7.3. CIRCUIT CONTINUITY SUPERVISION INPUTS

Supervision inputs will be tested as normal inputs, revising the voltage level, which will be 19 Volts.

#### Coil 1:

Apply 19 Vdc to both 52/a and 52/b "Coil 1" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a and 52/b "Coil 1" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

#### Coil 2:

Apply 19 Vdc to both 52/a and 52/b "Coil 2" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a and 52/b "Coil 2" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

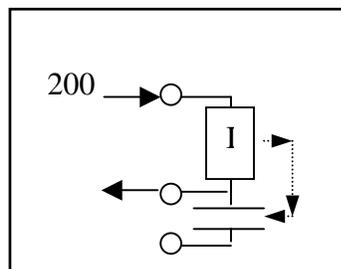
### 6.7.4. LATCHING CIRCUITS

Send a closing command to the latched contact.

Make circulate a current of 200 mA through the contact in series with the sensing terminal.

Send an opening command and verify that the contact does not open.

Interrupt current and check than the contact is released.



Repeat the test for the other latched contact