Hardware Instruction Manual

C4-IR

4-Channel SCR Power Controller with Independent PID Control

CHROMALOX
Advanced Thermal Technologies

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Important Safeguards

⚠WARNING

HIGH VOLTAGE (up to 480 VAC) is used in the operation of this equipment; DEATH ON CONTACT may result if personnel fail to observe safety precautions.

Learn the areas containing high-voltage connections when installing or operating this equipment.

⚠WARNING

Be careful not to contact high-voltage connections when installing or operating this equipment.

Before working inside the equipment, turn power off and ground all points of high potential before touching them.

⚠CAUTION

The owner/installer must provide all necessary safety and protection devices and follow all current electrical wiring standards and regulations. Failure to do so may compromise the integrity of the controller and/or cause product failure resulting in a safety risk to operational and service personnel.

⚠CAUTION

This controller utilizes a heat sink which is designed to cool the unit during operation. Under no circumstance should air flow around the controller be compromised in any way. Failure to do so may result in the overheating of the controller, product failure, product temperatures and even fire.

⚠WARNING

During continuous operation, the heat sink can reach very high temperatures, and keeps a high temperature even after the unit is turned off due to its high thermal inertia.

Higher voltages may be present. DO NOT work on the power section without first cutting out electrical power to the panel. Failure to do so may cause serious injury or death.

⚠WARNING

ELECTRIC SHOCK HAZARD: Any installation involving control equipment must be performed by a qualified person and must be effectively grounded in accordance with the National Electrical Code to eliminate shock hazard.

1. Initial Instructions

1.1 General Description

The C4-IR is an extremely compact advanced SCR power controller that provides a unique combination of performance, relia-bility, and flexibility. The C4-IR multiple zone SCR power controller manages both single phase and 3-phase industrial heating load applications. Load management options include single phase and 3-phase loads, resistive loads with high & low tempera-ture coefficient, short wave IR lamps, or transformer primaries.

Standard features: Output choices range from 30 kW to 60 kW per unit or from 16 to 40 Amps per zone at 480 Vac; Four uni-versal main process inputs, two digital inputs, two configurable alarm outputs, Modbus RTU/RS485 digital communications, DIN Rail or Panel mountable.

Optional features: Four current transformers (input), four analog inputs, integral fuse holder (30 kW & 60 kW only), four con-figurable outputs, modular Fieldbus Communication protocols including Modbus TCP, Ethernet IP, EtherCAT, Profibus, and Profinet. This new Chromalox controller is the ideal PID and power control solution for applications demanding high performance, continuous service, preventative maintenance information, and increasing need for process data and information for quality and process improvement analysis. Industry areas such as:

- Packaging
- Plastics Processing; Extrusion; Thermoforming; Injection Molding, Welding & Joining
- Semiconductor
- Material Finishing; Paint Booths;
- Textile
- Multiple zoned furnaces; Tunnel Ovens
- Food Processing
- Glass Tempering

1.2 Features

- 30, 60, 80kW controller size capacity
- Solid state relay control, Zero Cross or Phase Angle Firing Modes
- Four current transformers
- Fuses-holder (option) (not available on –404 model)
- 4 universal main inputs
- 4 heat/cool independent PID
- 4 main output internally wired to the SSR
- 4 auxiliary analog inputs (option)
- 4 configurable output (option): relay / logic / analog/ TRIAC
- 2 configurable relay alarm output
- 2 digital inputs
- Standard digital communication: Modbus RTU/ RS485
- Optional Fieldbus communication: Profibus DP, CANopen, DeviceNet, Modbus RTU, Ethernet Modbus TCP, Ethernet IP, EtherCAT, ProfiNET
- DIN rail mounting
- Integrated heat sink and fan
- cULus, CE

1.3 Product Inspection

Immediately after unpacking the unit and prior to installing, check the order code and the other data on the label attached to the outside of the container and write them down. If troubleshooting is necessary, you will need to provide this data to a Chro-malox customer service representative.

Upon removing package, ensure that there is no physical damage to the controller during shipment, and that the package also contains the “Configuration and Programming” manual.

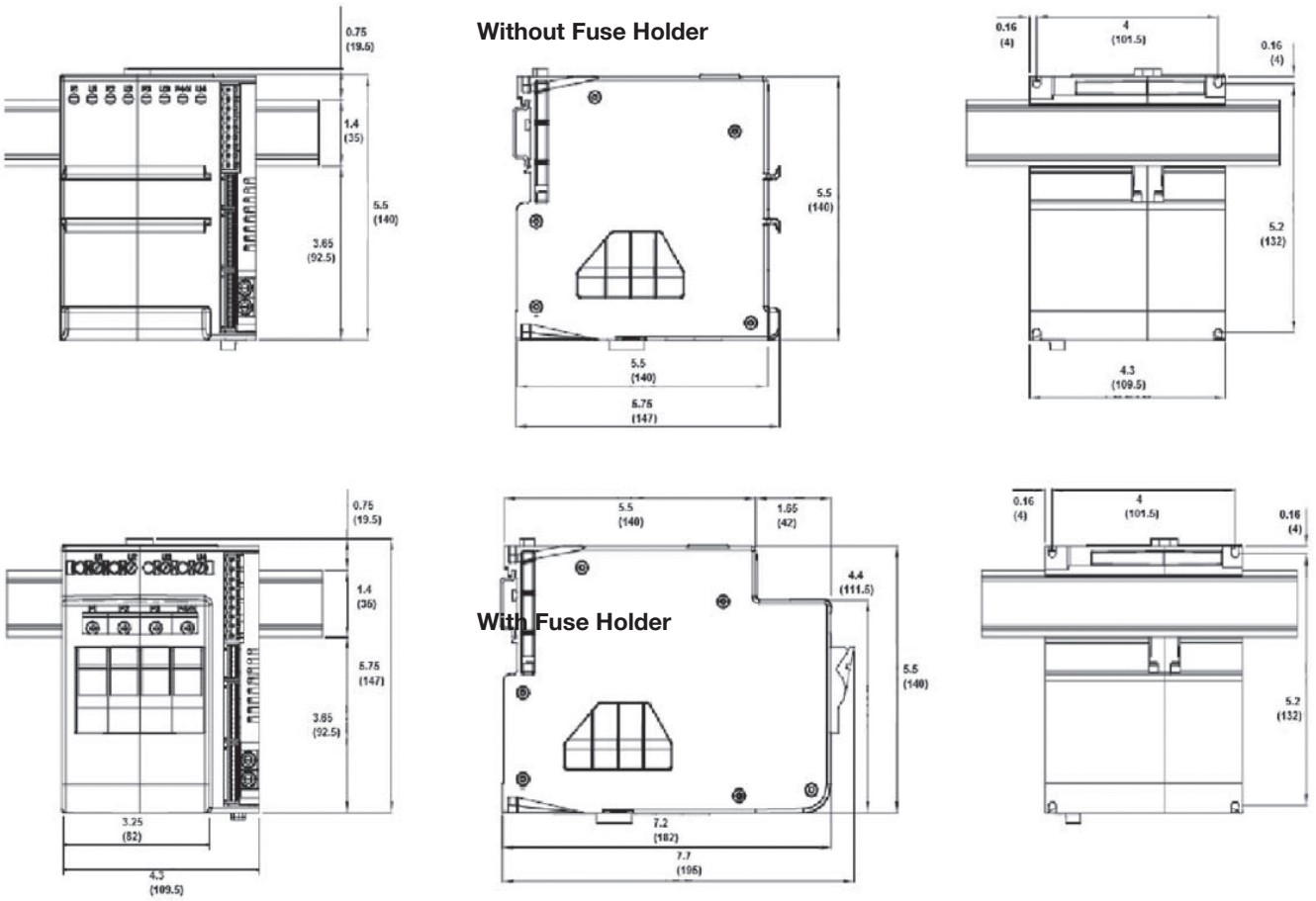
If there are signs of damage or if any parts are missing, notify your Chromalox representative immediately.

Read through all installation sections in detail within this document before installing the C4-IR on any piece of equipment or in a control panel enclosure. Spacing requirements must be honored for proper operation and safety.

2. Dimensions and Weights

Models without Fuse Holder

C4-IR Dimensions, In. (mm)



3. Installation

To ensure proper performance, maximum safety and reliability, it is essential to install the unit correctly. This includes proper mounting, spacing, hardware and wiring. See below:

- Maximum surrounding air temperature is 40°C in “Open Type Equipment” which is suitable for use in pollution degree 2. For temperature >40°C refer to the Derating Curves.
- Install the unit vertically (max 10° inclination from vertical axis).

Spacing

To ensure maximum reliability, the device must be correctly installed in the panel in such a way as to obtain adequate heat exchange between the heat sink and the surrounding air under conditions of natural convection. Under no circumstance shall any component, including cable channels, compromise minimum thermal spacing dimensions. Air must be able to flow vertically on the heat sink without any obstacles.

Solid state devices dissipate heat which may impact installation room temperature. Exchange with external air or an air conditioner may be necessary to transfer heat outside the panel.

- Minimum vertical distance between unit and panel wall: 3.9” (100 mm)
- Minimum horizontal distance between unit and panel wall: 0.8” (20 mm)
- Minimum horizontal distance between adjacent power control units: 0.4” (10 mm)

Mounting

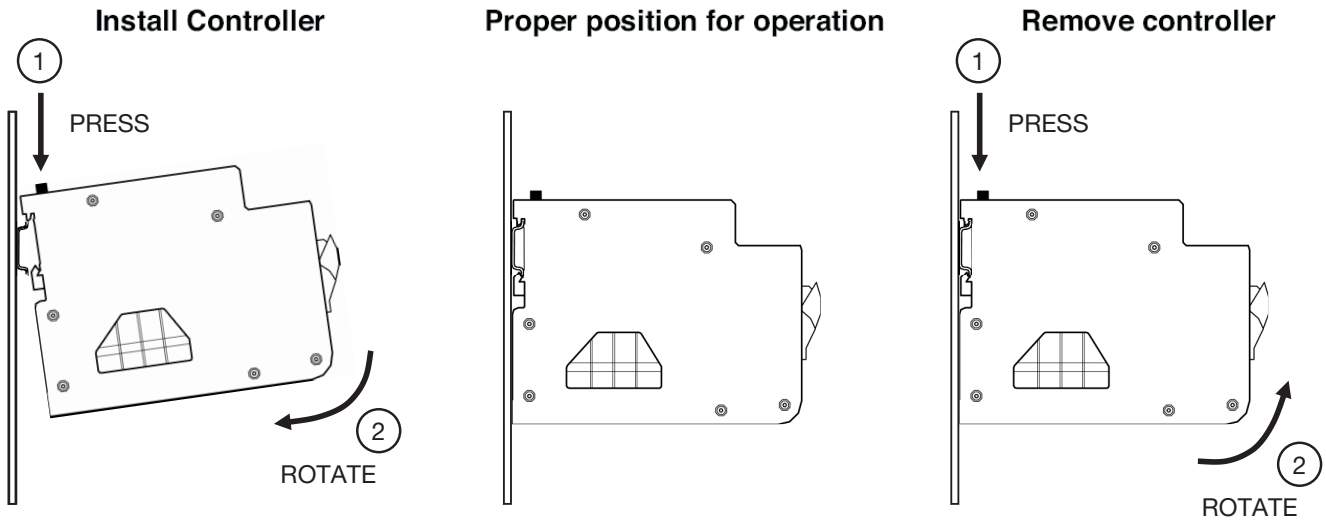
C4-IR Models to be installed on a DIN Rail . Rear panel dimensions are on previous page.

To install C4-IR onto a DIN Rail:

1. Depress DIN mounting spring. ❶
2. Position controller on the DIN Rail at a slight angle.
3. Lower controller on to DIN Rail. ❷
4. Release the mounting spring.

To remove from DIN Rail:

1. Depress DIN mounting spring. ❶
2. Rotate bottom of controller off of the DIN Rail. ❷
3. Remove from DIN Rail.



4. Installation – Wiring

This section covers the C4-IR wiring installation instructions for the power supply, inputs, outputs and interfaces.

⚠WARNING

CAREFULLY READ THE FOLLOWING WARNINGS BEFORE INSTALLING THE INSTRUMENT!

Failure to obey these warnings could create electrical safety and electromagnetic compatibility problems, as well as void the warranty and cause personal injury or death.

Electrical Power Supply

- The controller DOES NOT have an On/Off switch. The user must install a switch or isolator that conforms to all codes and electrical safety requirements (CE mark) to cut off the power supply upstream of the controller. The switch must be installed in the immediate vicinity of the controller and with-in reach of the operator. A single switch can be used for multiple devices.
- The earth connection must be made with a specific lead.
- If the product is used in applications with risk of harm to persons or damage to machines or materials, it MUST be equipped with auxiliary alarm device(s). It is advisable to provide the ability to check for tripped alarms during regular operation. DO NOT install the product in rooms with hazardous (inflammable or explosive) atmosphere; it may be connected to elements that operate in such atmosphere only by means of appropriate interfaces that conform to current safety standards..

Notes on Electrical Safety and Electromagnetic Compatibility

CE MARKING: EMC (electromagnetic compatibility) conformity in compliance with Directive 2004/108/CE and following modifications. Series C4-IR controllers are mainly intended for industrial use, installed on panels or control panels of production process machines or systems. For purposes of electromagnetic compatibility, the most restrictive generic standards have been adopted, as shown on the tables.

LV (low voltage) conformity Directive 2006/95/CE. EMC compliance has been verified with respect to the information in Tables 1 and 2.

<u>Recommended Installation for purposes of EMC</u>
Instrument power supply

- The power supply for the electronic instrumentation on the panels must always come directly from a cut/off device with fuse for the instrument part.
- Electronic instrumentation and electromechanical power devices such as relays, contactors, solenoids, etc., MUST ALWAYS be powered by separate lines.
- When the power supply line of electronic instruments is heavily disturbed by switching of SCR power groups or by motors, you should use an isolation transformer only for the controllers, grounding its sheathing.
- It is important for the system to be well grounded. Voltage between neutral and ground must not be > 1 V and resistance must be < 6Ω (Ohms).
- If the grid voltage is highly unstable, use a voltage stabilizer.
- In proximity of high frequency generators or arc welders, use adequate grid filters.
- The power supply lines must be separate from instrument input and output lines.
- Supply from Class II or from limited energy sources.

Input and output connections

Before connecting or disconnecting any connection, always check that the power and control cables are isolated from voltage. Appropriate devices must be provided: fuses or automatic switches to protect power lines.

- Connected outside circuits must be doubly isolated.
- To connect analog or linear inputs, strain gauges, TC, RTD, etc., you have to:
  - physically separate the input cables from those of the power supply, outputs, and power connections.
  - use braided and shielded cables, with sheathing grounded at a single point.
- To connect the control outputs and alarm outputs (contactors, solenoids, motors, fans, etc.), install RC (series of capacitors and resistors) groups parallel to inductive loads that work in AC.

  (Note: all condensers must conform to VDE standards (class X2) and support voltage of at least 220Vac. Resistances must be at least 2W).
- Install a 1N4007 diode parallel to the coil of inductive loads that work in DC.

Installation Notes

Use the extra rapid fuse indicated in Table 15.1 later in this manual, according to the wiring schematic examples and controller rating. Additionally, the applications with solid state units require a safety automatic switch to disengage the load power line during certain alarm events.

5. Emission, Immunity and Safety Standards

Table 1: EMC Emission

AC semiconductor motor controllers and conductors for non-motor loads	EN 60947-4-3	
Emission enclosure compliant in firing mode single cycle and phase angle if external filter fitted	EN 60947-4-3 CISPR-11 EN 55011	Class A Group 2

Table 2: EMC Immunity

Generic standards, immunity standard for industrial environments	EN 60947-4-3	
ESD immunity	EN 61000-4-2	4 kV contact discharge 8 kV air discharge
RF interference immunity		10 V/m amplitude modulated 80 MHz-1 GHz 10 V/m amplitude modulated 1.4 GHz-2 GHz
Conducted disturbance immunity		10 V/m amplitude modulated 0.15 MHz-80 MHz
Burst immunity	EN 61000-4-4	2 kV power line 2 kV I/O signal line
Surge immunity	EN 61000-4-4/5	PPower line-line 1 kV (level 2) Power line-earth 2kV (level 3) Signal line-earth 1kV (level 2)
Magnetic fields immunity	EN 61000-4-8	100 A/m (level 5)
Voltage dips, short interruptions and voltage immunity tests	EN 61000-4-11	100%U, 70%U, 40%U,

Table 3: LVD Safety

Safety requirements for electrical equipment for measurement, control and laboratory use	EN 61010-1 UL 508	

ATTENTION

This product has been designed for class A equipment. Use of the product in domestic environments may cause radio interference, in which case the user may be required to employ additional noise mitigation methods.

Per UL, the SCCR (Short Circuit Current Rating) is 100kA for models: C4-IR - XXXXX - 0 - XX Suitable for use on a circuit capable of delivering not more than 100RMS kA symmetrical, 480VAC when protected only by listed cartridge fuses manufactured by BUSSMAN type DFJ200 non renewable (JDDZ) 200A class J current limiting fuses.

The CE declaration of conformity is available on request.

External EMC Filters

EMC filters are required in PA mode (Phase Angle, i.e. SCR trigger with phase angle modulation). The filter model and current level depend on the configuration and load used.

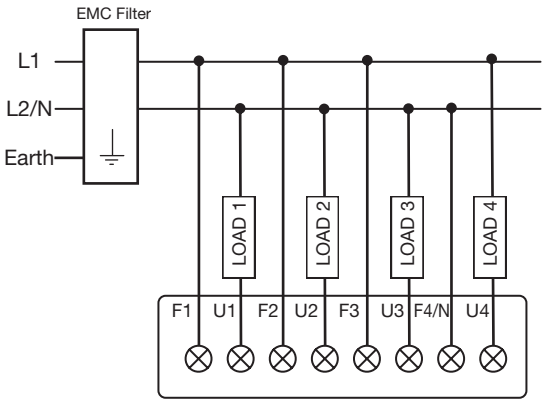
The power filter must be connected as close to the C4-IR as possible.

You can use a filter connected between the power supply line and the C4-IR or an LC group connected between each C4-IR output and the load. We recommend the following filters.

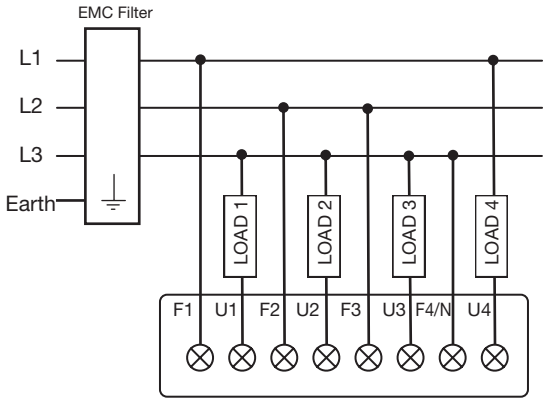
3-PHASE FILTERS WITHOUT FNEUTRAL (to be connected between line and C4-IR)		
Model REO	**Nominal Voltage (Vn)**	**Nominal Current (In)**
CNW103/16	Vn = 400V	
CNW207/20	Vn = 400V	
CNW207/35	Vn = 400V	
CNW207/50	Vn = 400V	
FILTERS WITH NEUTRAL (to be connected between line and C4-IR)		
Model REO	**Nominal Voltage (Vn)**	**Nominal Current (In)**
CNW105/16	Vn = 400V	
CNW106/25	Vn = 400V	
CNW105/36	Vn = 400V	
CNW105/50	Vn = 400V	
DISCRETE LC FILTERS (to be connected between C4-IR and load)		
MYRRA inductance code 74194	Ln = 450µH	Ln = 10A
MYRRA inductance code 74195	Ln = 250µH	Ln = 20A
KEVIN SHURTER inductance DLFP0132-16D2	Ln = 300µH	Ln = 16A
KEVIN SHURTER inductance DLFP0132-25D2	Ln = 150µH	Ln = 25A
KEVIN SHURTER inductance DLFP-0132-45D2	Ln = 200µH	Ln = 45A
ELECTRONICON condenser E62.C50-102E10	C = 1µH	Vn = 1200V
ELECTRONICON condenser E62-C51-152E10	C = 1.5µH	Vn = 1200V

EMC Filter Connection Examples

Connection for 4 single-phase loads, single-phase line

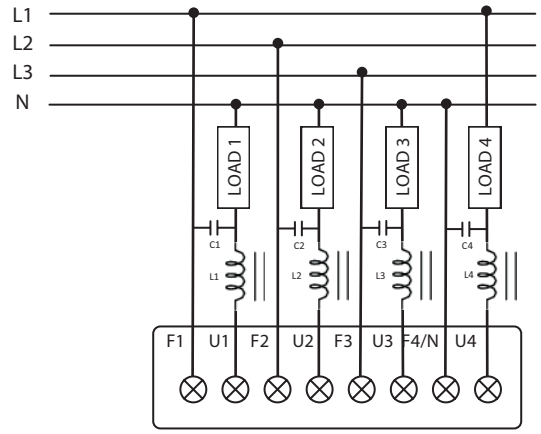


Connection for 4 single-phase loads, 3-phase line without neutral

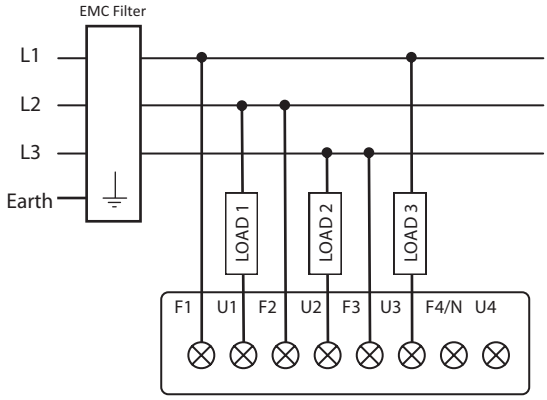


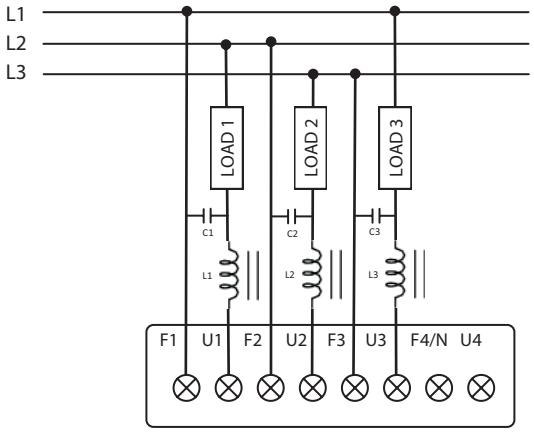
EMC Filter Connection Examples

Connection for 4 single-phase loads, three-phase line with neutral

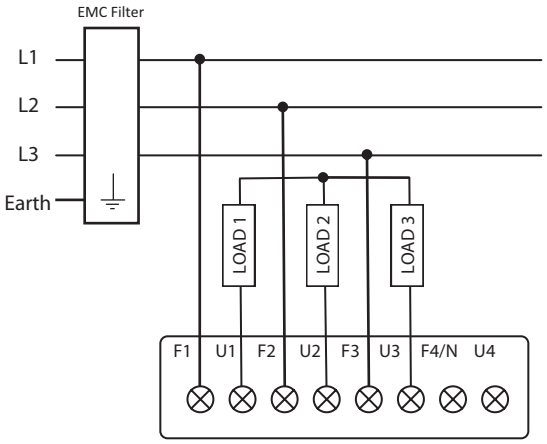


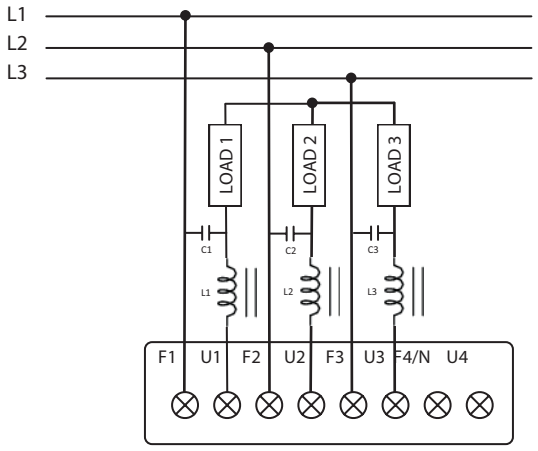
Connection for 3 independent single-phase loads in open delta, 3-phase line without neutral





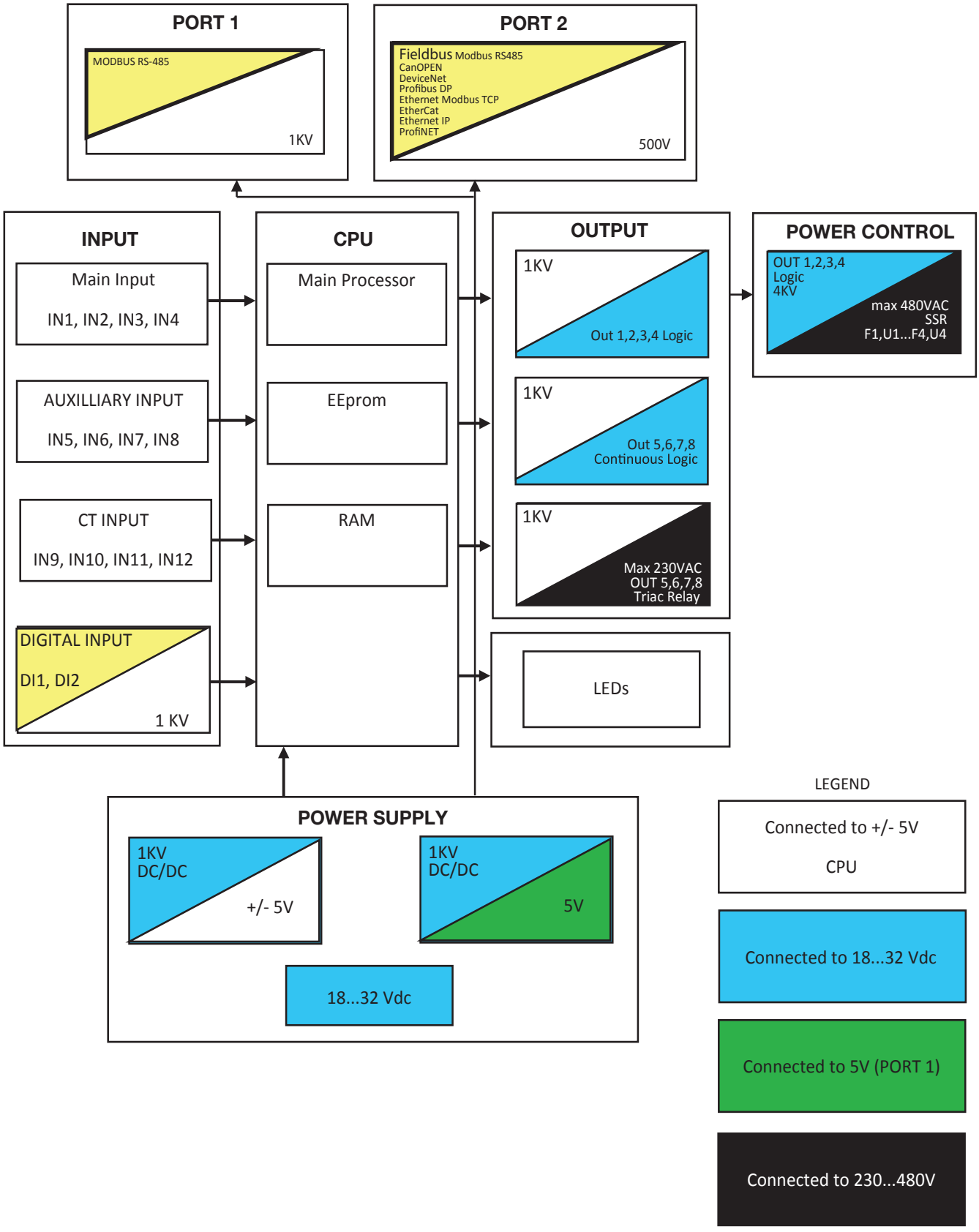
Connection for 3-phase star load without neutral





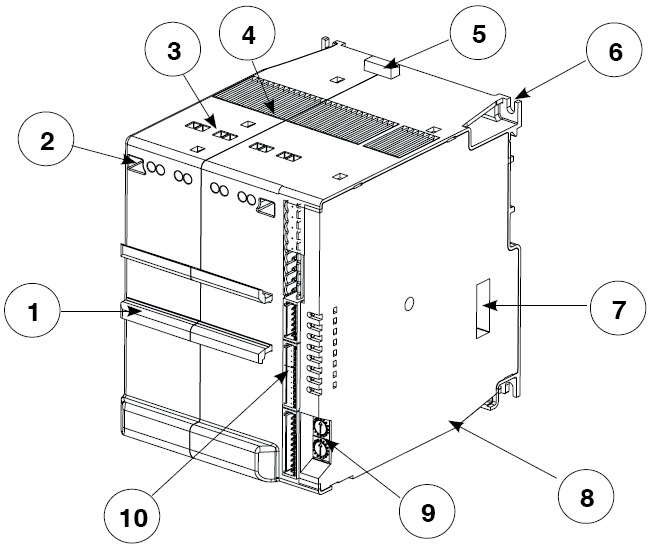
Connection for 3-phase load in closed delta

Insulation Diagram

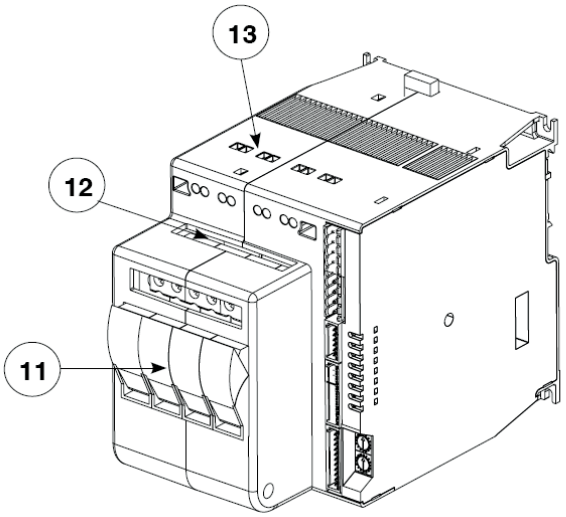


6. Controller Overview

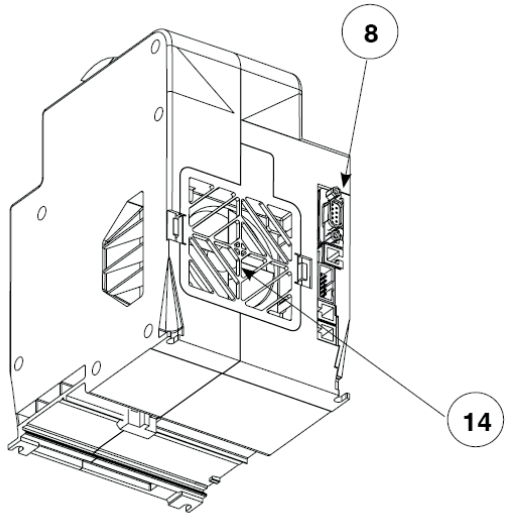
6.1 Layout



1. Front DIN rail mount for the C4-OP programming module. This mount is only present on models without fuse holders.
2. Screwdriver access to power connection screws.
3. Power supply connection terminals
4. Heat sink ventilation screen: DO NOT OBSTRUCT
5. Spring clamp release for rear DIN rail.
6. Fastening slots for additional mounting security.
7. DIP switches for controller function / load configuration.
8. Communication ports (Port1, Port2).
9. Rotary switches for setting node address or number
10. Input signal & low voltage power supply terminals (J1, J2, J3, J4)

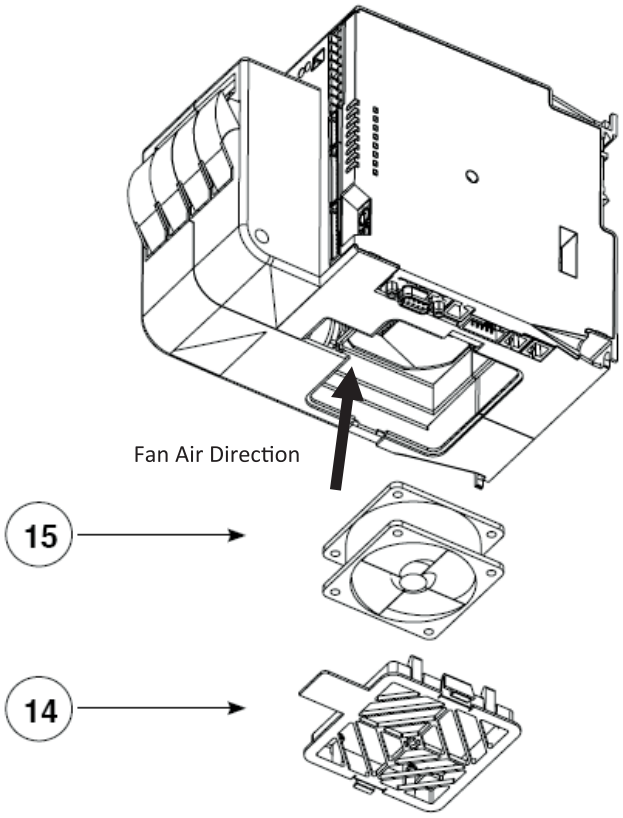


11. Fuse holders. (Only available on 30KW and 60KW models).
12. Terminals for fuse holder connection (F1, F2, F3, F4/N)
13. Terminals for load power connection (U1, U2, U3, U4)



14. Air intake / fan protection screen: DO NOT OBSTRUCT

6.2 Cooling Fan



PERIODIC CLEANING

Every 6-12 months (depending on the dust level of the installation) blow a compressed air jet downward through the upper rectangular cooling grilles (on the side opposite the fan). This will clean the internal heat dissipater and the cooling fan.

IN CASE OF OVERHEAT ALARM

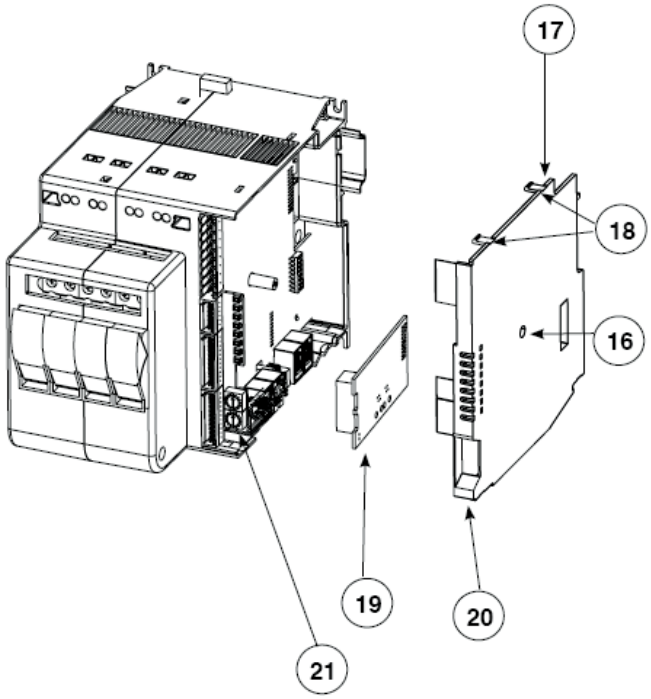
If periodic cleaning does not eliminate the problem, do as follows:

a. Remove the fan support grille by detaching the two support tabs
b. Disconnect the fan connector from the board
c. Check the condition of the fan
d. Clean or replace the fan
NOTE: Ensure that the air flow arrow on the fan is pointing towards the heat sink e Insert the connector into the board
f. Insert the fan support grille until it attaches
g. Power up the device and check fan rotation when at least one load is on

Before and during the inspection/ maintenance, cut power to the fan controller and verify that the system is isolated for operator safety.

14	Support Grill
15	Fan

6.3 Inserting a New Field Bus Interface Card



To insert a communication module, the Field Bus Interface Board compartment must be accessed.

Follow these steps:

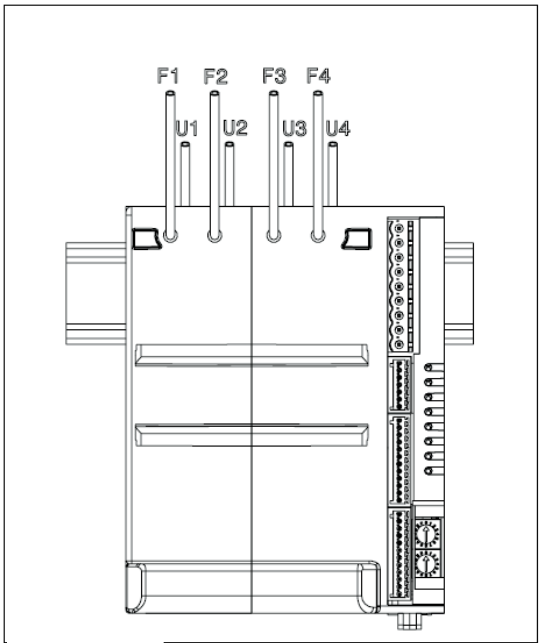
1. Remove the Fieldbus compartment cover screw (16)
2. With a flat screwdriver, gently apply pressure at (18)
3. Remove compartment cover (17)
4. Insert Fieldbus card (19) into the proper connector (21)
5. Remove applicable communication port tab (20) on cover (17)
6. Carefully replace compartment cover (17)
7. Tighten compartment cover screw (16)

Before attempting board replacement, ensure that power to the controller has been cut and verify that the system is isolated for operator safety.

7. Connections and Indication

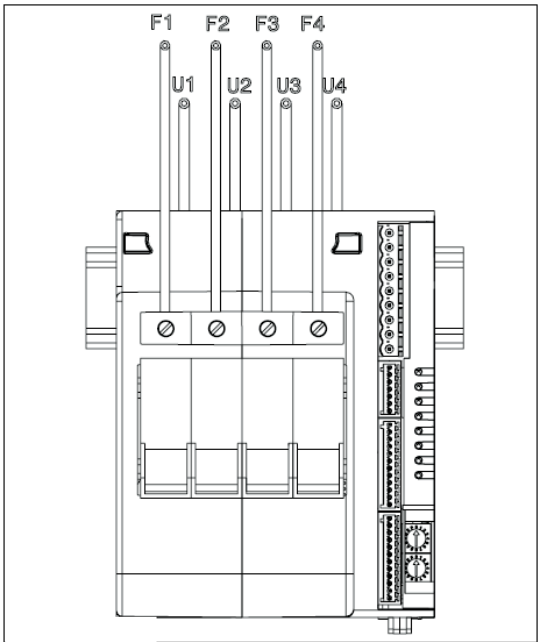
7.1 Power Connections

Model without fuse holder



F1,F2,F3,F4/	Line connection terminals
U1,U2,U3,U4	Load connection terminals

Model with fuse holder



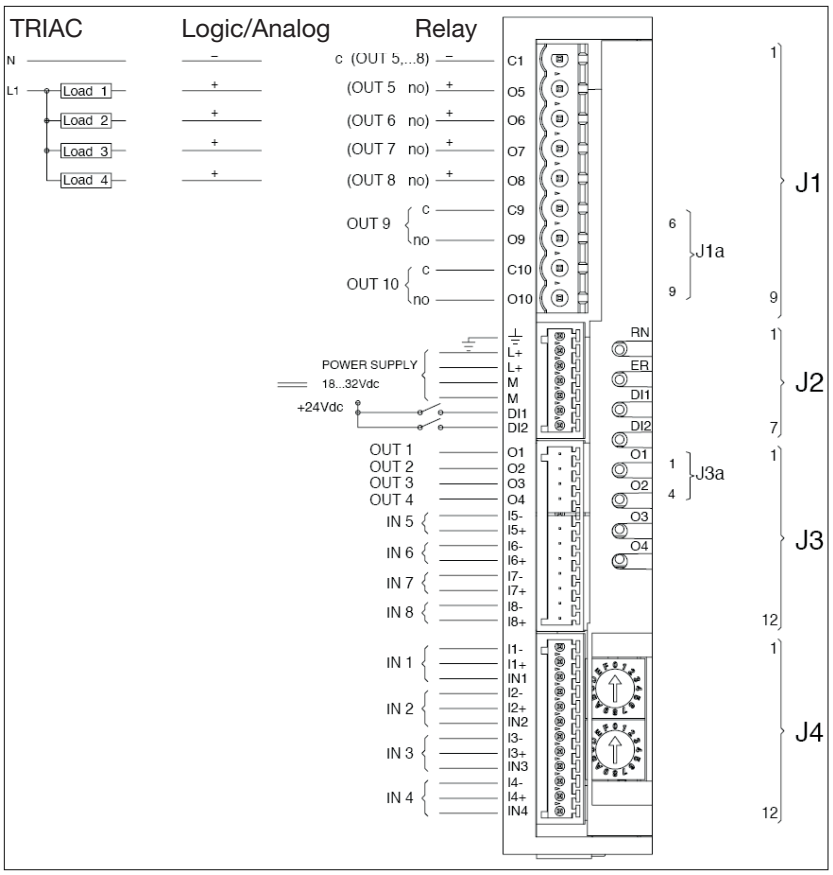
F1,F2,F3,F4/N	Line connection terminals
U1,U2,U3,U4	Load connection terminals

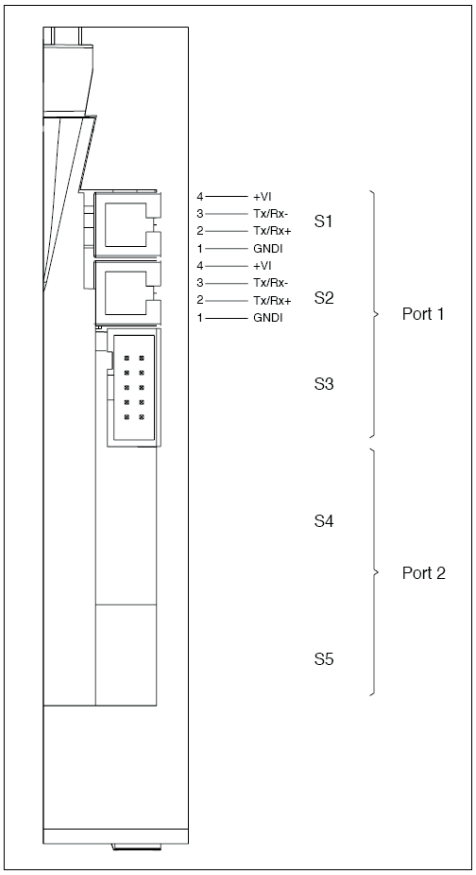
7.2 Power Wiring Considerations

Model	30kW		60kW		80kW	
Max Current	16 Amps		30 Amps		40 Amps	
 Solid Wire	0.2 - 6mm²	24 - 10 AWG	0.2 - 6mm²	24 - 10 AWG	0.5 - 16mm²	20 - 6 AWG
 Stranded Wire	0.2 - 4mm²	24 - 10 AWG	0.2 - 4mm²	24 - 10 AWG	0.5 - 10mm²	20 - 7 AWG
 Soldered, Pin Insulated Tube	0.25 - 4mm²	23 - 10 AWG	0.25 - 4mm²	23 - 10 AWG	0.5 - 10mm²	20 - 7 AWG
 Torque Force	0.5 - 0.6Nm	0.5 - 0.6 Nm	1.2 - 1.5Nm	4.4 - 5.3 In-lb	4.4 - 5.3 In-Lb	10.6 - 13.3 In-Lb

7.3 Input & Output Connections

- Use adequately compensated cable for thermocouple inputs. Maintain polarity by avoiding junctions on the cables.
- If using a grounded thermocouple, the connection must be at a single point.
- For RTD inputs, use copper extension cables and avoid junctions on the cables. Resistance must not exceed 20 Ohm.
- For 2-wire RTDs, make the connection indicated instead of the third wire.
- Refer to the applicable Connectors Detail starting in section 7.5





7.4 LED Logic

LED	Description	Color
RN	RN (green) flashing during normal operation RN (green) + ER (red) both flashing rapidly: autobaud in progress	Green
ER	ER (red) on: error in one of the main imputs (Lo, Hi, Err, Sbr)	Red
	ER (red) flashing: overheat alarm: (OVER_ HEAT or TEMPERATURE_SENSOR_BRO-KEN) or alarm SHORT)CIRCUIT)_CURRENT (only in single-phase configuration)	
	ER (red) - Ox (yellow) both flashing:: HB alarm or POWER FAUL zone x	
DI1	State of digital input 1: DI1	Yellow
DI2	State of digital input 2: DI2	Yellow
O1	State of output 1: O1	Yellow
O2	State of output 2: O2	Yellow
O3	State of output 3: O3	Yellow
O4	State of output 4: O4	Yellow

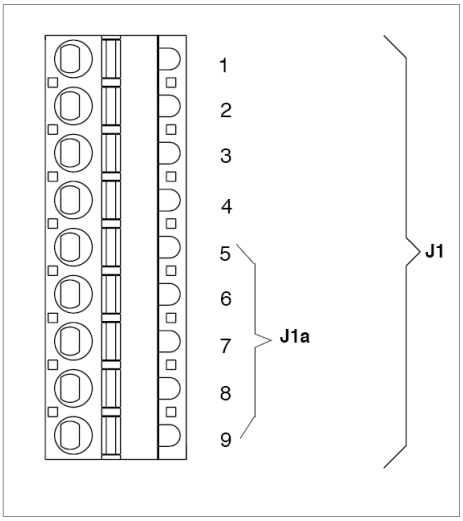
- All LED's flashing rapidly: ROTATION 123 alarm (only in 3-phase configuration)
- Switch off 3-phase network and reverse wires F2 and F3
- All LED's flashing rapidly except LED DI1: jumper configuration not provided for
- All LED's flashing rapidly except LED DI2: 30%_UN-BALANCED_LINE_WARNING (only in 3-phase configuration)
- ALL LED's flashing rapidly except LED O1: SHORT_ CIRCUIT_CURRENT alarm (only in 3-phase configuration)
- All LED's flashing rapidly except LED O2: TRI-PHASE_MISSING-LINE-ERROR alarm (only in 3-phase configuration)

7.5 Rotary Switches

Switch	Drescription
 X10 X1	Defines Address of Controller Module Available address: 00...99

7.6 Connector Detail

7.6.1 Connector J1 / J1a (Note: If Auxiliary Outputs O5 - O8, are present, connector J1a becomes J1.)



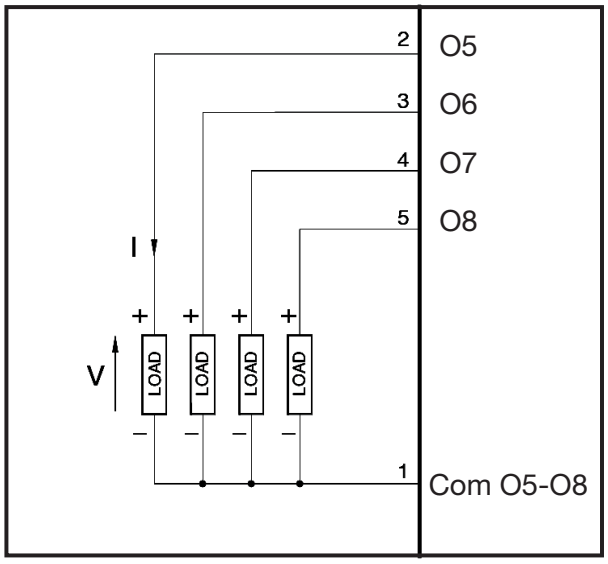
	0.2 - 2.5mm²	24-14 AWG
	0.25 - 2.5mm²	23-14 AWG

<u>Outputs 5 - 8: Logic or Analog Output Type</u>

Logic outputs: 18 - 36Vdc, max 20mA

Analog outputs: Voltage (default): 0 - 10V, 2 - 10V, max 25mA or Current: 0 - 20mA, 4 - 20mA, max 500Ω

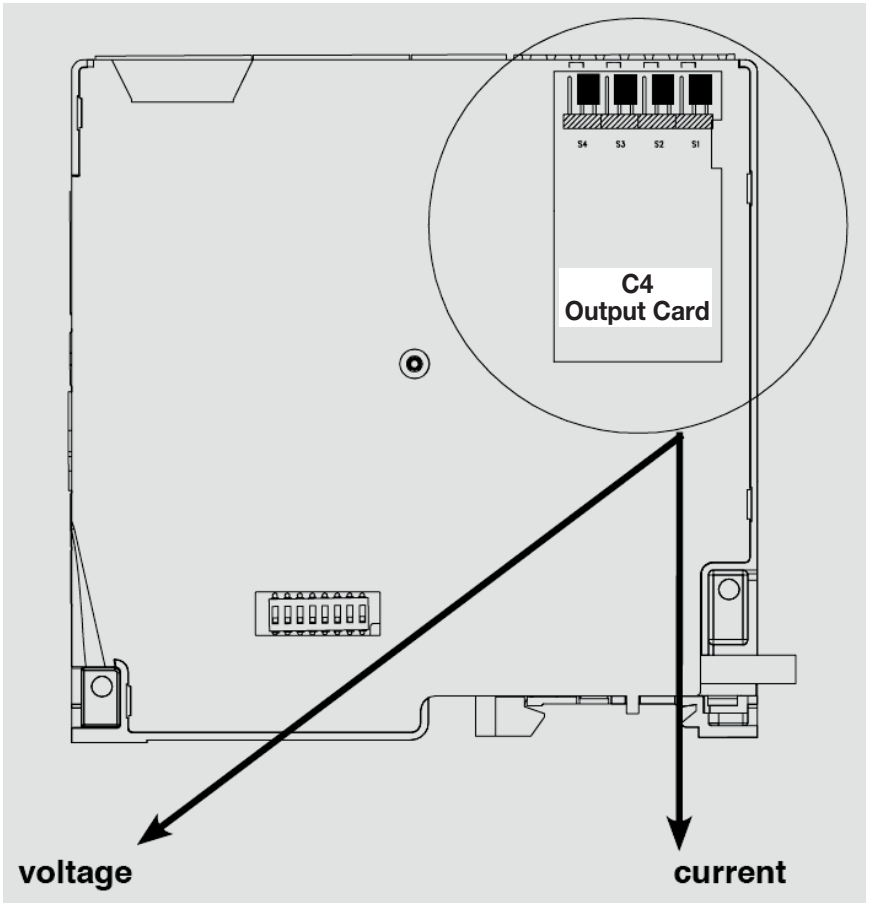
Wiring Schematic for Outputs 5 - 8, both Logic & Analog Outputs

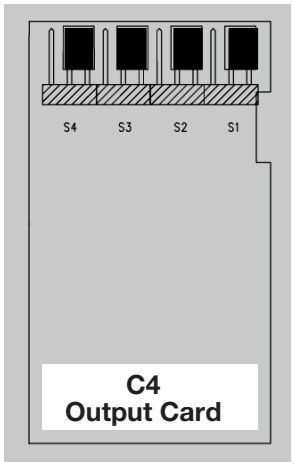


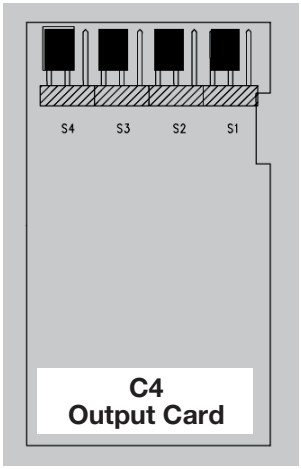
PIN Legend

PIN	Name	Description	Polarity (Logic or Analog)
1	Com O5-O8	Outputs Common	(–)
2	O5	Output 5	(+)
3	O6	Output 6	(+)
4	O7	Output 7	(+)
5	O8	Output 8	(+)

When the optional Auxiliary Output type “A” (Analog) is selected, one must choose whether the output is Voltage-based (default) or Current-based. This selection is carried out via proper jumper placement on the board as follows:



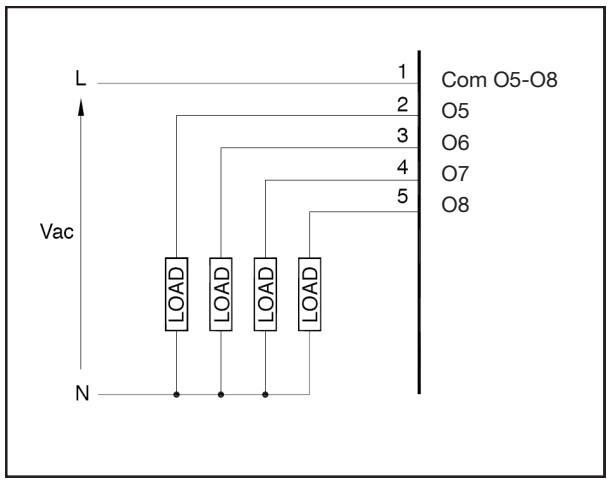




Outputs 5 - 8: TRIAC Type

TRIAC outputs: Voltage: 24...230Vac, max 1A

Wiring Schematic for Outputs 5 - 8, TRIAC Outputs



PIN Legend

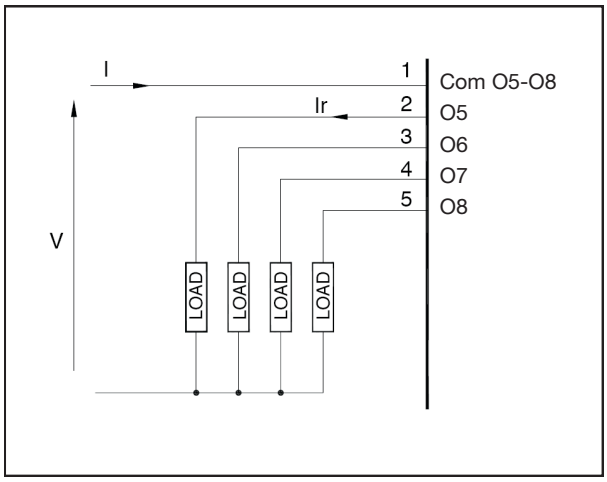
PIN	Name	Description
1	Com O5-O8	Outputs Common
2	O5	Output 5
3	O6	Output 6
4	O7	Output 7
5	O8	Output 8

Outputs 5 - 8: Relay Type

Outputs Out 5 - Out 8, Relay outputs: Ir = 3A max, NO (normally open)

V = 250V/30 Vdc cosφ = 1; I = 12A max

Wiring Schematic for Outputs 5 - 8, Relay Outputs



PIN Legend

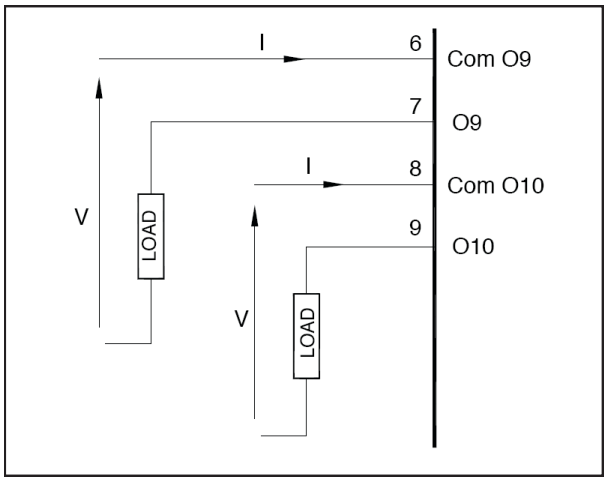
PIN	Name	Description
1	Com O5-O8	Outputs Common
2	O5	Output 5
3	O6	Output 6
4	O7	Output 7
5	O8	Output 8

Outputs 9, 10: Relay Type

Outputs Out 9, Out 10, Relay outputs: 5A max

V = 250V/30Vdc cosφ = 1; I = 5A max

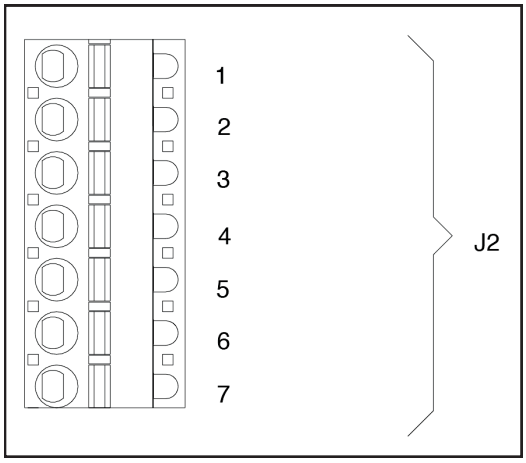
Wiring Schematic for Outputs 9 & 10, Relay Outputs



PIN Legend

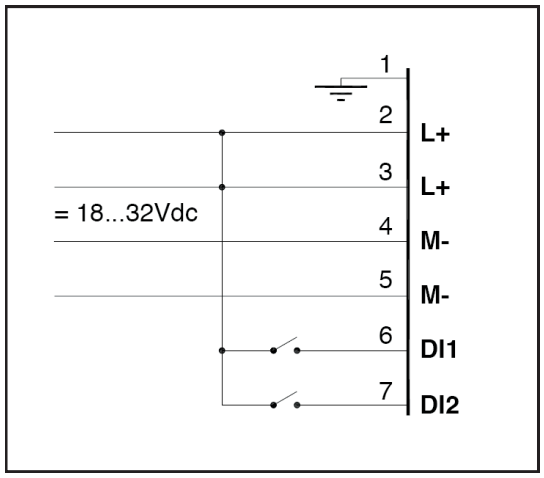
PIN	Name	Description
1	Com O9	Output Common O9
2	O9	Output O9
3	Com O10	Output Common O10
4	O10	Output O10

7.6.2 Connector J2 (Power Supply, Digital Input 1 & Digital Input 2)



	0.14 - 0.5mm²	28-20AWG
	0.25 - 0.5mm²	23-20AWG

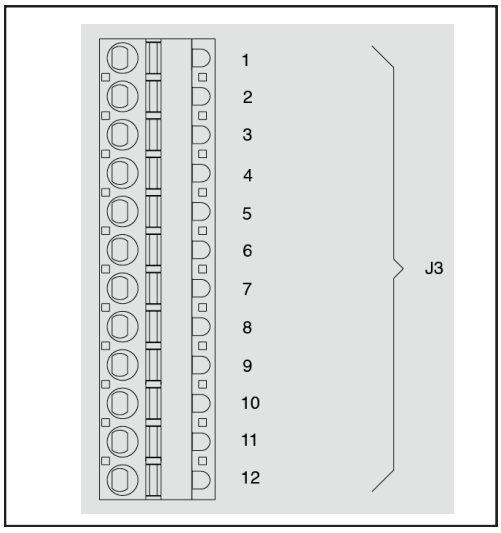
Wiring Schematic for J2 - Power Supply, Digital Inputs

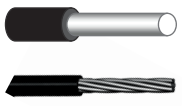


PIN Legend

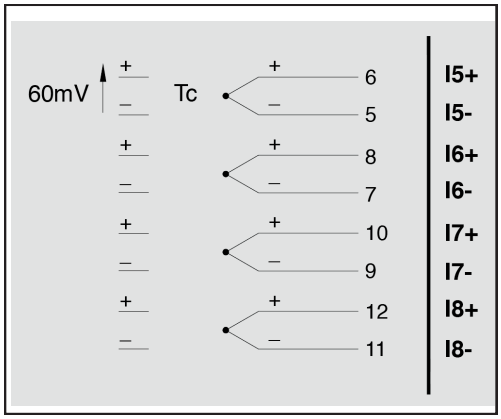
PIN	Name	Description
1	⏚	Ground
2	L+	Power Supply 18 - 32 Vdc
3	L+	
4	M-	
5	M-	
6	DI1	Digital Input 1
7	DI2	Digital Input 2

7.6.3 Connector J3 (Auxiliary Inputs)



	0.14 - 0.5mm²	28-20 AWG
	0.25 - 0.5mm²	23-20 AWG

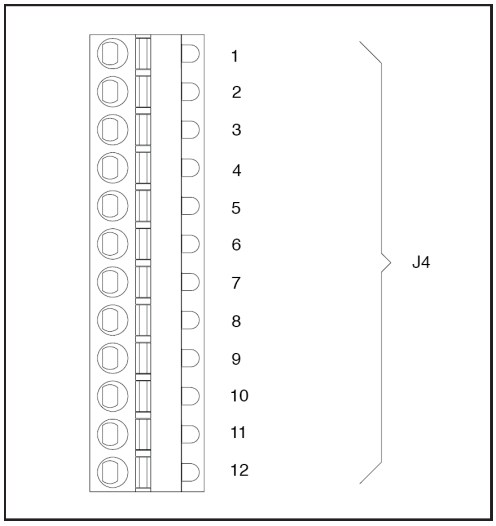
Wiring Schematic for J3 - Auxiliary Inputs



PIN Legend

PIN	Name	Description
1	-	No Connection
2	-	No Connection
3	-	No Connection
4	-	No Connection
5	15+	Auxiliary Input 5
6	I5-	Auxiliary Input 5
7	I6+	Auxiliary Input 6
8	I6-	Auxiliary Input 6
9	I7+	Auxiliary Input 7
10	17-	Auxiliary Input 7
11	I8-	Auxiliary Input 8
12	18+	Auxiliary Input 8

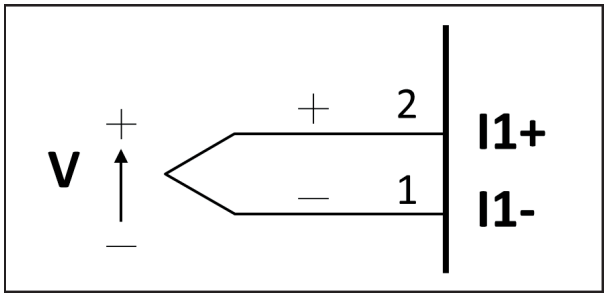
7.6.4 Connector J4 (Inputs 1 - 4)



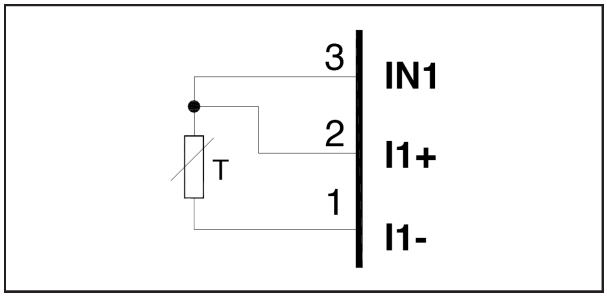
	0.14 - 0.5mm²	28-20 AWG
	0.25 - 0.5mm²	23-20 AWG

Inputs 1 - 4

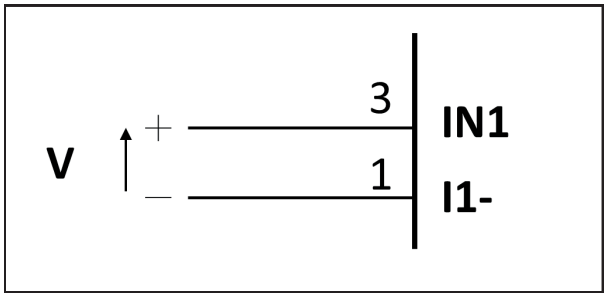
Wiring Schematic for 60mV TC or Linear (Analog) input



Wiring Schematic for RTD (Pt100) input



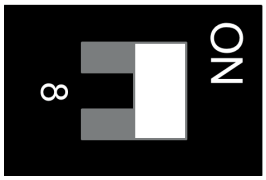
Wiring Schematic for 1V / 20mA Linear (Analog) input



PIN Legend

PIN	60mV/Tc Linear Input	1V/20mA Linear Input	Pt100 Input
1	I1-	I1-	I1-
2	I1+		I1+
3		IN1+	IN1
4	I2-	I2-	I2-
5	I2+		I2+
6		IN2+	IN2
7	I3-	II3-	13-
8	I3+		I3+
9		IN3+	IN3
10	I4-	I4-	I4-
11	I4+		I4+
12		IN4+	IN4

7.7 Dip-Switch Configuration



Dip Switch Legend

Dip Switch	Description
1	Connection type: (see table 18-a)
2	Connection type: (see table 18-a)
3	Connection type: (see table 18-a)
4	Connection type: (see table 18-a)
5	OFF = resistive load ON = inductive load (transformer primary control)
6	ON = reset factory configuration
7	ON = simulation function
8	ON = insert line termination for Port1 / RS485

Load Configuration Table

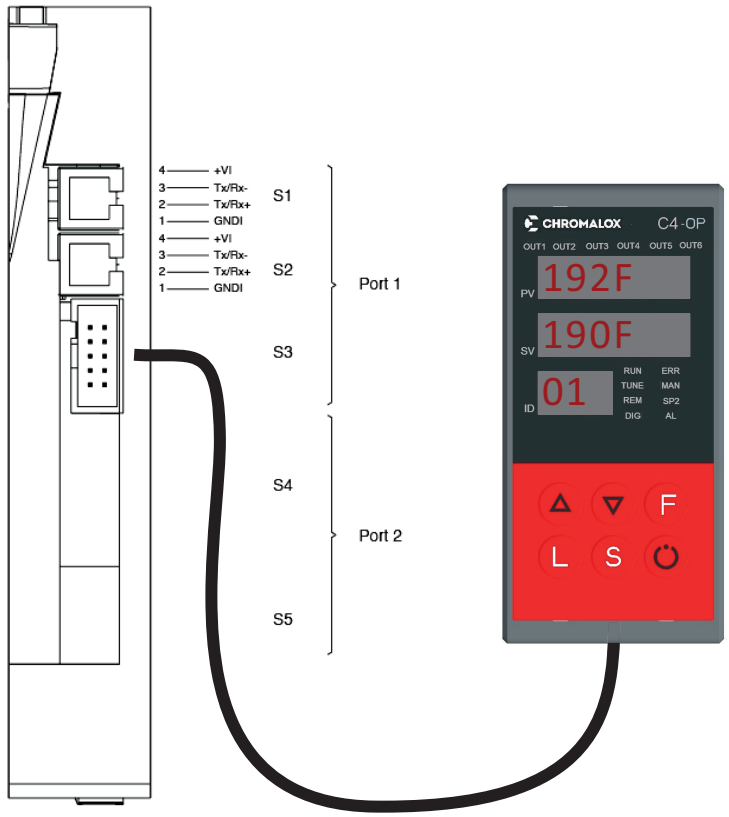
Single-phase / 3-phase	Star / Delta	Delta Open / Closed	With / without Neutral OFF ON	OFF: resistive load ON: inductive load (transformer primary control)	
Dip 1	Dip 2	Dip 3	Dip 4	Dip 5	Connection Type
OFF	OFF	OFF	OFF	OFF/ON	4 single-phase loads
OFF	ON	OFF	OFF/ON	OFF/ON	3 independent single-phase loads in open delta
ON	ON	OFF	OFF/ON	OFF/ON	3-phase load open delta
ON	ON	ON	OFF/ON	OFF/ON	3-phase load closed delta
ON	OFF	–	ON	OFF/ON	3-phase star load without neutral
ON	OFF	–	OFF	OFF/ON	3-phase star load with neutral

IMPORTANT!
After setting the required DIP-SWITCH configuration, run the following parameter initialization procedure once:
- Check the correct setting of DIPS 1-2-3-4-5
- Set DIP 6 to “ON” (factory configuration)
- Power the device with 24 VDC
- Wait for correct and regular flashing of the GREEN RUN LED
- Set DIP 6 to “OFF”
- The device is correctly configured

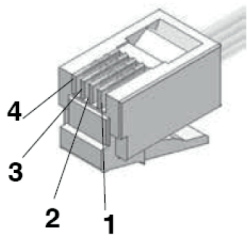
7.8 Serial Communication Ports

7.8.1 Port1 (Standard Local Bus): Connectors S1, S2, S3

Modbus RTU/RS485 Serial Interface

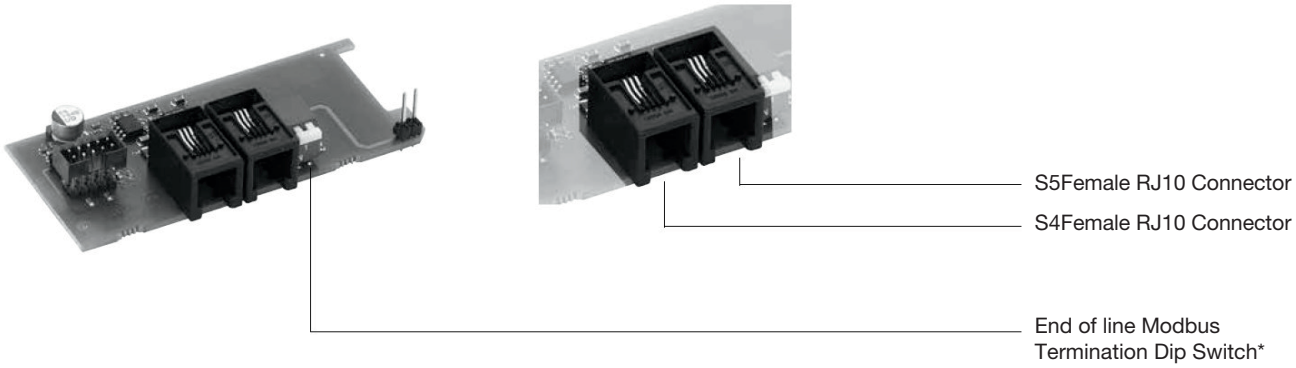


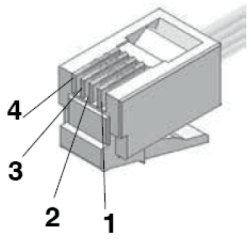
Connector S3 accepts the C4-OP local interface terminal. See the C4-OP Section for more detail.

Connector S1/S2 RJ10 4-4 Pin	Pin	Name	Description	Note
	1	GND1 (**)	-	(*) Enable #8 DIP Switch on last device on Modbus RS485 line (**) Connect the GND signal to Modbus devices with a line distance > 300 ft. (100 m)
	2	Tx/Rx+	Data reception/transmission (A+)	
	3	Tx/Rx-	Data reception/transmission (B-)	
	4	+V Reserved	-	
Cable Type: Flat telephone cable for pin 4-4 conductor 28 AWG				

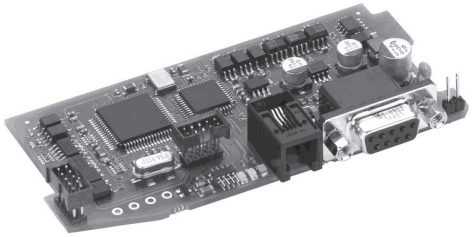
7.8.2 Port2 (Optional Fieldbus): Connectors S4, S5

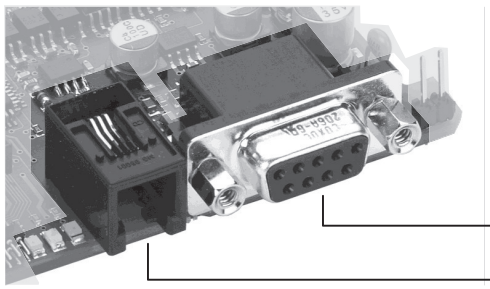
A. Modbus RTU/RS485, Modbus RTU/RS485

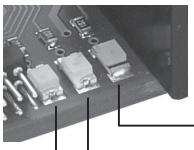


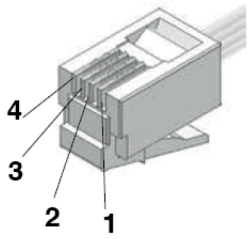
Connector S4/S5 RJ10 4-4 Pin	Pin	Name	Description	Note
	1	GND1 (**)	-	(*) Enable Fieldbus DIP Switch on last device on Modbus RS485 line (**) Connect the GND signal to Modbus devices with a line distance > 300 ft (100 m)
	2	Tx/Rx+	Data reception/transmission (A+)	
	3	Tx/Rx-	Data reception/transmission (B-)	
	4	+V Reserved	-	
Cable Type: Flat telephone cable for pin 4-4 conductor 28 AWG				

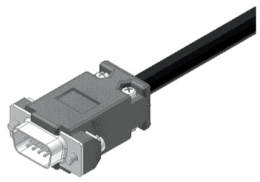
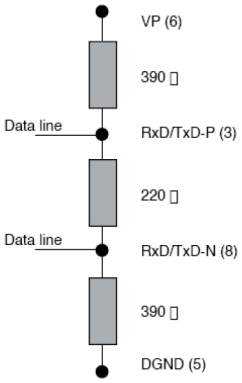
B. Modbus RTU/RS485, Profibus DP Interface



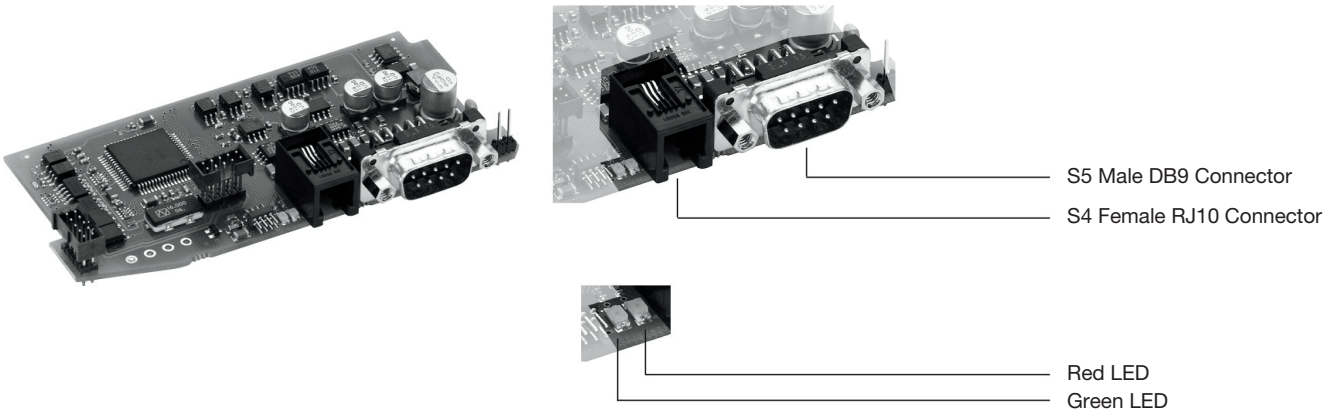


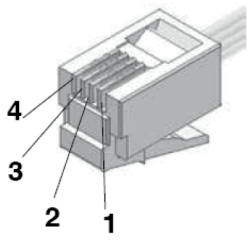


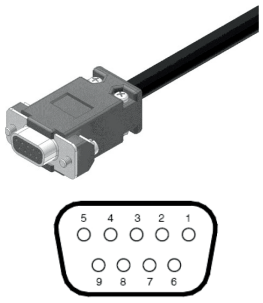
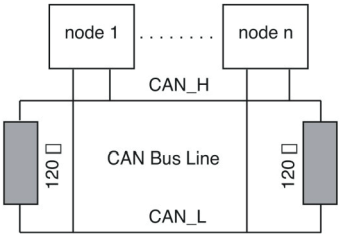
Connector S4 RJ10 4-4 Pin	Pin	Name	Description	Note
	1	GND1 (**)	-	(**) Connect the GND signal to Modbus devices with a line distance > 300 ft. (100 m)
	2	Rx/Tx+	Data reception/transmission (A+)	
	3	Rx/Tx-	Data reception/transmission (B-)	
	4	+V Reserved	-	
Cable Type: Flat telephone cable for pin 4-4 conductor 28 AWG				

Connector S5 D-Sub 9 Pins Male	Pin	Name	Description	Note
	1	Shield	EMC Production	Connect the terminal resistances as shown in the figure. 
	2	M24V	Output Voltage - 24V	
	3	RxD/TxD-P	Data reception/transmission	
	4	n.c.	n.c.	
	5	DGND	Data Ground	
	6	VP	Positive Power Supply +5V	
	7	P24V	Output Voltage +24V	
	8	RxD/TxD-N	Data Reception/Transmission	
	9	n.c.	n.c.	
Cable Type: Shielded 1 pair 22 AWG conforming to PROFIBUS.				

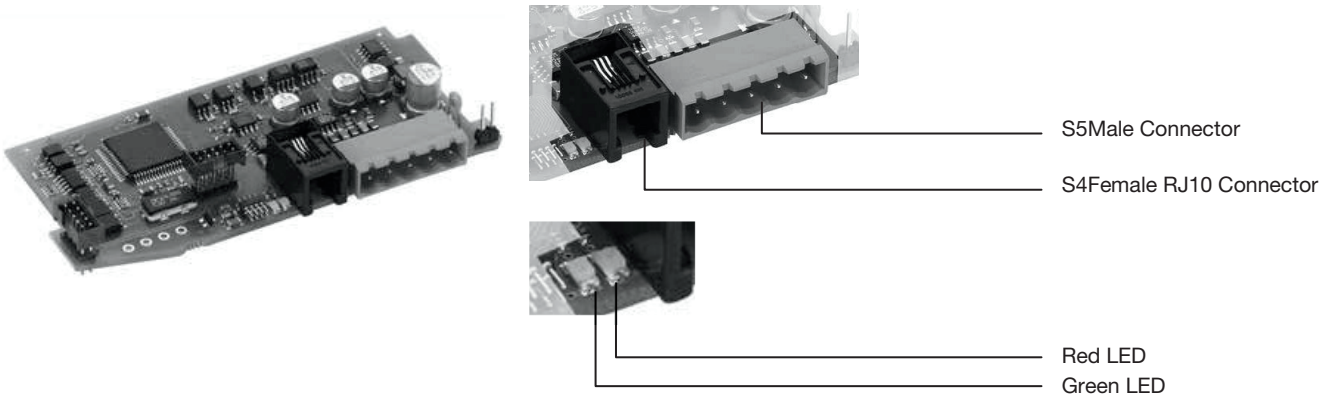
C. Modbus RTU/RS485, CANopen Interface

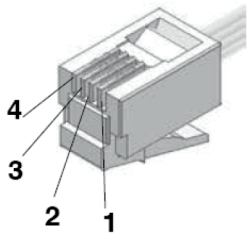


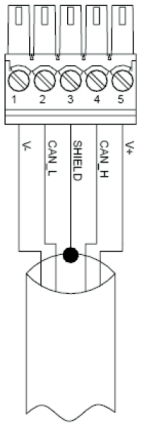
Connector S4 RJ10 4-4 Pin	Pin	Name	Description	Note
	1	GND1 (**)	-	(**) Connect the GND signal among Modbus devices with a line distance > 300 ft. (100 m)
	2	Rx/Tx+	Data reception/transmission (A+)	
	3	Rx/Tx-	Data reception/transmission (B-)	
	4	+V Reserved	-	
Cable Type: Flat telephone cable for pin 4-4 conductor 28 AWG				

Connector S5 D-Sub 9 Pins Female	Pin	Name	Description	Note
	1	-	Reserved	Connect the terminal resistances as shown in the figure. 
	2	CAN_L	CAN_L bus line (domination low)	
	3	CAN_GND	CAN Ground	
	4	-	Reserved	
	5	(CAN_SHLD)	Optional CAN Shield	
	6	(GND)	Optional Ground	
	7	CAN_H	CAN_H bus line (domination High)	
	8	-	Reserved	
	9	(CAN_V+)	Optional CAN external positive supply (dedicated for supply of transceiver and optocouplers, if galvanic isolation of the bus node applies)	
Cable Type: Shielded 2 pairs 22/24 AWG conforming to CANopen.				

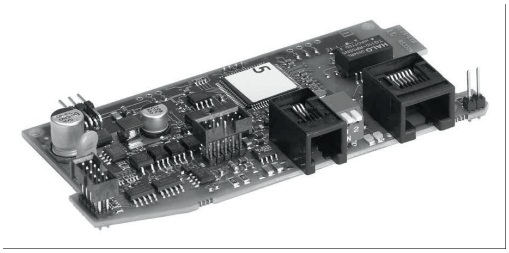
D. Modbus RTU/RS485, DeviceNet Interface

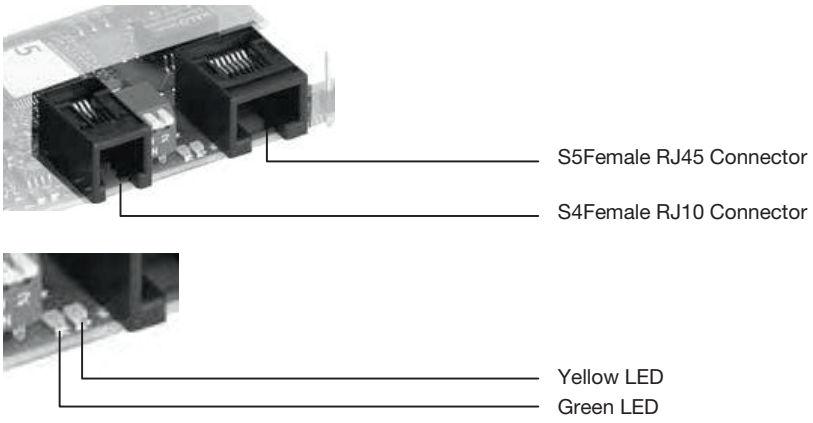


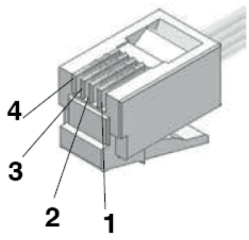
Connector S4 RJ10 4-4 Pin	Pin	Name	Description	Note
	1	GND1 (**)	-	(**) Connect the GND signal to Modbus devices with a line distance > 300 ft. (100 m)
	2	Rx/Tx+	Data reception/transmission (A+)	
	3	Rx/Tx-	Data reception/transmission (B-)	
	4	+V Reserved	-	
Cable Type: Flat telephone cable for pin 4-4 conductor 28 AWG				

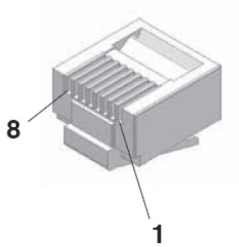
Connector S5 D-Sub 9 Pins Male	Pin	Name	Description	Note
	1	V-	Negative Power Supply	Connect a 120Ω / 1/4W resistance between the “CAN_L” and “CAN_H” signals at each end of the DeviceNet network.
	2	CAN_L	Low Signal	
	3	SHIELD	Shield	
	4	CAN_H	High Signal	
	5	V+	Positive Power Supply	
Cable Type: Shielded 1 pair 22 AWG conforming to PROFIBUS.				

E. Modbus RTU/RS485, Modbus TCP/Ethernet Interface

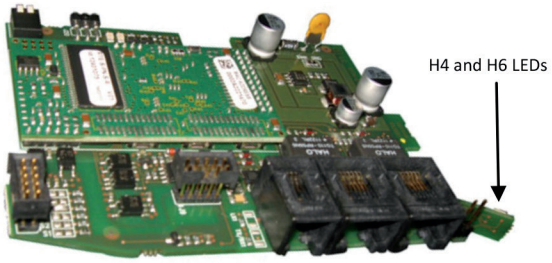




Connector S4 RJ10 4-4 Pin	Pin	Name	Description	Note
	1	GND1 (**)	-	(**) Connect the GND signal among Modbus devices with a line distance > 300 ft. (100 m)
	2	Rx/Tx+	Data reception/transmission (A+)	
	3	Rx/Tx-	Data reception/transmission (B-)	
	4	+V Reserved	-	
Cable Type: Flat telephone cable for pin 4-4 conductor 28 AWG				

Connector S5 RJ45	Pin	Name	Description	Note
	1	TX+	Data + Transmission	
	2	TX-	Data - Transmission	
	3	RX+	Data + Reception	
	4	n.c.		
	5	n.c.		
	6	RX-	Data - Reception	
	7	n.c.		
	8	n.c.		
Cable Type: Use standard category 6 cable according to TIA/EIA-568A.				

Modbus RTU/RS485, Ethernet IP Interface or Modbus RTU/RS485, EtherCAT Interface or Modbus RTU/RS485, ProfiNET Interface



LED Logic - Ethernet IP Fieldbus Module

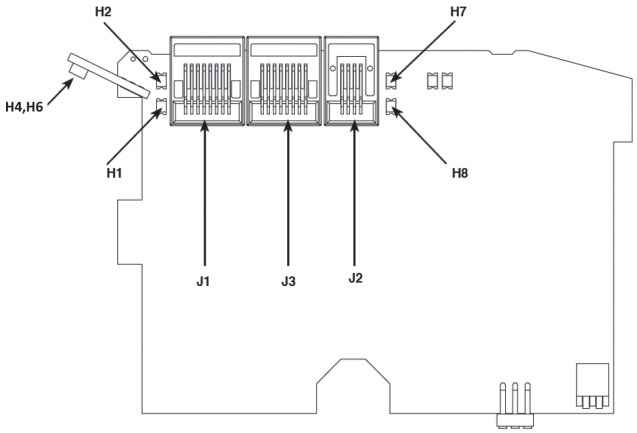
H1	LED GREEN Module State		
H2	LED RED Module State		
H7	LED RED Network State		
H8	LED GREEN Network State		
H4	LED Bicolor	GREEN (H1) RED (H2)	
H6	LED Bicolor	GREEN (H8) RED (H7)	
J1	Connector		Port ETH0
J3	Connector		Port ETH1
J2	Connector		Serial Modbus

LED Logic - EtherCAT Fieldbus Module

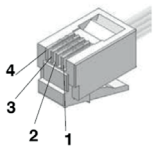
H1	LED GREEN Link/Activity		Port ETH0
H2	LED RED Run		Run
H7	LED RED Run		Run
H8	LED GREEN Link/Activity		Port ETH1
H4	LED Bicolor	GREEN (H1) RED (H2)	Port ETH0
H6	LED Bicolor	GREEN (H8) RED (H7)	Port ETH1
J1	Connector		Port ETH0 (IN)
J3	Connector		Port ETH1 (OUT)
J2	Connector		Serial Modbus

LED Logic - ProfiNet Fieldbus Module

H1	LED GREEN Link		Port ETH0
H2	LED RED Signal		Port ETH0
H7	LED RED Activity		Port ETH1
H8	LED GREEN Link		Port ETH1
H4	LED Bicolor	GREEN (H1) RED (H2)	Port ETH
H6	LED Bicolor	GREEN (H8) RED (H7)	Port ETH
J1	Connector		Port ETH0
J3	Connector		Port ETH1
J2	Connector		Serial Modbus



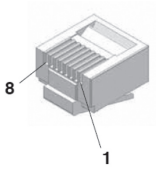
Connector J2 RJ10 4-4 Pin



Pin	Name	Description	Note
1	GND1 (**)	-	(**) It is adviseable to also connect the GND signal between Modbus devices with a line distance > 300 ft. (100 m)
2	Tx/Rx+	Data reception/ transmission (A+)	
3	Tx/Rx-	Data reception/ transmission (B-)	
4	+V Reserved	-	

Cable Type: Flat telephone cable for pin 4-4 conductor 28 AWG

Connector J1 and J3 RJ45



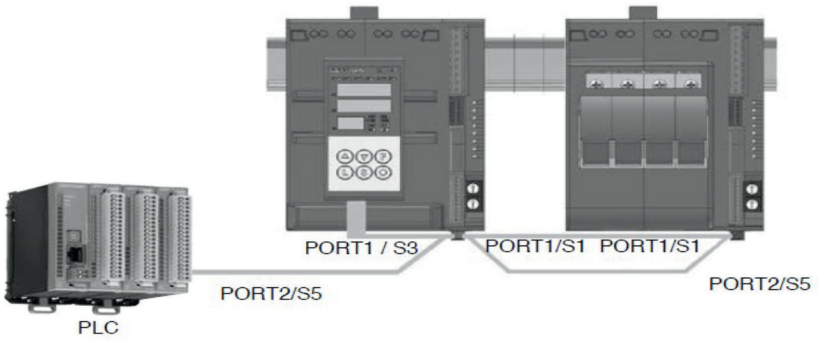
Pin	Name	Description	Note
1	TX+	Data Transmission +	
2	TX-	Data Transmission -	
3	RX+	Data Reception +	
4	n.c.		
5	n.c.		
6	RX-	Data Reception -	
7	n.c.		
8	n.c.		

Cable Type: Use standard category 5 cable according to TIA/ EIA-568B

7.8.3 Connection Example: Communication Ports

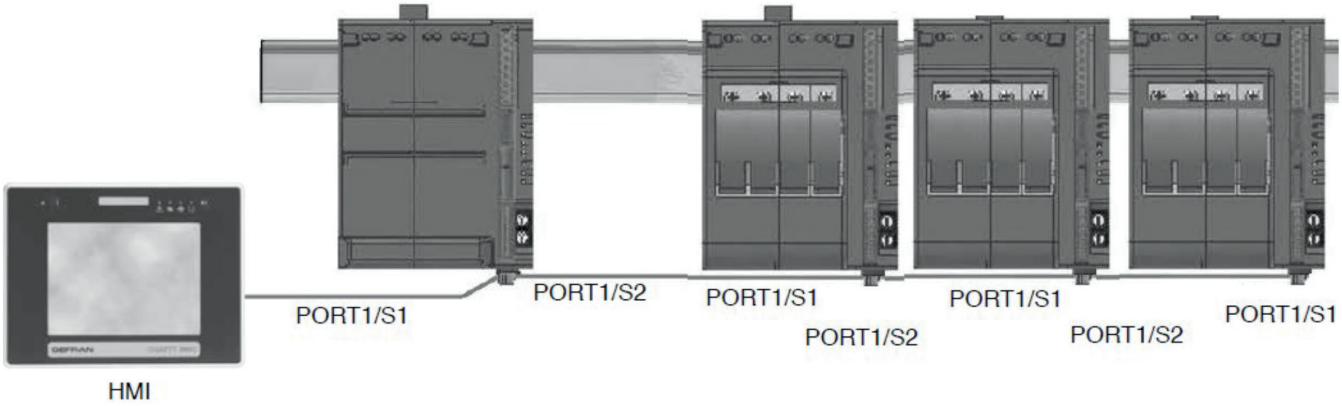
A. Supervisory PC/PLC with multiple C4-IR Modules, with C4-OP.

May need to use Autobaud to synchronize communications.

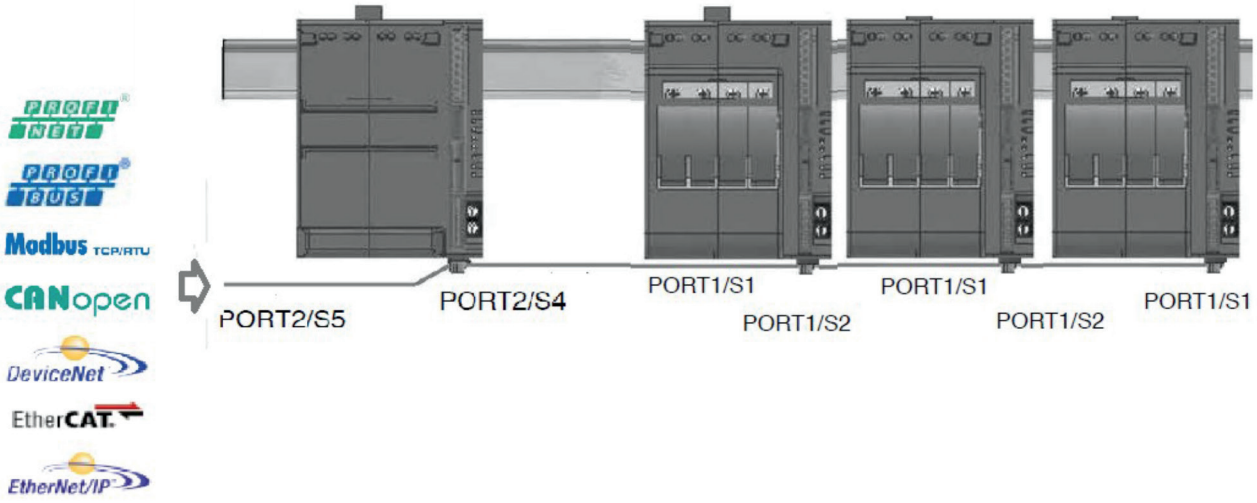


B. HMI Connection via Modbus RTU (RS-485) to four C4-IR Modules

May need to use Autobaud function to synchronize communications.



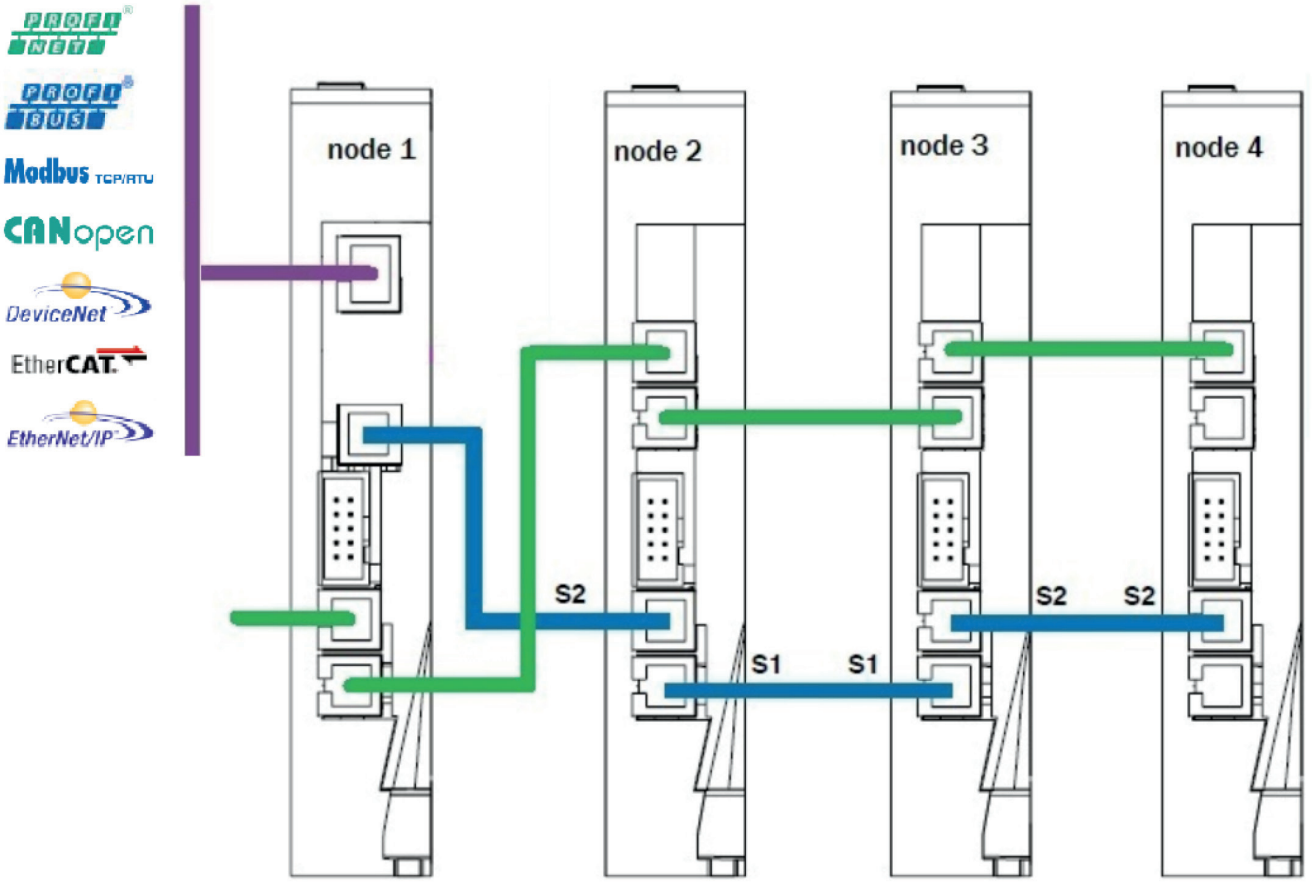
C. SCADA System with fieldbus interface, Single Master Setup



D. C4-IR with Multiple Master Communications Ports

This configuration will allow two masters to simultaneously operate. This will allow the fieldbus to operate, while allowing the 2nd port to be used for local information, verification of process, or for configuration tool C-PWR software to be utilized.

Use Autonode to set communications.



C4-IR or C4-IR-IR Fieldbus Network

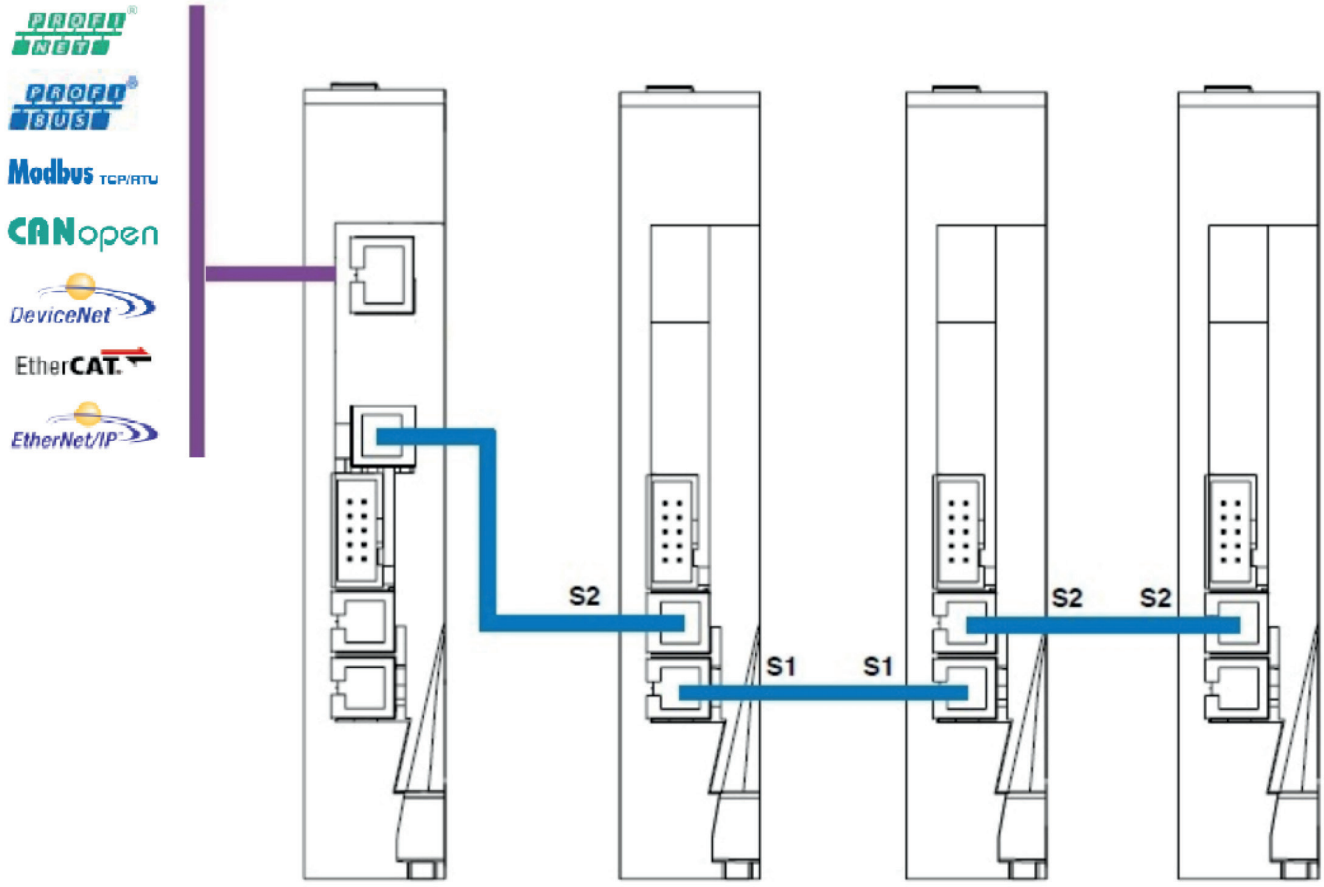
Purple: Fieldbus Network wiring to Master Unit.
SW7 must be set to “off” on all units.

Blue: Fieldbus Network Slave Unit connection via RS-485.

Green: 2nd Master Communications Port for local master or configuration using C-PWR Software

E. C4-IR with a Single Master Communication Port

Use Autonode Sequence for configuration. See section 12.2



C4-IR or C4-IR-IR Fieldbus Network

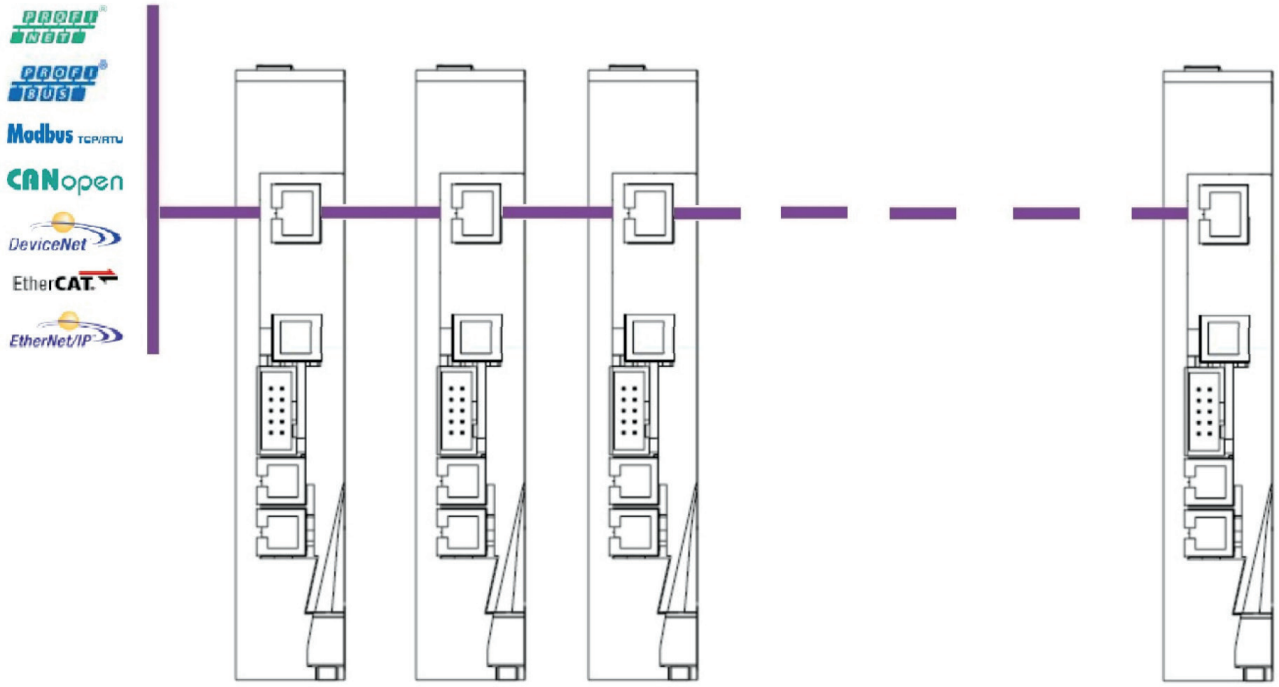
Purple: Fieldbus Network wiring to Master Unit.
SW7 must be set to “off” on all units.

Blue: Fieldbus Network Slave Unit connection via RS-485.

C-PWR Configuration Tool can be used via RS-485 ports only. Fieldbus connection must be broken to utilize configuration.

Single Master systems can be expanded to two master systems in field.

F. Multiple Fieldbus Connections



C4 or C4-IR Fieldbus Network
Purple: Fieldbus Network wiring to Master Unit.
SW7 must be set to off on all units.

C4-IR or C4-IR-IR Fieldbus Network

Purple: Fieldbus Network wiring to Master Unit. SW7 must be set to “off” on all units.

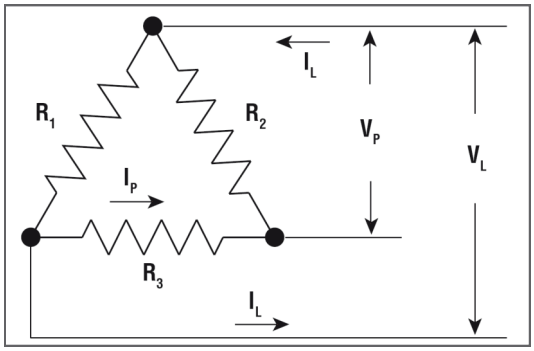
8. Load Connection Example

The following wiring diagrams and electrical equations are provided as a reference for this manual. The three phase equations shown can be applied to any balanced Delta or Wye (star) circuit. The terms used in the equations are identified below:

Vl = Line Voltage
Vp = Phase Voltage
Il = Line Current (Amps)
Ip = Phase Current (Amps)

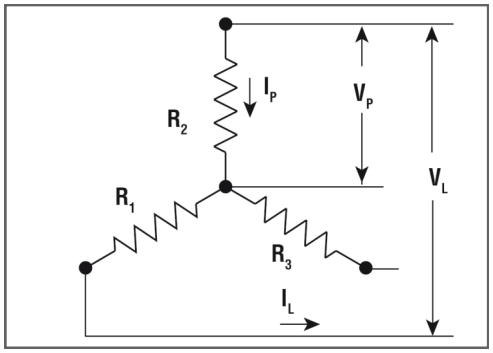
Wt = Total Watts
R1 = R2 = R3 = Element Resistance
Wc = Wattage per Circuit (Equal Circuits)
Rc = Circuit Resistance in Ohms Measured Phase to Phase

3Ø Delta



$V_P = V_L$ | $V_L = V_P$
$W_T = 1.73\ I_L \times V_L$ | $W_T = 3\ (V_L^2 \div R_1)$
$I_P = I_L \div 1.73$ | $I_L = I_P \times 1.73$
$R_C = (2 \times V_L^2) \div W_C$ | $R_C = V_L^2 \div 0.5 W_C$
$W_C = 1.73\ I_L \times V_L \div \#$ Circuits

3Ø Wye (Star)



$V_P = V_L \div 1.73$ | $V_L = V_P \times 1.73$
$W_T = 1.73\ I_L \times V_L$ | $W_T = V_L^2 \div R_1$
$I_P = I_L$ | $I_L = I_P$
$R_C = (2 \times V_L^2) \div W_C$ | $R_C = V_L^2 \div 0.5\ W_C$
$W_C = 1.73\ I_L \times V_L \div \#$ Circuits

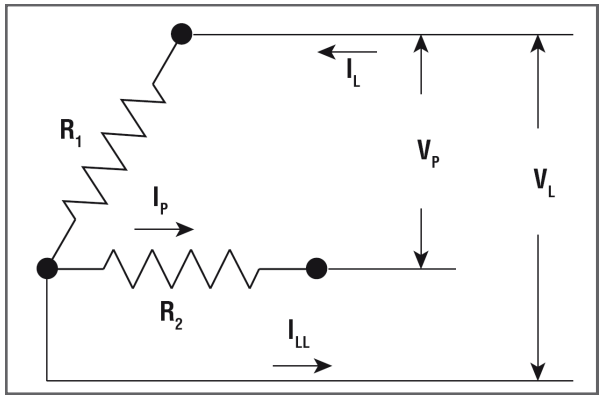
⚠CAUTION

The model C4-IR has specific dipswitch settings for the various load configurations. Incorrectly setting with a mismatch load configuration could result in unpredicted results. Please refer to section 7.7 or the Load Connection examples for these proper dipswitch settings.

Open Delta & Wye

Three phase heating circuits are most efficient when operated under balanced conditions. If it is necessary to operate an unbalanced load, the equations below can be used to calculate the circuit values for open three phase Delta or Wye circuits. The terms used in the equations are identified below:

3Ø Open Delta



$V_P = V_L$ | $V_L = V_P$

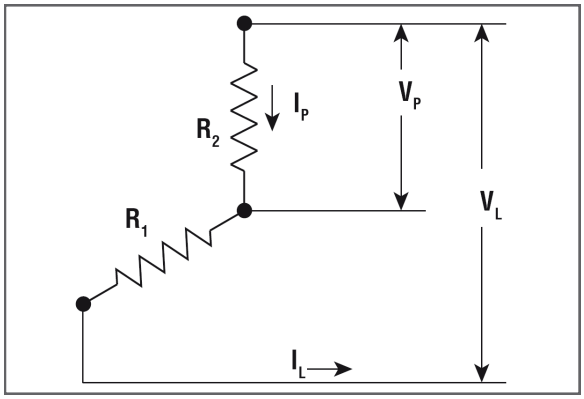
$W_T = 2V_L \times I_L$ | $W_T = 2 (V_L^2 \div R1)$

$I_P = I_L$ | $I_L = I_P$

$W_C = 2V_P \times I_P$ | $I_{LL} = 1.73 \times I_P$

Note:
The loss of a phase or failure of an element in a three (3) element Delta circuit will reduce the wattage output by 33%

3Ø Open Wye (Star)



$V_P = V_L \div 2$ | $V_L = V_P \times 2$

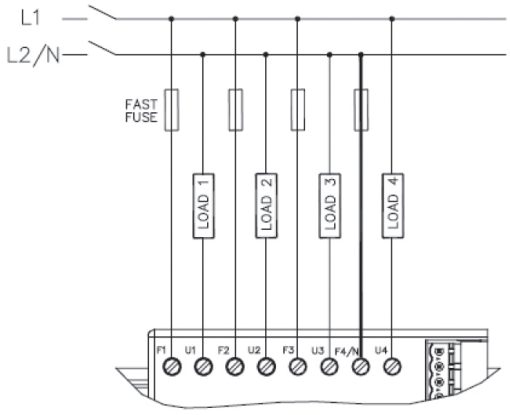
$W_T = I_L \times V_L$ | $W_T = V_L2 \div 2R1$

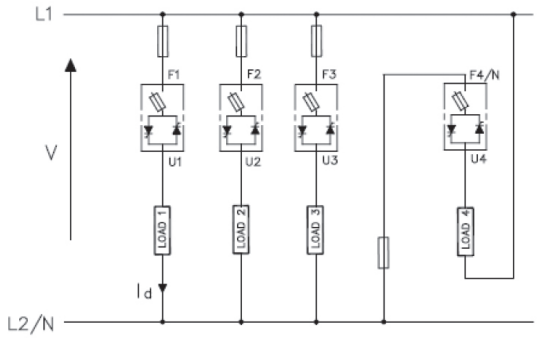
$I_P = I_L$ | $I_L = I_P$

$R_C = V_L2 \div W_C$

Note:
The loss of a phase or failure of an element in a three (3) element Wye circuit will reduce the wattage output by 50%. Heating elements are basically in series on single phase power.

8.1 Connection Example for 4 single phase loads, Single Phase Line L1-L2/N.





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
OFF	OFF	OFF	OFF	OFF

$$Id = \frac{P}{V \quad COS\varphi}$$

V = phase voltage (line L 1 - line l2/N)
P = power of each single-phase load
Id = load current
if resistive load coscφ = 1

- FIRING MODE ZC, BF, HSC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

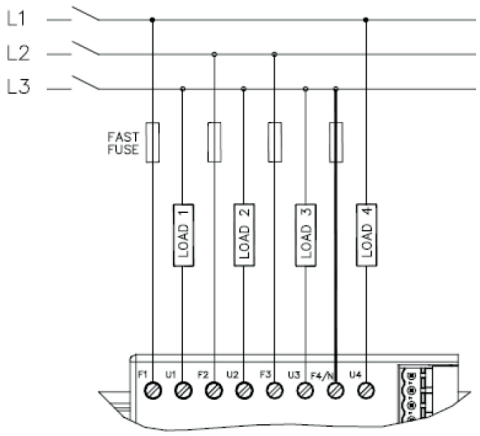
FAST FUSE needed only for controller without option "F"

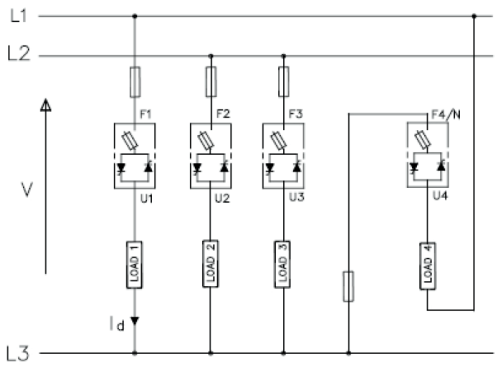
See table Fuse/Fuseholders

NOTE: Take care about the "F4/N" connection (see the picture)

The wire "F4/N" is required always (also if Load 4 is not used)

8.2 Connection Example for 4 single phase loads, 3 Phase line without neutral





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
OFF	OFF	OFF	OFF	OFF

$$Id = \frac{P}{V \quad COS\varphi}$$

V = phase voltage (line L 1 - line l2/N)
P = power of each single-phase load
Id = load current
if resistive load coscφ = 1

- FIRING MODE ZC, BF, HSC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

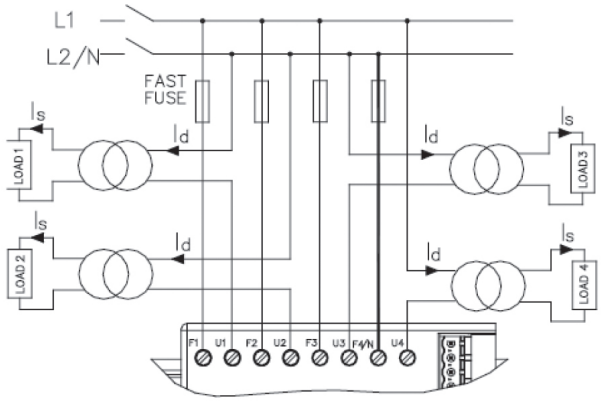
FAST FUSE needed only for controller without option "F"

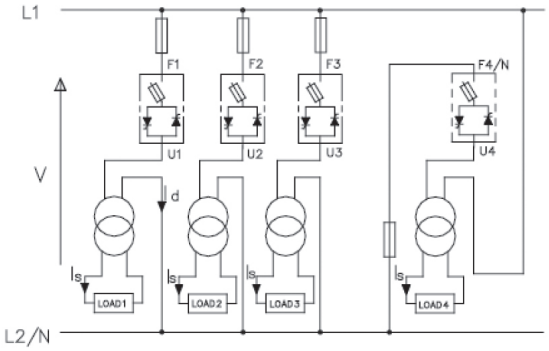
See table Fuse/Fuseholders

NOTE: Take care about the "F4/N" connection (see the picture)

The wire "F4/N" is required always (also if Load 4 is not used)

8.3 Connection Example for 4 single phase transformer loads, single phase line L1-L2/N.





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
OFF	OFF	OFF	OFF	ON

$$Id = \frac{P}{nV\ COS\varphi} \qquad Id = \frac{P}{Vload\ COS\varphi}$$

P = power of each single-phase load
V = phase voltage (line L 1- line L2/N)
Vload = voltage on secondary (load)
Id = current in primary
Is = current in secondary (load)
‘1 = transformer output (type 0.9)

if resistive load coscφ = 1

- FIRING MODE: ZC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

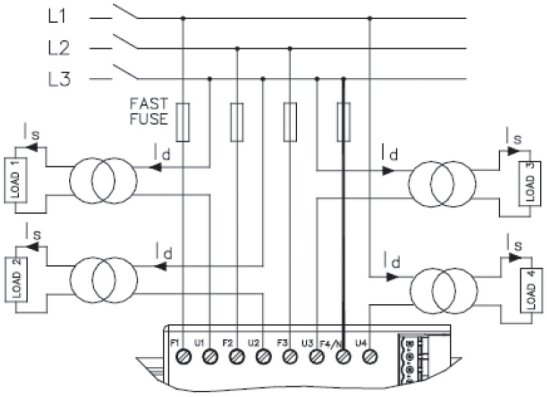
FAST FUSE needed only for controller without option “F”

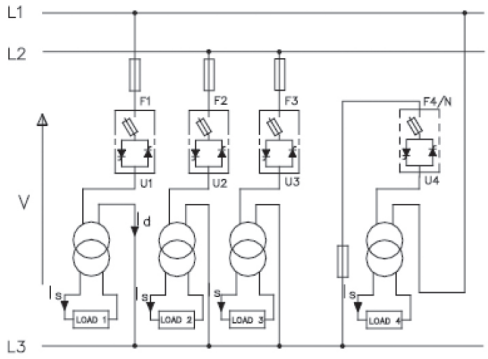
See table Fuse/Fuseholders

NOTE: Take care about the “F4/N” connection (see the picture)

The wire “F4/N” is required always (also if Load 4 is not used)

8.4 Connection Example for 4 single phase transformer loads, 3-Phase line without Neutral





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
OFF	OFF	OFF	OFF	ON

$$Id = \frac{P}{nV\ COS\varphi} \qquad Is = \frac{P}{Vload\ COS\varphi}$$

P = power of each single-phase load
V = phase voltage (line L 1- line L2/N)
Vload = voltage on secondary (load)
Id = current in primary
Is = current in secondary (load)
‘1 = transformer output (type 0.9)

if resistive load coscφ = 1

- FIRING MODE: ZC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

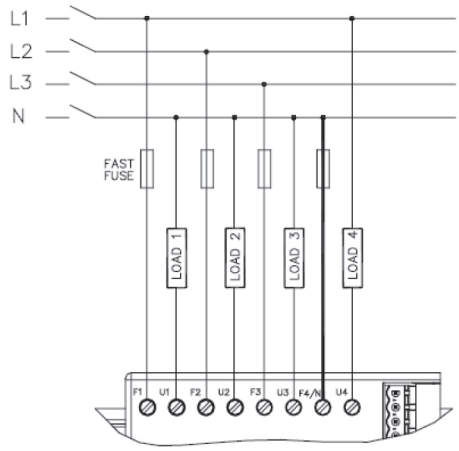
FAST FUSE needed only for controller without option “F”

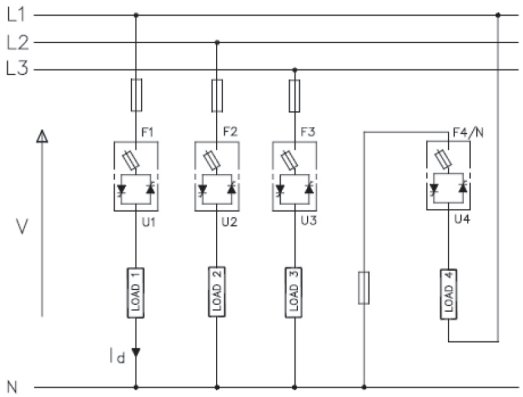
See table Fuse/Fuseholders

NOTE: Take care about the “F4/N” connection (see the picture)

The wire “F4/N” is required always (also if Load 4 is not used)

8.4 Connection Example 4 Single Phase loads, 3 Phase Line with Neutral





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
OFF	OFF	OFF	OFF	OFF

$$Id = \frac{P}{V \quad COS\varphi}$$

V = phase voltage (line - neutral)
P = power of each single-phase load
Id = load current
if resistive load coscφ = 1

- FIRING MODE: ZC, BF, HSC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

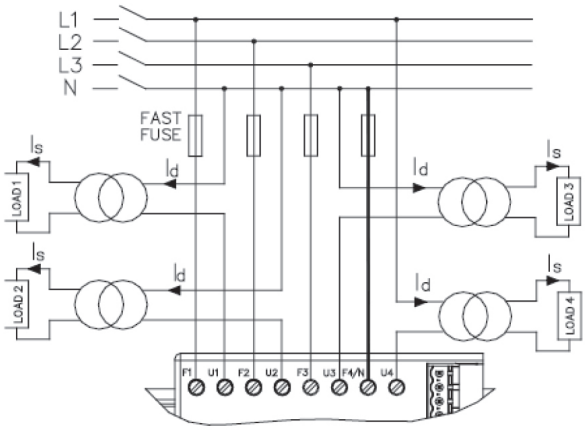
FAST FUSE needed only for controller without option "F"

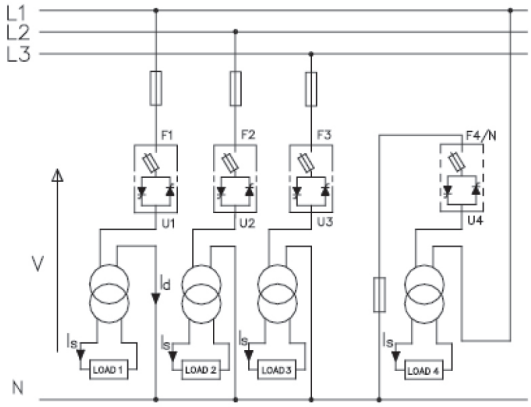
See table Fuse/Fuseholders

NOTE: Take care about the "F4/N" connection (see the picture)

The wire "F4/N" is required always (also if Load 4 is not used)

8.5 Connection example for 4 Single Phase Transformer Loads, 3 Phase Line with Neutral





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
OFF	OFF	OFF	OFF	ON

$$Id = \frac{P}{nV \quad COS\varphi} \qquad Is = \frac{P}{Vload \quad COS\varphi}$$

P = power of each single-phase load
V = phase voltage (line L 1- line L2/N)
Vload = voltage on secondary (load)
Id = current in primary
Is = current in secondary (load)
'1 = transformer output (type 0.9)

if resistive load coscφ = 1

- FIRING MODE: ZC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

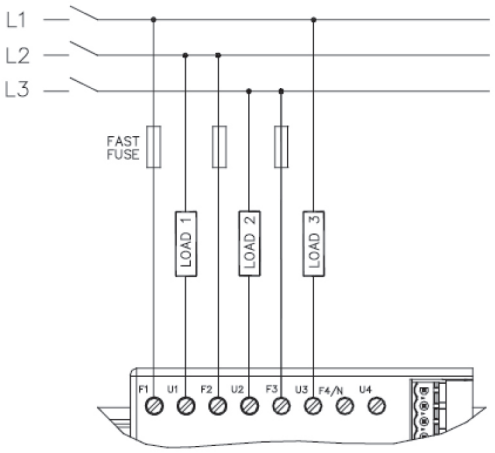
FAST FUSE needed only for controller without option "F"

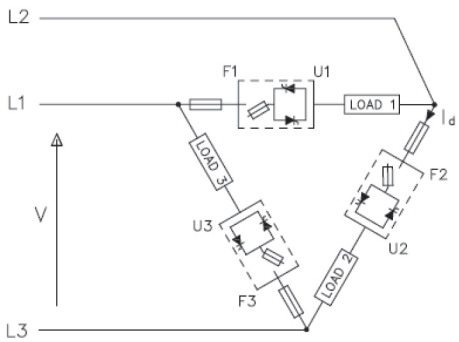
See table Fuse/Fuseholders

NOTE: Take care about the "F4/N" connection (see the picture)

The wire "F4/N" is required always (also if Load 4 is not used)

8.6 Connection Example, 3 Independent Single Phase Loads in open delta, 3 phase line without Neutral





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
OFF	ON	OFF	ON	OFF

- FIRING MODE: ZC, BF, HSC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

FAST FUSE needed only for controller without option “F”

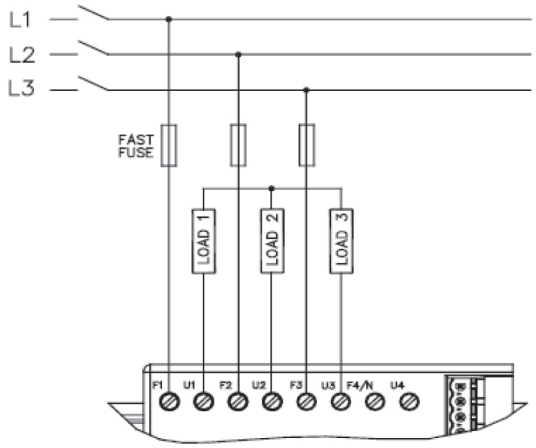
See table Fuse/Fuseholders

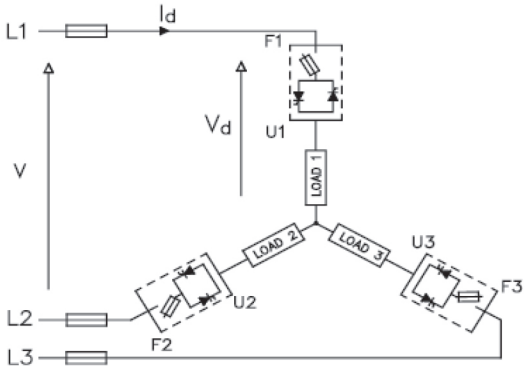
$$Id = \frac{P}{V \ COS\varphi}$$

V = phase voltage
P = power of each single-phase load
Id = load current

if resistive load coscφ = 1

8.7 Connection Example for one 3 Phase Star Load without Neutral (3 wires)





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
ON	OFF	–	ON	OFF

- FIRING MODE: ZC, BF, PA (P>6%)
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

FAST FUSE needed only for controller without option “F”

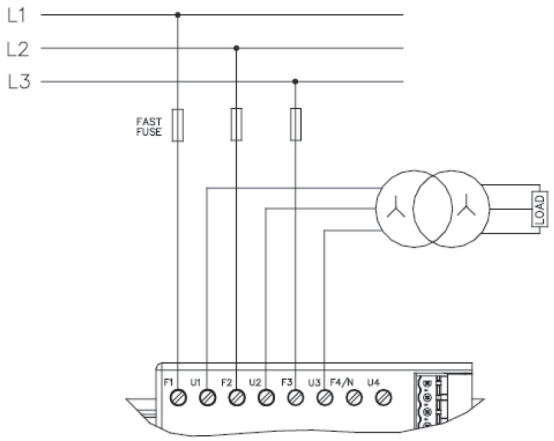
See table Fuse/Fuseholders

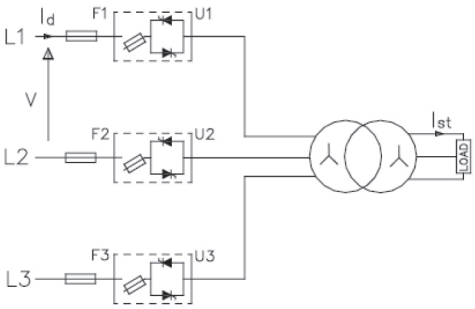
$$Vd = \frac{V}{\sqrt{3}} \qquad Id = \frac{P}{\sqrt{3} \ V \ COS\varphi}$$

V = phase voltage
Vd = load voltage
Id = load current
P = total power

if resistive load coscφ = 1

8.8 Connection Example, One 3 phase star transformer without Neutral (3 wires) with 3 Phase Load





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
ON	ON	ON	ON	ON

- FIRING MODE: ZC, PA (P>6%)
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

FAST FUSE needed only for controller without option “F”

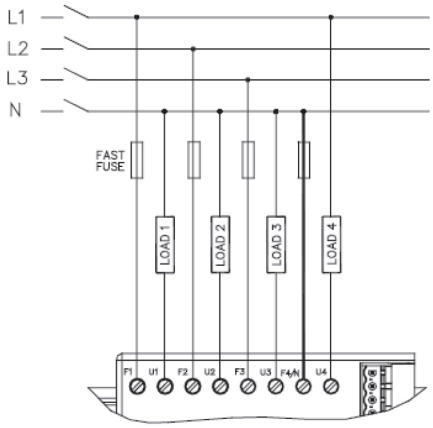
See table Fuse/Fuseholders

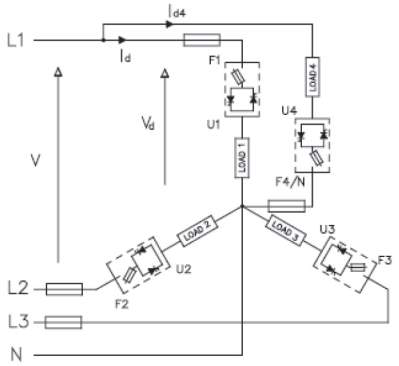
$$Vd = \frac{V}{n\sqrt{3}\ V\ COS\varphi} \qquad Ist = \frac{P}{\sqrt{3}\ Vload\ COS\varphi}$$

P = total power
V = phase voltage
Vload = line voltage on secondary (load)
Id = current in primary
Ist = current in secondary (3-phase load)
n = transformer output (type 0.9)

if resistive load coscφ = 1

8.9 Connection Example for one 3 Phase Star Load with Neutral (4 Wires) and possible single phase load





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
ON	OFF	–	OFF	OFF

- FIRING MODE: ZC, BF, HSC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

FAST FUSE needed only for controller without option “F”

See table Fuse/Fuseholders

NOTE: Take care about the “F4/N” connection (see the picture)

The wire “F4/N” is required always (also if Load 4 is not used)

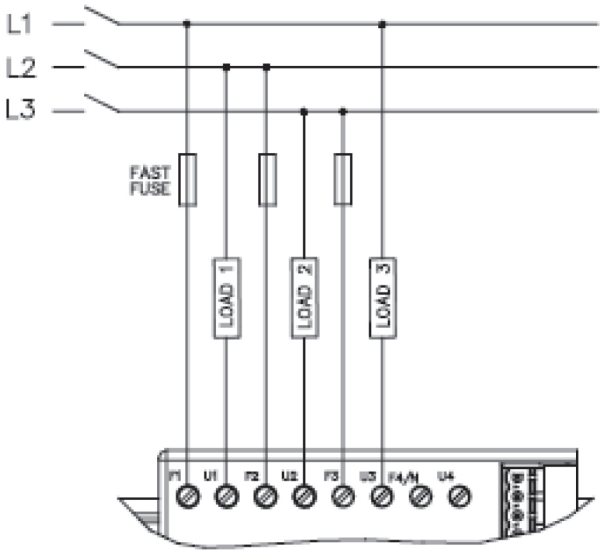
$$Vd = \frac{V}{\sqrt{3}} \qquad Id = \frac{P}{\sqrt{3}\ V\ COS\varphi}$$

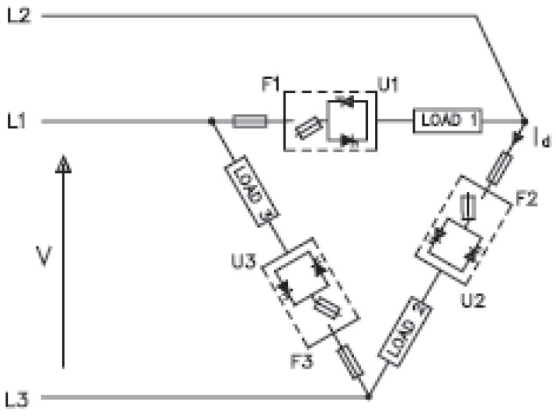
V = line voltage
Vd = load voltage
Id = current in 3-phase load
P = total power 3-phase load if resistive load cosφ = 1

$$Id4 = \frac{P4\ \sqrt{3}}{V\ COS\varphi}$$

Id4 = current in single-phase load
P4 = power in single-phase load if resistive load
coscφ = 1

8.10 Connection Example, One 3-phase open delta load, using 6 Wires





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
ON	ON	OFF	ON	OFF

- FIRING MODE: ZC, BF, PA, HSC
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

FAST FUSE needed only for controller without option “F”

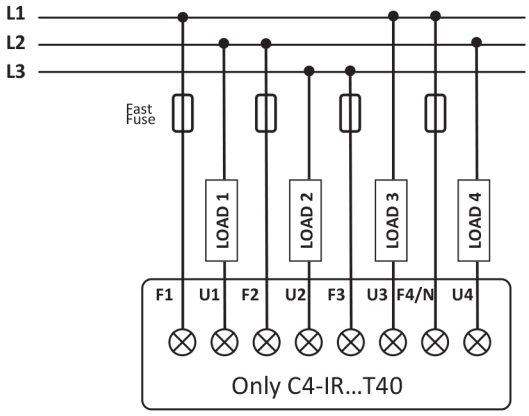
See table Fuse/Fuseholders

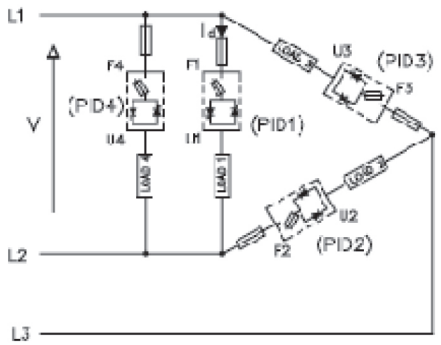
$$Id = \frac{P}{3V \ COS\varphi}$$

V = line voltage
Id = load current
P = total power

if resistive load cosφ = 1

8.11 Connection Example, Control of 4 Independent Loads Open Delta





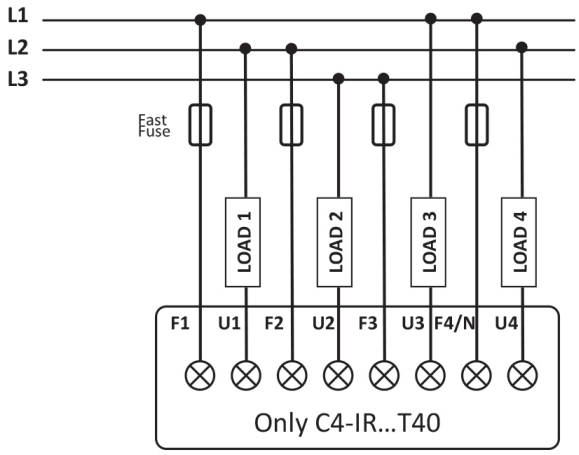
Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
OFF	ON	OFF	ON	OFF

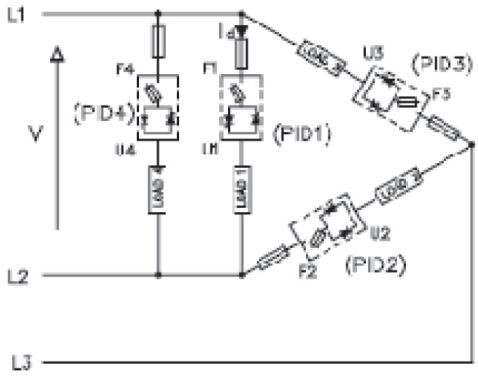
- FIRING MODE: ZC, BF, HSC, PA
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

FAST FUSE needed only for controller without option “F”

See table Fuse/Fuseholders

8.12 Connection Example, One 3-phase load, Open Delta, and 1 single load





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
ON	ON	OFF	ON	OFF

- FIRING MODE: ZC, BF, HSC, PA

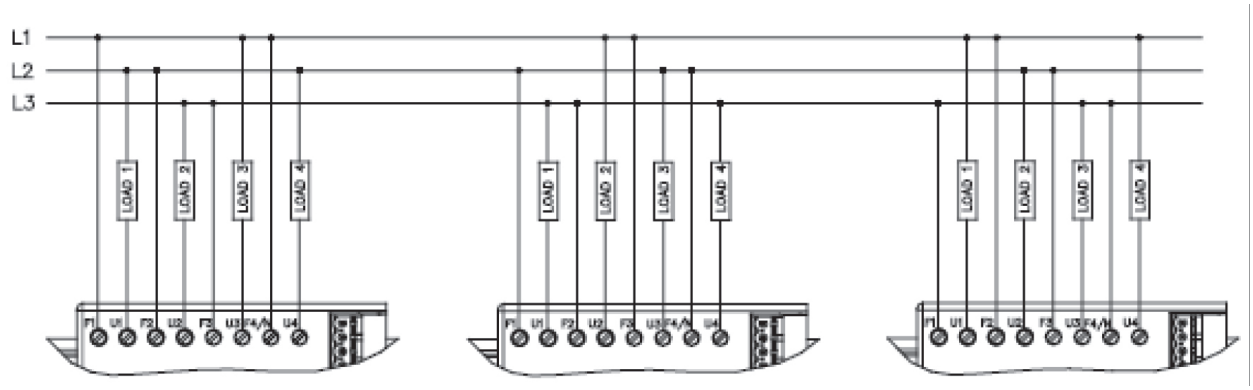
- HB DIAGNOSTIC AVAILABLE: Partial and total load failure of each single leg

FAST FUSE needed only for controller without option “F”

See table Fuse/Fuseholders

8.13 Wiring Example of three C4-IR’s with T40 Option. Optimized line current sharing.

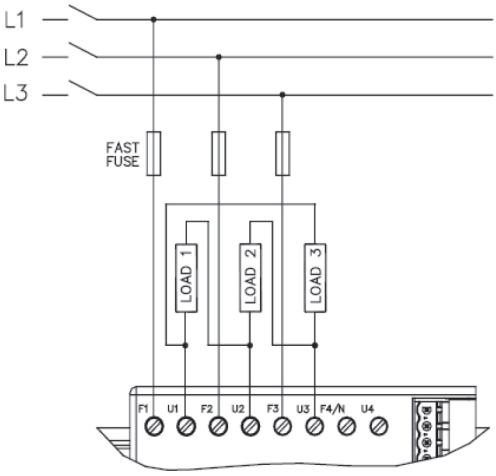
CAUTION: MUST HAVE SUFFIX CODE –T40 ON PART NUMBER

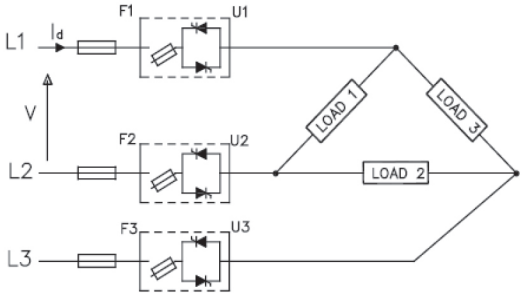


NOTES:

1. The C4-IR T40 product is especially designed for open delta applications, but can control other load configurations
2. The C4-IR T40 ca control a 3-phase load closed-delta (figure 48)
3. The C4-IR T40 can control a 3-phase load star with-out neutral (figure 44)
4. The C4-IR T40 can control a 3-phase transformer (Figure 45)
5. The C4-IR T40 can NOT control 1-phase loads or 3-phase loads with neutral (figure 39-39A—40-40A—41 –42—46)

8.14 Connection Example, One 3 phase closed Delta Load, 3 wires.





Dip Switch Configurations				
Dip 1	**Dip 2**	**Dip 3**	**Dip 4**	**Dip 5**
ON	ON	ON	ON	OFF

- FIRING MODE: ZC, BF, PA (P>6%)
- HB DIAGNOSTIC AVAILABLE: Partial and total load
- In PA mode, HB diagnostic active with P>30%

FAST FUSE needed only for controller without option “F”

See table Fuse/Fuseholders

$$Id = \frac{P}{V3 \quad V \cos\varphi}$$

V = line voltage
Id = load current
P = total power

if resistive load $\cos\varphi = 1$

9. Inductive and Transformer Coupled Load Guidelines

NOTES: USE WITH INDUCTIVE LOADS AND TRANSFORMERS

a) Connect a varistor (MOV) between each wire of the primary transformer and ground.
Varistor data: rated voltage 660Vrms, ... , 1000Vrms; minimum energy 100J

b) The maximum current controllable by the device is less than the product's rated value (see technical data).

c) In ZC nnd BF trigger mode, use the Delay-triggering function to limit peak magnetization current.

d) In PA trigger mode, use the Softstart function.

e) DO NOT use HSC trigger mode.

f) DO NOT connect RC snubbers in parallel to the transformer primary.

g) Always set Dip-Switch 5 to ON (and run the initial configuration procedure described in paragraph 3.7)

---

10. Firing (Trigger) Mode Overview

Trigger Modes

The C4-IR has the following power control modes:

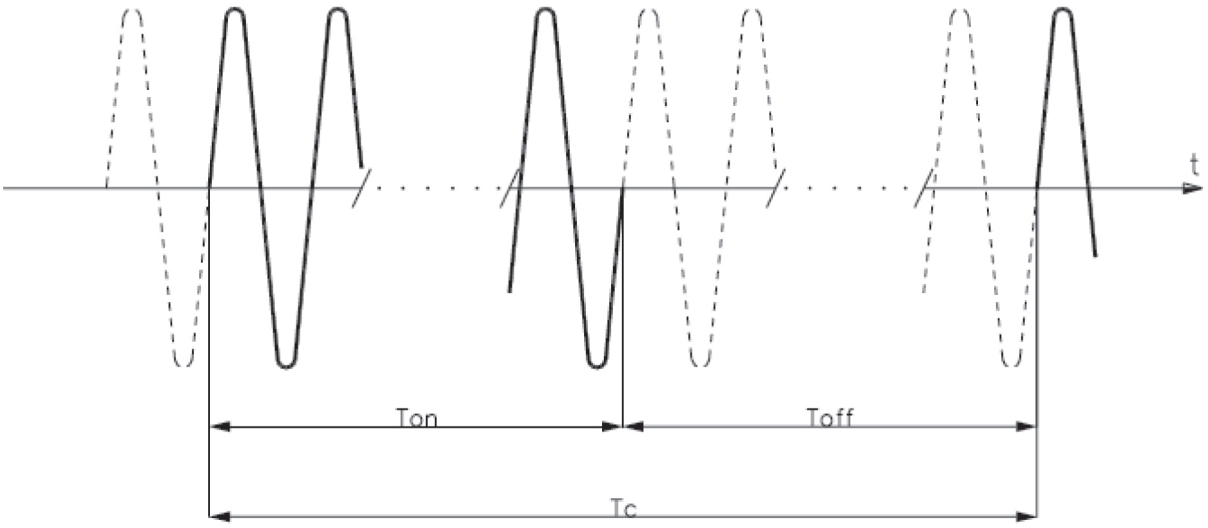
- modulation via variation of number of conduction cycles with zero crossing trigger.
- Module via variation of phase angle.

ZC- Zero Crossing Mode

This function eliminates EMC noise. This mode controls power on the load via a series of conduction ON and non conduction OFF cycles.

Constant cycle time (Tc > 1 sec, settable from 1 to 200 sec)

Cycle time is divided into a series of conduction and non conduction cycles in proportion to the power value to be transferred to the load.



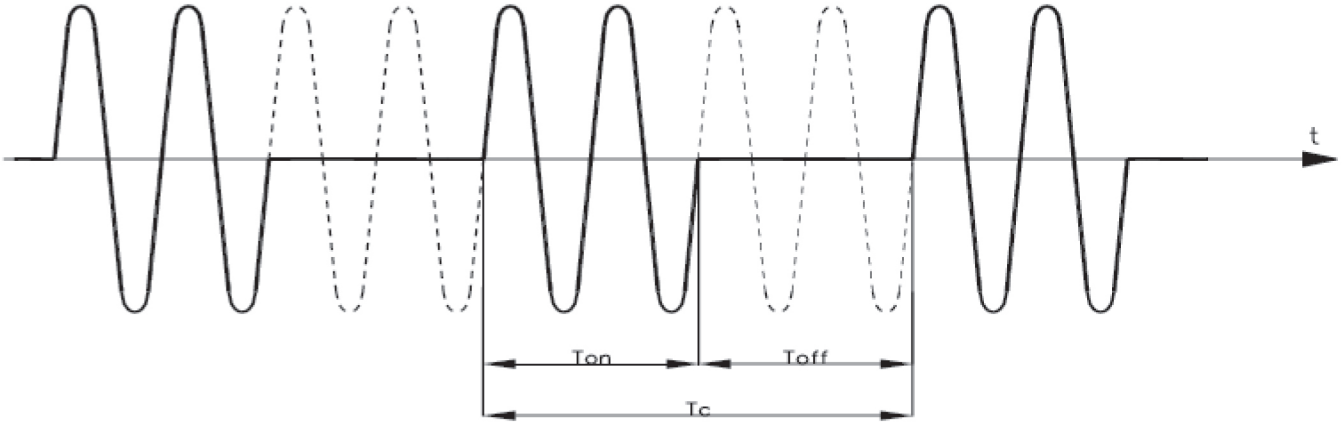
For example, if Tc = 10sec, if the power value is 20% there is conduction for 2 sec (100 conduction cycles @ 50 Hz) and non conduc-tion for 8 sec (400 non conduction cycles @ 50 Hz).

BF - variable cycle time (GTT)

This mode controls power on the load via a series of conduction ON and non conduction OFF cycles.

The ratio of the number of ON cycles to OFF cycles is proportional to the power value to be supplied to the load.

The CT repeat period is kept to a minimum for each power value (whereas in ZC mode the period is always fixed and not optimized).



Parameter defines the minimum number of conduction cycles settable from 1 to 10.

In the example, the parameter = 2.

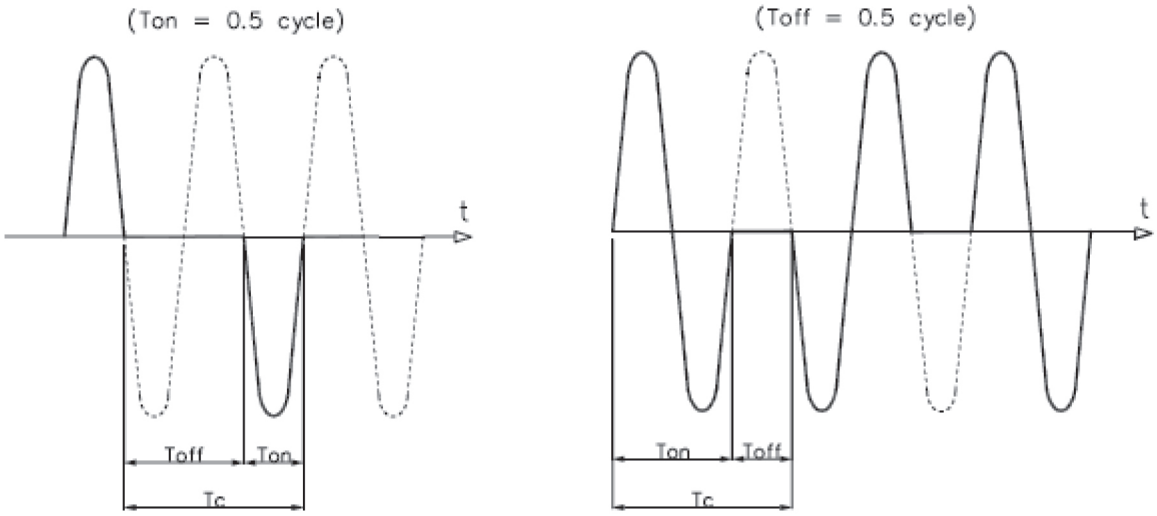
HSC - Half Single Cycle

⚠WARNING

This mode corresponds to Burst Firing that manages ON and OFF half-cycles. It is useful for reducing the flicker-ing of filaments with short/medium-wave IR lamp loads. With these loads, to limit operating current with low power, it is useful to set a minimum power limit (for example, Lo.p = 10%).

⚠WARNING

This mode is NOT allowed with inductive loads (transformers). It is used with resistive loads in single phase star with neutral, or open delta configuration.



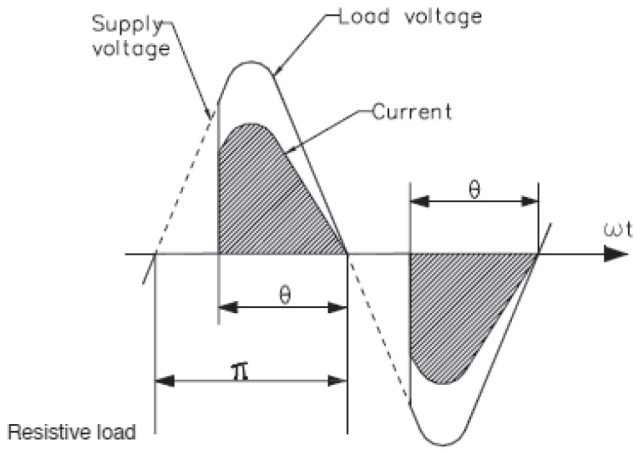
Example of operation in HSC mode with power at 33% and 66%.

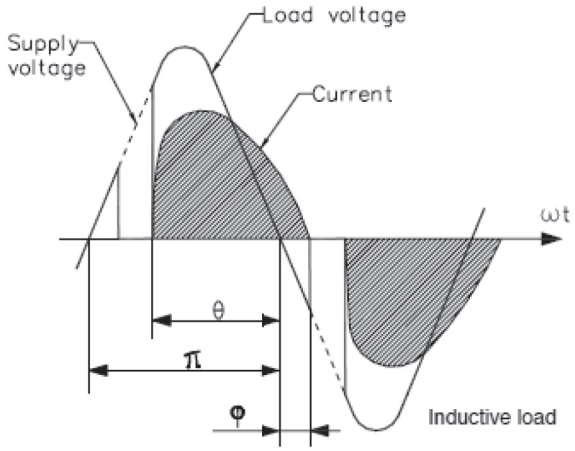
PA - Phase Angle

This mode controls power on the load via modulation of trigger angle Θ

If power to be transferred to the load is 100%, Θ = 180°

If power to be transferred to the load is 50%, Θ = 90°



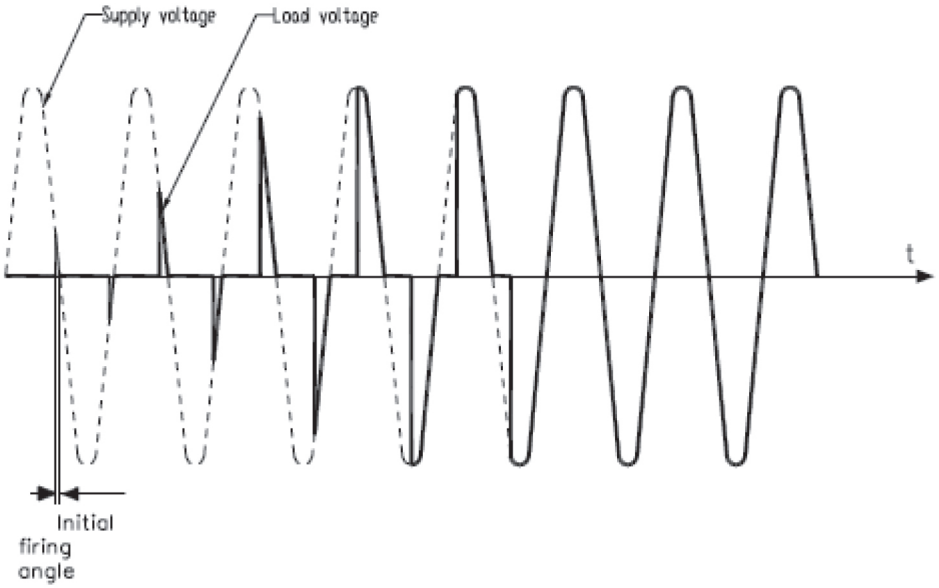


Softsart

This type of start can be enabled either in phase control or pulse train mode and in zero-crossing mode (ZC, BF, HSC).

In phase control, the increment of conduction angle q stops at the corresponding value of the power to be transferred to the load.

Control of maximum peak current (useful in case of short circuit on the load or of loads with high temperature coefficients to automatically adjust start time to the load) can be enabled during softstart. When the load shut-off time (settable) is exceeded, the ramp is reactivated at the next power-on.



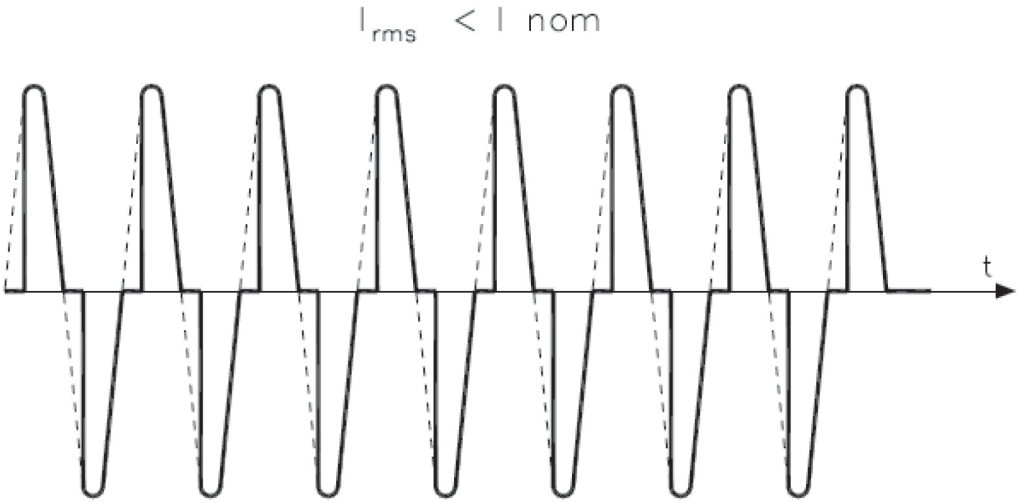
Example of firing ramp with phase Soft-Start

RMS Current Limit

The option for controlling the load current limit is available in all work modes.

If the current value exceeds the limit (settable in the nominal full-scale range) in PA mode, the conduction angle is limited, while in zero-crossing mode (ZC, BF, HSC) the cycle time conduction percentage is limited.

This limitation ensures that the RMS value (i.e., not the instantaneous value) of the load current does NOT exceed the set RMS current limit.

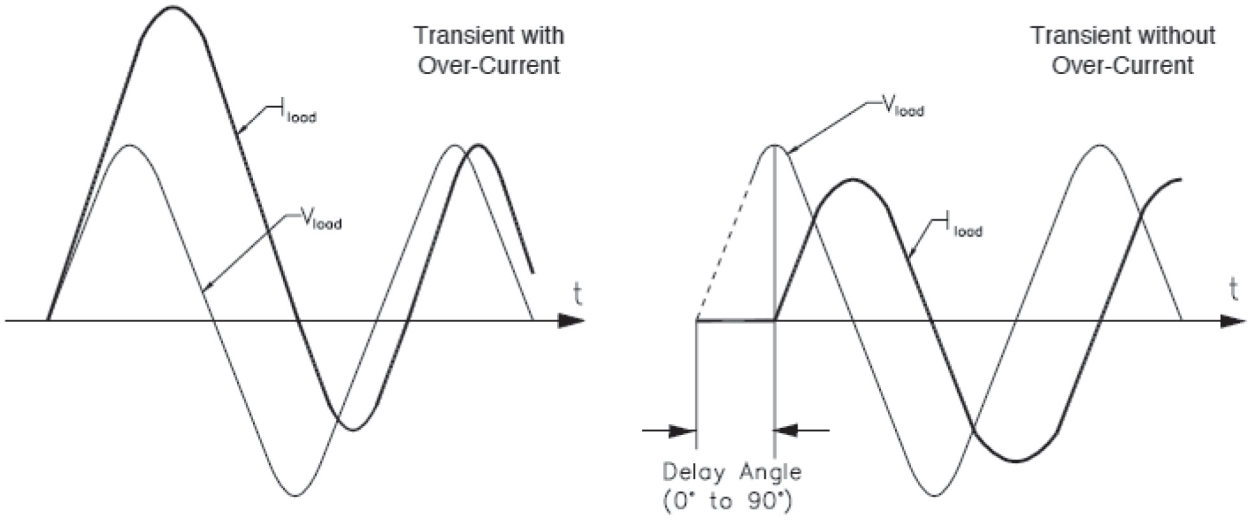


Example of conduction angle limitation in PA mode to respect an RMS current limit below the nominal current of the load.

DT— Delay Trigger (for ZC, BF control modes only)

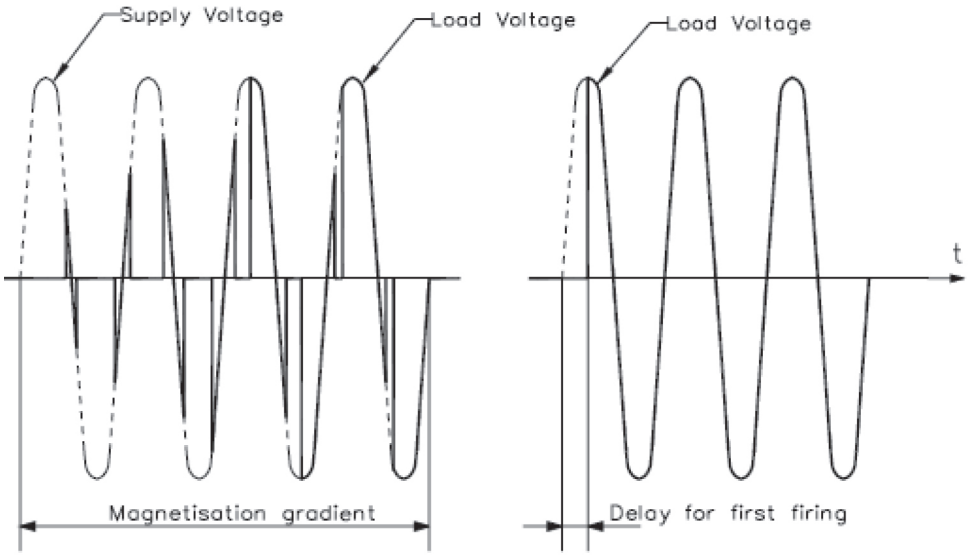
Settable from 0° to 90°.

Useful for inductive loads (transformer primaries) to prevent current peak that in certain cases could trip the high-speed fuses that protect the SCR's.



Example of firing of inductive load with/without delay-triggering.

To conduct inductive loads controlled in PA mode, do not use delay triggering; instead, use the phase Soft-Start ramp.



Example of phase ramp to fire a transformer in PA Mode

Example of firing with Delay-Triggering of a transformer in ZC mode

Comparison of method to fire a transformer:
Soft-Start Ramp (for PA mode) / Delay triggering (for ZC and BF mode)

Section 11 Communications Port (Modbus RTU/RS485)

A network typically has a Master that “manages” communication by means of “commands”, and Slaves that carry out these commands.

C4-IR modules are considered Slaves to the network master, which is usually a supervision terminal or a PLC.

They are positively identified by means of a node address (ID) set on rotary switches (tens + units).

A maximum of 99 C4-IR modules can be installed in a serial network, with node address selectable from “01” to “99” in standard mode in which each C4-IR identifies 4 zones with sequential node address starting with the code set on the rotary switches.

C4-IR modules have a Modbus serial (Serial 1) and, optionally (see order code) a Fieldbus serial (Serial 2) with one of the fol-lowing protocols: Modbus RTU, Profibus DP, CANopen, DeviceNet and Ethernet Modbus TCP.

The ModBus RTU port 1 has the following factory settings (default):

Parameter	Default	Range
Id	1	1...99
Baudrate	19.2KBIT/S	1,2...57.6KBIT /S
Parity	None	Odd/Even/None
Stopbits	1	-
Databits	8	-

The following procedures are indispensable for the Modbus protocol. For the other protocols, see the specific fieldbus datasheets.

The use of the rotary switches (A...F) letters is for particular procedures described in the following paragraphs.

Procedure	Positions of Rotary Switches		Description
	Tens	Units	
AutoBaud	0	0	Allows setting of the correct BaudRate value automatically detecting the master transmission frequency
AutoNode	A	0	Enables the transfer of the correct node (ID) address (tens) to eventual slave modules

Note: The AutoNode procedure is also required for Profibus DP, CANOpen, DeviceNet, Ethernet Modbus/TCP proto-cols. Check its correct address in the specific manuals in question.

12. Autobaud Function

12.1 Autobaud Port 1 Sequence

Function

Configures serial communications speed and parity of the C4-IR modules to the connected PLC, HMI, or PC. If a fieldbus card (port 2) is used then port 1 settings must remain at factory settings.

Note: Green LED L1 “STATUS” mentioned in the procedure can vary its behavior based on parameter Ld.1., which is set to a default value of 16.

Procedure

1. Connect the serial cables for all modules on the network to serial 1 and to the supervision terminal.
2. Set the rotary switch on the C4-IR modules to be installed, or on all modules present in case of first installation, to position “0+0”.
3. Check that the green “STATUS” LEDs flash at high frequency (10Hz).
4. The supervision terminal must transmit a series of generic “MODBUS” read messages to the network.
5. The procedure is over when all of the green L1 “STATUS” LEDs on the C4-IR models flash at a normal frequency (2Hz) (if parameter 197 Ld. 1 = 16 as default).

The new speed parameter is saved permanently in each C4-IR; therefore, the “AUTOBAUD SERIAL 1” sequence does not have to be run at subsequent power-ups.

Note: When the rotary switch is turned, the green “STATUS” LED stays on steadily for about 6 seconds, after which it resumes normal operation and saves the ad-dress.

12.2 AutoNode Port 1 Sequence

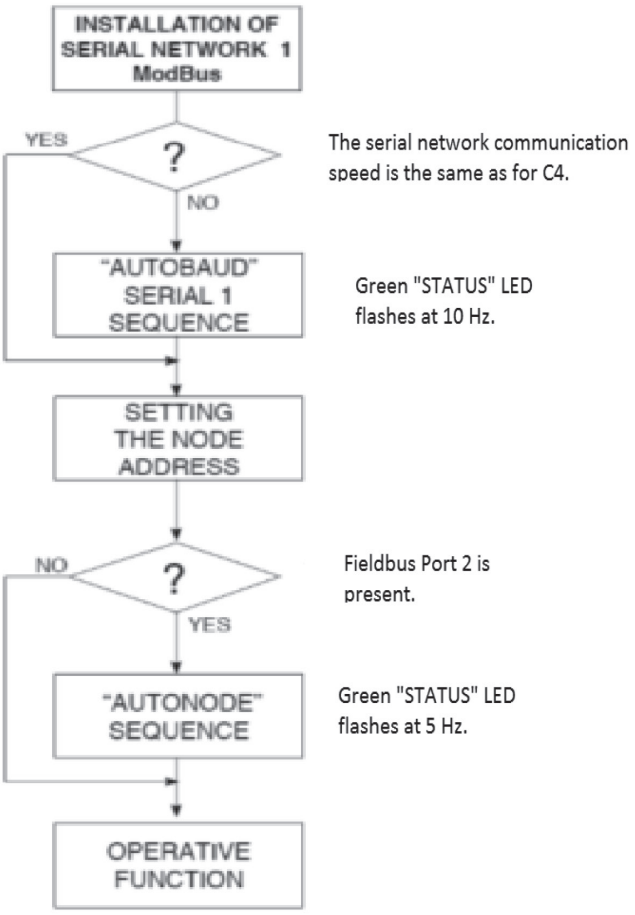
Function

Autonode should be run for all field bus installations.

Note: The L1 “STATUS” green LED mentioned in the proce-dure can vary its behavior according to the Ld.1 parameter which is 16 by default.

Procedure

1. Connect the serial cables to all the modules in the serial 1 network, disconnect supervision or C4-OP terminals.
2. Turn the rotary switches from the set node address to the position “A+0”.
3. Check that the “STATUS” green LED is blinking at an average frequency (5Hz) for 10 seconds and then that it returns to normal blinking (2Hz).
4. Turn the rotary switches in the position of the node



13. Specifications

INPUTS	
IN1, IN4 Analog Process Inputs	
Function	Acquisition of process variable
Max. Error	0,2% f.s. ± 1 scale point at room temperature of 25°C
Thermal drift	< 100 ppm/°C f.s.
Sampling time	120 ms
Thermocouple Tc (ITS90)	J,K,R,S,T (IEC 584-1 ,CEI EN 60584-1, 60584-2) Fault cold junction comp 0,1°/°C
Resistance thermometer RTD (ITS90)	Pt100 (DIN 43760) MMax line resistance 20ohm
Voltage	linear: 0, . .. ,60mV, Ri>1 Mohm 0, ... , 1V, Ri> 1 Mohm a 32 segment custom linearization can be inserted
Current	Linear: 0/4 ... 20mA, Ri =50ohm a 32 segment custom linearization can be inserted
IN5, ... ,1N8 Auxiliary Analog Inputs (option)	
Function	Acquisition of variables
Accuracy	1% f.s. + 1 scale point at room temperature of 25°C
Sampling time	480 ms
Thermocouple Tc (ITS90)	J,K,R,S,T (IEC 584-1, CEI EN 60584-1, 60584-2) Fault cold junction comp 0,1°/°C
Voltage	linear: 0, ... ,60mV, Ri>1 Mohm
IN9, ... IN12 Inputs Internal Current Transformers CT	
Function	Read internal CTs; (The acquisition of current values is valid for voltages in a range of 90 ... 530Vac)
Accuracy	1% f.s. ± 1 scale point at room temperature of 25°C
Sampling time	60 ms
DI1 ... DI2 Digital Inputs	
Function	Configurable (default: disabled)
Type	PNP, 24 VDC, 8mA 3500V isolation
OUTPUTS	
OUT1, ... , OUT4 Heat Control Outputs Connected Directly to Solid State Power Units	
Function	Configurable (default: heat control) Control state is displayed by LED (01 , . .. ,02)
OUT5, ... , OUT8 Cool Control Outputs (option)	
Function	Configurable (default: cool control)
Relay Type	3A NO Contact, 250V/30Vdc COSφ =1
Continuous Type	0/2 .. . 10V, (default) max 25mA protection against short circuit 0/4 . .. 20mA, max. load 500ohm 1500V isolation
Logic Type	24 Vdc, > 18V a 20mA
Triac Type	230V/max 4A AC51 (1 A for every channel)

OUT9, ... , OUT10 Alarms

Function	Configurable (default: alarms)
Relay Type	5A NO Contact, 250V/30Vdc COSφ =1

COMMUNICATIONS

PORT 1 (present)

Function	Local serial communication
Protocol	ModBus RTU
Baudrate	Settable to 1,2...57.6kbits/s, (default 19.2 kbit/s)
Address Node	Settable by rotary switch
Type	RS485 1500V isolation, double connector RJ10 telephone type 4-4

PORT 2 (Fieldbus Option)

Function	Fieldbus serial communication
Protocol	ModBus RTU, type RS485, baudrate 1,2...57.6 kbit/s CANOpen 10K….1Mbit/s DeviceNet 125K...0.5Mbit/s Profibus DP 9.6K...12 Mbit/s Ethernet Modbus TCP, Ethernet IP 10/100Mbps

POWER (SOLID STATE POWER UNITS, 4 UNITS)

Rated Voltage	480VAC		
Work Voltage	Range 90...530 Vac		
Non- repetitive Voltage	1200Vp		
Rated Frequency	50/60Hz Auto-Determination		
Nominal Current AC55b short wave infrared lamps	30KW 4 x 8A	60KW 4 x 16A	80KW 4 x 20A
	For applications in which you can set a minimum power output limit (ex: Lo.P = 10%) by also limiting the lamp power variation speed with gradient limit (ex: G.out = 20%, PS.TM = 20s). Under these conditions, the nominal currents shown on the table can be raised up to the values indicated for AC51 type loads.		
Rated Current AC6Aload transformer permitted trigger modes: ZC, BF with DOT (Delay Triggering), PA with softstart	30KW 4 x 12A	60KW 4 x 25A	80KW 4 x 32A
Non- Repetitive Overcurrent (t=20 msec)	400A	600A	1150A
I^2t For Fusion (t=1...10 msec)	645A's	1010A's	6600A's
Critical Dv/dt with output Deactivated	1000V/usec		
Rated Isolation Voltage	4000V		

FUNCTIONS

Safety	Detects short circuit or open probe circuit, probe, power supply failure, LBA alarm, HB alarm
Selection °C/°F	Configurable
Linear scale range	-1999 ... 9999
Control Actions	4 control loops: Double action (heat/cool) PID, on-off Self-tuning at power-up, Continuous Autotuning, One-shot Autotuning
pb-dt-it	0.0 ... 999.9 % - 0.00 ... 99.99 min - 0.00 ... 99.99 min
Action - Control Outputs	heat/cool - ON/OFF, PWM, GTT

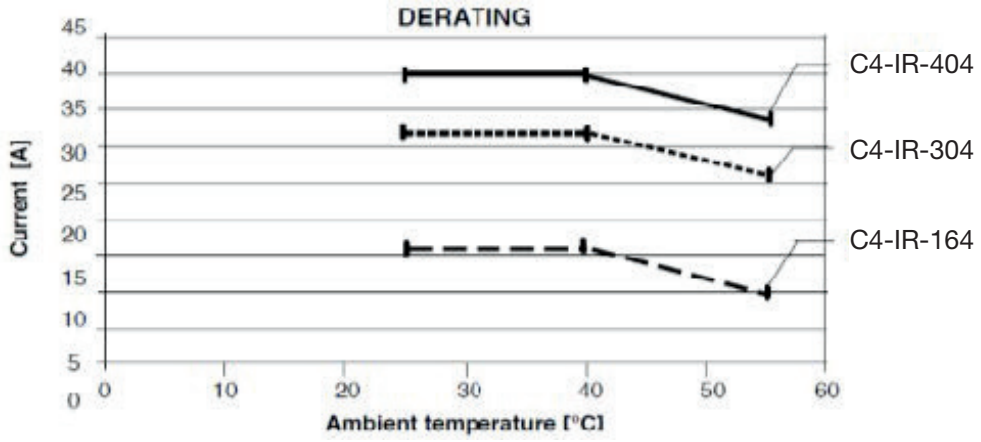
Heat/Cool Max. Power Limitation	0.0 ... 100.0%
Fault Power Setting	-100.0 ... 100.0%
Shut-Down Function	Maintains sampling of PV; maintains control off
Configurable Alarms	Alarm is assigned to an output, configurable as: maximum, minimum, symmetrical, absolute/deviation, LBA, HB
Alarm Masking	Exclusion at power-up, latch, reset by digital input

OPTIONS	
Options	- Timed Softstart firing ramp, with or without peak current control - Softstart firing ramp, specific for infrared lamps - Timed shut-off ramp - Limitation of RMS current in load - 0 to 90˚ Delay-Triggering for firing inductive loads in ZC and BF mode
Diagnostic	- SCR in short circuit (presence of current with OFF control) - No Voltage - No current due to open SCR/Interrupted load - Overheat alarm **Current Read** - HB alarm interrupted or partially interrupted load - Automatic calibration of HB alarm setpoint starting from current value in load - Alarm for load in short circuit or overcurrent **Voltage Read** - 3-Phase line imbalanced - Incorrect phase rotation in configuration of 3-phase load
Type of correction and load selection via dip-switches	4 single-phase loads 3 independent single-phase loads open delta 1 3-phase load open delta 1 3-phase load closed delta 1 3-phase load star with neutral 1 3-phase load star without neutral

GENERAL DATA	
Power Supply	24VDC +/-25%, max 8VA Class II
Indicators	Eight LEDS: RN CPU in run state ER Error Signal DI1, DI2 state of digital inputs O1,...O4 state SCR control
Protection	IP20
Work/Storage Temperature	0 - 50˚C (see dissipation curves) / -20˚C...70˚C
Relative Humidity	20 - 85% RH non-condensing
Ambient Work Conditions	Indoor use, altitude up to 2000m
Installation	DIN RAIL EN50022 or panel using screws
Installation requirements	Installation category II, Pollution level 2, double isolation Max surrounding air temperature 50˚C (for UL) Open type equipment
Weight(s)	
Models 30KW, 60KW, 80KW	1200g
Models 30KW, 60KW, with fuse holder	1600g

VOLTAGE/CURRENT CONSIDERATIONS						
C4-IR	Current (Amp)	Voltage (VAC)			Power (kW)	
	Max. Per Channel	Range	Nominal	Working	Per Channel	Controller Total
164 (4x16A)	16	90 - 530	480	120	1.9	7.7
				208	3.3	13.3
				240	3.8	15.4
				277	4.4	17.7
				400	6.4	25.6
				480	7.7	30.7
304 (4x30A)	30			120	3.6	14.4
				208	6.2	25.0
				240	7.2	28.8
				277	8.3	33.2
				400	12.0	48.0
				480	14.4	57.6
404 (4x40A)	40			120	4.8	19.2
				208	8.3	33.3
				240	9.6	38.4
				277	11.1	44.3
				400	16.0	64.0
				480	19.2	76.8

DISSIPATING CURVES



14. Ordering Information

Model	C4-IR Solid State Relay Power Controller
C4-IR	The C4-IR Series Multiple Zone SCR Power Controller manages both single phase and 3-phase industrial heating load applications which require zero cross or phase angle firing modes. Load management options include: Up to 4 independently controlled single phase loads or one 3-phase/2-Leg load or one 3-phase/3-leg load (with or without an additional single phase load). Load currents range from 16 to 40 Amps per zone at 110 to 480 Vac. Standard features: Four universal main process inputs, two digital inputs, two configurable alarm outputs, four internal Current Transformers, Modbus RTU/RS485 digital communications, LED output indication, DIN Rail/Panel mountable. Optional features: Four analog inputs, integral fuse holder, four configurable outputs, several Fieldbus Communication protocols. Approvals: CE, cULus

Code	Current Per Loop @ 40°C (104°F) Ambient, continuous service (110 Vac to 480 Vac)
164	16 Amps/Loop
304	30 Amps/Loop
404	40 Amps/Loop

Code	Auxiliary Outputs
0	None
R	Relay
D	Logic
A	Analog
T	Triac

Code	Auxiliary Inputs
0	None
4	4 Linear Inputs

Code	Fusing
0	None
F	Fuse holder & Extra rapid fuses (See Note 2)

Code	Second Fieldbus Option
00	None
MR	Modbus RTU (RS485)
ET	Modbus TCP/Ethernet
ER	Ethernet IP, Real Time[1]
PB	Profibus DP
PN	ProfiNET[1]
EC	EtherCAT[1]
CN	CANopen
DN	DeviceNet
EM	Euromap 66

C4-IR-	304	D	4 -	F	00	Typical Model Number

[1]Not available with EC, PN & ER Fieldbus Codes.
[2]Not available with 404 Current Code

Accessories

Description	PCN
Communication Cable, USB to RS485	309180
Connection Cable For Serial Modbus (RJ10)	307096
C4-OP Operator Terminal w/ Connection Cable (0.2m)	307117
C4-OP 24VDC 12W Stabilized Power Supply w/ Adapter	0081-10091

15. Configuration and Programming

15.1 C-PWR Configuration Software Program

See C-PWR Configuration Software Program instruction manual for proper program installation.

15.2 C4/C4X/C4-IR Programming Manual

See C4/C4X/C4-IR Programming Manual for complete controller set-up of communications, inputs, outputs, alarms and control modes.

16. Accessories

16.1 Fuses and Fuse Holders

C4-IR Model	I^2T Extra Rapid Fuses						Fuse Holder	
	Fuse Rating, Amps	I^2T	Power Dissipation	Fuse Size	Manufacturer's Model Code	Part No.	Part No.	Fuse Holder Rating (UL)
C4-IR-164	16A	645A^2s	3.5W	10x38	FUS-016	0024-07824	0024-12124	30A@600V
C4-IR-304	30A	1010A^2s	4.8W	10x38	FUS-030	0024-07825	0024-12124	30A@600V

16.2 Fieldbus Cards

Fieldbus Type	Part No.	Model No. (Fieldbus Card)	Manufacturer's Model Code	Description
Modbus RTU	0149-50103	C4-MOD	F032357	Card for Modbus RTU protocol (serial 2)
Profibus DP	0149-50104	C4-PROFI	F032358	Card for Profibus DP protocol (serial 2)
CANopen	0149-50105	C4-CAN	F032359	Card for CANopen protocol (serial 2)
DeviceNet	0149-50106	C4-DNET	F032360	Card for DeviceNet protocol (serial 2)
Modbus TCP/IP	0149-50107	C4-ETH	F033532	Card for Ethernet Modbus TCP protocol (serial 2)
EtherCat	0149-50108	C4-ETH2	F049411	Card for EtherCat protocol (serial 2)
Profinet	0149-50109	C4-ETH4	F054949	Card for Profinet protocol (serial 2)
Ethernet IP (Real-Time)	0149-50110	C4-ETH5	F058234	Card for Real Time Ethernet/IP protocol

Additional Spare Parts

Part No.	Manufacturer's Model Code	Description
0149-50099	F032861	Connection cable for serial Modbus (RJ10) 0.3M
0149-50100	F032862	Connection cable for serial Modbus (RJ10) 1M
0149-50101	F032863	Connection cable for serial Modbus (RJ10) 2M
0149-50102	F032864	Connection cable for serial Modbus (RJ10) 5M
0149-50111	VEN-61	Fan (flow 39m3/h) for C4-164
0149-50112	VEN-62	Fan (flow 56m3/h) for C4-304 and C4-404
0149-50113	GRI-4	Grill fan for C4
0149-50114	FLT-4	Filter for fan
0149-50115	COUT4-9	9-Terminal Connector (J1) For C4 Controller
0149-50116	COUT4-4	4-Terminal Connector (J1a) For C4 Controller
0149-50117	CSIG4-7	7-Terminal Connector (J2) For C4 Controller
0149-50118	CSIG4-12	12-Terminal Connector (J4) For C4 Controller

0149-50119	CSIG4-4	4-Terminal Connector (J3a) For C4 Controller

16.3 Configuration Software and Cabling

Configuration kit for C4-IR product line by means of PC with USB (Windows environment). Software is compatible with all C4-IR models. Download free at www.Chromalox.com

- Allows you to read and write all of the parameters of a single C4-IR device
- Easy and rapid configuration
- Saving and management of parameter recipes
- On-line trend and saving of historical data

Description	Part No.
Communication Cable, USB to TTL	309171
Communication Cable, USB to RS485	309180

16.4 C4-OP

Operator terminal for in-field configuration of the entire C4-IR product line.

Two types of terminals: - for installation on DIN guide
- for panel installation

See C4-OP Hardware Manual for more details.

Limited Warranty:
Please refer to the Chromalox limited warranty applicable to this product at http://www.chromalox.com/customer-service/policies/termsofsale.aspx.

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