MVR-200 series

4189341219E

Medium Voltage Relay

Installation instructions

DEIF Improve Tomorrow

1. Introduction

1.1 About the Installation instructions

1.1.1 Intended users of the Installation instructions

These are the Installation instructions for DEIF's Medium Voltage Relay MVR-200. The Installation instructions describes the MVR hardware, and applications, connections and wiring. The Installation instructions are primarily for the person who creates the electrical drawings for the MVR-200 installation.

More information
See the **Data sheet** for the functions supported by each controller, as well as all the technical specifications.

More information
See the **Designer's handbook** for detailed function information and descriptions.

DANGER!

High voltages and currents

Incorrect design can result in human injury or damage to the equipment

Read this manual before designing the system.

1.1.2 Abbreviations

CB – Circuit breaker

CBFP – Circuit breaker failure protection

CT – Current transformer

CPU – Central processing unit

EMC – Electromagnetic compatibility

HMI – Human machine interface

HW – Hardware

IED – Intelligent electronic device

IO – Input output

LED – Light emitting diode

LV – Low voltage

MV – Medium voltage

NC – Normally closed

NO – Normally open

RMS – Root mean square

SF – System failure

TMS – Time multiplier setting

TRMS – True root mean square

VAC – Voltage alternating current

VDC – Voltage direct current

SW – Software

uP - Microprocessor

1.1.3 Technical support

You can read about service and support options on the DEIF website, www.deif.com. You can also find contact details on the DEIF website.

You have the following options if you need technical support:

- Help: The display unit includes context-sensitive help.
- Technical documentation: Download all the product technical documentation from the DEIF website: www.deif.com/documentation
- Training: DEIF regularly offers training courses at the DEIF offices worldwide.
- Support: DEIF offers 24-hour support. See www.deif.com for contact details. There may be a DEIF subsidiary located near you. You can also e-mail support@deif.com.
- Service: DEIF engineers can help with design, commissioning, operating and optimisation.

1.2 Warnings and safety

1.2.1 Warnings

DANGER!

Electrical shock and arc flash

Risk of burns and electrical shock from high voltage.

Short all current transformer secondaries before breaking any current transformer connections to the controller.

WARNING

Electrical shock

Hazardous live currents and voltages.

Do not touch any terminals, especially the AC measurement inputs and the relay terminals. Only skilled personnel, who understand the risks involved in working with electrical equipment, may do the installation. Comply with local regulations.

WARNING

Electrical shock

Unintended breaker closing can cause a dangerous situation.

Disconnect or disable the breakers before connecting the controller power supply. Do not enable the breakers until after the wiring and controller operation are thoroughly tested.

Read the documentation

Before commissioning or maintenance, read the installation instructions and operating instructions, and check the equipment ratings.

For the hazards marked on the equipment, read the documentation to find out about the potential hazards and actions to avoid them.

System safety responsibility

The safety of the system that includes the equipment is the responsibility of the assembler of the system.

Check before working

Check the integrity of any protective conductor connections before carrying out any other actions.

Electrostatic discharge

You must protect the equipment terminals from electrostatic discharge when not installed in a grounded rack. Electrostatic discharge can damage the terminals.

Data security

To minimise the risk of data security breaches DEIF recommends:

- As far as possible, avoid exposing controllers and controller networks to public networks and the Internet.
- Use additional security layers like a VPN for remote access, and install firewall mechanisms.
- Restrict access to authorised persons.

1.3 Legal information

1.3.1 Disclaimer

DEIF A/S reserves the right to change any of the contents of this document without prior notice.

The English version of this document always contains the most recent and up-to-date information about the product. DEIF does not take responsibility for the accuracy of translations, and translations might not be updated at the same time as the English document. If there is a discrepancy, the English version prevails.

1.3.2 Copyright

2. Installation

2.1 Mounting requirements

2.1.1 Mounting

Ventilation requirement: For use on a flat surface of type 1 enclosure.

2.2 Space requirements

2.2.1 MVR-21x

Installation dimensioning

IED can be installed either to a standard 19” rack or cut-out to a switchgear panel (Installation type of the device has to be defined by ordering option). When installing to rack, the device will take ¼ of the rack width and total of four devices can be installed to same rack in parallel. Device panel installation and cut-outs are described below.

Figure 2.1 Dimensions of the IED.

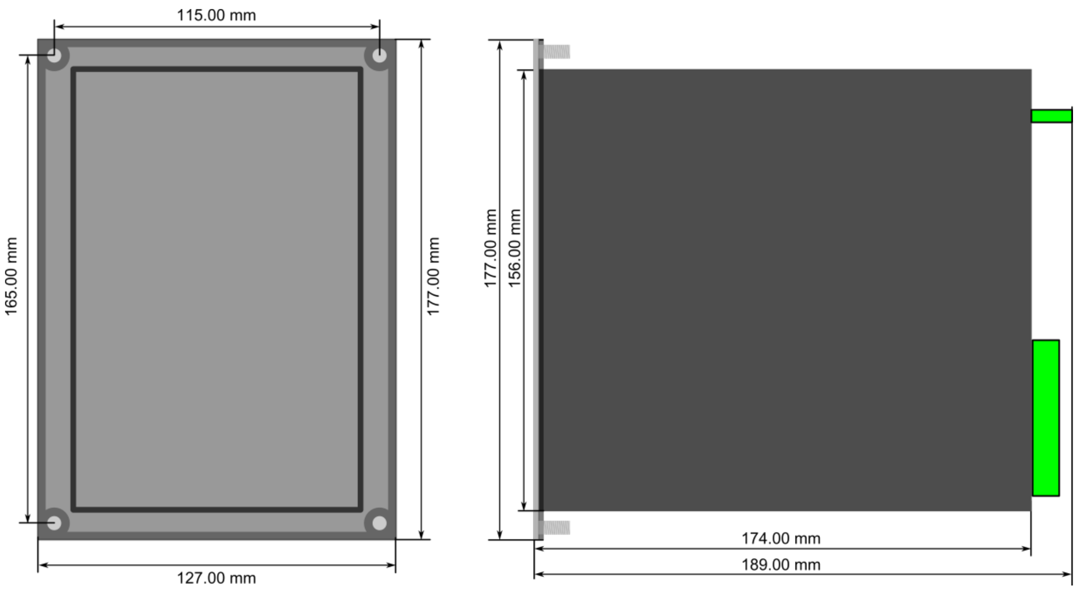


Figure 2.2 Installation of the IED

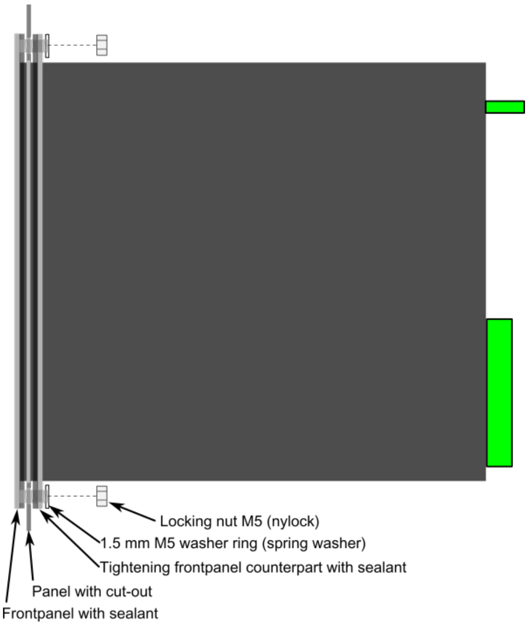
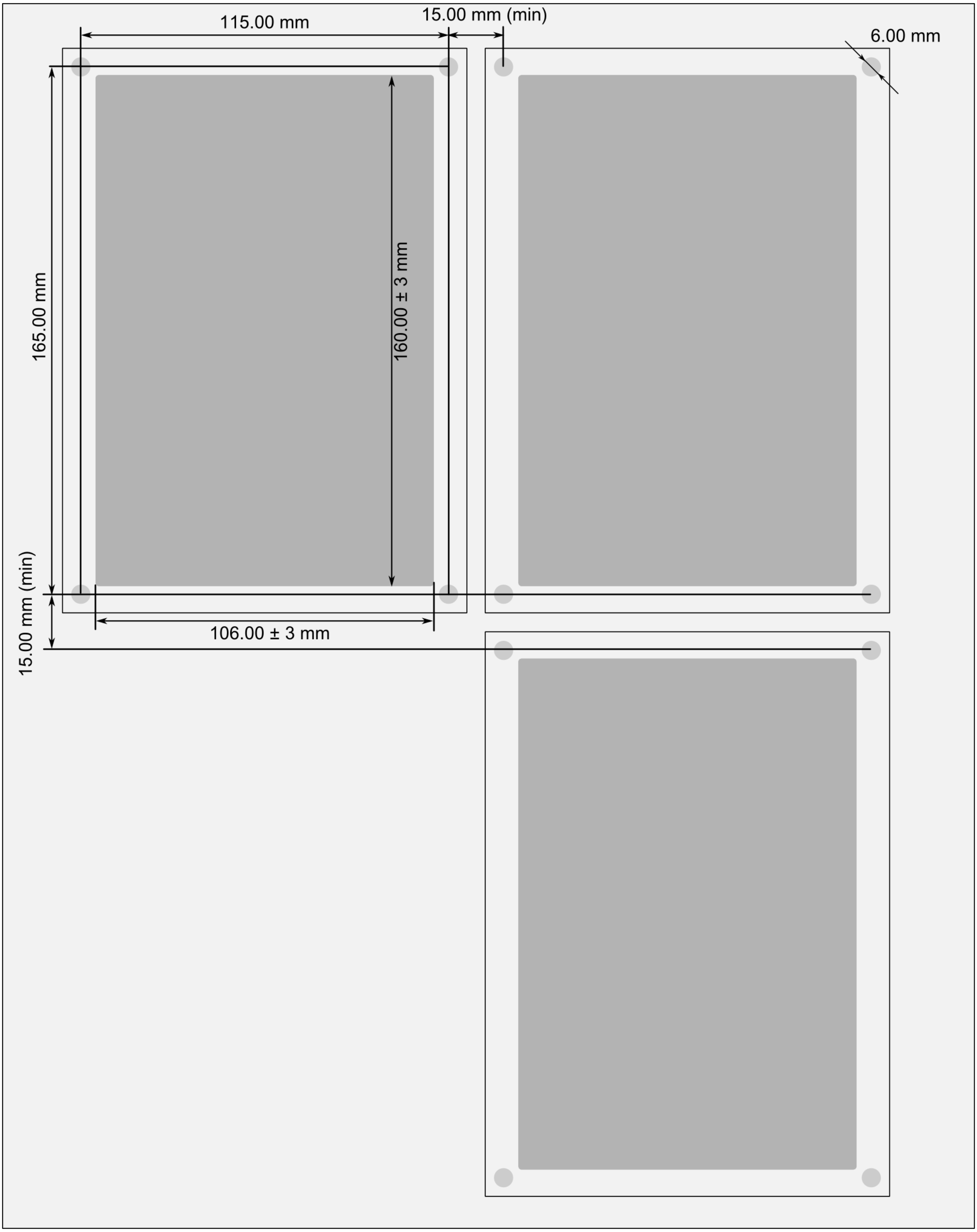


Figure 2.3 Panel cut-out and spacing of the IED.



2.2.2 MVR-25x

Installation dimensioning

IED can be installed either to a standard 19” rack or cut-out to a switchgear panel (Installation type of the device has to be defined by ordering option). When installing to a rack, the device will take ½ of the rack width and total of two devices can be installed to same rack in parallel. Device panel installation and cut-outs are described below.

Figure 2.4 Dimensions of the IED.

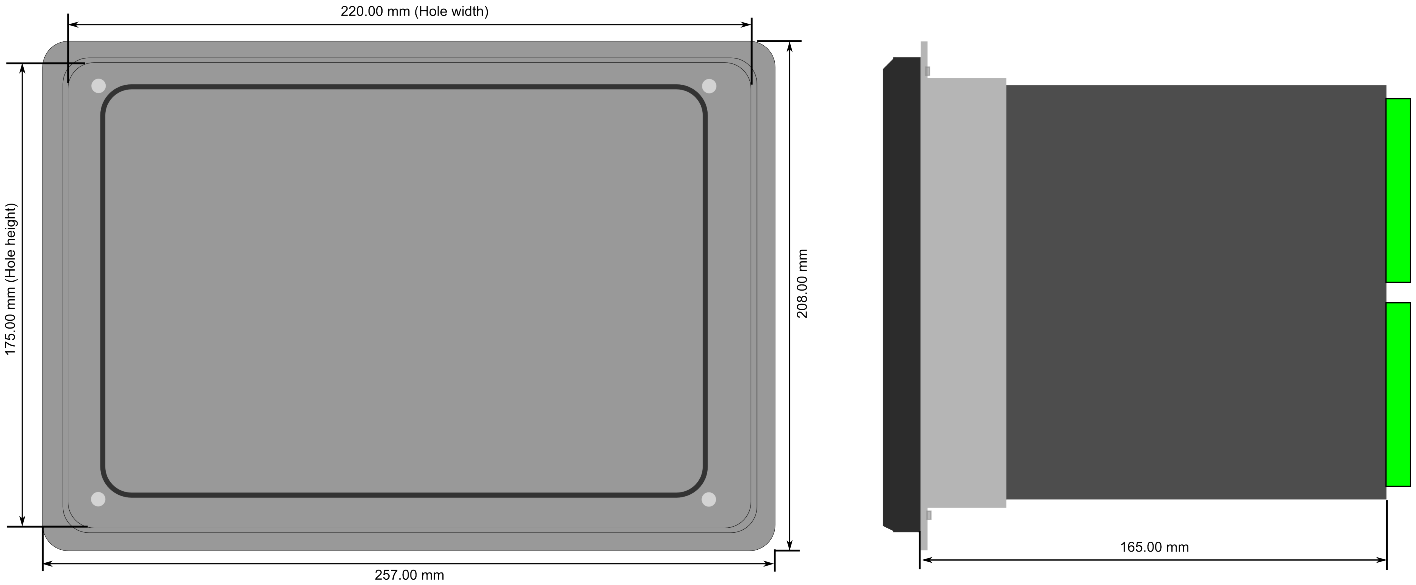


Figure 2.5 Installation of the IED

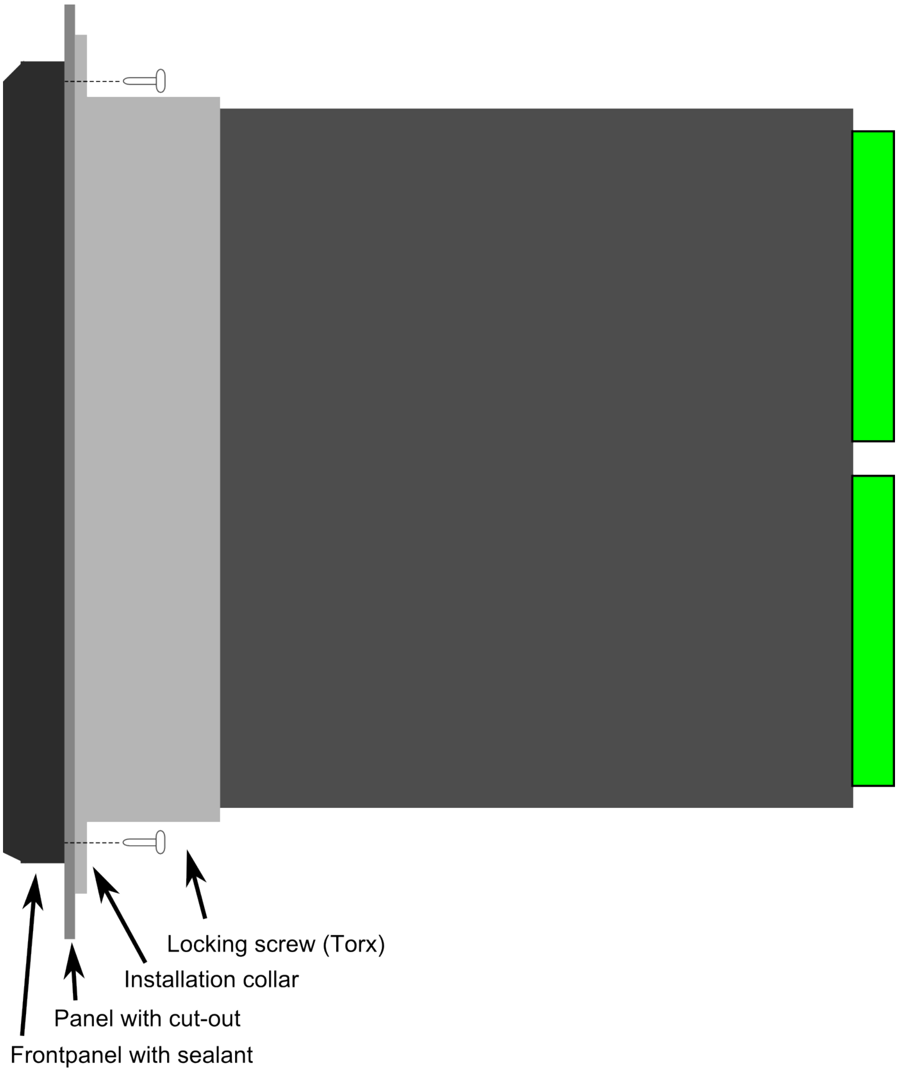
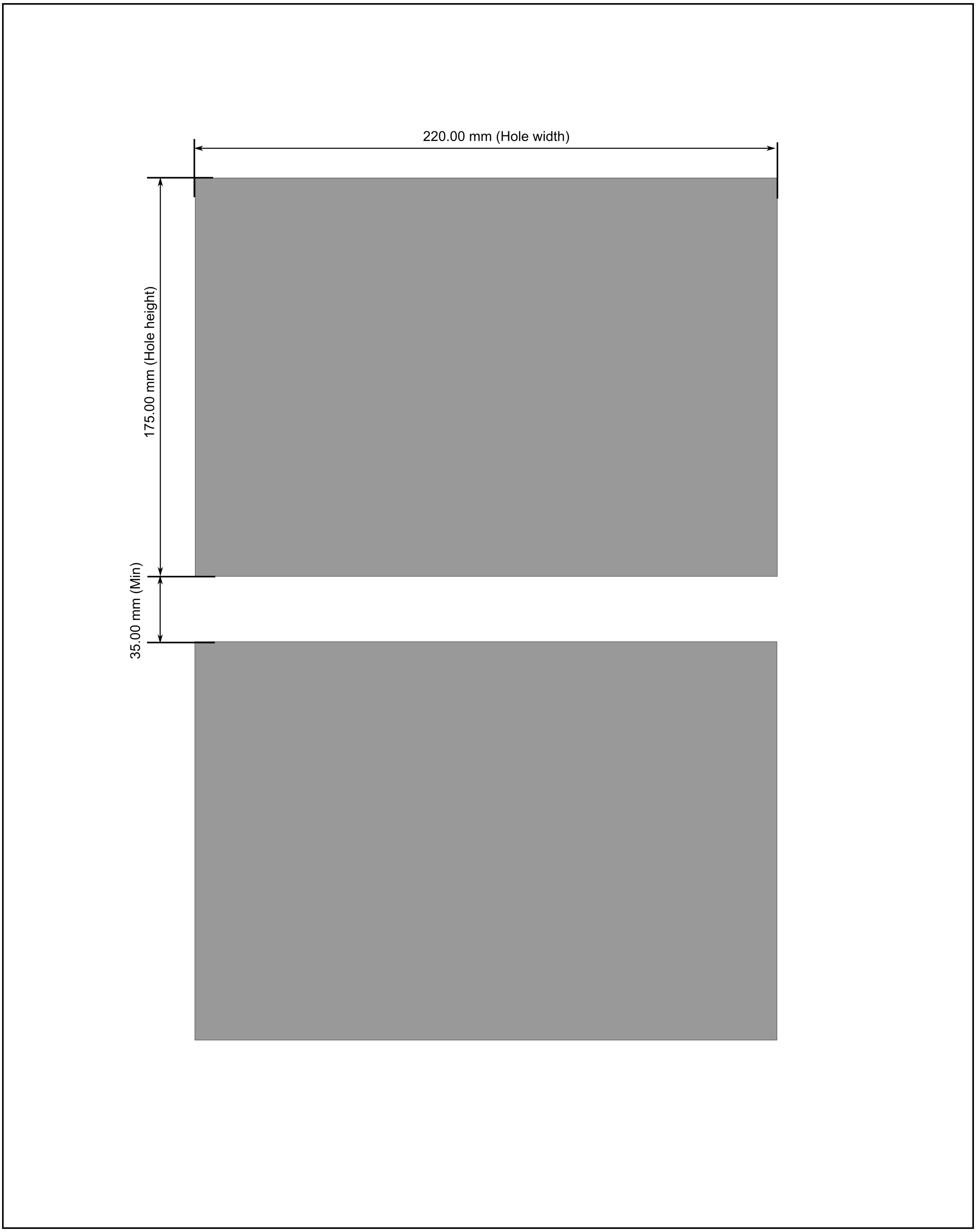


Figure 2.6 Panel cut-out and spacing of the IED.



2.3 Wiring requirements

2.3.1 Wiring

Terminal blocks

Only use the terminal blocks supplied. Do not use substitutes.

Accessories

Only use accessories that meet DEIF's specifications.

Terminal tightening torque

Use the recommended tightening torque (0.5 to 0.6 N·m) for tightening the wiring in each terminal.

2.3.2 Connecting the protective earth

Connect the protective earth.
Do not remove protective earth connections when the equipment is energised.

To connect the protective earth:

1. Use a grounding cable with a minimum wire size of 2.5 mm^2.
2. Bond the grounding cable to the earth according to local regulations.
3. Test the grounding cable bond.
4. Place the grounding hoop on the grounding terminal at the back of the MVR.
5. Tighten the grounding terminal screw to 0.5 to 0.6 N·m of torque.

2.3.3 Connecting the supply

Reliable power supply

To meet marine class society requirement, the MVR must have a reliable power supply, which must include a backup power supply. In addition, the switchboard design must ensure that the system is sufficiently protected if the MVR power supply fails.

No protection when unpowered

If the MVR has no power supply:

- The MVR is OFF and does not provide any protection.
- The MVR cannot enforce any trips, shutdowns or latches.
- All the MVR relays de-energise.

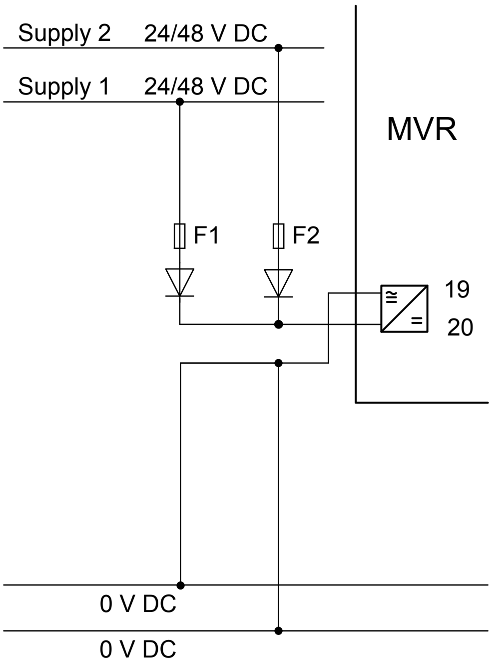
Supply specifications

See the **Data sheet**.

Supply wiring

The supply is connected to the *CPU, IO and Power supply module*. The wiring will depend on whether the source is low DC (model L) or high AC/DC (model H).

An example for supply wiring for a low DC source (model L), including backup, is given below.



DEIF recommends using a 4 A slow blow fuse for F1 and F2.

DEIF recommends that the diodes are rated 100 V or higher.

2.3.4 Connecting the voltage measurements

DEIF recommends using a 2 A slow blow fuse on each voltage measurement line. Install the fuse as close to the voltage transformer as possible.

2.3.5 Connecting the output relays

Do not exceed the maximum current rating for the module by connecting too many output relays to the MVR.

For example, for *Option card C*, the output relays can draw a maximum of 3A at 220 V AC, or 0.2 A at 220 V DC. The *PSU card* has the same restriction.

3. Hardware modules

3.1 MVR-21x

3.1.1 CPU, IO and Power supply module

Figure 3.1 Main processor module CPU, IO, communications and PSU.

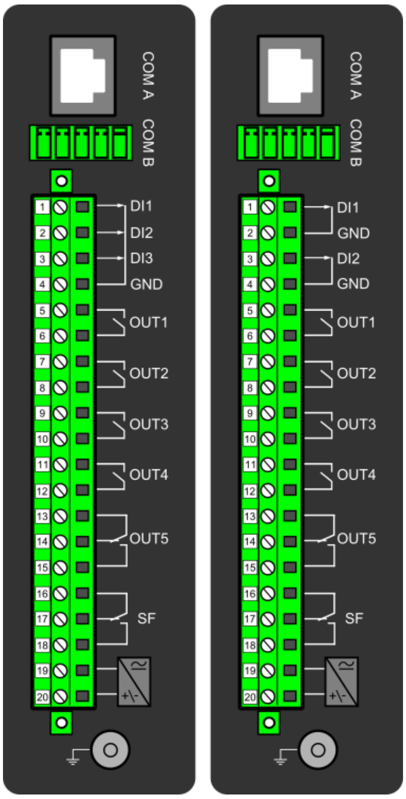


Table 3.1 CPU, IO and Power supply module connector descriptions

Connector	Description	
COM A:	Communication port A, RJ-45. For MVR Utility Software connection, IEC61850, Modbus TCP, IEC104, DNP TCP and station bus communications.	
COM B:	Communication port B, RS-485. For Modbus RTU, Modbus IO, SPA, DNP3, IEC101 and IEC103 SCADA communications. Pin-out starting from the left: 1=DATA +, 2=DATA -, 3=GND, 4&5=Terminator resistor enabled by shorting.	
	3 digital input model	**2 digital input model**
X 1	Digital input 1, nom. threshold voltage 24 V, 110 V or 220 V	Digital input 1, nom. threshold voltage 24 V, 110 V or 220 V
X 2	Digital input 2, nom. threshold voltage 24 V, 110 V or 220 V	Digital input 1 ground.
X 3	Digital input 3, nom. threshold voltage 24 V, 110 V or 220 V	Digital input 2, nom. threshold voltage 24 V, 110 V or 220 V
X 4	Digital inputs 1, 2 and 3 common ground.	Digital input 2 ground.
X 5:6	Output relay 1, Normally open contact	
X 7:8	Output relay 2, Normally open contact	
X 9:10	Output relay 3, Normally open contact	

Connector	Description
X 11:12	Output relay 4, Normally open contact
X 13:14:15	Output relay 5, Changeover contact
X 16:17:18	System Fault output relay, changeover contact. 16 & 17 are closed when unit has a system fault or is powered off. 16 & 18 are closed when unit is powered on and no system fault is present.
X 19:20	Power supply in, Either 100 – 125 V DC, +20/-10 % (model H) or 24/48 V DC, +30/-25 % (model L), **Positive side** (+) **to pin X1:20**
GND	Relay grounding connector

By default, the MVR-2xx IED platform combination CPU, IO and Power supply module is included in the MVR-2xx IED which includes two standard communication ports and basic binary IO of the relay. Module can be ordered either with 2 or 3 digital inputs included.

- Binary inputs current consumption is 2 mA when activated and the operating voltage range is 24 V/110 V/220 V depending on ordered hardware. All binary inputs are scanned in 5 ms program cycle and have software settable pick-up and release delay and software settable NO/NC (normally open/-closed) selection.
- Binary outputs controls are user settable. As standard binary outputs are controlled in 5 ms program cycle. All output contacts are mechanical type. Rated voltage of the NO/NC outputs is 250 V AC/DC.

Auxiliary voltage shall be defined in the ordering code of the device, either H (100-125 V DC, +20/-10 %) or L (24/48 V DC, +30/-25 %) model power supplies are available. For further details refer to the “Technical data” section of this document.

Settings and scanning cycle of binary inputs

Table 3.2 CPU card binary input settings

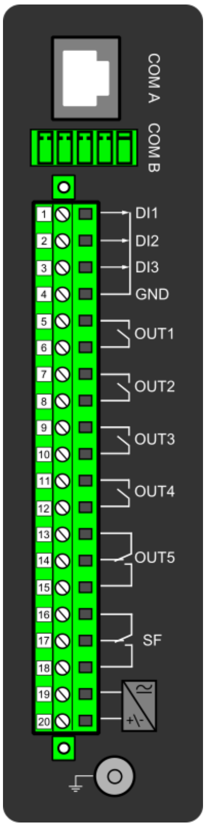
Name	Description	Range	Step	Default
DIx Polarity	Defines if binary input status is 1 or 0 when the input is energized	0:NO (Normally open) 1:NC (Normally closed)	-	0:NO
DIx Activation delay	Defines the delay for status change from 0 to 1	0.000...1800.000 s	0.001 s	0.000 s
DIx Drop-off time	Defines the delay for status change from 1 to 0	0.000...1800.000 s	0.001 s	0.000 s
DIx AC Mode	Adds 30 ms deactivation delay to account for alternating current.	0:Disabled 1:Enabled	-	0:Disabled

Binary inputs are scanned in 5 millisecond cycle. This makes the state of input to be updated between 0...5 milliseconds. When input is used internally in IED (group change or logic) it takes additional 0...5 milliseconds to operate. So in theory when binary input is used for group control or similar it takes 0...10 milliseconds to change the group. In practice the delay is between 2...8 milliseconds about 95 % of the time. In case the binary input is connected directly to binary output (T1...Tx) it takes additional third 5 millisecond round. When binary input is controlling internally binary output it takes 0...15 milliseconds in theory and 2...13 milliseconds in practice. This delay excludes the mechanical delay of the relay.

3.2 MVR-25x

3.2.1 CPU, IO and Power supply module

Figure 3.2 Main processor module CPU, IO, communications and PSU with 3 digital inputs.



Connector	Description
COM A:	Communication port A, RJ-45. For Modbus TCP and station bus communications.
COM B:	Communication port B, RS-485. For Modbus RTU and IEC-103 SCADA communications. Pin-out starting from the left: 1=DATA +, 2=DATA -, 3=GND, 4&5=Terminator resistor enabled by shorting.
X1-1	Digital input 1, nominal threshold voltage 24 V, 110 V or 220 V
X1-2	Digital input 2, nominal threshold voltage 24 V, 110 V or 220 V
X1-3	Digital input 3, nominal threshold voltage 24 V, 110 V or 220 V
X1-4	Digital input Common Ground

Connector	Description
X1-5:6	Output relay 1, Normally open contact
X1-7:8	Output relay 2, Normally open contact
X1-9:10	Output relay 3, Normally open contact
X1-11:12	Output relay 4, Normally open contact
X1-13:14:15	Output relay 5, Changeover contact
X1-16:17:18	System Fault output relay, Changeover contact
X1-19:20	Power supply in, Either 100-125 V DC, +20/-10 % (model H) or 24/48 V DC, +30/-25 % (model L), Positive side (+) to pin X1:20
GND	Relay grounding connector

By default combination CPU, IO and Power supply module is included in the IED which includes two standard communication ports and basic binary IO of the relay.

- Binary inputs current consumption is 2 mA when activated and the operating voltage range is 24 V/110 V/220 V depending on ordered hardware. All binary inputs are scanned in 5 ms program cycle and have software settable pick-up and release delay and software settable NO/NC (normally open/-closed) selection.
- Binary outputs control is settable from the software. As standard binary outputs are controlled in 5 ms program cycle. All output contacts are mechanical type. Rated voltage of the NO/CO outputs is 250 V AC/DC.

Auxiliary voltage shall be defined in the ordering code of the device, either H (100-125 V DC, +20/-10 %) or L (24/48 V DC, +30/-25 %) model power supplies are available. Power supply minimum allowed bridging time for all voltage levels is > 150 ms. Power supply maximum power consumption is 15 W max. Power supply allows DC ripple of <15 % and start-up time of power supply is < 5ms. Further details refer to the “Technical data” section of this document.

Settings and scanning cycle of digital inputs

Table 3.3 CPU card binary input settings

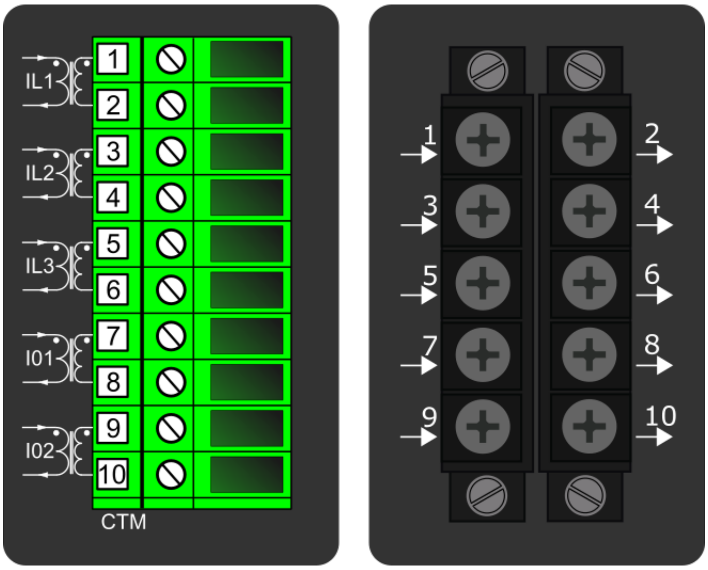
Name	Description	Range	Step	Default
DIx Polarity	Defines if binary input status is 1 or 0 when the input is energized	0:NO (Normally open) 1:NC (Normally closed)	-	0:NO
DIx Activation delay	Defines the delay for status change from 0 to 1	0.000...1800.000 s	0.001 s	0.000 s
DIx Drop-off time	Defines the delay for status change from 1 to 0	0.000...1800.000 s	0.001 s	0.000 s
DIx AC Mode	Adds 30 ms deactivation delay to account for alternating current.	0:Disabled 1:Enabled	-	0:Disabled

Binary inputs are scanned in 5 millisecond cycle. This makes the state of input to be updated between 0...5 milliseconds. When input is used internally in IED (group change or logic) it takes additional 0...5 milliseconds to operate. So in theory when binary input is used for group control or similar it takes 0...10 milliseconds to change the group. In practice the delay is between 2...8 milliseconds about 95 % of the time. In case the binary input is connected directly to binary output (T1...Tx) it takes additional third 5 millisecond round. When binary input is controlling internally binary output it takes 0...15 milliseconds in theory and 2...13 milliseconds in practice. This delay excludes the mechanical delay of the relay.

3.3 MVR-21x and MVR-25x

3.3.1 Current measurement module

Figure 3.3 Current measurement module connections with standard and ring lug terminals.



Connector	Description
CTM 1-2	Phase current measurement for phase L1 (A)
CTM 3-4	Phase current measurement for phase L2 (B)
CTM 5-6	Phase current measurement for phase L3 (C)
CTM 7-8	Coarse residual current measurement I01
CTM 9-10	Fine residual current measurement I02

Basic five channel current measure module includes three phase current measurement inputs and coarse and fine residual current inputs. CT module is available with either standard or ring lug connectors.

Current measurement module is connected to secondary side of conventional current transformers (CTs). Nominal dimensioning current for the phase current inputs is 5 A. Input nominal current can be scaled for secondary currents of 1...10

A. Secondary currents are calibrated to nominal currents of 1A and 5A which provide ± 0.2% inaccuracy in range of 0,05 x In – In – 4 x In.

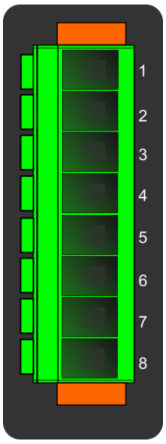
Phase current input characteristics are as follows:

- Measurement range
    - Phase currents 0...250 ARMS
    - Coarse residual current 0...150ARMS
    - Fine residual current 0...75ARMS
- Angle measurement accuracy less than ± 0.5 degrees with nominal current.
- Frequency measurement range of the phase current inputs is in range from 6 Hz to 1800 Hz with standard hardware.
- Quantization of the measurement signal is applied with 18 bit AD converters and the sample rate of the signal shall be 64 samples / power cycle in system frequency range of 6 Hz to 75 Hz.

For further details refer to the "Technical data" section of this document.

3.3.2 Voltage measurement module

Figure 3.4 Voltage measurement module



Connector	**Description**
VTM 1-2	Configurable voltage measurement input U1
VTM 3-4	Configurable voltage measurement input U2
VTM 5-6	Configurable voltage measurement input U3
VTM 7-8	Configurable voltage measurement input U4

Basic four channel voltage measurement module includes four freely configurable voltage measurement inputs.

Voltage measurement module is connected to secondary side of conventional voltage transformers (VTs) or directly to low voltage systems secured by fuses. Nominal dimensioning voltage can be 100...400 V. Voltages are calibrated in range of 0... 240 V which provide ± 0.2% inaccuracy in same range.

Voltage input characteristics are as follows:

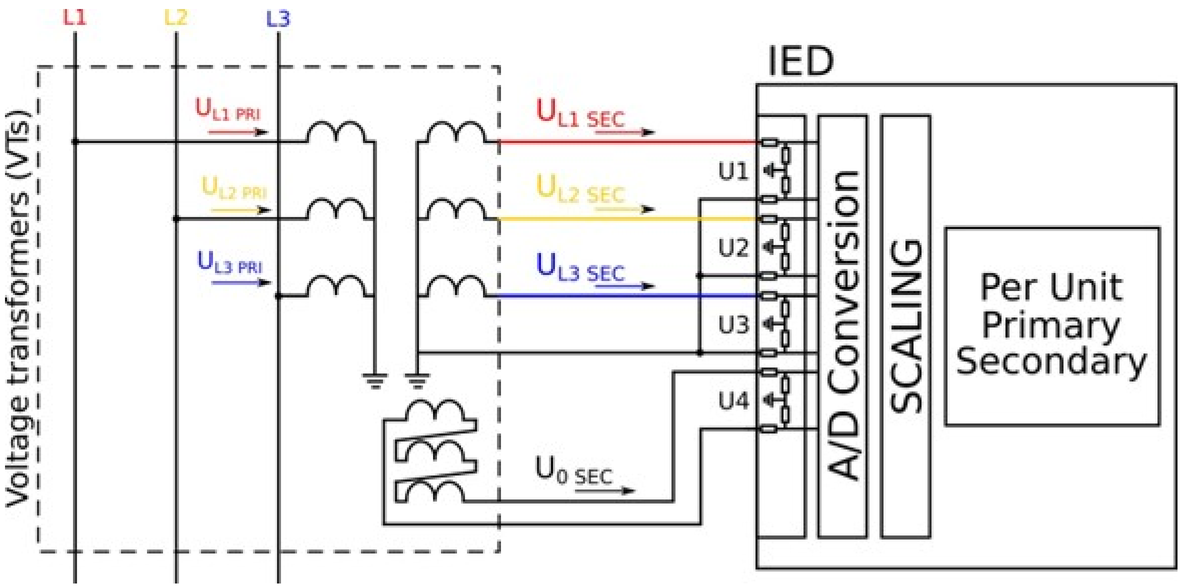
- Measurement range
    - Per channel 0...480 V
- Angle measurement accuracy less than ± 0.5 degrees within nominal range.
- Frequency measurement range of the voltage inputs is in range from 6 Hz to 1800 Hz with standard hardware.
- Quantization of the measurement signal is applied with 18-bit AD converters and the sample rate of the signal shall be 64 samples / power cycle in system frequency range of 6 Hz to 75 Hz.

For further details refer to the “Technical data” section of this document.

Voltage measurement input configurations

It is essential to understand the concept of voltage measurements to be able to get correct measurements. The following will show some examples of the possible configurations.

Figure 3.5 Terminologies



PRI: The primary voltage, that is, the voltage in the primary circuit which is connected to the primary side of the voltage transformer.

SEC: The secondary voltage, that is, the voltage which the voltage transformer transforms according to the ratio. This voltage is measured by the protection relay.

For the measurements to be correct the user needs to ensure that the measurement signals are connected to the correct inputs, that the voltage direction correct, and that the scaling is set correctly.

Figure 3.6 3 LN + U4 configuration

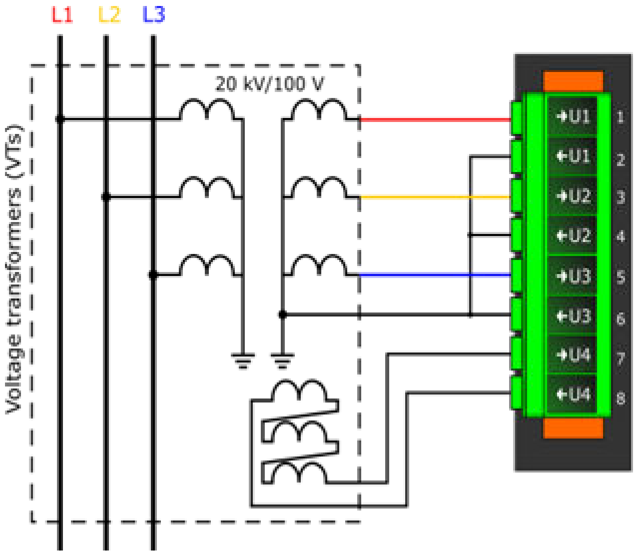


Figure 3.7 3 LL + U4 configuration

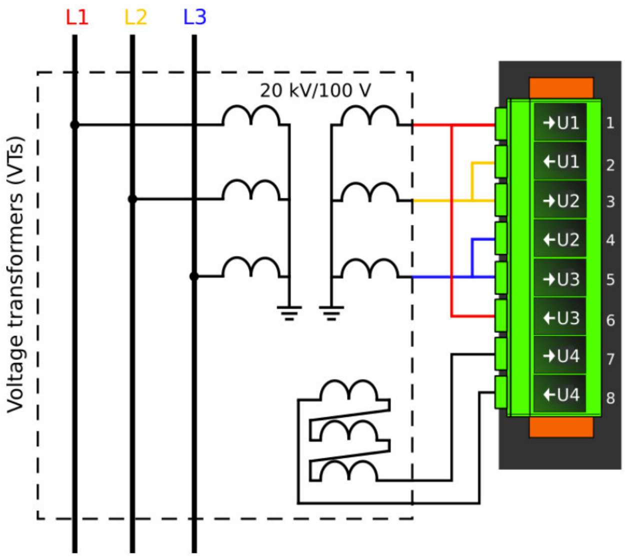
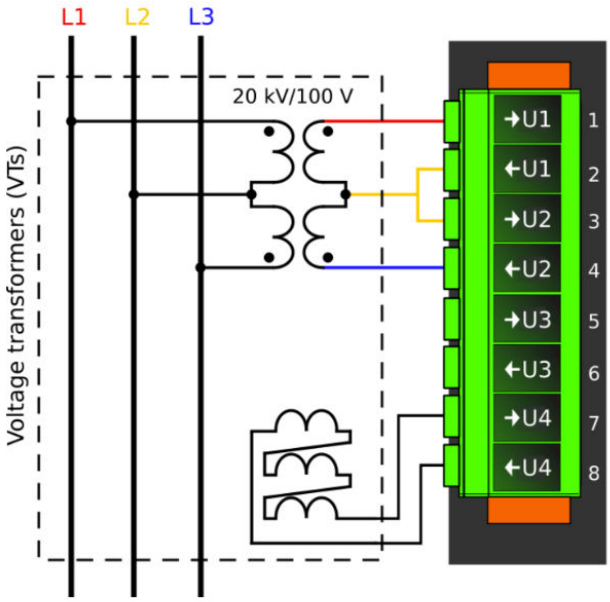


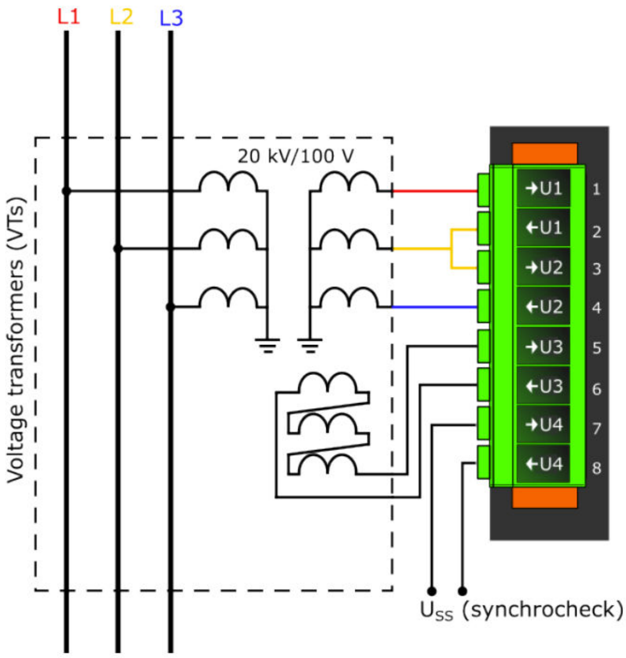
Figure 3.8 2 LL + U3 + U4 configuration



The third phase (U_{L31}) is calculated based on the U_{L12} and U_{L23} vectors. When measuring line-to-line voltages, the line-to-neutral voltages can also be calculated as long as the value of U0 is measured and known.

NOTE U3 is available, but not used.

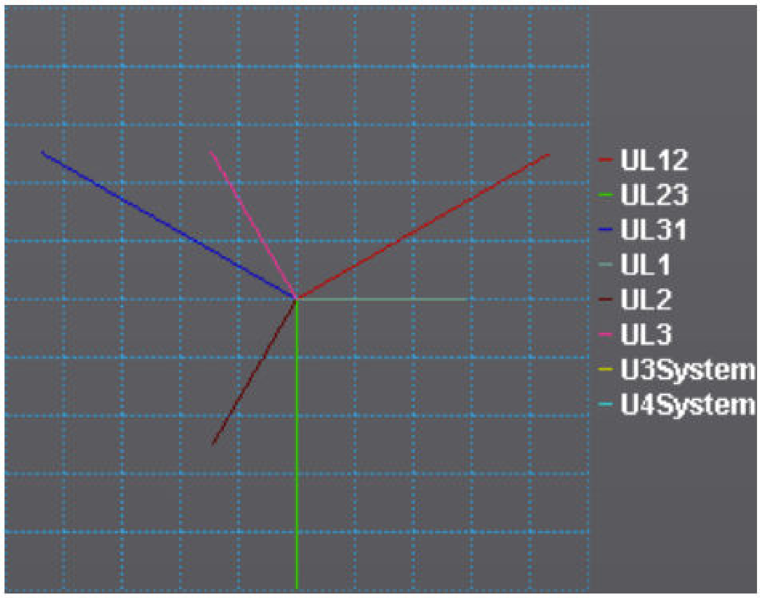
Figure 3.9 2 LL + U3 + U4 configuration with synchrocheck



The U3 selection is U0, and the U4 selection is SS.

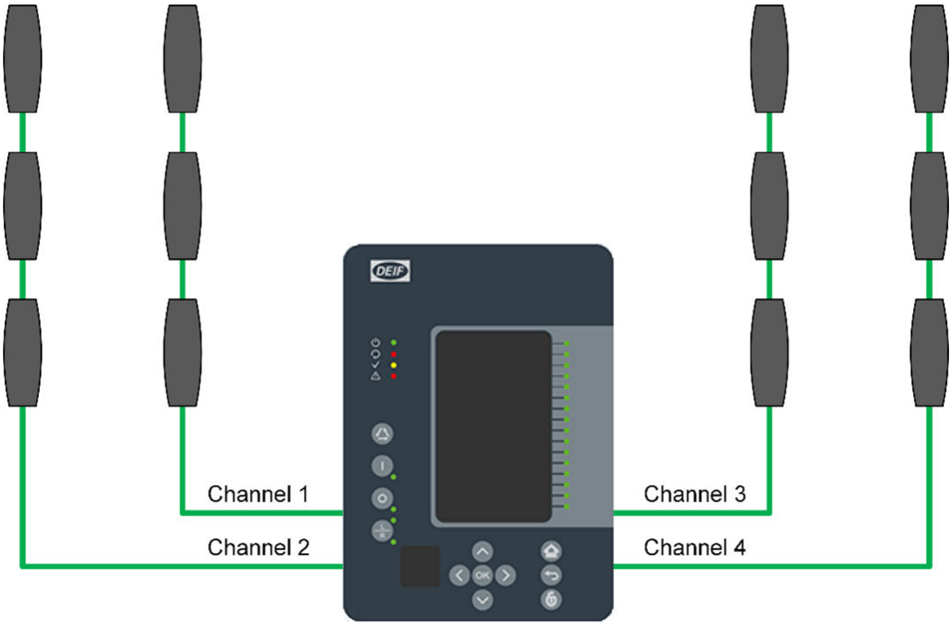
Troubleshooting

When the measured voltage values differ from the expected voltage values, this table offers possible solutions.

Problem	Check / Resolution
The measured voltage amplitude in all phases does not match the injected voltage.	The scaling settings or the voltage measurement mode may be wrong, check that the settings match with the connected voltage transformer (Measurement → Transformers → VT Module).
The measured voltage amplitude does not match one of the measured phases. The calculated U0 is measured even though it should not be.	Check the wiring connections between the injection device or the VTs and the relay.
The measured voltage amplitudes are OK but the angles are strange. The voltage unbalance protection trips immediately after activation. The earth fault protection trips immediately after it is activated and the voltage is calculated.	The voltages are connected to the measurement module but the order or polarity of one or all phases is incorrect. In relay settings, go to *Measurement* → *Phasors* and check the "System voltage vectors" diagram. When all connections are correct, the diagram (symmetric feeding) should look like this: 

3.3.3 Arc flash protection module (option D)

Figure 3.10 System overview



The module has 4 sensor channels, each of which supports up to 3 arc point sensors.

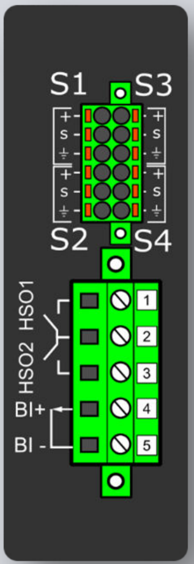
The sensors come in 2 variants:

- Light sensing
- Light and pressure sensing

The arc sensing can be combined with an overcurrent / residual current sensing so that only sensing of an arc AND overcurrent triggers the alarm.

The arc protection module is an add-on module for four (4) light sensor channels. This module also has two (2) high speed outputs and one (1) binary input. This module can be ordered directly as a factory-installed option.

Table 3.4 Arc protection module

	Connector	Description
	S1	Light sensor channels 1...4 with plus, sensor and ground connectors.
	S2	
	S3	
	S4	
	SlotX term. 1	High Speed Output 2 + NO
	SlotX term. 2	Common battery + for High Speed Output
	SlotX term. 3	High Speed Output 1 + NO
	SlotX term. 4	Arc BI1 + pole
	SlotX term. 5	Arc BI1 - pole

The sensor channels S1...S4 must be connected correctly to operate.

Each channel can have up to three light sensors connected in parallel. It is up to the user how many channels are used.

High speed outputs 1 and 2 operate only with DC supply. Battery plus (+) has to be wired according the drawing and output 1 or 2 NO side is wired through trip coil to battery minus (-). High speed output voltage withstand is up to 250 VDC. For further information see the technical data chapter of the MVR Data Sheet.

The high speed output operation time is less than 1ms.

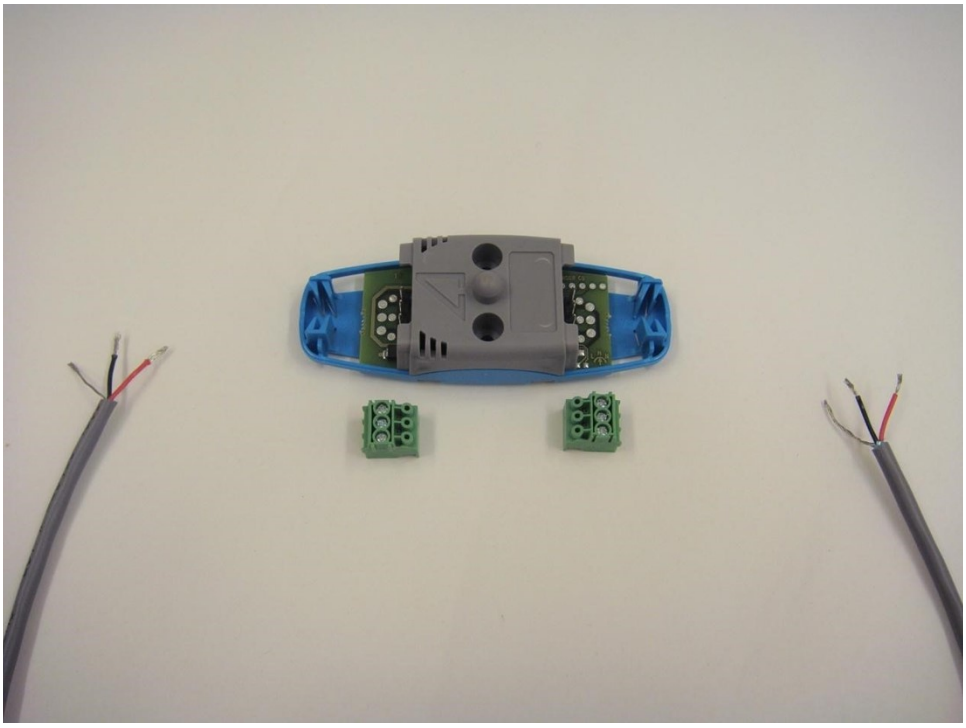
The binary input rated voltage is 24 VDC. The threshold picks up at ≥16 VDC. The binary input can be used for external light information or similar, as a part of various ARC protection schemes. Note that the delay of the binary input is 5...10ms.

Arc sensors AQ-01 and AQ-02 are fixed to the wall using two screws. The same screw pattern is also used in the through wall mounting arrangement. The unit is turned around, the eye is pushed to the compartment to be protected, and two screws are attached from the back side of the sensor. No external mounting plates are needed.

Arc sensor wiring

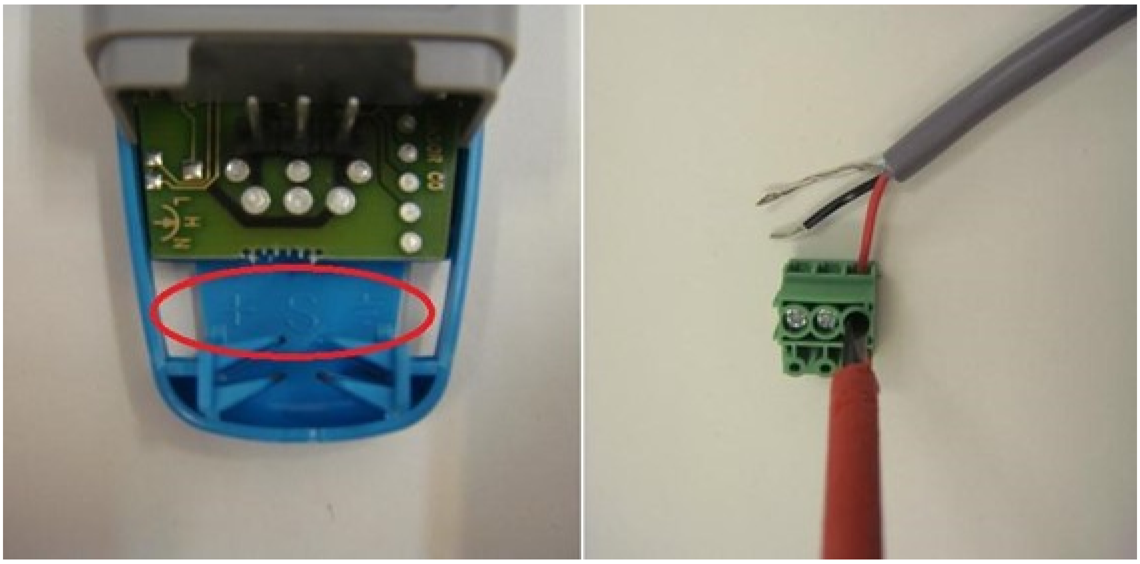
1. Open the sensor side-covers, then detach the pluggable connectors from the sensor PCB, and prepare the three-twisted shielded pair cables for the connection.

Figure 3.11 Prepare the cables



2. Before connecting the cable to connector, make sure that the connecting order is right (+, signal, shield). The pin information is shown on the bottom shell of the sensor. Plug the wires into the connector and fasten them by using a screwdriver.

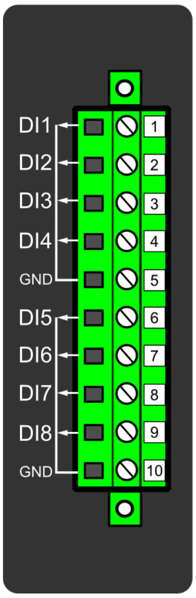
Figure 3.12 Connect the cables



3. Connect the other end of the cable to a sensor channel on the MVR Arc Flash module.
4. A maximum of 3 arc sensors can be daisy-chained to the same sensor input on the MVR option D input.

3.3.4 Binary input module (DI8) (option B)

Figure 3.13 DI8 Binary input module with eight add-on binary inputs.



Connector	Description
SlotX 1	DIx + 1
SlotX 2	DIx + 2
SlotX 3	DIx + 3
SlotX 4	DIx + 4
SlotX 5	GND common ground for this module 1-4 DI
SlotX 6	DIx + 5
SlotX 7	DIx + 6
SlotX 8	DIx + 7
SlotX 9	DIx + 8

Connector	Description
SlotX 10	GND common ground for this module 5-8 DI

The DI8 module is an add-on module with eight (8) galvanically isolated binary inputs. This module can be ordered directly as factory installed or it can be field upgraded if needed after the first installation of the IED.

Properties of this binary input module provided inputs are the same as inputs in the CPU-module.

Binary inputs have as standard current consumption of 2 mA when activated and the operating voltage range is from 0V to 265VAC/DC with software settable activation/release threshold and 1V resolution. All binary inputs are scanned in 5 ms program cycle and they have software settable pick-up and release delay of input signal and software settable NO/NC (normally open/-closed) selection.

Naming convention of the binary inputs provided by this module is presented in the chapter 6 Construction and installation.

For technical details refer to the "Technical data" section of this document

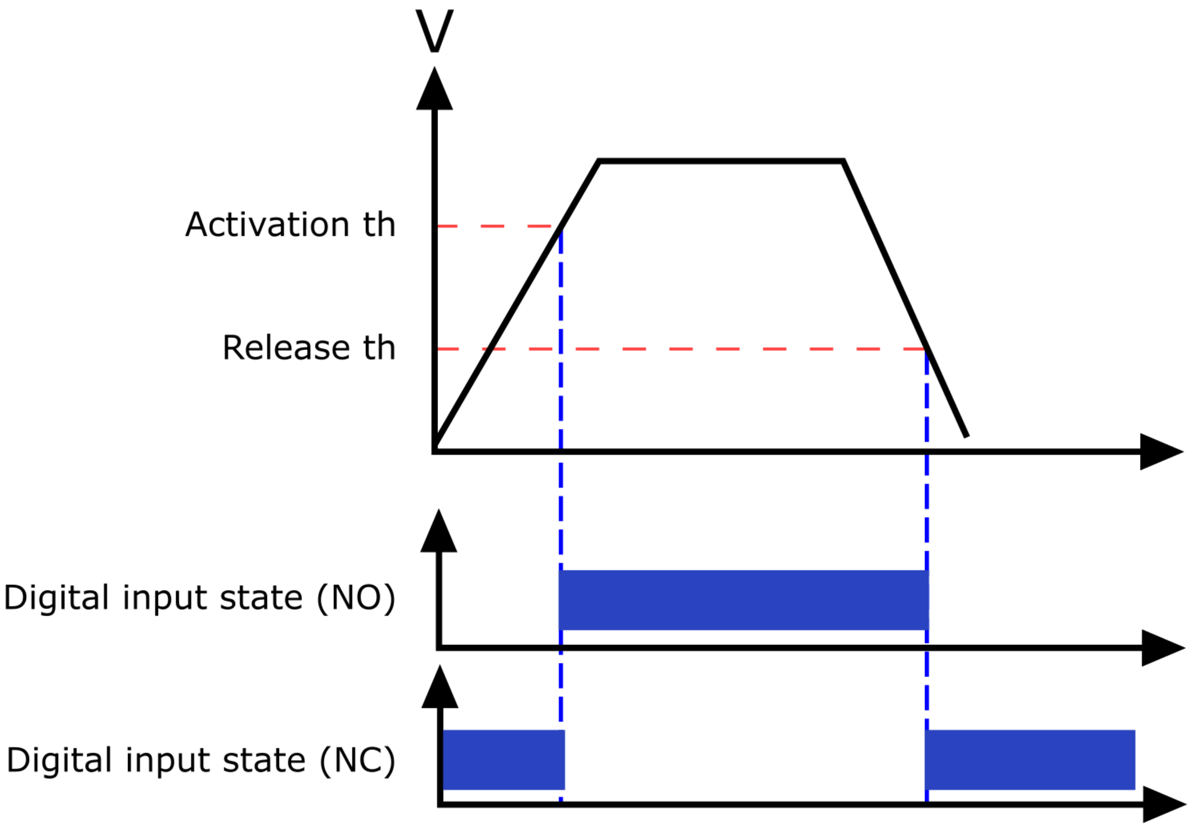
Setting up the activation and release delays

Table 3.5 DI8 card binary input settings

Name	Description	Range	Step	Default
DIx Polarity	Defines if binary input status is 1 or 0 when the input is energized.	0:NO (Normally open) 1:NC (Normally closed)	-	0:NO
DIx Activation threshold	In NO mode: measured voltage exceeding this setting activates the input. In NC mode: measured voltage exceeding this setting deactivates the input.	16.0…200.0 V	0.1 V	88 V
DIx Release threshold	In NO mode: measured voltage below this setting deactivates the input. In NC mode: measured voltage below this setting activates the input.	10.0…200.0 V	0.1 V	60V
DIx Activation delay	Defines the delay for status change from 0 to 1	0.000…1800.000 s	0.001 s	0.000 s
DIx Drop-off time	Defines the delay for status change from 1 to 0	0.000…1800.000 s	0.001 s	0.000 s
DIx AC Mode	Adds 30 ms deactivation delay to account for alternating current. Release threshold parameter is hidden and forced to 10% of set activation parameter.	0:Disabled 1:Enabled	-	0:Disabled

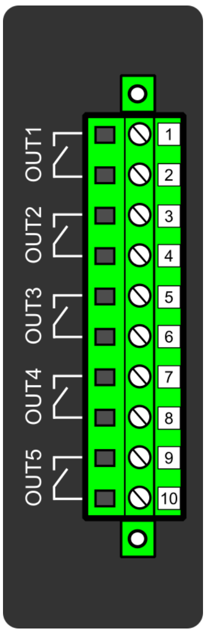
Digital input activation threshold can be set for each digital input individually by the user. Properly set activation and release thresholds will result in reliable activation and release of the digital input states. User settable normal state (normally open/ normally closed) defines if the digital input is considered activated when the digital input channel is energized.

Figure 3.14 Digital input state when energizing and de-energizing the digital input channels.



3.3.5 Binary output module (DO5) (option C)

Figure 3.15 DO5 Binary output module with five add-on binary outputs.



Connector	Description
SlotX 1	OUTx + 1 first pole NO
SlotX 2	OUTx + 1 second pole NO
SlotX 3	OUTx + 2 first pole NO
SlotX 4	OUTx + 2 second pole NO
SlotX 5	OUTx + 3 first pole NO
SlotX 6	OUTx + 3 second pole NO
SlotX 7	OUTx + 4 first pole NO
SlotX 8	OUTx + 4 second pole NO
SlotX 9	OUTx + 5 first pole NO
SlotX 10	OUTx + 5 second pole NO

The DO5 module is an add-on module with five (5) binary outputs. This module can be ordered directly as factory installed or it can be field upgraded if needed after the first installation of the IED.

Properties of binary outputs are the same as binary outputs in the CPU-module.

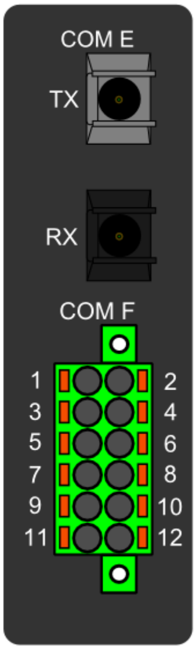
Binary outputs controls are software settable by the user. Binary outputs are controlled in 5 ms program cycle. All output contacts are mechanical type. Rated voltage of the NO/CO outputs is 250VAC/DC.

Naming convention of the binary outputs provided by this module is presented in the chapter Construction and installation.

For further details refer to the “Technical data” section of this document.

3.3.6 Serial RS232 communication module (option L/M/N/O)

Figure 3.16 Serial RS232-card connectors



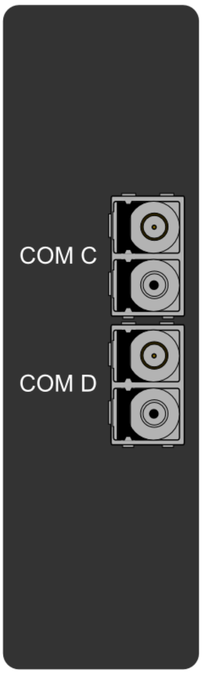
Connector	Name	Description
COM E	Serial fiber (GG/PP/GP/PG)	• Serial based communications • Wavelength 660nm • Compatible with 50/125µm, 62.5/125µm, 100/140µm, and 200µm Plastic-Clad Silica (PCS) Fiber. • Compatible with ST type connector.
COM F Pin1	+24Vinput	Optional external auxiliary voltage for serial fiber
COM F Pin2	GND	Optional external auxiliary voltage for serial fiber
COM F Pin3	-	-
COM F Pin4	-	-
COM F Pin5	RS-232 RTS	Serial based communications
COM F Pin6	RS-232 GND	Serial based communications

Connector	Name	Description
COM F Pin7	RS-232 TX	Serial based communications
COM F Pin8	RS-232 RX	Serial based communications
COM F Pin9	-	-
COM F Pin10	+3.3V output (spare)	Spare power source for external equipment (45mA)
COM F Pin11	Clock sync input	Clock synchronization input (IRIG-B)
COM F Pin12	Clock sync GND	Clock synchronization input (IRIG-B)

Option card includes two serial communication interfaces. COM E is a serial fiber interface with glass/plastic option. COM F is a RS-232 interface. To use COM F IRIG-B time sync Time sync source should be set to IRIG-B in General menu.

3.3.7 LC100 Ethernet communication module (option J)

Figure 3.17 LC 100 Mbps Ethernet card connectors

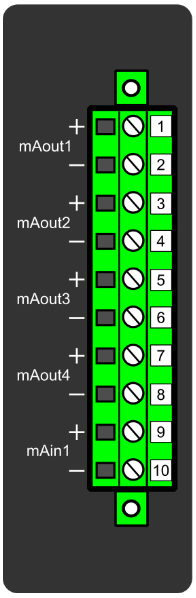


Connector	Description
COM C:	• Communication port C, LC fiber connector. • 62.5/100µm or 50/125µm multimode (glass). • Wavelength 1300nm
COM D:	• Communication port D, LC fiber connector. • 62.5/100mm or 50/125mm multimode (glass). • Wavelength 1300nm

Optional LC 100 Mbps Ethernet card supports HSR and PRP protocols according to IEC 61850 substation communication standard. Card has IEEE1588 (PIP) clock sync functionality. Card has two PRP/HSR ports which are 100Mbps fiber ports and can be configured to 100Mbps or 10 Mbps.

3.3.8 mAout & mAinput module (option I)

Figure 3.18 mA output & input module connections.



Connector	Description
SlotX 1	mAout1 + connector (0-24mA)
SlotX 2	mAout1 – connector (0-24mA)
SlotX 3	mAout2 + connector (0-24mA)
SlotX 4	mAout2 – connector (0-24mA)

Connector	Description
SlotX 5	mAout3 + connector (0-24mA)
SlotX 6	mAout3 – connector (0-24mA)
SlotX 7	mAout4 + connector (0-24mA)
SlotX 8	mAout4 – connector (0-24mA)
SlotX 9	mAin1 + connector (0-33mA)
SlotX 10	mAin1 – connector (0-33mA)

mA output module is an add-on module with four (4) mA outputs and one (1) mA inputs. mA option card includes 4 pcs mA-outputs that are grouped in 2 galvanically isolated groups. The option card also has one galvanically isolated mA-input channel.

This module can be ordered directly as factory installed option or it can be field upgraded if needed after the first installation of the IED.

The mA Outputs are user settable in the mA Outputs control function.

4. Applications and wiring

4.1 MVR-F201

4.1.1 Connections F201

Figure 4.1 F201 hardware.

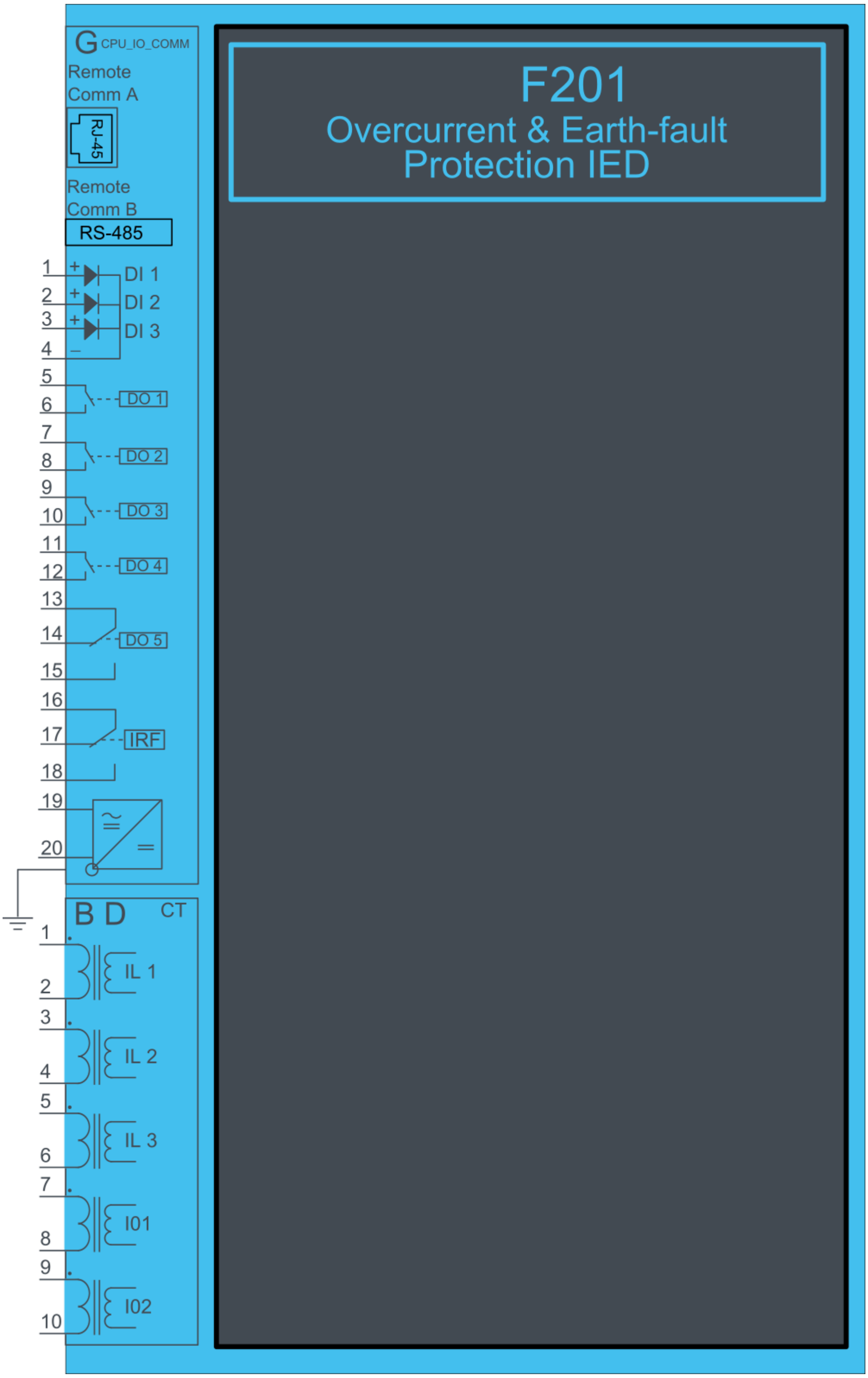
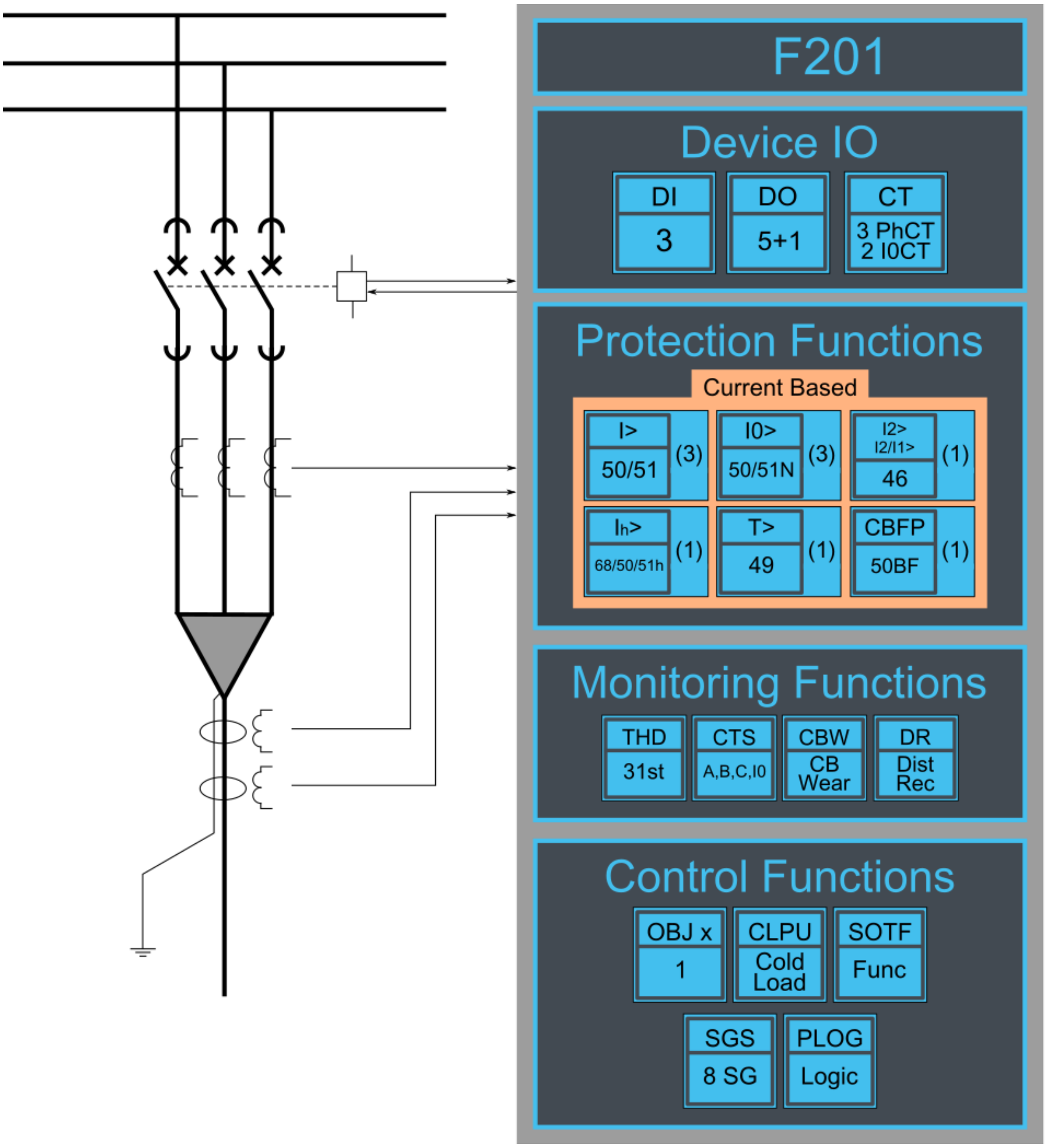


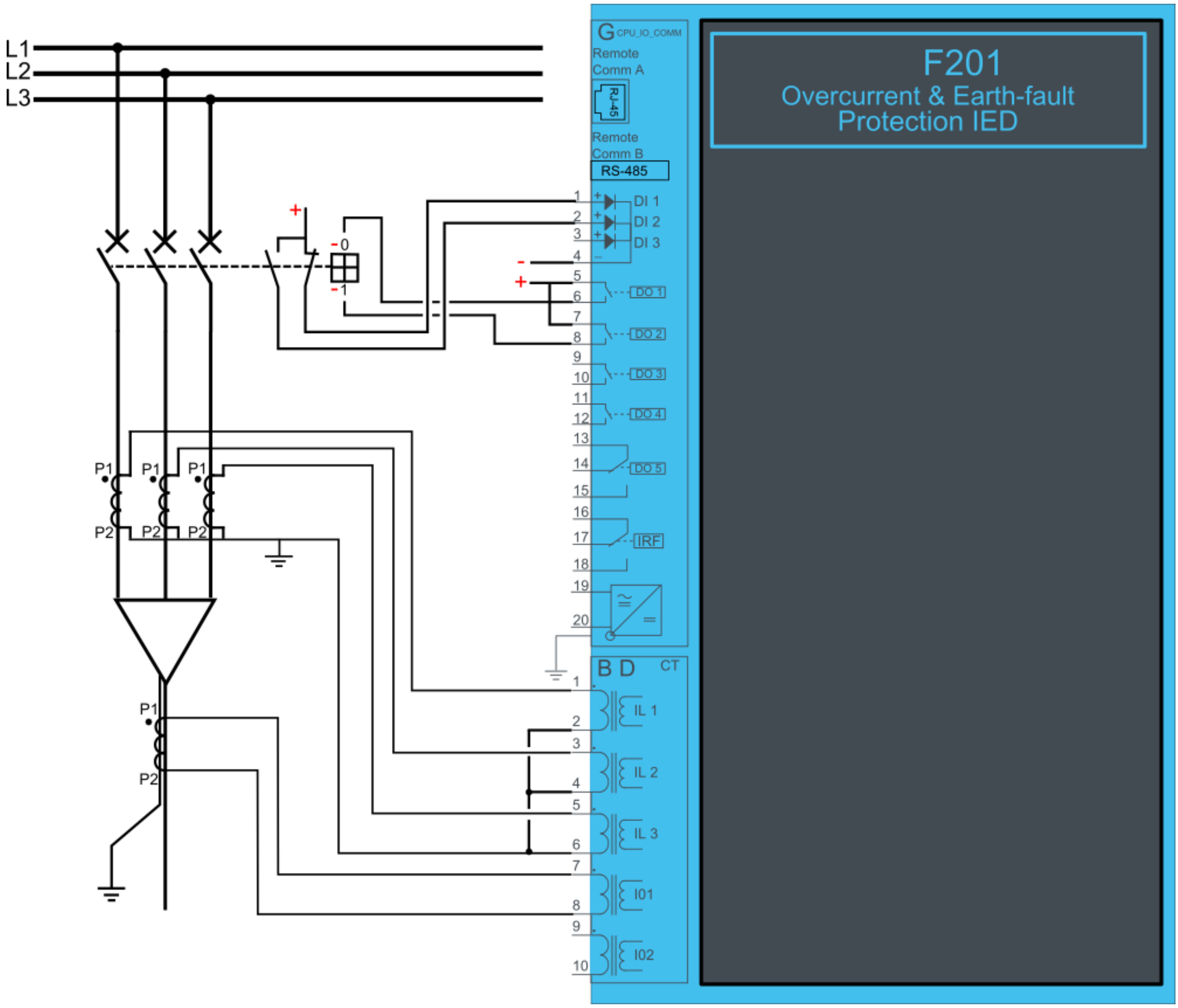
Figure 4.2 F201 application example with function block diagram.



4.1.2 Example feeder application connection

Connection example with three phase currents and residual current connected. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.3 Application example for F201



4.2 MVR-F205

4.2.1 Connections F205

Figure 4.4 F205 connections. F205 has fixed hardware with binary input and output cards always included.

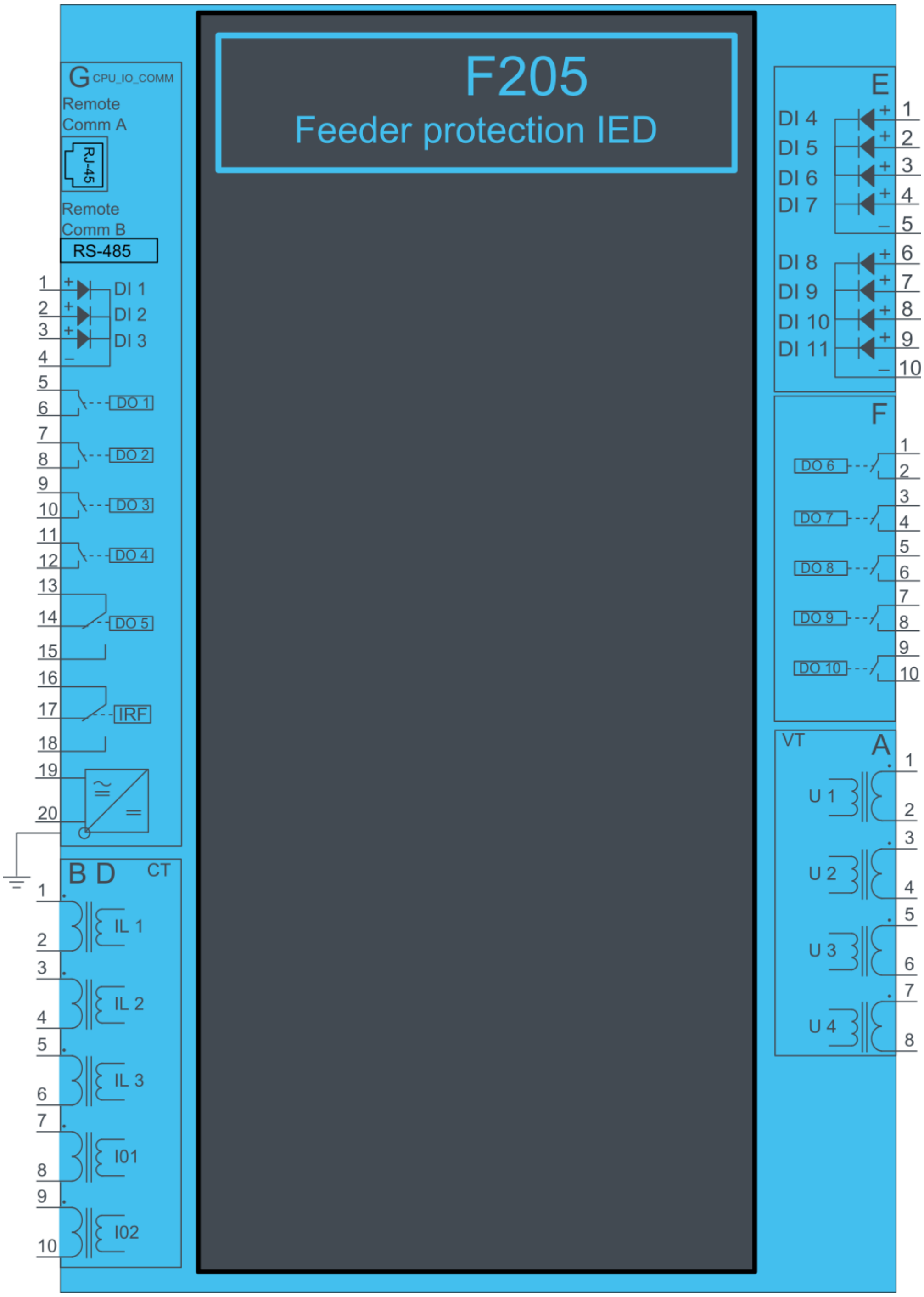
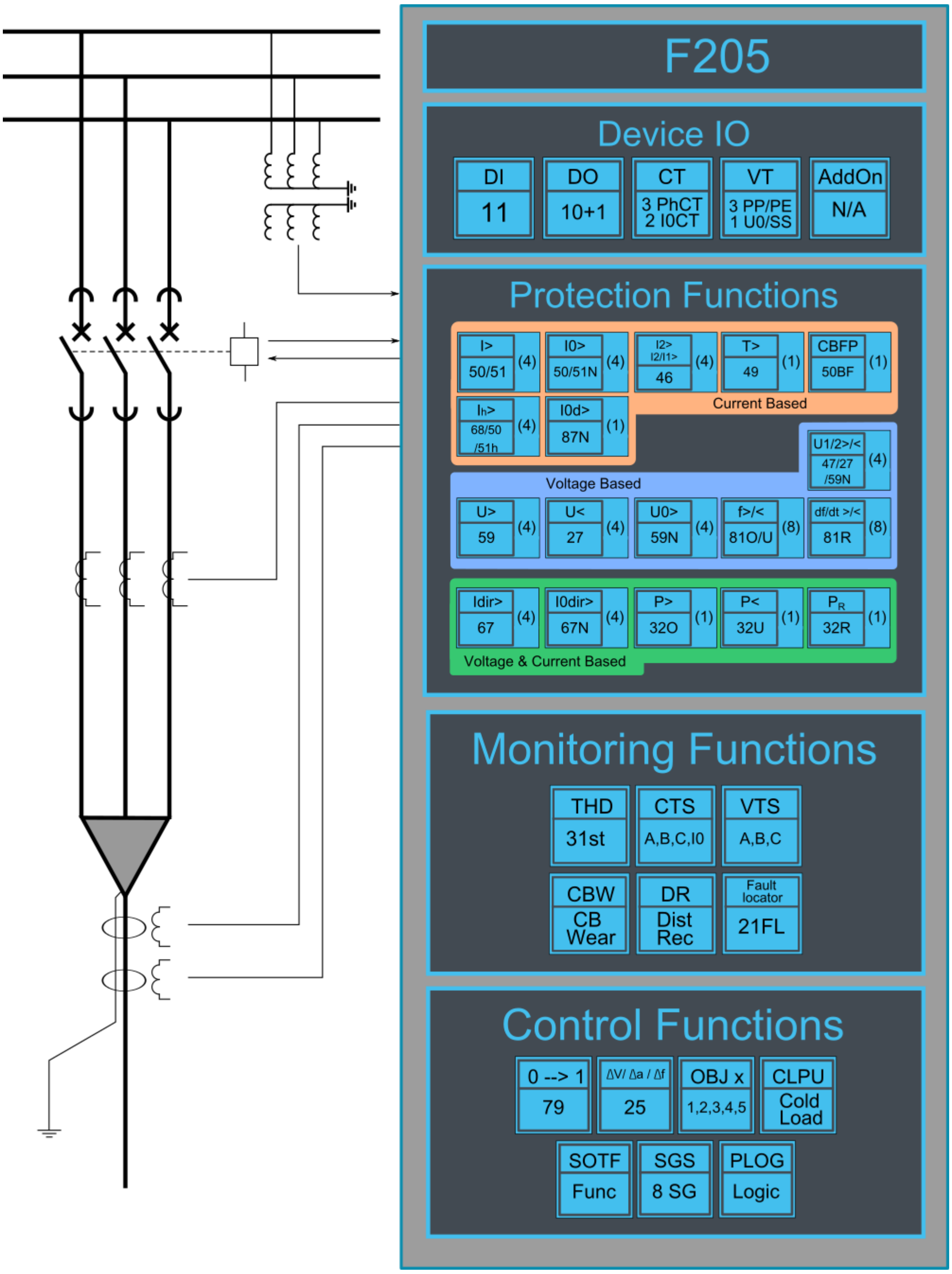


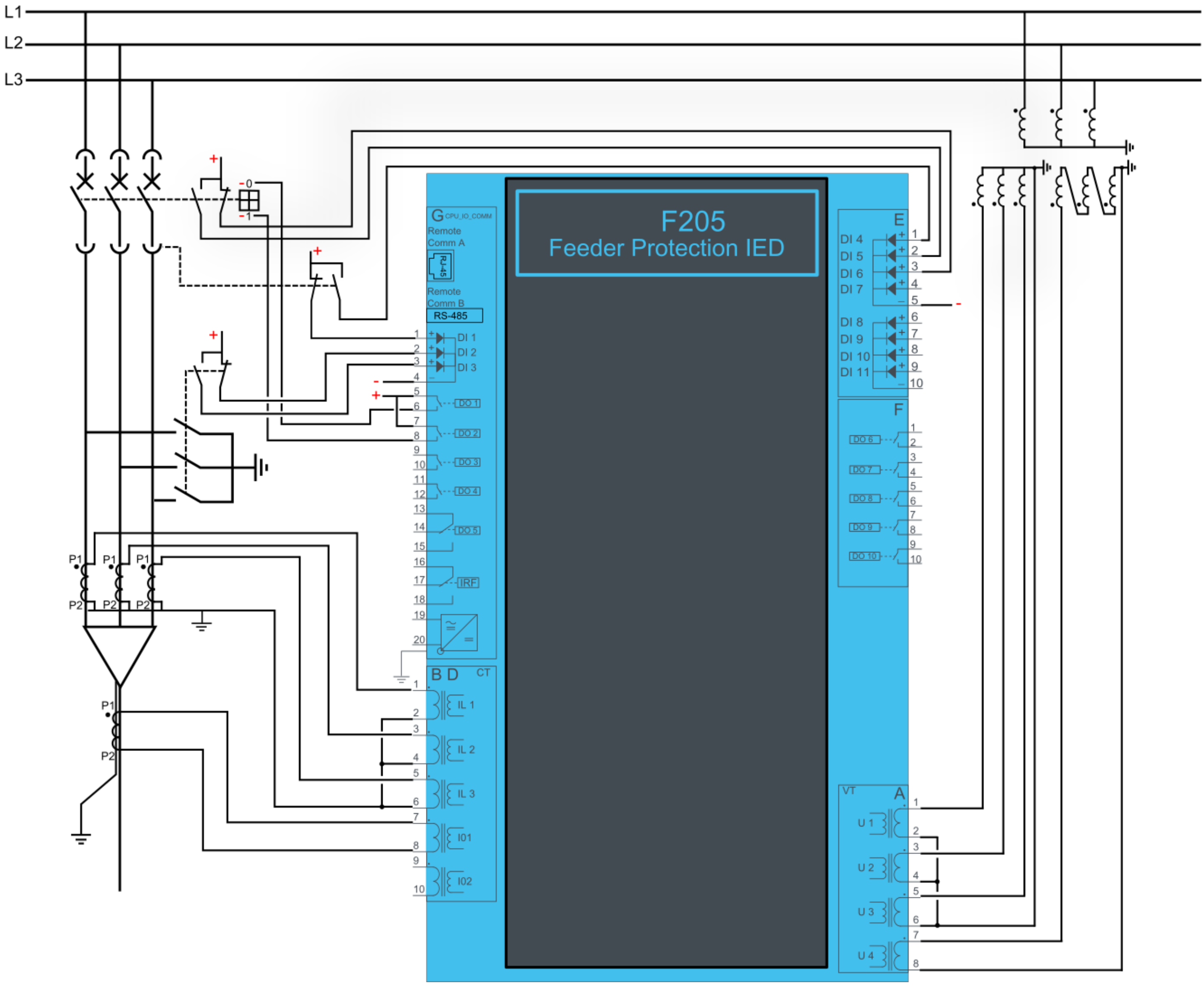
Figure 4.5 F205 application example with function block diagram.



4.2.2 Example feeder application connection

Connection example application with three lines to neutral voltages and zero sequence voltage connected. Three phase currents and residual current are connected as well. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.6 Voltage measurement mode is 3LN+U0.



4.3 MVR-F210

4.3.1 Connections F210

Figure 4.7 F210 variant without add-on modules.

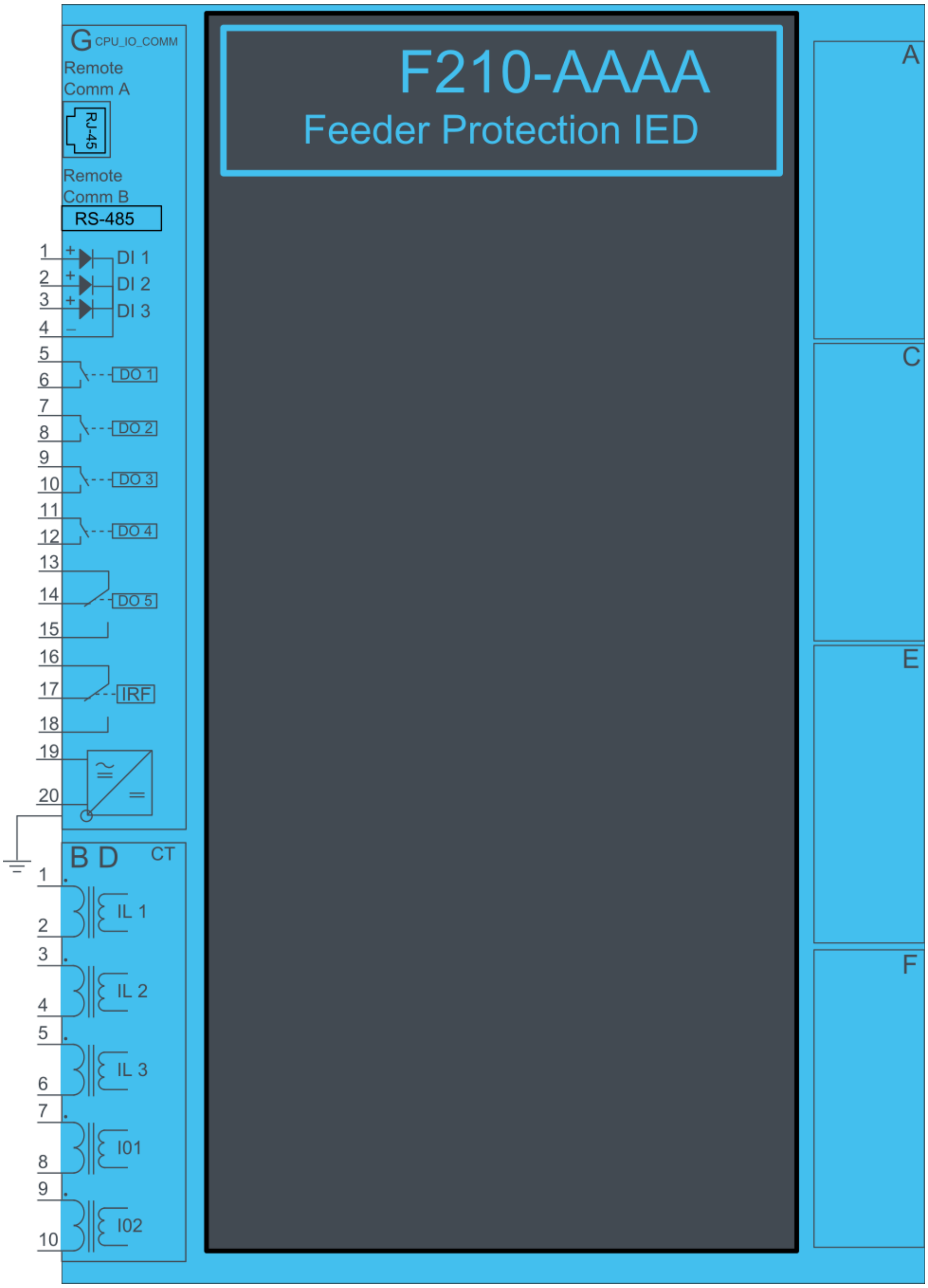


Figure 4.8 F210 variant with binary input and output modules.

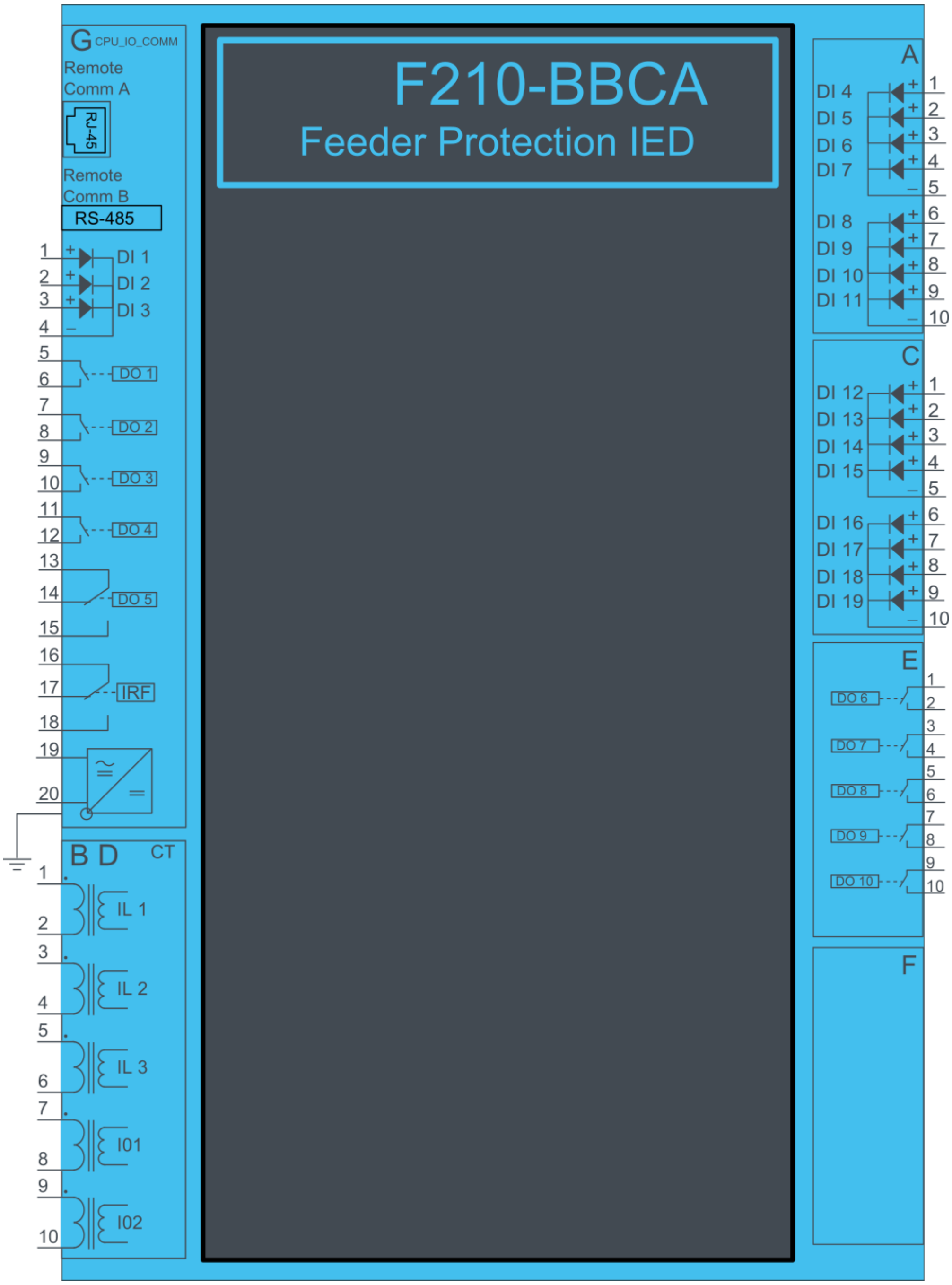
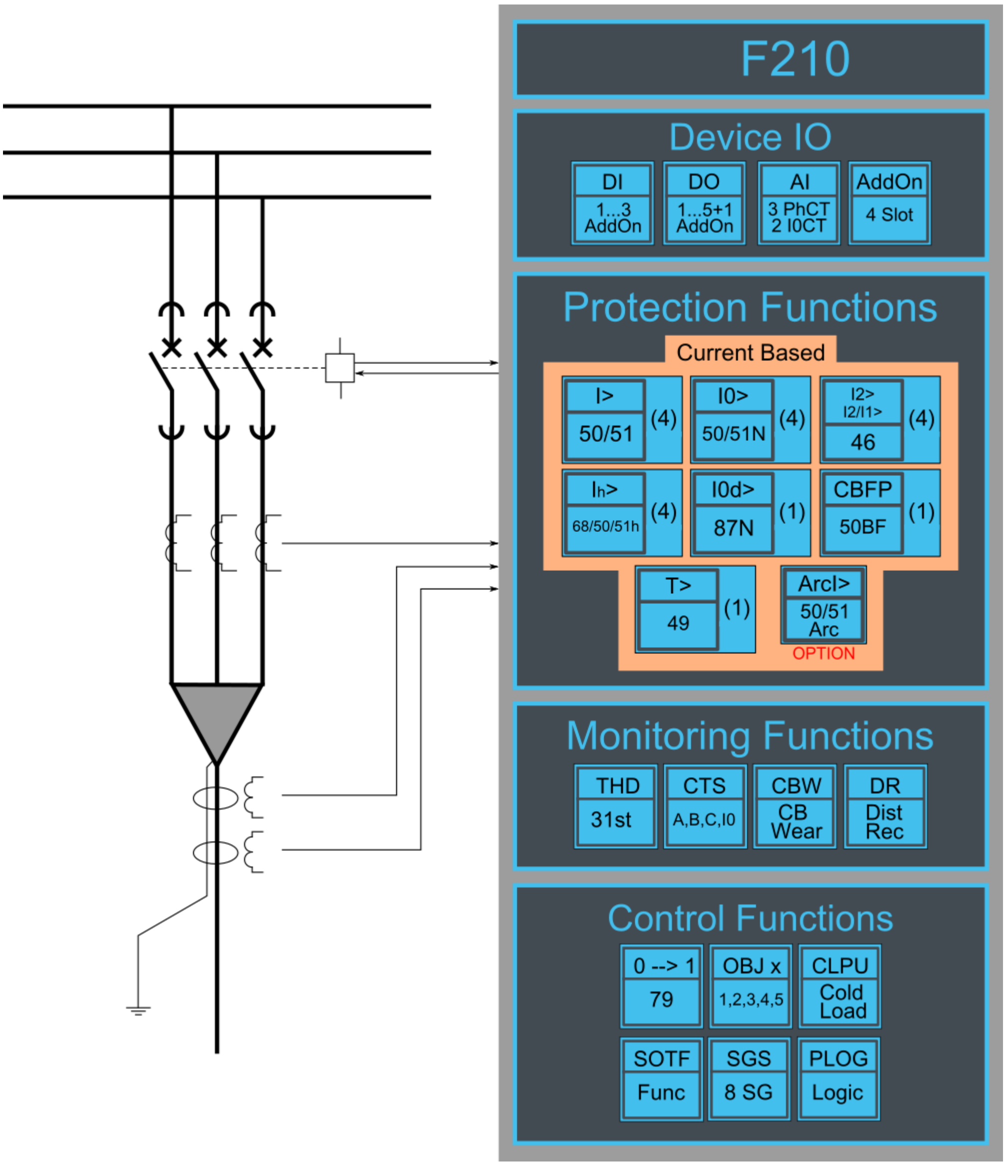


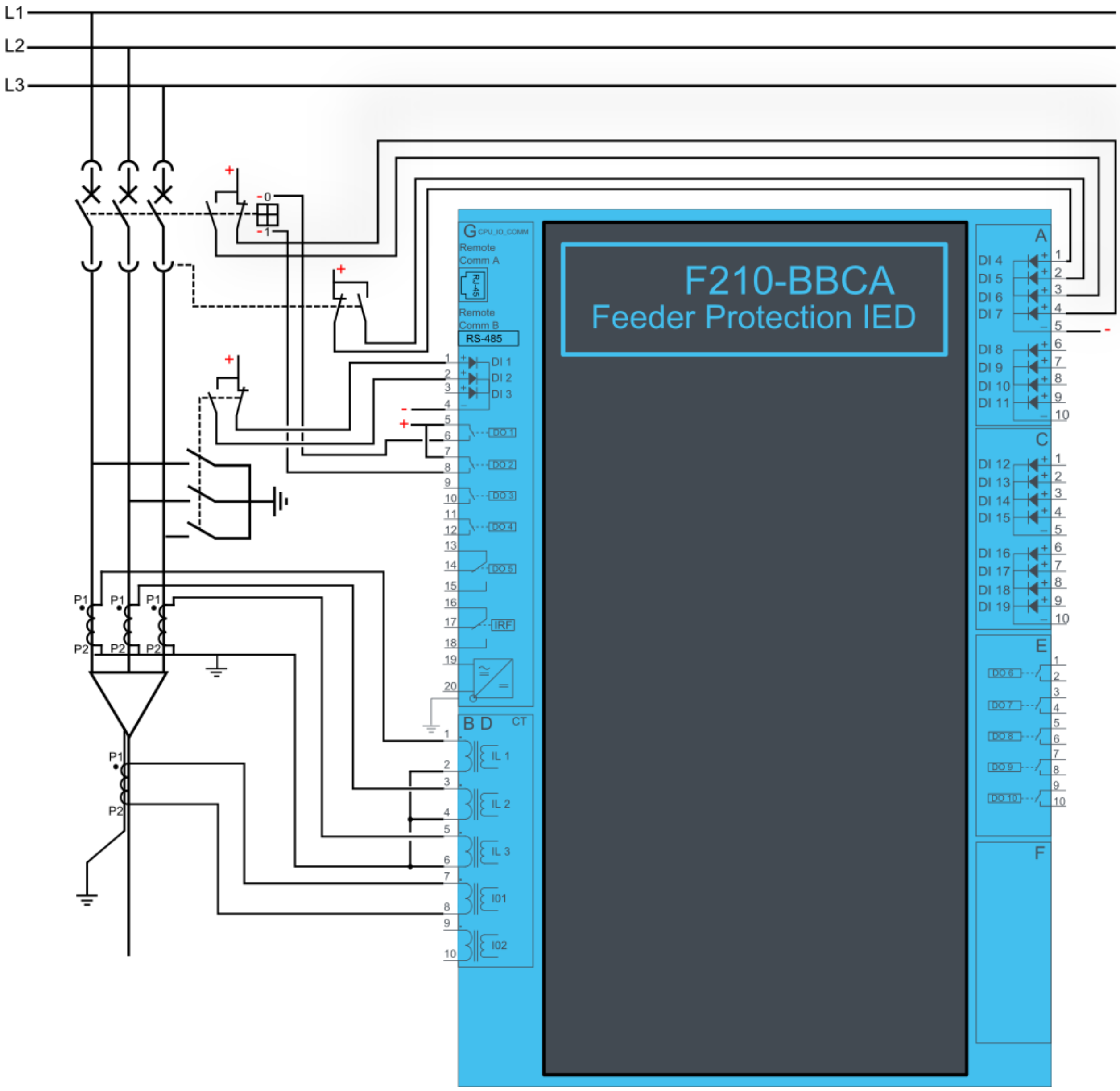
Figure 4.9 F210 application example with function block diagram.



4.3.2 Example feeder application connection

Connection example application with three phase currents and residual current connected. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.10 Three phase currents and residual current measurement connected.



4.4 MVR-F215

4.4.1 Connections F215

Figure 4.11 F215 variant without add-on modules.

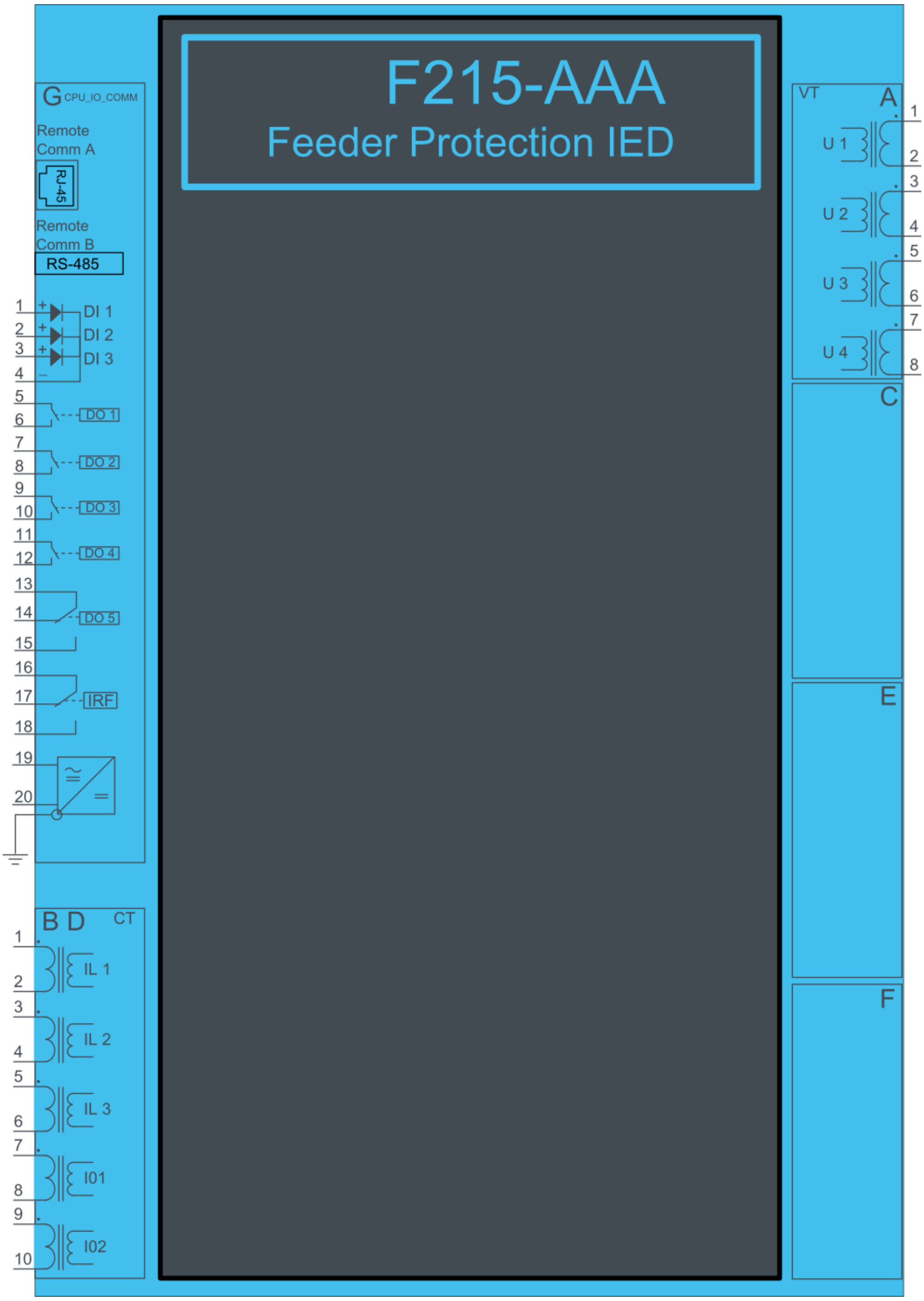


Figure 4.12 F215 variant with binary input and output modules.

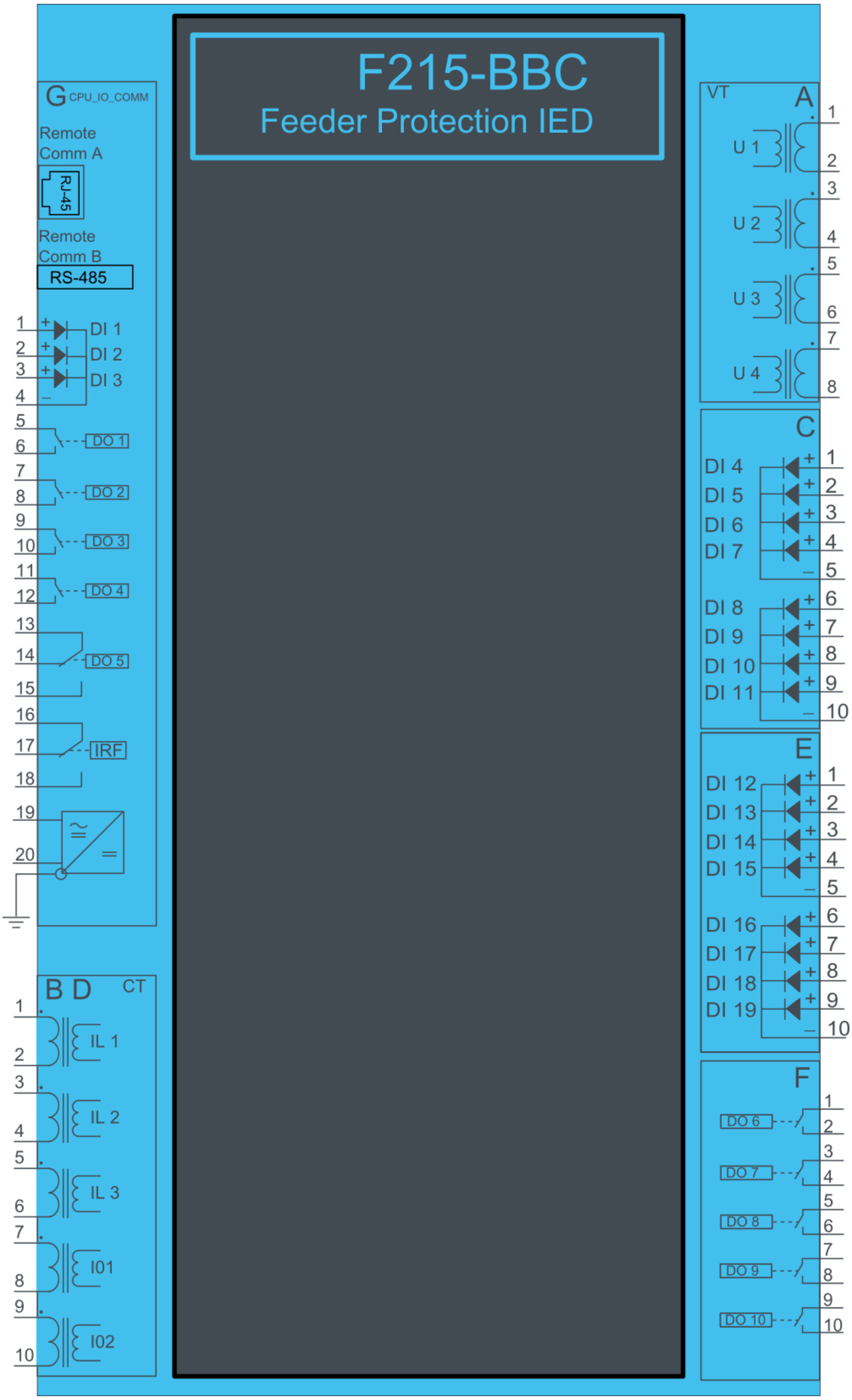
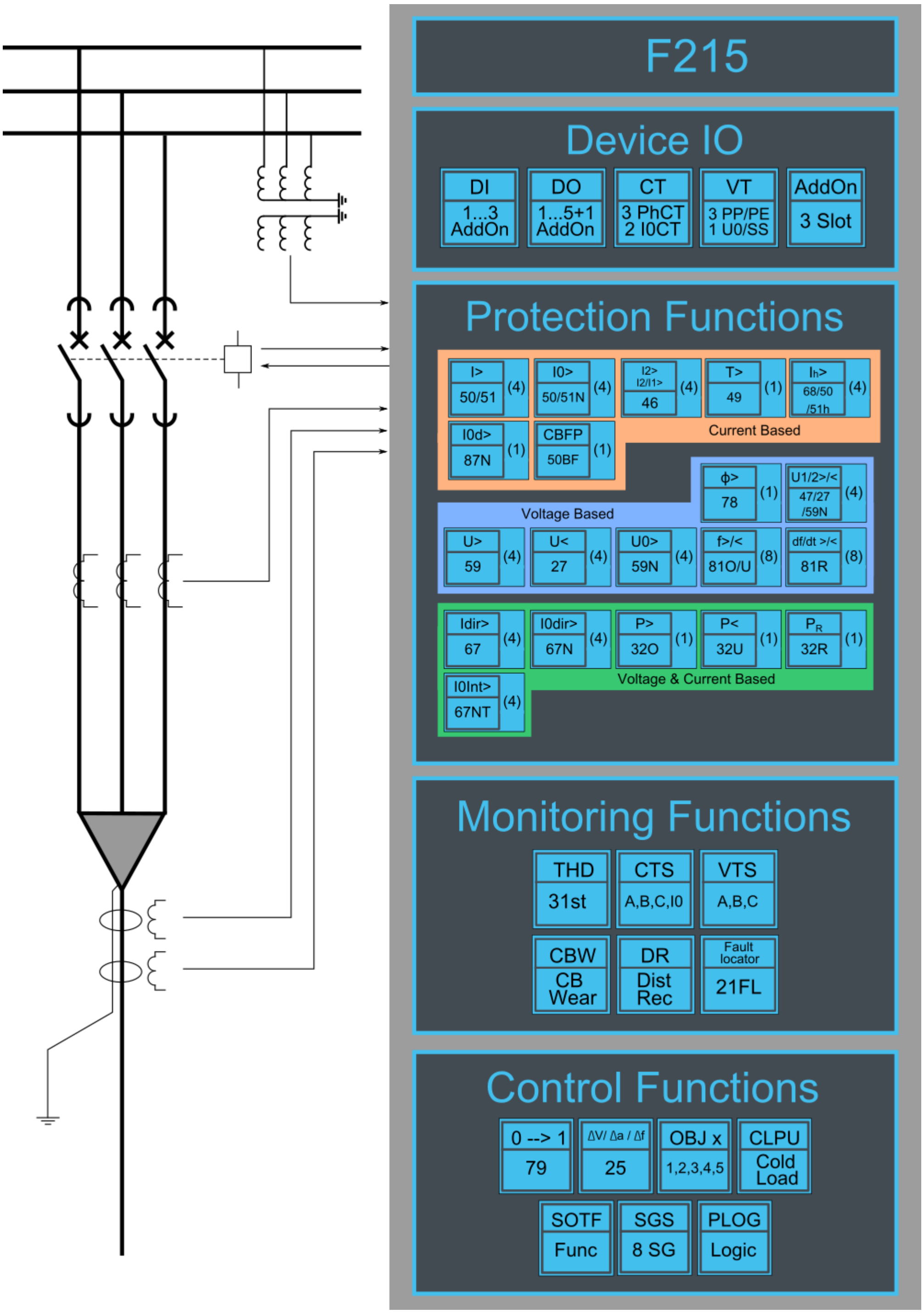


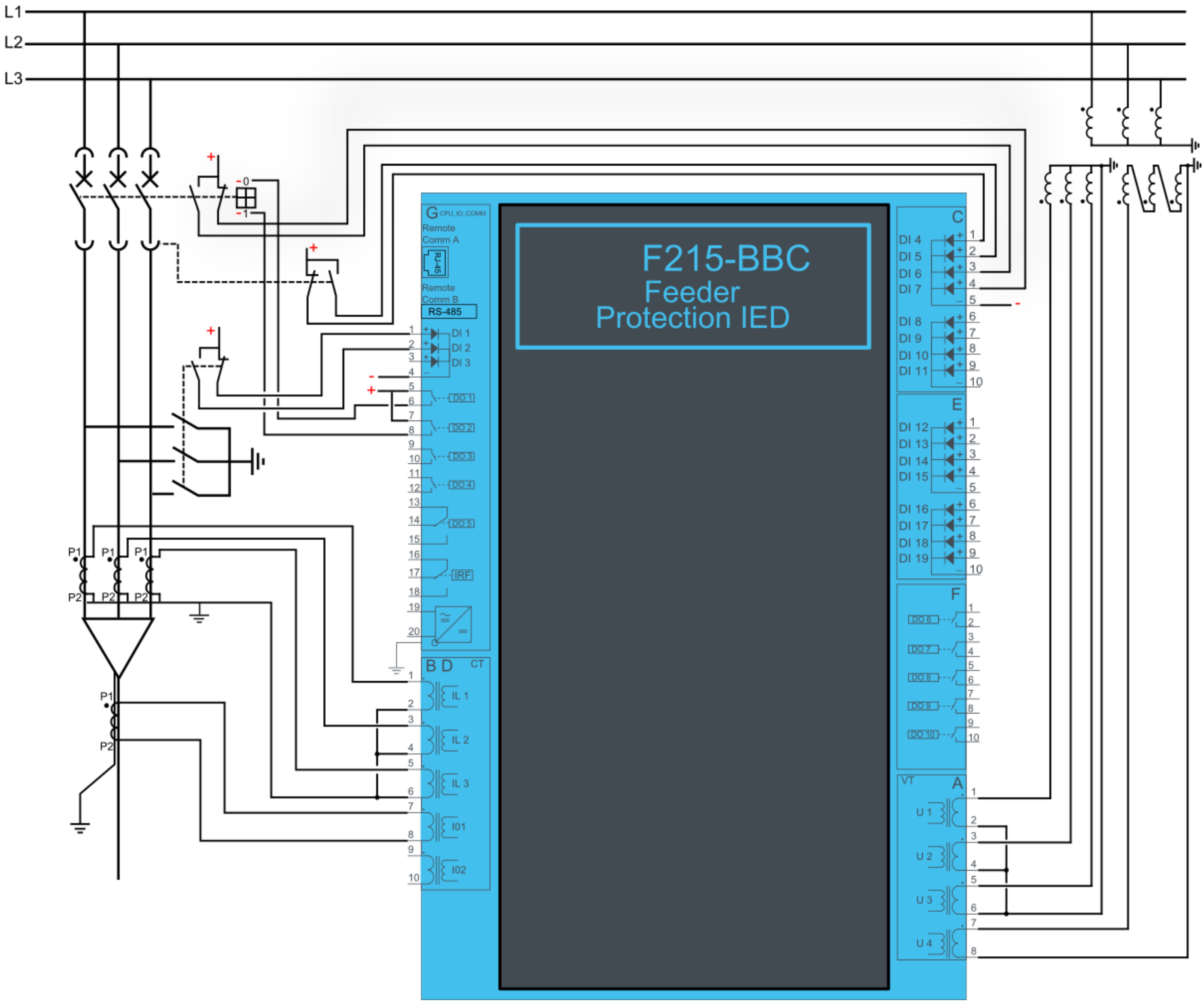
Figure 4.13 F215 application example with function block diagram.



4.4.2 Example feeder application connection

Connection example application with three lines to neutral voltages and zero sequence voltage connected. Three phase currents and residual current are connected as well. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.14 Voltage measurement mode is 3LN+U0



4.5 MVR-F255

4.5.1 Connections F255

Figure 4.15 F255 variant without add-on modules.

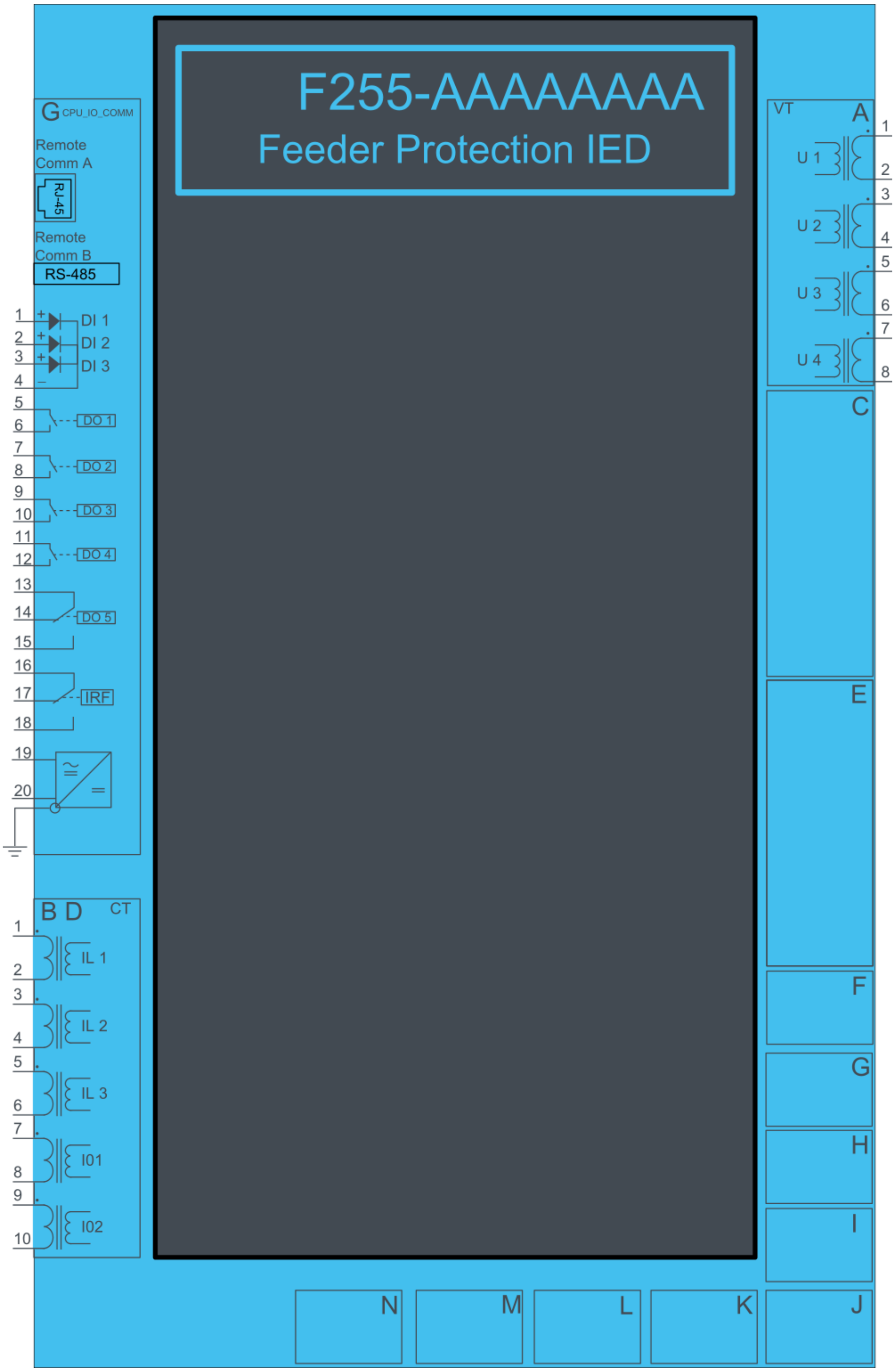


Figure 4.16 F255 variant with binary input and output modules.

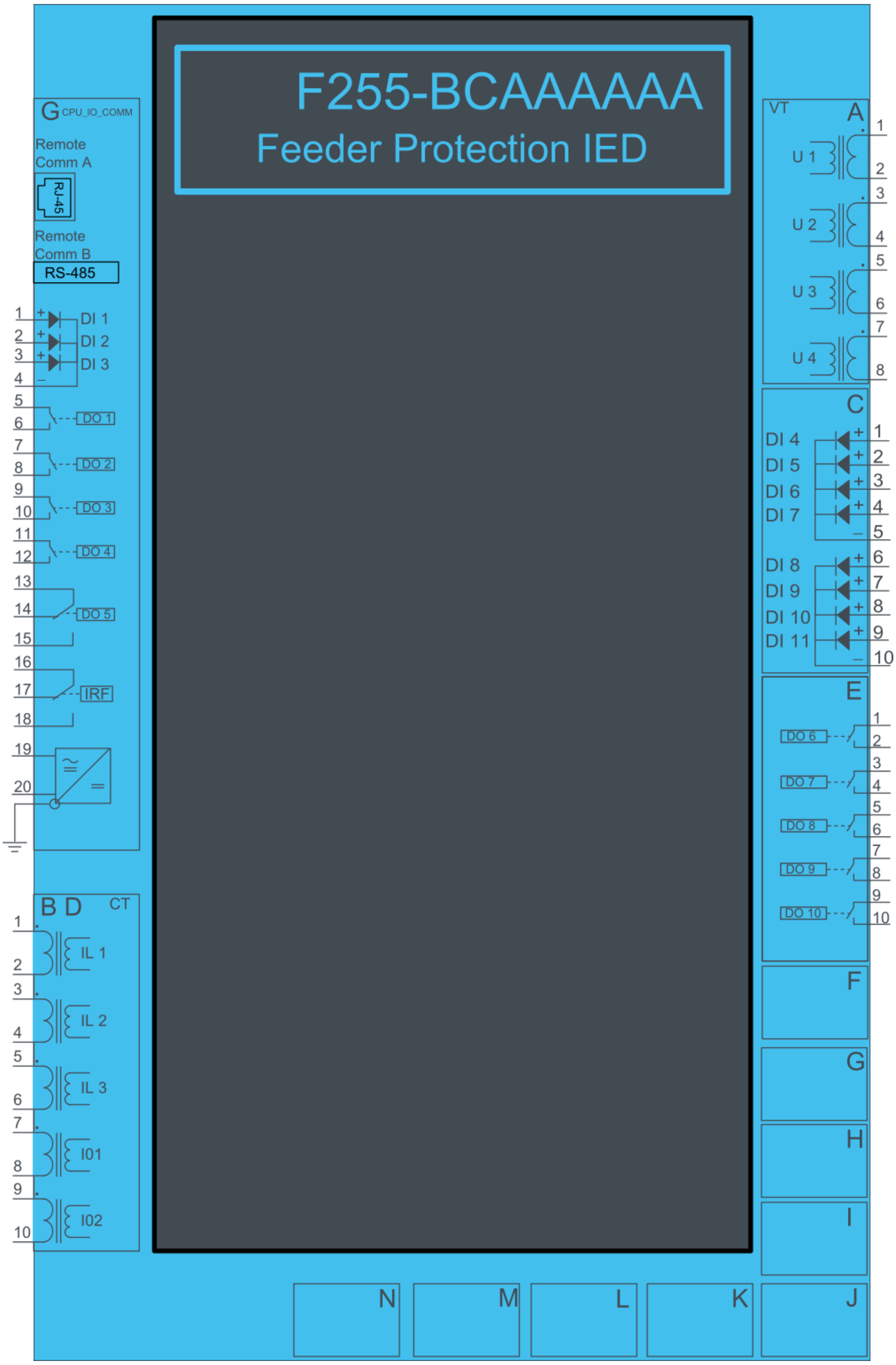
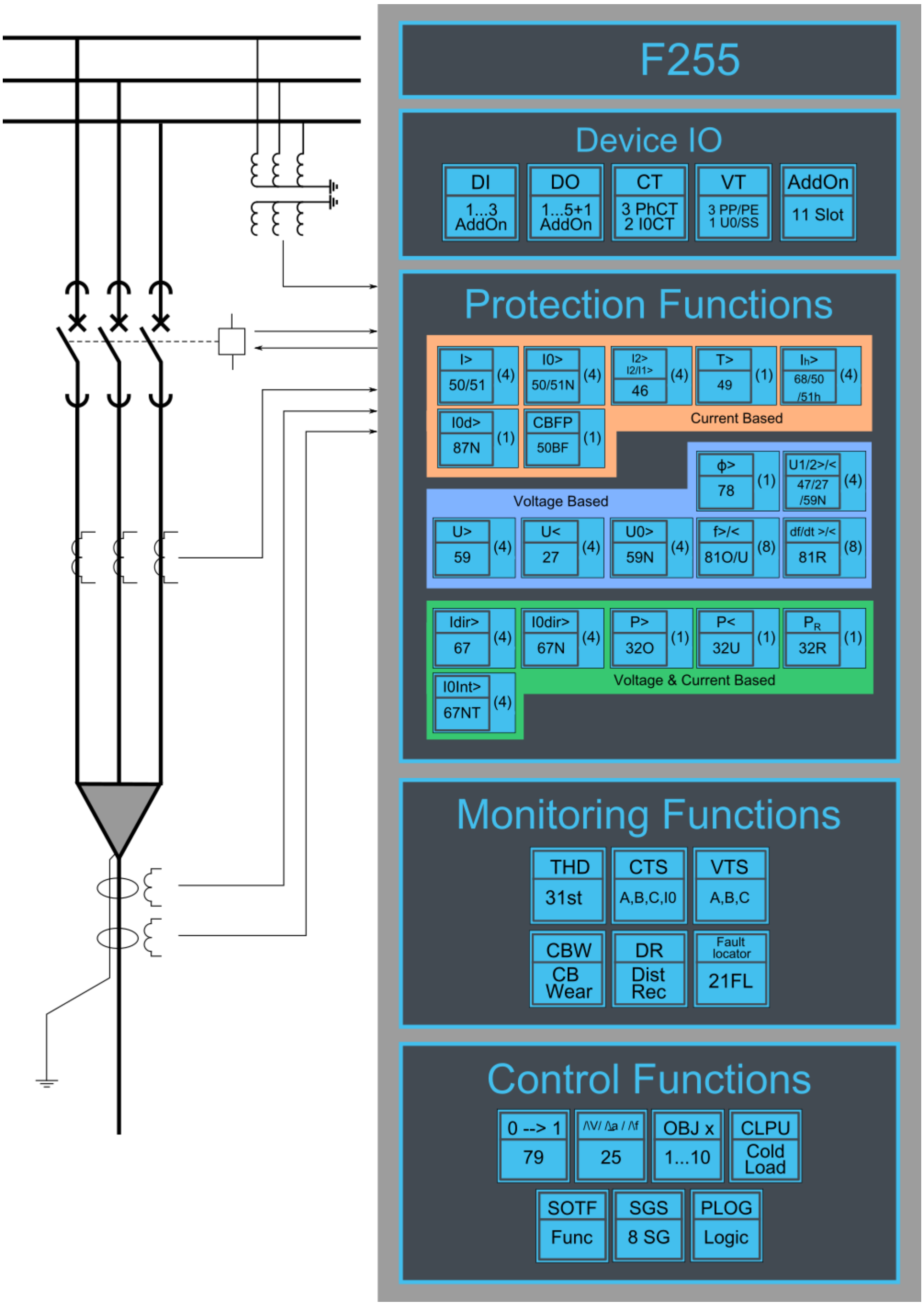


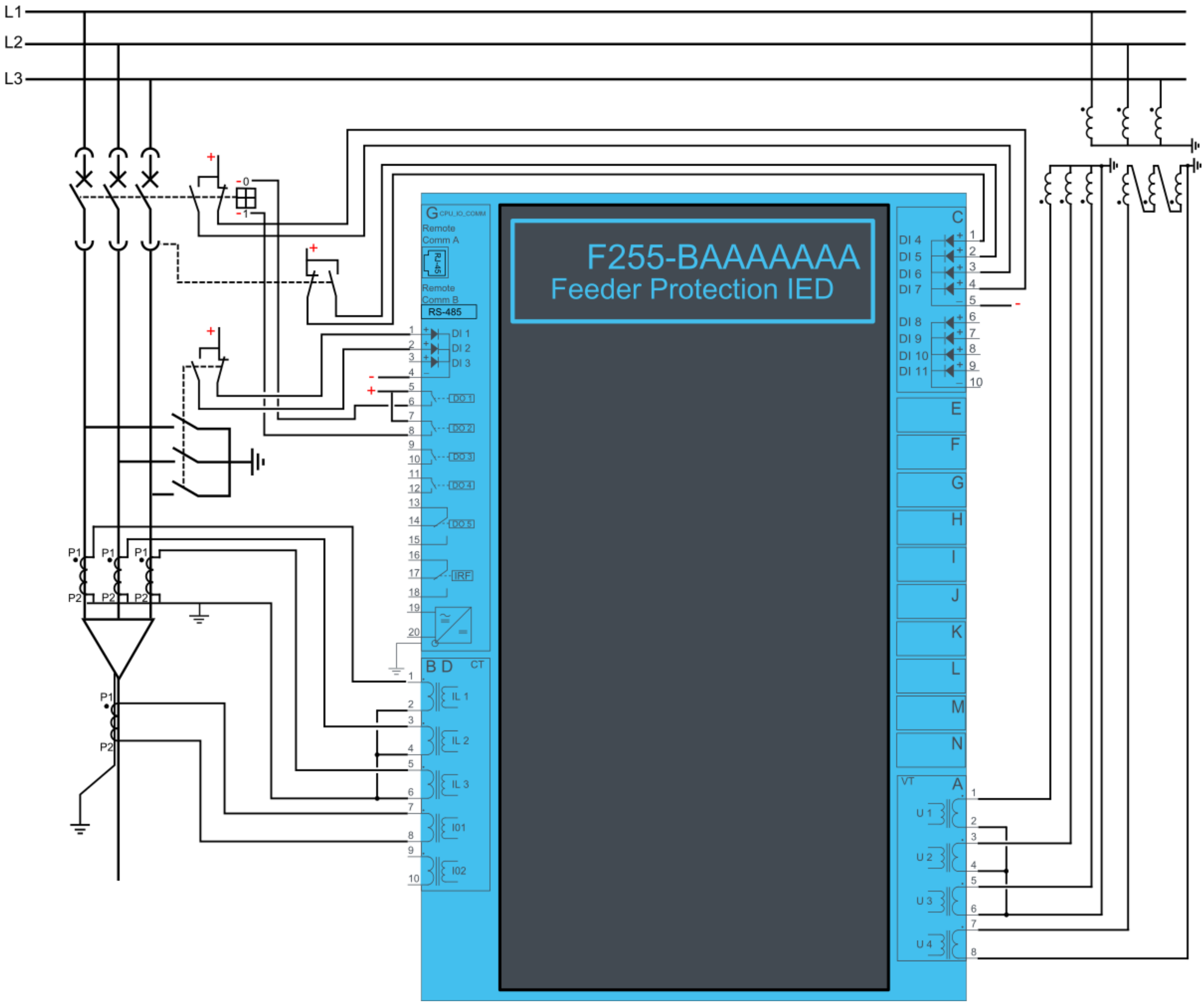
Figure 4.17 F255 application example with function block diagram.



4.5.2 Example feeder application connection

Connection example application with three lines to neutral voltages and zero sequence voltage connected. Three phase currents and residual current are connected as well. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.18 Application example for F255

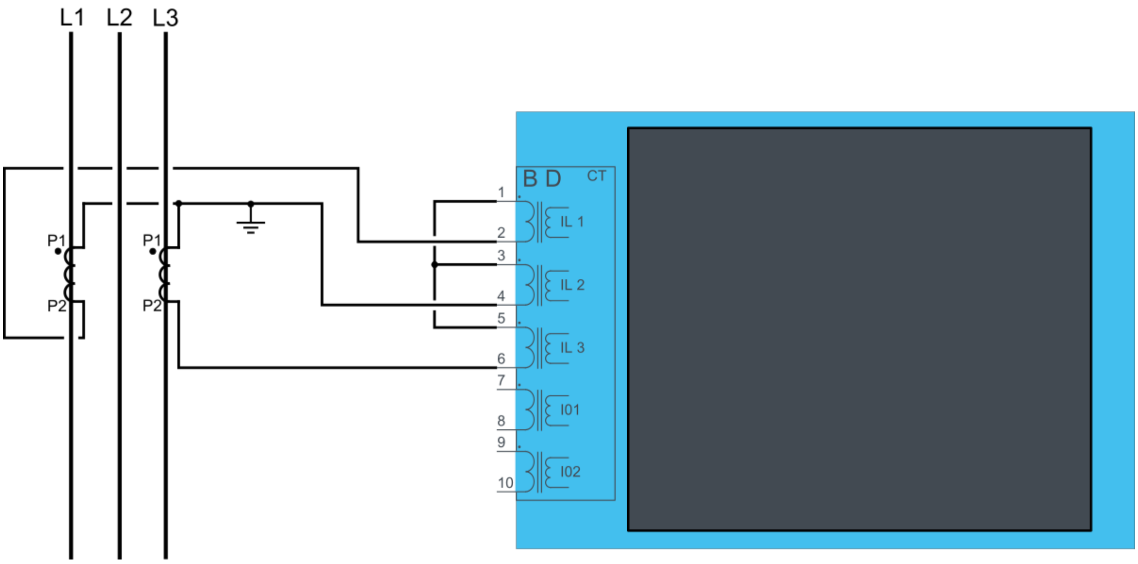


4.6 Only 2 CTs (F201, F205, F210, F215, F255)

4.6.1 3-phase, 3-wire ARON input connection

This chapter presents a connection example of an application with protection current transformers for just two phases. Connection is suitable for both motor –and feeder applications.

Figure 4.19 3-phase, 3-wire ARON input connection.



ARON input connection can measure load symmetrically despite the fact that one of the CTs is missing from the installation. Normally the current transformer of phase two is without installed CT since it is much more likely that external fault appears on line 1 or 3.

Fault between line 2 and ground cannot be detected when ARON input connection is used. For detecting ground fault in phase two a cable core CT has to be used.

4.7 MVR-M210

4.7.1 Connections M210

Figure 4.20 M210 variant without add-on modules.

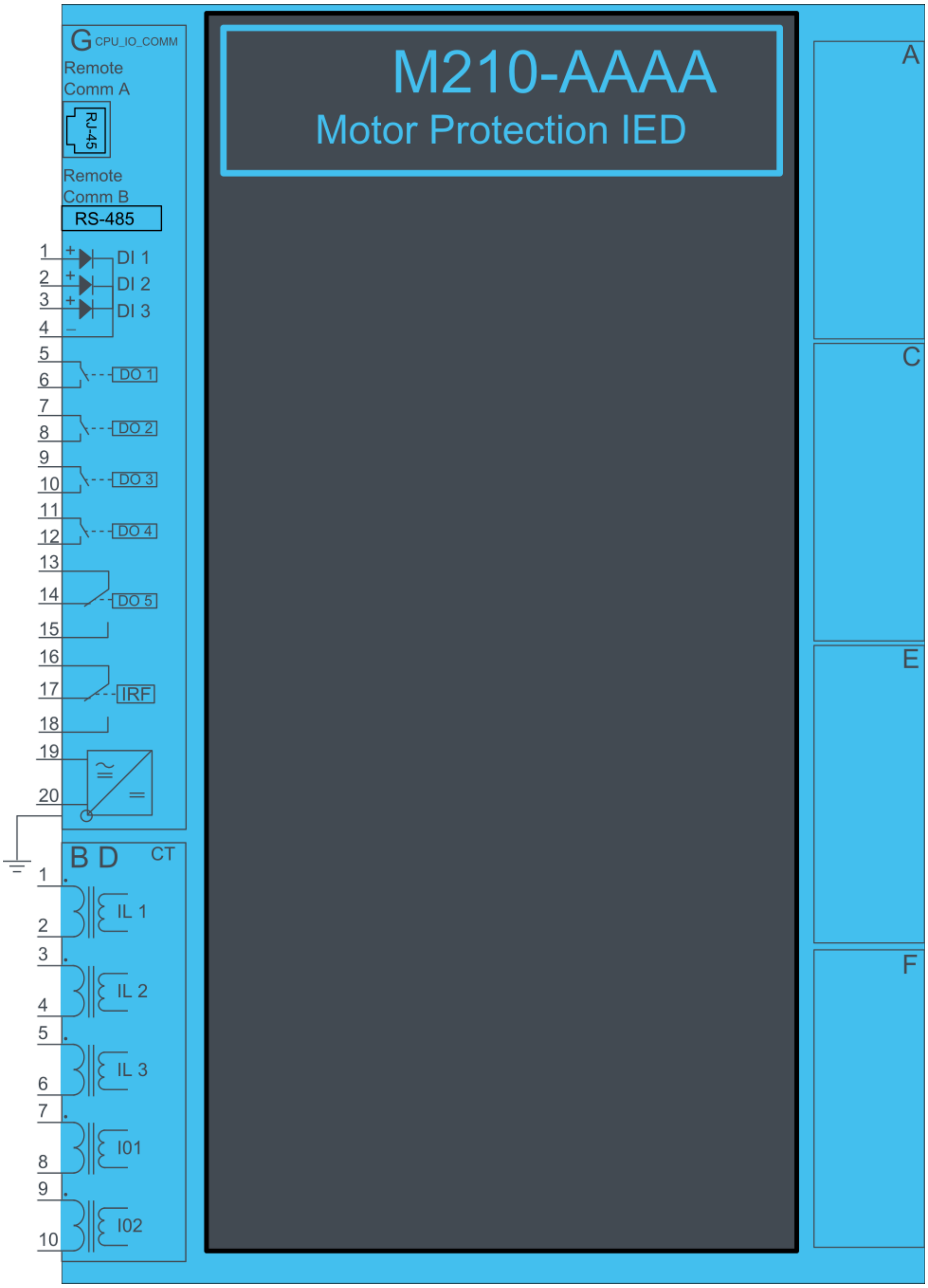


Figure 4.21 M210 variant with binary input and output modules.

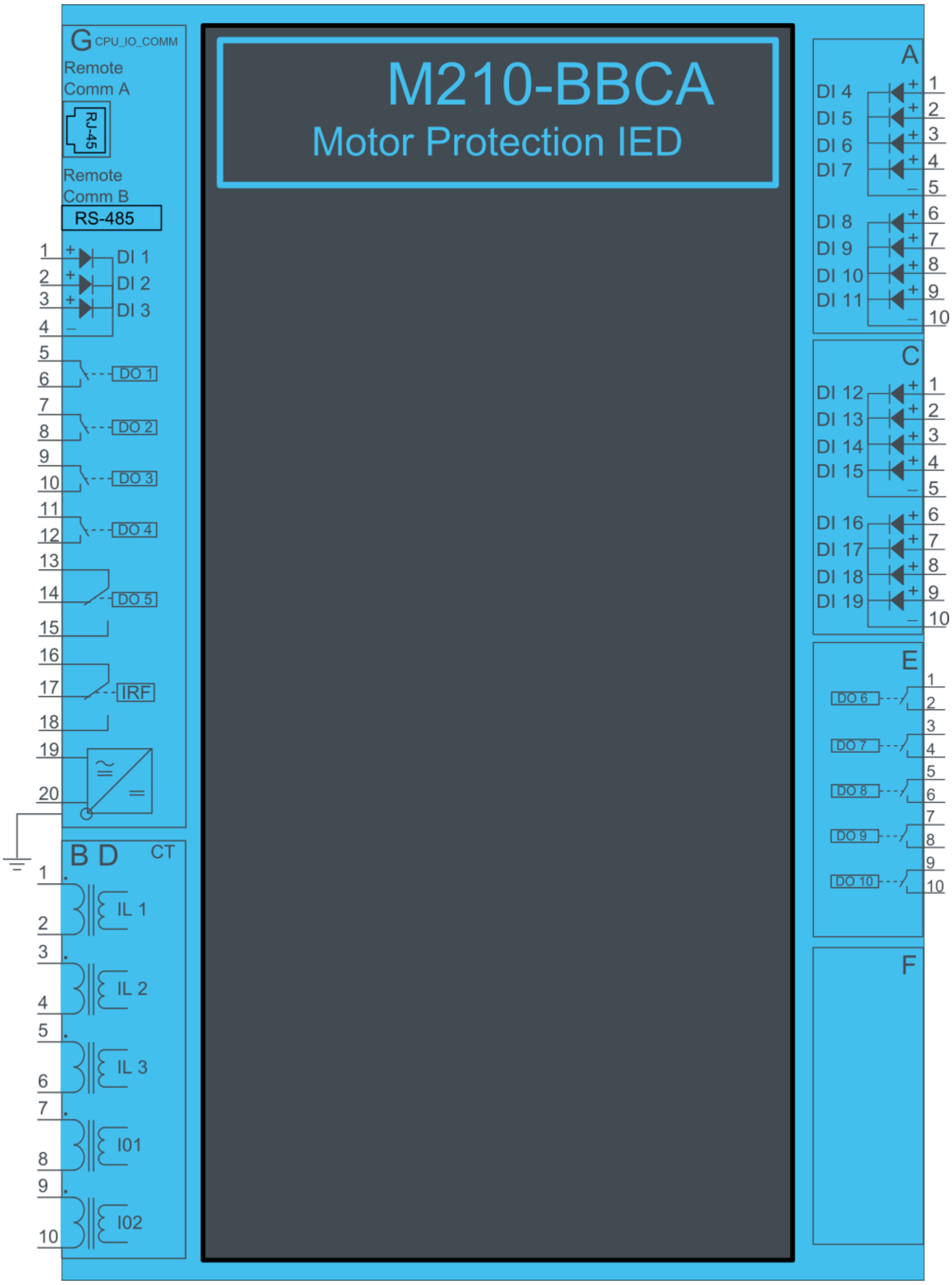
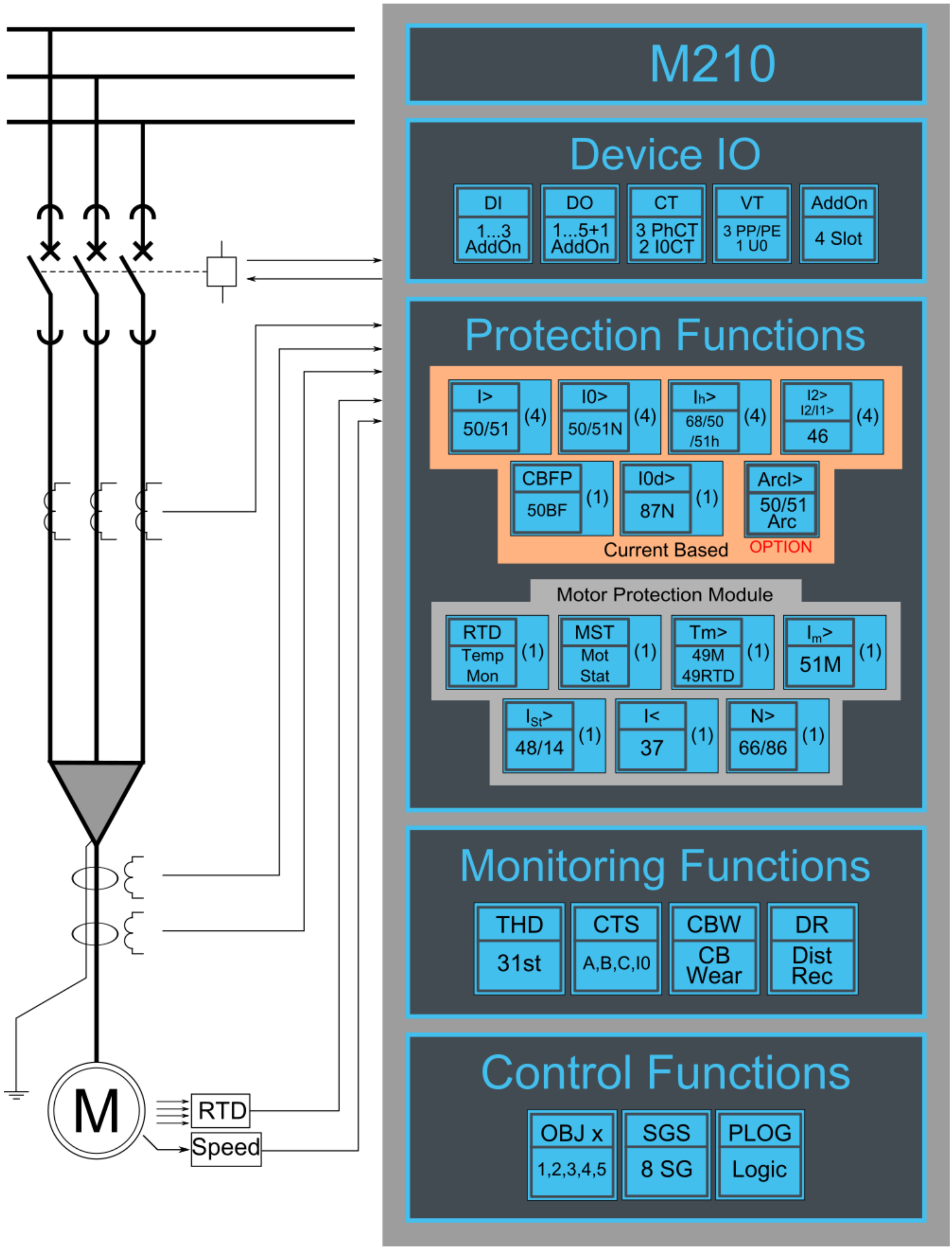


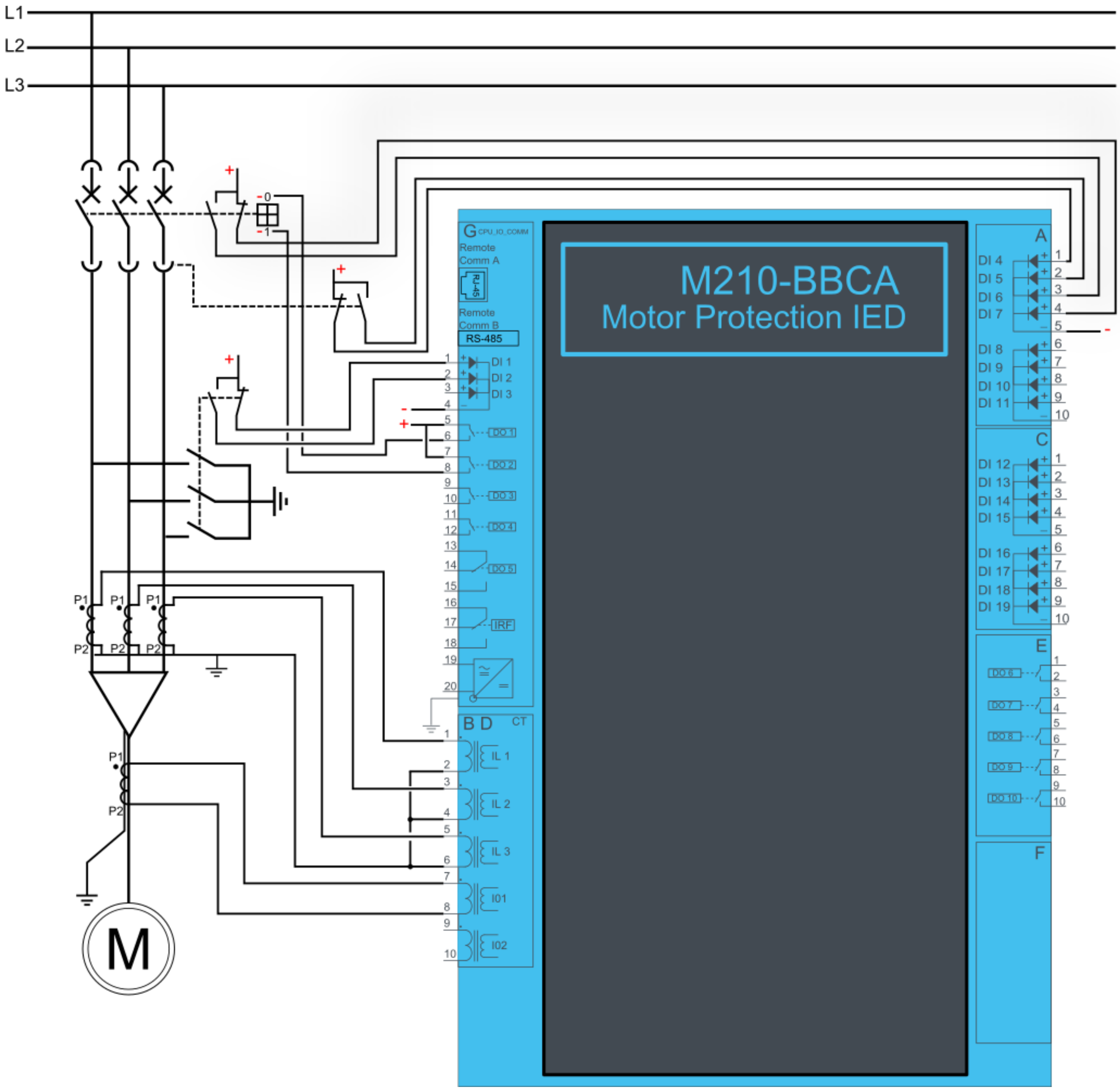
Figure 4.22 M210 application example with function block diagram.



4.7.2 Example motor application connection

Connection example application with three phase currents and residual current connected. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.23 Three phase currents and residual current measurement connected.



4.8 MVR-M215

4.8.1 Connections M215

Figure 4.24 M215 variant without add-on modules.

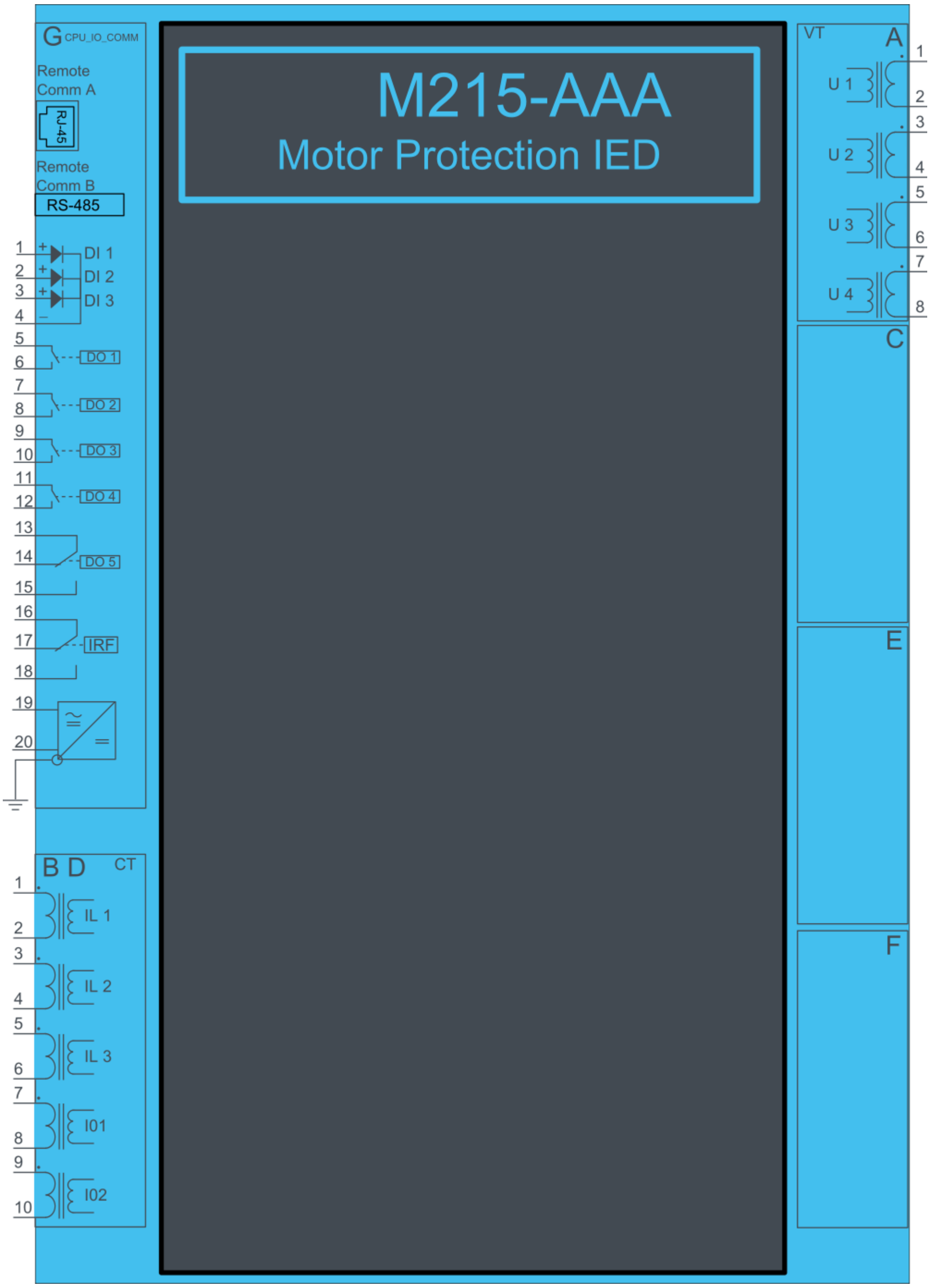


Figure 4.25 M215 variant with binary input and output modules.

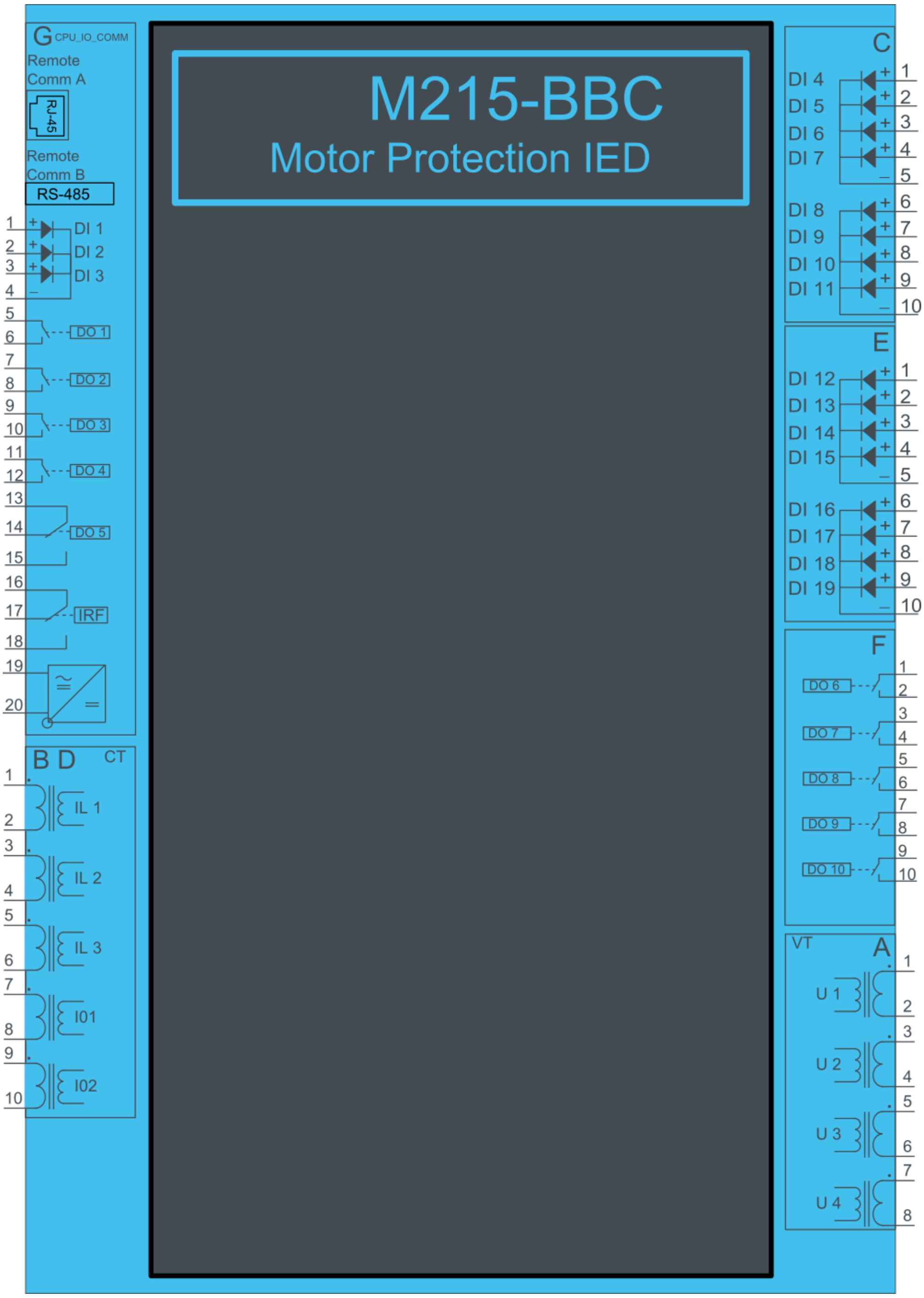
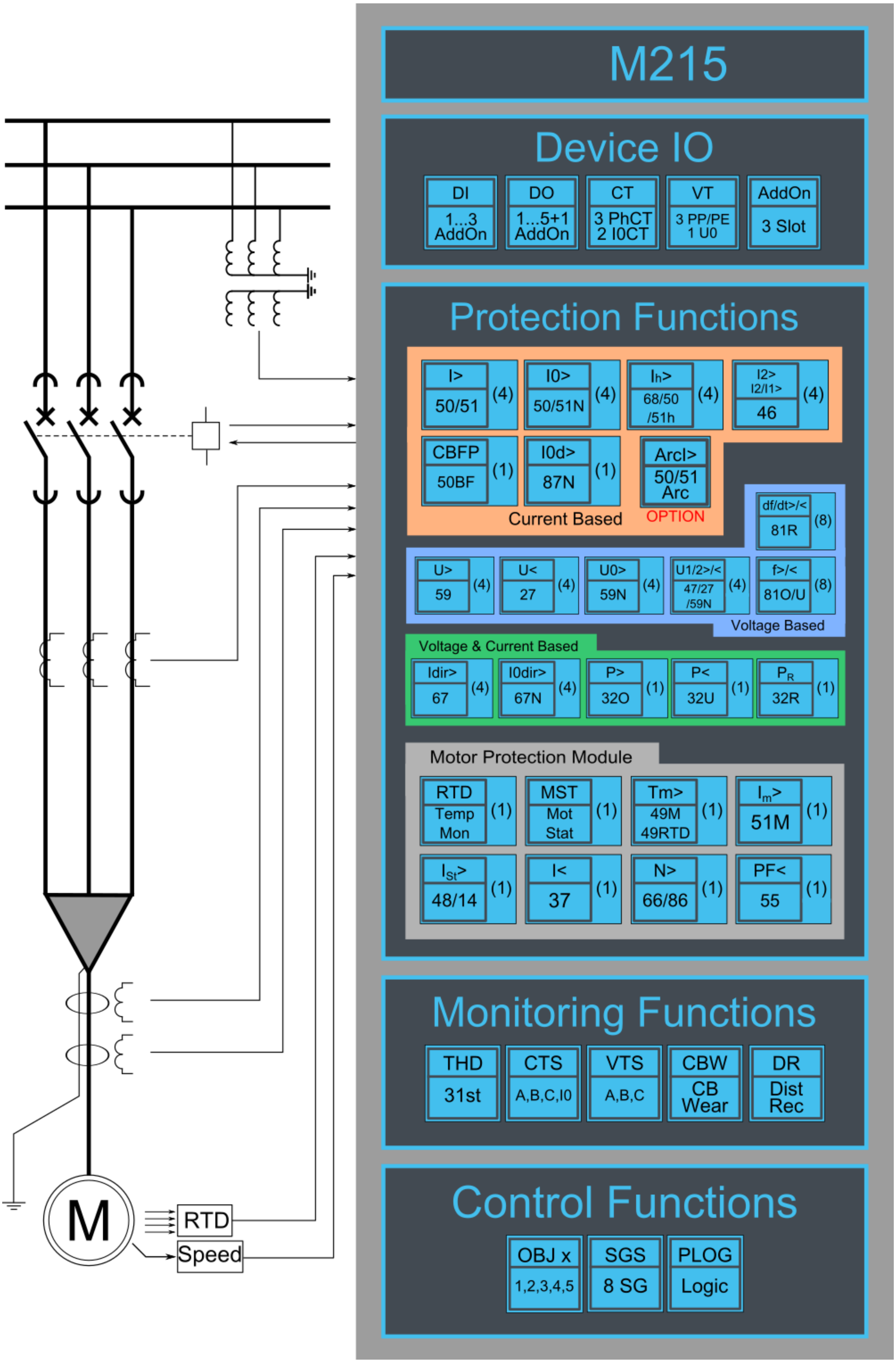


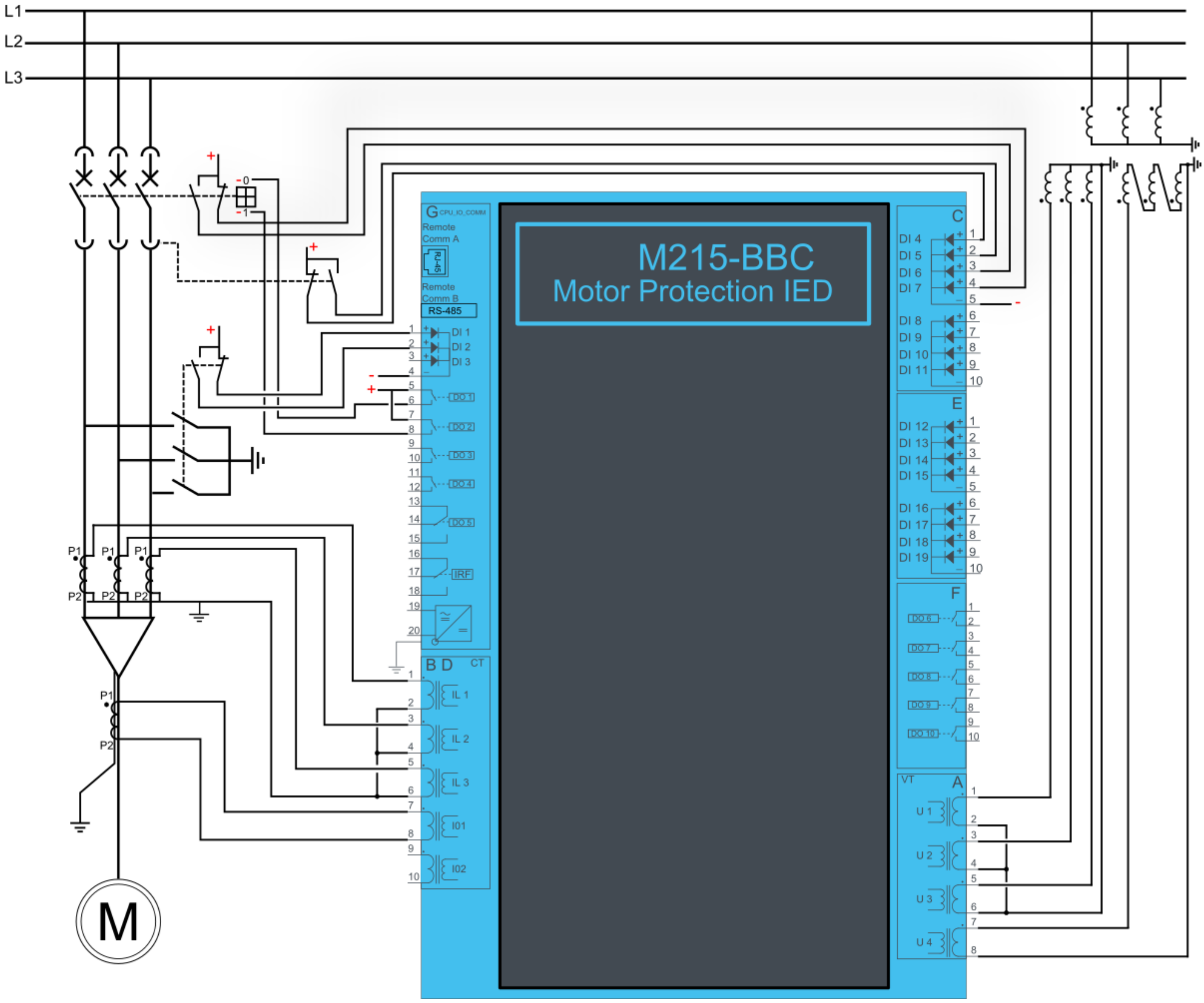
Figure 4.26 M215 application example with function block diagram.



4.8.2 Example motor application connection

Connection example of motor application with three lines to neutral voltages and zero sequence voltage connected. Three phase currents and residual current are connected as well. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.27 Application example for M215



4.9 MVR-M255

4.9.1 Connections M255

Figure 4.28 M255 variant without add-on modules.

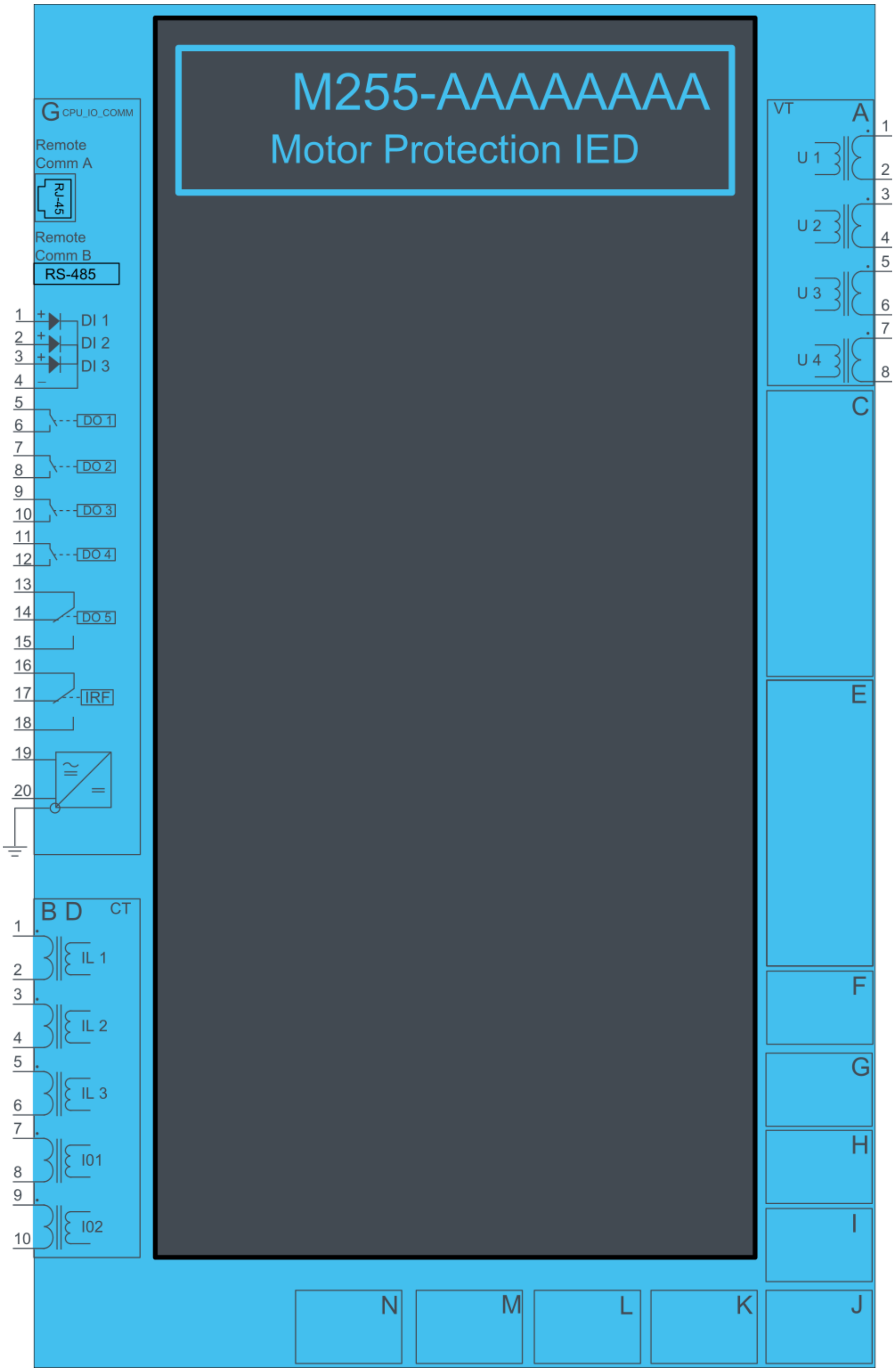


Figure 4.29 M255 variant with binary input and output modules.

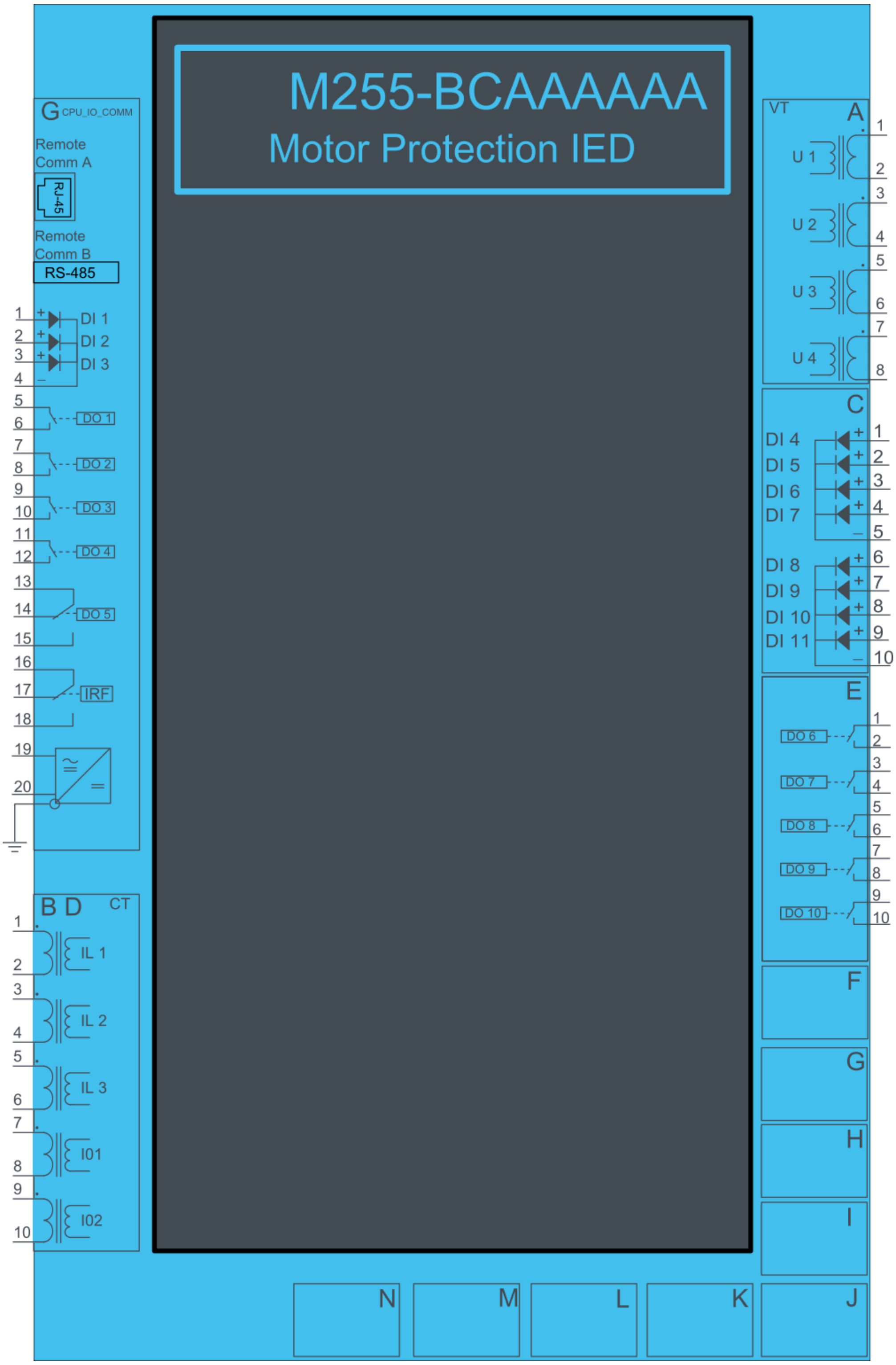
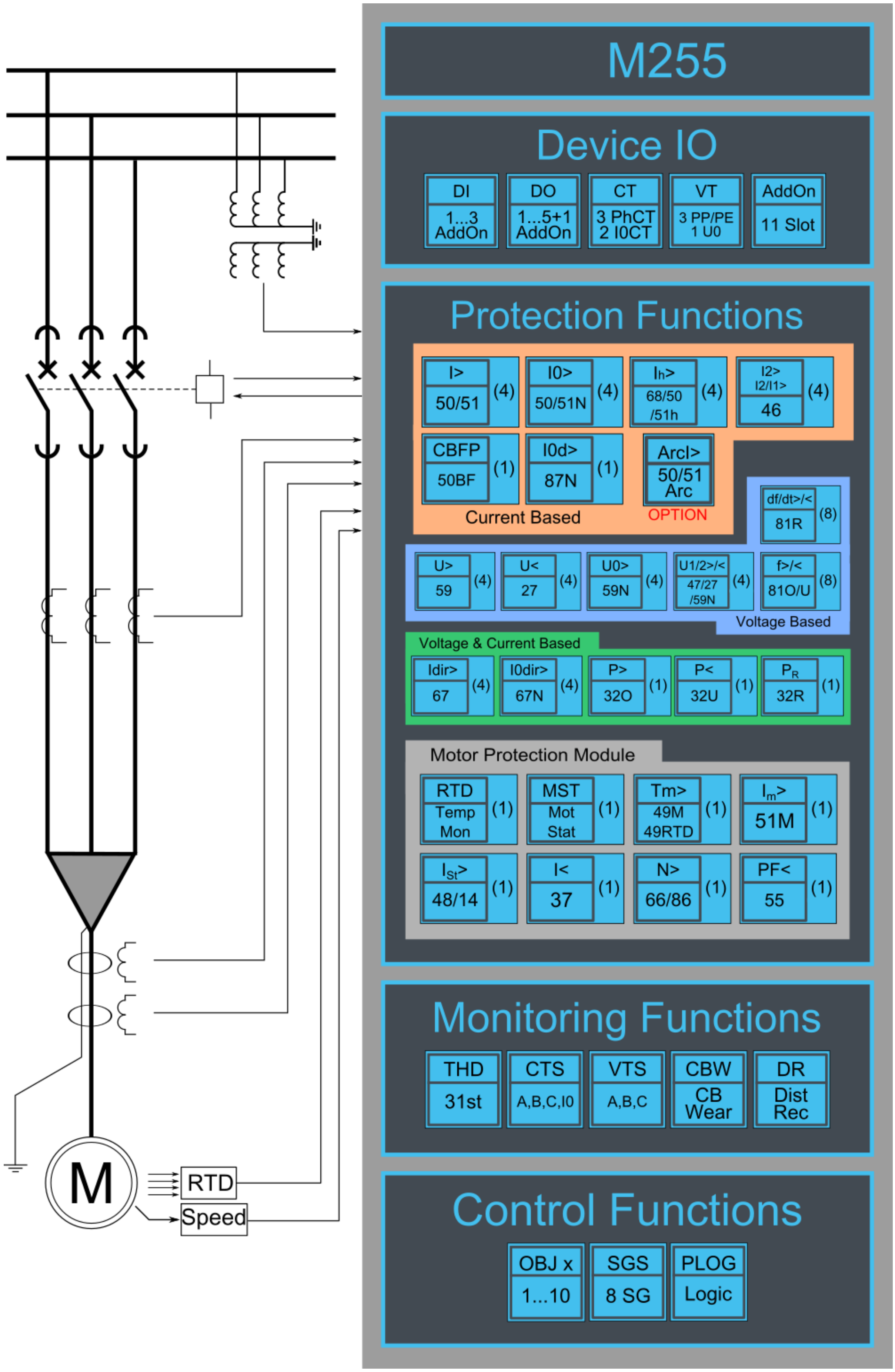


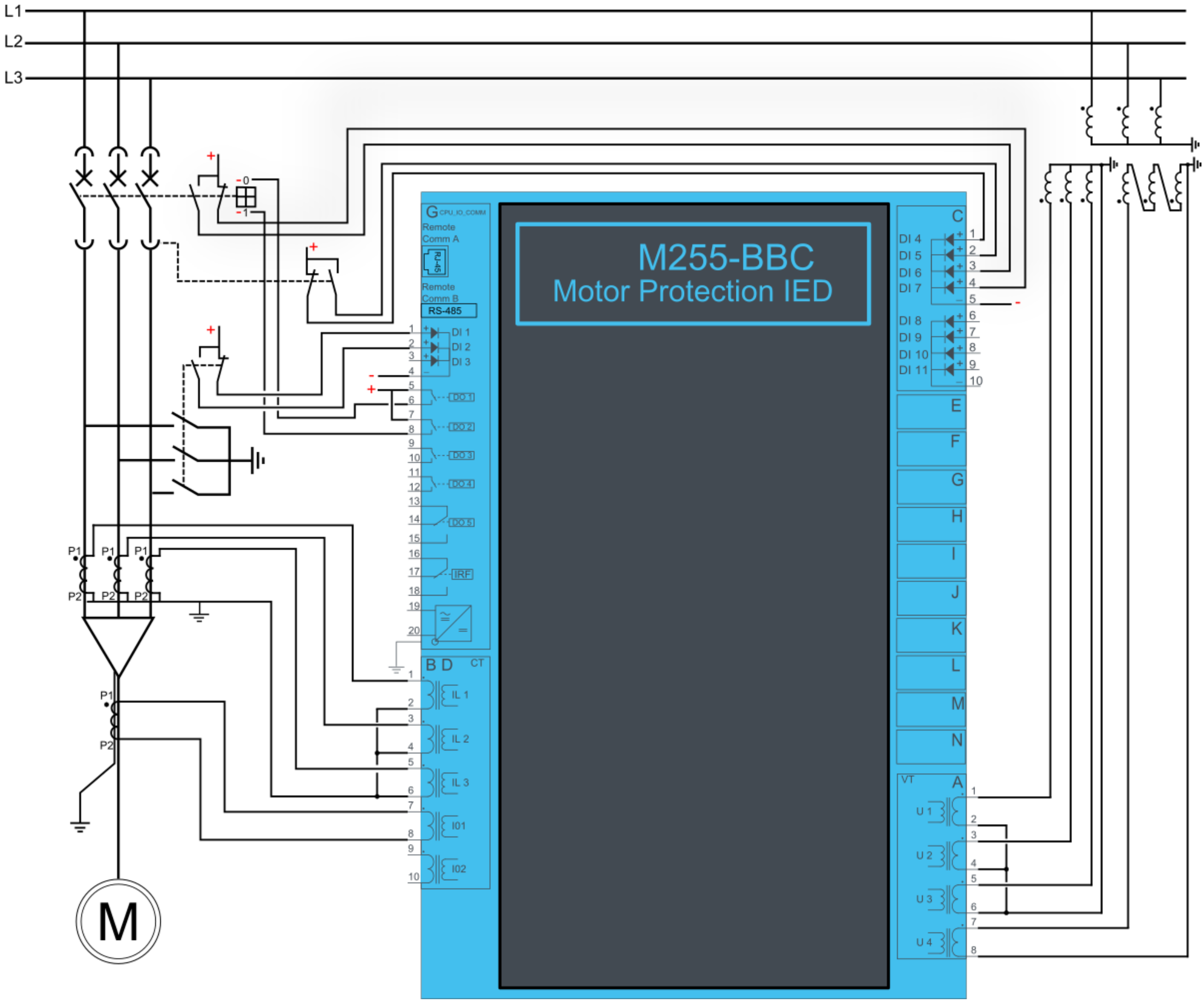
Figure 4.30 M255 application example with function block diagram.



4.9.2 Example motor application connection

Connection example application with three lines to neutral voltages and zero sequence voltage connected. Three phase currents and residual current are connected as well. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.31 M255 example application drawing



4.10 MVR-M257

4.10.1 Connections M257

Figure 4.32 M257 variant without add-on modules.

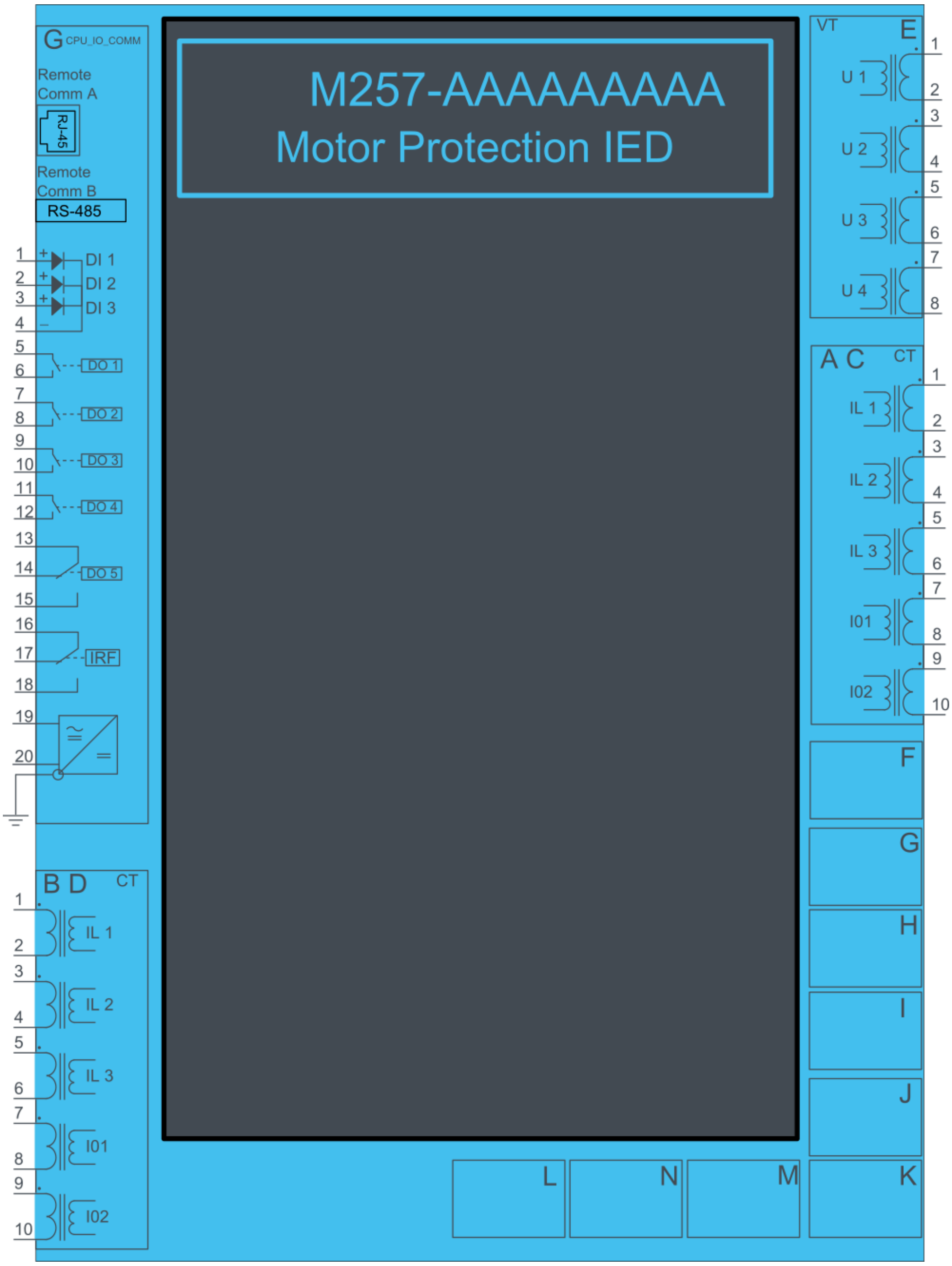


Figure 4.33 M257 variant with binary input and output modules.

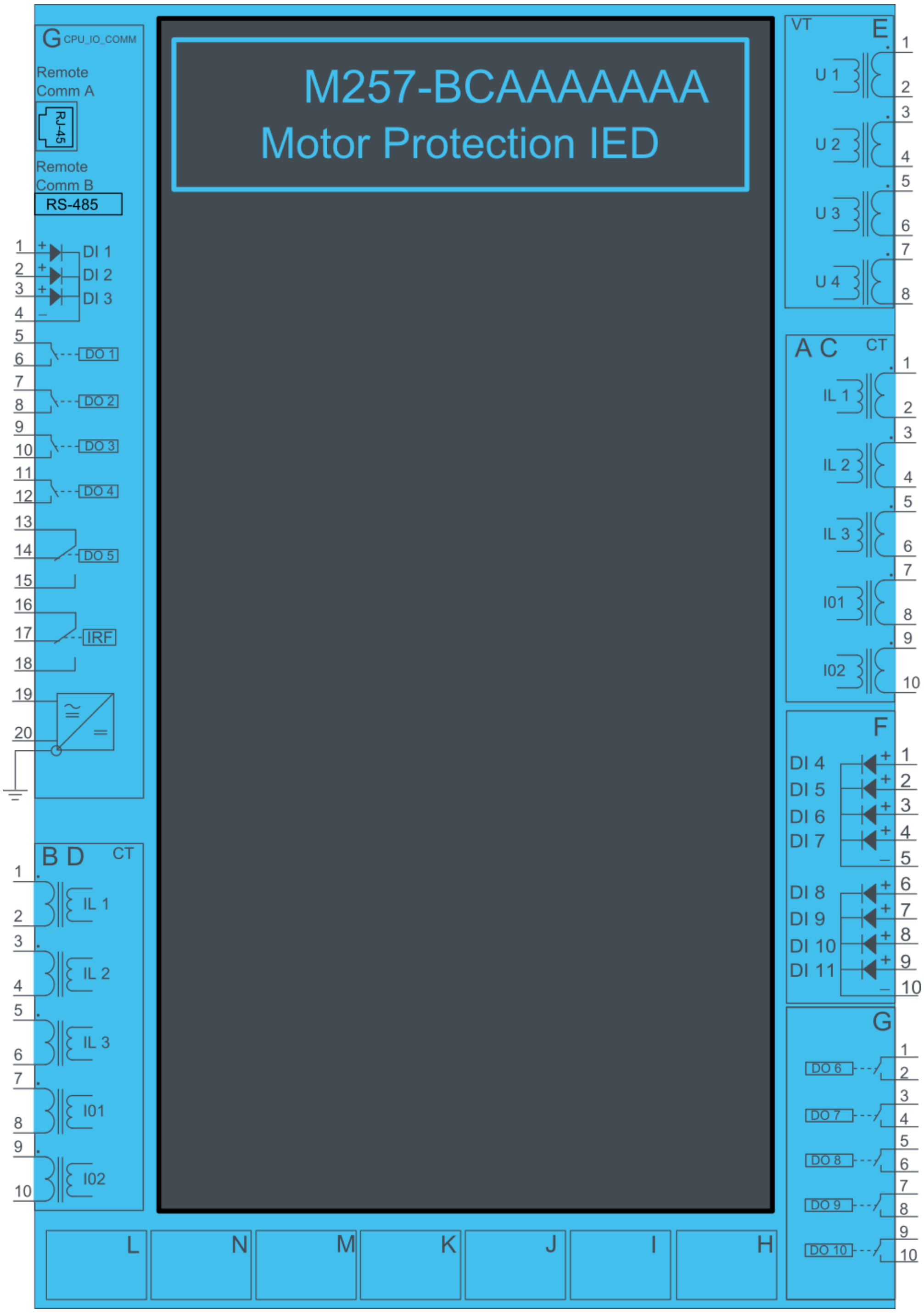
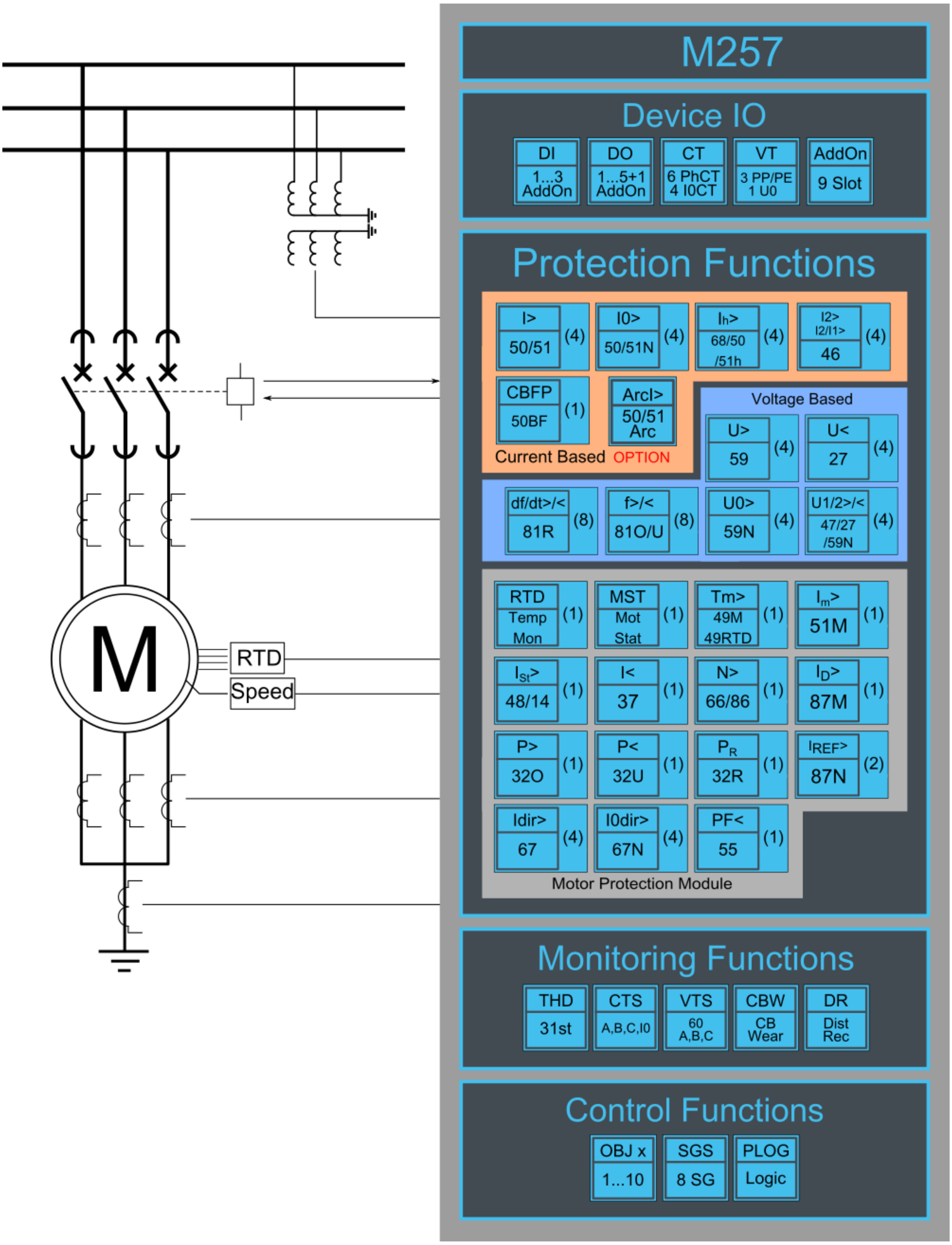


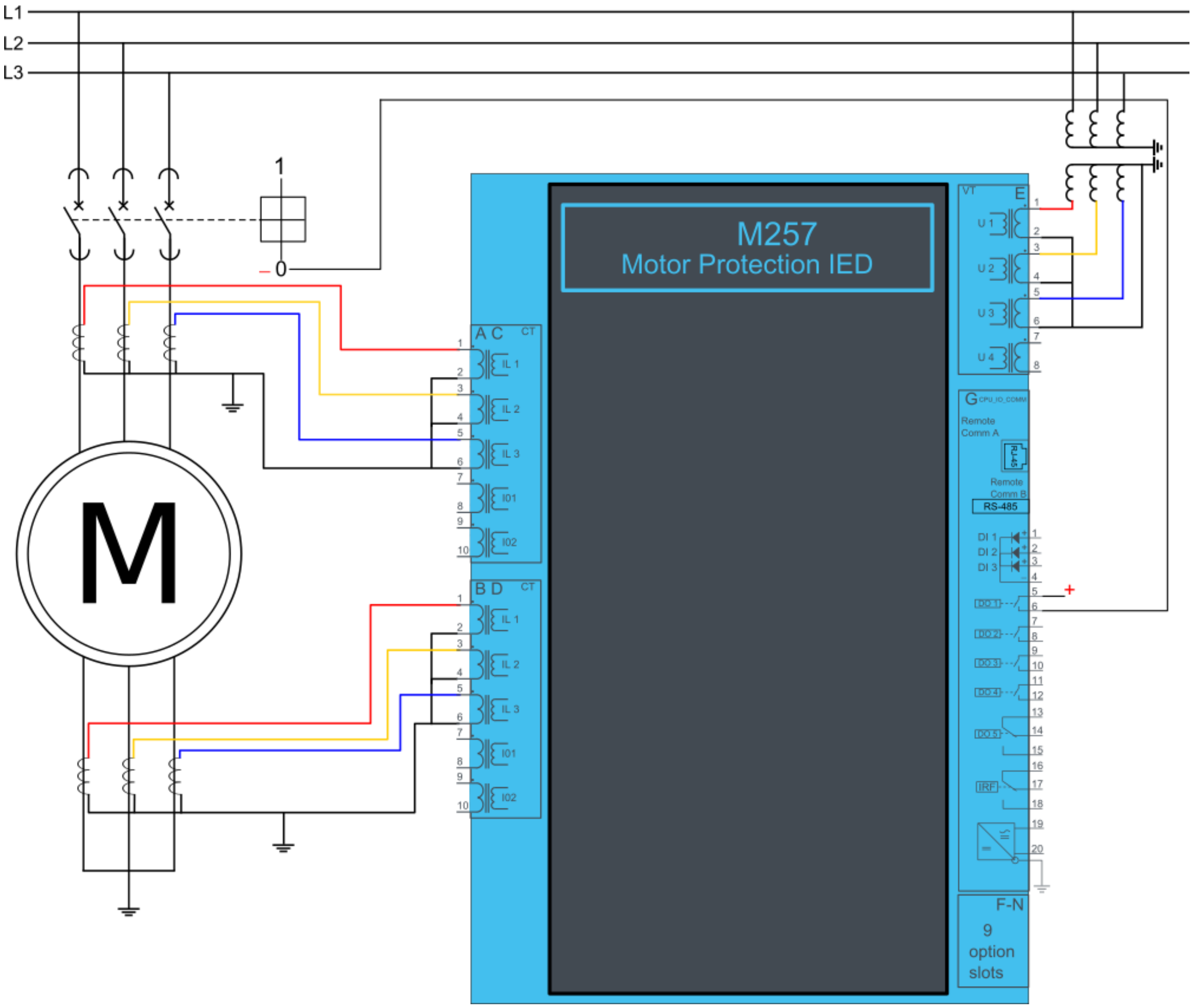
Figure 4.34 M257 application example with function block diagram.



4.10.2 Example motor application connection

Example motor differential protection application drawing. Two current transformers connected on both sides of the motor. Three line-to-neutral voltages connected.

Figure 4.35 Example motor differential protection application drawing.



4.11 MVR-G215

4.11.1 Connections G215

Figure 4.36 G215 variant without add-on modules.

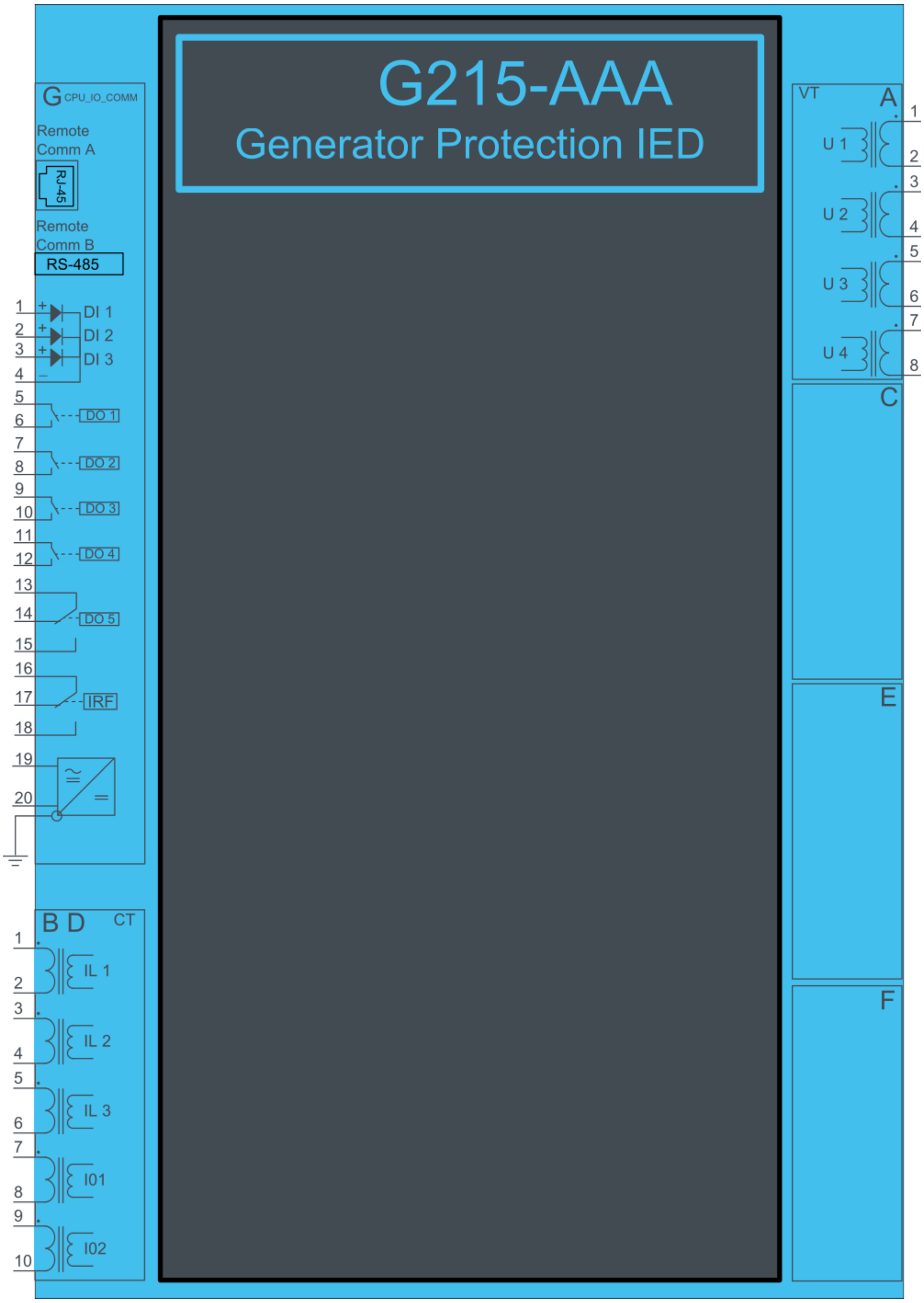


Figure 4.37 G215 variant with binary input and output modules.

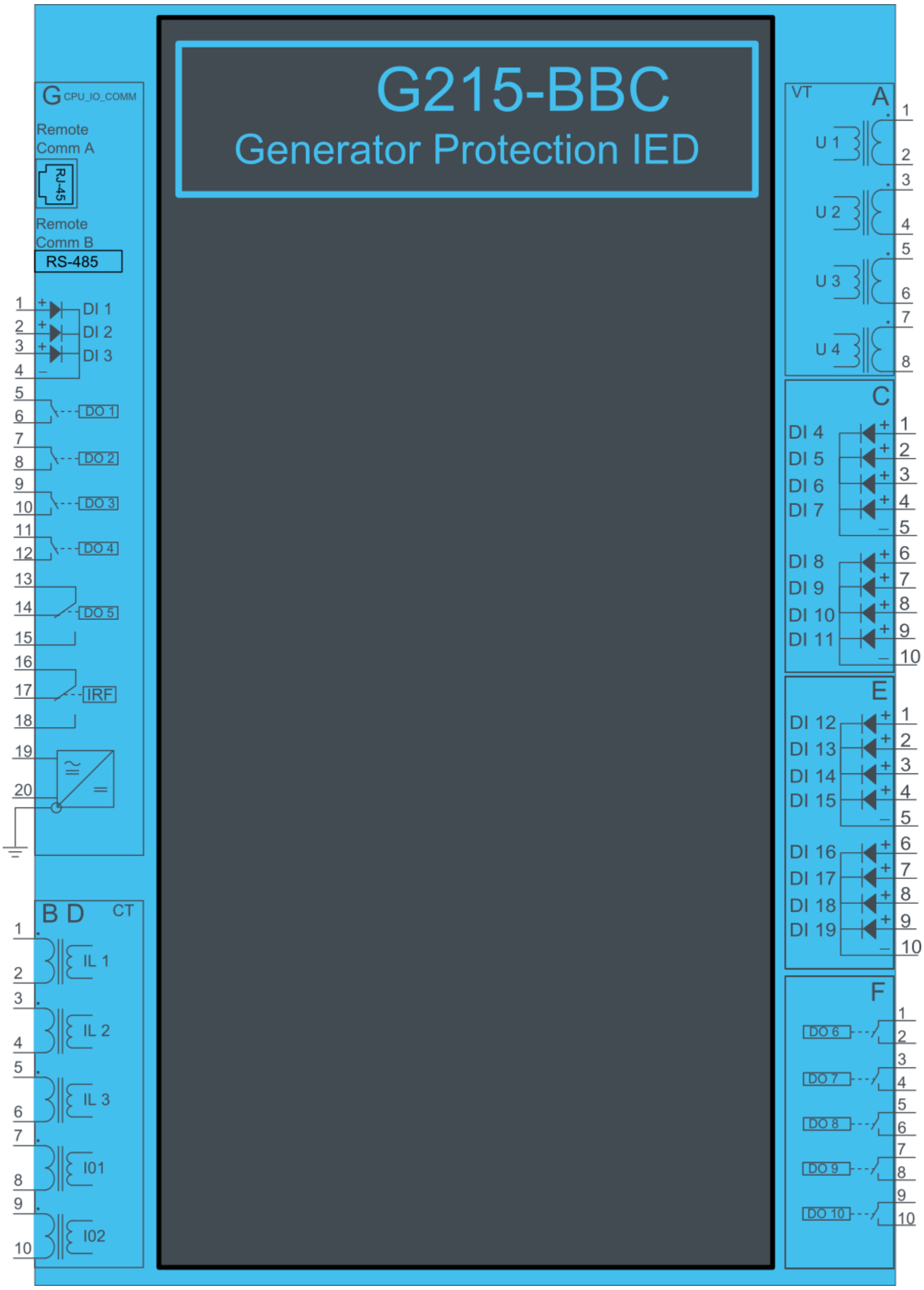
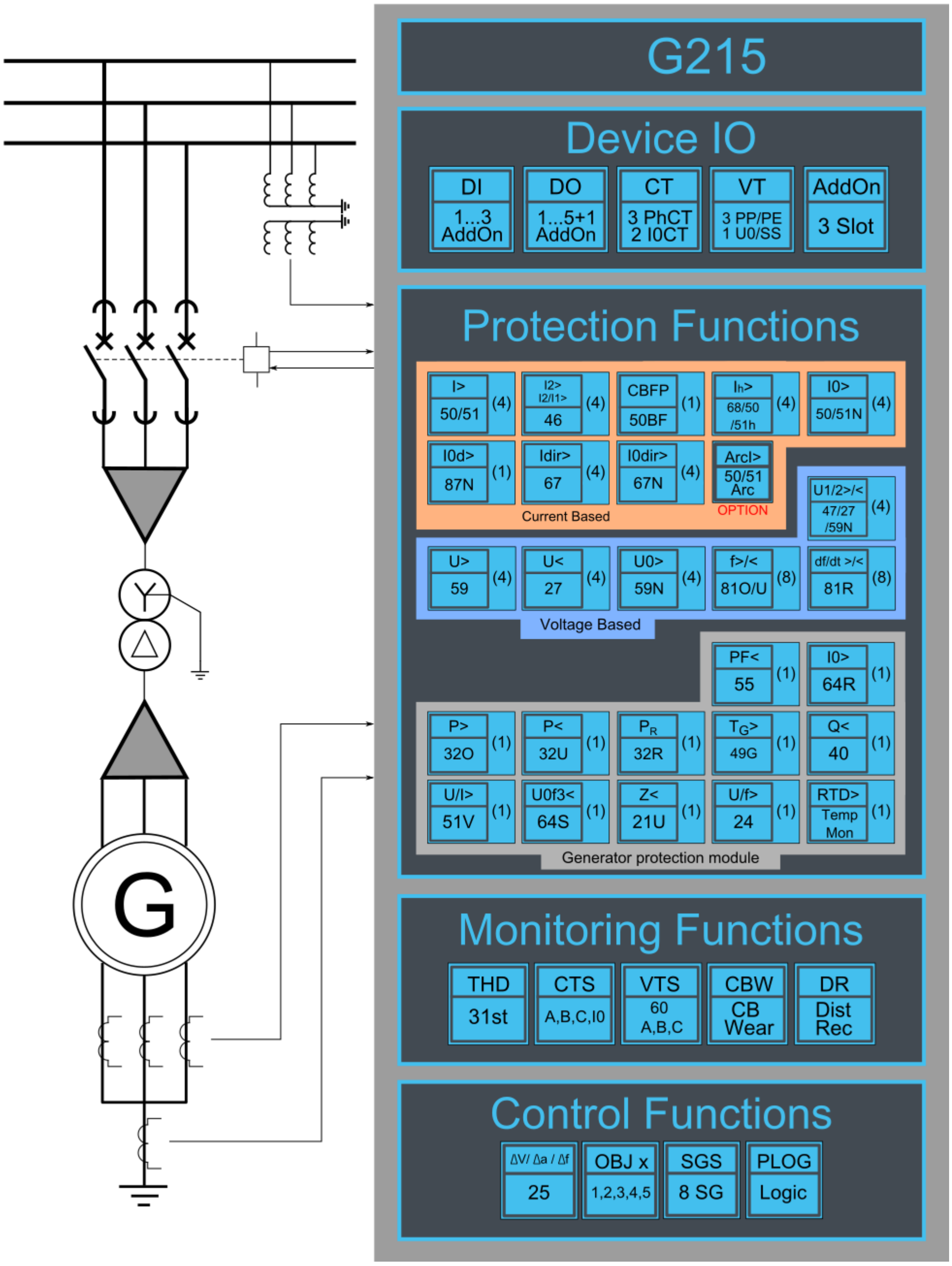


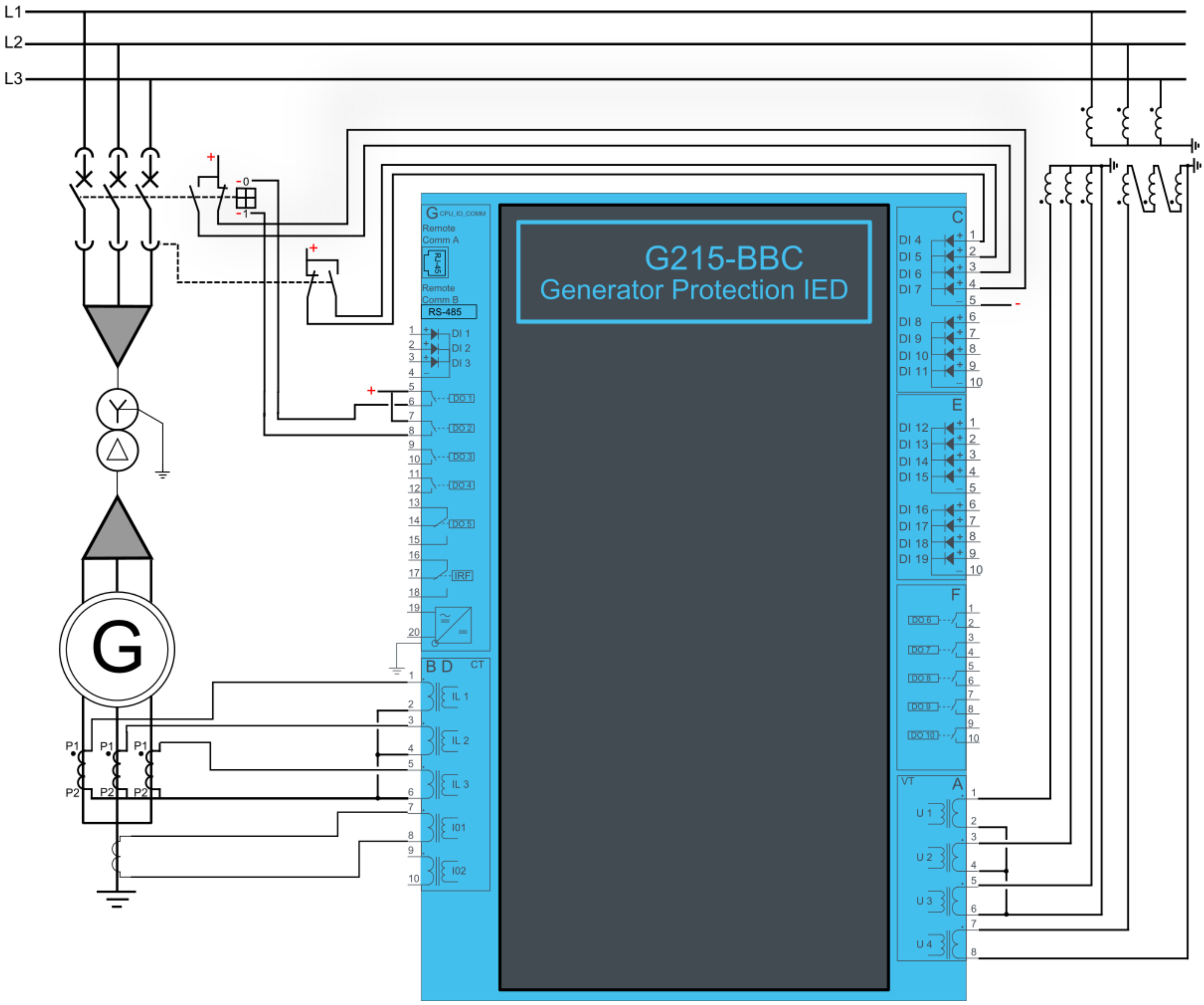
Figure 4.38 G215 application example with function block diagram.



4.11.2 Example generator application connection

Connection example of generator application with three lines to neutral voltages and zero sequence voltage connected. Three phase currents and residual current are connected as well. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

Figure 4.39 Application example for G215



4.12 MVR-G257

4.12.1 Connections G257

Figure 4.40 G257 variant without add-on modules.

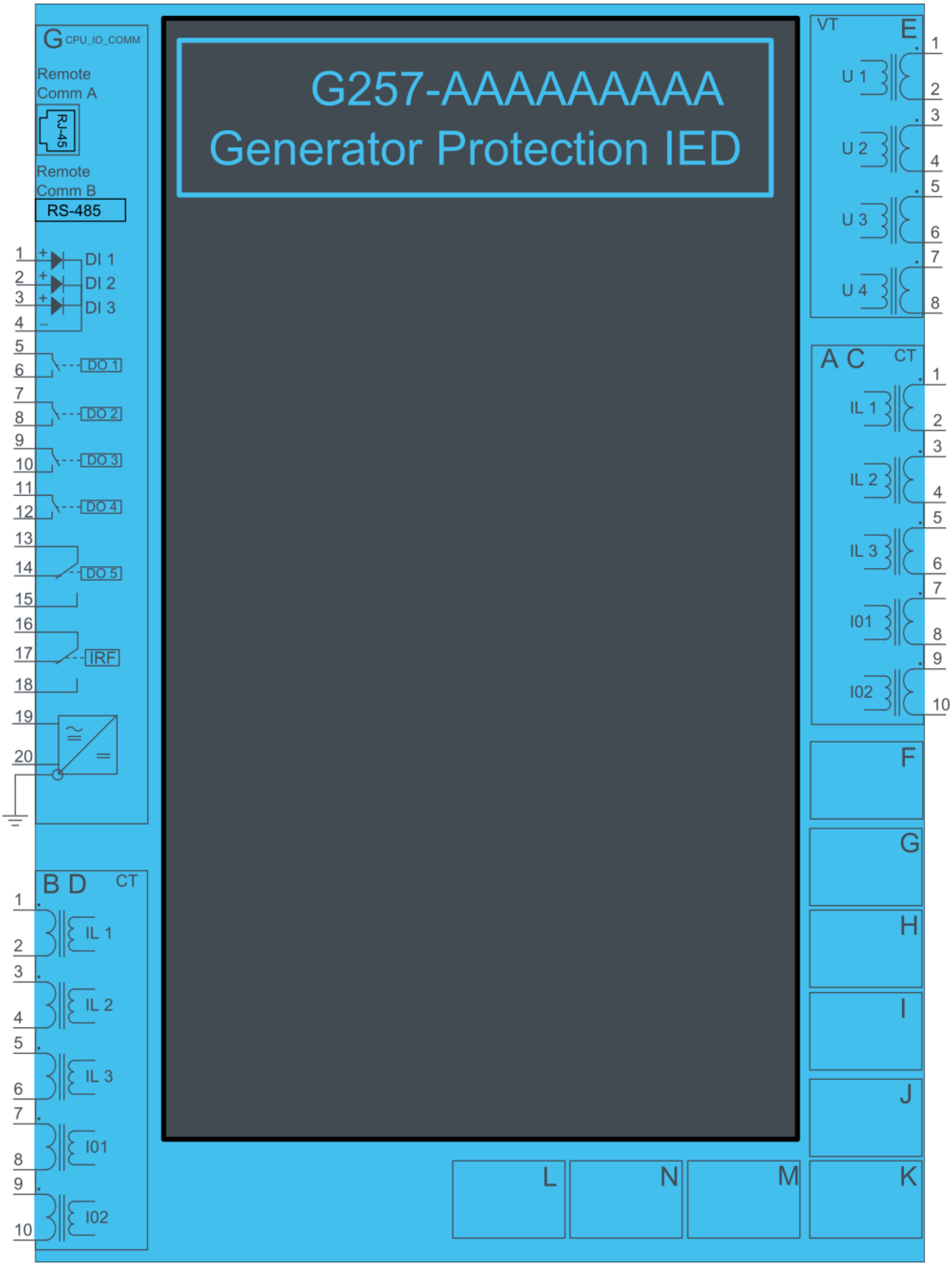


Figure 4.41 G257 variant with binary input and output modules.

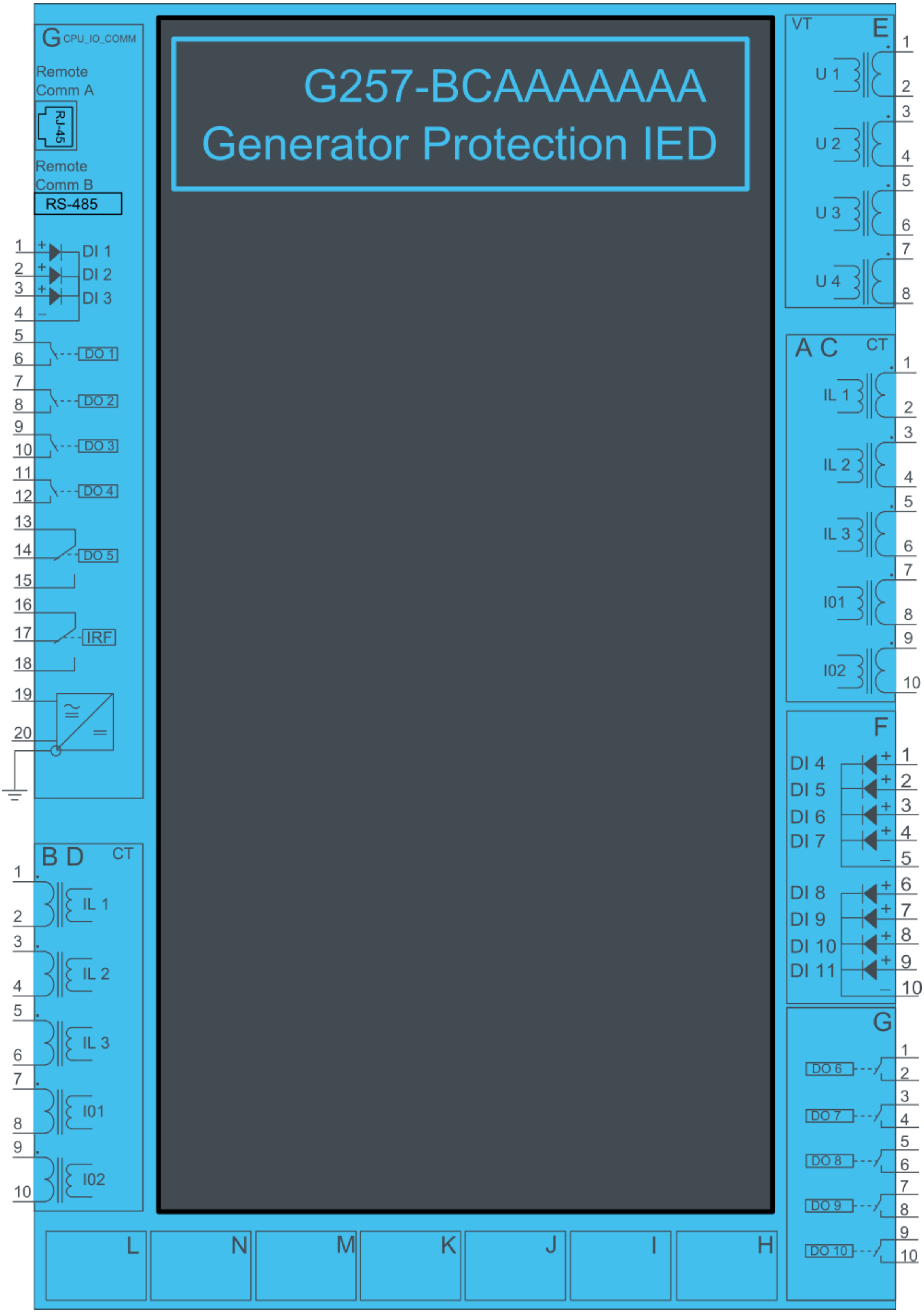
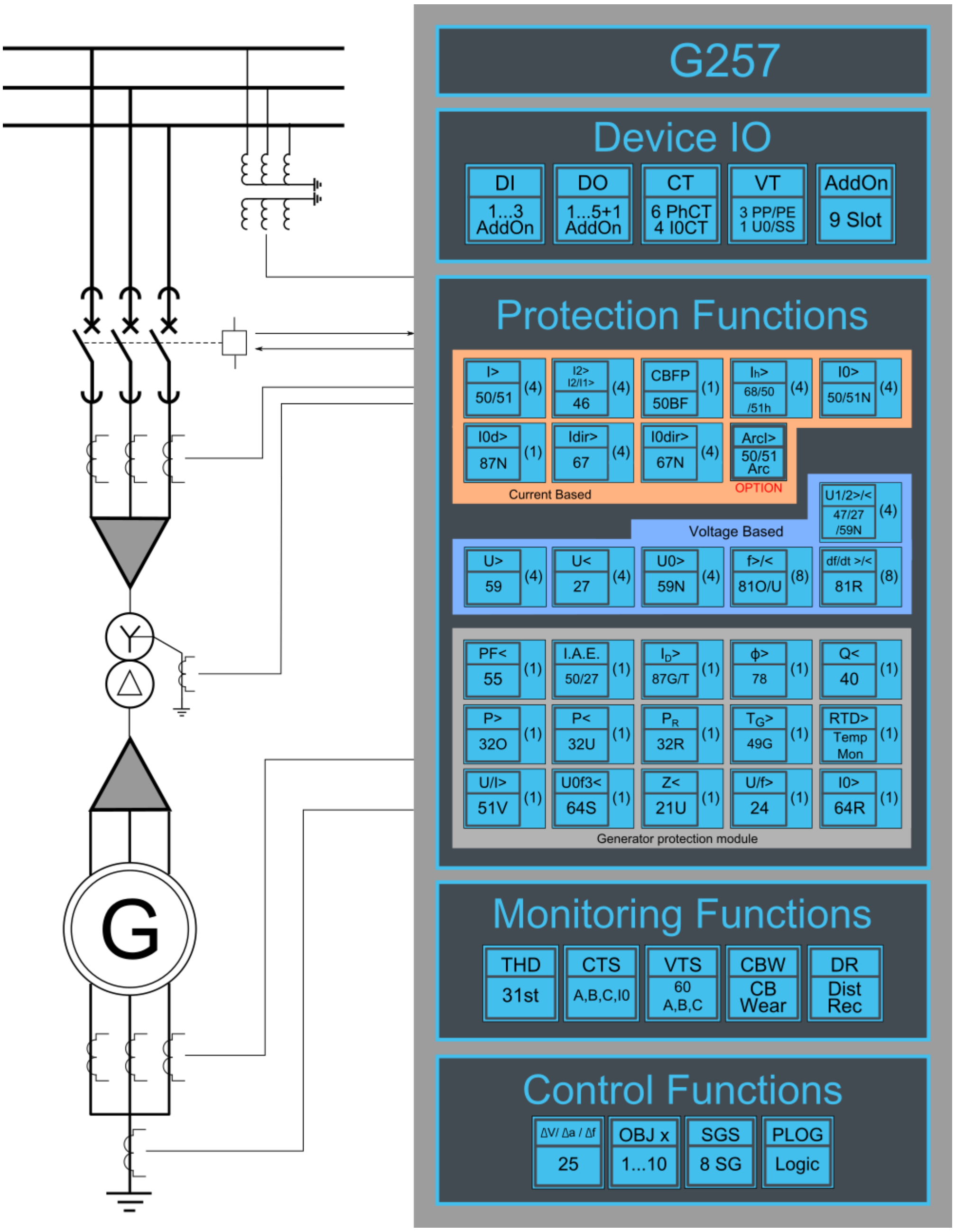


Figure 4.42 G257 application example with function block diagram.



4.12.2 Example generator application connection

Generator and transformer differential application examples. First example has transformer and generator between the current transformers. The second one has only generator between the current transformers.

Figure 4.43 Example generator differential protection application drawing with generator and transformer between the current transformers.

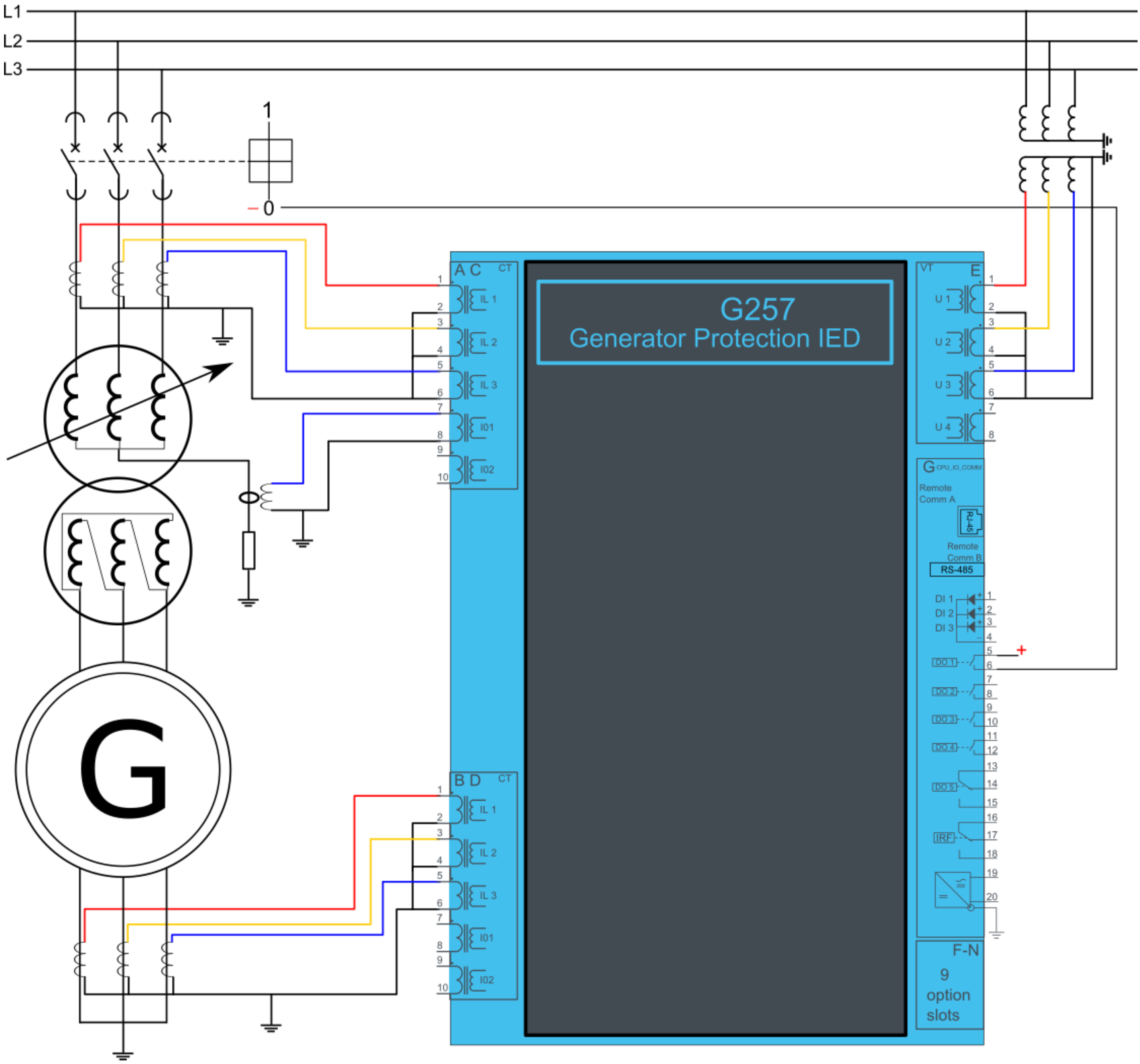
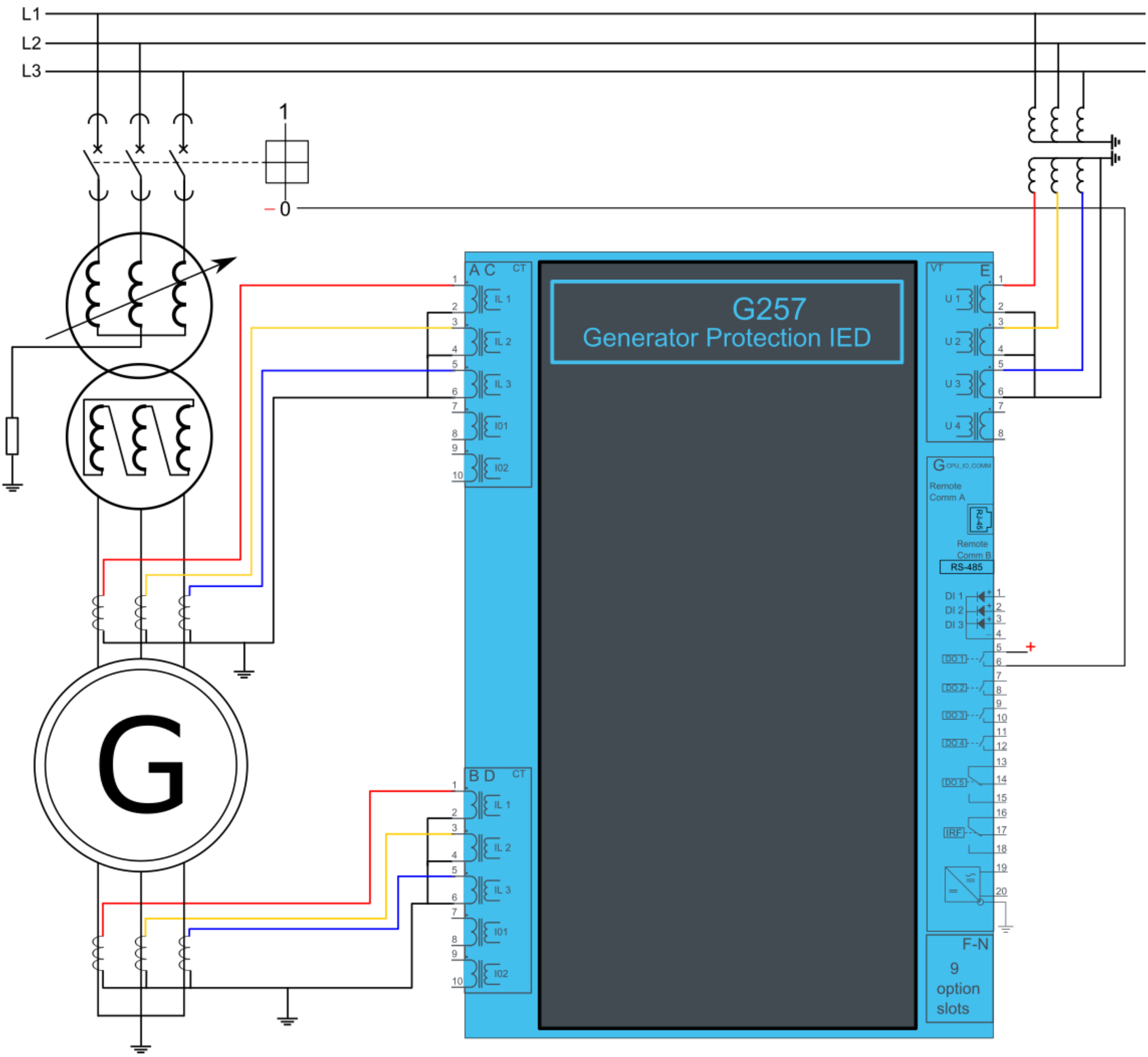


Figure 4.44 Example generator differential protection application drawing with just generator between the current transformers.



4.13 MVR-T215

4.13.1 Connections T215

Figure 4.45 T215 variant without add-on modules.

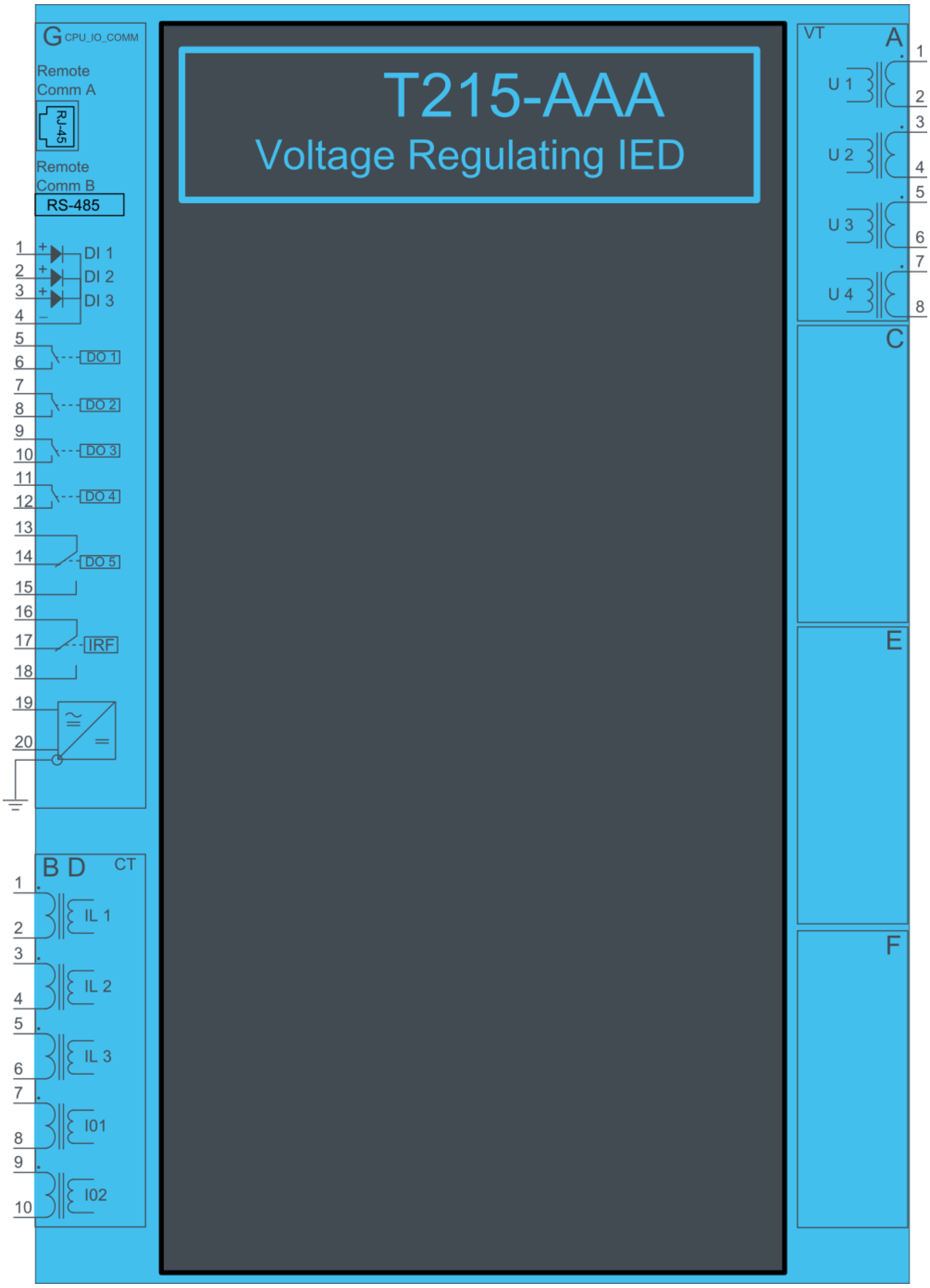


Figure 4.46 T215 variant with binary input and output modules.

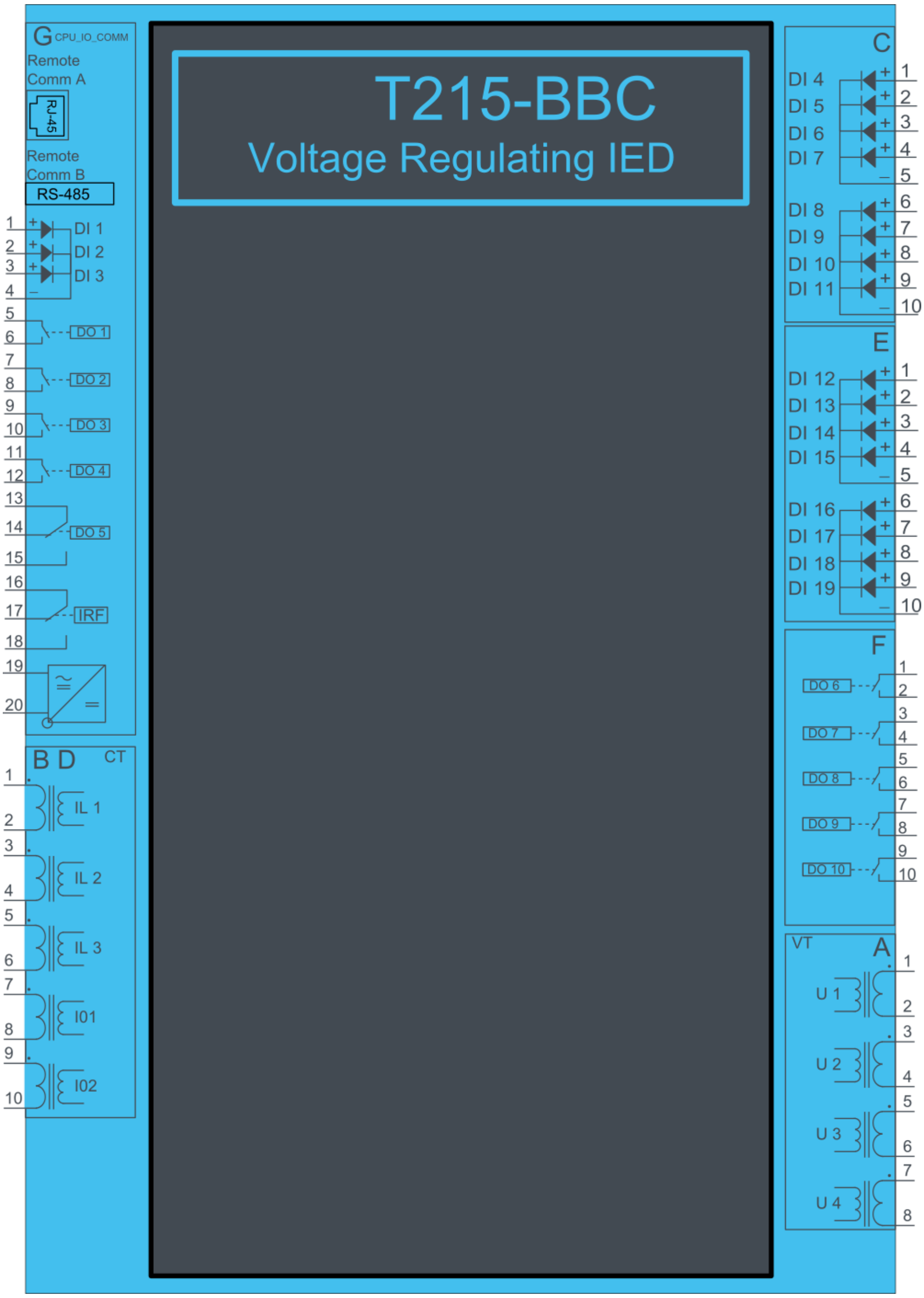
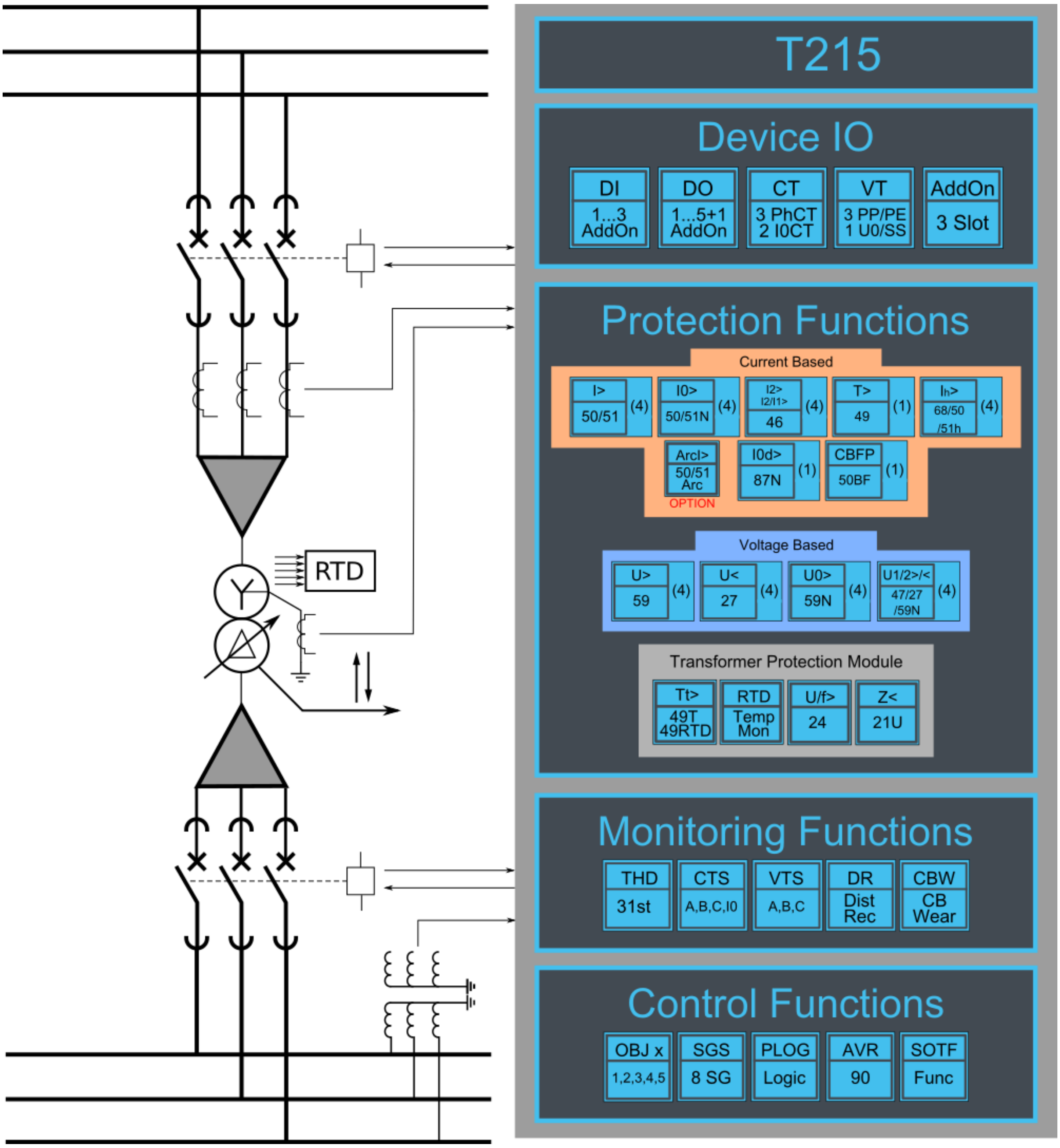


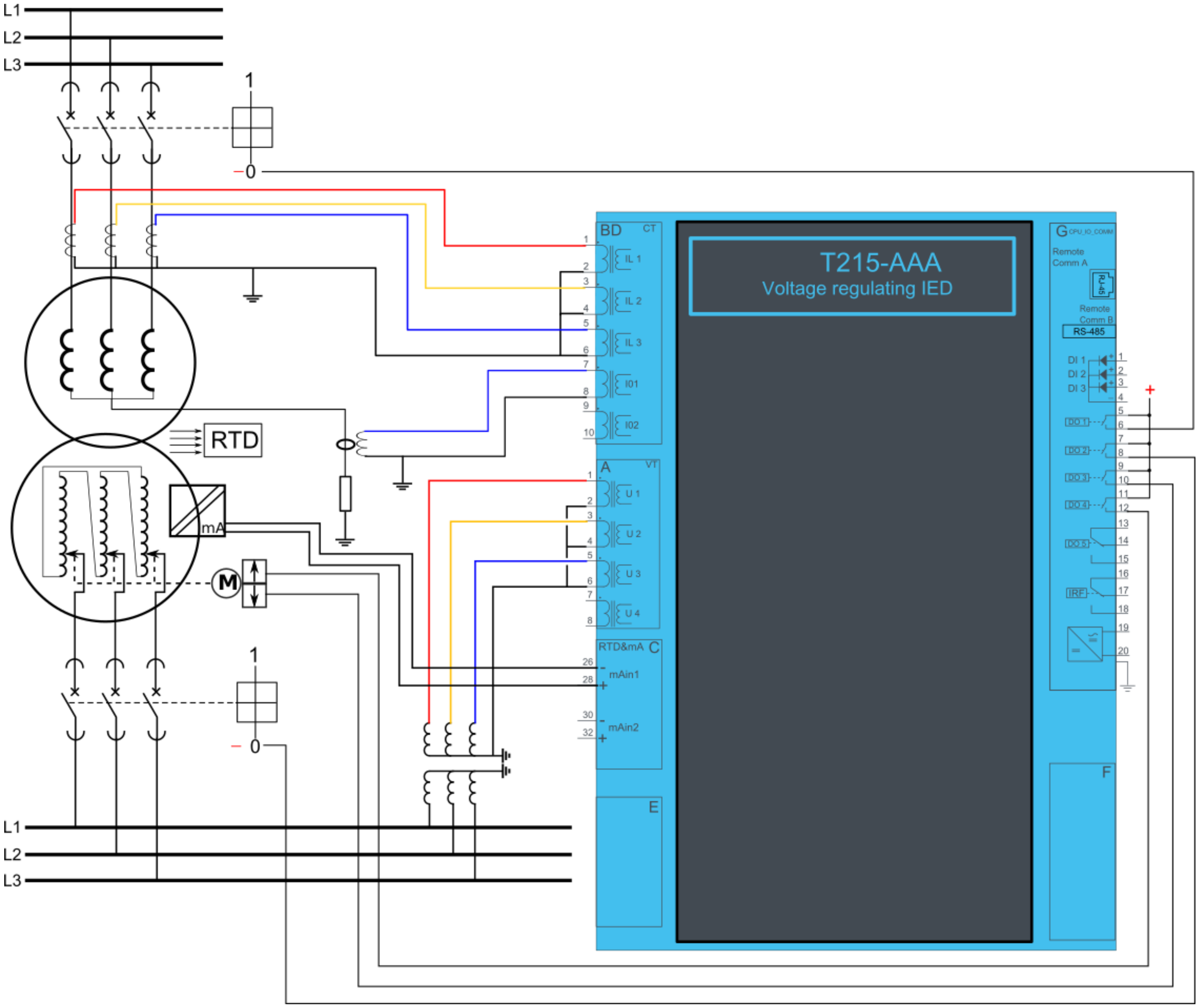
Figure 4.47 T215 application example with function block diagram.



4.13.2 Example voltage regulation application connection

Transformer voltage regulator connection example. Phase currents and voltages connected. In this example mA input used as the indication of tap changer position. Voltage raise and voltage lower commands connected to tap changer with outputs 3 and 4.

Figure 4.48 Voltage regulator IED connection example.



4.14 MVR-T216

4.14.1 Connections T216

Figure 4.49 T216 variant without add-on modules.

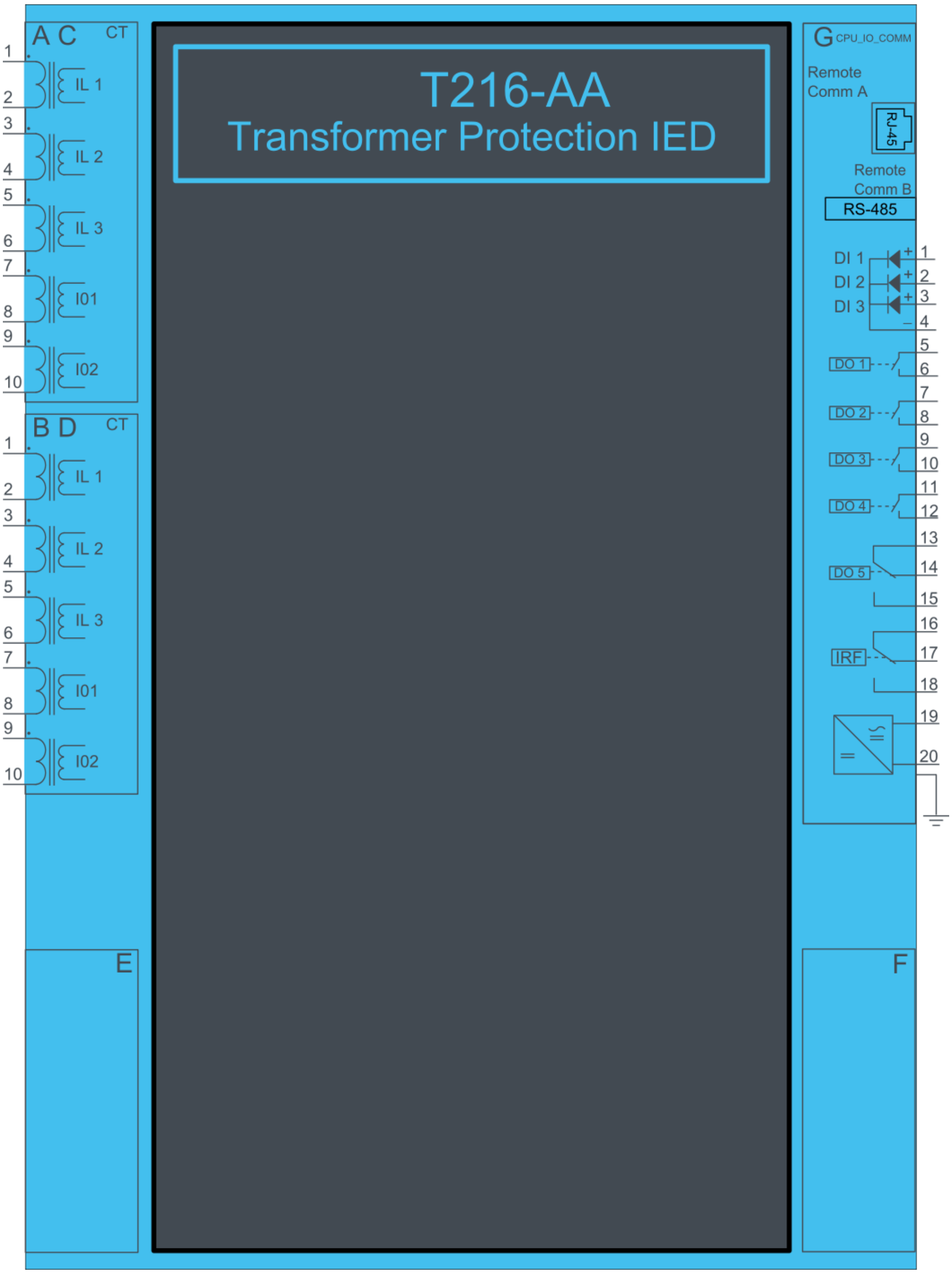


Figure 4.50 T216 variant with binary input modules.

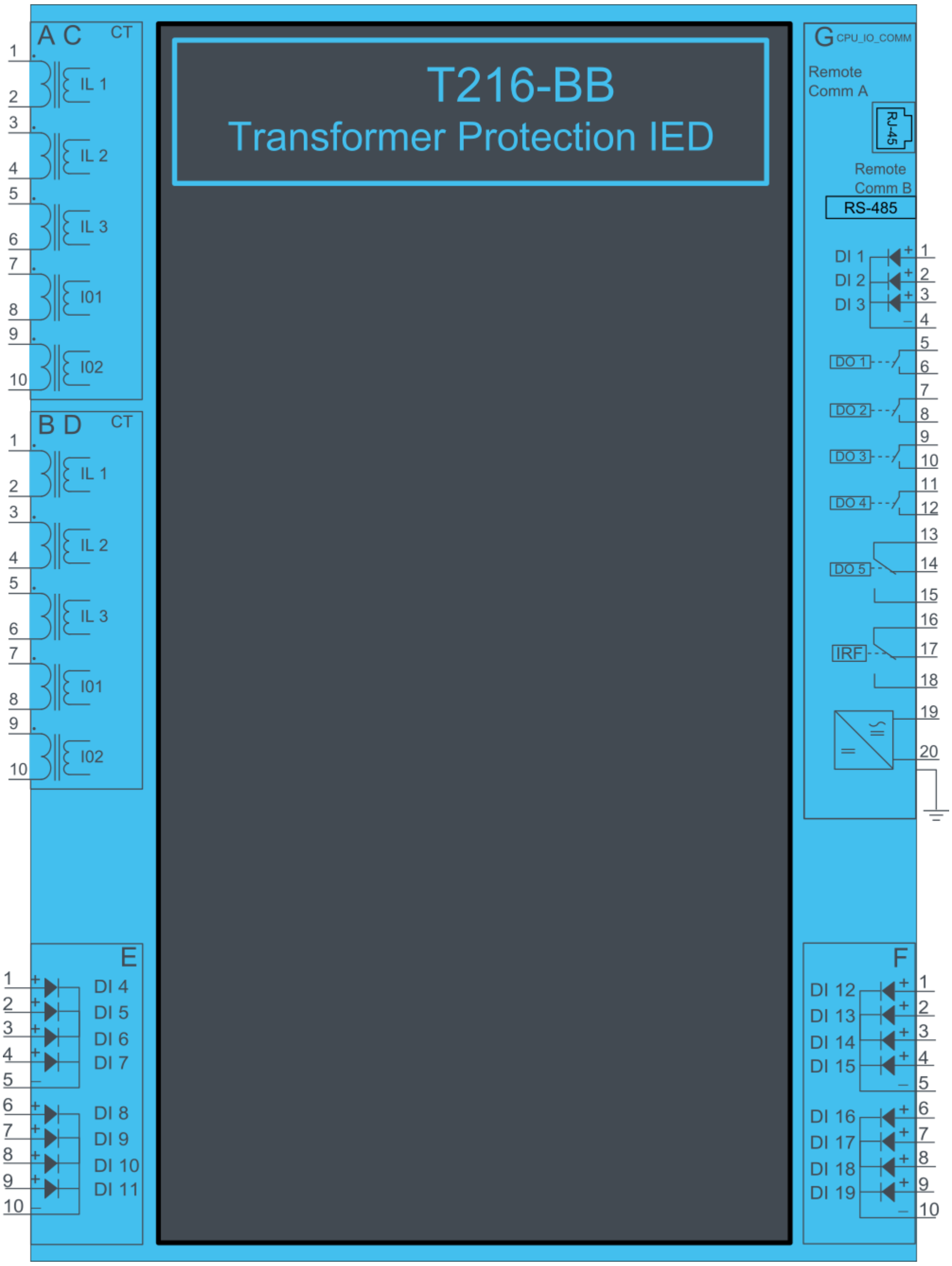
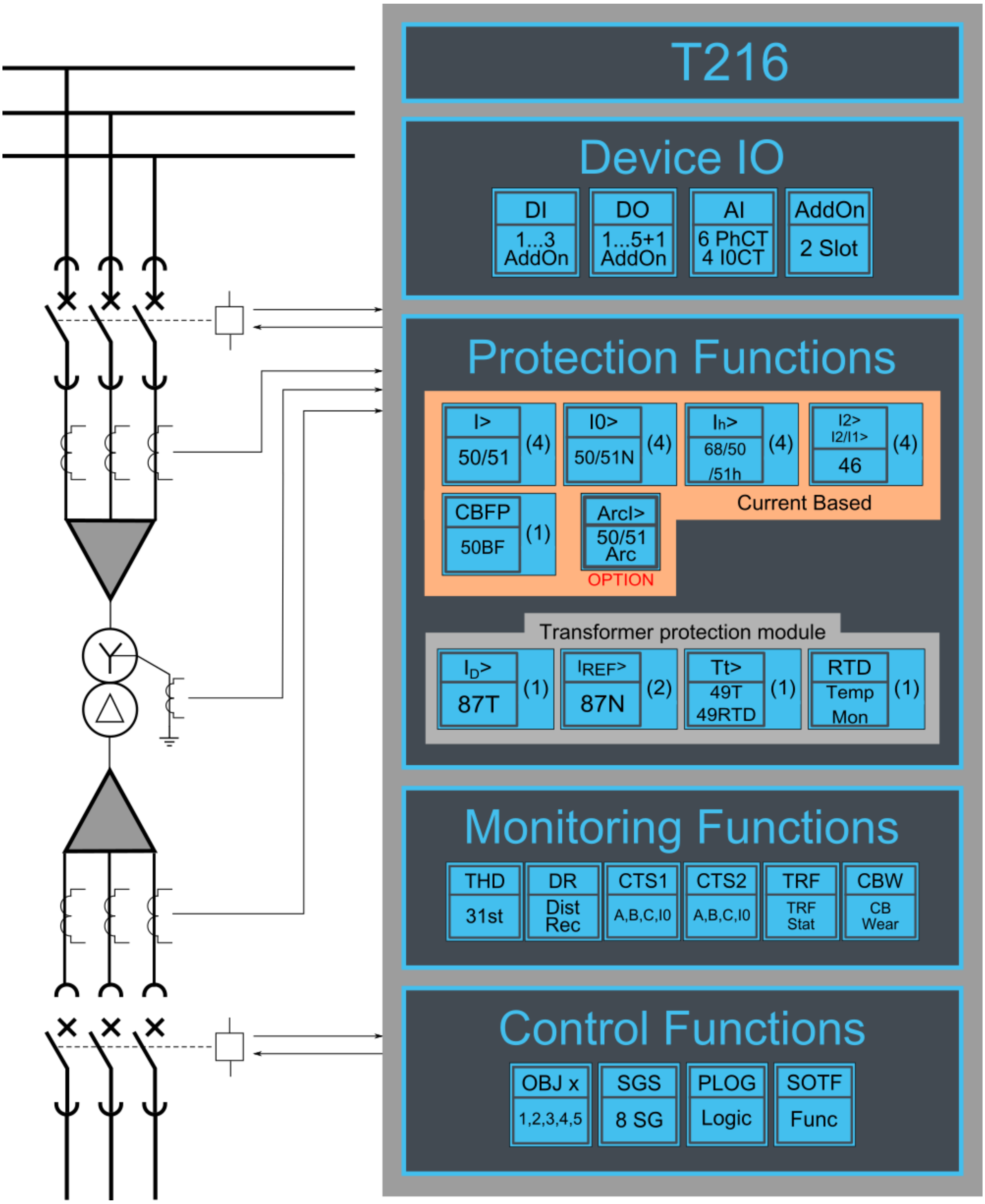


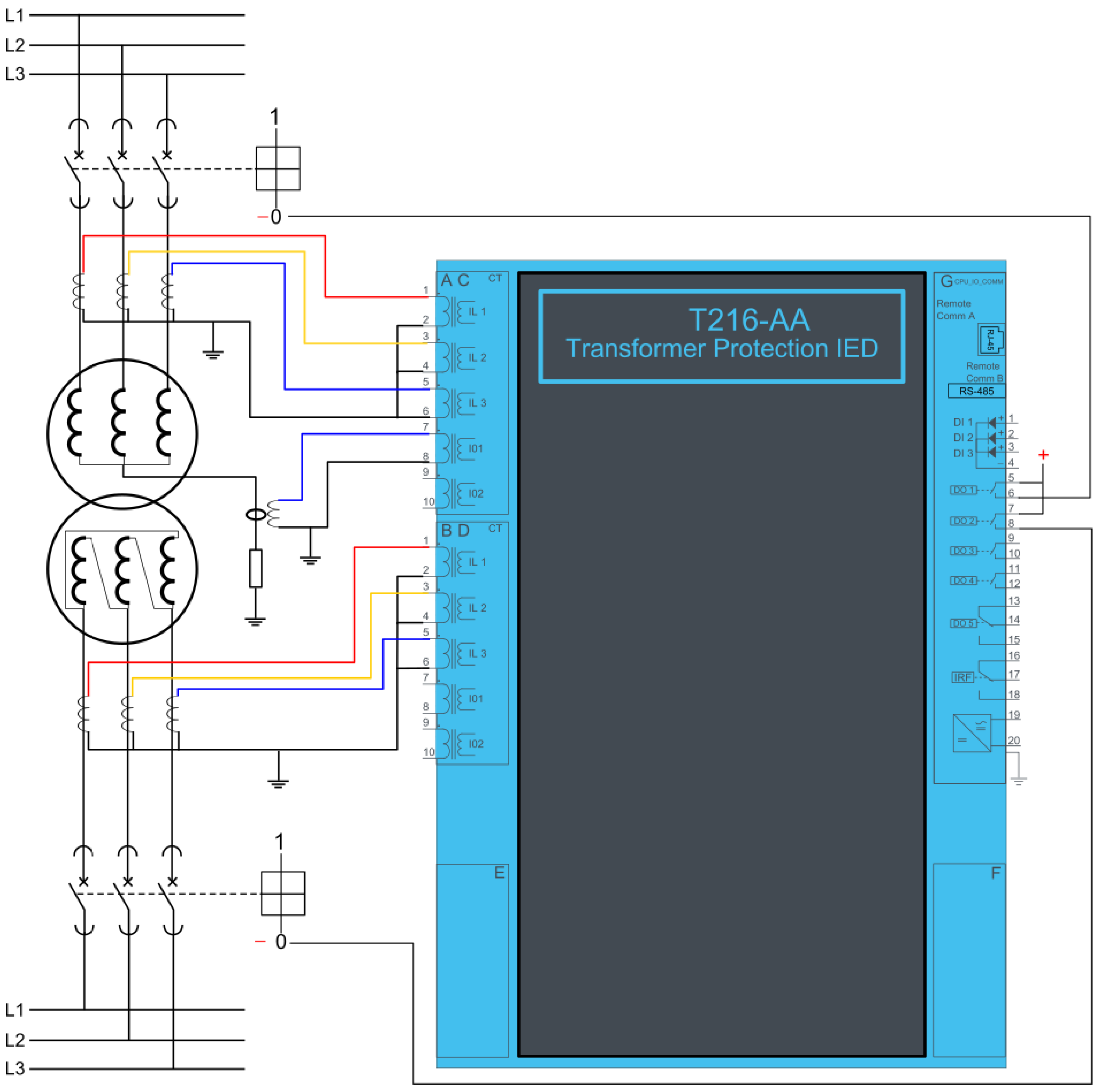
Figure 4.51 T216 application example with function block diagram.



4.14.2 Example transformer application connection

An application example of 2 winding transformer differential relay T216. Regular differential scheme with high voltage side restricted earth-fault protection.

Figure 4.52 Application example for T216 2 winding transformer protection



4.15 MVR-T256

4.15.1 Connections T256

Figure 4.53 T256 variant without add-on modules.

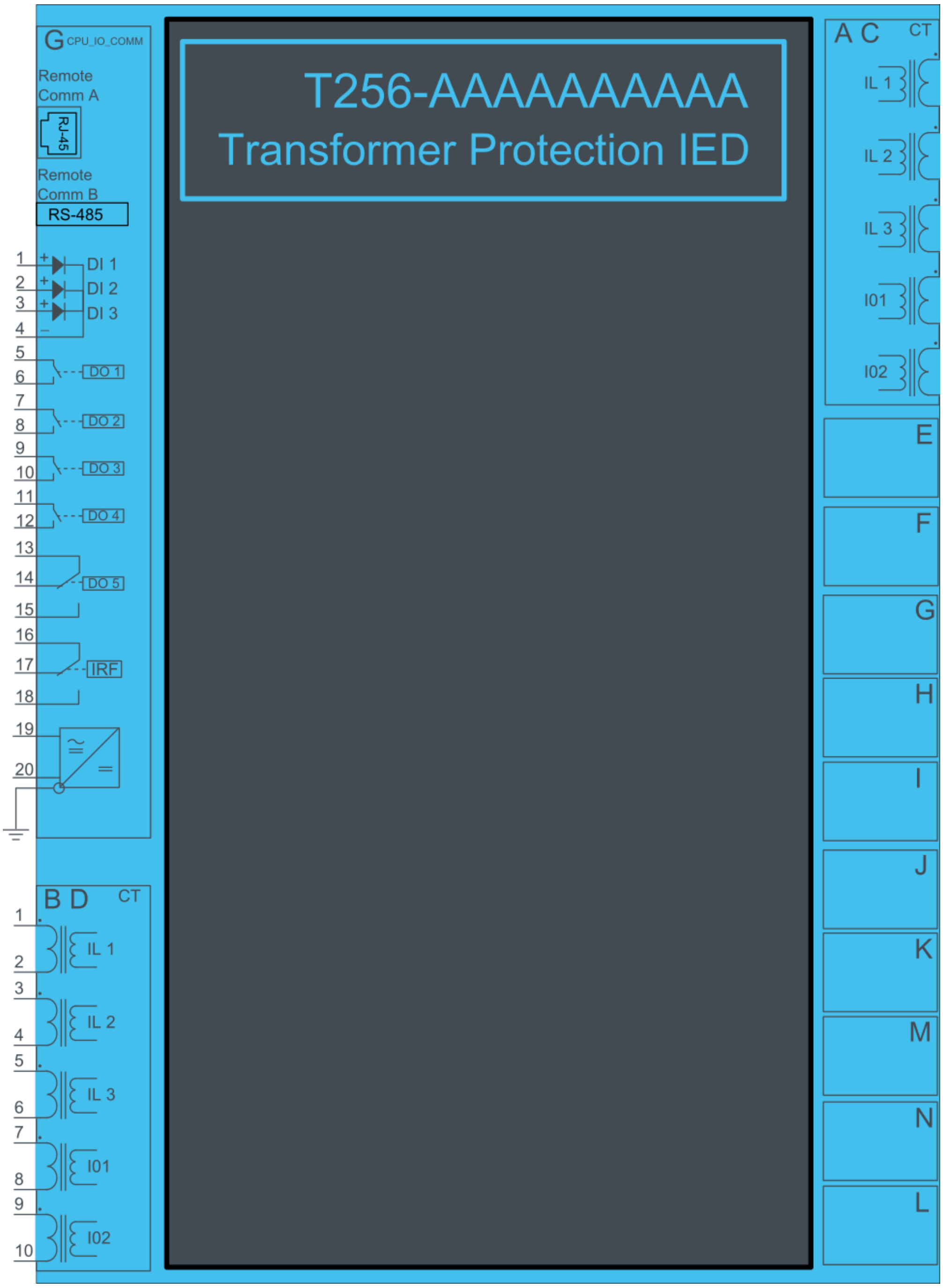


Figure 4.54 T256 variant with binary input and output modules.

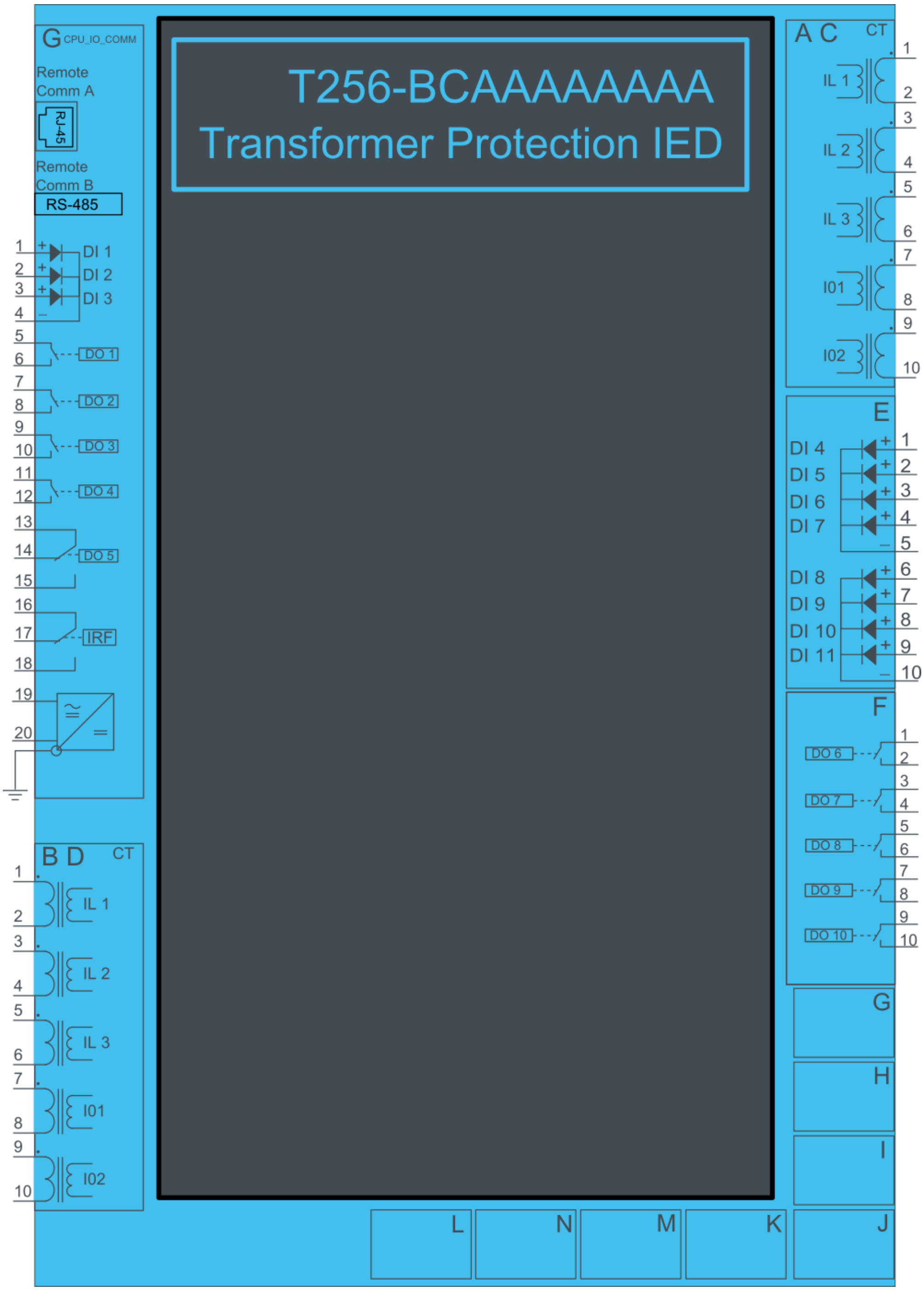
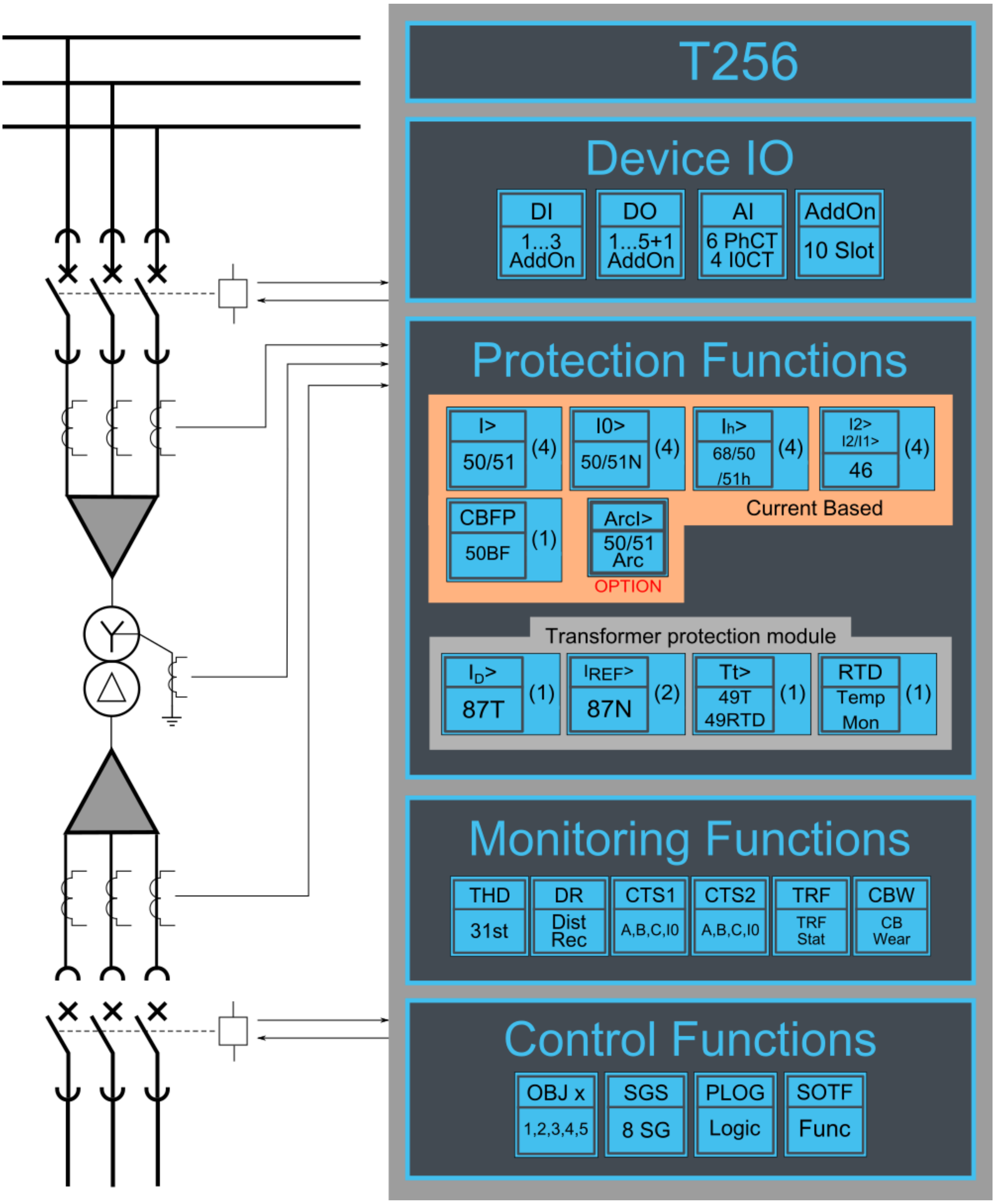


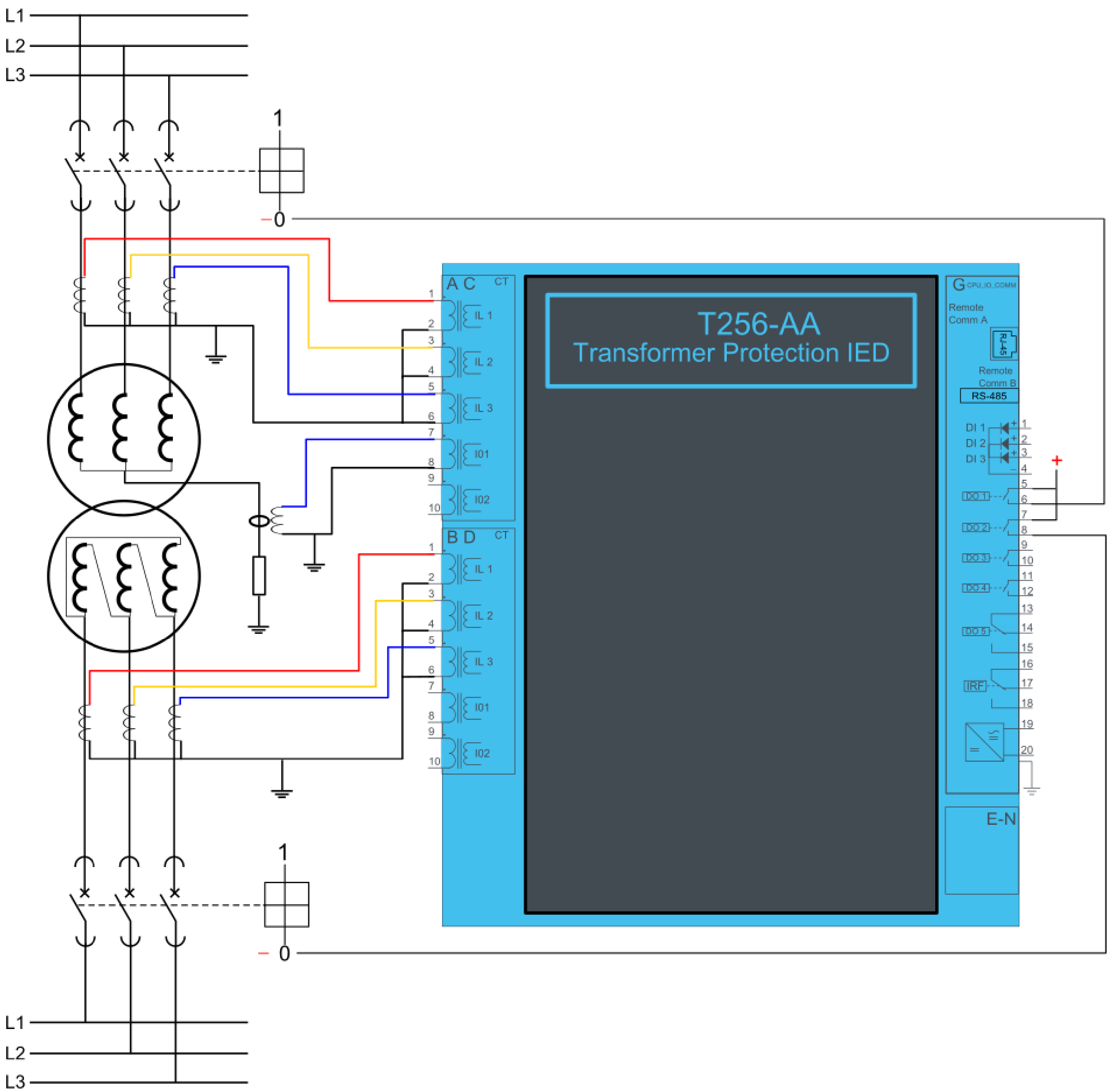
Figure 4.55 T256 application example with function block diagram.



4.15.2 Example transformer application connection

An application example of 2 winding transformer differential relay T256. Regular differential scheme with high voltage side restricted earth-fault protection.

Figure 4.56 Application example for T256 2 winding transformer protection



4.16 MVR-T257

4.16.1 Connections T257

Figure 4.57 T257 variant without add-on modules.

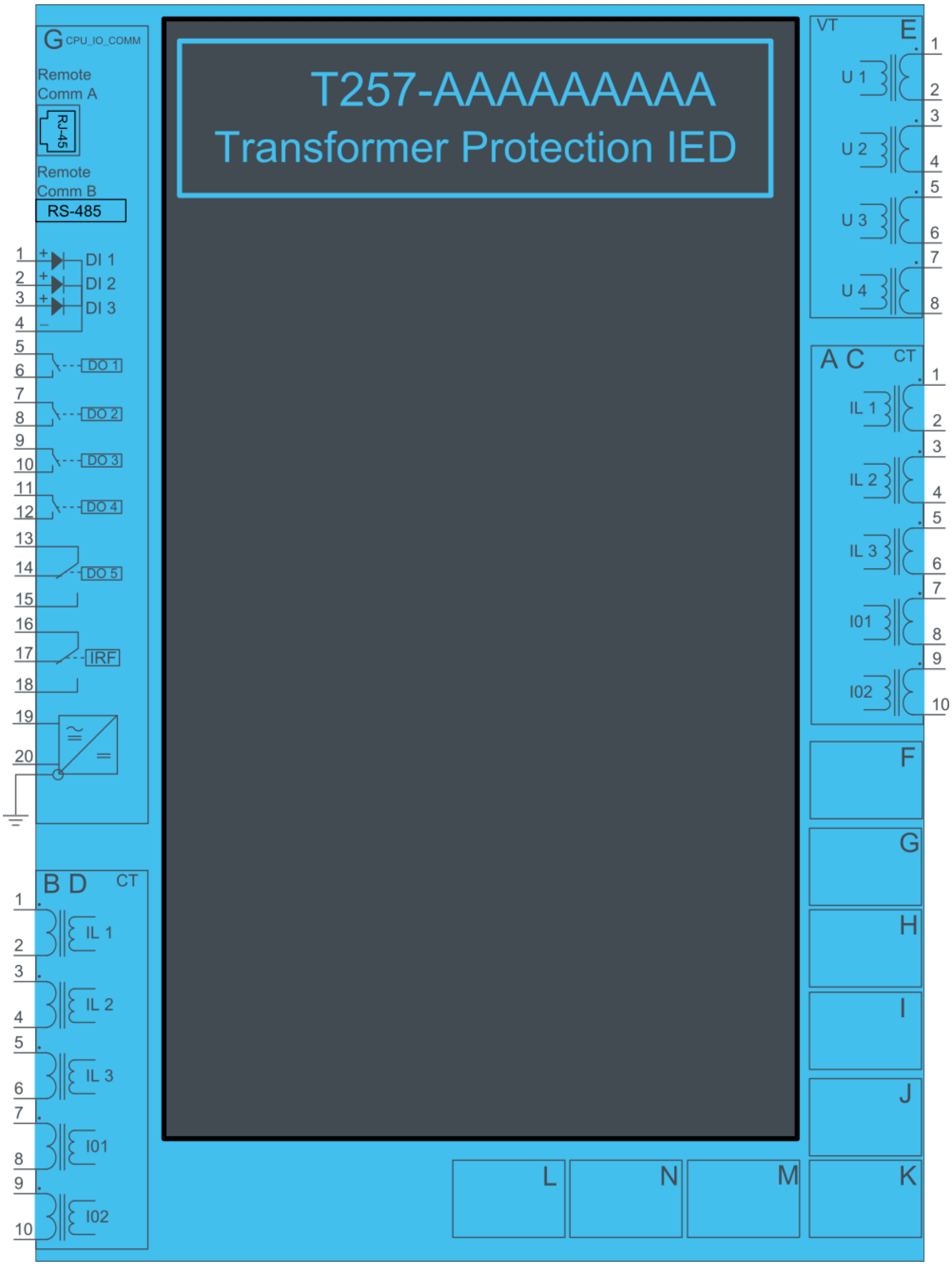


Figure 4.58 T257 variant with binary input and output modules.

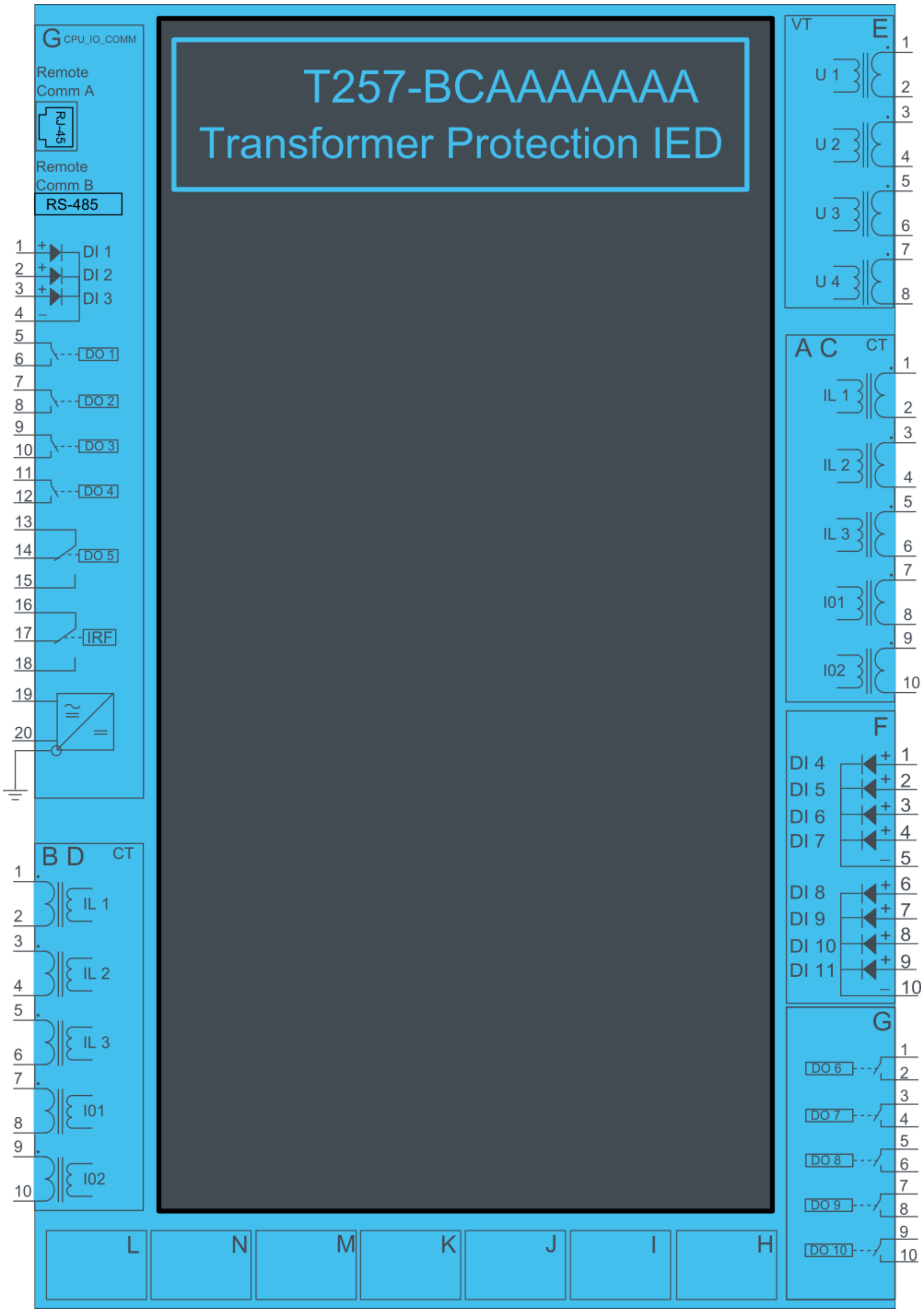
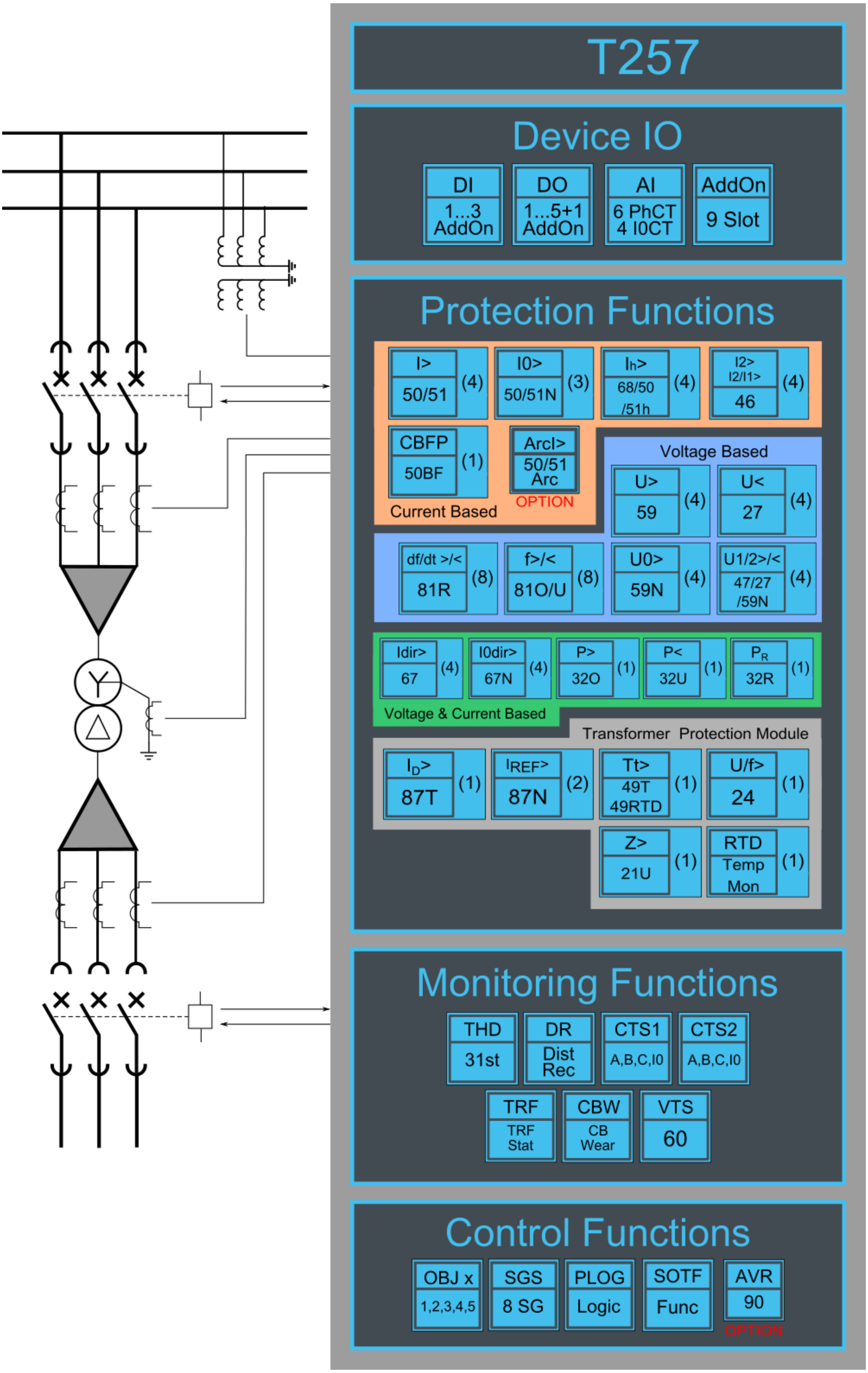


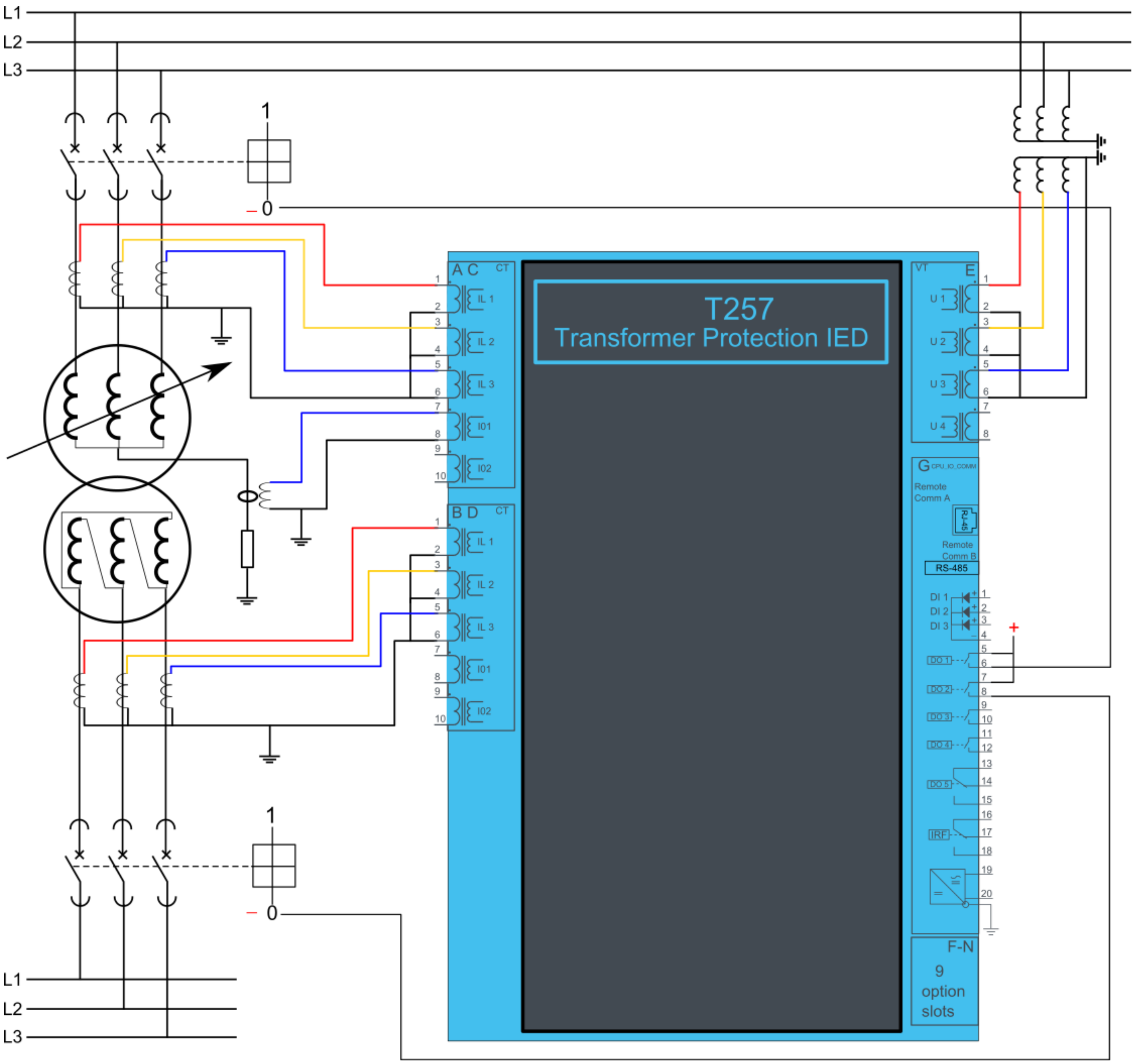
Figure 4.59 T257 application example with function block diagram.



4.16.2 Example 2 winding transformer protection connection

An application example of 2 winding transformer differential relay T257. Regular differential scheme with high voltage side restricted earth-fault protection.

Figure 4.60 Application example for T257 2 winding transformer protection



4.17 MVR-V211

4.17.1 Connections V211

Figure 4.61 V211 variant without add-on modules.

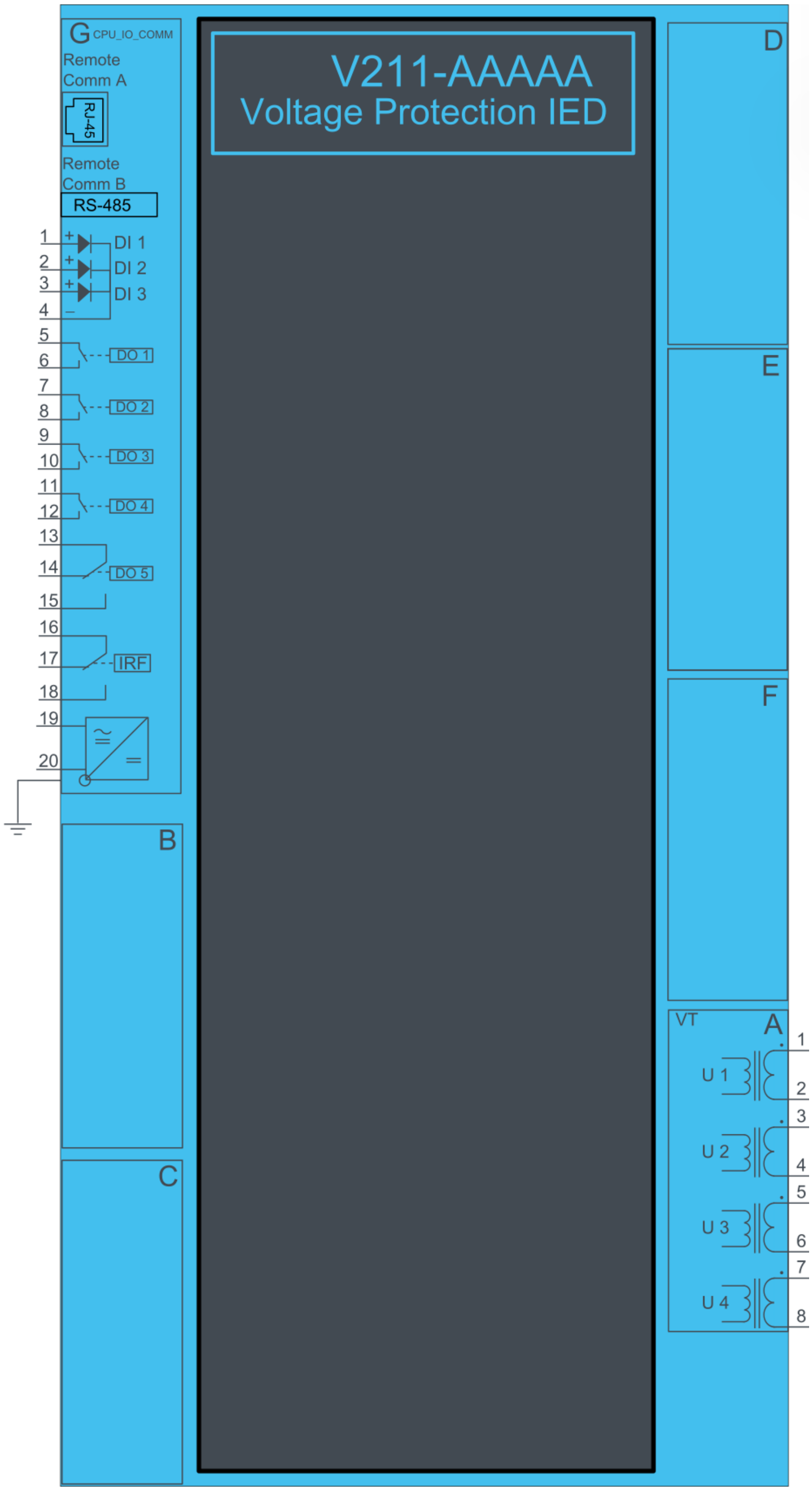


Figure 4.62 V211 variant with binary input and output modules.

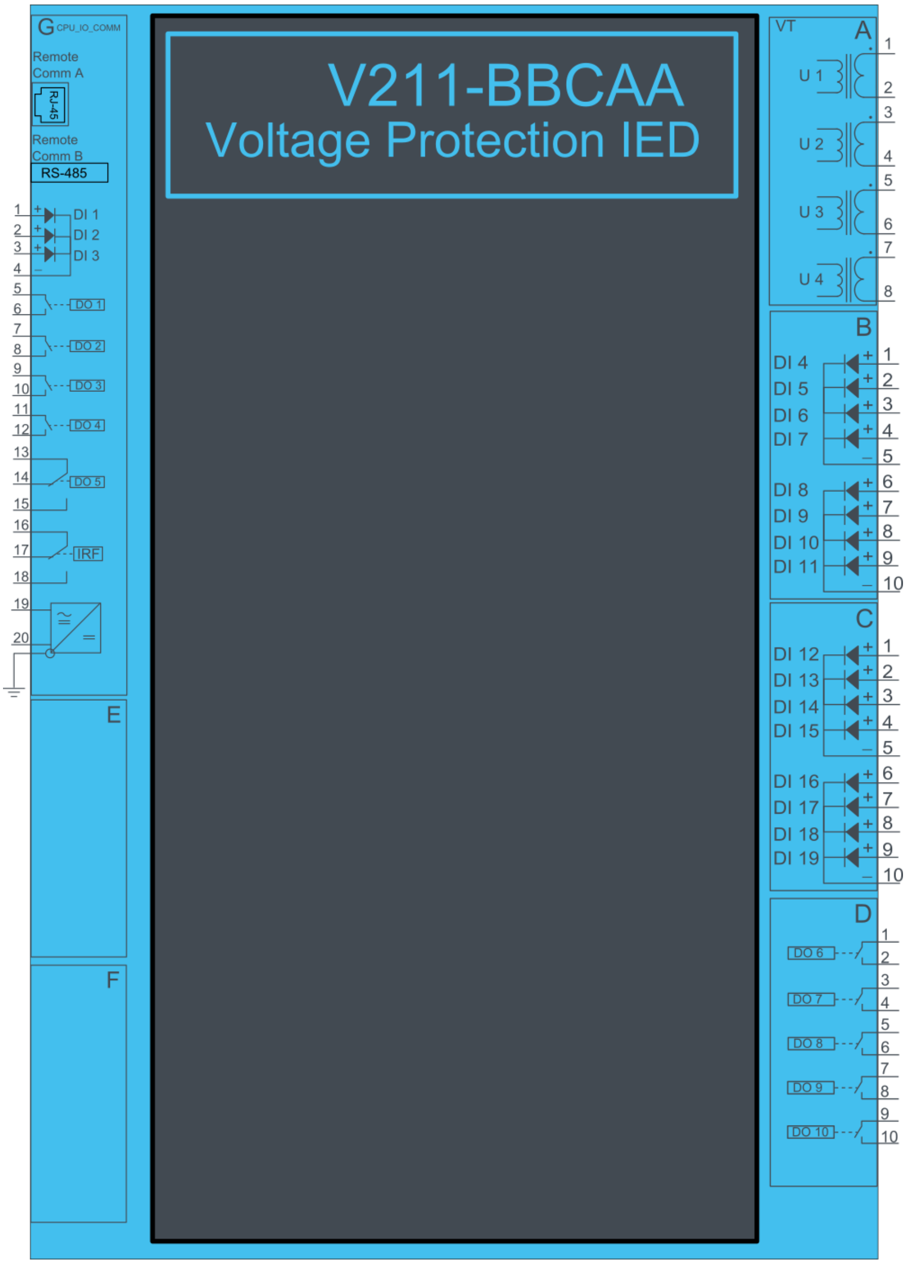
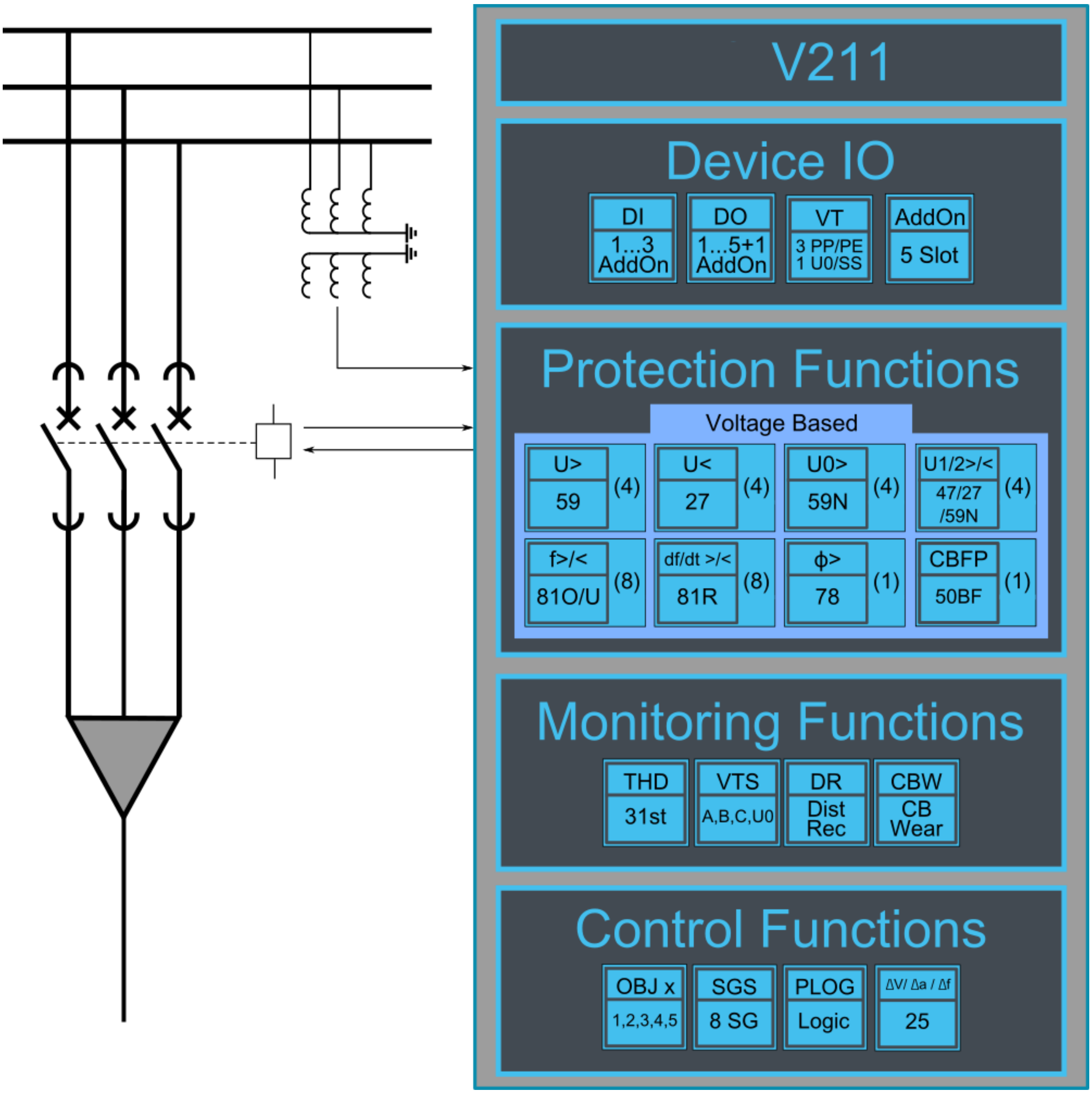


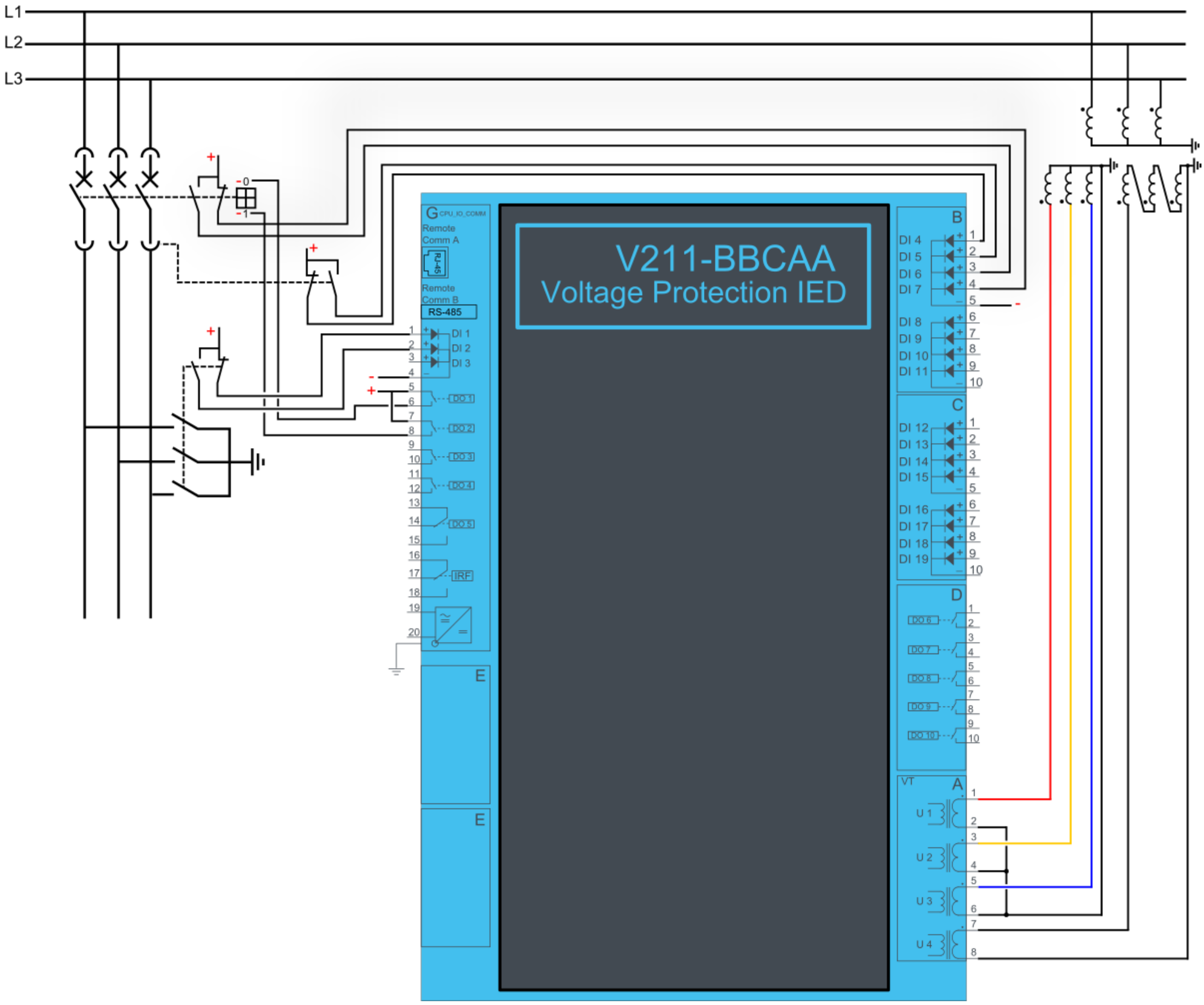
Figure 4.63 V211 application example with function block diagram.



4.17.2 Example voltage protection application connection

Connection example application with three lines to neutral voltages and zero sequence voltage connected. Binary inputs are connected for breaker status indication. Binary outputs are used for breaker control.

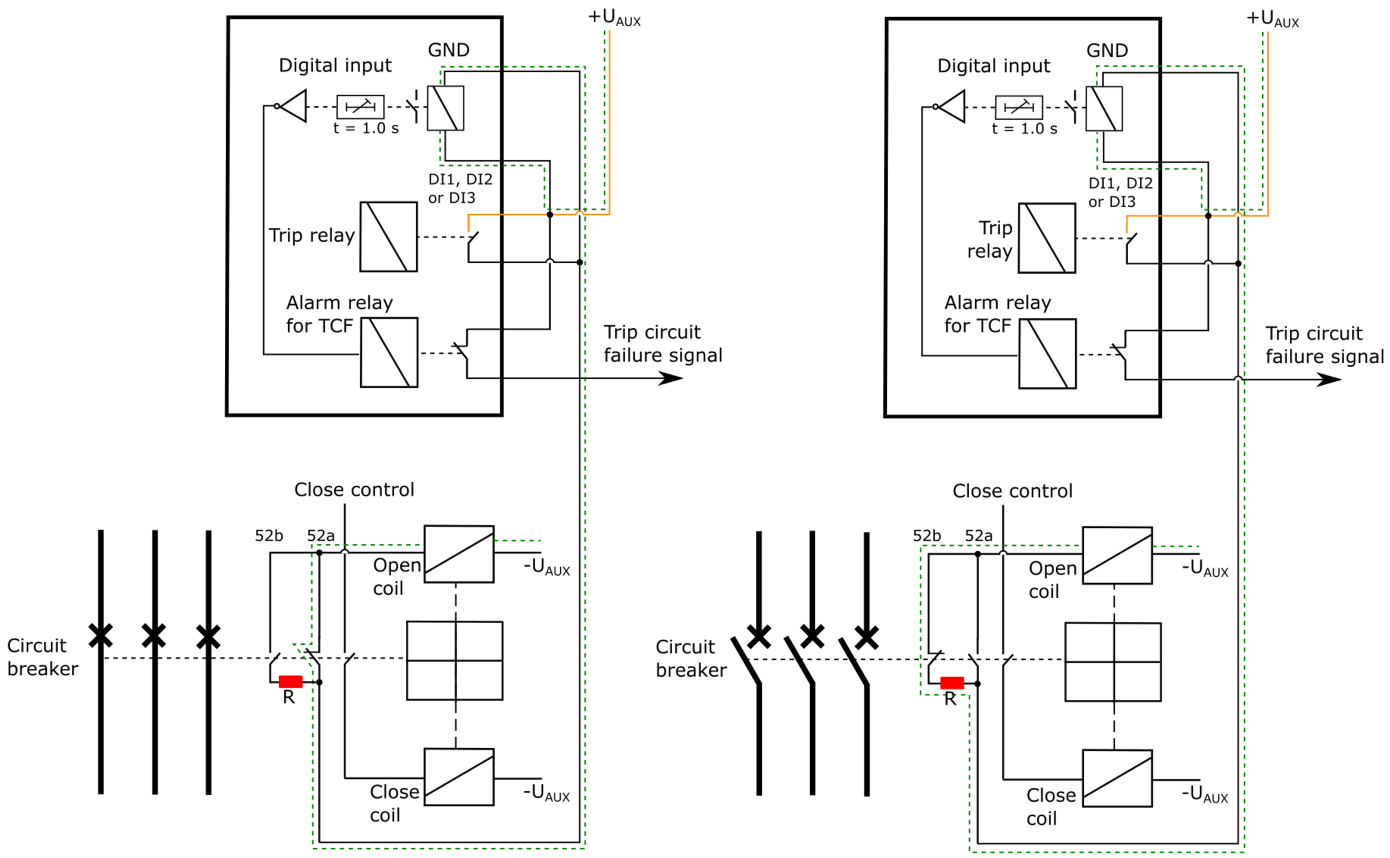
Figure 4.64 Application example for V211



4.18 Trip circuit supervision (95)

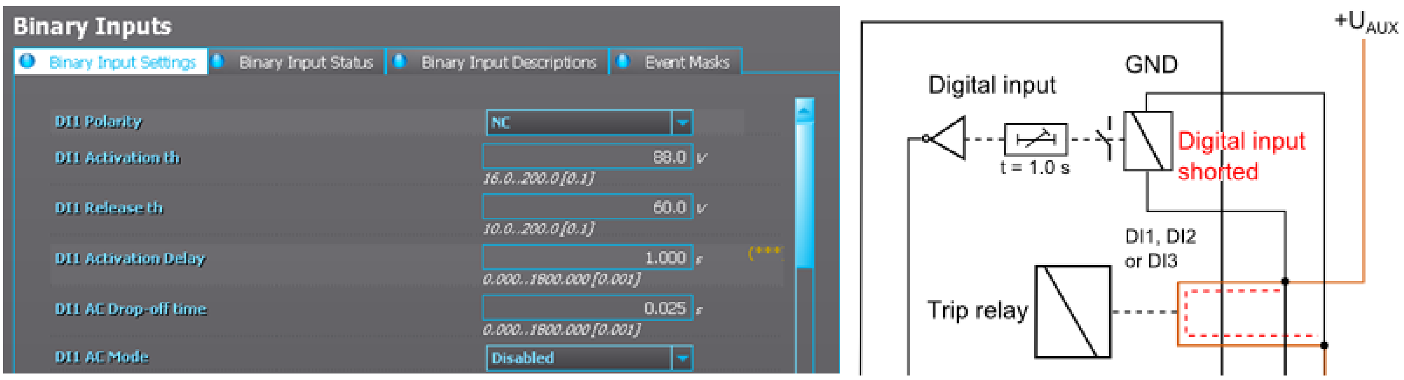
Trip circuit supervision is used to monitor the wiring from auxiliary power supply trough IEDs binary output and all the way to the open coil of the breaker. It is recommended to know that trip circuit is on healthy state when the breaker is closed. Application scheme for trip circuit supervision with one digital input is presented in figure below.

Figure 4.65 Trip circuit supervision by using one DI and non-latched trip output. With this connection, the current keeps flowing to circuit breaker opening coil via the closing auxiliary contacts (52b) of the circuit breaker even after the circuit breaker is opened. This leads to a need for resistor R which will reduce the current so that the coil is not energized, and the relay output does not need to cut off the coils inductive current.



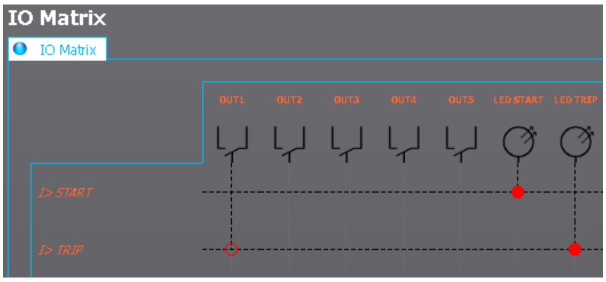
Notice that DI monitoring the circuit is used as normally closed. Same applies with the used alarm relay (if used). In monitoring purposes and especially in trip circuit supervision it is recommended to use closed contact in normal condition to confirm the condition of wiring. Active digital input generates less than 2mA current to the circuit. Normally current this small is not able to make the breaker open coil operate. While the trip relay is controlled, and the circuit breaker is being opened the digital input is shorted by the trip contact as long as the breaker opens. This normally takes approximately 100ms if the relay is non-latched. Therefore t = 1.0 second activation delay should be added to the digital input. Basically, activation delay just a bit longer than the operation time of circuit breaker would be long enough. When CB failure protection is used it might be good to add the CBFP operation time to the digital input activation time ($t_{DI} = t_{CB} + t_{IEDrelease} + t_{CBFP}$). See attached picture below.

Figure 4.66 The digital input used for TCS needs to have normally closed polarity and 1.0 second activation delay to avoid nuisance alarms while circuit breaker is controlled open.



Non-latched outputs are seen in the output matrix as hollow circles. Latched contacts are painted. See below presented figure.

Figure 4.67 IED trip contact used to open the circuit breaker has to be non-latched.



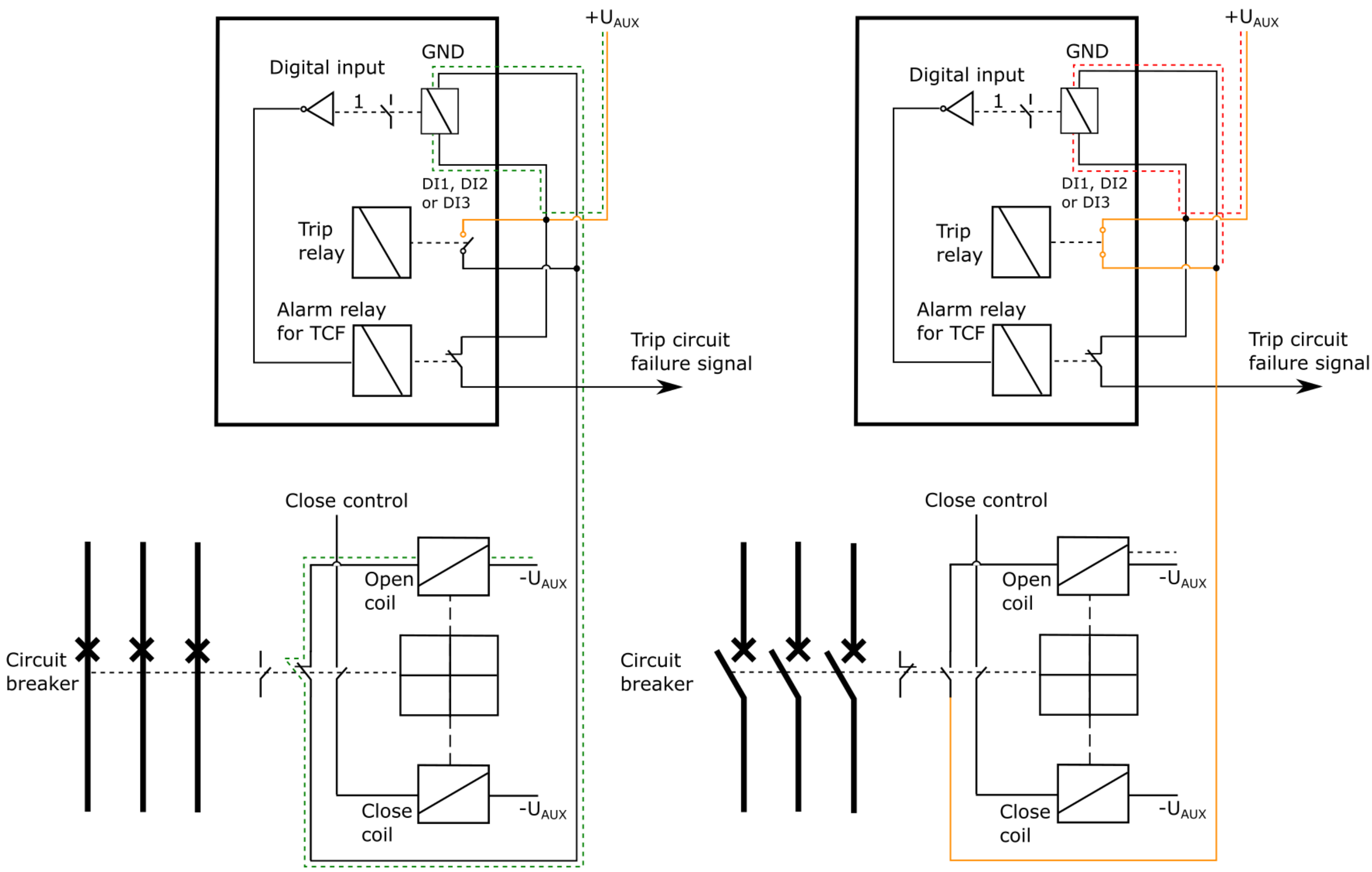
Non-latched trip output contact is a mandatory to have if Autorecloser is used in feeder applications. TCS is generally easier and more reliable to build with non-latched output.

The open coil is energized only as long as the circuit breaker is opened and IED output releases. This takes approximately 100ms depending of the size and type of the breaker. When the breaker opens the auxiliary contacts will open the inductive circuit but the IED trip contact won't open at the same time. IEDs output relay contact will open in <50ms or after configured release delay due the breaker is open. This means that the open coil is energized for a short moment even the breaker is already open. Coil could be energized even moment longer if circuit breaker failure protection has to be used and incomer is performing the tripping.

Trip circuit open coil supervision with one digital input and connected and latched trip output

The main difference between non-lathed and latched control in trip circuit supervision is that when latched control is used it is not possible to monitor the trip circuit in open state due the digital input is shorted by the trip output of the IED.

Figure 4.68 Trip circuit supervision by using one DI and latched output contact.



It is possible to monitor trip circuit with latched output contact but then monitoring the trip circuit is possible only while the circuit breaker status is closed. Whenever the breaker is open the TCS is blocked by an internal logic scheme. The disadvantage is that you don't know whether the trip circuit is intact or not when the breaker is closed again.

While the circuit breaker is in open position the TCS alarm is blocked by using following logic scheme or similar. TCS alarm is giving whenever the breaker is closed and inverted digital input signal (TCS) activates. Normally closed digital input activates only when there is something wrong in the trip circuit and the auxiliary power goes off. While the breaker is open the logic is blocked. Logical output can be used in output matrix or in SCADA as pleased.

Figure 4.69 TCS block scheme when non-latched trip output is not used.