Fundamentals

Data Sheet

SuperTAPP SG Essential

Tapchanger Control Relay

SuperTAPP SG Essential is the industrial & private-network edition of the market-leading SuperTAPP SG automatic-voltage-control relay. SuperTAPP SG Essential provides reliable and economical tapchanger control for routine applications. There is an easy upgrade path to other SuperTAPP SG editions which cater for more complex industrial networks.

Now in its **fourth generation**, SuperTAPP SG distils Fundamentals' decades of hands-on power-system experience into a compact, high-precision relay—delivering the proven accuracy and resilience demanded by modern voltage-control schemes.

Key Features

- Complete tapchanger control solution optimised for industrial and private network operations
- Accommodates reverse power flows, and diverse and variable power factors
- Integrated control panel with real control switches
- Comprehensive SCADA support including IEC 61850, DNP3 and IEC 60870 series
- PC software for management of entire SuperTAPP SG fleet, including settings, tapchanger operation, relay and tap-changer diagnostics and historical data
- Optional transformer temperature monitoring and control

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Key Benefits

For operation

- Maximise voltage headroom and reduces generator curtailment
- Avoids complex schemes for generation management
- Reduces DG connection costs

For asset management

- Maintains healthy assets at lower lifecycle costs
- Minimises maintenance interventions and unplanned outages
- Reduces the risk and associated impacts of tapchanger failure

For retrofit

- Delivers reinforcement plan at reduced cost
- Fast and easy to install/commission
- Compatible with all transformer types, tapchanger mechanisms, and control schemes

1 Functional Description

1.1 Basic Tapchanger Control

The basic operation compares a measured voltage (V_{VT}) with a *target voltage* for the relay (V_{tgt}). If the difference exceeds the *bandwidth* setting, following an *initial delay* a tapchange operation is initiated to adjust the transformer voltage to a satisfactory level.

Figure 1 Simplified AVC operation

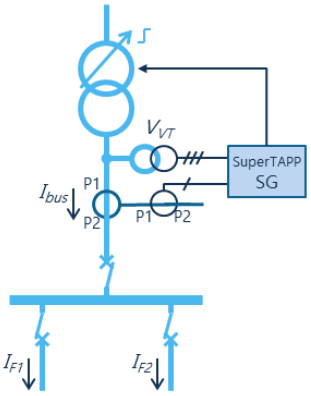
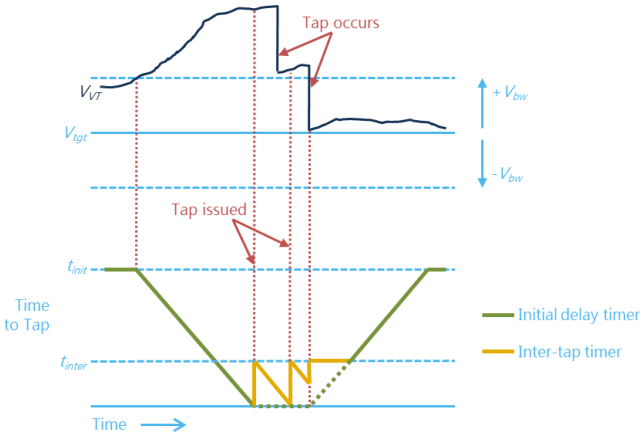


Figure 2 Tapchanger operation timing



Successive Tap Operations

Following a tapchanger operation, if further corrections are required, an *inter-tap delay* is used. A tapchange operation usually requires a number of seconds to complete, and the *inter-tap delay* allows for this before requesting further operations, Figure 2.

Fast Tap

Under some circumstances the initial time delay is bypassed and a corrective tapchanger operation is initiated after a short, fixed time delay of 5 seconds. The conditions under which fast tapping can take place are 2% outside the band (user configurable), or following a change to the target voltage.

1.2 Integrated Control Panel

Figure 3 Front panel features

Control Points

The SuperTAPP SG accommodates three points of control for tap-changers:

- Local, i.e. local to the tap-changer.
- This Panel, i.e. on the SuperTAPP SG integrated control panel or adjacent panel switches .
- SCADA, via the relay by SCADA communications (DNP3, IEC 61850 etc, or hardwired)

Modes of Operation

There are two modes of operation:

- Auto – controlled by the SuperTAPP SG AVC algorithm
- Manual – an operator controls the tapchanger
- In manual mode the relay maintains measurements and indications according to the operational state but does not issue tapchanger operations or operational alarms.

1.3 Tapchanger Monitoring and Runaway Prevention

If the voltage cannot be corrected (e.g. tapchanger mechanism fault or end of range), the relay will stop issuing raise/lower signals and may additionally trip the tapchanger motor MCB. Additionally after a common alarm time the associated AVC alarm will be raised. A list and description of each monitored condition is given in Table 1.

Table 1 Monitored conditions and alarms

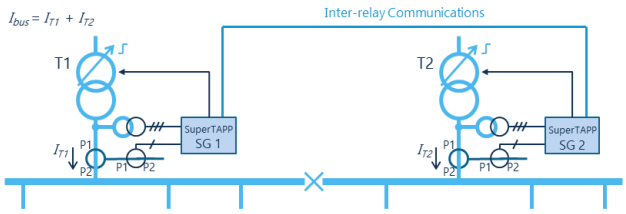
Condition	Blocking	Alarm
VT fuse failure	Both directions	After alarm time
End of tap range	In relevant direction	Immediate
Target not achievable		Immediate
CAN bus failure		After alarm time
Overload	Both directions	After alarm time
Voltage high	Raise blocked	After alarm time
Voltage low	Lower blocked	After alarm time
Phase reference alarm	Both directions	After alarm time
Voltage out of band alarm		After alarm time
Tapchanger runaway	Tapchanger motor may be tripped	Immediate
Tap incomplete	Tapchanger motor may be tripped	Immediate

1.4 Parallel Transformers – optional feature

Inter-relay Communications

Parallel transformers require the addition of an optional communication module (module R or S – see section 5 Ordering Options). SuperTAPP SG can accommodate parallel operation of up to eight units using the Inter-relay communications system.

Figure 4 Inter-relay communications



Circulating Current Minimisation

SuperTAPP SG employs the 'enhanced TAPP' method to calculate the circulating current and convert it into a bias which promotes tapchanger operations that reduce the circulating current to a minimum. The circulating current bias is made up of two components: a bias arising from site circulating current, and a bias arising from network circulating current.

Master-Follower

SuperTAPP SG can also be set to use master-follower method for parallel transformers. This method is inferior to enhanced TAPP in many respects but some operators may have a preference to use this method.

1.5 Transformer Temperature Monitoring and Control – optional feature

A high proportion of transformer faults are related to the temperatures and there is not enough useful information about asset condition. The SuperTAPP SG enables users to manage transformers by measuring:

- Ambient temperature
- Transformer oil temperature
- Transformer winding temperature
- Tap changer temperature

These signals are then used to monitor oil pumps and fans.

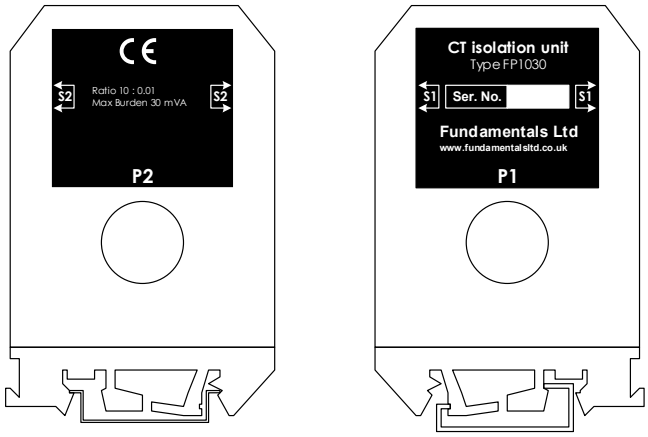
Temperature monitoring requires the addition of an optional analogue DC module to take temperature sensor inputs (module K or L – see section 5 Ordering Options).

2 Interposing CT

The interposing CT designed for use with the SuperTAPP SG provides a high level of electrical isolation between the source current circuitry and imposes virtually no burden upon the measurement current transformer.

Figure 5 gives an external view of the interposing unit, which can be mounted within a circuit breaker or relay panel using a DIN rail.

Figure 5 Interposing CT



3 Physical Description

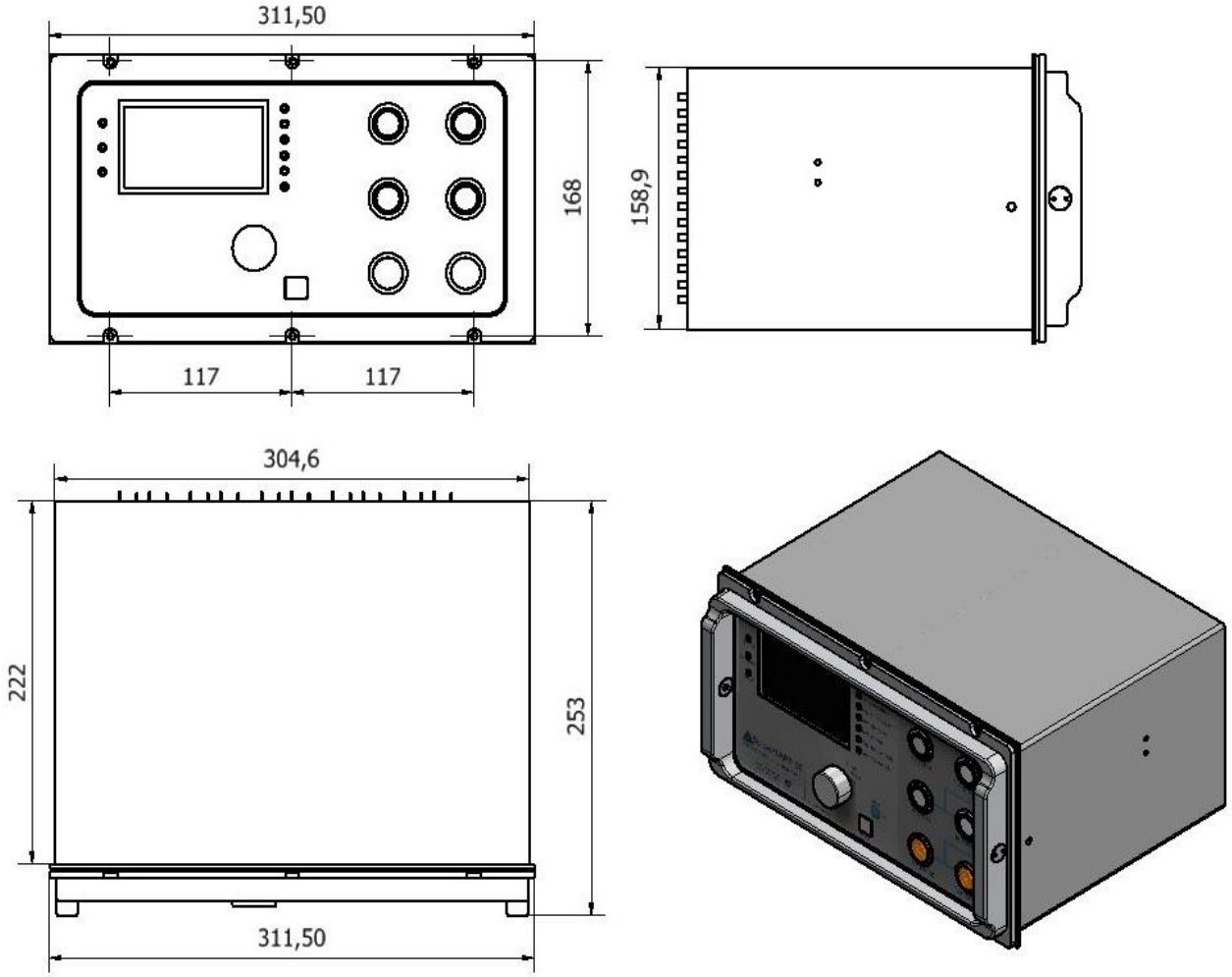
The SuperTAPP SG is designed for fitting in the front panel of a 19" rack-mounting system and occupies ¾ width of a 4U subrack, allowing a complete voltage control for one transformer and test blocks to be fitted in a single subrack.

SuperTAPP SG is a modular relay. Ordering options allow the user to select the hardware functions which are required for the particular scheme and these are easily built into the relay. Additional hardware can be added later if required.

SuperTAPP SG is a withdrawable relay. Once the relay is wired into the panel the relay chassis can be withdrawn from the case without disturbing the wiring.

Figure 6 SuperTAPP SG dimensions

(all dimensions in mm)



4 Specifications

4.1 General

Legal Requirements – UK and European Union

Conformity	UK regulation	EU directive
Low Voltage / Electrical Safety	SI 2016/1101	2014/35/EU
Electromagnetic Compatibility	SI 2016/1091	2014/30/EU
Batteries and Accumulators	SI 2015/63	2013/56/EU
Restriction of Hazardous Substances	SI 2023/658	2023/1437/EU

SuperTAPP SG is UKCA and CE marked.

Product Standards

Standard		Reference
Measuring relays and protection equipment	Electromagnetic compatibility requirements	BS EN 60255-26:2013 (IEC 60255-26:2013)
	Product safety requirements	BS EN 60255-27:2014 (IEC 60255-27:2013)

Reference Conditions

Specification	Levels
Ambient temperature	20 °C
Energising quantities	Nominal (unless specified)
Frequency	50 / 60 Hz

Operating Environment

Specification	Levels
Environmental level	Zone A, severe electrical environment
Overvoltage category	III
Pollution degree	2

4.2 Functional Characteristics

Functional Accuracy

Characteristic	Accuracy
Timers	±250 ms
Frequency	±0.05 Hz
Frequency response	400 ms

Communications

Characteristic	Specification
Physical layer options	RS485 over serial twisted pair, ethernet 100base-T, ethernet 100base-F
Data link layer options	RS485, TCP/IP
Application layer options	IEC 61850, DNP3, IEC 60870-5-103

4.3 Electrical Characteristics

Energising and Output Quantities

Port		Nominal‡	Operating Range	Withstand	Burden	Accuracy
Auxiliary supply	(type A)	Vx = 110/115/120 V ~	87.5–132 V ~ 47-63 Hz ~	300 V ≂	< 30/50 VA †	–
		Vx = 110/125 V ⎓	87.5–137.5 V ⎓		< 15/25 W †	
	(type B)	Vx = 24/48 V ⎓	18–72 V ⎓	75 V ⎓	< 15/25 W †	
Tapchanger interface		110/230 V ≂	87.5–260 V ≂ 45-63 Hz ~	300 V ≂	–	–
Voltage inputs		Vn = 63.5/110 V ~	0–145 V ~ 45-65 Hz ~	264 V ~ cont. 300 V ~ 1 s	< 1 VA (across op. range)	±0.5% (80%-120% Vn)
Current inputs		5 mA ~	0–10 mA ~ 45-65 Hz ~	10 mA ~	≤ 30 mVA (across op. range)	±1% (20%-120% nom.)
with external CT type FP1030		In = 0.5/1/5 A ~	0–10 A ~ 45-65 Hz ~	40 A cont. 1000 A 1 s (1 turn)	≤ 30 mVA (across op. range)	±1% (20%-120% In)
Digital inputs		24/48/110/220 V ⎓ 110/230 V ~	19.2–260 V ⎓ 87.5-260 V ~ 45-63 Hz ~	300 V ≂	< 0.2 W ⎓ < 0.5 VA ~	–
mA inputs (passive)		0-10 / 0-20 / 4-20 mA ⎓	−25 - +25 mA ⎓	25 mA ⎓	100 Ω	±1% (20%-100% nom.)
RTD inputs (Pt100 Temperature sensor resistor)		IEC 60751 100 Ω platinum resistor	−80 - +327 ˚C	0 - ∞ Ω	–	±0.5 ˚C
Analogue tap position input		–	chain resistance 50 Ω - 50 kΩ min. 5 Ω per res.	0 - ∞ Ω	–	±0.2 taps on 40 position tapchanger
mA (passive)		0-10 / 0-20 / 4-20 mA ⎓	0 - +25 mA ⎓	50 mA ⎓	270 Ω	±1% (20%-100% nom.)
Digital tap position inputs		Dry / volt-free contacts	–	–	–	–
mA outputs (active)		0-10 / 0-20 / 4-20 mA ⎓	0 - 24 mA ⎓ loop res. ≤ 1 kΩ	–	–	±1% (20%-100% nom.)

† Quiescent / Maximum burden ‡ Nominal AC frequency 50/60 Hz

Output Relays

Specification	Levels
No. of cycles	>100,000
Operating Voltage	110V/230V ≂ Nominal 400V~/300V⎓ Withstand
Make and carry	10 A ≂
Break	10 A ~ 300 W ⎓

Electrical Withstand

Specification	Levels
Rated insulation voltage	300 V ≂
Dielectric test voltage	2.3 kV ~ for 1 min
Impulse test voltage	5 kV

Insulation Class I. Equipment must be earthed.

4.4 Electromagnetic Characteristics

Radiated Emissions

Specification	Levels
CISPR 11 30 – 230 MHz	40/50 dB qp 10/3m
CISPR 11 230 – 1000 MHz	47/57 dB qp 10/3m
CISPR 22 1 – 3 GHz	56 dB avg / 76 dB pk 3m
CISPR 22 3 – 6 GHz	60 dB avg / 80 dB pk 3m

Conducted Emissions

Specification	Levels
CISPR 22 0.15 – 0.5 MHz	79 dB qp / 66 dB avg
CISPR 22 0.5 – 30 MHz	73 dB qp / 60 dB avg

Electromagnetic Immunity

Specification	Levels
IEC 61000-4-2 Electrostatic discharge	6 kV contact
IEC 61000-4-3 Radiated radiofrequency interference	10 V/m rms
IEC 61000-4-4 Fast transient	4 kV (2kV comms)
IEC 61000-4-5 Surge	4 kV (2kV comms)
IEC 61000-4-6 Radiofrequency interference	10 V rms sweep
	10 V rms spot 27, 68 MHz
IEC 61000-4-8 Power frequency magnetic field	30 A/m continuous
	300 A/m 1 s – 3 s
IEC 61000-4-18 Slow Damped Osc Wave	1kVpk diff, 2.5kVpk Common

4.5 Mechanical and Atmospheric Characteristics

IP Rating

Specification	Levels
From front of panel when mounted in normal position of use	IP54

Temperature

Specification		Levels
IEC 60255-1 dry heat and cold	operational	0 – +55 °C
	storage	-20 – +70 °C
IEC 60255-1 damp heat	operational	+55 °C 95% r.h.

Mechanical

Specification	Levels
IEC 60255-21-1 vibration	Severity class 1
IEC 60255-21-2 shock	Severity class 1
IEC 60255-21-2 bump	Severity class 1
IEC 60255-21-3 seismic	Severity class 1

Weight Unpackaged

Specification	Kg
Relay with no additional cards	7 Kg
Relay with all additional cards	8 Kg

4.6 Interposing CT specification

Electrical Characteristics

Parameter	Specified value
Ratio	10A : 0.01 A
Maximum primary current	10 A
Burden	0.03 VA
Isolation	> 3 kV
Material	UV 94-V-0 polyamide 66/6

Interposing CT turns

CT Secondary Rating	Recommended Turns
5 A	1
1 A	5
0.5 A	10

5 Ordering Options

Table 2 SuperTAPP SG product code

Product code	FP1034	-							0	C		-		vv	-	0	
Power supply																	
110/230 V AC/DC			A														
24/48 V DC			B														
Tap position measurement																	
None				0													
Resistor chain, BCD, binary, mA				P													
Digital I/O																	
Scheme I/O only (4I & 7O)					0	0	0	0									
Scheme I/O + 5I & 4O (1 c/o)					G	0	0	0									
Scheme I/O + 10I & 8O (2 c/o)					G	G	0	0									
Scheme I/O + 15I & 12O (3 c/o)					G	G	G	0									
Scheme I/O + 20I & 16O (5 c/o)					G	G	G	G									
Analogue DC																	
None									0								
mA 2I & 3O + PT100 input									K								
mA I & 1 O + 3 PT100 input									L								
Communications features																	
None											0		O				
Transformer parallelling											R		O				
Transformer parallelling and SCADA											S		L				
Ethernet																	
None																	0
100base-T RJ45																	A
100base-SX (850nm MM) LC																	B
100base-T RJ45 x2																	C
100base-SX (850nm MM) LC x2																	D
100base-FX (1300nm MM) LC																	E
100base-FX (1300nm MM) LC x2																	F
100base-LX (1300nm SM) LC																	G
100base-LX (1300nm SM) LC x2																	H

Note 'v v' in the product code is a 2-digit number indicating the hardware version. This data sheet is valid for hardware version 06.

6 Connection Diagrams

The diagrams which follow show connection arrangements for the various modules which SuperTAPP SG can contain. All labelling and numbering is **typical**, with the exact allocation being dependent on the number, location and configuration of the modules fitted. Please refer to the connection diagram, provided on request and with each SuperTAPP SG, to determine the exact configuration and **do not rely on the numbering in these diagrams** *.

The user must refer to the relay code, printed on the front of the relay, to determine which module is in each location, and hence connected to which terminal block.

Figure 7 Typical connection diagram for power supply and scheme logic module (type A or B)

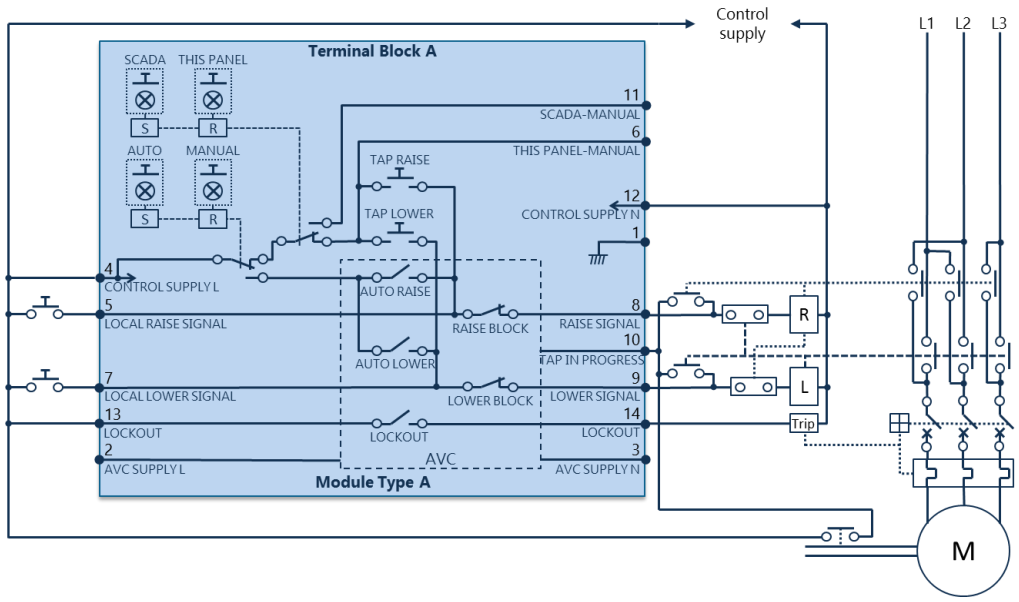


Figure 8 Typical connection diagram for tap position input module (type P)

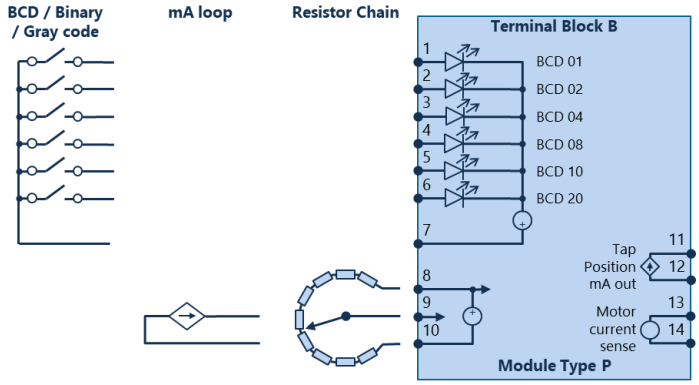


Figure 9 Terminal arrangements for additional I/O modules (type G)

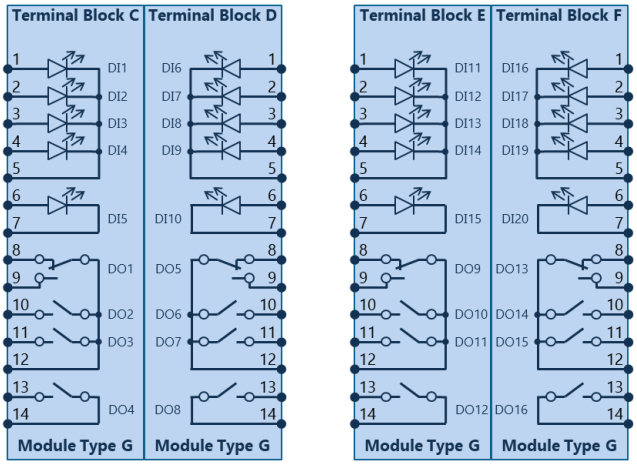


Figure 10 Terminal arrangements for DC analogue modules (type K and type L)

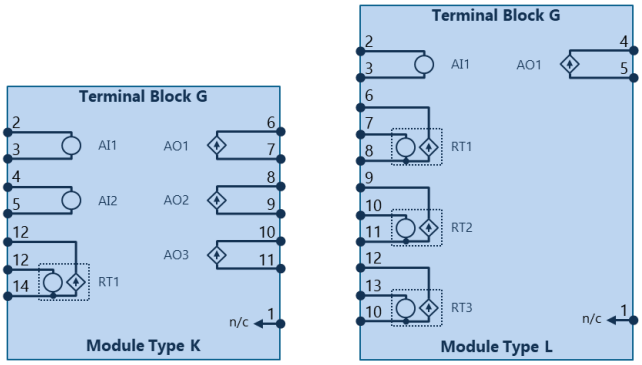


Figure 11 Typical connection diagram for AC input module (type C)

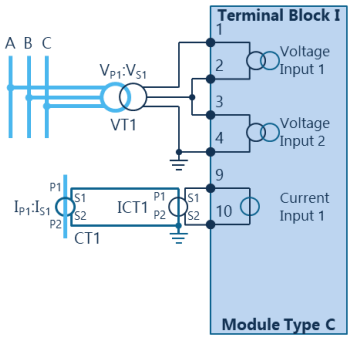
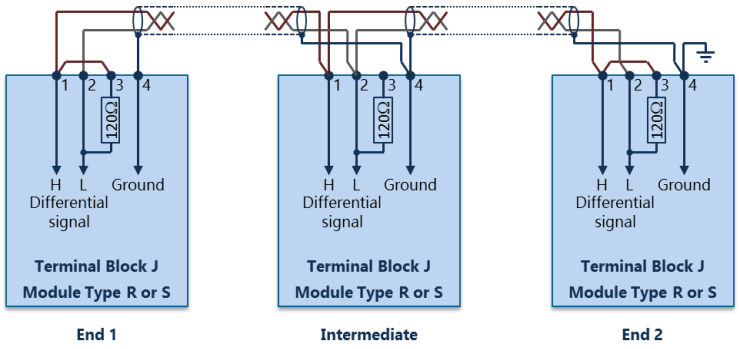


Figure 12 Typical connection diagram for inter-relay communications (type R or S)



Fundamentals Services

Fundamentals Application Support

When you buy a Fundamentals product you can expect to receive expert assistance to apply your relay. Please contact your sales office or agent and we will do our best to advise you. We will gladly provide you with advice on an ad hoc basis, or if you have an extensive requirement for support, we can offer services for scheme design, panel builds, installation and commissioning.

Our global partners are carefully chosen to ensure that they have application support capabilities which are backed up by Fundamentals voltage control experts.

Other Services

Fundamentals can assist with all aspects of voltage control applications and transformer and tapchanger management:

- Design and engineering
- Panel/cubicle build
- Site surveys, installation, and commissioning
- Tapchanger health checks, maintenance, and reverse power assessments
- Technical support and troubleshooting
- Power system analysis
- Generation connection assessment

Contact Information

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