# VA TECH TRANSMISSION & DISTRIBUTION

## VA TECH Reyrolle ACP Ltd

# Automatic voltage control - MicroTAPP


REYROLLE

# MICROTAPP

## Automatic voltage control

## Introduction


The MicroTAPP range of Automatic Voltage Control (AVC) relays combines the power and flexibility of microprocessor technology with the renowned operating philosophy and effectiveness of the established TAPP method.

The relay provides three function areas:

1. The efficient control of power system levels by control of an on-load tap-changer
2. The monitoring and guarding of the power system and tap-changer
3. The collection of system data for analysis

The relay provides a complete AVC system, eliminating complex schemes and reducing inter-transformer-panel wiring to a single twisted-pair cable.

High integrity and confidence is maintained through the use of watchdog self-monitoring and supervision, and independent algorithms to perform the tap-change monitor functions.

Communications using the IEC 60870 standard allows remote update of settings, and provides access to the instrumentation, waveform storage and data collection facilities.

The relay may be setup to run in TAPP, circulating current or master-follower modes.

## Features

**Standard**

- Enhanced **TAPP** (Transformer automatic paralleling package) principle for voltage control
- User-specified system power factor eliminates errors associated with other circulating current schemes
- **Load drop compensation** counteracts network related voltage drop
- Circulating current is minimised with the **Coupling** control while **Tap-stagger** allows circulating current to be introduced for network operation purposes
- Multiple settings groups allow **Voltage offsets** to be applied for **Load reduction** and network operation
- **Low system frequencies** are detected and, if appropriate, system voltage can be reduced by tapping down
- **Homing** enables transformers to be tapped to the correct busbar voltage prior to switching in to or out of service
- **Tap position indication** accepts inputs from either analogue or digital sender units
- **Runaway prevention** locks out the tap-changer to prevent runaway due to electrical or mechanical failure
- **VT Fuse monitor.** Negative-phase sequence (NPS) voltage element detects blown VT fuses to prevent incorrect voltage control
- **Data storage capability.** Events, short-term waveforms and long-term system data are provided
- **Communications.** The relay provides IEC 60870-5-103 for in-station communications
- **Self monitoring.** Hardware and software watchdogs ensure that the relay operates in the correct manner
- **IRIG-B.** Time synchronising

**Advanced**

- **Pseudo-VT™** allows control of voltage on remote side of transformer
- Applications with embedded generation, traction and induction furnaces
- VAR control
- Incremental voltage target change.

# Description

### Voltage control

The user specifies system power factor, target voltage, dead band, initial delay and inter-tap delay.

When a voltage excursion outside the dead band occurs the MicroTAPP acts to restore correct system voltage. When deciding on voltage excursion the measured voltage is compensated for:

- Load drop compensation (LDC) - applied along the system power factor line
- Corrective coupling voltage (CCV) - proportional to the circulating current flowing in the transformer
- Frequency compensation - if the frequency drops beneath a pre-set level a compensation can cause a drop in the system voltage to reduce load

After an initial delay, to ignore short-term fluctuations, a tap-change instruction is issued. The delay is a definite time for low voltages. For high voltages a definite time delay (DTL) or an inverse time delay can be specified. If a DTL is specified a fast-tap down can be enabled, which is a high-set of band + 2% and a 2 second delay.

The inter-tap delay sets a minimum period between successive tap instructions to allow time for the tap-changer to operate.

### Advanced control functionality

Through its Pseudo-VT™ algorithm the MicroTAPP can calculate and hence control the voltage on the remote side of the transformer to that on which the VT and CT are located.

It makes use of the tap position, which it ensures is correct through an intelligent operation monitor, to calculate the actual transformer ratio and voltage drops in the transformer.

Together with multiple settings groups this allows the user to operate the system flexibly when used with embedded generation. When the generation is operating on power factor control the MicroTAPP can control the LV side, when the generation is operating on voltage control the MicroTAPP can control the HV side.

Other applications of this feature are with traction systems and induction furnaces.

### Voltage monitoring

Independent algorithms monitor the system voltage.

Excessive voltage unbalance can be caused by VT fuse failures. If 3-phase VTs are used this condition can be recognised. Tap change operations to raise voltage are blocked to prevent dangerously high voltages appearing on the system.

The blocking matrix (see Figure 2) intelligently blocks raise and lower operations depending on system conditions. High currents when the power factor is abnormal may be as a result of circulating currents. In this situation the relay should act to reduce them rather than applying over-current blocking. If an excessive current flows at normal system power factors the relay inhibits all tap-changing operations. A system voltage below 80% will most likely be a fault condition and all tap-changing is inhibited.

For added integrity when a 3-phase VT is used a different phase voltage is used for monitoring than for voltage control.

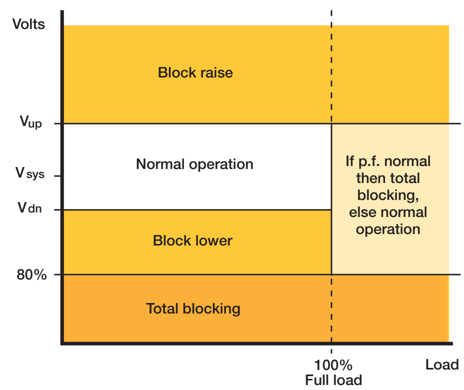


*Figure 2 Voltage monitoring blocking matrix*

If the voltage remains abnormal for the user-specified time an alarm is generated.

### Tap-changer monitoring

An intelligent tap-position indicator and runaway prevention algorithm monitors the entire tap-change operation. A Tap-changer Runaway is quickly detected and the tap-changer is locked out. Incomplete tap-changes are detected and indicated.

If the voltage requires a tap-change beyond the limits of the tap-changer this is inhibited and an alarm is sent.

### Operations counter

A tap-changer operations count and a sum of I squared count is provided. Alarm levels can be set which, when reached, can be input to a condition-based maintenance system.

### $I^2$ counter

This can provide a measure of contact erosion and be used for planning tap-changer maintenance schedules.


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### Data recording

Data collection capabilities contribute to management of the network asset.

A tap-change counter and $I^2$ summation assists in tap-changer condition based maintenance.

Power quality can be assessed through the use of 24 hour records of voltage, load, power factor, tap position, frequency and NPS/PPS voltage. Additionally, form factor and crest factor provide an indication of the presence of harmonics in the voltage waveform.

Voltage control and tap-changing events are stored and time tagged to 1ms resolution. These are available via the communications.

If a tap-changer failure occurs a record is made of the tap position and reason for failure. This is available via the communications.

### Communications

Two fibre-optic communications ports are provided on the rear of the relay. These are optimised for either 62.5/125µm glass-fibre using BFOC/2.5 (ST®) bayonet-style connectors. One front RS232C 25 pin D type port is provided to assist setting and commissioning.

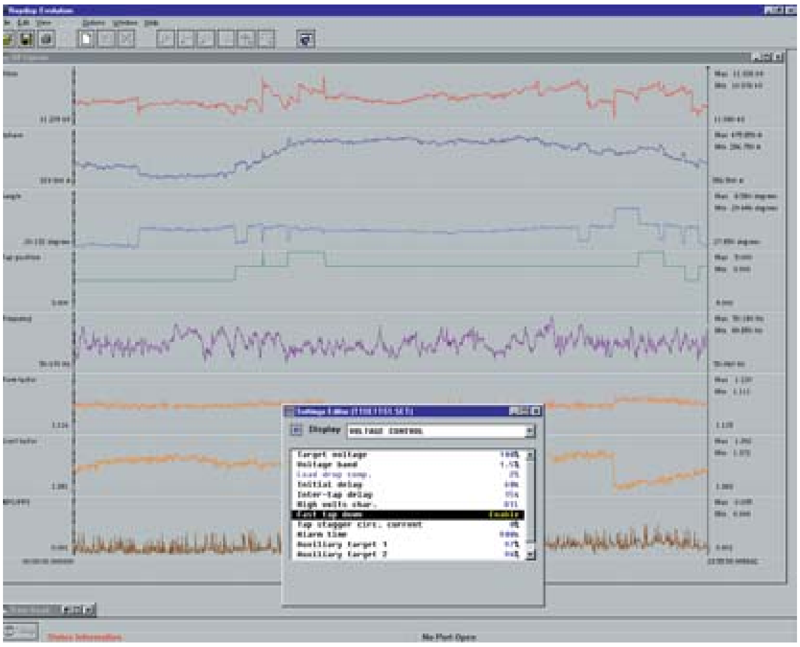
The MicroTAPP uses the IEC 60870-5-103 communications protocol.

### ReyDisp Evolution

This support software is common to the entire range of Reyrolle numeric products. It provides the means for the user to apply settings to the MicroTAPP, interrogate settings and retrieve events and 24 hour data from the MicroTAPP.

### IRIG-B

The relay supports a GPS derived clock input to provide time synchronisation.



*Disturbance records in ReyDisp Evolution*

# Typical applications diagrams

Figure 3 shows two options for AC measuring connections: one using a 3-phase VT, the other for when only a single-phase VT is available. Any phase may be chosen for the CT. Figure 4 and 5 show typical control circuit connections. Figure 4 is the traditional connection with step-by-step contactor. In figure 5 the step-by-step control within the MicroTAPP is used. The phase currents used for compensation may differ between parallel transformers (i.e. transformer 1 may use an "a" phase CT and transformer 2 may use a "b" phase CT).

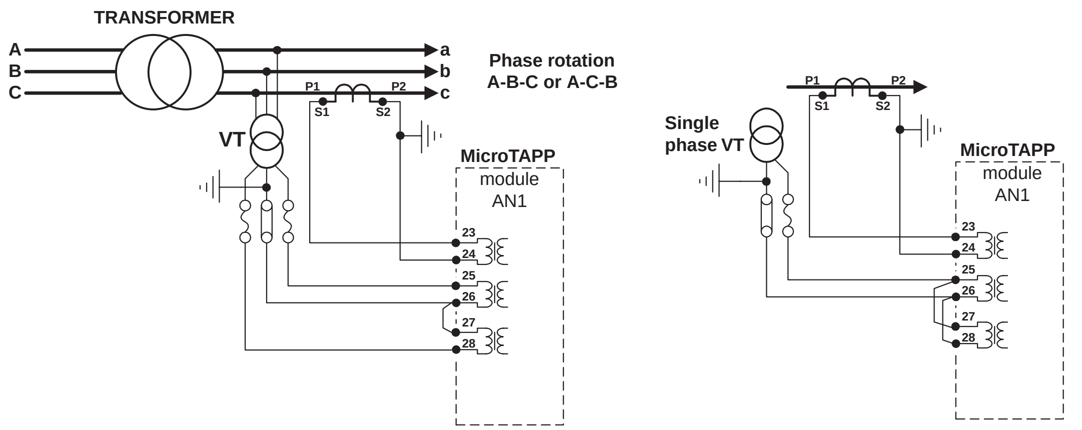



*Figure 3 Typical voltage and current measurement inputs with a 3-phase VT*

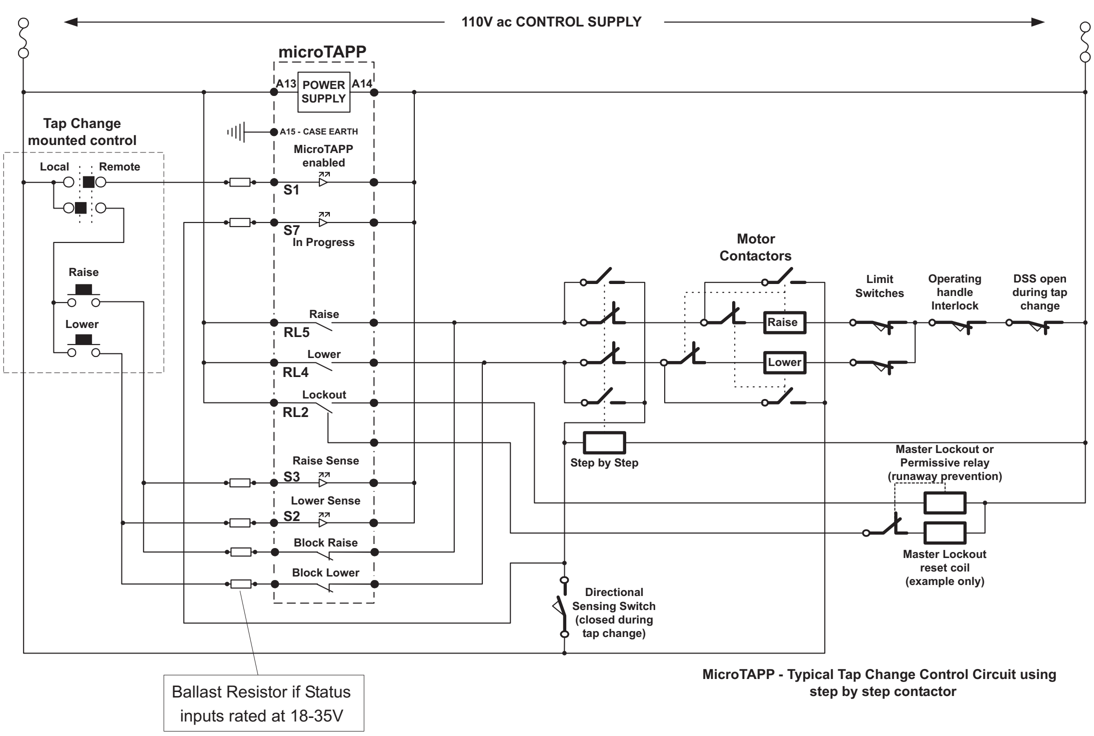



*Figure 4 Typical tap-change control circuit with traditional step-by-step contactor*

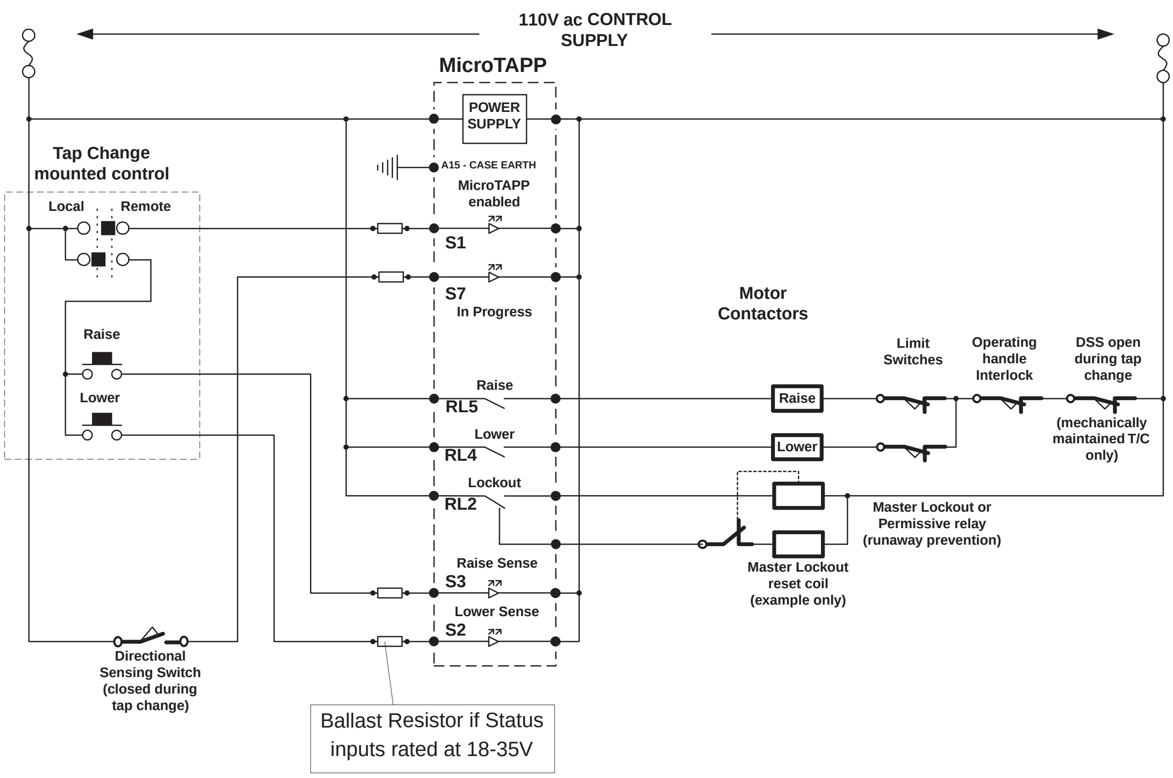



*Figure 5 Typical tap-change control circuit with step-by-step control internal to the MicroTAPP*

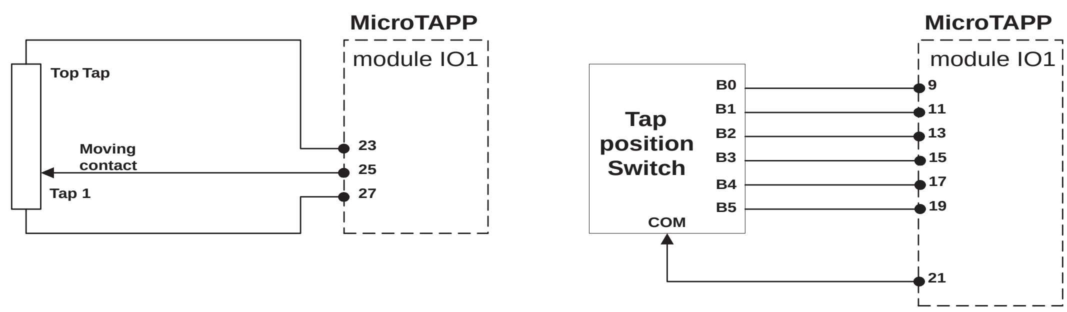



*Figure 6 Tap position input connections for resistor and BCD/binary sender units*

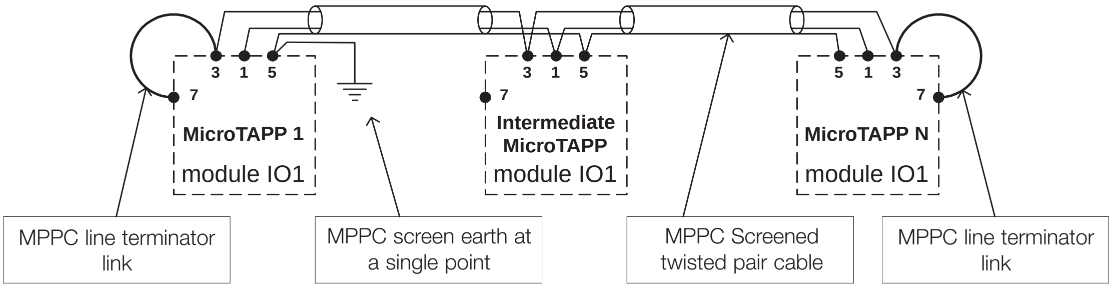



*Figure 7 Connections for MicroTAPP peer-peer communications (MPPC)*

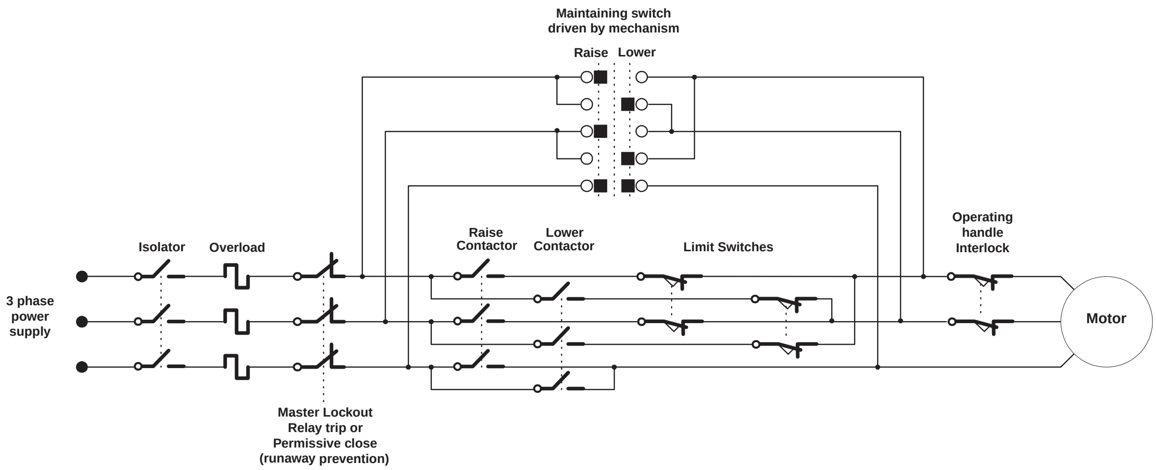



*Figure 8 Typical tap-change motor circuit*


# MICROTAPP

## Automatic voltage control

### Technical information

Performance data to IEC 60255-3

**Characteristic energising quantity**

| AC Current | Frequency |
|---|---|
| 1 A / 5 A | 50/60 Hz |

**Auxiliary energising quantity**

**Power supply**

| Nominal Voltage | Operating Range | | |
|---|---|---|---|
| 48, 110 VDC | 37.5 | to | 137.5 VDC |
| 110 VAC | 82.5 | to | 137.5 VDC |

**Status inputs**

| Nominal Voltage | Operating Range V | | |
|---|---|---|---|
| 30, 34 V | 18.0 | to | 37.5 |
| 48, 54 V | 37.5 | to | 60.0 |
| 110, 125 V | 87.5 | to | 137.5 |
| 220, 250 V | 175.0 | to | 280.0 |

The status voltage need not be the same as the main energising voltage.

**Status input performance**

| Parameter | Value |
|---|---|
| Minimum DC current for operation (30/34V and 48/54V inputs only) | 10 mA |
| Reset/operate voltage ratio | ≥ 90 % |
| Typical response time | < 5 ms |
| Minimum pulse duration | 40 ms |

### Control Elements

**General**

| | |
|---|---|
| No. of transformers | 1 to 16 |
| No. of taps | 1 to 39 |
| Sender unit | Resistor chain, binary, BCD, gray code |

Recommended resistor chain 1K to 10K ohms in total.

**Method**

| | |
|---|---|
| Setting | TAPP, true circulating current |

**Voltage control**

| | |
|---|---|
| Target | 85 to 115% Vn |
| Dead band | ±0.1 to ±5.0% Vn |
| Accuracy | ±0.1% Vn |
| Repeatability | ±1% |

**Initial delay**

| | |
|---|---|
| Characteristics | see below |
| Setting | see below |
| Accuracy | ±0.25 s |
| Repeatability | ±0.25 s |

When the volts are low the initial time delay is always a definite time. When the volts are high the initial delay can be a definite time or an inverse time, selectable by a setting. When a definite time is selected the "fast tap-down" definite time characteristic can be enabled.

The volts-time characterstic for high volts definite time is:

If $V - V_{target} > V_{band} + 2.0\%$, and fast tap down is enabled, $t = 2s$

else if $V - V_{target} > V_{band}$, $t = t_{initial}$

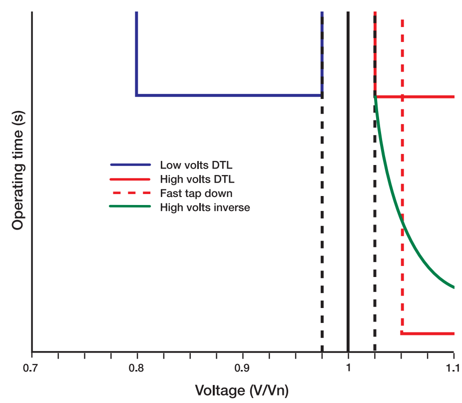
The volts-time characterstic for high volts inverse time is:

$$t = \frac{t_{initial}}{(V - V_{target}) / V_{band}}$$

| | | |
|---|---|---|
| $t$ | = | time to lap change |
| $t_{initial}$ | = | initial delay setting |
| $V$ | = | measured voltage |
| $V_{target}$ | = | target voltage setting |
| $V_{band}$ | = | dead band setting |

**Inter-tap delay**

| | |
|---|---|
| Setting | Continuous, 1 to 120 s |
| Accuracy | Is |
| Repeatability | Is |




### General Accuracy

**Reference conditions**

| Parameter | Reference or Value |
|---|---|
| Auxiliary supply | Nominal |
| Frequency | 50/60 Hz |
| Ambient temperature | 20°C |

## Accuracy influencing factors

**Temperature**

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

**Frequency**

| Range | Variation |
|---|---|
| 47 Hz to 62 Hz | Level: ≤ 5%<br>Operate Time: ≤ 5% |

**Harmonic content**

| Range | Variation |
|---|---|
| Frequencies to 550Hz | Setting: ≤ 5% |

## Thermal withstand

**Current input**

| | |
|---|---|
| 3.0 x In | continuous |
| 3.5 x In | 10 minutes |
| 100A | 1 second |
| 2500A | 1 cycle |

**Voltage inputs**

| | |
|---|---|
| 250V | continuous |

**Burdens**

| Input | Burden | Impedance |
|---|---|---|
| Current input | 1 VA | ≤ 0.5 Ω |
| Voltage input | 0.1 VA | ≤ 1 M Ω |
| Auxiliary supply | 17 W (quiescent)<br>20 W (maximum) | |

**Note:** Burdens and impedances are measured at nominal current rating.

## Output contacts

**Contact rating to IEC 60255-0-2.**

| | |
|---|---|
| Carry continuously | 5 A ac or dc |

**Make and carry**

(limits: L/R ≤ 40ms and V ≤ 300 volts)

| Time | Current |
|---|---|
| 0.5 sec | 20 A ac or dc |
| 0.2 sec | 30 A ac or dc |

**Break**

(limits: 5A or ≤ 300 volts)

| Type | Value |
|---|---|
| ac resistive | 1250 VA |
| ac inductive | 250 VA @ PF ≤ 0.4 |
| dc resistive | 75 W |
| dc inductive | 30 W @ L/R ≤ 40 ms<br>50 W @ L/R ≤ 10 ms |
| Minimum recommended load | 0.5 W, limits 10 mA or 5 V |

## Environmental

**Temperature IEC 68-2-1/2**

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

**Humidity IEC 68-2-3**

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

**Transient Overvoltage IEC 60255-5**

| Test | Levels |
|---|---|
| Between all terminals and earth or between any two independent circuits without damage or flashover | 5 kV<br>1.2/50 µs<br>0.5 J |

**Insulation IEC 60255-5**

| Test | Level (rms for 1 min) |
|---|---|
| Between all terminals and earth | 2.0 kV |
| Between independent circuits | 2.0 kV |
| Across normally open contacts | 1.0 kV |

**Immunity**

**Auxiliary DC supply IEC 60255-11**

| Quantity | Value |
|---|---|
| Allowable superimposed ac component | ≤12% of dc voltage |
| Allowable breaks/dips in supply (collapse to zero from nominal voltage) | ≤ 20 ms |

**High frequency disturbance IEC 60255-22-1 Class III**

| Type | Level | Variation |
|---|---|---|
| Common (longitudinal) mode | 2.5 kV | ≤ 3% |
| Series (transverse) mode | 1.0 kV | |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**Electrostatic discharge IEC 60255-22-2 Class III**

| Type | Level | Variation |
|---|---|---|
| Contact discharge | 8 kV | ≤ 5% |

**Radio frequency interference IEC 60255-22-3**

| Frequency range | Level | Variation |
|---|---|---|
| 80 to 1000 MHz | 10 V/m | ≤ 5% |

**Fast transient IEC 60255-22-4 Class IV**

| Type | Level | Variation |
|---|---|---|
| 5/50ns, 2.5 kHz, repetitive | 4kV | ≤ 3% |

**Conducted RFI IEC 60255-22-6**

| Frequency range | Level | Variation |
|---|---|---|
| 0.15 to 80 MHz | 10 V | ≤ 5% |

**Emissions**

**Conducted limits IEC 60255-25**

| | Limits dB(μV) | |
|---|---|---|
| Frequency range | Quasi-peak | Average |
| 0.15 to 0.5 MHz | 79 | 66 |
| 0.5 to 30 MHz | 73 | 60 |

**Radiated limits IEC 60255-25**

| | Limits 10 m |
|---|---|
| Frequency Range | Quasi-peak, dB(μV/m) |
| 30 to 230 MHz | 40 |
| 230 to 10000 MHz | 47 |

**Mechanical**

**Vibration (sinusoidal)**
**IEC 60255-21-1 Class 1**

| Type | Level | Variation |
|---|---|---|
| Vibration response | 0.5 gn | ≤ 5% |
| Vibration endurance | 1.0 gn | |

**Shock and bump IEC 60255-21-2 Class 1**

| Type | Level | Variation |
|---|---|---|
| Shock response, 11ms | 5 gn | |
| Shock withstand, 11ms | 15 gn | ≤ 5% |
| Bump test, 16ms | 10 gn | |

**Seismic IEC 60255-21-3 Class 1**

| Type | Level | Variation |
|---|---|---|
| Seismic response | 1 gn | ≤ 5% |

**Mechanical classification**

Durability — In excess of $10^6$ operations

**IRIG-B**

Operating band — 3 to 6V pk-pk

Some GPS receivers output greater than 6V pk-pk and may saturate the relay input above these limits. A common shunt resistor in the 50 ohm range may be used to bring the signal inside the operating band.

## Sample specification

The specification below is in brief, a more comprehensive version is available on request.

**Functionality**

**Voltage control**

The following standard system conditions should be catered for with minimal or no adjustment to the Automatic Voltage Control System (AVC):

1. Where a transformer operates in parallel with other transformers, either within a site or across a network, the AVC should operate in order to (a) maintain the system voltage at the correct level and (b) operate at a tap position where minimal reactive circulating current flows from or into any system transformer which is a part of the network
2. In the event of a failure of communications either between grouped transformers or from a remote control centre, the AVC should be able to operate in a stand-alone mode and achieve a satisfactory overall system voltage
3. If a transformer in a group is switched IN, no significant change in voltage will occur
4. If a transformer in a group is switched OUT, no significant change in voltage will occur
5. The Load Drop Compensation (LDC) method, if used, must remain at the correct level regardless of the number of transformers connected to a common busbar
6. Settings applicable to different network running arrangements should be applied to the AVC and be capable of implementation by a single instruction (either from a remote source or locally) or plant status change
7. The AVC must be provided with the capability of independently protecting against incorrect operation which would allow abnormal voltages to be applied to the network

The AVC shall be capable of controlling at least 8 transformers operating in parallel as a group.

The operating characteristics of the voltage regulating relay is to be such that a raise or lower command will only be issued after an initial time delay as set on the voltage regulating relay. A definite time characteristic and an inversely related initial time characteristic shall be selectable. When a definite time delay is selected a fast tapping feature which bypasses the initial time delay in the event of substantial voltage excursions above the set band is preferred. Any subsequent corrective signals for the same voltage deviation will be delayed by a separate inter-tap time delay.

The voltage regulating relay shall include a 'Load Drop Compensation' facility. LDC shall be used where the busbar voltage is increased in proportion to the total substation load current. The LDC effect shall be proportional to the total connected busbar load. This method will provide the correct voltage boost given by the chosen LDC setting, irrespective of the number of transformers in service. Full LDC functionality shall be retained when parallel control based on the minimum circulating current method is used. Full details on how this feature is achieved should be submitted with tender documents.

**Voltage monitoring**

Monitoring of the voltage level shall be via separate connections to those used for voltage control.

If the measured system voltage is less than a pre-set under-voltage limit or greater than a pre-set over-voltage limit, the system shall inhibit the appropriate tap control outputs to the relevant transformer but allow tap change operations that will correct the abnormal voltage. An alarm will be generated if the abnormal voltage persists.

Where a 3 phase VT is used the system shall monitor all voltages in order to ensure the integrity of the VT secondary output. Any abnormalities detected will inhibit the voltage raise outputs from the system and initiate an alarm.

If the load current is greater than a pre-set limit, the system shall inhibit all tap control outputs to the relevant transformer(s) and generate an alarm, unless the situation is caused by circulating current flowing between transformers. In this case tap changing will be allowed to reduce the circulating current.

**Tap-changer monitoring**

The tap changer operation monitor circuits shall be provided for tap changer runaway protection in the event of a mechanism, wiring or relay fault. The following shall be considered minimum requirements for such protection:

Protection is required that will detect incorrect tap change operation at the earliest opportunity. An incorrect tap change operation is defined as 'a tap change operation that is not initiated by a 'true' control signal'. As an example, a slow to clear 'raise' contactor may allow a motor drive to continue driving the mechanism at the end of a tap change cycle such that the tap change maintaining switch recloses and thus allows the tap change to 'run away'.

Full details of the proposed detection method shall be detailed in the tender documentation. The preferred scheme, however, should not rely on timing systems for determination of this situation, but intelligently monitor the




relationship between the control signals, the tap change in progress inputs and the tap position.

If a lockout is required the AVC will initiate contacts both for lockout and alarms. The lockout contacts shall provide for the tripping of a mechanically latched contactor or the permissive operation normally open contactor. Both contactors shall control the tap change motor power supply.

### Interfaces

#### Inputs from plant

To avoid drain on substation batteries, the tap changer control supply will provide the supply for all AVC equipment and have a nominal AC voltage of 110V (+10% to -25%).

Measuring voltage inputs shall be provided capable of operating with VTs with secondary rating between 63.5 and 250V. Adjustment shall be provided to eliminate any VT ratio errors.

A measuring current input shall be provided capable of operating with CTs of 1, 2 or 5A secondary rating. The relay shall be configurable to allow non-standard CT ratios to be used. The relay shall be capable of using the CT regardless of the phase to which it may be connected.

The relay shall be capable of measuring up to 33 tap positions, including special tap positions (e.g. 8A, 8B, 8C) from resistor chain, BCD, binary and gray code sender units.

A tap-change in progress (TCIP) signal shall be detected by the relay from a contact provided in the tap changer. The TCIP contact will close as the tap change starts and open at the end of the tap change sequence.

#### Outputs to plant

The tap raise/lower outputs shall be via normally open clean contacts with a minimum pulse time of 1.5s rated for 5A AC.

The AVC system will be required to prevent operation of the tap changer motor drive in the event of unwanted operations. Two methods may be used:

1. Tripping of a mechanically latched contactor connected into the supply for the motor
2. Permissive operation of a normally de-energised contactor connected into the motor supply during the tap changing sequence

To enable either option, change-over clean output contacts rated for at least 5A AC shall be provided.

#### Operator controls

The AVC system shall provide the means to:

- switch control points between local (at the AVC) and remote (network control centre),
- switch between manual and automatic control, and,
- raise and lower the tap-changer manually.

When set to local it shall not be possible for a remote point to operate the tap-changer or switch the AVC between manual and automatic modes.

If a Master/Follower tap change control scheme is proposed additional control switches will be required. The tender shall indicate the additional equipment that will be required for this type of scheme. A Master/Follower design is NOT the preferred scheme for submission as a solution, as TAPP and circulating current are superior, master-follower may be implemented using the MicroTAPP set in TAPP mode.

#### Indication and instrumentation

The following indications shall be provided:

- Circuit identifier
- AVC healthy LED
- Voltage normal/high/low LEDs
- Tap in progress LED
- Voltmeter showing system voltage
- Tap position indication, allowing for unusual tap arrangements (e.g. 8A, 8B, 8C)
- Indication of transformer load, transformer load power factor and total load of all paralleled transformers

#### Remote access

Remote access shall be provided through both hard-wired inputs and outputs, and using a non-proprietary communications protocol, e.g. IEC 60870-5-103.

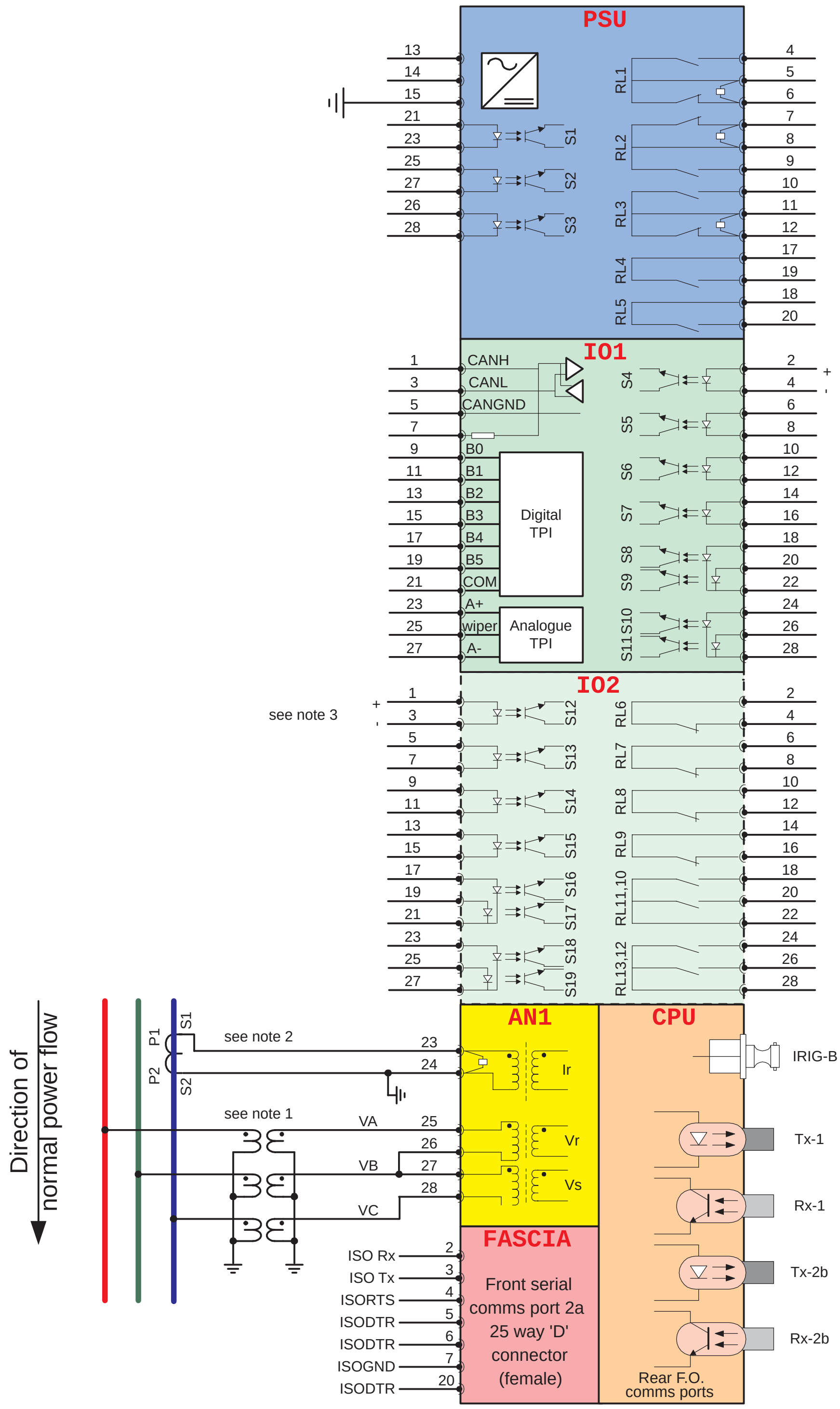
The following features shall be available using both access methods:

- When the AVC system is set to remote, it will be possible to switch the AVC between automatic and manual, and, when in manual, to operate the tap-changer from a remote point
- It will be possible to select between a minimum of 3 pre-set voltage targets
- Alarms will be provided for AVC failure, VT fuse failure, voltage out of limits, tap-changer runaway, tap-change incomplete, target not achievable.

The following data shall be made available using the communications protocol:

- Metering values of voltage, load, power factor and tap position
- Traces of voltage, current, tap position, frequency and a measure of power quality for a minimum period of 24hrs
- IEC and private events

*Figure 9 Typical connection diagram*




## *Notes*

1. VT connections show use with a star-connected VT, other arrangements can be used
2. CT connection is shown on blue phase, any connection can be used.
3. IO2 is provided on MT1-xxx xJ variants only (E12 case)

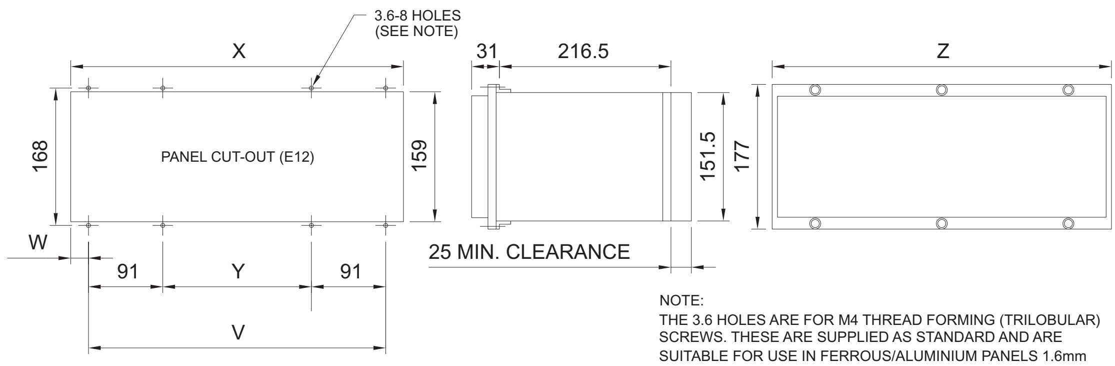

# MICROTAPP

## Automatic voltage control

### Case

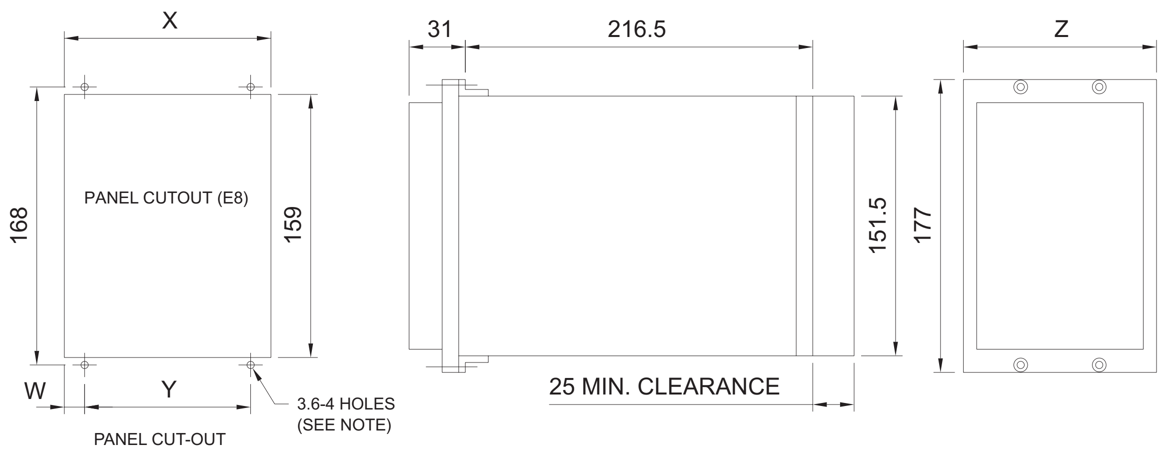
The MicroTAPP is supplied in either a size 8 or size 12 case, depending on the status input and output relay requirement, see the table below.

| | | |
|---|---|---|
| Digital I/O Provision | 11 status inputs,<br><br>5 output relays<br>(3 changeover, 2 normally open) | 19 status inputs,<br><br>13 output relays<br>(3 changeover, 6 normally open,<br>4 normally closed) |
| Case size | Size 8 | Size 12 |




***Overall Dimensions and panel drilling for Epsilon E12 case***

NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS/ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).




***Overall Dimensions and panel drilling for Epsilon E8 case***

| | E8 | E12 |
|---|---|---|
| V | – | 286 |
| W | 9.75 | 9.25 |
| X | 201.5 | 304.5 |
| Y | 182 | 104 |
| Z | 207.5 | 311.5 |

***All dimensions are in Millimetres***

## Ordering information

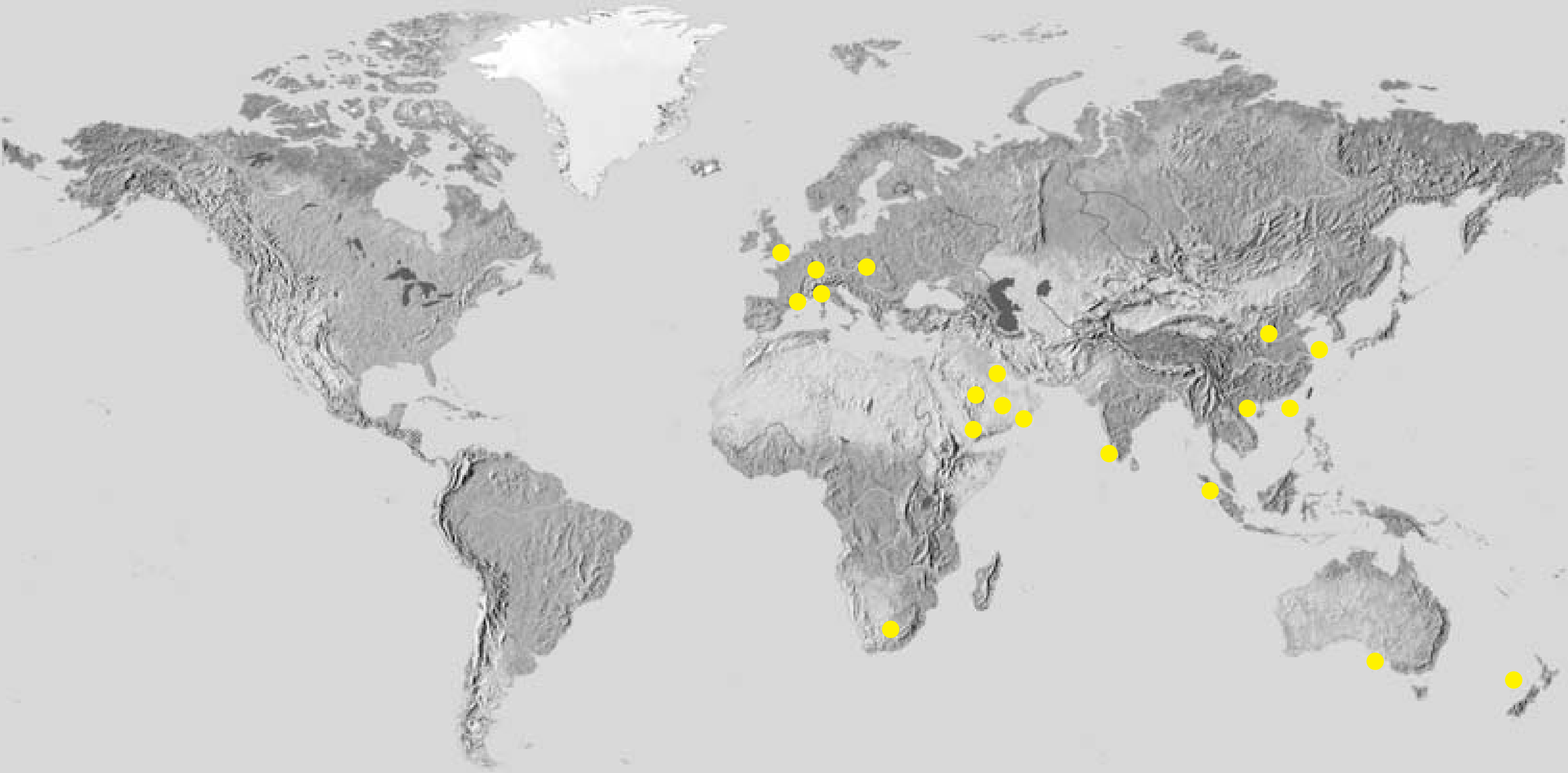
**Order No.** MT1 – 10 ☐ ☐ ☐

| **Measurement capability** | | |
| --- | --- | --- |
| Basic functionality | | **1** |
| Advanced control functionality | | **2** |

| **Auxiliary and status input voltage** | | |
| --- | --- | --- |
| **DC/DC** | **Status** | |
| 30VDC | 30VDC/AC | **A** |
| 30VDC | 48VDC/AC | **B** |
| 48/110VDC | 30VDC/AC | **C** |
| 48/110VDC | 48VDC/AC | **D** |
| 48/110VDC | 110VDC/AC | **E** |
| 220VDC | 110VDC/AC | **F** |
| 220VDC | 220VDC/AC | **G** |
| 110VAC | 110VDC/AC | **H** |
| 110VAC | 48VDC/AC | **I** |
| 110VAC | 220VDC/AC | **J** |
| 110VAC | 30VDC/AC | **K** |

| **Status input and output relay arrangement** | |
| --- | --- |
| 11 status inputs, 5 output relays (incl. 3 changeover) - E8 size cover | **E** |
| 19 status inputs, 13 output relays (incl. 3 changeover and 4 normally closed contacts) - E12 size cover | **J** |

A mounting bracket with 19 off 220ohm resistors (article number 2512H10072) is available for use with resistors sender units



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