Contents

1. INTRODUCTION

The RTMU control and monitor relays and RTPI tap position indicators are designed for use with SuperTAPP type RVM relays or as stand alone monitor devices for existing or new voltage control systems.

When used in conjunction with RVM voltage control relays, a comprehensive, self contained tap change control system is provided in an extremely cost effective manner, such that minimum external wiring is required to complete the installation.

The RTMU monitor relay is designed for use with RVM/5 voltage control relay while the RTPI complements the use of the RVM/4 relay in existing installations. Four relays are available:

RTMU/1m	Control and monitor unit with Resistor tap position input (BCD Optional)
RTMU/2m	Control and monitor unit with return to centre off Auto/Manual position and resistor or BCD tap position input
RTPI/1m	Tap position indicator
RTPI/2m	Tap position indicator with runaway prevention

2. TAP CHANGE MONITOR FUNCTIONS

2.1. Tap Position Measurement

A tap position indicator with mechanical runaway prevention logic monitors each tap change operation and checks that a genuine tap change signal has been initiated.

2.2. Voltage Measurement (RTMU only)

A voltage monitor checks the output voltage of the power transformer and inhibits tap change operations which would cause the voltage to go above or below pre-set maximum and minimum voltage levels.

2.3. Output Contacts

2.3.1. Tap change lockout (not RTP1/**1**m)

Relay output contacts are provided such that the tap change motor supply circuit can be disconnected in the event of a runaway situation.

2.3.2. Voltage monitor (RTMU only)

Normally closed contacts are provided on each of the high and low monitors which inhibit further tap change operations in the wrong direction when connected into the raise and lower contactor initiation circuits.

2.3.3. Alarm (not RTP1/**1**m)

An output relay with a normally open contact is provided for external alarm if a tap change runaway or voltage abnormality is detected after a time delay.

3. DESIGN

For general use the RTMU/1m relay is available to meet the requirements of standard tap change schemes. The RTMU/2m relay has modified Auto/Manual with return to 'centre off' position control switch for use with some systems. Figures 1, 2, 3 & 4 are block diagrams of the relay functional structure.

3.1. Tap Position Indication

The tap position is indicated by a liquid crystal display (LCD) driven via a filtered input circuit from a resistor type sender unit.

A digital input circuit is additionally available as standard on the RTMU/2m or as an option on the RTMU/1m. This can be either binary coded decimal (BCD) or true binary.

If used with a resistor sender unit the tap position indicator will read the correct tap position regardless of the number of taps or the resistor values (within the limits set, see specification).

Underlying the tap position indicator is the runaway prevention logic, detection of raise or lower signals is used to determine the valid operation of the tap change mechanism. If a tap change takes place without a previous raise or lower tap change initiation signal, a lockout relay is operated which can be used to disable the tap change motor.

The RTPI/1m is essentially a simple tap position indicator. If required In Progress signals can be applied in order to drive the In progress indicator.

3.2. Voltage Monitor (RTMU only)

In automatic operation the voltage monitor continuously checks the output voltage of the power transformer and inhibits tap change operations which would cause the voltage to go above or below pre-set maximum and minimum voltage levels. If for any reason the maximum or minimum levels are exceeded, instantaneous indication is provided followed by closing of an output contact after 15 minutes for a remote alarm.

All phases are monitored. Any out of balance inhibits unwanted raise tap change operations, for example those which could be caused by a blown H.V. voltage transformer fuse.

1a DESCRIPTION OF OPERATION
RTMU & RTPI Monitor Relays

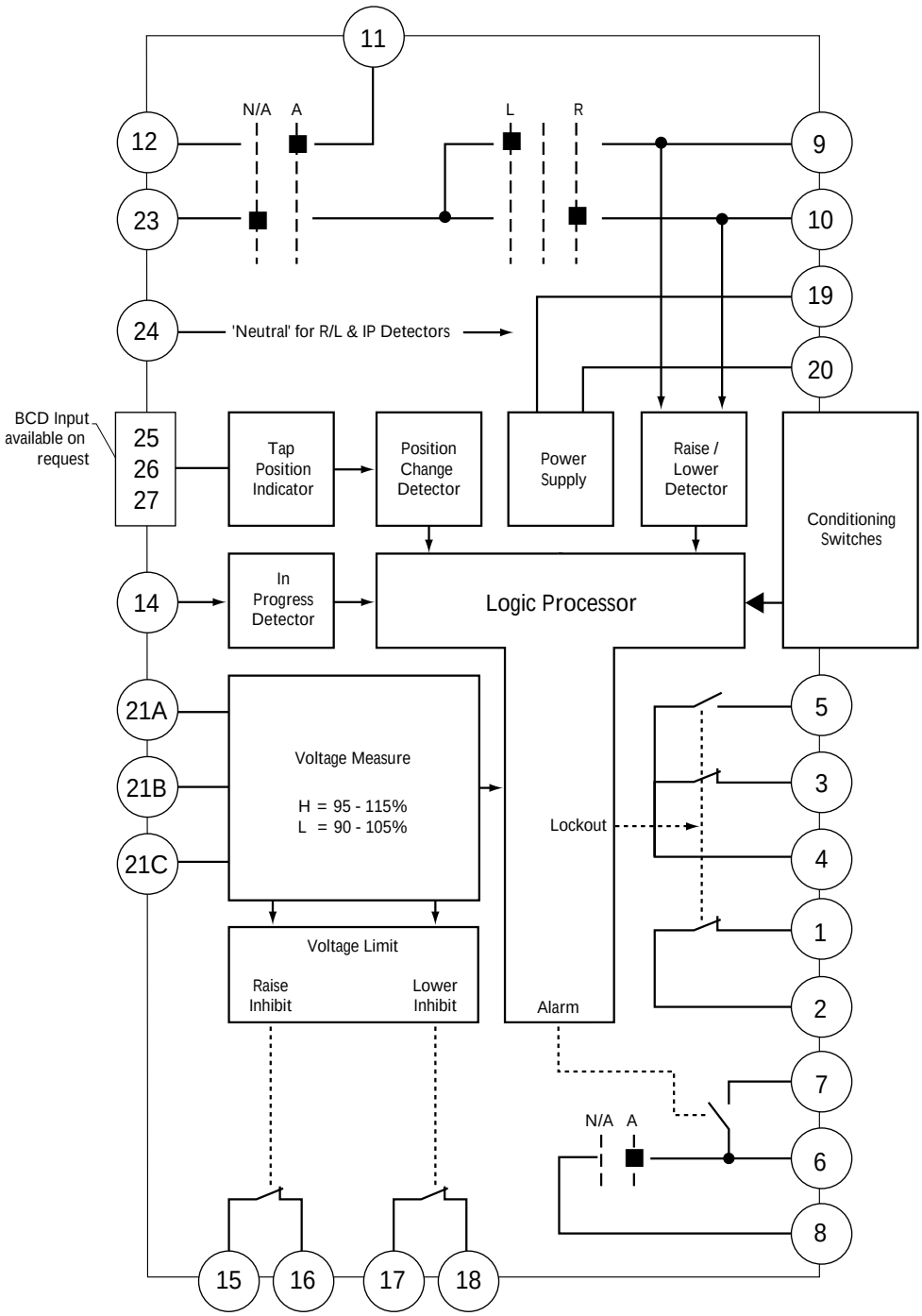

Figure 1 RTMU/**1**m Relay Block Diagram

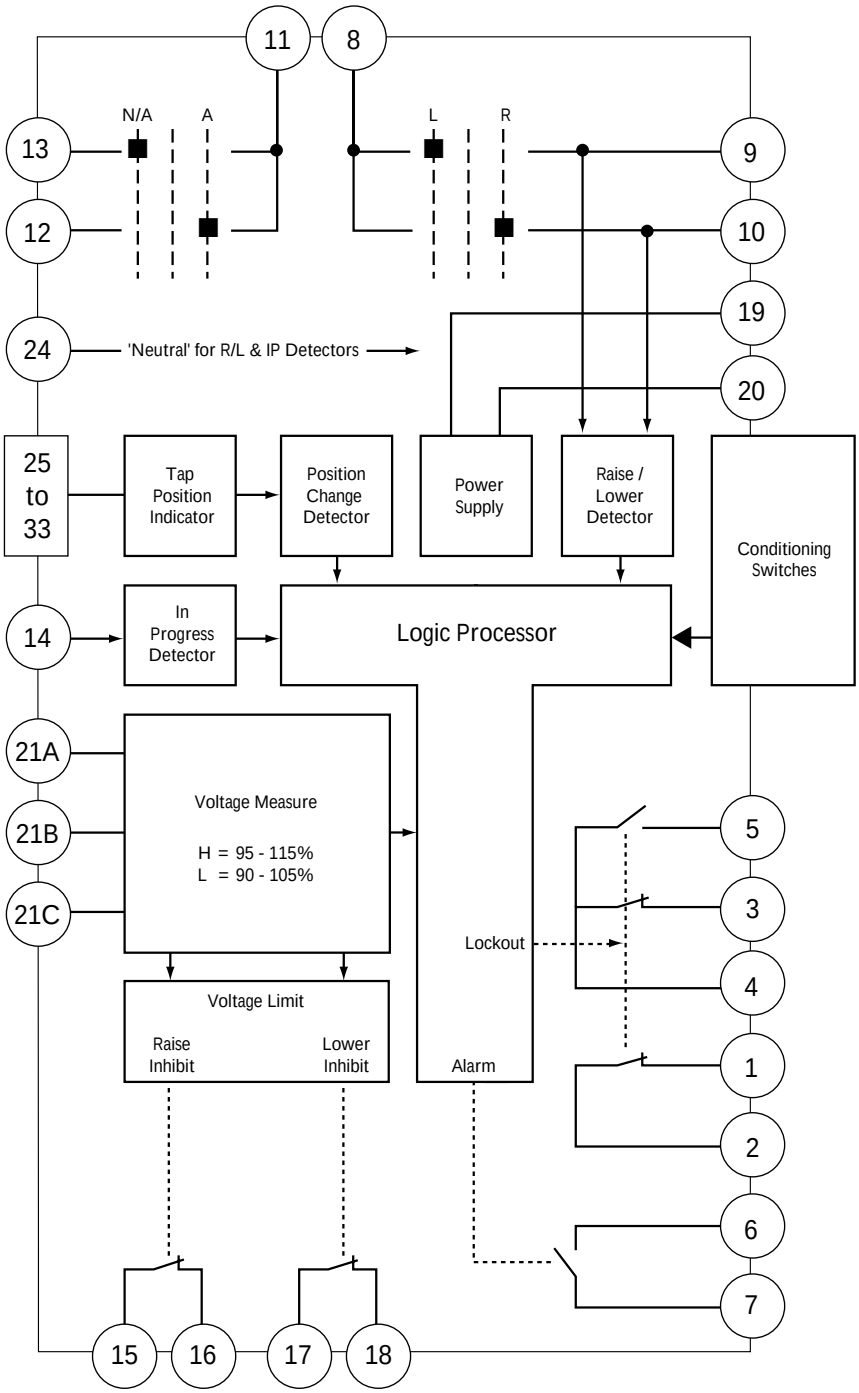

Figure 2 RTMU/2m Relay Block Diagram

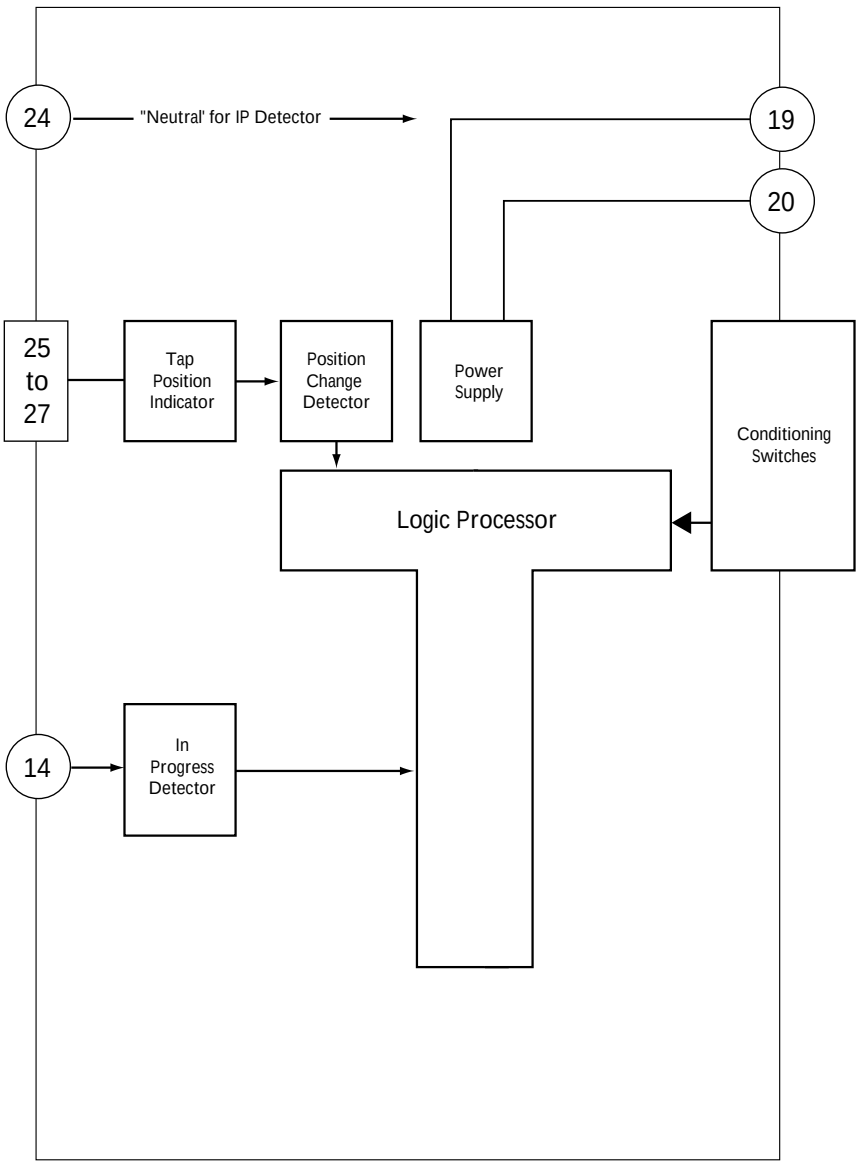

Figure 3 RTPI/**1**m Relay Block Diagram

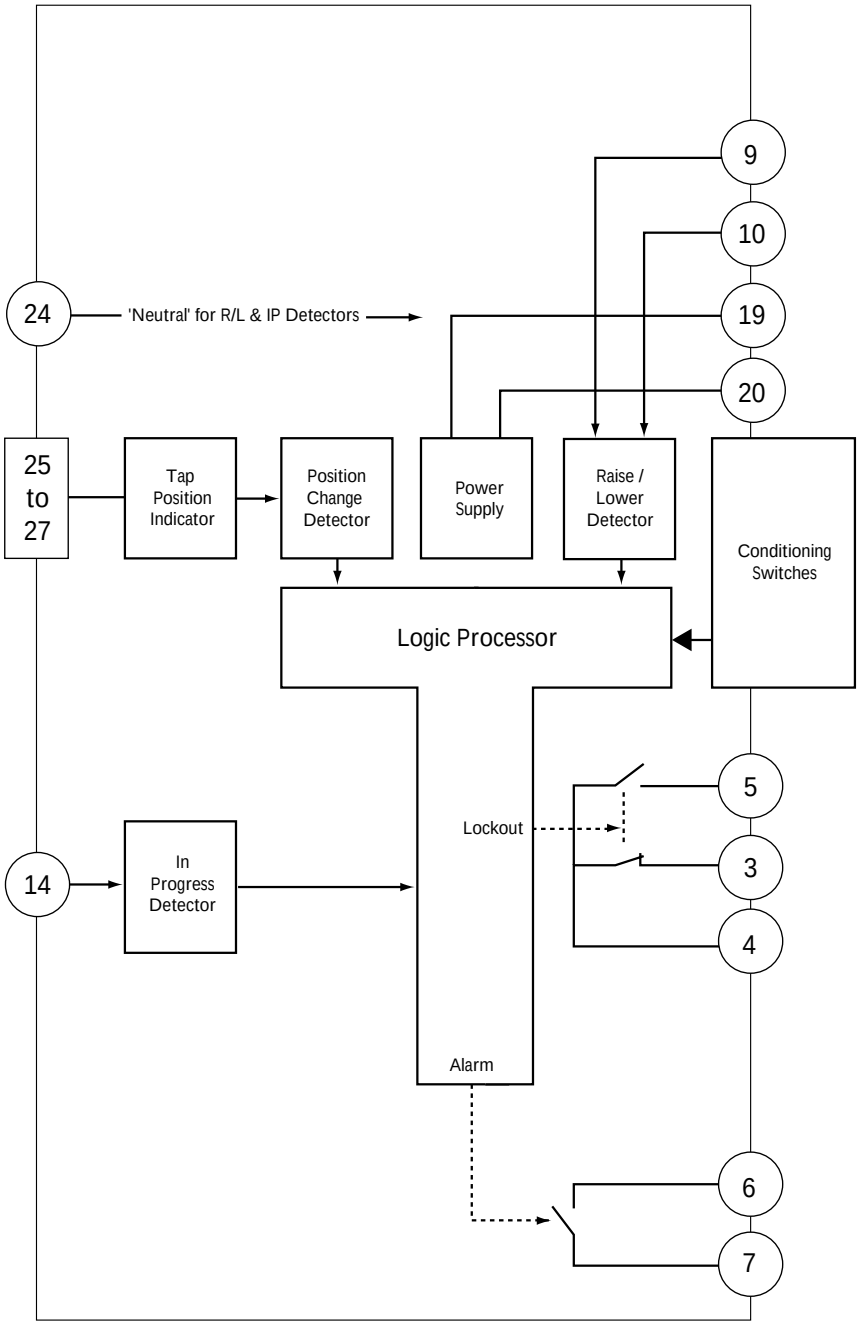

Figure 4 RTPI/2m Relay Block Diagram

4. DESCRIPTION OF FEATURES

4.1. Control Switches (RTMU Only)

The relay includes Auto/Manual and Raise/Lower control switches, these switches are internally connected for inclusion into an overall tap change control scheme, see Figure 1. Figure 2 shows the internal arrangement for an Auto/Manual selector switch with a return to centre off position. This is used in some applications to allow auto/manual selection from multiple sources.

4.2. In Progress Indication

An indicator shows that a tap change is in progress and, unlike a normal indication which is driven from an auxiliary switch, is triggered by:

- Detection of a 'raise' or 'lower' control signal
- A genuine tap position change
- An 'In Progress' auxiliary tap change mechanism switch

Given a control 'raise' or 'lower' the IP indication will stay on, and an incomplete alarm sent if a tap position change is not detected.

4.3. Tap Position Indication

The tap position indicator (TPI) is a digital indicator which can be driven by practically any sender unit. Except for the RTPI/1m, which is a simple indicator, runaway prevention logic offers a high degree of protection against inadvertent tap change operations.

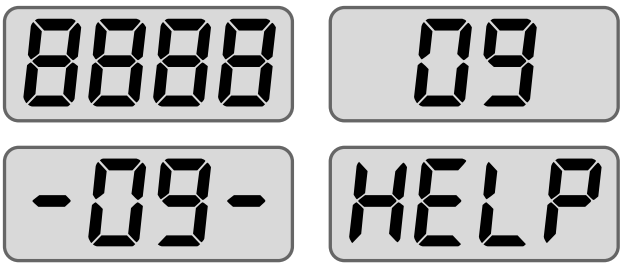

Figure 5

Information given by the display is shown in figure 5.
On startup the processor checks internal functions and drives all segments on the display. The calculated tap position is then indicated, this reading is dependent on the set up switch (see commissioning notes) and the tap position sender unit output.
If, for any reason the tap position changes, other than during a controlled tap changing operation, the display will mark the tap position as suspect.

If the calculated tap position changes to read tap 1 (resistor sender unit) or tap 0 (BCD sender unit), the display will read 'help' and an alarm will be sent.

4.4. Runaway Prevention

A Runaway can be defined as a condition where the tap changer is operating in a direction which will either cause the Voltage to move further away from the desired value and/or the circulating current to increase. There are two main causes:

- Wiring fault or mechanism failure on the transformer causing unwanted tap changes.
- Relay fault causing repeated raise or lower pulses.

4.4.1. Mechanism Faults

If the mechanism is working correctly every tap change operation will be preceded by a new control signal. If the mechanism starts to run away a tap change will take place without a further initiating signal. The Runaway Prevention Unit monitors every change in tap position via signals from the tap position indicator. If, after an initial tap change, any operations are detected without a further genuine control signal being sent, a lockout is initiated which can be arranged to disconnect supply to the tap change drive motor. This applies to manual or automatically initiated electrical operations.

Some tap changers have transfer positions where more than one operation is required to complete a tap change. In this event the unit can be configured to allow for transfer tapping.

4.4.2. Lockout Logic

For a tap change to be correct, the following sequence must take place, as shown for a normal operation, Figure 6:-

1. A control signal must be sent to initiate the process
2. The tap position must change to a new position
3. The tap change mechanism must stop completely

On most schemes an 'In Progress' (IP) auxiliary switch is also closed and used to indicate the operation of the mechanism, the operation of this contact is also shown.

To confirm correct operation of the runaway logic a definite break between successive tap change operations must be detected as indicated by the reclaim time in figures 6, 7 and 8.

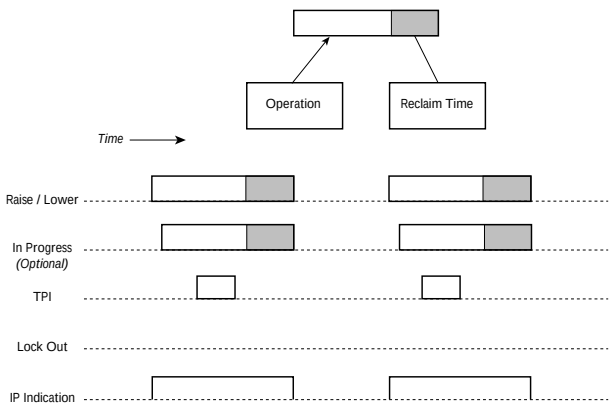

Figure 6 Normal Operation

For an incorrect tap change, Figure 7, where the mechanism over-runs, or continues to operate, a new control signal AND/OR IP is detected before the internally generated reclaim time has expired. The tap change has satisfied 3 above, and a further tap position change will result in a lockout.

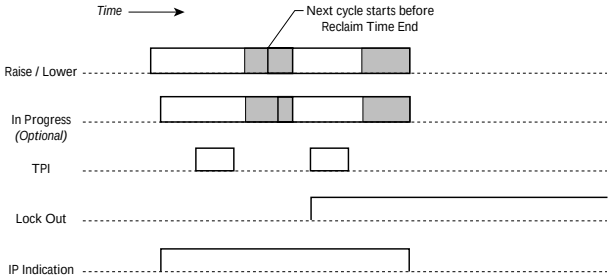

Figure 7 Runaway Condition

The runaway prevention unit also protects against a runaway situation during push button operation. Unwanted operations in manual control are prevented by avoiding further operations until the "in Progress" LED is extinguished.

Where apparent changes in tap position are seen, i.e. a faulty/high resistance sender unit contact, Figure 8 shows how a lockout will not be initiated. In this case no control signals are detected and, as the mechanism is in a quiescent state a runaway is unlikely to occur. The LCD display will mark the visible indication of tap position as suspect in this case until a further control signal initiates a tap change operation.

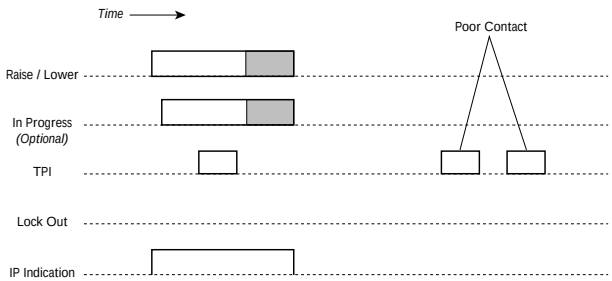

Figure 8 Poor Contacts - No Lockouts

If, because of the particular design of a tap change scheme, 'raise', 'lower' and 'in progress' signals are not available during the tap change cycle, monitor relays using tap position logic only for runaway prevention can be supplied, to specific order.

4.5. System Voltage Levels (RTMU only)

The voltage monitor checks the maximum and minimum levels of system voltage, each level being dependent upon the settings applied to the voltage control relay. For security the voltage monitor settings and measurement circuits are not included in the RVM voltage control relay.

The voltage level is monitored for valid upper and lower limits. The limits beyond which the system voltage should not persist is set by the voltage control relay settings, i.e. Basic, LDC and V Offset. Active blocking of Raise or Lower control signals takes place automatically 2% within the upper and lower alarm limits.

To clarify the action of the voltage monitor refer to Figure 9.

When the system voltage moves to point 'A' a raise blocking contact is opened. As the voltage is now within 2% of the normal upper limit the voltage control relay should not correctly request a raise operation.

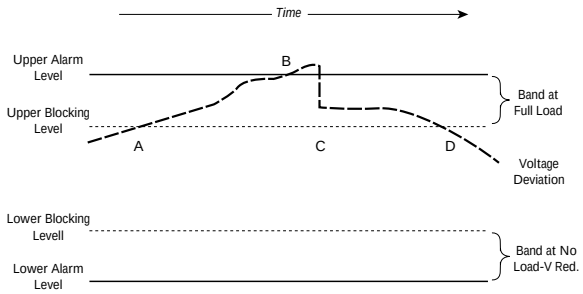

Figure 9 Voltage Monitor Blocking and Alarm

As the system voltage increases further to 'B' the alarm timer is initiated, the voltage control relay, if operating correctly, will initiate a lower tap change operation and the system voltage will be changed to 'C' before the alarm time-out is exceeded and the timer is reset.

As the system voltage reduces to 'D' the raise blocking contacts are released, allowing raise tap change operations to take place if needed.

The reverse action takes place if the system voltage drifts in the lower direction.

Unlike the voltage control relay, which uses two of the three available voltage transformer (VT) phase voltages for measurement purposes, the voltage monitor uses all phases, and detects any voltage difference between phase voltages as a check against VT HV or LV fuse failure. If a difference is detected the monitor will inhibit tap change 'raise' operations but allow 'lower' operations.

5. USER INTERFACE
5.1. General

The design of the relay fascia plate is user friendly each function is shown as a set of logical functions organised to be easily understood.

Fascia plate arrangements for the RTMU/1m and RTMU/2m relays are shown in figure 10. Figure 11 shows the fascia plate arrangements for the RTPI/1m and RTPI/2m tap position indicators.

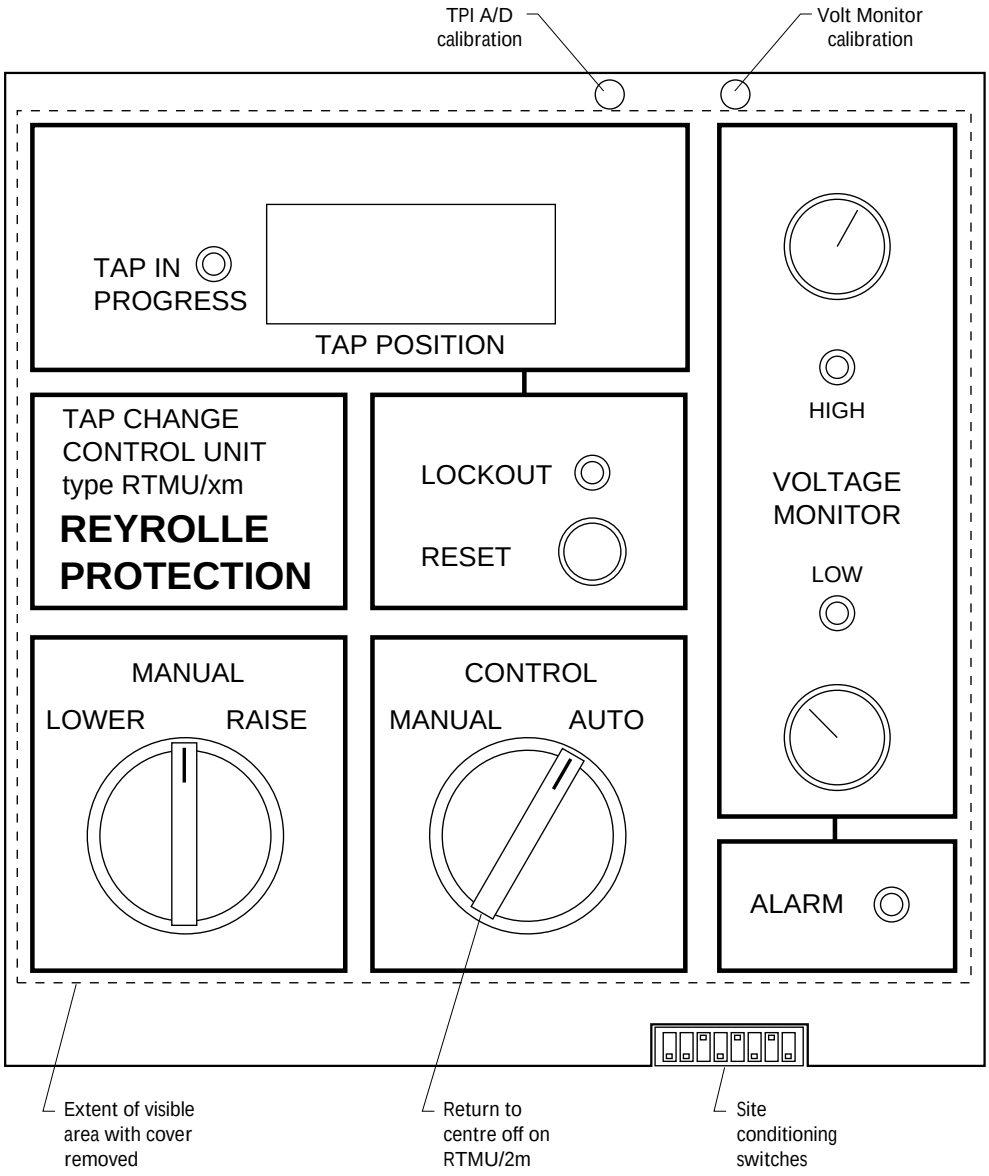

Figure 10 RTMU/Xm Fascia

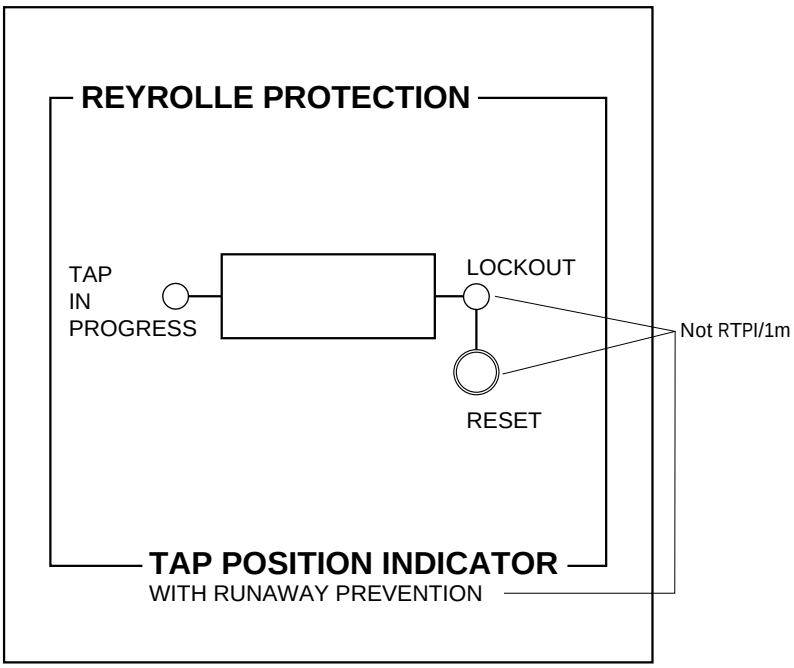

Figure 11 RTPI/Xm Fascia

5.2. Indications

Indications provided are:

Function	Colour	Indication
TAP IN PROGRESS	Amber	Operation of the tap changer via the Raise, Lower, In Progress contact or Tap Position
LOCKOUT (not RTPI/1m)	Red	Invalid tap change operation
HIGH (RTMU)	Red	System voltage is above a maximum level
LOW (RTMU)	Red	System voltage is below a minimum level
ALARM (RTMU)	Red	System voltage has remained at an abnormal level (not zero) for more than 15 minutes

TAP POSITION	LCD	The current tap position

5.3. Controls (RTMU only)

5.3.1. Control (Manual/Auto)

A control switch is provided which allows the tap change control system to be operated under hand control or under the control of a voltage control relay.

5.3.2. Manual (Raise/Lower)

When the control switch is set to manual, this switch, with a centre off position, allows manual electrical control of the tap change mechanism.

5.3.3. High

A high setting adjustment is provided which allows the high limit of normal voltage to be set.

5.3.4. Low

A low setting adjustment is provided which allows the low limit of normal voltage to be set.

6. SETTINGS

6.1. Site Arrangement

It is necessary for the tap position indicator to be configured for the particular tap change mechanism. The relays can be configured on site for the particular tap changer, for further information see the commissioning section of this document.

6.2. Network Operation, Voltage Levels

The operational settings of the voltage control system determine the normal range of voltage that will be expected at a site, the high and low voltage monitor settings should be set in accordance with these levels.

Depending on the type of VT used the 3 phase monitor sensitivity will be set for the on site condition.

Where a 3 phase VT is installed a setting of 5% is normally selected unless the voltages are severely unbalanced, where a 10% selection is usually sufficient. If a single phase VT is used for voltage sensing the voltage difference should be disabled.

7. HARDWARE

7.1. Relay Construction

The relay is housed in a mild steel case finished in black oven baked powder coating. The relay is mounted within the case on a semi-withdrawable chassis which carries the complete assembly including the rear connector strips.

7.2. Terminal Blocks

At the rear of the relay terminal strips allow for all connections to the relay, see also Figures 1, 2, 3 and 4 for connections.