

| TEST DATE | CUSTOMER | SERIAL No |
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OLTC ACKNOWLEDGE SETUP

AUTOMATIC or

FEEDBACK
CONTROL

PRODUCT / TEST MANUAL

2V162K4

VOLTAGE REGULATOR RELAY

| Issue Level | Date | Summary of changes |
|-------------|------------|--------------------|
| I | 21/05/1998 | Initial issue. |
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1. BROAD DESCRIPTION

1.1 Basic Functional Operation

The 2VI62 continuously monitors the transformer output voltage and current. Voltages proportional to the current and having definite phase relationships with it (according to the external wiring configuration and line characteristics) are subtracted from the monitored voltage to give a replica of the Load Centre voltage.

The corrected sensed voltage is rectified and smoothed to give a proportional DC voltage, which is subtracted from a DC reference proportional to the thumbwheel switch "Set Voltage" setting. If the magnitude of the error voltage exceeds a value determined by the "Sensitivity Setting", a "Raise" or "Lower" LED lights, according to the polarity of the error voltage.

The "Initial Raise/Lower" timer is also initiated, and if the error persists for the duration of this timer setting, an operation of the appropriate output relay will occur. If the resultant tap change fails to bring the corrected sensed voltage to the desired value, a "Tap Change Interval" timer is initiated, and after this time has elapsed, a further tap change will take place.

This last cycle will be repeated until the corrected sensed voltage is within the desired bandwidth, when both timers will be reset.

The "Raise" and "Lower" output relays remain energised only in the time interval between initiation of the tap change and subsequent opening of the normally closed Tap Changer auxiliary contacts.

1.2 Line Drop Compensation

Line Drop Compensation is used to enable the voltage at the source end of the transmission line to be adjusted to compensate for the Line voltage drop, and therefore achieve the required voltage at the load end of the Line, independent of the load current.

To achieve this, the Line voltage at the source is sensed and a voltage proportional to the Line drop is subtracted from it. The resultant voltage is sensed by the electronic circuitry and a Tap changer is operated until the resultant derived Load voltage equals the voltage indicated on the Set Voltage thumbwheel switches.

2. SPECIFICATION

2.1 Power Supply

| | |
|--------------------------------------|--|
| Auxiliary Supply Range | 40V to 275V AC 40V to 350V DC |
| Auxiliary Supply Burden (Continuous) | Less than 10VA |
| Peak Inrush Current | 3A at 40V AC |
| RMS Inrush Current (Fully loaded) | 40VA |
| Ambient Temperature Range | -5 to 55 deg C |
| Input Transients | Withstands multiple high-energy transients and ring waves in accordance with IEE28 -ANSI C26.1 category 11, accordingly: |
| Ring wave | 0.5uS 100KHz 6KV, 500A S/C, 4J |
| Surge voltage | 1.2/50uS 6KV O/C |
| Surge current | 8/20uS 3KA S/C, 80J clamped at 1000VEMI Noise |
| | Mains conducted EMI within limits specified by AS 3584 Class B |

2.1 Power Supply (Cont)

Electrical Isolation The outputs are isolated from the input in accordance with AS 3260 class 11 Limited Current Circuit, accordingly:
 Withstand voltage of 2.5KV RMS 50Hz for one minute.
 Creepage and clearance distance greater than 4mm.
 Output leakage current less than 0.25mA to earth.

Power Supply Fail Alarm Relay Normally closed contact rated at 250V AC and isolated as per AS 3260 are energised when both the input auxiliary supply and internal +24V DC rail is within acceptable limits. The relay will drop out causing an alarm output if either supply fails.

2.2 Voltage Sensing Circuitry

| | |
|---------------------------------|--------------------------------|
| Nominal Sensing Voltage | 110 or 63.5 (tapped) |
| Sensing Supply Burden | Less than 1VA Nominal |
| Sensing Frequency | 50Hz \pm 2Hz |
| Regulated Voltage Setting Range | 100 - 129.5 Volts (0.5V steps) |
| Precision of Voltage Setting | \pm 0.5 Volt |

2.3 Line Drop Compensation (LDC)

| | |
|---------------------------------------|--|
| Nominal Sensing Current | 1 Amp or 5 Amp (tapped CT) |
| CT Burden | Less than 0.25VA |
| Maximum Sensing Current | 5 x nominal continuous, 20 x nominal for 3 seconds |
| Resistance Compensation setting Range | 0 - 20 Volts |
| Accuracy | \pm 0.5V |
| Reactance Compensation setting Range | 0 - 20 Volts |
| Accuracy | \pm 0.5V |
| LDC Connection Mode | Pos/Neg X, In-phase/Quad via front panel switch. |
| Raise / Lower Comparator Sensitivity | 0.5 to 3.0 Volts (continuously adjustable) |
| Hysteresis | 50% of error voltage (Other values may be specified) |

2.4 Timers & Logic

| | |
|--|-------------------------------------|
| Initial Raise/Lower Timer | 20 - 260 sec \pm 5% of full-scale |
| Norm/Inverse Mode switch on front panel. | T = Tset x Vsense setting/Verror |
| Inverse timing curve | True inverse |
| Tap Change Interval Timer | 5 - 65 sec \pm 5% of full scale |
| "Raise" Output | 1 N/O relay contact |
| "Lower" Output | 1 N/O relay contact |

2.5 Alarms

| | |
|-----------------------|---|
| Under voltage Lockout | 70 to 100 Volts (continuously adjustable). |
| Hysteresis | Approximately 95 % |
| | Relay contacts: 1 C/O provided |
| Over voltage Alarm | 100 to 130 Volts (continuously adjustable). |
| Hysteresis | Approximately 95 % |
| | Relay contacts: 1 C/O provided |

2.5 Alarms (Cont)

| | |
|--------------------------------|--------------------|
| Tapchanger Fail Alarm Timer | 5 min ± 10% |
| Auxiliary/Internal Supply Fail | 1N/C relay contact |

2.6 Alarm & Control Output Relays

| | |
|-----------------|--|
| Type: | Idec RHI B |
| Contact Ratings | 10A 24V DC resistive 0.5A 256V DC L/R 40 ms |

2.7 Insulation Withstand

5KV 1/50us Impulse (coil to contacts)
 1KV RMS across open contacts

3. TEST EQUIPMENT REQUIRED

| | |
|--|------------------------------------|
| 110V 50Hz adjustable supply | 5A Phase-adjustable current source |
| 50V DC current- limited power supply | Frequency/period counter |
| Digital Voltmeter (4 1/2 digit preferable) | DC Auxiliary Supply |
| Electronic Counter | HV Test Equipment |

4. ASSOCIATED DRAWINGS

| | |
|-------------|------------------------------|
| 165-162-204 | Circuit Schematic Diagram |
| 660-272-301 | Main Circuit Loading Diagram |
| 660-258-301 | Front Panel Loading Diagram |
| 678-028-201 | Power Supply Circuit Diagram |
| 678-028-301 | Power Supply Loading Diagram |

5. HIGH VOLTAGE TESTING

CLASS III Circuit Tests (5KV 1/50 and 2KV RMS)

- a) Apply 2KV RMS 50Hz between terminal groups 1 and 2 in table 1 below for 1 minute.
- b) Apply three 5KV 1/50us pulses of each polarity between terminal groups 1 and 2 in Table 1 below.

TABLE 1

| TEST | GROUP 1 | GROUP 2 |
|----------|---|--|
| A | 8,9,22,23,24,25,26,27,28,29,30, (Inputs) | 1,2,3,4,5,6,7,10,11,12,13,14,15,16,17,18,31,32, (Outputs) |
| B | All terminals excluding 5,6 & 7 connected together | Earth (Frame) |

NOTE: LEAKAGE CURRENT WILL BE APPROX 1.5mA DURING 2kV TEST DUE TO NOISE SUPPRESSION CAPACITORS IN THE POWER SUPPLY

HIGH VOLTAGE TEST PASS

6. CALIBRATION & TEST PROCEDURE

6.1 Power Supply

- a) Connect 50V DC current limited supply to Auxiliary Supply input terminals 29 and 30.
- b) Check that the following supply rail voltages are within limits:
 Voltages are measured with respect to SK2-1

| | RAIL | MIN | MAX | NOMINAL | ACTUAL |
|-------|------|-------|-------|---------|--------|
| SK2-6 | 24 | 23 | 27 | 24 | |
| SK2-2 | 18 | 17 | 19 | 18 | |
| SK2-4 | 12 | 11.2 | 12.8 | 12 | |
| SK2-3 | -12 | -11.2 | -12.8 | -12 | |

6.2 Line Drop Compensation

- a) Set LDC rotary switch (on the front panel) to "Pos X in Phase" position, and both LDC controls to the 20 V position.
- b) Connect a phase meter to monitor the difference between the input sensed current and the compensation voltage waveform appearing at SK2-15.
- c) Apply 1 Amp AC \pm 5% to the 1 Amp CT input.
- d) Adjust trimpot VR2 so that there is a 90 degree phase difference between input current and the SK2-15 waveform.

| MIN | MAX | NOMINAL | ACTUAL |
|------|------|---------|--------|
| 86.0 | 94.0 | 90.0 | |

- e) Adjust amplitude setting trimpot VR1 so that the SK2-15 voltage is 2.00V RMS when the input current is 1 Amp.

| MIN | MAX | NOMINAL | ACTUAL |
|------|------|---------|--------|
| 1.95 | 2.05 | 2.00 | |

- f) Connect phase meter to measure phasing of SK2-14 with respect to the input current; they should be in anti-phase.

| MIN | MAX | NOMINAL | ACTUAL |
|-----|-----|---------|--------|
| 176 | 184 | 180 | |

- g) Adjust trimpot VR3 to give a SK2-14 Voltage of 2.00V at 1 Amp input current.

| MIN | MAX | NOMINAL | ACTUAL |
|------|------|---------|--------|
| 1.95 | 2.05 | 2.00 | |

6.2 Line Drop Compensation (Cont)

- h) Check that the resistive and reactive compensation voltages (all of 2.00V RMS magnitude) have the following phase relationships with the input current:

| Switch Position | Resistive Comp | Reactive Comp | |
|-------------------------|----------------------|------------------|--|
| 1 Pos. react - in phase | SK2-14 Anti-phase | SK2-15 90 lag | |
| 2 Neg. react - in phase | Anti-phase | 90 lead | |
| 3 Pos. react - in quad | 90 lead | Anti-phase | |
| 4 Neg. react - in quad | 90 lead | In phase | |
| 5 LDC DISABLED | | | |

- i) Record Resistive Compensation voltage (SK2-14) position 1 at the following settings:

| SETTING | MIN | MAX | NOMINAL | ACTUAL |
|---------|------|------|---------|--------|
| 5 V | 0.45 | 0.55 | 0.5 | |
| 15 V | 1.45 | 1.55 | 1.5 | |

- j) Record Reactive Compensation voltage (SK2-15) position 1 at the following settings:

| SETTING | MIN | MAX | NOMINAL | ACTUAL |
|---------|------|------|---------|--------|
| 5 V | 0.45 | 0.55 | 0.5 | |
| 15 V | 1.45 | 1.55 | 1.5 | |

- k) Apply 5.0 Amp input current to the 5 Amp CT input and check that the SK2-14 voltage at 20 V setting "Resistive" is within limits:

| MIN | MAX | NOMINAL | ACTUAL |
|------|------|---------|--------|
| 1.85 | 2.05 | 2.00 | |

- l) Apply 5.0 Amp input current to the 5 Amp CT input and check that the SK2-15 voltage at 20 V setting "Reactive" is within limits:

| MIN | MAX | NOMINAL | ACTUAL |
|------|------|---------|--------|
| 1.85 | 2.05 | 2.00 | |

- m) Disconnect current source from CT

6.3 Input Voltage Transformer Calibration

- a) Apply 110 V AC 50Hz to 110 V RMS sensing input (Term 24 Active and Term 22 Neutral) and select R31/R32 to give 110V at SK2-12 with respect to V (SK2-1)).
- b) Apply 63.5V AC 50Hz to 63.5V sensing input (Term. 23 Active and Term. 22 Neutral) and check that SK2-12 voltage is within limits:

| MIN | MAX | NOMINAL | ACTUAL |
|-------|-------|---------|--------|
| 10.97 | 11.03 | 11.00 | |

6.4 Average Detector Calibration

Disable LDC and re-connect 110V to 110V sensing input and adjust trimpot VR5 until voltage at SK2-9 is 11.00V DC.

| MIN | MAX | NOMINAL | ACTUAL |
|-------|-------|---------|----------------------|
| 10.99 | 11.01 | 11.00 | <input type="text"/> |

6.5 Voltage Indication Circuitry & Reference Voltage Calibration

Note:

For this step the 10V reference voltage may not end up exactly at 10.00V, since tolerances on R50/R51/R52/R53 will cause the 10V Reference (SK2-8) to differ from the set voltage at "100.0" Voltage Setting. Optimum setup is for the SK2-5 voltage to be 10.00V at 100.00V "Set Voltage" setting.

- a) Set thumbwheel switches to "100.0"V.
- b) Adjust trimpot VR4 to give 10.00V DC at SK2-5.

| MIN | MAX | NOMINAL | ACTUAL |
|------|-------|---------|----------------------|
| 9.99 | 10.01 | 10.00 | <input type="text"/> |

- c) Set voltage to 110V.
- d) Adjust trim pot VR8 to give 11.00V DC at SK2-5.

| MIN | MAX | NOMINAL | ACTUAL |
|-------|-------|---------|----------------------|
| 10.99 | 11.01 | 11.00 | <input type="text"/> |

- e) Set voltage to 119V.
- f) Adjust trim pot VR9 to give 11.90V at DC SK2-5.

| MIN | MAX | NOMINAL | ACTUAL |
|-------|-------|---------|----------------------|
| 11.89 | 11.91 | 11.90 | <input type="text"/> |

6.6 Undervoltage Lockout Calibration

Note:

Before performing this calibration, adjust AC sense voltage until a raise or lower signal is detected by the error detector. Switch the inverse/definite time switch to inverse (this reduces the waiting time), and wait for the VRR to output a raise or lower signal as indicated by the output contacts of either the raise or lower relays. Ensure that when the under voltage condition is detected that the raise or lower indication is reset. The only indicator LED's that should be illuminated in this condition is the Auxiliary supply and the Under voltage indicator.

- a) Set undervoltage control to (VR1-3) to 100 V and AC sensing voltage input to 100.0 volts.
- b) Adjust trimpot VR7 until the U/V LED comes on at 100.0 volts
- c) Set U/V control to 70 V and AC sensing voltage input to 70 volts.
- d) Adjust VR10 until the U/V LED comes on at 70 volts
- e) Repeat steps a) to d) until dial is calibrated.

6.6 Undervoltage Lockout Calibration (Cont)

- f) Set U/V control to 100 V and record the dropout voltage.

| | MIN | MAX | NOMINAL | ACTUAL |
|----------|------|-------|---------|----------------------|
| Drop out | 99.5 | 100.5 | 100.0 | <input type="text"/> |

- g) Set U/V control to 70 V and record the dropout voltage.

| | MIN | MAX | NOMINAL | ACTUAL |
|----------|------|------|---------|----------------------|
| Drop out | 69.5 | 70.5 | 70.0 | <input type="text"/> |

6.7 Overvoltage Alarm

Note:

Before performing the over voltage calibration, increase the sensing voltage until an overvoltage condition is indicated by the "overvoltage LED" becoming illuminated. Ensure that this condition **does not** cause the VRR to go into overvoltage lockout, ie all front panel lamps extinguish with only the "Auxiliary supply" and "Overvoltage" LED on. This test is to ensure that diode D12 has not been fitted.

- a) Set overvoltage control to 130 V and sensing voltage to 130.0 volts.
- b) Adjust VR6 until overvoltage LED comes on.
- c) Set overvoltage control to 100 V and sensed voltage to 100 volts.
- d) Adjust VR11 until overvoltage LED comes on.
- e) Repeat steps a) to d) until scale is calibrated.
- f) Set O/V alarm control to 130 V and record the pick up voltage.

| | MIN | MAX | NOMINAL | ACTUAL |
|---------|-------|-------|---------|----------------------|
| Pick up | 129.5 | 130.5 | 130.0 | <input type="text"/> |

- g) Set O/V control to 110 V setting and record the pick up voltage.

| | MIN | MAX | NOMINAL | ACTUAL |
|---------|------|-------|---------|----------------------|
| Pick up | 99.5 | 100.5 | 100.0 | <input type="text"/> |

6.8 Error Detector Calibration

- a) Set AC Sensing input voltage to 110 V AC.
- b) Set bandwidth potentiometer to max (3.0 V) setting.
- c) Monitor TP3 and adjust VR13 for 3.00 V DC.

| | |
|--------|----------------------|
| Actual | <input type="text"/> |
|--------|----------------------|
- d) Rotate the bandwidth control anticlockwise to the min (0.5 V) setting, adjust VR12 for 0.50 volts.

| | |
|--------|----------------------|
| Actual | <input type="text"/> |
|--------|----------------------|

6.9 Initial Raise / Lower Timer Calibration

- a) Set AC Sensing input voltage to 110 V AC.
- b) Increment the set voltage thumbwheel to give a continuous raise signal and switch the time delay characteristic to definite.
- c) Adjust VR15 to achieve a span of 13:1 irrespective of absolute value.

6.9 Initial Raise / Lower Timer Calibration (Cont)

- d) Pad C43/C44/C45 to give a waveform period of 507.8ms at the maximum time setting at SK2-11.
- e) Check min setting (20 sec) and readjust VR15 for 39mS if necessary.
Note: Check the operate times of the Initial Raise/Lower Timer by measuring the interval between application of AC Sensing Supply and subsequent output relay operation. Note that Auxiliary supply should remain "on" and the sensing voltage should be set about 10V lower than the Reference voltage, to give a "Raise" signal. Record results (seconds).

| SETTING | MIN | MAX | NOMINAL | ACTUAL |
|---------|-----|-----|---------|--------|
| 20 | 10 | 30 | 20 | |

6.10 Calibration of Tap Change Interval Timer

- a) Adjust AC Sensing voltage until the Bandwidth Error gives continuous "Raise" signal.
- b) Connect a frequency counter to SK6-4.
- c) Adjust VR17 for a span of 13:1 irrespective of absolute values.
- d) Pad C36/C37/C38 until the waveform period is 15.87ms at scale maximum setting (65s) and 1.21ms at minimum setting (5s).
Note: Connect PU/DO time measuring apparatus to measure the time interval between operation of the T/C auxiliary contact and subsequent closure of the "Raise" output relay contacts. Record results (seconds).

| SETTING | MIN | MAX | NOMINAL | ACTUAL |
|---------|-----|-----|---------|--------|
| 5 | 3 | 7 | 5 | |
| 20 | 18 | 22 | 20 | |
| 65 | 62 | 68 | 65 | |

6.11 Calibration of Auto Raise / Lower Control Pulse

Note This test is only performed if the Automatic mode is selected.

- a) Set jumpers J1 and J2 for auto tap change operation by linking J1 and linking J2-2 to J2-3. Set up the voltage and set voltage thumbwheel to give a tap raise or lower.
- b) Set initial delay timer to 20 seconds and interval timer to 5 seconds.
- c) The lower or raise LED should light after the initial time out. Adjust VR14 so that the LED on time is set as shown below (seconds).

| MIN | MAX | NOMINAL | ACTUAL |
|-----|-----|---------|--------|
| 1.8 | 2.2 | 2.0 | |

6.12 Tapchanger Failure Alarm Timer

- a) Connect a frequency counter to SK7-1.
- b) Adjust trimpot VR18 to give a waveform period of 9.15ms.
- c) Record operate time of Tap Changer Failure Alarm Timer by generating a "Raise" signal as previously but not simulating operation of the Tapchanger. Record time (seconds).

| NOMINAL | ACTUAL |
|---------|--------|
| 300 | |

7. GENERAL & FUNCTIONAL

7.1 Operation of Logic Circuitry

Set Sensitivity to 1V, toggle switch to "Inverse", Initial Raise/ Lower time to 20s, T/C Interval to 5s, AC sensing voltage to 110V, Thumbwheel to 120V. Voltage Error Detected "Low" LED should light and IC17 (Initial Raise/Lower Timer) should commence timing. The "Raise" output relay should pick up when IC17 times out, and the output relay LED (Raise Tap Initiate) should also light. Simulate the opening of the tapchanger Auxiliary contact by operating the temporary pushbutton; the output "Raise" relay should drop out.

Closing of the N/C tapchanger contact removes the reset from the Tap Change Interval Timer, and after this time has elapsed, the "Raise" output relay will again pick up. The two above steps are repeated until the AC sensed voltage reaches the desired value, when the error comparator ceases to give a "Raise" signal and the timers will all be reset. Operation of the circuit for a "Lower" signal is similar to that for a "Raise".

If a "Raise" or "Lower" input signal persists, along with failure of the N/C tapchanger contact to open, IC16 timer will time out, operating the Tapchanger Fail Alarm relay and LED. Removal of the "Raise" or "Lower" signal or opening of the N/C tapchanger contact will reset the timer.

7.2 LDC Operational Check

- a) Set the Line Drop Compensation controls to the following;
 Pos X in ϕ , Error detector = 3.0 V, Balance setting = 110 volts, 1Amp in 1 Amp CT tap,
- b) Adjust the sense voltage source and note when the raise/lower LED extinguishes, this should be as per the table below.

| Voltage Phase angle | Resistive Volts | Reactive Volts | Volts High | Balance Volts |
|---------------------|-----------------|----------------|------------|---------------|
| 0 deg | 10 | 0 | 123 | 120 |
| 90 deg | 0 | 10 | 123 | 120 |

7.3 General

Check operation of all output relays.

Check that the relay is electrically sound and mechanically robust as per Standard Inspection & Test Schedule 903-000-026.

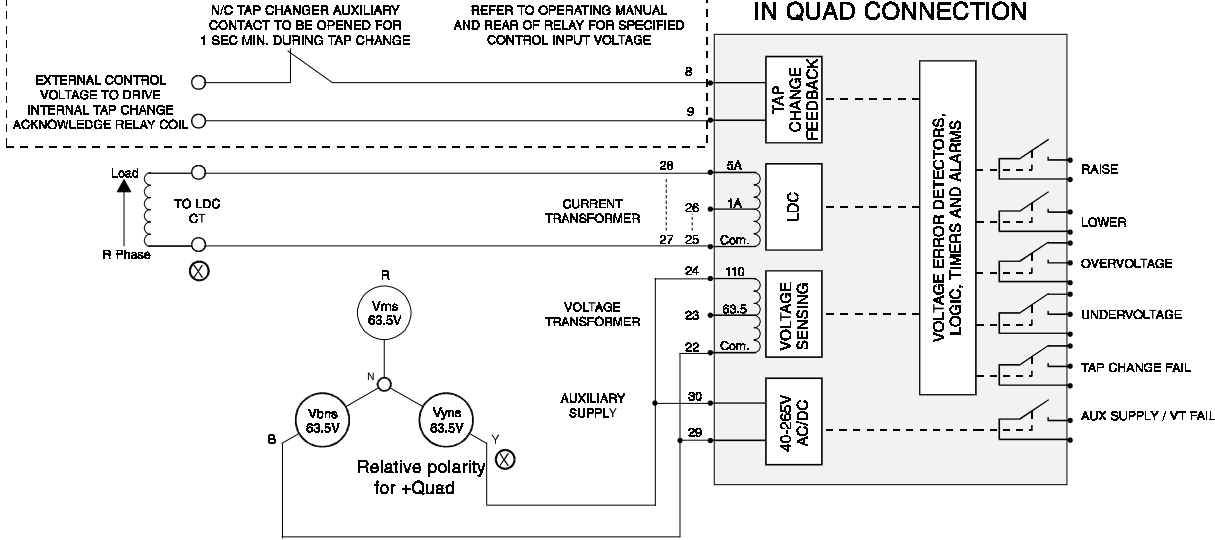
PASS



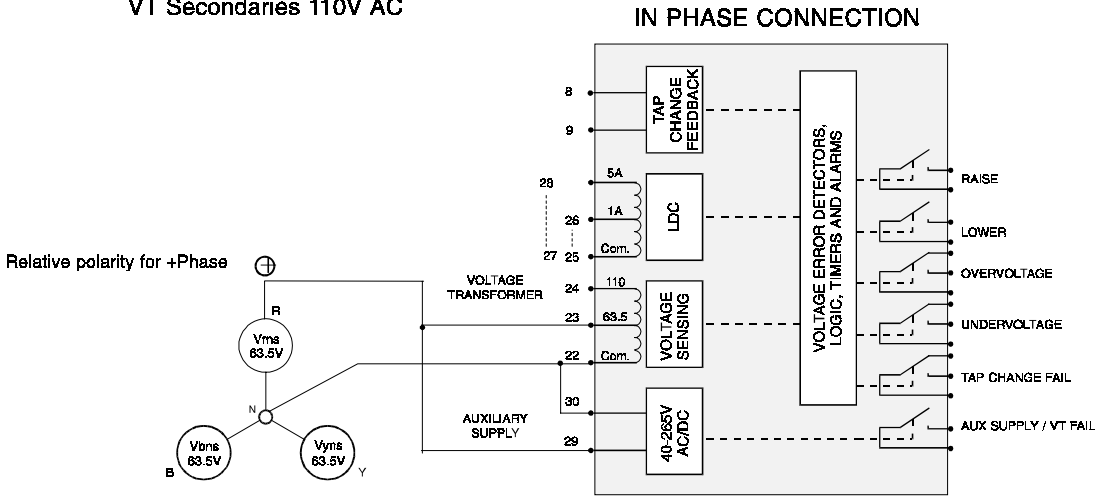
TESTED BY : _____ DATE : _____

8. CONNECTION DIAGRAM

THESE CONNECTIONS ARE ONLY REQUIRED IF THE RELAY IS SETUP TO ACCEPT A CONTROL SIGNAL FROM THE OLTC ACKNOWLEDGING THAT A TAP CHANGE IS IN PROGRESS.



VT Secondaries 110V AC



VT Secondaries 110V AC

OUTPUT RELAY CONNECTIONS

| | RAISE | LOWER | T/C FAIL |
|-----|-------|-------|----------|
| COM | 1 | 3 | 10 |
| N/O | 2 | 4 | 11 |
| N/C | | | 12 |

OUTPUT RELAY CONNECTIONS

| | U/V BLOCK | O/V ALARM |
|-----|-----------|-----------|
| COM | 13 | 16 |
| N/O | 14 | 17 |
| N/C | 15 | 18 |

OPTIONAL COARSE CONTACTS

| | |
|--------------|---|
| COARSE RAISE | 5 |
| COARSE LOWER | 6 |
| +24 VOLTS | 7 |