

(ISO 9002 COMPANY)

**Automatic
Voltage Regulating
Relay
EE 301 - T**

INSTRUCTION MANUAL

Instruction Manual
for
Automatic
Voltage Regulating Relay
Type EE 301-T

EMCO ELECTRONICS

Works Unit No. 13, "Kedarnath", Tungareshwar Industrial Complex No. 1, Village sativali,
Vasai(E), Dist : Thane - 401208. Tel.:(0250)2481783 / 1804, Fax : (0250)2481087,
Email : mumbai@emcoelectronics .org

Office 302,Vasan Udyog Bhavan, Sanapati Bapapat marg, OPP. Phoenix mill / BIG BAZAAR
Lower Parel (W), Mumbai - 400 013. Tel.:(0250)2481783 / 1804, Fax : (0250)2481087
E-mail : office@emcoelectrons.com

South 15, Wood Street, (1st Floor),Richmond Road, Bangalore - 560 025
Office Tel : (080) 557 0215 Fax : +91-80-556 6606
E-mail : emcobl@bgl.vsnl.net.in

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I INTRODUCTION

EMCO's Solid State Voltage Regulating Relay Type EE 301- T is used for regulating the secondary voltage of power transformer with on-load tap changer . The required dead-band settings are set by setting the Nominal value and L & R levels independently. The Time Delay setting on the front panel eliminates the relay operations for momentary fluctuations of the regulated voltage, thus reducing the number of operations of the tap changer.

When the regulated voltage falls below the specified Under Voltage limit, the control relays are automatically blocked i.e. there is no voltage correction, and a pair of relay contacts is made available for alarm.

When the regulated voltage goes above the specified Over Voltage limit, the control relays are automatically blocked i.e. there is no voltage correction, and the same pair of relay contacts (for UV) is made available for alarm.

A built-in Tap Position Indicator with 1K ω step resistance can be provided optionally to indicate the Tap No. of the Power Transformer upto a maximum of 35.

The relay uses all solid state circuitry which increases its reliability and life. The output, input connections are made through a terminal block. However all normal precautions/care in handling/ storage should be observed as for a sensitive electronic instrument.

II GENERAL DESCRIPTION

EMCO's Solid State Automatic Voltage Regulating Relay Type EE301-T is designed for maximum operational simplicity. It regulates the secondary voltage of power transformers with on-load tapchangers. The bandwidth control allows the dead-band to be set in terms of upper (LOWER VOLTS) and lower (RAISE VOLTS) voltage limits around a particular nominal value with specified sensitivity.

The Time Delay control allows the regulator to respond only to voltage fluctuations lasting for periods greater than the selected time delay. Where the voltage correction requires more than one tap change, the time delay is re-initiated before further tap changes. No special provisions are required to reset the time delay which resets automatically after the voltage correction. Solid State Lamps (LEDs) indicate voltage outside the preset limits and control relay operations.

Operation of the RAISE / LOWER Control Relay is automatically inhibited when the voltage falls below the specified undervoltage limit or goes above the Overvoltage limit. One pair of normally open relay contacts are provided to effect the tapchanger RAISE and LOWER operations and to trigger an alarm in case of Undervoltage / Overvoltage conditions. (Only one pair of contacts is available for either UV or OV)

An alarm in the form of normally open contacts is provided in case of control failure i.e. AVR Relay continuously showing either 'L' or 'R' command for more than 15 minutes due to malfunctioning of AVR/OLTC/ any reason.

A built-in Tap Position Indicator with 1K ω step resistance can be provided optionally to indicate the Tap No. of the Power Transformer upto a maximum of 35.

III SPECIFICATIONS

Auxiliary Supply.....	110V/230V AC \pm 15% 50Hz, 15VA
PT Supply	110V AC 50Hz, 1.5VA and readable on display
Nominal Value Setting (NVA)....	Adjustable between 110V \pm 10% & readable on display
LOWER Volts Setting.....	Adjustable between 0.5V to 5V above the NVA and readable on display
RAISE Volts setting.....	Adjustable between 0.5V to 5V below the NVA and readable on display
Time Delay Setting.....	Fixed (Voltage Independent) Time Delay adjustable from 10 to 120 Secs
Time Delay Resetting.....	Instantaneous resetting with voltage returning to deadband
Undervoltage Blocking.....	Internal blocking at 80% of regulated value. Restoration at 85% of regulated value
Overvoltage Blocking.....	Internal Blocking at 132V & Restoration at 127V
Control Relays.....	One pair of normally open potential free contacts of rating 5A at 240V AC or 24V DC resistive load for each Lower, Raise, Control Fail & Undervoltage / Overvoltage control relays (Only one pair of contacts is available for either UV or OV)
Control Operation.....	Single Pulse operation with approx. 2 secs on time
Operating Temperature.....	0°C - 45°C
Overall Size.....	378mm X 160mm X 260mm (H X W X D)
Weight.....	5 Kgs. (approx.)
Options.....	<ol style="list-style-type: none">1. Tap Position Indicator , Max. 35 Taps with 1Kw resistance2. Line drop compensator with resistive and reactive compensation of either polarity upto 20% and suitable for operation with 1A, 5VA current transformer3. Normally closed Auxiliary Supply Fail Relay Contacts4. User defined settings for PT Supply, Time Delay, Undervoltage & Overvoltage Blocking. User specified step resistance for TPI5. 4-20 mA TPI output for SCADA

IV. FAMILIARIZATION WITH VARIOUS INDICATIONS / CONTROLS :

A. INDICATIONS

- 1. 4x7 Segment Display (AVR)** : Display lights when Auxiliary Supply is 'ON'.
- 2. 2x7 Segment Display (TPI)** : Display lights when Auxiliary Supply is 'ON'.
- 3. 'L' Lamp** : 'ON' whenever the PT voltage exceeds the 'LOWER VOLTS' set limit.
- 4. 'R' Lamp** : 'ON' whenever the PT voltage falls below the 'RAISE VOLTS' set limit.
- 5. UV / OV Lamp** : 'ON' whenever the PT voltage falls below the factory set Undervoltage limit i.e. below 80% of the Nominal voltage. This lamp will turn-off only when the PT voltage raises above 85% of the Nominal voltage value. This lamp will also be 'ON', when the PT voltage goes above the factory set Overvoltage limit i.e. above 132V. This lamp will turn-off only when the PT voltage falls below 127V.
- 6. 'LR' Lamp** : 'ON' when Lower Relay is energised.
- 7. 'RR' Lamp** : 'ON' when Raise Relay is energised.
- 8. 'CF' Lamp** : 'ON' when Control Fail Relay is energised, i.e. when the PT voltage remains outside the bandwidth for more than 15 minutes.
- 9. 'TEST' Lamp** : 'ON' when AVR is in "TEST" mode.

B. CONTROLS

- 1. Power - ON** : This is a toggle switch which when 'ON' supplies Auxiliary Voltage to the instrument.
- 2. 'R' Set** : This is a variable control varying from 0.5V to 5.0V below NVA setting. This control sets the (lower limit of the PT voltage below which if the voltage reduces, then corrective action will be taken by the instrument. The setting is to be read on display.
- 3. 'NOM' Set** : This is a variable control to set the Nominal value of PT voltage varying between $\pm 10\%$ of 110V. This setting becomes the reference level around which L & R setting can be varied. The setting is to be read on the display.
- 4. 'L' Set** : This is variable control, varying from 0.5V to 5.0V above NVA setting. This control sets the upper limit of the PT voltage beyond which if the voltage rises, corrective action will be taken by the instrument. The setting is to be read on display.

- 5. Time Delay** : Corrective action takes place only after the Time Delay as set by this control has elapsed and the PT Voltage continues to remain outside the set Lower or Raise limits (but does not fall below the UV / OV limit).
- 6. Test/Normal Switch for AVR** : It selects the Test or Normal mode of operation. In the Test mode, PT Voltage is simulated internally & can be varied through the Test Control on the front panel. An LED indication is provided to indicate that the instrument is in Test mode. In the Test mode, the control relays are "cut off" so that undesired operation of OLTC is prevented during testing. The voltage is monitored on the display in PT I/P position. In the Normal mode external PT voltage gets connected to the instrument. This switch must be kept in "Normal" mode when the instrument is in use.
- 7. Test Voltage Control** : Simulates PT I/P in Test mode and can be varied from 0V to 150V AC.
- 8. Test / Normal Switch for TPI** : In the Test mode, display indicates "88" for checking the display. In Normal mode it displays the actual tap no. of OLTC. This switch must be kept in "Normal" mode.
- 9. Selector Switch** : Selects the voltage setting to be monitored on the display. It also enables the PT voltage to be read on the display.

NOTE : Before connecting Aux. Supply & PT Supply to the AVR Relay, Check-up following points.

- A) **Mechanical Damage** : Remove the front acrylic cover by removing the thumbscrews & check for any mechanical damage to the unit.
- B) **Aux fuse & PT fuse (on Rear Panel)** : Note that Aux. fuse is 300mA (20mm) & PT fuse is 100mA (20mm). Do not interchange these fuses. Check them & replace with good ones if required.

V. OPERATING INSTRUCTION :

1. Check the PT & Auxiliary fuses.
2. Connect 110V / 230V A.C. Aux. Supply to pins 1 & 2 of the Rear Panel Terminal Block.
3. Connect PT Supply to pins 3 & 4 of the Rear Panel Terminal Block.
4. Turn on the instrument by putting Power Switch to 'ON' position.
5. Leave the unit on for 15 minutes before making any settings.
6. Check the Test / Normal Switch is in the Normal mode.
7. Make the following settings by changing selector switch.

NOMINAL VALUE	110V
LOWER VOLTS Setting	112V
RAISE VOLTS Setting	108V
TIME-DELAY Setting	30 Sec.
%R & %X Setting	'0' %

(in case of relay with LDC)

8. Keep the selector switch to PT I/P position.
9. Increase the PT voltage to read PT = 110V
10. Note that under this condition all the lamps viz. L, R, LR, RR & UV/OV are off.

11. LOWER VOLTS OPERATION CHECK :

Increase the PT Supply above 112V (atleast 112.5V), but ensure that it is below UV limit (132V). 'L' lamp should immediately turn on.

The 'LR' control pulse will come only after 30 secs. from the instant of turning on of 'L' lamp. The control pulse will remain 'ON' for 2 secs, after which the Time Delay of 30 secs. will restart & the control pulse will come again for 2 secs. & the cycle is repeated. Check the LR contacts on pins 9-10 of the Rear Panel Terminal Block.

12. RAISE VOLTS OPERATION CHECK :

Decrease the PT Supply below 108V (atleast 107.5V), but ensure that it is above UV limit (88V). 'R' lamp should immediately turn on.

The 'RR' control pulse will come only after 30 secs. from the instant of turning on of 'R' lamp. The control pulse will remain 'ON' for 2 secs, after which the Time Delay of 30 secs. will restart & the control pulse will come again for 2 secs. & the cycle is repeated. Check the RR contacts on pins 11-12 of the Rear Panel Terminal Block.

NOTE : Please note that for the operational safety, RAISE and LOWER relays are interlocked and hence OLTC will never receive two opposite commands simultaneously.

13. UNDER VOLTAGE OPERATION CHECK :

Reduce PT Supply below 88V (atleast 87.5V) (UV is factory set at 80% of the Nominal voltage), UV/OV lamp will turn-on immediately. (Under this condition R lamp will also be on) but the Raise control is inhibited. Note that between Blocking & Release (Restoration), a hysteresis of 5% has been provided. Check the UV contacts on pins 13 & 14 of the Rear Panel Terminal Block.

Raise the PT Supply above 94V, UV/OV lamp should turn off immediately. 'R' lamp indication however shall remain on, if the PT voltage is still below the Raise setting. The raise control pulse comes on after the set time delay.

Disconnect external PT supply the UV/OV & Rlamp will turn on immediately. The UV/OV relay will operate. After restoration of PT supply, the lamp will turn 'off' & UV/OV relay will be deenergised.

NOTE : Blocking (80%) & Restoration (85%) are factory set values, unless the customer has specified other values.

14. OVER VOLTAGE OPERATION CHECK :

Increase PT Supply above 132V (atleast 132.5V), UV/OV lamp will turn-on immediately.(Under this condition L lamp will also be on) but the Lower control is inhibited. Note that between Blocking & Release (Restoration), a hysteresis of 5V has been provided. Check the UV/OV contacts on pins 13 & 14 of the Rear Panel Terminal Block.

Decrease the PT Supply below 127V, UV/OV lamp should turn off immediately. 'L' lamp indication however shall remain on, if the PT voltage is still above the Lower setting. The lower control pulse comes on after the set time delay.

NOTE: Blocking (132V) & Restoration (127V) are factory set values, unless the customer has specified other values.

15. CONTROL FAIL ALARM RELAY :

Change the PT voltage to get either R or L indication. Keep the regulated voltage outside the set dead band. After 15 minutes (approx.). the control fail alarm relay will operate and will remain in energised condition till the voltage returns to set dead band. This operation will be indicated by red LED marked CF mounted on front panel of AVR Relay. The relay contacts can be checked on Pins 15 & 16 of the Terminal Block.

Take the regulated voltage within set dead band. The control fail Relay will get deenergised and the contacts on Pins 15 & 16 will open and CF LED will stop glowing. Similarly this operation can be checked by taking regulated voltage on other side of set dead band

16. TEST MODE :

When the 'Test / Normal' switch is put in the 'TEST' mode, the PT I/P can be simulated through the 'TEST Control'. However to prevent any undesirable operation of the OLTC, the relays are cut off, but the lamp indications are available.

17. TIME DELAY :

This is a variable control with variation from 10 sec. to 120 sec. The actual setting can be made as required. The corrective action will take place only after the set Time Delay interval is elapsed provided the voltage deviation persists even after the set Time Delay and that the relay is not operating in UV / OV mode.

18. CONTROL RELAYS :

Connect the respective Lower, Raise, Control Fail and Under / Over voltage NO contacts to operate the respective contactors / Alarms.

19. TPI OPERATION CHECK :

Keep the Test/Normal Switch of TPI in Normal mode & connect Min., Max. & Wiper from OLTC to the Rear Panel Terminal Block. Change the tap position from 1 to maximum tap and check whether TPI reads correctly.

Keep the TPI "Test/Normal" switch in "Test" mode & check whether display reads "88".

FUSE REPLACEMENT :

- 1 After switching power-on, the display indication must come. If it does not come, check whether AUX. fuse on the rear panel is properly tightened. If the instrument still does not work, unscrew the fuse & check if it is open. Replace it by another fuse of 300mA (20mm).

Once again ensure that the fuse is not loose. The instrument should turn on now. If the fuse keeps on blowing repeatedly or the instrument does not work inspite of good fuse, proceed to identify the faulty PCB as given in fault finding procedure VII.

- 2 Connect the PT supply and put the Test/Normal switch in Normal position. If the Instrument is turning on but you are continuously getting 'R' and 'UV' indication, check whether PT fuse is loose. If the condition persists even after tightening PT fuse, remove the same and replace by another 100mA (20mm) fuse. If 'UV' and 'R' indication still persist, proceed to identify the faulty PCB as given in fault-finding procedure VIII.

VI. FUNCTIONAL DESCRIPTION OF VARIOUS MODULES :

1. **Mains Transformer** : This transformer is mounted on a plate towards the Rear Panel . This takes 230V/110V A.C. and steps it down to 16V, 10V & 5V A.C. voltages required for generating dc power.
2. **P.T. Transformer** : This is also mounted on the plate towards the Rear Panel & steps down PT input from 110V AC to 3.3V AC. which is used for sensing PT voltage.
3. **Main PCB** : This module generates $\pm 12V$ DC, +5V DC required for circuit operation. Three pin regulator ICs 7812, 7912, 7805 are used to give regulated +12V, -12V & + 5V D.C. Supplies. The PT input is stepped down in the ratio 110/3.3. This stepped down voltage is rectified, filtered and amplified by IC10. This voltage is used for comparison with reference voltage settings (on Display PCB). L, R, UV/OV signals are received from Display PCB. On receiving any of L or R signals, IC5 generates Time Delay followed by LR and RR commands generated by IC4 for energizing appropriate relay. The NO contacts are brought out on the Rear Panel Terminal Block. In case of UV/OV condition, the relays are blocked and no control pulses are available. The IC8 is used to convert the analog voltage to digital voltage and display the same on 7 segment display on Display PCB.
4. **Display PCB** : R set, Nom set, L set potentiometers allow the required settings to be set. The L, R, UV, OV settings are compared with the DC output by IC3 and the L, R, UV/OV LEDs indicate these conditions. Selector switch selects the Nominal Value L and R settings and PT I/P to be displayed on the 7 segment display. LR, RR LEDs indicate the relay operation condition. Time Delay potentiometer allows the required time delay to be set.
5. IC1 generates 15 minutes delay for CFR condition which is indicated by CFR LED.
6. When LDC option is required %R & %X potentiometers allow for %R & %X compensation. SW3 & SW4 allow for polarity selection. IC7 sums the PT I/P & LDC O/P.
7. **TPI PCB** : This PCB generates constant current which is used for generating 100mV per step. The IC2 is used to convert analog voltage to digital voltage & display the same on 7 segment display.

VII. FAULT FINDING procedure :

- Step-1** : Check for any physical damage by opening front panels.
- Step-2** : Check the Aux. fuse (300mA) & PT fuse (100mA). If necessary, replace them. (Do not interchange the fuses). Tighten them properly.
- Step-3** : Confirm that the Display PCB's 40 pin connector mate properly with the Main PCB's 40 pin connector
- Step-4** : Connect 'Aux' supply & PT supply & Switch ON the unit. If the unit does not get switched ON, then check Power ON switch.
- Step-5** : Measure DC voltages on TP5, TP6 & TP4 w.r.t.TP3. They should be +12V, -12V & +5V respectively. If the voltages are not correct, remove 40 pin connector and check once again. If the voltages are correct then there is problem with the Display PCB. Replace the Display PCB. If the voltages are still not OK, check the mains transformer. Replace the mains transformer if faulty or else replace Main PCB. Confirm all DC voltages are OK.
- Step-6** : Keep the selector switch to 'N' set position and vary 'N' set control to read 99V to 121V on display. Set 'N set' control to 110V. Keep the selector switch to 'R' set position and vary 'R' set control to read 104.5V to 109.5V on display. Set 'R set' control to 108V. Set selector switch to 'L' set position and vary 'L' set control to read 110.5V to 115.5V on display. Set 'L set' control to 112V. If any of the settings are not obtainable, it means Display PCB is faulty. Check potentiometers for their open/short conditions & replace if necessary. If not, IC6 or IC4 or selector switch on Display PCB may be faulty. Replace the faulty component.
- Step-7** : Put selector switch to PT I/P position. Vary the PT/IP and read the display. If display does not vary then measure AC Voltage at TP4 on Display PCB w.r.t. GND. It should vary from 0 to 5V AC, when PT/IP is varied from 0 to 150V AC. If the voltage is not coming, it means that the sense transformer is faulty. Replace the sense transformer. If the voltage is OK, check on Main PCB 7.5V DC on TP9 for PT I/P = 110V. If DC voltage is not OK then IC10 is faulty. If it is OK then either selector switch on Display PCB is faulty or IC8 on Main PCB is faulty. Replace the faulty component.
- Step-8** : Vary the PT I/P to less than 80V (UV level), then the UV indication alongwith 'R' indication should come. Increase the voltage above 85V then UV command goes "off". However 'R' command remains "ON". Increase PT I/P voltage slightly more than 108V, 'R' will go off. This is Bandwidth condition. Increase PT I/P slightly more than 112V, 'L' indication should come.

- Step-9** : Vary the PT I/P to more than 132V (OV level), then the OV indication alongwith 'L' indication should come. Decrease the voltage below 127V then OV command goes "off". However 'L' command remains "ON". Decrease PT I/P voltage slightly less than 112V, 'L' will go off. This is Bandwidth condition. Decrease PT I/P slightly less than 108V, 'R' indication should come. If the UV/OV, L & R indications are coming as above that means Display PCB is OK.
- Step-10** : Set Time Delay (TD) control to 30 sec. Vary the PT I/P to get 'L' condition. Measure time from which 'L' indication comes to the time 'LR' indication comes. The 'LR' indication will remain 'ON' for 2 sec. after which once again 'TD' is initiated. (The 'TD' indication is provided on Main PCB). If time delay is not ok, it means Main PCB or TD pot is faulty. Replace the faulty component. If 'LR' & 'RR' indications are not coming after set time delay then IC4 on Main PCB is faulty.
- (In above description, it is assumed that display & LEDs are OK).
- Step 11** : To check relay, vary PT I/P to get 'L & R' conditions in Normal mode & confirm that Lower relay and Raise relay are operating, by checking continuity at rear terminals. If "RR" & "LR" indication are coming but relays are not operating then check 12V supply to relay on Main PCB or check Test / Normal switch S2. If relays are operating but 'NO' contacts are not closing means relay contacts are faulty. Ensure that Relay contacts are not connected to the Tap-Changer. Replace Main PCB.
- Step-12** : To check TPI PCB, connect Resistor chain between Max. & Min. & wiper to Common. Measure approx. +1V on the IC2 pin 36 with DMM. Adjust pot P5 to get +1V. Measure the step voltage across individual resistor. It should be $100 \pm 3mV$. If not then adjust pot P2 to get $100 \pm 3mV$. If the voltage does not come then IC3 may be faulty. If the voltage is OK but still the display does not read properly, then IC2 on the TPI PCB may be faulty. Check TPI displays 88 in "Test" mode. If not then "Test / Normal" switch is faulty.

Table No.1 On Main PCB

Test Points	Expected Voltage
betTP5 & TP7	+12V \pm 0.5 V
betTP6 & TP7	-12V \pm 0.5 V
betTP4 & TP3	+5V \pm 0.25V

On Display PCB

Bet TP4 (on Display PCB) & TP7 (on Main PCB) (For PT I/P = 110VA.C.)	3.3VAC \pm 0.2%
Bet TP1 (on Display PCB) & TP7 (on Main PCB) (For PT input 110V A.C.) (Varies with PT input)	+7.5VDC \pm 0.2% (DC O/P)
Bet TP3 (on Display PCB) & TP7 (on Main PCB) (For 110V Nom. Set) Varies with Nom Set	+7.5VDC (Reference voltage)

NATURE OF FAULT	PROBABLE CAUSES
<p>Unit not switching 'ON'</p>	<p>Check fuses, Power On Switch, Connections to Rear Panel Terminal Block OK. Check Mains transformer and DC voltages as per Table 1. If faulty replace Main PCB.</p>
<p>UV indication permanently 'ON'</p>	<p>Check PT supply, PT Fuse and Sense transformer. If all are OK, check DC O/P voltage @ TP9 on Main PCB. If faulty replace Main PCB. If OK replace Display PCB</p>
<p>Display reads '000' in all position of selector switch. Or No variation in display reading by varying R,L set controls</p>	<p>A to D convertor is faulty. Replace Main PCB or else Display PCB.</p>
<p>L or R or UV/OV indications not coming after varying P.T. input beyond dead band settings. Or L or R indication remains permanently 'ON'</p>	<p>IC3 on Display PCB is faulty. Replace Display PCB.</p>
<p>LR or RR not coming after varying PT I/P voltage after the set time delay. Or Time delay LED on Main PCB remains 'ON' permanently</p>	<p>Digital circuitary on Main PCB faulty. Replace Main PCB.</p>
<p>Time delay is not as per set value</p>	<p>Time Delay dial might have shifted. Adjust the setting of T.D. as follows. Slightly loosen the Knob and rotate T.D. control fully anticlockwise to match the dot with the starting dot marked below. Tighten & check the T.D. value for 30 secs. Readjust slightly if necessary.</p>
<p>LR & RR commands coming but OLTC not operating</p>	<p>Check contacts on Rear Panel Terminal Block. If OK, check control panel wiring. If contacts are not OK, replace Main PCB.</p>
<p>'LR' or 'RR' commands remain "ON" permanently</p>	<p>IC4 on Main PCB faulty. Replace Main PCB.</p>

VIII. OPTIONS

A. LINE DROP COMPENSATOR

I. DESCRIPTION

The Line Drop Compensator is optional with the Automatic Voltage Regulating Relay Type EE-301 T. The option is housed in the same enclosure.

The Voltage at the generating end and at the receiving end are not the same due to the drop across the line. The LDC is used to compensate for this line drop, and the amount of compensation required is calculated as a % of the Nominal voltage knowing the length of the line, its resistance/unit length, its reactance/unit length and the rated current, and set on the front panel.

The line current is stepped down to 1Amp and fed to the LDC unit. The resistive and reactive drops are simulated by having 90° phase-shifted voltages and their polarity is selected by polarity switches. The net compensation is then summed with the stepped down PT voltage.

II. SPECIFICATION :

Resistive & Reactive Compensation	:	0-20% of the regulating value continuously adjustable.
Input rated current	:	1 Amp, 50 Hz.
Power consumption	:	5VA max. at 1 Amp.
Accuracy	:	10%.
Max. Over current	:	50% of rated current (1.5Amp).
Polarity Selection	:	Both positive and negative Compensation.

III. OPERATING AND CONNECTION INSTRUCTION:

CT I/P Connections to the AVR are made through the rear panel terminals (5,6). The line current is stepped down to 1Amp. 50 Hz and fed to the AVR.

The required amount of %R and %X compensation can be set on the front panel of the AVR.

The polarity select switches will provide both positive and negative compensation.

The %R & %X settings can be calculated from following formulae.

$$\%X = \frac{3IL \times XL \times 100}{VL}$$

$$\%R = \frac{3IL \times RL \times 100}{VL}$$

Where IL = the primary rated current of the line.

VL = the voltage between lines of power transformer.

X_L = the line reactance in ohms/phase.

R_L = the line resistance in ohms/phase.

The LDC simulates the resistive & reactive drops across the line. The %R setting gives the resistive drop which is in phase with line current. The polarity switch VR selects whether the drop has to be added or subtracted from PT Voltage.

In +VR position this voltage is subtracted from the PT voltage so that its effect on AVR is to Raise the voltage equal to the resistive drop to make the voltage at the load equal to nominal value. In -VR position drop is added & its effect on AVR is to 'LOWER' the voltage. In normal use, VR switch is kept on + position.

The % X setting gives the reactive drop across the line. This drop is in phase quadrature to the line current. The +VX gives lagging compensation and -VX gives leading compensation. Since the reactive compensation is in quadrature, its effect on AVR magnitude is very less. However, its effect is observable for power factors bet. 0.5 & 0.7 and is similar to VR compensation i.e. +VX raises the voltage & -VX Lowers.the Voltage.

The PT I/P to the AVR is internally stepped down to 3.3V corresponding to 110V. The vector sum of resistive & reactive drops i.e. LDC O/P is added vectorially to the stepped down PT voltage to get the sense voltage at load end.

TESTING OF LDC

- a) Feed 110V PT to AVR and keep $R = 108$ & $L = 112$.
- b) Keep %R & %X setting of LDC to minimum position.
- c) Now the AVR is in dead-band condition. Feed 1A current through the terminals 5 & 6 on rear panel.
- d) Keep both polarity switches to +VR & +VX position.
- e) Increase %R compensation from 0 to 20%, 'Raise' indication should come.
- f) Put polarity switch to -VR position, "Lower" indication should come.
- g) Bring back %R control to zero position.
- h) Increase % X control from 0 to 20%, Raise indication should come. Put polarity Switch to -Vx position, Lower indication should come.

(N.B.)- This can be observed only for a power factor of 0.5 to 0.7. For lower power factor effect is not observable.

Note :- If above tests are not ok, then interchange CT connections at 5 & 6 and carry out same tests.

CALIBRATION CHECK OF %R

- a) Assuming current in phase with voltage (i.e. pf. = 1)
set $L = 115V$ & $R = 105V$, %R = 0 & %X = 0.
Check operation of AVR without feeding 1Amp current to LDC.

- b) Note down values at which R & L indications come. Let us say they come at 105V & 115V respectively.
- c) Pass 1 Amp current through LDC and increase %R setting to 5%. Put polarity switches in + position.
- d) Vary the PT Voltage and note value at which R & L indications come. They should be 5.5V above set Values, i.e. R = 110.5V & L = 120.5.
- e) Put VR switch to – position and vary voltage and check the voltages when R & L indication come. They should be 5.5V below the set values i.e. R = 99.5 & L = 109.5. Similarly check for 10% compensation. The difference will be +11V i.e. levels will be L = 126V, R = 116V, for +VR & L = 104, R = 94V for -VR.
- f) The %X Compensation cannot be checked, because of its small effect on AVR.

VERY IMPORTANT

- 1. Switch off CT current or short CT before disconnecting AVR.
- 2. When LDC is not to be used then both %X and %R dials should be kept at 0%. This position will give 0 compensation.

B. AUXILIARY FAIL RELAY OPTION

AFR option can be incorporated in the same enclosure to give alarm instantaneously when Auxiliary supply to the AVR Relay fails.

The internal relay remains energised as long as 110V A.C. (Aux supply) is present at Pin Nos. 1 & 2 of the AVR relay. When Aux supply fails, this relay gets deenergised, & the Contacts at pin No.7 & 8 close to operate the alarm (externally provided).

TESTING PROCEDURE

- 1) Give Aux supply 110V A.C. to the AVR Relay and check continuity between Pin Nos. 7 & 8. It should show open. Remove Aux supply to the relay and check the continuity between Pin Nos. 7 & 8. It should show short.

C. 4-20mA TPI Output for SCADA.

4-20mA TPI Output option also can be incorporated in the same enclosure.

This option provides 4-20mA TPI output on the Rear Panel Terminal Block (pins 20, 21), proportional to Taps 1 to 17, which can be used for SCADA.

TESTING PROCEDURE

Check TPI, for taps 1 to 17 & measure O/P current varies from 4 to 20mA (1mA/ tap) i.e. tap1 = 4mA, tap2 = 5mA & so on till tap17 = 20mA.

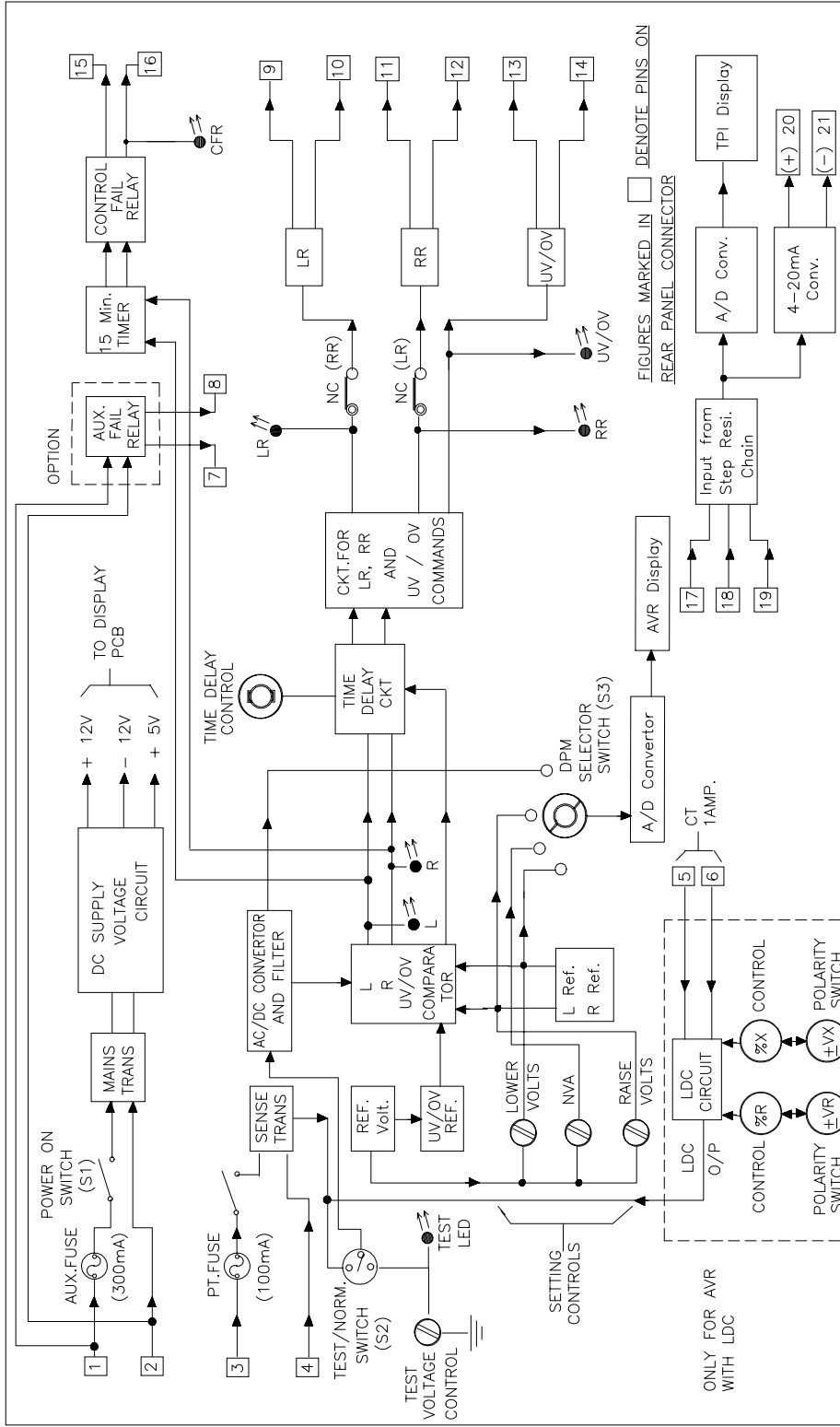
In case the number of taps are more or less than 17, the change in current per tap change = $16 \text{ mA} / \text{no. of step resistance}$ eg. for 21 taps = $16 / 20 = 0.8 \text{ mA/step}$. Thus tap1 = 4mA, tap2 = 4.8mA, tap3 = 5.6mA & so on.

IX. LIST OF DRAWINGS :

- | | | | |
|----|---|---|----------|
| 1. | Block Diagram | : | 05-ED-09 |
| 2. | Front Panel View | : | 05-MD-19 |
| 3. | Rear Panel View with Cutout
Dimensions & AVR connections | : | 05-MD-20 |

RECOMMENDED SPARES :

1. Main PCB
2. Display PCB
3. TPI PCB
4. Mains Transformer
5. Sense Transformer



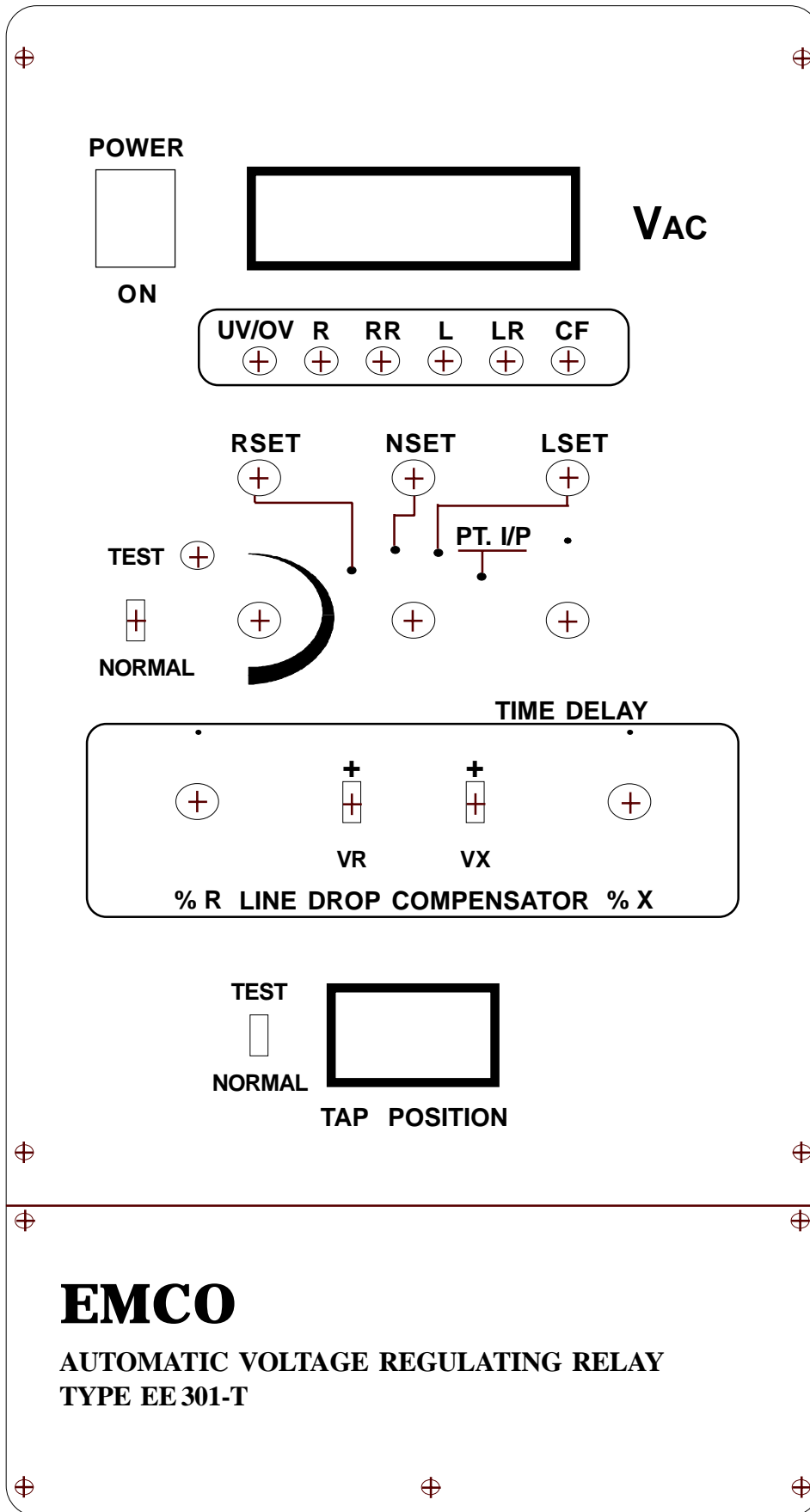
FIGURES MARKED IN DENOTE PINS ON REAR PANEL CONNECTOR

ALL DIMENSIONS ARE IN mm UNLESS STATED OTHERWISE

4	PRODUCT : AVR (301-T)
3	ASSEMBLY : -
2	MATERIAL : -
1	SCALE: N.T.S.
ISS.	DATE APPR. BY DRN. BY : J.J.P.
DOC No.: DC00-405/ISS.1	

EMCO ELECTRONICS
 TITLE : BLOCK DIAGRAM
 SCALE: N.T.S.
 DATE : 14-1-02
 DRG. No. : 05-ED-09/ISS.1

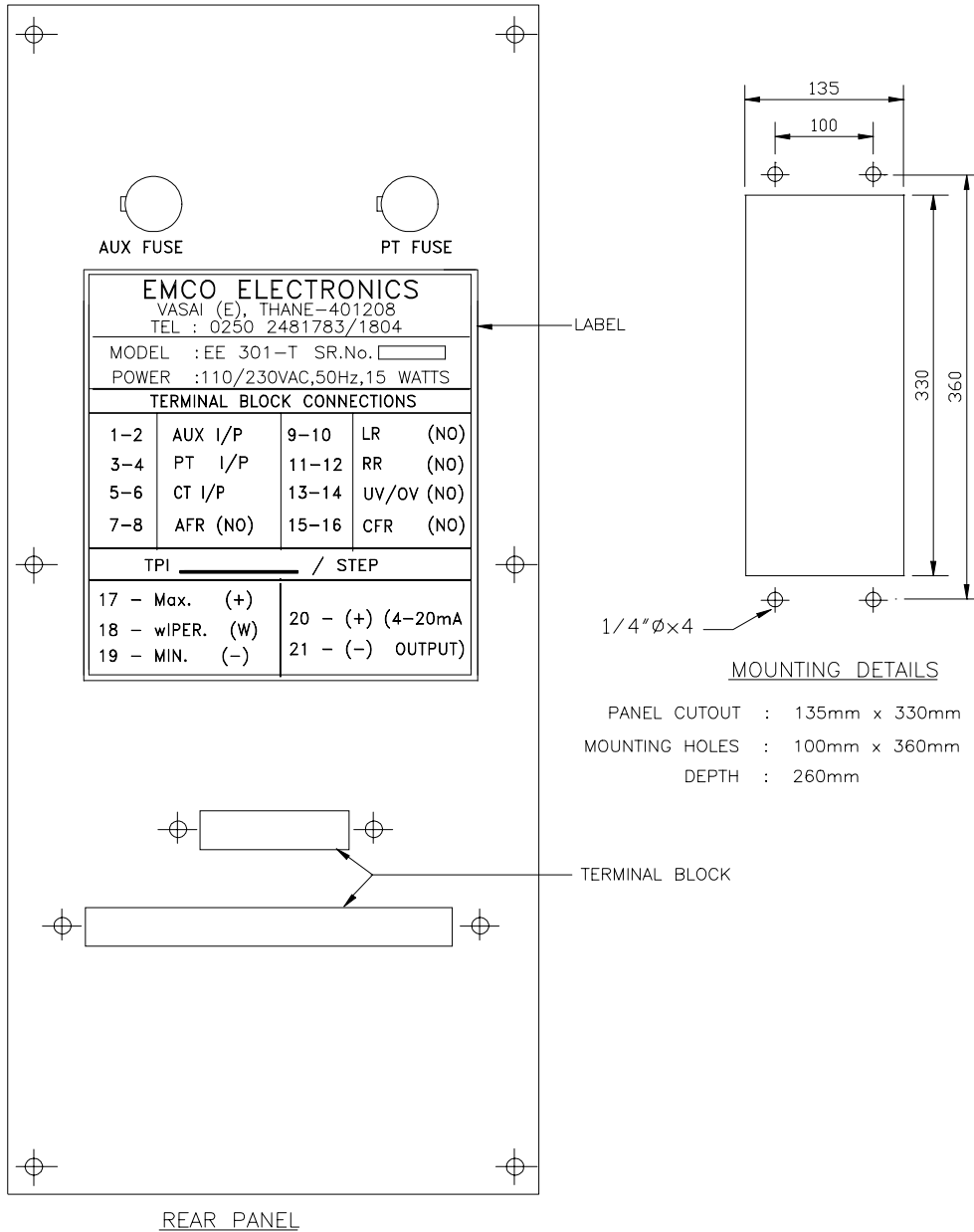
FOR TOLERANCES NOT SPECIFIED, REFER DIMENSION TOLERANCE CHART PD00 - 606



4			ALL DIMENSIONS ARE IN mm UNLESS STATED OTHERWISE	
3		PRODUCT : AVR (301-T)	EMCO ELECTRONICS	
2		ASSEMBLY:	TITLE : FRONT PANEL STICKER (BOTTOM)	
1		MATERIAL :	SCALE : N.T.S.	
ISS.	DATE	APPR. BY	DRN. BY : J.J.P.	DATE : 9 - 4 - 03
				DRG. No. : 05-MD-19 / ISS.2

DOC No. : DC00-405 / ISS.1

FOR TOLERANCES NOT SPECIFIED REFER DIMENSION TOLERANCE CHART PD00-606



MOUNTING DETAILS
 PANEL CUTOUT : 135mm x 330mm
 MOUNTING HOLES : 100mm x 360mm
 DEPTH : 260mm

REAR PANEL

4			ALL DIMENSIONS ARE IN mm UNLESS STATED OTHERWISE	
3			PRODUCT : AVR (301-T)	EMCO ELECTRONICS
2			ASSEMBLY : -	TITLE : REAR PANEL WITH CUTOUT
1			MATERIAL : -	SCALE : N.T.S. DIMENSIONS & AVR CONNECTIONS
ISS. DATE	APPR. BY	DRN. BY : J.J.P.	DATE : 9-4-03	DRG. No. : 05-MD-20/ISS.2

DOC No. : DC00-405/ISS.1

WARRANTY

This product from **EMCO ELECTRONICS** is warranted against defects in materials and workmanship for a period of 12 months from the date of despatch to the first buyer/purchaser of this equipment, this being essentially limited by warranties given to **EMCO ELECTRONICS** on the component used in equipment.

During the warranty period **EMCO ELECTRONICS** will at its option, either repair or replace the product which prove to be defective provided the product has been used with reasonable care and in accordance with the manuals/product specification. Consequently this warranty shall also not apply to defects/damages in transit or resulting from misbehaving, misuse, Unauthorised modifications or repairs operations outside the environmental, electrical and/or other specification, improper or inadequate maintenance of the product, or site conditions as required/recommended and damages arising from accidental or abnormal causes.

The warranty period for items repaired/replaced shall not exceed then period for which the equipment was originaly warranted and also the liability of **EMCO ELECTRONICS** to the purchaser shall not in any case, exceeds the original purchase price of the equipment.

For warranty service or repair, the equipment must be returned to **EMCO ELECTRONICS** securely packed on Freight paid basis and accompanied by a certificate stating that the equipment is being returned for warranty repairs and also note giving details of the purchase (Purchaser's Name. and address, invoice No. and Date of purchase) and details of the equipment failure. faults conditions, other useful information to faciliate early repair/rectification or the equipment.

Return of the equipment duly repaired can be arranged on payment of the packing and forwarding charges together with any cther taxes. duties, other miscellaneous expenses incurred, alternatively the purchaser may arrange to collect the equipment from **EMCO ELECTRONICS**. In case the repairs are not covered under warranty, the charges tor the same must also be paid before collection of the equipment.

Our engineer's services are available at site for instruments during warranty or out of warranty period, on chargeable basis. Details of which are available on request.

In the interest of development and improvement **EMCO ELECTRONICS** reserve the right to amend without notice details contained in this publication. No legal liabilities will be accepted by **EMCO ELECTRONICS** for any errors, omissions or amendments.

To,
EMCO ELECTRONICS
106, Industrial Area,
Sion (East), Mumbai-400 022.
Tel. : 4096731 / 82

From : _____

FAULT REPORTING FORM FOR AVR EE301-T

Please fill this form when sending the faulty AVR for repairs. This will help us to serve you better.

AVR Serial No. : _____

Supplied By : _____

Working Since : _____

Nature of problem : _____

Settings on AVR : L SET=_____ R SET=_____ NVA=_____ TD=_____ Display Rdg. =_____

Check Auxillary & PT Fuses before proceeding. Conect Aux. & PT supplies.

Please observe the following on the faulty AVR & tick the appropriate box.

Put AVR in "TEST" Mode & vary the "TEST CONTROL" (TC.) Potentiometer.

- | | Yes | No |
|--|--------------------------|--------------------------|
| 1. Display rdg. varies with TC. | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. 'R' LED glows when Display rdg.<R SET | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. 'RR' LED pulses after TD. | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. 'L' LED glows when Display rdg.>L SET. | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. 'LR' LED pulses after TD. | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. 'UV' glows for UV condition. | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. 'OV' glows for OV condition. | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. 'CF' glows for CF condition. | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. ALL LEDs are off in Deadband condition. | <input type="checkbox"/> | <input type="checkbox"/> |
| Put AVR in 'NORMAL' Mode & check respective relay contacts. | | |
| 10. 'RR' contacts close & open for step 3. | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. 'LR' contacts close & open for step 5. | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. 'UV / OV' contacts close (& open when UV/OV restored) for steps 6/7. | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. 'CF' contacts close (& open when CF restored) for step 8. | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. Any of the LR / RR / UV / OV contacts permanently closed. | <input type="checkbox"/> | <input type="checkbox"/> |
| *15. TD LED on Main PCB toggles ON/OFF for continuous L or R conditions. | <input type="checkbox"/> | <input type="checkbox"/> |
| *Note : Open bottom front plate to observe the LED. | | |
| 16. TPI displays properly. | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. OPTIONS : LDC / AUXILIARY FAIL / 4-20mA TPI O/P operating properly. | <input type="checkbox"/> | <input type="checkbox"/> |
| 18. Any other information : _____
_____ | | |

NAME OF TEST ENGINEER : _____

SIGN. : _____

DATE : _____