



**Specification**  
**For**  
**Remote Transformer Monitoring Cum Tap Changer Control System**  
**(TMCTCS)/ITCS/DIGITAL RTCC RELAY**

This Specification covers requirements for category of ITCS/TMCTCS as per following.

The digital RTCC panel shall have Automatic Tap Changer control and monitoring relay with Automatic Voltage regulating features (referred as Digital RTCC relay) to remotely control and monitor OLTC. The relay shall be offered from the manufacturer who has already supplied Digital RTCC relay, which is in operation for at-least 2 years for transformer OLTC application.

**General:- PGCIL APPROVED Digital RTCC relay/TMCTS** shall be microprocessor based adopting the latest state of the art design & technology with in-built large display (128x128 or higher) for ease of programming and viewing. The unit supplied shall be field programmable so that in the event of change in transformer / location, it could be customized to site conditions without sending back to works. The programming shall be menu driven and easily configurable. If it is designed with draw out type modules, it should take care of shorting all CT inputs automatically while drawing out. The CT / VT ratio shall be field programmable and Relay shall display the actual HV Voltage and current considering suitable multiplying factors. The system shall be self-sufficient and shall not require any additional devices like parallel balancing module etc. for parallel operation of Transformers with following features –

- The relay shall have 4 selectable set point voltage.
- It shall have following methods as option for the compensation of voltage.
  - Apparent current (Z comp.)
  - Line drop compensation (LDC)
  - Active current
  - Reactive current.
  
- Relay shall have under voltage / over voltage blocking facility which shall make the control inoperative if voltage falls/rise by percentage value of set point value.
- The relay shall have integrated features for the display of parameters like Tap position , Nominal Voltage , Load current , Bandwidth , measure the value of V.I. Active Power, Reactive Power , Apparent Power , Frequency, Power factor , Reactive current etc.
- Relay shall be capable for compensating VT and CT errors.
- Relay shall have facility to register the tap changer statistics like the display the number of tap changing operations occurred on each tap.
- It shall have facility to record the voltage and current with respect to time.
- it shall have facility to monitor or control the parameters like life time consumption of Transformer, operating hours of Tap changer, Fans and pumps, controls of cooling level of transformer and recording hot spot temperature .



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- The relay shall have software to make the parameter setting of the device and it shall be also possible to do the parameter setting through keyboard of relay.
- The relay shall have suitable interface to make communication with systems. The following minimum ports shall be available on the device
  - a. RS 232 port (or other suitable method) for doing the parameter setting and local communication / data exchange with other devices.
  - b. Fiber optic port with IEC 61850 protocol for communication with higher level SCADA systems. RS 485 port with Modbus protocol or other method may also be needed as per end user requirement and same will be finalize (any one) during placing P.O. of individual work orders.
- It shall have facility by which a customer specific software programme can be written and incorporated in the relay.
- Digital RTCC relay having Raise/Lower push buttons, Manual/ Automatic mode selection features, Master / Follower/ Independent/ Off mode selection features and emergency stop Push Button for control of OLTC. Touch screen option in the relay, instead of electrical push button/switch is also acceptable.
- **Monitoring:** The relay shall have programmable Binary Inputs and Binary outputs .It shall have binary inputs with LED indications & binary output and analog input/output as per table.

Sl.no	Features	Nos.	Remarks
1	Minimum number of Binary Inputs	32	Freely programmable inputs with LED indications
2	Minimum number of Binary Relay Outputs	08	Freely programmable outputs
3	Minimum number of Analog Inputs	08	4-20mA freely programmable inputs
4*	Minimum number of Analog Outputs	05	4-20mA freely programmable outputs

\* As per PGCIL specification, for transferring Analog input data to SCADA / control room, in place of Analog Outputs, IEC-61850 compliant communication protocol also acceptable.

Detail description and definitions as explained below need to refer for further clarifications -

### **Detail description and definitions:-**

**Manual Mode:** In this mode, power system voltage based automatic control from digital RTCC relay shall be blocked and commands shall be executed manually by raise/lower push buttons.

**Auto Mode:** In Auto mode, digital RTCC relay shall automatically control OLTC taps based on power system voltage and voltage set points. An interlock shall be provided to cut off electrical control automatically upon recourse being taken to the manual control in emergency.



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The Microprocessor based technology has been envisaged for the control and monitor of forced cooling equipment, condition monitoring and OLTC control of Power transformers.

The Tenderers shall provide full description of the control system offered and details of deviations from specified requirement shall be brought out in the offer along with necessary justifications.

The intent of this section is to describe the desired functional and environmental requirements in respect of microprocessor based Intelligent Transformer Control System (ITCS)/ without limiting the additional features that the tenderer may be able to include in the offer. The ITCS /TMCTCS should provide facilities such as SCADA/SAS links, transformer cooler control and data logging, control of the OLTC, remote OLTC tap position indication in digital form at local and the remote, temperature indications for windings and top oil, temperature alarms and trip, marshalling of other control and alarm functions, emergency overload control, recording of accumulated "use of life" local display of status of control and alarm functions and selection of local and remote control etc. With following features -

**A) FUNCTIONS of relay:-**

**I) Monitoring:**

The system shall be capable of monitoring the analog/Digital data and status signals of the following functions:

Transformer LV load voltage, tap changer status including tap position, tap changing in progress, status of control switches, OLTC motor current, OLTC motor trip, temperature difference between OLTC compartment and main tank. Temperature and condition of the transformer cooler status including top oil temperature, ambient temperature, winding hot spot temperature, running status of cooler fans and/or pumps, fan and/or pump trip, Interface with the fiber optic thermometer (where fiber optics probe have been specified) etc. This data shall be available for display, data logging and remote communication. For each analog value the ITCS/TMCTCS shall display the present and minimum and maximum value reached since the last time that the minima and maxima were reset to the current values.

**II) Cooling Control:-**

The relay shall be capable of controlling all cooling systems of the transformer including pumps & fans. The control function shall operate in such a way as to keep the transformer temperature within the limit set by the Purchaser.

**The ITCS shall be capable for:**

Predictive mode to **turn on** the cooling system based on predicted top oil and winding hot spot temperatures in addition to normal control based on actual temperatures. This should work in the event of a sudden sustained increase in load current, before the temperatures had risen to normal control settings, so as to keep the transformer cooler for longer time. Predicted temperature shall be based on a thermal model of each specific transformer (based on actual heat run tests), ambient temperature and load.

**Periodic automatic testing:**



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The ITCS/TMCTCS shall be possible to automatically exercise testing of the cooler system at preset intervals to ensure that they are still functional, with an alarm if the test fails.

### III) OLTC Control:

The relays shall ensure positive completion of lowering/raising of the OLTC tap, once the command is issued from the relay. "Step-by-Step" operation shall be ensured so that only one tap change from each tap changing pulse shall be effected. If the command remains in the "operate" position, lock-out of the mechanism is to be ensured.

- Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated to the next (higher or lower) tap.
- Following minimum indications/alarms shall be provided in Digital RTCC relay either through relay display panel or through relay LEDs:
  - a. Incomplete STEP alarm
  - b. OLTC motor overload protection alarm
  - c. Supply to DM Motor fail alarm
  - d. OLTC IN PROGRESS alarm
  - e. Local / Remote Selector switch positions in DM Box
  - f. OLTC upper/lower limits reached alarm
  - g. OLTC Tap position indications for transformer units
  - h. 'Independent-combined-remote selector switch positions of CMB In case of parallel operation or 1-Phase Transformer unit banks OLTC out of step alarm shall be generated in the digital RTCC panel for discrepancy in the tap positions.

The control shall include selection of the following operating modes and features as applicable, by push buttons or keys at the controller or from SCADA/SAS.

- Manual OLTC control by pushbuttons or keys at the controller or from SCADA.
- AVR (automatic voltage regulation)
- Independent mode
- Master or follower parallel mode
- Circulating current parallel mode
- Circulating current based on MVA rating of transformer
- VAR sharing parallel mode
- Reverse reactance parallel mode
- AVR time delay shall be settable with definite time, fast – tap – down and inverse-time modes.
- AVR shall have the option of Line Drop Compensation ("LDC").
- AVR shall be blocked, if the voltage drops below the under voltage set points, to prevent false operation in the event of supply line faults, VT fuse failure etc.
- OLTC operations shall be blocked if the current through the OLTC exceeds a preset value.



**IV) Performance Calculations and Prediction:**

The relay shall be capable of calculating:

- Watts and VARs.
- Accumulated number of tap changers from each tap position (discrete counter for each position) and total number of tap changers.
- Winding hot spot temperatures for each winding and maximum achieved.
- Winding hot spot insulation ageing rate (per unit).
- Accumulated insulation ageing (use of life) based on the winding hot spot (years) as per the loading guide for oil immersed power transformer. The use of life calculations shall also convey to the operator the amount of time available at the present over load rating and the amount of overload available for two hours duration from the time in question.
- Accumulated operating hours for each fan and pump group.
- Accumulated number of starts for each fan and pump group.

**V) Alarms:**

The system should be suitable for Alarms to be extended to the SCADA/SAS system for:

- Voltage exceeds over-voltage alarm setting or is less than under-voltage alarm setting.
- OLTC auxiliary power failure.
- OLTC fail (tap changed in progress too long or OLTC motor trip).
- Temperature abnormalities such as high oil temperature and high winding temperature.
- Top oil or winding hot spot temperature exceeds alarm / trip settings.
- Cooler auxiliary power failure.
- Cooler fail (contactor failed to close when switched on, or motor trip, or oil flow failed).

All OLTC and temperature trip signals shall be provided by means of potential free contacts where the contacts have a rating of not less than 0.4A at 125 VDC resistive. All other trip signals such as Buchholz, pressure relief and OLTC surge shall be provided directly from the potential free contacts of the respective device, not via the ITCS/TMCTCS. The alarms can however be wired via the ITCS/TMCTCS.

**VI) Data Logging and Event Recording:**

Monitored data shall be time and date stamped and logged in a format, which can be easily imported to data analysis software such as MS Excel/Access etc. The local data storage capability which can store all data at one minute intervals shall be stated by the tenderer. The TCS unit shall have integrated facility to do time sync with IEC 61850 Master. Built in real time clock with facility for synchronization with GPS shall be available.

A separate event record is required to record the date and time (to nearest second) when the status of any alarm changes. The number of events that can be stored shall be stated by the tenderer. The data stored shall remain intact even during a power failure.

**VII) Communication:**



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Digital RTCC relays shall communicate with SCADA using IEC 61850 protocols to monitor, parameterize & control the OLTC. Any software required for this purpose shall be supplied. The supplied software shall not have restriction in loading on multiple computers for downloading and analyzing the data. Software shall indicate the current overview of all measured parameters of the connected transformer in real time.

The digital RTCC Relay shall have multiple selectable set point voltages and it shall be possible to select these set points from SCADA, with a facility to have the possibility of additional set points command from SCADA.

Communication between the Digital RTCC relays to execute the commands for parallel operation shall be implemented using required communication protocol. IEC- 61850 , GOOSE messaging between Digital RTCC relays for OLTC parallel operation is not permitted. Suitable communication hardware shall be provided to communicate up to distance of 1km between digital RTCC relays. Scope shall also include special communication cables (if required) between digital RTCC relays.

The ITCS/TMCTCS shall accept all Analogue / Digital quantities relevant to the control of the transformer or as required by the user. These quantities shall be able to be interfaced to the purchaser's SCADA/SAS equipment. The ITCS shall be capable of down loading data files . The protocol for communication shall be as per IEC 60870-5-103 and IEC 61850.

### **VIII) Other capabilities:**

Tenderers may also offer ITCS/TMCTCS which performs both Dissolved Gas Analysis and moisture in oil condition monitoring.

### **B) MAN MACHINE INTERFACE:-**

Access to control variables within the ITCS/TMCTCS shall be available to the personnel as required by the user/purchaser. The form of these interface should preferably be via a permanent front panel that contains a display and keypad. The menu facilities shall be as simple and intuitive as possible. Facilities to access the ITCS/ TMCTCS via local RS-232 port and software running on a laptop PC under the latest version of Windows shall also be provided. A sample of the PC software shall be supplied to the purchaser for evaluation before proceeding with that method. Software supplied to the purchaser is not returnable and becomes the property of the user/purchaser.

### **C) ELECTRICAL ISOLATION AND TRANSIENT PERFORMANCE:-**

All equipment shall be type tested, tested during manufacture and after completion are in accordance with latest IEC 60255 and IEC 60068.

### **D) POWER SUPPLIES:-**

The TMCTS shall be capable of operating by auxiliary supply 95-260 V AC/ DC both. (Universal auxiliary supply ).

### **E) INPUTS / OUTPUTS:-**

#### **a) DIGITAL INPUT AND OUTPUT MODULES:**



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The "on" state of all digital inputs and outputs shall be indicated by Light Emitting Diodes (LED) on the front of the modules. These LEDs shall be visible from the front panel on which the ITCS/TMCTCS equipment is mounted. All inputs shall be electrically isolated from the external circuit and capable of being driven from 42 V DC to 240 V DC.

All output shall be electrically isolated from external circuit and rated for switching 42 V dc to 240 V dc and 0.5 Amp.

Sufficient no of DI and DO modules shall be provided as specified at clause no A (I) to suit the scheme requirements by the user as per the field requirements.

**b) ANALOG INPUT AND OUTPUT MODULES:**

4-20mA Analog input shall be provided for the following main functions and other inputs as per actual need of user:

- Oil temperature.
- Core Temperature.
- IV-R phase & B phase winding temperature.
- All DGA in PPM & water content in PPM.
- Additional 20 % spare 4-20mA analogue input shall be provided for future use.

Digital RTCC Relay shall be capable of transferring data to SCADA / control room through IEC-61850 compliant communication protocol/ Analog output for all input given to relay including 4-20mA input signals.

**F) SELF-MONITORING:-**

The ITCS/TMCTCS shall have a self-check of power on and shall continually monitor all functions and the validity of all input values to make sure the control system is in a healthy condition. In the event that the unit is unable to control the transformer, the device is to revert to a fail-safe condition. Any monitoring system problem shall initiate an alarm.

**G) MEMORY RETENTION:-**

The TCS shall be capable of retaining its information in the event of a power failure.

**H) REAL TIME CLOCK:-**

There shall be real time clock for time stamping the data log and event records. A long life battery shall be provided to keep the clock operating in the event of the power failure. An alarm shall be generated if the battery fails. It shall also be possible to synchronize the ITCS/TMCTCS clock with GPS system provided at the substations.

**I) SECURITY:-**

Preferably, provision for Levels of security to limit access to authorized users shall be provided with

- Viewing data and down loading data files (no access control)



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- Changing control mode and manual control operations (password control)
- Changing settings and configuration (password control)
- Software upgrade (password control).

#### **J) MOUNTING:-**

The ITCS/TMCTCS input/output modules /units shall be mounted within the auxiliary marshalling cubicle or in a separate cubicle with a similar construction located on the transformer. The cubicle shall be suitable for IP-56. The cubicle shall be capable of protecting the equipment contained within and keep it in operational condition at all times given the conditions described in the environmental section. The Man Machine Interface (MMI) unit will be mounted on the transformer Tap changer control (RTCC) panel in the control room. Cabling between the MMI unit and input / output modules /unit shall be arranged by the user/Purchaser. However, the equipment supplier shall supply any kind of necessary plug in sockets port connection or any special cable with the system. The details of the same shall be described & furnished. It shall be possible to have a second MMI mounted in the transformer control cubicle if required.

#### **K) DIMENSIONAL & MOUNTING DETAILS:-**

The dimensional details for overall size, cut out size, front, back & side view dimensions to be submitted by bidder for each type of requirements separately.

#### **L) TEST CERTIFICATES:-**

All equipment should have type tested and reports to be submitted or testing during manufacture and after completion accordance with IEC 60255 and IEC 60068.

#### **M) INSTALLATION & COMMISSIONING OF ITCS/TMCTS AT SITE:-**

The ITCS/TMCTCS equipment (other than MMI/HMI and microprocessor unit) shall be located within the auxiliary marshalling cubicle or RTCC panel and the Man Machine Interfacing (MMI) unit in the transformer RTCC panel in the control room.

The commissioning & demonstration of proper functioning to user at site with RTCC panel is the responsibility of the supplier when and where called for this purpose.

#### **N) TRAINING FOR PROPER OPERATION, MAINTENANCE OF THE SYSTEM:-**

One time training, demonstration and skill input for successful operation of the system is also in the scope & responsibility of the system supplier.



**O) PERFORMANCE CERTIFICATE & WARRANTY:-**

Type test certificate and performance certificate of the product & solutions as per international standard to be submitted. The warrantee of the product and solutions as per international standard shall be furnished and guarantee for availability of spare and solution for at least 10 years from the date of supply to be furnished.

**P) REGULATIONS & STATANDARDS APPLICABLE:-**

Bidder to ensure all the relevant parts of IEC and regulation to comply for the product. The IEC standards IEC-60255, IEC-60068, IEC-61850, IEC-61010, IEC-61326, IEC-60529, IEC-60688&IEC-61000 etc. or all the other applicable IEC be referred.

**NOTES:** The required input/output and features indicated above are minimum & indicative only and any combination of features can be used as per customer specific contract requirements.