TRANSFORMER TEMPERATURE MONITOR
AND COOLING CONTROL SYSTEM


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I. Description of Operation

The model TTM-AC/DC is a solid state transformer temperature monitor that is SCADA ready and monitors both oil and winding temperatures. The TTM-AC/DC is designed for easy installation on single or three phase single tank transformers.

In addition to temperature monitoring and cooling control functions there are two new Barrington innovations added for utility convenience and to extend the useful life of the transformer. (1.) The “LOOKBACK” feature is provided for ambient compensation. This feature allows the utility to compensate for hot spells with ambient temperature set back capability. This feature can be used to start the cooling system at a lower temperature for hot spells and can effectively provide a cooling “head start.” (2) The cooling monitor feature can be set to alarm for any reduced cooling current. (i.e. One or two fans not running.) Another selectable feature is provided to exercise the cooling system for a ten minute period each 24 hours. The “alternate cooling stage” feature allows a user to select the mode that switches between the two cooling stages every 168 hours. This feature, if enabled, allows the unit to swap the cooling stage that is selected to operate as the first stage to exercise and use the stages equally. This can be both a labor saving and a desired maintenance feature.

Local indication includes calculated winding temperature, calculated peak winding temperature, top oil temperature and peak top oil temperature with manual reset. Winding temperature is obtained using a single pt100 RTD probe and one or three snap on current transformers with calculations to closely approximate actual conditions. Displays are .39” backlit LCD’s that continuously display all four temperatures simultaneously. Communications include SCADA ready outputs, dry contacts for local annunciation and a RS232/485 port. The TTM-AC/DC measures the actual Top Oil temperature in the transformer and measures the actual current in each phase of a transformer using three supplied snap-on current transducers. The current is displayed as a percentage of full scale for each phase, using only highest phase for calculation. The winding temperature over top oil temperature is calibrated at maximum based upon the transformer manufacturer’s “heat run.” This insures that at higher temperatures, where winding temperature is important, the readings are very accurate. In testing per National standards, placing the probe in a calibration oil bath, the TTM-AC/DC measurement accuracy is within plus/minus 0.2 degrees C compared with the calibration temperature of the oil bath. Readings are displayed as a directly linear curve over top oil temperature. For example:

<table>
<thead>
<tr>
<th>Top oil temperature</th>
<th>Load</th>
<th>Winding temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 deg C</td>
<td>0 amps</td>
<td>40 deg C</td>
</tr>
<tr>
<td>80 deg C</td>
<td>Full Load</td>
<td>80 + heat run</td>
</tr>
</tbody>
</table>

The TTM-AC/DC is housed in an 8” X 10” X 6” NEMA 4 windowed enclosure. The enclosure is designed to be mounted on an existing transformer control cabinet. Ambient operating temperature range is -40 degrees C to 70 degrees C. Winding and oil temperatures are both obtained using a single RTD probe in the top oil well of the main transformer tank and one or three snap on current transformers. Installation requires connecting supplied snap on CT’s (current transducers) to existing secondary current and cooling supply circuits. Installation is quite easy. Operation is very reliable. Power requirements are auto-sensing, 120 or 240 VAC 50/60hz -or- 110 to 270VDC. The analog outputs can be connected to an existing SCADA system. The analog outputs supplied are 0 - 5 VDC, 4-20 ma, or 0-1ma “switchable” for oil and winding temperatures. The TTM-AC/DC-AC/DC is designed to meet IEEE/ANSI C37.90 specifications for protective relaying applications.

TTM-AC/DC-AC/DC FRONT PANEL CONTROL AND DISPLAY

The new TTM-AC/DC-AC/DC design includes a 2 line by 16 character alpha-numeric display and a five key keypad. This document outlines the basic operation and concepts of the various displays. The TTM-AC/DC-AC/DC has a standard display of temperature data. This standard display will be shown at all times except when a user has entered one of the two menus to setup the control of the TTM-AC/DC-AC/DC. If the user leaves the TTM-AC/DC-AC/DC in one of these menus it will timeout and return to the standard display.
The five key pad keys:

**MENU**  When pressed and released the TTM-AC/DC will start the main menu sequence of displays to allow the user to setup the normal operating parameters. When held for three seconds the TTM-AC/DC will enter the configuration menu. This secondary menu allows the user to setup the configuration and calibration of the TTM-AC/DC.

**NEXT**  When the TTM-AC/DC is displaying the standard display no action is taken. When in the main or secondary menu press this key will advance to the next item in the menu's sequence.

**PREV**  When the TTM-AC/DC is displaying the standard display no action is taken. When in the main or secondary menu, pressing this key will return to the previous item in the menu's sequence.

**▼**  When the TTM-AC/DC is displaying the standard display no action is taken. When in the main or secondary menu, pressing this key will reduce the current parameter to the next possible value.

**△**  When the TTM-AC/DC is displaying the standard display no action is taken. When in the main or secondary menu, pressing this key will increase the current parameter to the next possible value.

**▼ △**  Simultaneously pressing both the ▼ △ will reset both peak temperatures to the current values.

The following menus & lists detail the sequence for the TTM-AC/DC. The COMM column indicates which values may be read and /or written through the communication link.

<table>
<thead>
<tr>
<th>MAIN MENU DISPLAY</th>
<th>DESCRIPTION</th>
<th>COMM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MANUAL CONTROL ON</strong></td>
<td>Digital control to turn on the cooling system</td>
<td></td>
</tr>
<tr>
<td><strong>OFF</strong></td>
<td>Range: Off (normal) On</td>
<td></td>
</tr>
<tr>
<td><strong>OIL TEMP ALARM</strong></td>
<td>Top oil temperature alarm value</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: -40.0 to +180.0ºC</td>
<td></td>
</tr>
<tr>
<td><strong>WIND TEMP ALARM</strong></td>
<td>Calculated winding temperature alarm value Range: -40.0 to +180.0ºC</td>
<td>yes</td>
</tr>
<tr>
<td><strong>STAGE 1 OIL</strong></td>
<td>Stage 1 cooling control oil temperature</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: -40.0 to +180.0ºC</td>
<td></td>
</tr>
<tr>
<td><strong>STAGE 1 WIND</strong></td>
<td>Stage 1 cooling control winding temp</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: -40.0 to +180.0ºC</td>
<td></td>
</tr>
<tr>
<td><strong>STAGE 1 CURRENT</strong></td>
<td>Stage 1 cooling current minimum value</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: 0 to 100% of full scale cooling current</td>
<td></td>
</tr>
<tr>
<td><strong>STAGE 2 OIL</strong></td>
<td>Stage 2 cooling control oil temperature</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: -40.0 to +180.0ºC</td>
<td></td>
</tr>
<tr>
<td><strong>STAGE 2 WIND</strong></td>
<td>Stage 2 cooling control winding temp</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: 4.0.0 to +180.0ºC</td>
<td></td>
</tr>
<tr>
<td><strong>STAGE 2 CURRENT</strong></td>
<td>Stage 2 cooling current minimum value</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: 0 to 100% of full scale cooling current</td>
<td></td>
</tr>
<tr>
<td><strong>HYSTERESIS</strong></td>
<td>Control Hysteresis value</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: 0.1 to 100.0ºC</td>
<td></td>
</tr>
<tr>
<td><strong>ALARM DELAY</strong></td>
<td>Alarm delay time</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Range: 0.1 to 999.9 seconds</td>
<td></td>
</tr>
</tbody>
</table>

Default display shows current top oil temperature, current calculated winding temperature, peak top oil temperature and peak calculated winding temperature.
**Configuration Menus**

The TTM-AC/DC-AC/DC has secondary menus for controlling the communications, analog output signals and temperature calibration. TTM-AC/DC-AC/DC also provides for calibration of the five current sensing inputs.

<table>
<thead>
<tr>
<th>COMM. DISPLAY</th>
<th>ACTION</th>
<th>DESCRIPTION</th>
<th>COMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMM. MODE</td>
<td>Down/Up to select</td>
<td>Communications mode Modes: RS232, RS485, RS485 Multi-point</td>
<td>no</td>
</tr>
<tr>
<td>COMM RATE</td>
<td>Down/Up to select</td>
<td>Communication baud rate Possible rates: 1200, 2400, 4800, 9600</td>
<td>no</td>
</tr>
<tr>
<td>COMM FORMAT</td>
<td>Down/Up to select</td>
<td>Communication data format Possible formats: 8-N-1, 7-N-1, 7-E-1</td>
<td>no</td>
</tr>
<tr>
<td>COMM ADDRESS</td>
<td>Value entry</td>
<td>Communication address (RS485 Multi only) Possible values: 0-255</td>
<td>no</td>
</tr>
<tr>
<td>COMM PERIOD</td>
<td>Value entry</td>
<td>Communication output period Range: 0.0 to 3000.0 minutes</td>
<td>yes</td>
</tr>
<tr>
<td>FULL SCALE RISE</td>
<td>Value entry</td>
<td>Transformer manufacturer’s heat run data</td>
<td>yes</td>
</tr>
<tr>
<td>ANALOG 1 OUT</td>
<td>Down/Up to select</td>
<td>Analog output 1 mode (Top Oil Temp) Possible modes- 0-1ma, 4-20ma, 0-5v</td>
<td>no</td>
</tr>
<tr>
<td>ANALOG 2 OUT</td>
<td>Down/Up to select</td>
<td>Analog output 2 mode (Calculated Winding Temp) Possible modes- 0-1ma, 4-20ma, 0-5v</td>
<td>no</td>
</tr>
<tr>
<td>RTD 1 OFFSET</td>
<td>Value entry</td>
<td>RTD 1 offset value in tenths of a degree Range: -20.0 to +20.0°C</td>
<td>read</td>
</tr>
<tr>
<td>RTD 2 OFFSET</td>
<td>Value entry</td>
<td>RTD 2 offset value in tenths of a degree Range: -20.0 to +20.0°C</td>
<td>read</td>
</tr>
<tr>
<td>24 HR FAN CYCLE</td>
<td>Down sets to “1” [on]</td>
<td>Automatically run cooling stages for 10 minutes each 24 hours</td>
<td>yes</td>
</tr>
<tr>
<td>FAN ALTERNATE</td>
<td>Down sets to “0” [off]</td>
<td>Automatically alternates cooling stages every 168 hours. (Weekly)</td>
<td>no</td>
</tr>
<tr>
<td>LOOKBACK PERIOD</td>
<td>Value entry</td>
<td>Number of previous hours used to make setback decision Range: 0 to 120 hours</td>
<td>no</td>
</tr>
<tr>
<td>LOOKBACK TEMP</td>
<td>Value entry</td>
<td>Ambient temp above which is counted toward setback decision Range: -40 to 180 °C</td>
<td>no</td>
</tr>
<tr>
<td>LOOKBACK HOURS</td>
<td>Value entry</td>
<td>Number of hours that the ambient temperature must be above the lookback temperature to trigger the setback Range: 1 to 120 hours</td>
<td>no</td>
</tr>
<tr>
<td>LOOKBACK SETBACK</td>
<td>Value entry</td>
<td>Number of degrees C that both stages of cooling start will be reduced Range: 0 to 180 °C</td>
<td>no</td>
</tr>
</tbody>
</table>
### NEXT DISPLAY

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>COMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMBIENT TEMP</td>
<td>Display ambient temperature (RTD #2)</td>
</tr>
<tr>
<td>STAGE #1 %  STAGE #2 %</td>
<td>Display cooling current percentage value</td>
</tr>
<tr>
<td>PHASE A %  -  B %  -  C %</td>
<td>Display primary current (percentage of full scale)</td>
</tr>
</tbody>
</table>

### CALIBRATION DISPLAY

(Select Next and previous together)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>COMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANALOG #1 =</td>
<td>Used to set analog output to match jumper settings and Calibrate analog output #1</td>
</tr>
<tr>
<td>ANALOG #2 =</td>
<td>Used to set analog output to match jumper settings and Calibrate analog output #2</td>
</tr>
<tr>
<td>STAGE #1 AMPS &lt;value&gt;</td>
<td>Used to set full scale cooling current value for Stage #1</td>
</tr>
<tr>
<td>STAGE #2 AMPS &lt;value&gt;</td>
<td>Used to set full scale cooling current value for Stage #2</td>
</tr>
<tr>
<td>PHASE A AMPS &lt;value&gt;</td>
<td>Used to calibrate primary current value for A phase</td>
</tr>
<tr>
<td>PHASE B AMPS &lt;value&gt;</td>
<td>Used to calibrate primary current value for B phase</td>
</tr>
<tr>
<td>PHASE C AMPS &lt;value&gt;</td>
<td>Used to calibrate primary current value for C phase</td>
</tr>
</tbody>
</table>

### TTM-AC/DC-AC/DC – IBM (PC) INTERFACE CABLE REQUIREMENTS

<table>
<thead>
<tr>
<th>SIGNAL</th>
<th>TTM-AC/DC-AC/DC</th>
<th>9 PIN SERIAL CABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS232</td>
<td>DATA FROM PC</td>
<td>PIN 3</td>
</tr>
<tr>
<td></td>
<td>DATA TO PC</td>
<td>PIN 4</td>
</tr>
<tr>
<td></td>
<td>GROUND</td>
<td>PIN 2</td>
</tr>
<tr>
<td>RS-485</td>
<td>DATA +</td>
<td>PIN 5</td>
</tr>
<tr>
<td></td>
<td>DATA -</td>
<td>PIN 6</td>
</tr>
<tr>
<td></td>
<td>5VDC (Modem supply power)</td>
<td>Pin 1</td>
</tr>
</tbody>
</table>

**RS232 TERMINAL SETTINGS:** Emulation – ANSI, Data Bits – 8, Parity – None, Stop Bits – 1, Flow Control – None, Keyboard Caps – On. (Remove JMP1)

HyperTerminal can be used. (supplied with Windows 98)

### ANALOG SCALING VALUES

<table>
<thead>
<tr>
<th>Temperature 0°C</th>
<th>0 to 1 mA</th>
<th>4 to 20 mA</th>
<th>0 to 5 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope per °C</td>
<td>0.004 mA</td>
<td>0.050 mA</td>
<td>0.020 VDC</td>
</tr>
<tr>
<td>Minimum Scale</td>
<td>0 mA = -50°C</td>
<td>4 mA = -120°C</td>
<td>0 VDC = -50°C</td>
</tr>
<tr>
<td>Maximum Scale</td>
<td>1 mA = +200°C</td>
<td>20 mA = +200°C</td>
<td>5 VDC = +200°C</td>
</tr>
</tbody>
</table>
TTM FUNCTIONAL EXAMPLE
For Transformer Monitor and Cooling

The solid state TTM unit monitors oil temperature, calculates winding temperature for a single phase or three phase transformer contained in one oil filled unit, and is ready to provide input for existing SCADA system.

Design to meet IEEE/ANSI C37.90 specifications for protective relaying.

 specifying either 115VAC or 230 VAC, 50 or 60 Hz.
Configuration Jumpers:  (* = default)

 JP3           Top Oil Analog Output         Jumper on 1&2 – Enables Voltage
            Jumper on 2 & 3 - Enables Current *

 JP2           Winding Analog Output:       Jumper on 1 & 2 - Enables Voltage
            Jumper on 2 & 3 - Enables Current *

 JP6           Top Oil Analog Output       Jumper on - 4 to 20 ma
            Jumper off - 0 to 1 ma *

 JP5           Winding Analog Output       Jumper on - 4 to 20 ma
            Jumper off - 0 to 1 ma *

 JMP1          RS485 Termination.          Jumper on – RS485/Enables 120 Ohm termination *
            (Remove for RS232)
COMMUNICATIONS STRING FORMAT
Syntax:

[ ] Optional items
<..> Value field
? Value query
* Preceding item may be repeated
<cr> Carriage return
<lf> Line feed
<chksum> Checksum, sent only if received with command.

Sum of all ASCII characters up to and including =

COMMANDS

[<adr>:] <nem> (?|<value>) [,<nem> (?|<value>)]* [=<chksum>] (<cr>|<lf>)

Optional

Mnemonics may be repeated

Query (?) or value

Communications address – see table below

Ending checksum

RESPONSES

[<adr>:] <nem> <value> [,<nem> <value>] [* [=<chksum>] <cr>|<lf>]

Optional

Mnemonics may be repeated

Value

Mnemonic command – see table below

Communication Address – multipoint only

ENDING

COMMUNICATIONS ADDRESS

TERMINAL COMMUNICATION COMMANDS

TTM-AC/DC

Output: [<adr>:] TOT, CWT, POT, PWT [=<chksum>] <cr>|<lf>

TOT is Top Oil Temp
CWT is Calculated Winding Temp
POT is Peak Oil Temp
PWT is Peak Winding Temp

OTA ?<value> 0.0 to +3000.0 minutes per transmission (Top Oil Temp Alarm)
WTA ?<value> 0.0 to +180.0 °C (Winding Temp Alarm)
S1O ?<value> 0.0 to +180.0 °C (Stage 1 [Oil Cooling Control])
S1W ?<value> 0.0 to +180.0 °C (Stage 1 [Winding Cooling Control])
S1C ?<value> 0.0 to 100.0 % Full Scale (Stage 1 cooling current minimum value in %)
S2O ?<value> 0.0 to +180.0 °C (Stage 2 [Oil Cooling Control])
S2W ?<value> 0.0 to +180.0 °C (Stage 2 [Winding Cooling Control])
S2C ?<value> 0.0 to 100.0 % Full Scale (Stage 2 cooling current minimum value in %)
FST ?<value> 0.0 to 9999.9 Seconds (Alarm Delay Time)
FST ?<value> 0.0 to +180.0 °C (Full Scale Temperature)
FCC ?<value> 0 OR 1 (Fan Cycle – off/on)
LBP ?<value> 0.0 to 120 Hours (Lookback Period)
LBH ?<value> 1 to 120 Hours (Lookback Hours)
LBT ?<value> 0 to +180.0 °C (Lookback Temperature)
LBS ?<value> 0 to +180.0 °C (Lookback Setback Temperature)
FRONT PANEL LED INDICATORS AND ALARMS

EACH LED INDICATOR WILL LIGHT CONTINUOUSLY WHILE AN ALARM CONDITION IS PRESENT. EACH LED WILL BLINK IF THE ALARM CONDITION IS NO LONGER VALID. BLINKING WILL CONTINUE UNTIL THE TTM-AC/DC-AC/DC HAS BEEN RESET BY PUSHBUTTONS. This feature is useful to identify the cause of short term alarm conditions.

EXPLANATION OF HYSTERESIS

The HYSTERESIS setting is a deadband adjustment for toggling an event or alarm. It is there to increase stability and prevent fast on-off operations of alarms and events.

Example 1: (HYSTERESIS = 2.0 deg C and Alarm is set for 60 Deg C.)
Alarm is activated at 60 Deg. C (After ALARM TIME DELAY)
Alarm will not reset until temperature is reduced to 58 Deg. C.

Example 2: (HYSTERESIS = 2.0 deg C and cooling stage #1 is set to start at 50 Deg C.)
Cooling starts at 50 Deg. Cooling stage #1 runs until temperature is reduced to 48 Deg. C.
(This will prevent repeated application of starting current to the cooling motors)

Lookback setback example: Given lookback period setting= 96 hours; Lookback temperature setting=+33 C ("+" sign not entered on TTM-AC/DC-AC/DC); Lookback hours setting= 8 hours; and Lookback setback= 10 C. In a rolling window of 96 hours from any present hour, when there have been 8 cumulative hours during which the ambient temperature exceeded 33 C (91.4 F), the cooling devices start point will be biased to initiate 10 degrees C less than the TTM-AC/DC-AC/DC display cooling mode entered set point.
II. TTM-AC/DC-AC/DC INSTALLATION GUIDE

MODEL TTM SYSTEM 3  SERIAL NO CD-1001

- TOP OIL TEMP ALARM
- WINDING TEMP ALARM
- COOLING ALARM
All relay contacts are normally closed until power is applied to the TTM-AC/DC. This will provide a “fail safe” mode of operation. Before installation, always safety check your work area, review your plans, and apply caution to preclude accidents, errors, or undesired outcomes.

FIELD MOUNTING & INSTALLATION
1. Mount the TTM using four machine screws.
2. Punch and mount a 3/4” conduit elbow from the underside of the TTM to the interior of the control cabinet. Provide rated power to the TTM.
3. Install the temperature probe. The temperature probe supplied is ¼” X 6” (spring loaded). For field orders an adapter sleeve for ¼” to ½” is also supplied. Additionally an adapter is supplied for ½” NPT to 7/8” X 14 thread thermowells. Coil up the extra probe cable and tie wrap, or shorten to desired length.
4. Factory orders include a ½"NPT Brass Thermowell and no adapters are included.
5. Set the analog out put jumpers on the back of the circuit board for the desired analog output modes. (see page #5) 0-1 ma is the factory default
6. Configure the TTM (Using the Configuration Menu) for the same analog scaling values selected above.
7. Connect the top oil / winding alarm contact point to an existing annunciation system. The contacts are “dry” and are compatible with existing annunciators.
8. Snap the A, B, & C phase snap on current transducers around the high or low side bushing CT secondaries. (Shorting blocks should be available in the control cabinet for easy accessibility) Wire them to the CURRENT SENSE input terminals. (12-17)
9. Snap the stage one and stage two snap on current transducers around the power source to each stage of cooling. (Usually available and located at the cooling stage contactor.) Wire them to the cooling CT input terminals. (18-21)

CALIBRATING MAIN TANK AND AMBIENT TEMP ANALOG OUTPUT VALUES

Pressing "NEXT" AND "PREVIOUS" at the same time enters the calibration mode.
1. Determine which analog output is desired and configure the jumpers on the rear of the circuit board.
   Note: Remove the 120 ohm termination jumper (JMP1) for RS232 applications. The following is a description of the 0 – 1 mA calibration procedure.
2. Enter the configuration mode by pressing menu and holding for 3 seconds.
3. Configure the analog outputs to match the output jumpers selected in step 1.
4. Press “MENU” (or wait for 30 seconds) to return to the default four temperature display.
5. Enter calibration procedure by pressing “NEXT” AND “PREV” AT THE SAME TIME.
6. Display will read ANALOG #1.
7. With a very accurate DC ammeter, read current across analog output #1.
8. Current should read 1.000 DC ma.
9. Using the up and down arrows, adjust the output voltage to read 1.000 DC mA.
10. Pressing “NEXT” will display ANALOG OUTPUT #2.
11. Repeat steps 7 and 8 for analog #2.
12. Press the “MENU” key (or wait for 30 seconds) to return to normal operation.

CALIBRATING STAGE 1 AND STAGE 2 100% CURRENT VALUES

Pressing “NEXT” AND “PREVIOUS” at the same time enters the calibration mode.

1. After entering the calibration mode, press next until the Stage#1 display appears.
2. While stage #1 cooling is running, adjust the percentage to 100%. Use up or down arrow to nudge the percentage values. Note: Pressing both the up and down arrows simultaneously will automatically set the 100% value. The current transformer normally supplied is rated for 15 amps AC cooling current. (Other ranges are available)
3. Press next until the Stage#2 display appears.
4. While stage #2 cooling is running, adjust the percentage to 100%. Use up or down arrow to nudge the percentage values. Note: Pressing both the up and down arrows simultaneously will automatically set the 100% value. The current transformer normally supplied is rated for 15 amps AC cooling current. (Other ranges are available)

CALIBRATING A B & C PHASE 100% CURRENT VALUES

THE TTM-AC/DC-AC/DC IS SET AT THE FACTORY FOR 5 AMPS SECONDARY EQUALS 100% PRIMARY CURRENT.
Pressing “NEXT” AND “PREVIOUS” at the same time enters the calibration mode.
(METHOD #1)

1. After entering the calibration mode, press next until the PHASE A display appears.
2. While applying 5 amps (or full scale secondary CT rated current) through the A PHASE snap on current transformer, adjust the percentage to 100%. Use up or down arrow to nudge the percentage values. Note: Pressing both the up and down arrows simultaneously will automatically set (“LEARN”) the 100% value.
3. Press next until the PHASE B display appears.
4. While applying 5 amps (or full scale secondary CT current) through the B PHASE snap on current transformer, adjust the percentage to 100%. Use up or down arrow to nudge the percentage values. Note: Pressing both the up and down arrows simultaneously will automatically set the 100% value.
5. Press next until the PHASE C display appears.
1. While applying 5 amps (or full scale secondary CT current) through the C PHASE snap on current transformer, adjust the percentage to 100%. Use up or down arrow to nudge the percentage values. Note: Pressing both the up and down arrows simultaneously will automatically set the 100% value.
(METHOD #2) This calibration method is useful for installation on in service transformers

1. Determine the current percentage of full load current.
2. After entering the calibration mode, (NEXT AND PREVIOUS) press next until the PHASE A display appears.
3. Adjust the calibration percentage (USING THE UP AND DOWN ARROWS) to match the actual percentage.
4. Press NEXT to display PHASE B.
5. Repeat step 3.
6. Press NEXT to display PHASE C.
7. Repeat step 3.

The display “Full Scale Rise” refers to the winding temperature increase above Top Oil temperature furnished by the manufacturer. The TTM-AC/DC-AC/DC calculates the winding temperature as a direct degree (C) increase over top oil temperature based upon this data. Using the configuration menu enter the full scale winding temperature increase over the oil temperature provided by the transformer manufacturer’s heat run data. This data refers to the C temperature difference between the transformer main tank oil temperature and the winding temperature at full rated load. The referenced value is not nameplate ambient temperature rise. The winding temperature is calculated based upon the highest of the three current values. If the manufacturer’s value has been de-rated or modified by your authorized in-house actions, use the value specified by your authorized alternative sources.

For installation on single phase transformers connect only one of the snap on CTs.

Barrington consultants would appreciate any feedback about the TTM-AC/DC-AC/DC. We want to provide top quality products to satisfied customers. We will be happy to answer any questions you might have about installation or operation of our products.

It is the user’s responsibility to determine proper set points, adequately engineer, test, install, and ensure desired operating status.

Barrington Consultants Inc. assumes no responsibility for installation or user operation of the TTM-AC/DC-AC/DC.
### TTM-AC/DC Specifications

#### RTD

-100°C to 600°C (DIN 43760 Class B) .00385 ohms/ohm/°C

#### STABILITY

Maximum change in ice point resistance of less than 0.2°C/Year

#### REPEATABILITY

0.05% of actual span

#### Input

**Dual Pt 100 RTD** (One Top Oil Temp & One Ambient Temp)

**TOP OIL INPUT PROBE TYPE**

(1ea) 6” X ¼” probe W ½” NPT Thread (7/8” X 14 thread adapter supplied) or (1ea) 75LB Pull Surface Magnetic

**INPUT PROBE CABLE**

24’ type UV/SJT

**INPUT SPAN**

-40°C to 200°C Max

**ANALOG OUTPUT**

0 - 5V, 0-1mA or 4-20mA (Independently selectable)

**CALIBRATION**

Automatic -40°C to 200°C

**LINEARITY**

Better than 0.2% of span

**LEAD WIRE COMP.**

Automatic – 3 wire

**TEMPERATURE STABILITY**

Better than .03% /°C of span

**Surge Withstand**

Designed to meet ANSI/IEEE C37.90

**C.M.R.R.**

120db DC to 60 Hz

**POWER SUPPLY RANGE**

120 or 240 VAC 50/60hz -or- 110 to 270VDC (auto-sensing)

**OPERATING TEMP.**

-20°C (-40 optional heater) to +75°C

**ENCLOSURE**

NEMA 4 10” X 8” X 6”

**DIGITAL RESOLUTION:**

>12 bits.

**OVERALL ACCURACY**

Less than 0.3°C input temperature / display

**ALARM:**

Dry contact spst relay output rated @ 5A 250 VAC.

**ALARM RESPONSE TIME:**

Programmable - .1 sec to 999.9 sec.

**ALARM HYSTERESIS**

0.1 TO 100 DEG C (DEAD BAND)

**DISPLAY:**

16 × 2 Character .39” LCD indicator for programming and display of input and output parameters and status.

**SUPPLY:**

AC: 115 or 230 VAC 50/60 Hz ± 10%.

**OPERATING CONDITIONS:**

-40°C to +75°C. 0-95% RH, non condensing.

**STORAGE TEMP.:**

-55°C to 105°C.

**HUMIDITY:**

0-95% RH, non condensing.

**TURN-ON TIME:**

Within 10 seconds to rated response.

**RESPONSE TIME:**

5 seconds to 99% of reading. (1 update/second).

**DAMPING FACTOR:**

3.0 Seconds.

**TTM-AC/DC-AC/DC LONG TERM STABILITY:**

Less than ±0.1% of span for six months.

**(D/A) LINEARITY:**

±0.05% of span.

**LINEARIZATION:**

better than ±0.03°C for Pt-100 RTD.

**CALIBRATION:**

adjustable on-site, factory preadjusted
TTM-AC/DC, Transformer Temperature Monitor, Complete with Standard 6” ½”NPT thread replacement RTD well probe, 24ft SJT UV treated connector cables, 5 Snap-On current transformers, SCADA ready outputs for Top Oil, Calculated Winding Temperatures, Two adjustable dry contacts for temperature and cooling alarms, Ambient compensation, 2 stage cooling control, Four display readout with Top oil, Calculated Winding, Peak Top oil, and Peak Winding temperatures, RS232/485/485 multipoint communications. NEMA type 4x windowed enclosure. **Delivery - Stock to 6 weeks ARO**

The TTM-AC/DC may be special ordered with the following options:

1. Special sensor probe lengths and threads.
2. Top Oil and/or Winding Temperature TRIP capability
3. Various Cooling CT ratios. 5, 15, 30, 60, 100 Amp
5. ¼” x 6” ½”NPT Brass Thermowell
6. 7/8 x 14 thread adapter for 7/8 x 14 thermowell

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