WESCHLER INSTRUMENTS

DIVISION OF HUGHES CORP.

Transformer Advantage II Enhanced Series

Owners Manual

Manual Part Number OMAMT200

Revision 5, January 5, 2009

Use with Firmware AMTSYS0201, Revision 00 and Higher

(See Page 3 “Displaying Firmware Part Number”)

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1.0 Introduction

Description

Advantage transformer monitors are compact, fully electronic, programmable instruments designed for accurate and reliable thermal management of liquid immersed power and distribution transformers. This manual describes the Enhanced SC, DC, TC, LTC, CT, CTX and CT/LTC models, collectively referred to as the Advantage IIE series. The standard Advantage IIE platform offers expanded alarm techniques, easier set-up, many user-convenience additions and provides the basis for expansion into advanced data collection and communications. All models use the same firmware and optional configuration & monitoring software, for a reduced software management burden. The computing engine is based on the Motorola ColdFire microprocessor, a high performance 32 bit product.

Standard thermal inputs for all models are platinum RTD's, which measure various temperatures in and around the transformer. Thermowell type probes are used to measure top oil when inserted into an unheated thermowell, or simulated winding temperature when inserted into a thermowell which is heated by current from a winding temperature indicator (WTI) CT. The thermowell type probes also measure ambient temperature when mounted in free air with a supplied bracket. Magnetically attached probes are used to measure tank wall temperatures when thermowells are not available.

The SC (Single Channel), DC (Dual Channel) and TC (Triple Channel) are, as their model designations connote, intended to measure up to three thermal inputs. Depending upon where the probes are located, the DC and TC models can be used to measure several different combinations of thermal values. An example of a popular DC model application is measurement of top oil and simulated winding temperatures. An example of a popular TC model application is measurement of top oil, simulated winding and ambient temperatures.

The LTC model is designed for thermal monitoring of Load Tap Changers. It is equipped with two thermal channels which are used for main tank and LTC tank temperature measurement. Calculations of LTC conditions include a user-configurable filter which compensates for environmental and application-specific conditions which could effect measurement accuracy.

The CT, CTX and CT/LTC models add a standard single winding current input, for calculation of winding temperatures.

The CT model is a transformer Winding Temperature Indicator (WTI) that is classified as an indirect, calculating type. This classification of WTI measures the temperature of the insulating oil and the magnitude of the winding current and executes a sequence of complex, proprietary mathematical calculations to accurately determine the temperature of the windings. This sequence of mathematical operations is called a Winding Temperature Algorithm (WTA). The WTA uses several key user-configurable transformer parameters and concepts based on world recognized transformer standards. The winding current is measured proportionally through a CT, which is where the series name originated. It does not need a heated thermowell. All of the models which bear the CT designation can be equipped with the LCAM module, which enables monitoring of up to three winding temperatures. The LCAM module is also designed to provide cooling auxiliary health feedback to the winding temperature algorithm, which is vital to accurate indication in today's highly loaded transformer operations.

The CTX model is simply a CT model with an additional channel which can measure any thermal value in the range of -40 to 250 °C. The channel title can be set to several common choices.

The CT/LTC model, as its name implies, combines the functions of the CT model Winding Temperature Indicator and the LTC model Load Tap Changer thermal monitor, into a single unit. It monitors the temperature of the top oil, main tank, LTC tank and winding current. If thermowells are provided for the top oil and the LTC tank, the third RTD sensor can be assigned to measure bottom oil or ambient temperatures.

The enclosure and electrical components of the Advantage are designed to withstand the harshest operating environment. The enclosure is made from a heavy gauge aluminum extrusion; designed and manufactured specifically for the Advantage. The electronics have been designed to continue functioning under extreme EMI/RFI conditions, including close proximity walkie-talkie keying and near lightning strike. Their performance has been documented through testing to world recognized EMC standards.

All of the Advantage IIE series models are capable of being equipped with option modules to allow them to perform functions that compliment their primary mission. The present option module offerings are the **M**ulti-**C**hannel **A**nalog **R**etransmit (MCAR) module and the **L**oad and **C**ooling **A**pparatus **M**onitoring (LCAM) modules.

The MCAR module provides for up to 3 analog current loop outputs which are proportional to values measured or calculated by the Advantage.

The LCAM module allows Advantage to measure multiple winding currents and monitor auxiliary inputs which provide information on cooling equipment health, and pressure, flow and oil chemistry values.

Optional DNP-3 and ModBus digital communications protocols assure compatibility with other DNP-3 and ModBus compliant devices.

Upgrading or servicing the Advantage hardware platform is a simple matter of unplugging and plugging modules which slide into slots from the front of surface-mounted units, or from the rear of panel mounted units.

Upgrading the firmware is performed through digital communications, either on site or remotely. While configuration can be done through the front panel controls, digital communications provides the same level of access and ease of configuration on-site, or around the world.

Major Features

- ★ High accuracy 22 bit, 8 channel A/D conversion. Resolvable Accuracy ± 0.1 Degrees or 1 Amp.
- ★ Winding Temperature Algorithm based on IEEE and IEC transformer concepts.
- ★ Optional DNP-3 slave level 1 and ModBus RTU / ASCII communications protocols.
- ★ Firmware is upgraded by simple upload of an electronic file through digital communications.
- ★ Time stamped peak and valley values. History is downloaded via digital communications.
- ★ Real time clock power back-up five days standard, Thirty days optional.
- ★ 3 Button front panel programming. No covers to open.
- ★ Walk-up selectable display of ten operating measurements and alarm annunciators.
- ★ Alpha-numeric displays for prompts/units and values make indications clear and non-confusing.
- ★ User-entered transformer parameters for on-site custom tailoring of thermal profiles.
- ★ Standard cooling control module with 5 form B and 1 form C high capacity set point relays.
- ★ Optional cooling control module with 4 form C high capacity relays for assignment flexibility.
- ★ Two cooling control modules can be combined to provide 5 form B and 5 form C, or 8 form C relays.
- ★ 1 Optional high capacity auxiliary set point relay for logic or alarm functions.
- ★ Relays may be driven by any of up to 17 alarm sources and remote digital commands.
- ★ Each relay may be operated by multiple alarm sources.
- ★ Relay set up options include user-programmable response to sensor failure.
- ★ Alarms have software configurable relay pick-up and drop-out delay periods.
- ★ Hourly and calendar alarm sources allow for relay operation in response to time events.
- ★ Up to three analog retransmit channels to remotely indicate any 3 of 11 selectable values.
- ★ Rugged extruded, hardcoated aluminum, NEMA 4X+ enclosure.
- ★ Compact Size; 6.75 W x 10.50 H x 7.65 D. Mounting Plate 8 ¼ W x 13 ⅜ H.
- ★ Power source options to suit all normal substation requirements (see Tables 1A and 1B).

Features Provided by the Optional MCAR Module

- ★ Two or three outputs
- ★ Current outputs are independent of load resistance.
- ★ Available with Channel to Channel Isolation
- ★ Both Measurement and Output Ranges are User Configurable.

Features Provided by the Optional LCAM Module

- ★ In SC, DC, TC and LTC models, monitoring of up to 8 analog or digital values with ranges from 5v to 300v AC or DC, and two low current ranges 0-1 and 0-20 madc. High AC current inputs are handled through air-core (Rogowski coil) CT's. Can be used to report cooling auxiliary state (on / off) and health, contact closures from pressure and flow switches and outputs from various transducers such as oil chemistry.
- ★ Each auxiliary input can be configured independently of the others.
- ★ Optional 3000 volt optically isolated inputs.
- ★ In CT series models, independent monitoring of up to three winding currents, using direct connection for up to 10 amps and clamp-on air-core CT's for higher currents. Provides 8 new displayable values, which can also be used as alarm sources; 4 current magnitudes (current 1, current 2, current 3, highest current) and 4 winding temperature magnitudes (winding 1, winding 2, winding 3 and highest winding temperature).
- ★ In CT series models, monitoring of up to 5 or 7auxiliary analog or digital values, with the same ranges and flexibility as described above.
- ★ Associative alarms can be used to monitor the result of a control action and operate another alarm independently if the control action failed. Can be used to construct redundant alarms for increased reliability.

Using This Manual

This manual covers multiple models, not all of which contain all features described herein. For example, the CT model does not have any LTC features and the SC, DC, TC and LTC models have no calculated winding temperature features. The CTX can be thought of as a CT model with an extra thermal channel input. Although not present in all locations within the manual, the graphics below will indicate a model specific feature where possible:

① SC Model Only, ② DC Model Only, ③ TC Model Only, ④ CT Series only, ⑤ CTX Only, ⑥ LTC & CT/LTC Only
⑦ LCAM Equipped Only, ⑧ Multi-Channel Analog Retransmit Module Equipped Only

Intended Usage

The Transformer Advantage IIE family of thermal monitors are intended to be used on liquid immersed power and distribution transformers of 10 KVA to 999.99 MVA capacity where a high degree of accuracy, faithfulness to thermal response profile and reliability is required.

Displaying Firmware Part Number

The Advantage Enhanced (Advantage IIE) series uses the same firmware, regardless of model type, because the model type definition is simply a configuration command that is sent to the unit via digital communications, at the factory. Thus, the firmware part number does not need to include a model type code. The firmware part number "AMTSYS02YY" simply includes coding to identify the series (AMT = Advantage IIE), that it is operating system software ("SYS"), that the version is 02 (" 02") and what the revision is ("YY"). Thus AMTSYS0200 is the revision 00 (initial) release of version 02 firmware for the Advantage IIE series. This manual is intended to be used with revision 00 and higher revisions of version 02 firmware.

The firmware version and model type can be shown on the front panel display in the walk-up (normal operation) mode by pressing the "E" (enter) key repeatedly until the version is displayed. The firmware code is of the form AMTGXT02YY where "AMT" identifies the unit as an Advantage IIE, the "X" in "GXT" is the model code, "02" is the firmware version and "YY" is the firmware revision. The model code is included in the front panel display for the convenience of the user in identifying the model (s)he has.

If the "GXT" in the front panel display is replaced with "SYS" the result is the firmware part number.

The model number codes are as follows; 3 = Single Channel (SC), 4 = CT, 5 = CTX, 6 = LTC, 7 = DC (Dual Channel), 8 = CT/LTC and 9 = TC (Triple Channel)

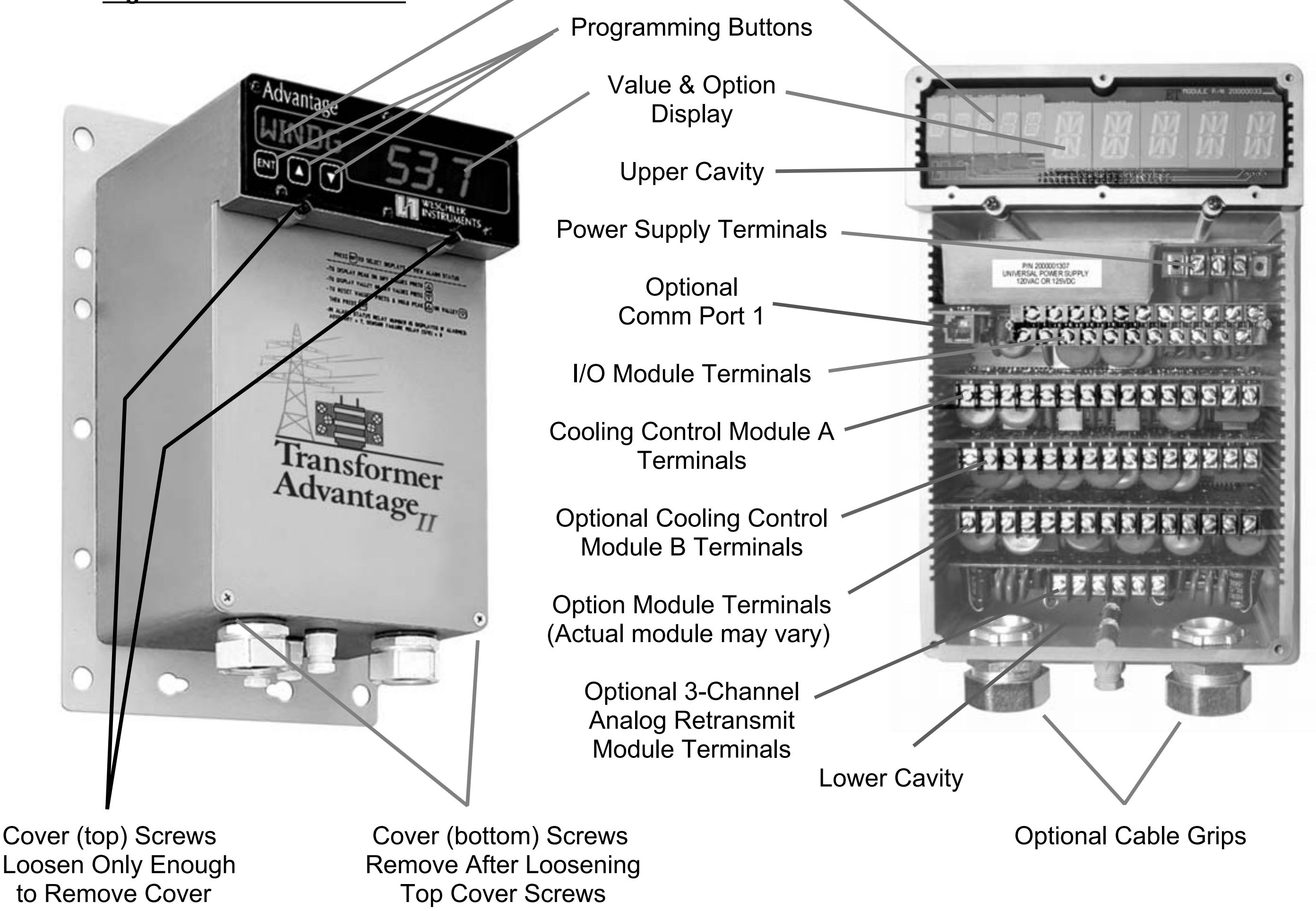
Feature and Module Locations

The feature locations are illustrated in Figure 1 below and Figure 2 on page 5. Detail dimensions are contained in the specifications section and Figures 22 and 25.

Note that access to the modules is from the front for surface mount and from the rear for through-panel mount. For each of the two mounting configurations the modules are positioned in the same order, and slot position.

Figure 1A. Surface Mount

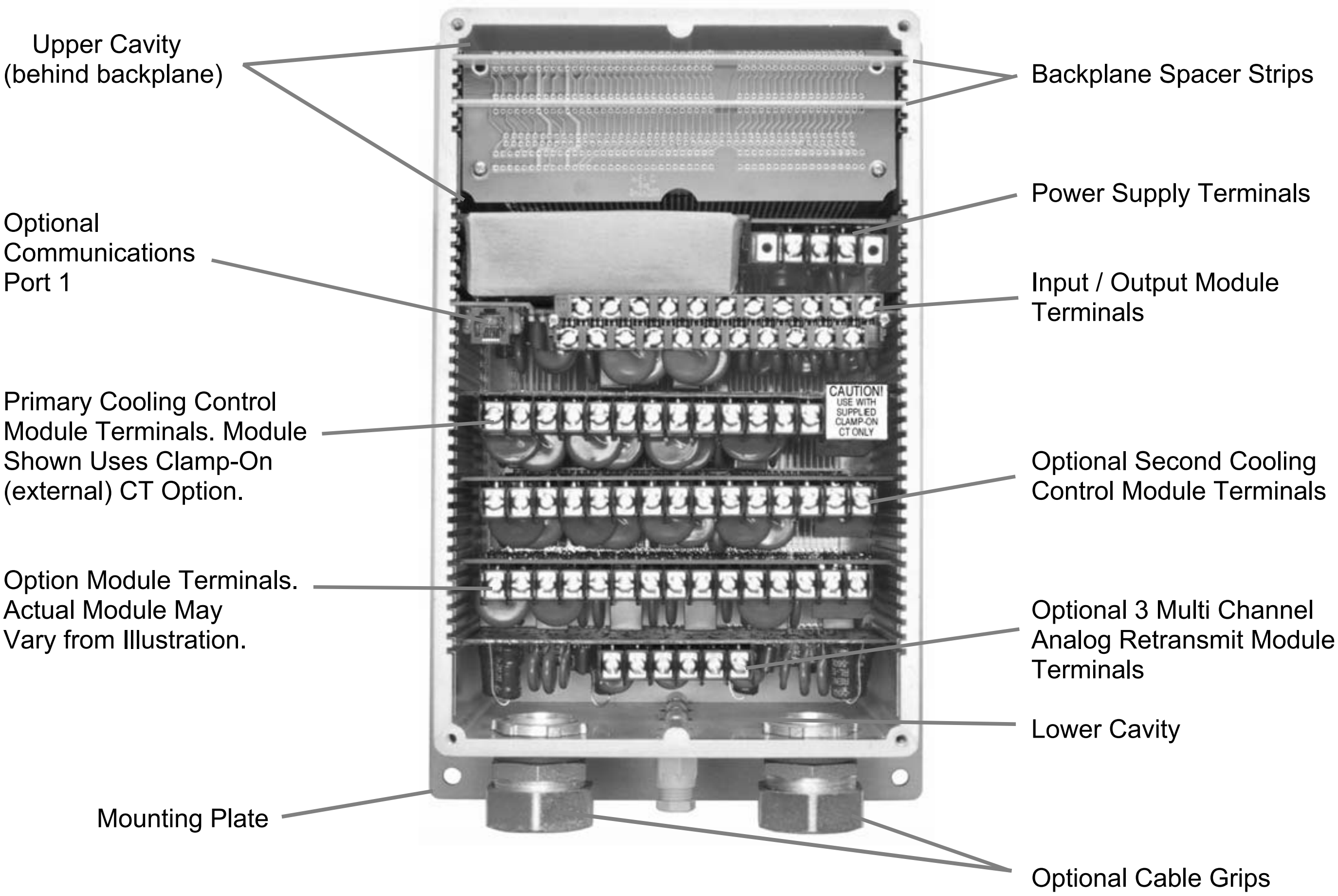
Figure 1B Surface Mount with Cover and Window Removed.



The figures and text of this manual describe or illustrate all optional equipment and features which are available in the Advantage LTC and CT-series models. Since each Advantage is built-to-order from many catalog options, the optional equipment and features will only be present if they are ordered so-equipped or upgraded later in the factory or the field.

The positions of the modules in the upper cavity, illustrated in figures 1 and 2 must not be changed. The positions of modules in the lower cavity show the default locations, as they would be shipped from the factory, for most configurations. The locations were selected based primarily on convenience of wiring for installers. The actual position of the modules is optional and they may be moved to other slots as required.

Figure 2. Rear View of Through-Panel Mount with Cover Removed



2.0 Receipt Inspection

Packaging Inspection

The packaging in which your Advantage is shipped is designed to protect its contents against normal shipping shock and vibration. If the external carton is damaged in any way, report any damage to the carrier as soon as possible and immediately unpack the carton for internal inspection.

Unpacking

The Advantage is packaged with this manual, hardware and spares kit, 2 or 3 RTD cable grips (depending on number of probes ordered), and any RTD probes which were ordered with the instrument. Other accessories such as external (clamp-on) current probes, calibration tools, additional cable grips, or other items which may have been ordered at the same time will be included only if the packaging integrity is not compromised. Please remove all packing materials and check them for included accessories before discarding them.

Physically inspect the Advantage and its accessories for signs of hidden shipping damage. Evidence of excessive roughness in shipping include bent mounting plates and distorted display windows. Remove the front cover (surface mount models) or the rear cover (through-panel mount models) and check for dislodged modules or other parts adrift inside the case.

3.0 Installation

Internal Inspection

Prior to operation, remove the cover plate and inspect the module cavity for accessories and shipping blocking items. In some cases spare parts bags may be placed in the bottom cavity for installation convenience. These bags contain terminal screws, jumpers and other items which may be misplaced during the installation process. Remove any panels which have the word “DISCARD” printed on them. Check to see that the modules were not twisted or dislodged from their slots by violent shipping shock by comparing the slot they are in with the slot marking on the front edge of the case. If a module has been dislodged, correct the misalignment by pulling it straight out of the case, then reinserting in the correct slot. If this cannot be easily accomplished, contact the shipping carrier and the factory to report the damage and receive further instructions.

Surface Mounting

The Advantage may be mounted on studs welded to main or LTC tank side walls, structural channels or control cabinets or may be bolted to uni-strut type universal mounting channels. When mounted directly to main or LTC tank walls, spacers must be installed to provide a minimum ⅜ inch space between the mounting plate and the wall, for air circulation. Elastomeric vibration isolators, spacers or grommets can be used but are not necessary, unless vibration causes the modules to resonate within their slot mountings.

The location of the Advantage on the transformer should be determined by agreement with the transformer manufacturer, following recognized practice standards. It can be mounted in any compass direction; however, consideration should be made as to ability of service personnel to install, configure and read the displays comfortably. Although the displays have been selected for their excellent brightness, readability of the display in direct sunlight may be impaired. An accessory hood is available for conditions where sunlight’s effect becomes objectionable.

Refer to Figure 22 for mounting and overall dimensions and figures 23 and 24 for recommended and prohibited mounting methods. The minimum recommended mounting stud or screw diameter is ¼ inch (6.4 mm). The holes towards the center of the mounting plate are intended to be used with a uni-strut type channel in which the screw can be inserted through the mounting plate and channel and the nut can be tightened from the channel side. Flat and Lock washers must be used.

Through-Panel Mounting

Advantage through-panel mounting configuration is designed to be installed such that the case’s display area alone protrudes through an opening cut in a panel. The panel may be an exterior one, allowing the display to be exposed to the outdoors, or may be an interior one, mounting the unit totally inside of the control cabinet. The operating temperature of the Advantage must be considered if mounting inside of a control cabinet. If the temperature will exceed 70 °C the unit must be mounted in another location.

The location of the Advantage on the transformer should be determined by agreement with the transformer manufacturer, following recognized practice standards. It can be mounted in any compass direction; however, consideration should be made as to ability of service personnel to install, configure and read the displays comfortably. Although the displays have been selected for their excellent brightness, readability of the display in direct sunlight may be impaired. An accessory hood is available for conditions where sunlight’s effect becomes objectionable.

Refer to Figure 25 for mounting panel cut-out and drilling details. The recommended screw and thread size is ¼-20. The through-panel mount installation material includes a silicon-poron gasket for sealing the space between the front of the mounting plate and the mounting panel. The gasket must be installed for applications where the display projection is to be exposed, but it need not be installed if the unit is entirely enclosed in a cabinet. Flat and Lock washers must be used.

Terminal - by - Terminal Connection Guide

All signal, power and control connections are made at the terminal strips mounted at the edges of the installed modules. If your Advantage is not equipped with a particular feature, the terminal screws will be omitted and replaced with plastic hole plugs. The standard barrier strip terminations for all but the I/O module use #6-32 binding head screws suitable for retaining spade or eyelet lugs. The I/O module will also accommodate spade or eyelet lugs for #6 screws, however; the screws have METRIC 3.5-0.6 threads (color coded red) or 3.0-0.5mm threads (color coded blue-black). These screws must not be mixed with the screws from the other modules or thread damage will result. All of the barrier strip connections will accept a lug with a maximum width of 0.25 inches. The I/O module may optionally be fitted with phoenix-type terminals suitable for connection of stripped conductor. Stripped conductor connections are not recommended for the power supply, cooling control and current input modules. The connection assignments are printed on a sticker attached to the inside of the front (surface mount) or rear (through-panel mount) cover. This diagram is also printed in this manual, see Figures 10A through 10D on pages 27 - 30. When wiring the RTD common leads of the RTD's to the common terminal, it is advised that all sense(-) wires be crimped into a single terminal lug.

It is preferred that the power and communications (digital and analog retransmit) enter through the left hand cable grip and that relay and current sense cables enter through the right hand cable grip. This orientation will result in the least electrical noise transfer to the communications wiring. The signal input (RTD) cables enter through the small center cable grip holes.

Cable entry grips are not supplied standard, due to the wide variety of cable entry treatments used in the industry. Grips are available from the factory as an option. The installer can use any appropriately sized, liquid-tight grips provided they form a satisfactory seal to the case. The RTD grips are sized to fit the RTD cables of the probes which are shipped with the unit. In the case of user-supplied probes, the standard ¼ inch ID grip will be supplied unless another size is specifically ordered. It is important to have as tight a seal as possible to prevent the entry of dust and moisture. While it is recognized that a perfect seal is sometimes difficult, the service life of the Advantage will be reduced by inadequate attention to sealing.

The terminal numbering convention used in the connections section of this manual shall refer to the module-specific numbers shown on figures10A through 10D. For example, the terminals for Cooling Control Module A (CCA) are labeled CCA-1 to CCA-15.

Power Supply Module Connections

The Advantage is powered by one of the power sources listed in tables 1 and 2. The voltage level, including deviations due to battery charging and expected fluctuations, must not exceed the stated tolerances given in the specifications section. This requirement is based on EMI/RFI fence circuitry which clamps excessive voltages to prevent damage to sensitive electronic circuitry.

In order for the EMI/RFI protection circuitry to work properly, **an earth ground cable of 12-14 AWG must be installed** between power supply terminal 2 and the substation ground net. The cable must be as short as possible and may connect directly to the transformer tank or control cabinet if it is in turn sufficiently grounded. Simply mounting the Advantage to the transformer will not adequately ground the unit because the anti-corrosive treatment which is applied to the case is also an electrical insulator.

Connections to the power supply terminals should be made using 12-14 AWG wire with insulation appropriate to the power source voltage level. Insulated crimp-type eyelet terminals for #6 studs are recommended. Do not over-tighten the terminal screws. Refer to the terminal assignment label on the furnished power supply for appropriate connection polarities and voltage input ranges.

Table 1A tabulates the Wide Range power supply and its derivatives. The original 2000006301 WR supply was designed to allow the Advantage to operate from any of the standard power sources available to it. The 2000006303 WR supply was derived from the original WR supply to meet the need for a lower, low-range DC voltage level together with the standard higher DC and AC voltage levels. The 2000006302, 48vdc and 2000006303, 32 vdc were derived from the original WR supply where a lower-cost, low-range-only dc voltage level was required.

Table 1A. Wide Range Power Supply Fuse Ratings and Sizes

Power Supply Part Number	Voltage Nominal (Range)	Fuse Rating	Fuse Type	Fuse Component ID	Figure
2000006301	48 vdc (36-60 vdc) 90-264vac/100-300vdc	¾ amp slow-blow ½ amp slow-blow	2AG (4.5 x 15 mm) "	F2 F1	3B
2000006302	48 vdc (36-60 vdc)	¾ amp slow-blow	2AG (4.5 x 15 mm)	F2	3C
2000006303	32 vdc (24-40 vdc) 90-264vac/100-300vdc	¾ amp slow-blow ½ amp slow-blow	2AG (4.5 x 15 mm) "	F2 F1	3B
2000006304	32 vdc (24-40 vdc)	¾ amp slow-blow	2AG (4.5 x 15 mm)	F2	3D

Table 1B tabulates power supplies that were developed for the shallow-case First Gen, Advantage IIR and early Advantage IIE models. While still supported, these supplies do not provide the broad power source coverage, nor do they have the improved power margin and reliability that the WR power supply provides.

Table 1B. Standard Power Supply Fuse Ratings and Sizes

Power Supply Part Number	Voltage Nominal (Range)	Fuse Rating	Fuse Type	Fuse Component ID	Figure
2000001304	48vdc (36-60vdc, low power)	¾ amp Slow-Blow	2 AG (4.5 x 15mm)	F1	-
2000001307	120vac / 125vdc 240vac / 250vdc	½ amp Slow-Blow ¼ amp Slow-Blow	2 AG (4.5 x 15mm) 2 AG (4.5 x 15mm)	F1 F1	3A
2000001308	240vac / 250vdc	¼ amp Slow-Blow	2 AG (4.5 x 15mm)	F1	3A
2000001309 ①	48vdc (36-60vdc)	¾ amp Slow-Blow	2 AG (4.5 x 15mm)	F1	-
2000001310	48vdc (36-60vdc, high power)	¾ amp Slow-Blow	2 AG (4.5 x 15mm)	F1	-
2000001311 ①	125vdc ± 18%	¾ amp Slow-Blow	2 AG (4.5 x 15mm)	F1	-

① These supplies were provided in limited quantities as a transition to the WR power supply. Replaced by the WR power supply.

Table 2. Summary of Field Configurable Jumpers on Standard Advantage Modules

Model	Module	Figure Number	Jumper ID	Function	Position(s)
SC, CT	Input / Output	4A	J2	RTD1, 3 or 4 Wire	Installed / Removed
			J3	RTD2, 3 or 4 Wire	N/A, Hardware Not Installed
DC, CTX, LTC	Input / Output	4A	J2	RTD1, 3 or 4 Wire	Installed / Removed
			J3	RTD2, 3 or 4 Wire	Installed / Removed
TC, CT/LTC	Input / Output	4B	J2	RTD1, 3 or 4 Wire	Installed / Removed
			J3	RTD3, 3 or 4 Wire	Installed / Removed
			J4	RTD3, 3 or 4 Wire	Installed / Removed
All	4-Relay C^3	5	J4	Primary or Secondary	Pri / Sec

Table 3. Summary of Field Configurable Jumpers on Optional Advantage Modules (Figure 8).

Model	Module	Jumper ID	Function	Position(s)
All	LCAM	J2	Channel 1 Current / Contact Wetting	1ma, 20ma, Wetting, Off
		J6	Channel 2 Current / Contact Wetting	1ma, 20ma, Wetting, Off
		J10	Channel 3 Current / Contact Wetting	1ma, 20ma, Wetting, Off
		J14	Channel 4 Current / Contact Wetting	1ma, 20ma, Wetting, Off
		J18	Channel 5 Current / Contact Wetting	1ma, 20ma, Wetting, Off
		J22	Channel 6 Current / Contact Wetting	1ma, 20ma, Wetting, Off
		J26	Channel 7 Current / Contact Wetting	1ma, 20ma, Wetting, Off
		J30	Channel 8 Current / Contact Wetting	1ma, 20ma, Wetting, Off
		J5	Channel 1 Voltage Range Selection	5, 75, 150, 300
		J9	Channel 2 Voltage Range Selection	5, 75, 150, 300
		J13	Channel 3 Voltage Range Selection	5, 75, 150, 300
		J17	Channel 4 Voltage Range Selection	5, 75, 150, 300
		J21	Channel 5 Voltage Range Selection	5, 75, 150, 300
		J25	Channel 6 Voltage Range Selection	5, 75, 150, 300
		J29	Channel 7 Voltage Range Selection	5, 75, 150, 300
		J33	Channel 8 Voltage Range Selection	5, 75, 150, 300

Figure 3A. Power Supply Jumper & Fuse Location, Power Supplies 2000001307 & 2000001308

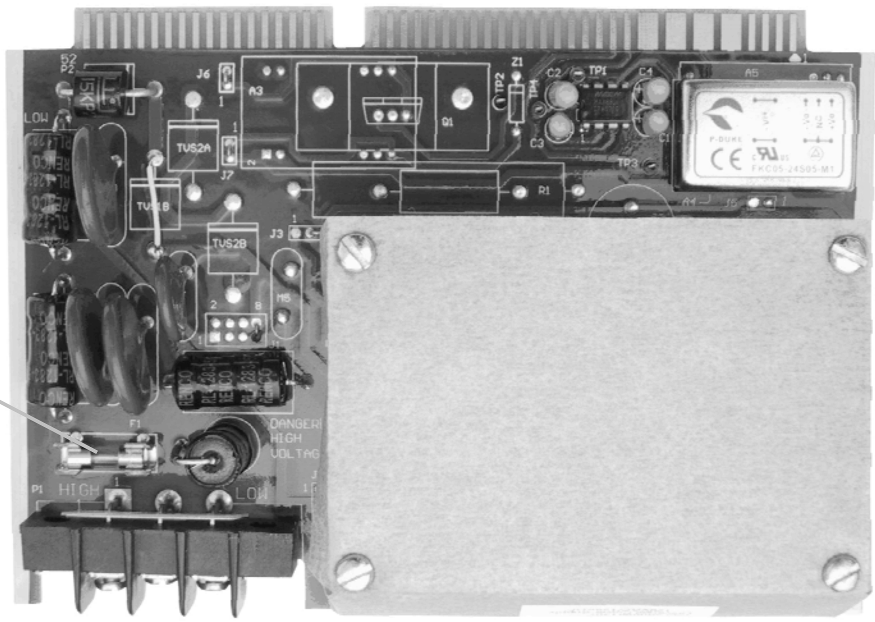


Figure 3B. Wide Range Power Supply 2000006301 & Derivative 2000006303 Top View

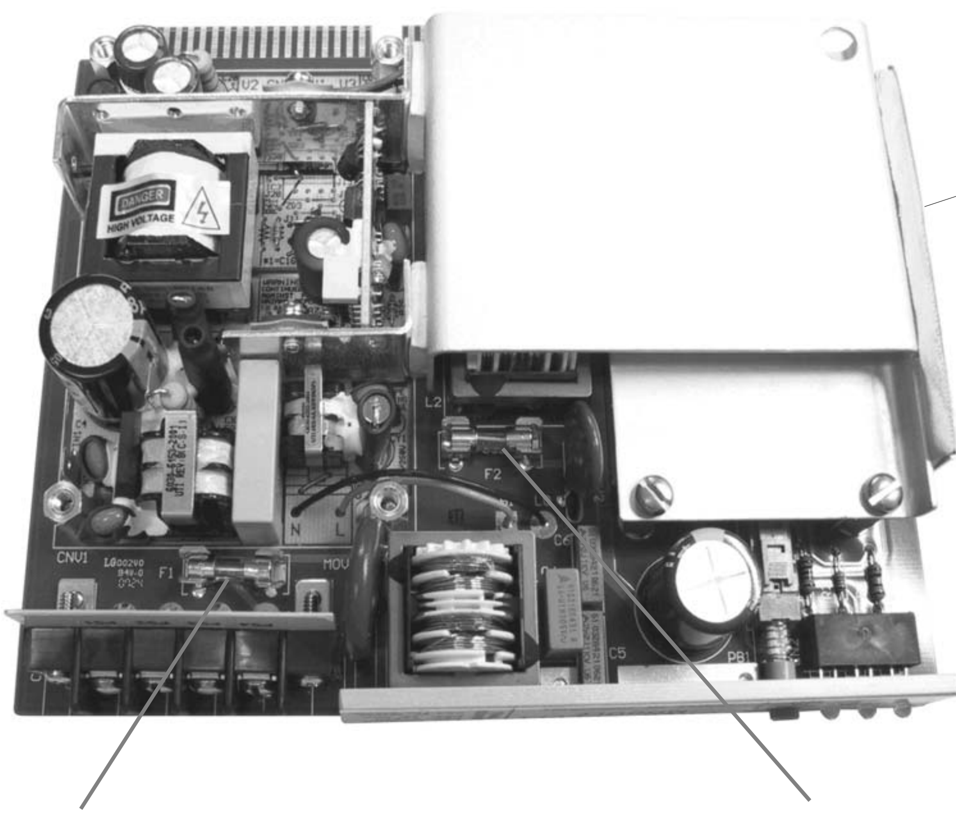


Figure 3C. 48 VDC Wide Range Power Supply Derivative 2000006302

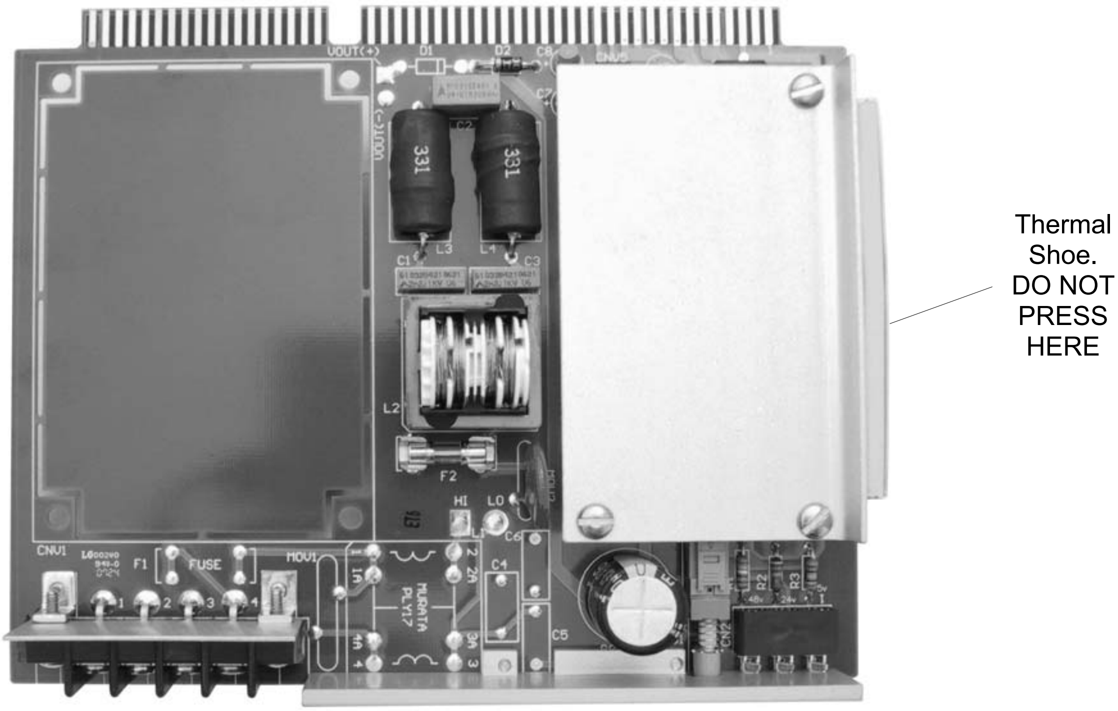


Figure 3D. 32 VDC Wide Range Power Supply Derivative 2000006304

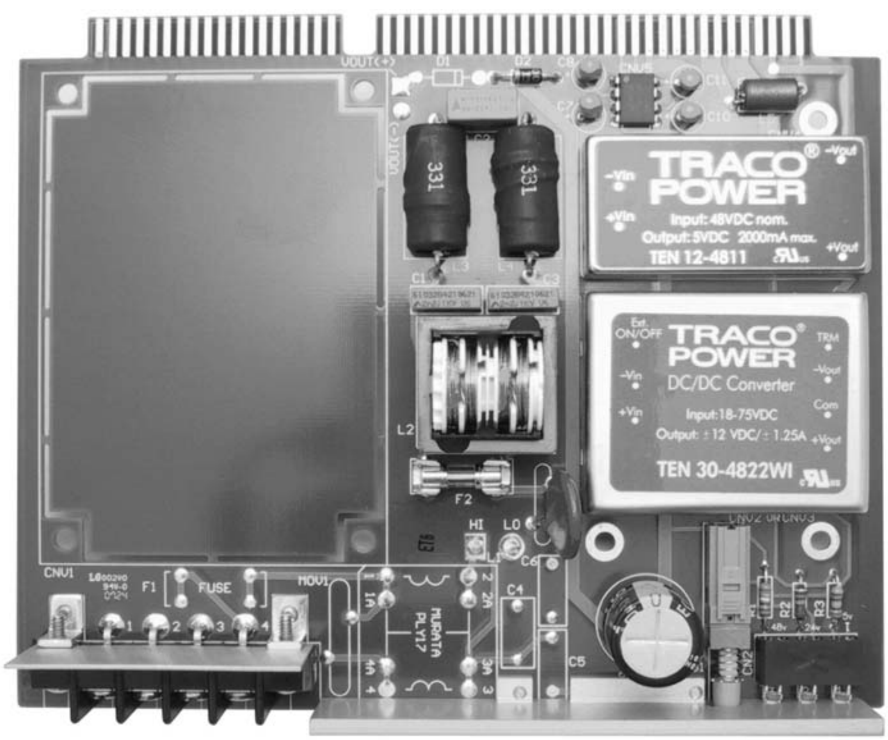
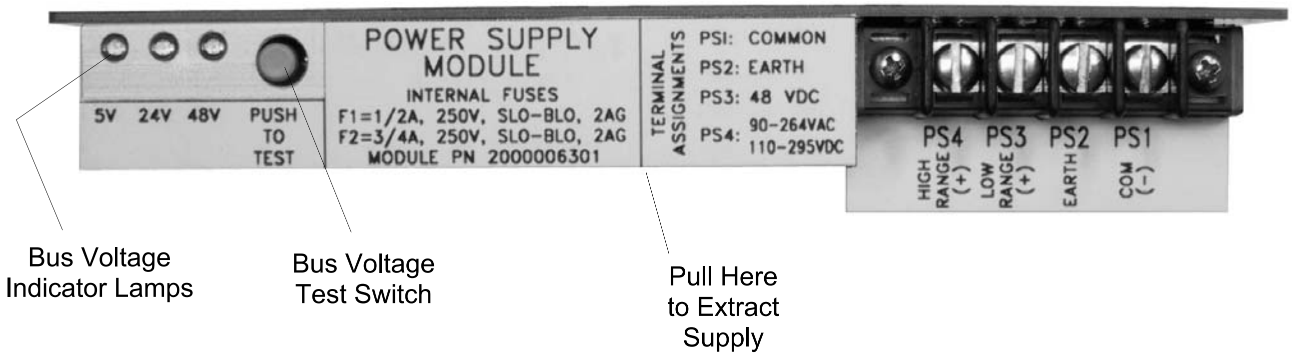


Figure 3E. Typical Wide Range Power Supply & Derivatives Front Panel. Label for 2000006301 Shown



The terminal assignments on the wide range power supply differ from its predecessor to accommodate the two voltage ranges that it can be connected to. The supply also offers the ability to verify that the three internal bus voltages are operating. Simply press the “push to test” button and the three blue indicator lamps will light at approximately the same brightness if they are working properly. A dim or overly bright indicator gives a quick indication that a section may be malfunctioning. The blue LEDs are of a high intensity type, intended to be visible in direct sunlight that is common to most substation environments.

The substation environment is a harsh one where high temperatures can damage electronic circuits and components that do not have an adequate thermal management system. The Wide Range power supply 2000006301 and its derivatives 2000006302 and 2000006303 are high power supplies that have an advanced thermal management system to remove heat from critical components, thus increasing reliability and life. A critical component in the thermal management system is the thermal shoe, which transfers heat energy from the components to the case, where it can be dissipated to the outside environment. The shoe must be in intimate contact with the inside of the case, and it is therefore very important that the shoe not be distorted is any way, if the supply is removed. It is recommended that the supply not be disturbed unless a fuse has opened or it has failed. If it is suspected that the supply is the source of a problem, first press the bus voltage test button. If the three bus voltage indicator lamps illuminate, the supply is not the problem, it should be left in place and another troubleshooting area should be investigated.

It the supply must be removed, it must be extracted by pulling straight out from the center-rear of the front panel. See figure 3E “Pull Here to Extract”. Do not set the supply down on the thermal shoe, nor compress it in handling. When re-inserting the supply, it must be inserted straight in, without cocking it to the side. There will be slight resistance to insertion as the shoe contacts the side of the case. This is normal and desirable.

I/O Module Connections

There are two-channel and three-channel I/O modules used in Advantage IIE. Two channel I/O modules are used in SC,DC, CT and CTX models while three channel I/O modules are used in TC, LTC and CT/LTC models. Connections to the I/O module are made to a 20 circuit (two-channel) or 22 circuit (three channel) pluggable stadium terminal block. The terminal block may be removed, with connections intact, by unscrewing the small screws on either side of the block. Be sure to re-tighten the screws after re-plugging the block to the module. See the “Terminal by Terminal Connection Guide” paragraphs beginning on page 6 for details regarding the metric screws used on the I/O module.

Analog Retransmit Connections

The optional, I/O module based single-channel analog retransmit output is provided in the event that a single retransmit channel is required. If more than one analog retransmit channel is required, the multi channel analog retransmit (MCAR) module, described in detail starting on page 19 should be ordered. The single-channel retransmit provides an analog signal which is proportional to any three of eleven displayable values selected by the user in the ANLOG RTRN1 submenu of the main menu’s ANRTN SETUP. See Figure 16E for selection details and table 9 for available sources.

The retransmit output is a constant current source providing up to 24 madc within the compliance voltage range of 0-20 vdc. The maximum loop resistance is determined by dividing 20 by the loop current desired. For example, with a 20ma loop current, the maximum loop resistance is 20 / 0.02 = 1000Ω. As another example, with a 1 ma loop current, the maximum loop resistance is 20 / 0.001 = 20000Ω. The resistance can be as low as one ohm.

The outputs' isolation is determined by the surge and EMI fence circuitry. Figure 9D shows a simplified circuit representation of the retransmit output. Circuit-to-earth ground isolation is greater than 1 megohm when the circuit-to-earth voltage is below 24 volts.

The terminal connections for SC, DC, CT, CTX and LTC models can be found on the diagrams of Figures 10A & 10B and the terminal connections for TC and CT/LTC models can be found on the diagrams of Figures 10C & 10D. If the terminal screws are missing from the terminal block, the feature is not installed.

Connections to the I/O module terminals may be made using #6 x 0.25" wide lugs suitable for the wire size which meets the maximum loop resistance calculated above. It is recommended that at least 24 AWG wire be used, for reasons of ruggedness. A distance of 15500 feet can be covered by a pair of 24 AWG wires without exceeding the maximum loop resistance at 24 madc loop current.

The analog retransmit has been factory calibrated to meet 0.5% accuracy requirements for the standard output range of four to twenty milliamps. This factory calibration will be effective even if the output is changed from 4 - 20 milliamps to, for example, 0 - 1 ma. There are some installations where errors in transmission equipment may result in errors at a remote site where it is desired to indicate a local transformer temperature or winding current. In this instance, the user's retransmit coefficient may be used to trim the output of the channel to force the remote site to read properly. This is not a calibration action, it is simply a user convenience feature. If the coefficient is set to 0.0, the output will be nominal. See the "Prompt COEF1, COEF2, COEF3" in the analog retransmit section of the keystroke-by-keystroke guide to set up for details of this feature.

RTD Inputs

Either 3 wire or 4 wire RTD's can be connected to the RTD inputs. The Weschler standard probe is 4 wire, chosen for enhanced probe accuracy regardless of lead length. The lead wire of the standard probe is 24 AWG and a crimp terminal suitable for 22-26 AWG wire and a #6 stud should be used. Users should consult the documentation that came with their probes if they are not using probes provided by Weschler. Refer to figures 10A through 10D of this manual or the label affixed to the back of the Advantage terminal access cover for terminal assignments. Note that like colors are assigned to like polarities. For example, red wires are connected to ***positive*** sense and ***positive*** source and white wires are connected to ***negative*** sense and ***negative*** source. On SC, DC, CTX and LTC models terminal I/O-15 is the source negative terminal for RTD's 1 and 2. On TC and CT/LTC models terminal I/O-10 is the common source negative for all RTD's To avoid the difficulty in connecting three crimp lugs to this terminal, it is suggested that the three RTD negative sense leads be twisted together and the splice be crimped into a single lug suitable for 20-24 AWG wire.

A fifth wire is provided for grounding of the woven stainless steel cable jacket. The wire is typically color coded gray, but may be any color other than white, red or green. This wire is provided to connect the RTD cable jacket to the earth-ground terminal of the power supply, or another known-good earth ground point ***when it is known that the RTD probe itself is isolated*** from a good earth ground. It is important that both ends of the cable jacket ***not*** be grounded, to avoid a current loop in the jacket created by coupled electric or magnetic fields.

The I/O module has jumpers that need to be set, according to which RTD configuration is being used. The default setting is 4-wire, corresponding to the standard RTD supplied by Weschler. When a 4 wire probe is being used, the jumper must be removed (default), or can be installed on one pin of the header only. If a three wire RTD is used the jumper must be installed across both header pins. 3-wire jumpers are provided in the hardware and spares kit in the event that 3-wire RTD's are used. Any mix of 3 and 4-wire RTD's may be connected as required, provided the appropriate jumpers are used.

The two-channel I/O module has one jumper (J2) to be set for SC and CT models and two jumpers (J2 and J3) to be set for DC, CTX and LTC models. See figure 4A for the location.

The three channel I/O module has three jumpers (J2, J3 and J4) to be set for TC and CT/LTC models. See figure 4B for the location.

If a 3-wire RTD is being used and the jumpers are not installed properly, the sensor failure alarm will flash on the display. If a four-wire RTD is being used and the jumper is installed, the measured temperature may appear to be low.

Auxiliary and Sensor Failure Relays

The present I/O module design has on-board positions for two form C relays. When the firmware has been configured for the legacy relay map, the relays on the I/O module are assigned relay numbers 7 and 8. Like all other relay configurations in the enhanced feature set, relays 7 and 8 can be configured to respond to any of the alarm sources in the alarm source list. In prior Advantage versions, relay 7 was referred to as the auxiliary (AUX) relay and relay 8 was a dedicated sensor failure relay. In order to provide continuity from the older models to the Advantage IIE, relay number 8 is always installed with the legacy map and it is set up at the factory to emulate a sensor failure relay. Also as in prior Advantage versions, relay 7 is optional. If there are relays installed on the I/O module, the legacy relay map is in use.

When the firmware has been configured for the consolidated relay map, there are no relays installed on the I/O module, because the firmware “looks” for all relays on the relay modules. The consolidated relay map was created to remove the relays from the I/O module and transition to a new relay module that is capable of having six form C relays installed. Thus all 12 relays will be installed on two modules, instead of three. This will simplify connections, troubleshooting and understanding of relay operation and reduce the possibility of cross-connecting the relay circuits with communications and RTD circuits. Like the legacy relay map, all relays are capable of being configured for any alarm source. For example, if it is desired, relay 8 (or any other relay number) can be configured as the SFR, the only difference being that relay 8 will be on relay module B instead of the I/O module. The consolidated relay map can be used with the present six relay and four relay modules. If there are no relays on the I/O module, the consolidated relay map is in use.

The relay map type is set at the factory, but can be changed in the field by a Weschler authorized representative or by sending a command through digital communications. The command is not included in the user’s AMTCMF software, in order to protect the integrity of the transformer’s cooling and alarm scheme from inadvertent change. For more information on legacy and consolidated relay maps, refer to the cooling control module connections section beginning on page 15.

If there are relays installed on the I/O module, refer to connection diagrams 10A to10D for connections to relays 7 and 8. If the screws are missing from the terminal block, the relay is not installed.

Digital Communications

SC, DC, LTC, CT and CTX Models

Hard wired connections for digital communications are made to the I/O module, at terminals I/O-16 to I/O-20. RS-232 is connected to I/O-16 (comm transmit 1), I/O-18 (comm receive 1) and I/O-20 (digital comm ground). Note that the ***digital communications ground is for communications only ; internal circuitry may be damaged if earth or other protective ground is connected to this terminal.***

RS-485 may be connected as two wire or 4 wire. For 2-wire connections the host’s receive “+” or “B” conductor is connected to I/O-16 (comm transmit 1) and the host’s receive “-“ or “A” conductor is connected to I/O-17 (comm transmit 2). A jumper must be installed between I/O-16 and I/O-18 and a second jumper must be installed between I/O-17 and I/O-19. If the host has only a 4-wire connection, jumpers may also be required at the host’s terminals. Consult the host’s literature for details regarding connections at the host end of the cable. A 120 ohm resistor may be required across terminals I/O-18 and I/O-19 to comply with the RS-485 specification. It is suggested that the system be tested first without the resistor, and if it performs properly, do not install it.

For RS-485 4-wire connections the host’s receive “+” or “B” conductor is connected to terminal I/O-16 (comm transmit 1) and the host’s receive “-“ or “A” conductor is connected to I/O-17 (comm transmit 2). The host’s transmit “+” or “B” conductor is connected to terminal I/O-18 (comm receive 1) and the host’s transmit “-“ or “A” conductor is connected to I/O-19 (comm receive 2). A 120 ohm resistor may be required between each of terminals I/O-16 and I/O-17 and between I/O-18 and I/O-19 to comply with the RS-485 specification. It is suggested that the system be tested first without the resistors, and if it performs properly, do not install it.

TC and CT/LTC Models

Hard wired connections for digital communications are made to the I/O module at terminals I/O-17 to I/O-21.

RS-232 is connected to I/O-17 (comm transmit 1), I/O-19 (comm receive 1) and I/O-21 (digital comm ground). Note that the ***digital communications ground is for communications only*** ; internal circuitry may be damaged if earth or other protective ground is connected to this terminal.

RS-485 may be connected as two wire or 4 wire. For 2-wire connections the host's receive "+" or "B" conductor is connected to I/O-17 (comm transmit 1) and the host's receive "-" or "A" conductor is connected to I/O-18 (comm transmit 2). A jumper must be installed between I/O-17 and I/O-19 and a second jumper must be installed between I/O-18 and I/O-20. If the host has a 4-wire connection, jumpers may also be required between its transmit and receive "-" or "A" terminals and its transmit and receive "+" or "B" terminals. Consult the host's literature for details regarding connections at the host end. A 120 ohm resistor may be required across terminals I/O-19 and I/O-20 to comply with the RS-485 specification. It is suggested that the system be tested first without the resistor, and if it performs properly, do not install it.

For RS-485 4-wire connections the host's receive "+" or "B" conductor is connected to terminal I/O-17 (comm transmit 1) and the host's receive "-" or "A" conductor is connected to I/O-18 (comm transmit 2). The host's transmit "+" or "B" conductor is connected to terminal I/O-19 (comm receive 1) and the host's transmit "-" or "A" conductor is connected to I/O-20 (comm receive 2). A 120 ohm resistor may be required between each of terminals I/O-17 and I/O-18 and between I/O-19 and I/O-20 to comply with the RS-485 specification. It is suggested that the system be tested first without the resistors, and if it performs properly, do not install them.

All Models

The connections for RS-422 communications are the same as the RS-485 4-wire configuration. The RS-485/422 specification has a differential signal and should not require a communications ground between the host and Advantage. Some systems will not work properly; however, if the communications ground is not connected. It is suggested that the system be tested first without the ground and if it functions normally, do not connect the ground. If a ground is necessary, two 100 ohm resistors must be placed in series between the host's communications ground and the Advantage communications ground terminal; one at the Advantage end and one at the host end, to reduce circulating currents.

All communications cables should be a shielded, twisted pair type with AWG 20 minimum conductor size for short runs and AWG 18 for longer runs. The shield must be grounded to a frame or earth ground.

RS-485, 2-wire systems must be properly biased to provide reliable communications. If not properly biased, when all drivers are in the tristate (listen) mode, the state of the bus may be unknown. If the voltage difference between the lines is not greater than ±200mv, the last bit transmitted will be interpreted to be the state of the line. This may result in communications errors if the last bit transmitted is low, because the receivers must be idle in the logic high state, in order to determine when a communication has begun. If the logic state is low continuously, framing errors will result, causing communications to fail. If communications are poor or are not functioning and an RS-485 2-wire scheme is in use, bus bias could be the problem. There are excellent tutorial documents available from National Semiconductor on their website, www.national.com. The two application notes that cover the bus biasing issue are AN-847 and AN-1057.

Figure 4A. 3-Wire RTD Jumper Location on the I/O Module for SC, DC, CT, CTX and LTC Models

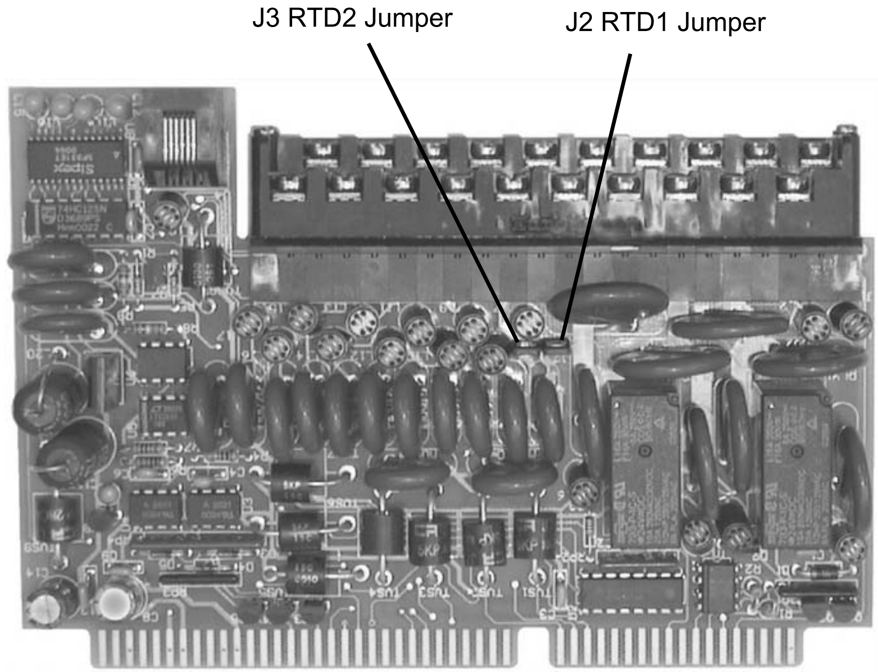
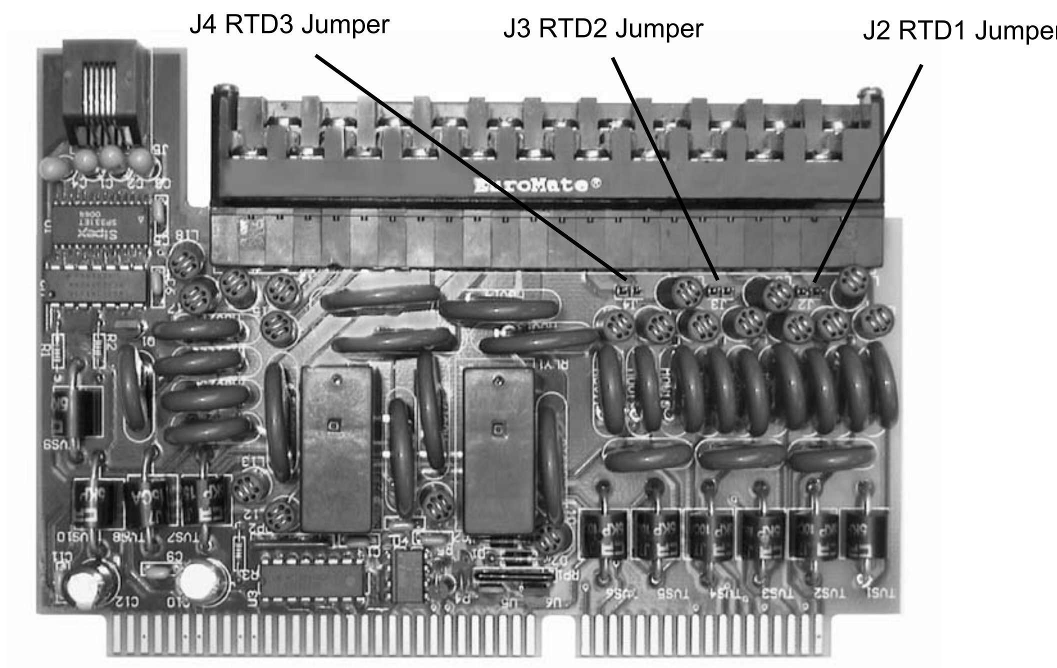


Figure 4B. 3-Wire RTD Jumper Locations on the I/O Module for TC and CT/LTC Models



Cooling Control Module Connections:

The original name of the cooling control module was the “cooling control and current input” (C^3) module, to connote its primary mission - to turn on cooling apparatus - and to identify the current input needed by CT-series models. Confusion arose when the module was used in non-CT models or in the secondary cooling control module position, where the current input was not needed. The name was therefore simplified to cooling control module to reduce confusion. There are two cooling control module positions in every Advantage, referred to as CCA and CCB on terminal assignment diagrams.

In 2008 the current inputs will be removed from the cooling control modules and migrated to board space on the LCAM module. The board space on the cooling control module that is vacated by removing the current input will be used to increase the module's relay capacity to six, form C relays. For the purpose of continuity, the new relay modules will continue to be referred to as CCA and CCB on wiring diagrams, but may be referred to simply as relay modules. The cooling control design that is being replaced will be maintained for service and repair purposes.

Connections to the relay terminals can be made using the lugs described in the connections general section above. Lugs and hook-up wire conductor should be appropriate for the current level plus expected overloads. Hook up wire insulation should be chosen appropriate to the peak circuit voltage level.

Relay Refresher

Form C relays provide both form A (normally open) and form B (normally closed) stationary contacts with a third contact which moves between and is common to both the form A and B contacts. The third contact is referred to as the common contact. The common contact is mounted on an armature which is made of a ferritic material that is attracted to the magnetic field created when operating current is passed through the relay coil. The armature is hinged at one end to allow it to swing back and forth between the form A and form B contacts. A spring holds the armature such that the moving contact rests on the form B contact when there is no current in the relay coil. In order to open, or break the circuit between the form B and common contacts, an operating current must be passed through the relay coil to attract the armature against the restoring force of the spring and separate the common contact away from the form B contact.

The same spring that holds the common contact against the form B contact, keeps the common contact separated from the form A contact to maintain an open circuit condition, when there is no operating current in the relay coil. In order to close the circuit between the common and form A contacts, operating current must be passed through the relay coil to create a magnetic field, attract the armature and force the common contact against the form A contact.

A form B contact is considered to be a normally closed failsafe configuration. This means that in an unalarmed state, the contact is held separated from the common contact by an operating current in the relay coil. In the event that an alarm is called for, the operating current in the coil is shut off and the contacts revert to their normally closed condition. The failsafe name comes from the fact that if an alarm is required, or power fails, or an internal failure occurs, the relay coil current will shut off and the contacts will revert to their normally closed condition by spring action. These contacts are normally used for fan circuits and power-fail alarms. Form B contacts are the only configuration available on relays 1 to 5 of the present 6-relay cooling control module.

Relay Maps

A relay map is simply the location of the relays on the various modules and the method of numbering them and their terminal connections. The Advantage has two relay map versions, referred to as the legacy and consolidated maps.

Legacy Relay Map

In the legacy relay map scheme, relays are located on modules CCA, CCB and the I/O module. This arrangement was designed to provide as many relays as possible into the limited space of the previous Advantage generation's more compact case. This concept is planned to be phased out, in order to remove relays and their support components from the I/O module and allow more space for other low-voltage I/O features. The legacy relay map will continue to be supported, however.

The present complement of cooling control modules includes a six-relay and a four-relay layout. The six relay layout has five sets of form-B contacts and one set of form C contacts. The four-relay layout has four sets of form C contacts.

The legacy relay map includes various module deployments which provides a considerable amount of flexibility, and perhaps a bit of confusion. The module deployment is described by a three number series separated by slashes as a short-hand for what types of modules the relays are installed on. See Table 4 for a summary of coding. The first number is for the first, or primary cooling control module (CCA). The second number is for the I/O module and the third number is for the secondary cooling control module (CCB). On the cooling control modules the numbers simply indicate the ***maximum*** number of relays that ***can be installed*** on each module, without regard to the number of relays that are actually installed. On the I/O module the number indicates how many relays are ***actually installed***.

The legacy relay map allows the four-relay cooling control module to be a primary (CCA) or secondary (CCB) cooling control module, but allows the six-relay module to be only a primary (CCA) cooling control module. Since the four-relay cooling control module can be CCA or CCB, a jumper is provided on board to identify the difference between the two modules, to the operating system firmware. See figure 5 For the location of the jumper on the four-relay module.

Because the six-relay module can only be CCA, no jumper is required for it. The legacy relay map's standard configuration has the six-relay cooling control module as CCA, with a form B relay in the relay 1 position and a form C relay in the relay 8 position on the I/O module. Relay 8 is always supplied in the standard legacy map configuration, configured by default as a sensor failure relay. Table 4 summarizes the legacy relay map.

Table 4. Legacy Relay Map Summary

Module Arrangement	Module	Relay Numbers	Contact Forms Respectively
4/1/0	Primary CCA	1, 2, 3, 4	C,C,C,C
	I/O	8 (SFR)	C
	Secondary CCB	None	-
4/2/4	Primary CCA	1, 2, 3, 4	C, C, C, C
	I/O	7 (AUX), 8 (SFR)	C, C
	Secondary CCB	9, 10, 11, 12	C, C, C, C
6/1/0 (standard)	Primary CCA	1, 2, 3, 4, 5, 6	B, B, B, B, B, C
	I/O	8 (SFR)	-
	Secondary CCB	None	-
6/2/4	Primary CCA	1, 2, 3, 4, 5, 6	B, B, B, B, C
	I/O	7, 8	C, C
	Secondary CCB	9, 10, 11, 12	C, C, C, C

<u>Consolidated Relay Map</u>

The name "consolidated" came from the planned consolidation of all relays onto dedicated relay modules. There are no relays on the I/O module in the consolidated map. The consolidated map is presently implemented with the six-relay module as CCA, or the four-relay module as CCA, or 2 four-relay modules as CCA and CCB or the six-relay module as CCA and the four-relay module as CCB. This is the same arrangement of relay modules as the legacy map, except no relays on the I/O module. In the second quarter of 2008 a new relay module will be available that will have 6 form C relays. Two of these modules can be combined to have 12 form C relays, replacing the previous maximum of seven form C relays. Relays 1-6 will be located on module CCA and relays 7-12 will be located on module CCB. A jumper is provided on each module to identify it as CCA or CCB. See figure (later) for the jumper location.

The consolidated relay map, with the new six-relay module is considerably simpler, since all relays are on relay modules and none are on the I/O module. The consolidated map was created to remove relays from the I/O module, thus simplifying connections, troubleshooting and understanding of relay operation and reducing the possibility of cross-connecting the relay circuits with communications and RTD circuits.

See figure (later) for the consolidated relay map terminal connections.

<u>Current Input Connections (CT Series Models Only)</u>

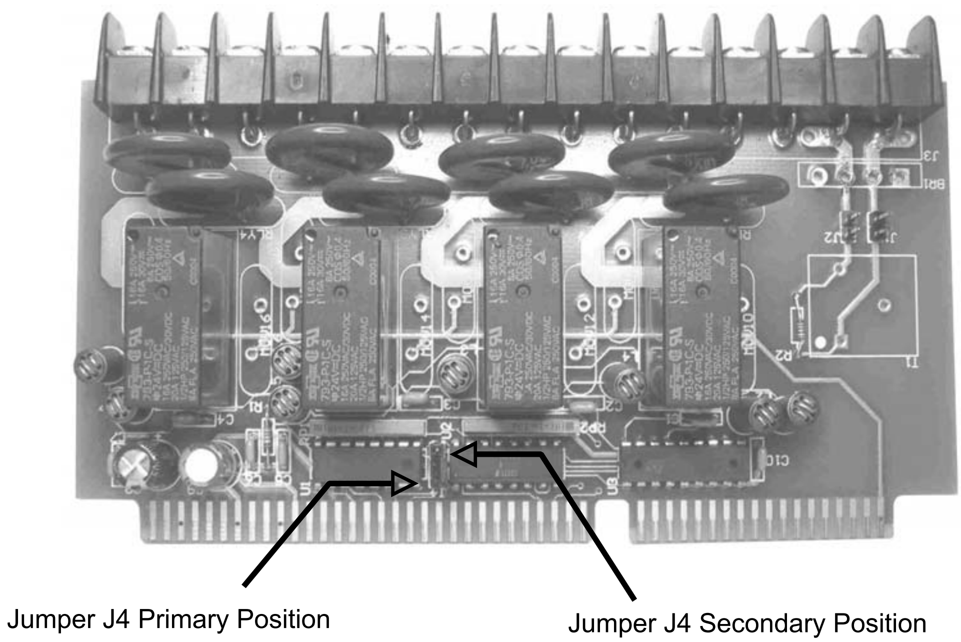
If your model has a Polyphase Current Input (PCI) module or Load and Cooling Apparatus Monitoring (LCAM) module installed, the proportional load current (WTI) connections must be made to it. Refer to the Optional Module Connections sections below, for connection details.

If your CT-series unit does not have a PCI or LCAM module, connections for current sensing are made to the current input terminals of the cooling control module. In configurations with two cooling control modules, only the module in the CCA position has current sense input hardware installed on the module. In 2008 the current inputs will be removed from the cooling control modules and migrated to board space on the LCAM module. The board space on the cooling control module that is vacated by removing the current input will be used to increase the module's relay capacity to six, form C relays.

Connections to the current terminals can be made using the lugs described in the connections general section above. Lugs and hook-up wire conductor should be appropriate for the current level expected plus overloads. Hook up wire insulation should be chosen assuming an open circuit in the CT secondary could occur at any point in the circuit.

Special attention must be taken when wiring to the current sense inputs if wiring directly to the WTI current transformer (CT), since the open secondary of a CT can generate high voltages which may be lethal to personnel. Precautions must be taken to either de-energize the transformer (preferred) or short circuit the CT secondary before making any wiring changes. Consult with your safety personnel for appropriate safety practice prior to making any wiring connections. Once connections to the current sense terminals are made, the sense circuit must be configured to the transformer's CT, by performing the CT SETUP operation. Reference the keystroke-by-keystroke configuration section paragraph titled "Prompt CT1, 2, 3 SETUP" for configuration information on this important step.

Figure 5. Four Relay Cooling Control Module Primary / Secondary Jumper Location



Optional Module Connections

The modules in this section are not part of the Advantage standard hardware feature set. They are generally ordered as an optional feature at the same time as the Advantage, but may be ordered separately. In the latter case, installation instructions will be included with the module in the shipping carton.

Multi-Channel Analog Retransmit (MCAR) Module Connections:

The MCAR module provides an analog signal which is proportional to any three of eleven displayable values selected by the user in the ANLOG RTRN1, 2 or 3 submenus of the main menu's ANRTN SETUP. See Figure 16E for selection details and table 9 for available sources.

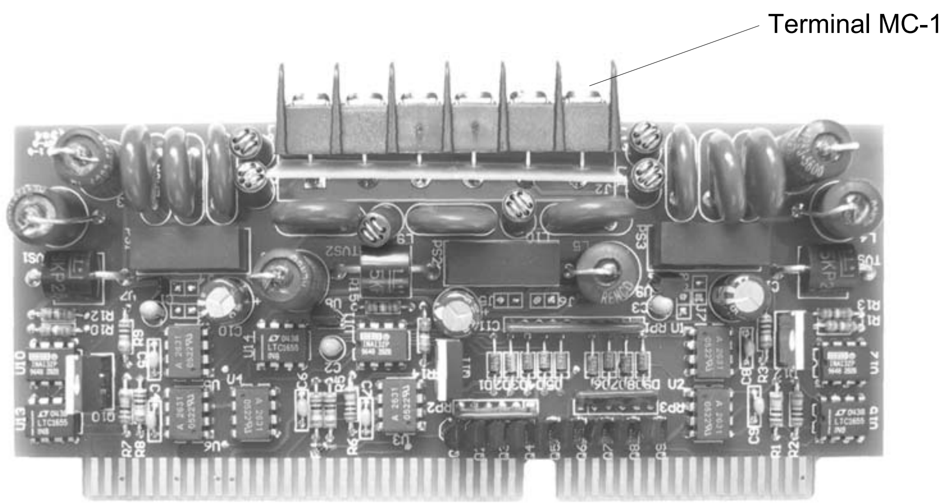
The outputs are constant current sources of up to 24 madc within the compliance voltage range of 0-20 vdc. The maximum loop resistance is determined by dividing 20 by the loop current desired. For example, with a 20ma loop current, the maximum loop resistance is 20 / 0.02 = 1000Ω. As another example, with a 1 ma loop current, the maximum loop resistance is 20 / 0.001 = 20000Ω. The resistance can be as low as an ohm on the lower side.

The outputs' isolation is determined by the surge and EMI fence circuitry. Figure 9D shows a simplified circuit representation of the retransmit outputs. Adjacent channel isolation is greater than 1 megohm when the output voltage difference channel-to-channel is less than 48 volts. Circuit-to-earth ground isolation is also greater than 1 megohm when the circuit-to-earth ground voltage is below 24 volts.

The MCAR module terminals are numbered MC-1 to MC-6. Connections to the MCAR module terminals may be made using #6 lugs suitable for the wire size which meets the maximum loop resistance calculated above. It is recommended that at least 24 AWG wire be used, for reasons of ruggedness. A distance of 15500 feet can be covered by a pair of 24 AWG wires without exceeding the maximum loop resistance at 24 madc loop current.

The analog retransmit has been factory calibrated to meet 0.5% accuracy requirements for the standard output range of four to twenty milliamps. This factory calibration will be effective even if the output is changed from 4 - 20 milliamps to, for example, 0 - 1 ma. There are some installations where errors in transmission equipment may result in errors at a remote site where it is desired to indicate a local transformer temperature or winding current. In this instance, the user's retransmit coefficient may be used to trim the output of the channel to force the remote site to read properly. This is not a calibration action, it is simply a user convenience feature. If the coefficient is set to 0.0, the output will be nominal. See the "Prompt COEF1, COEF2, COEF3" in the analog retransmit section of the keystroke-by-keystroke guide to set up for details of this feature.

Figure 6. Multi Channel Analog Retransmit (MCAR) Module



Polyphase Current Input (PCI) Module

The Polyphase Current Input (PCI) module incorporates three separate, electrically isolated channels to convert the current signals from 3 individual CT's into a single one to be displayed as ILOAD. The PCI incorporates circuitry to automatically compare the three signals and select the one having the greatest magnitude for display. The PCI module can only be used by CT series models.

Special attention must be taken when wiring to the current sense inputs if wiring directly to the current transformer (CT) since the **open secondary of a CT can generate high voltages which may be lethal to personnel.** Precautions must be taken to either de-energize the transformer (preferred) or short circuit the CT secondary before making any wiring changes. Consult with your safety personnel for appropriate practice prior to making any wiring connections. Once connections to the current sense terminals are made, the sense circuit must be configured to the transformer's CT, by performing the CTX SETUP operation. Reference the keystroke-by-keystroke configuration section paragraph titled "Prompt CT1 SETUP, CT2 SETUP, CT3 SETUP" on page 67 for configuration information on this important step.

Refer to figure 7 for PCI module terminal layout. When installed, terminal numbers are counted right to left. Connections to the PCI are made at terminals PCI-1 and PCI-2 (phase A), terminals PCI-8 and PCI-9 (phase B) and terminals PCI-14 and PCI-15 (phase C). Delta or Wye connections are permissible. For Wye connections polarity should be high to terminals PCI-1, PCI-8 and PCI-14 and neutral to terminals PCI-2, PCI-9 and PCI-15. For delta circuits PCI-1 and PCI-2 should be connected A-B, PCI-14 and PCI-15 should be connected B-C and PCI-14 and PCI-15 should be connected C-A. Lugs and hook-up wire conductor should be appropriate for the current level plus expected overloads. Hook up wire insulation should be chosen assuming an open circuit in the CT secondary could occur at any point in the circuit.

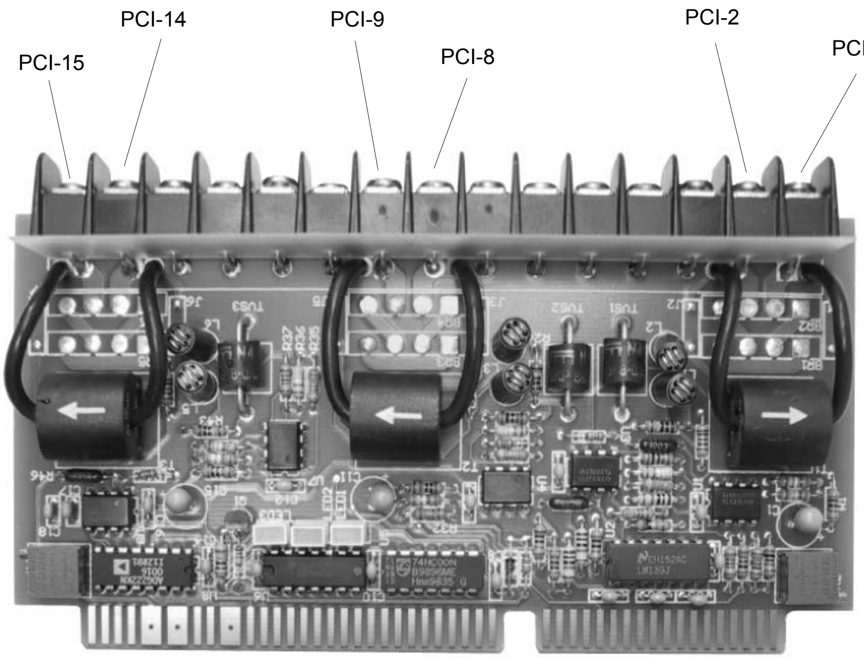


Figure 7. Polyphase Current Input (PCI) Module
Module with On-Board CT's Shown

Load and Cooling Auxiliary Monitoring (LCAM) Module

The LCAM module is an eight channel multi-range input module that accepts AC and DC voltage and current in 9 ranges, plus 10 vdc contact wetting excitation on each input. The LCAM module must be used with Advantage II Enhanced Firmware in the AMTSYS family. The LCAM module has two input types; dedicated winding current or multi-range. Refer to the figure 10A - 10D connection diagrams for wiring details.

The LCAM 1, 2 and 3 inputs are primarily intended to be used to measure winding current for CT-series calculating winding temperature indicators (WTI). These circuits can be populated with on-board isolation CT's or to support external donut or clamp-on CT's.

The on-board CT's can be directly connected to current sources with a maximum 10 amp AC level. The continuous overload is 25 amps and the momentary overload is 200 amps. Momentary overload by definition is a non-repeating transient lasting less than 1 second within a 1 minute period.

The clamp-on CT's that the LCAM 1, 2 and 3 inputs use are current-to-voltage transducers, which are simply split-core coils with a shunt resistor across the secondary winding leads. The clamp-on CT's for inputs LCAM 1, 2 and 3 can be ordered from Weschler or can be purchased from another source. If they are ordered from Weschler they will be factory-calibrated with the Advantage host. CT's purchased from another source must have a 2 vac output at the rated primary current. As an alternative, the LCAM 1, 2 and 3 inputs can be specified as multi-range inputs and the 5 vac range can be used to sense voltage from CT's with higher secondary voltages.

When the LCAM module is used on non-CT series Advantage, LCAM 1, 2, and 3 inputs can be ordered configured as additional multi-range inputs.

The LCAM inputs 4 through 8 are dedicated multi-range inputs which accept 5, 75, 150 and 300 vdc; 5, 150 and 300 vac; 1 and 20 madc and provide 10 vdc contact wetting excitation. The 5 vac range may be used with current-to-voltage transducers to measure currents from cooling apparatus or higher AC currents from auxiliary windings. The current-to-voltage transducers can be purchased from Weschler or another source, or can be made from a donut CT with a shunt resistor across its output leads. Users must be cautious of the potentially hazardous voltage levels that can be generated if the CT is put into service without the shunt resistor connected to its output leads. The LCAM 4 through LCAM 8 inputs cannot be used to measure winding temperature.

When used with SC, DC, TC and LTC models, all eight inputs can be configured as multi-purpose auxiliary inputs.

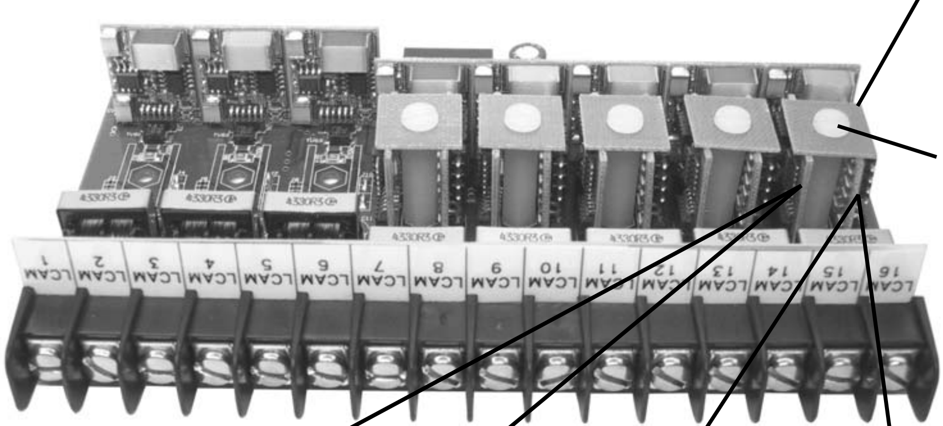
The LCAM inputs are optically isolated from measurement circuits, magnetically isolated from power mains and either magnetically or optically isolated channel to channel. See table 11B for full isolation specifications.

The LCAM module can sense up to eight different signals and alarm on each one as well as report the values through digital communications. When LCAM channels 1-3 are configured as current inputs for CT-series models, any one or all three current values can additionally be retransmitted using the optional MCAR module. The optional DNP-3 and ModBus digital communications protocols support value reporting on all LCAM channels and state information on all alarms driven by the LCAM alarm sources.

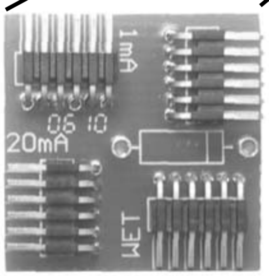
The Advantage II enhanced alarm system, coupled with the LCAM inputs, allow the user to monitor equipment controlled by the Advantage relays and alarm if the equipment's supply voltage or current is outside of a user-defined range. If the voltage or current is out-of-range, the alarm system can operate another relay which can remotely alarm, supervise the equipment or turn on backup equipment. Cascading (redundant) alarms can be set up this way.

Refer to the LCAMX SETUP menu paragraphs in the configuration section's keystroke-by-keystroke set up guide for details and examples regarding advanced alarm configuration.

Figure 8A. LCAM Module
The module configuration shown has five analog multi-range circuits on the right side of the photo and 3 Clamp-on CT inputs to the left side of the photo.



<u>Figure 8B.</u>
LCAM Module Current/Voltage Contact Wetting Daughterboard



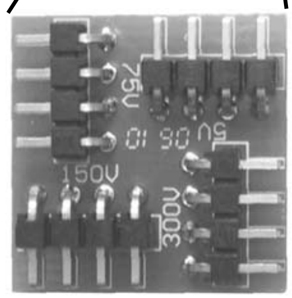


Figure 8C. LCAM Voltage Range Daughterboard

<u>LCAM Jumper Setting</u>

The jumpers on the LCAM module are actually small circuit boards, popularly called “daughterboards”. This design was chosen to eliminate the need for many more individual jumpers on each channel. There is a voltage range and a current-voltage-wetting daughterboard for each channel, shown in figures 8B and 8C. The ranges are identified by printing next to the pin headers on the daughterboards. The boards cannot be installed into the wrong socket because the pitch (distance between pins) is different for each board. Setting a range is as simple as removing the retaining screw and plate, plugging the correct daughterboard pin header into the motherboard socket and reinstalling the retaining plate and screw.

Each populated multi-range input has the same two daughterboards. The LCAM 1, 2 and 3 inputs will only have these two boards if they were ordered as multi-range auxiliary inputs. In figure 8A, the LCAM 1, 2 and 3 inputs are configured as dedicated current inputs, using current-to-voltage, clamp-on CT’s as their sensors.

The voltage range daughterboard has four ranges; 5, 75, 150 and 300 volts. To set the range, simply rotate the board until the pin header with the desired range marking can be plugged into the appropriate motherboard receptacle. When ***not*** measuring a voltage level, the voltage daughterboard must be plugged in at the 300v range (preferred) or removed.

The current-voltage-wetting daughterboard has 1madc and 20madc ranges, a relay or switch contact wetting range and a “volt bypass” range. To set the range, simply rotate the board until the pin header with the desired range marking can be plugged into the appropriate motherboard receptacle. The daughterboard’s volt bypass header must be plugged in (preferred), or the current-voltage-contact wetting daughterboard must be removed when a voltage range is used. The daughterboard settings are summarized in table 5.

When the wetting range is selected, approximately 10 vdc is applied to the external terminals for wetting of unpowered contacts. Switches or relay contacts that are connected to a power source must not be connected to the terminals of any channel which has its hardware set up for contact wetting, otherwise the LCAM module may be permanently damaged.

It is of paramount importance that the daughterboard jumpers be set to the proper range. The LCAM module can be damaged if a voltage or current is applied that is beyond the full scale rating of the daughterboard. Multi-range inputs are configured for 300v AC as the factory default.

Table 5. Summary of LCAM Daughterboard Plug-in Settings

Range	Voltage Daughterboard	Small Signal Current Daughterboard
5v	5v	Volt Bypass
75v (dc only)	75v	“
150v	150v	“
300v	300v	“
1 ma	“	1ma
20ma	“	20ma
Wetting of Dry Contacts	“	Wet

Special attention must be taken when wiring to the current sense inputs if wiring directly to the current transformer (CT) since the **open secondary of a CT can generate high voltages which may be lethal to personnel.** Precautions must be taken to either de-energize the transformer (preferred) or short circuit the CT secondary before making any wiring changes. Consult with your safety personnel for appropriate practice prior to making any wiring connections. Once connections to the current sense terminals are made, the sense circuit must be configured to the transformer’s CT, by performing the CTX SETUP operation. Reference the keystroke-by-keystroke configuration section paragraph titled “Prompt CT1 SETUP, CT2 SETUP or CT3 SETUP" for configuration information on this important step.

Calibration Check

It is generally unnecessary to check calibration prior to installation, because all adjustments are made in firmware and there are no manual adjustments that are sensitive to shipping shock and vibration. Some user’s standard operating practice requires calibration verification prior to commissioning, to satisfy quality assurance mandates. Please refer to section 7.0, Calibration, for details of calibration checks.

Table 6. Channel Assignments

Model	Channel Number / Name	Channel Inputs on Module	Type of Input
SC	1	I/O	RTD1
DC	1	I/O	RTD1
	2 ③	I/O	RTD2
TC	1	I/O	RTD1
	2 ③	I/O	RTD2
	3 ③	I/O	RTD3
LTC	1	I/O	RTD1
	2 ②	I/O	RTD2
CT	1	I/O	RTD1
	4	I/O ⑧	AC Current
CTX	1	I/O	RTD1
	2	I/O	RTD2
	4	I/O ⑧	AC Current
CT/LTC	1	I/O	RTD1
	2 ②	I/O	RTD2
	3 ③,⑥,⑦	I/O	RTD3
	4	I/O ⑧	AC Current
SC, DC, TC, LTC	LCAM1 ⑤	LCAM	Multi-Range
	LCAM2 ⑤	“	“
	LCAM3 ⑤	“	“
All CT Series	LCAM1 ④	LCAM	AC Current
	LCAM2 ④	“	AC Current or Multi-Range
	LCAM3 ④	“	“
All Models	LCAM4 ⑤	LCAM	Multi-Range
	LCAM5 ⑤	“	“
	LCAM6 ⑤	“	“
	LCAM7 ⑤	“	“
	LCAM8 ⑤	“	“

Notes:

① Where more than one title is shown, the user has a choice of titles. The ones shown are appropriate for the model type.

② If the LTC function is not being used, it must be set to “OFF” in the “LTC FUNCT” set up loop. This suppresses all LTC-related operation, including display, set point alarms, analog retransmit, value logging and inclusion in DNP-3 and ModBus data strings.

③ If this channel is unused, the title selection must be set to “OFF”. This suppresses all channel operation, including display, set point alarms, internal failure alarms and sensor failure alarms, analog retransmit, value logging and inclusion in DNP-3 and ModBus data strings. It also causes calibration of the channel to be by-passed, when doing calibration operations. See the CHNL2 TITLE and CHNL3 TITLE menus in Figure 16D and the “Prompt CHNL1 TITLE, CHNL2 TITLE, CHNL3 TITLE” paragraphs in the keystroke-by-keystroke set up guide for details. Setting the channel title to OFF is not the same as setting the display option to OFF. See the DSPLY ENABL menu in Figure 16D and the “Prompt DSPLY ENABL” paragraph in the keystroke-by-keystroke diagram for details.

④ If this channel is unused, it must be disabled in the” LCAM ENABL” menu. This suppresses all channel operation, including display, set point alarms, analog retransmit, value logging and inclusion in DNP-3 and ModBus data strings. It also causes calibration of the channel to be by-passed, when doing manual calibration operations. See the “Prompt LCAM ENABL” paragraph in the keystroke-by-keystroke guide for details.

⑤ If this channel is unused, it must be disabled in the” LCAM ENABL” menu. This suppresses applicable channel operation, including display, set point alarms, and inclusion in DNP-3 and ModBus data strings. It also causes calibration of the channel to be by-passed, when doing manual calibration operations. See the “Prompt LCAM ENABL” paragraph in the keystroke-by-keystroke guide for details.

⑥ The probe types used for LTC differential measurement may be inserted into a thermowell or magnetically attached. If thermowell type probes are used for BOTH LTC and Main Tank Fluid temperature, see note 7. If there is not thermowell in the LTC tank, then channels 2 and 3 must use magnetically attached RTD’s for the LTC differential measurement and the “MANTK” title must be selected in the CHNL3 TITLE loop.

⑦ If the LTC tank and main tank probes are inserted into thermowells, the main tank temperature will be obtained from the channel 1 Fluid temperature probe and channel 3 may be used with an RTD probe to measure other values such as ambient air or bottom oil temperature.

⑧ If the CT-series Advantage is equipped with a PCI or LCAM module, current input will be connected to the LCAM, not a CCC module.

High Potential (Hi Pot) and Insulation Resistance (Megger) Testing

Power and Input / Output Transient Protection Circuitry:

The Advantage incorporates surge and transient suppression circuitry on its power, input and output circuits to protect sensitive internal electronic components from electrical disturbances which are common to the application environment. The suppression circuitry forms a classic filter and clamp network. Typical examples of the input and output network's suppression circuitry are shown below in Figures 9A through 9E. The clamping components used are chokes, varistors and TVS diodes. These components protect internal components by blocking large and rapid voltage changes or conducting current when their clamping voltage is exceeded. The components are capable of handling large amounts of power but only for the very short duration typical of transients. It is therefore necessary when doing hi-pot testing, to disconnect the circuits under test from the Advantage to prevent damage to these components. Advantage internal circuit integrity can be verified using megger testing. When doing megger testing, set the applied voltages below the voltages shown in Figures 9A - 9E in order to avoid false indication of low insulation resistance.

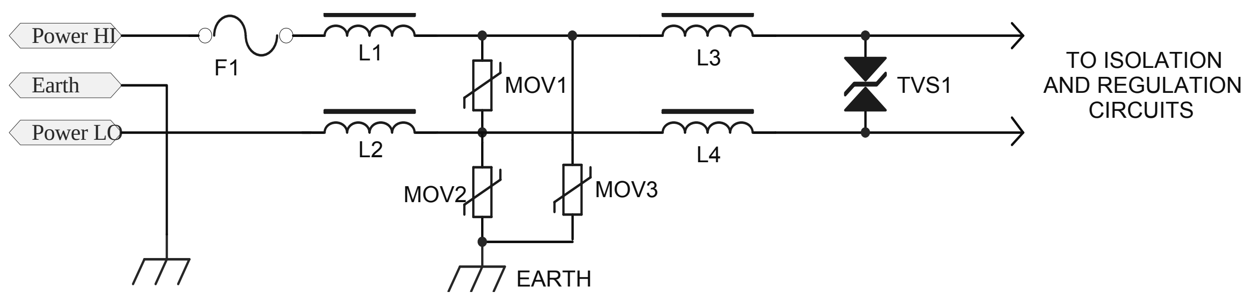


Figure 9A. Standard Power Supply Input EMI Suppression Network
Maximum Test Voltage, Circuit-to-Circuit or Circuit -to-Earth is 110% of Source Voltage

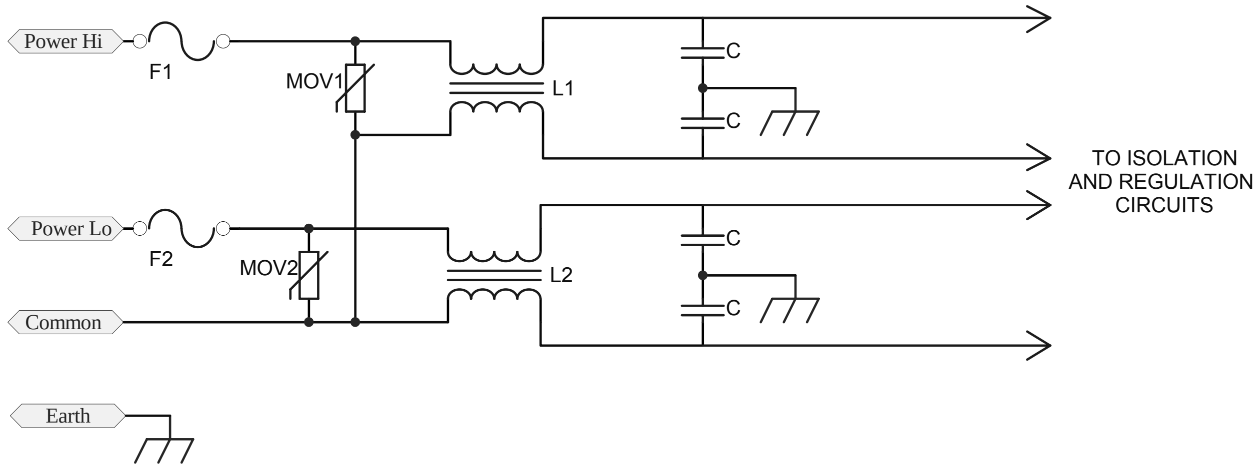


Figure 9B. Wide Range (and derivatives) Power Supply Input EMI Suppression Network.
Maximum Test Voltage, Circuit-to-Earth is 275vrms.

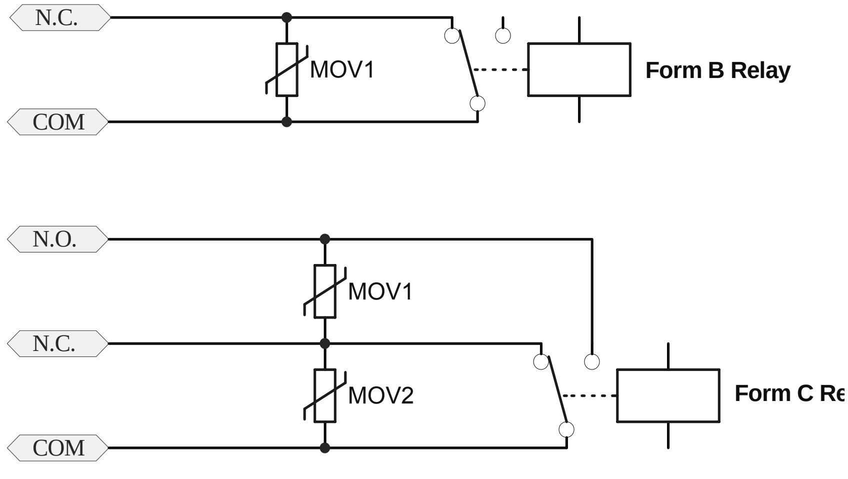


Figure 9C. Alarm Relay EMI Suppression Networks
Maximum voltage contact-to-contact is 250 Vrms. Maximum test voltage contact-to-earth is 250 Vrms.

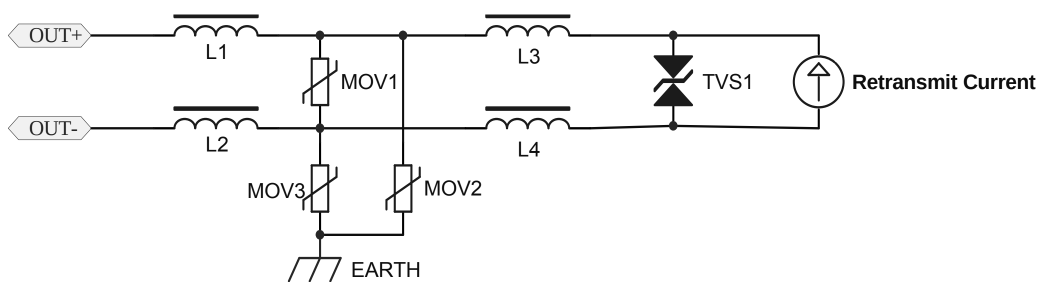


Figure 9D. Analog Retransmit EMI Protection Network
Maximum test voltage output-to-output or output-to-earth is 24 volts

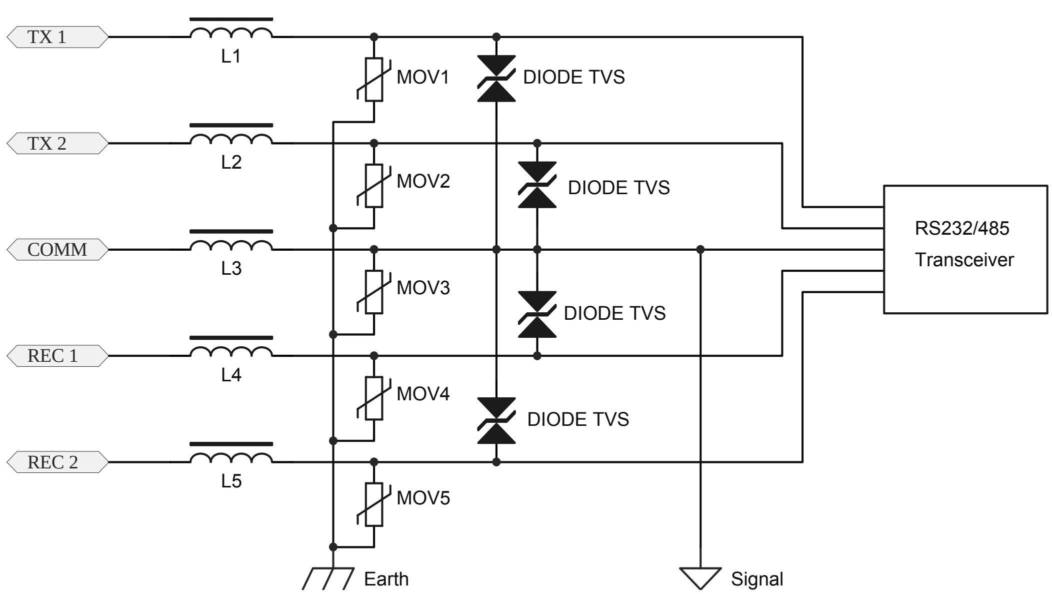


Figure 9E. Digital Communications EMI Protection Network
Maximum test voltage input-to-input, input-to-comm or input-to-earth is 12 v.

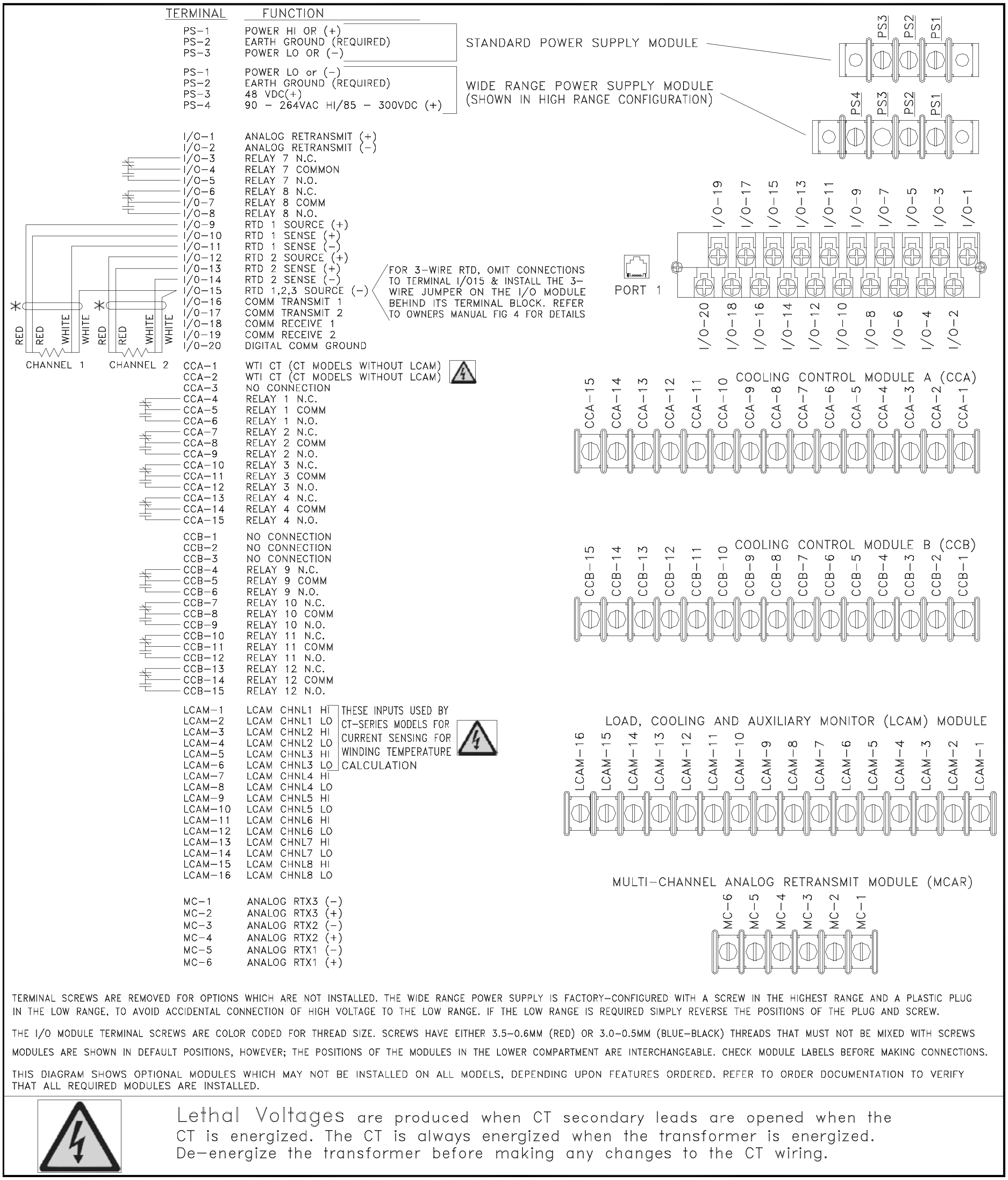


Figure 10A. Terminal Assignments. SC, DC, CT, LTC & CTX Models with 4/2/0 or 4/2/4 Relay Module Schemes

The SC model's analog retransmit output is always located on the I/O module. Terminal Screws on all modules except the I/O module have #6-32 threads. Do not mix I/O module screws with screws from another module, or thread damage will result. The actual model may not contain all optional hardware shown.

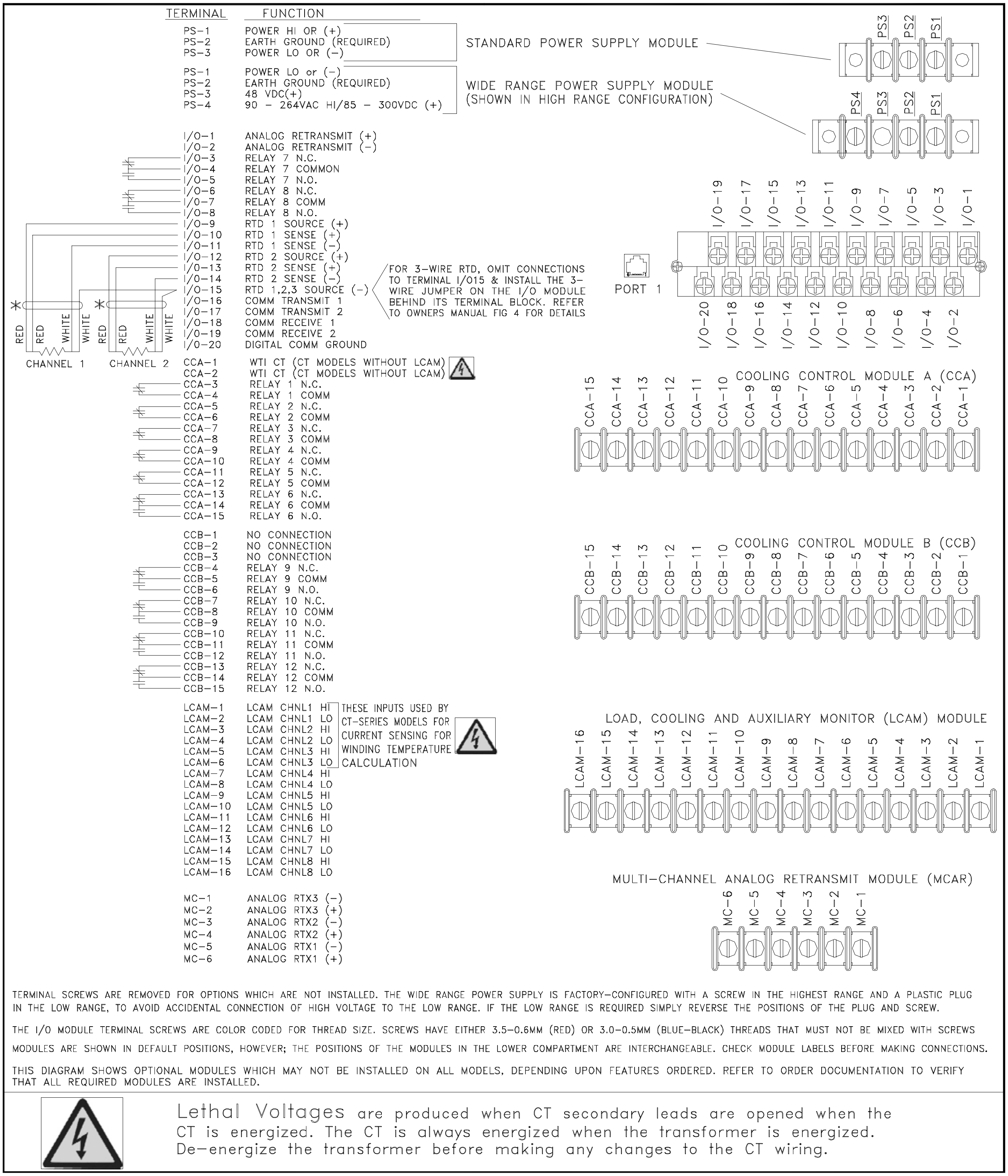


Figure 10B. Terminal Assignments. SC, DC, LTC, CT & CTX Models with 6/2/0 or 6/2/4 Relay Module Schemes

The SC model's analog retransmit output is always located on the I/O module. Terminal Screws on all modules except the I/O module have #6-32 threads. Do not mix I/O module screws with screws from another module, or thread damage will result. The actual model may not contain all optional hardware shown.

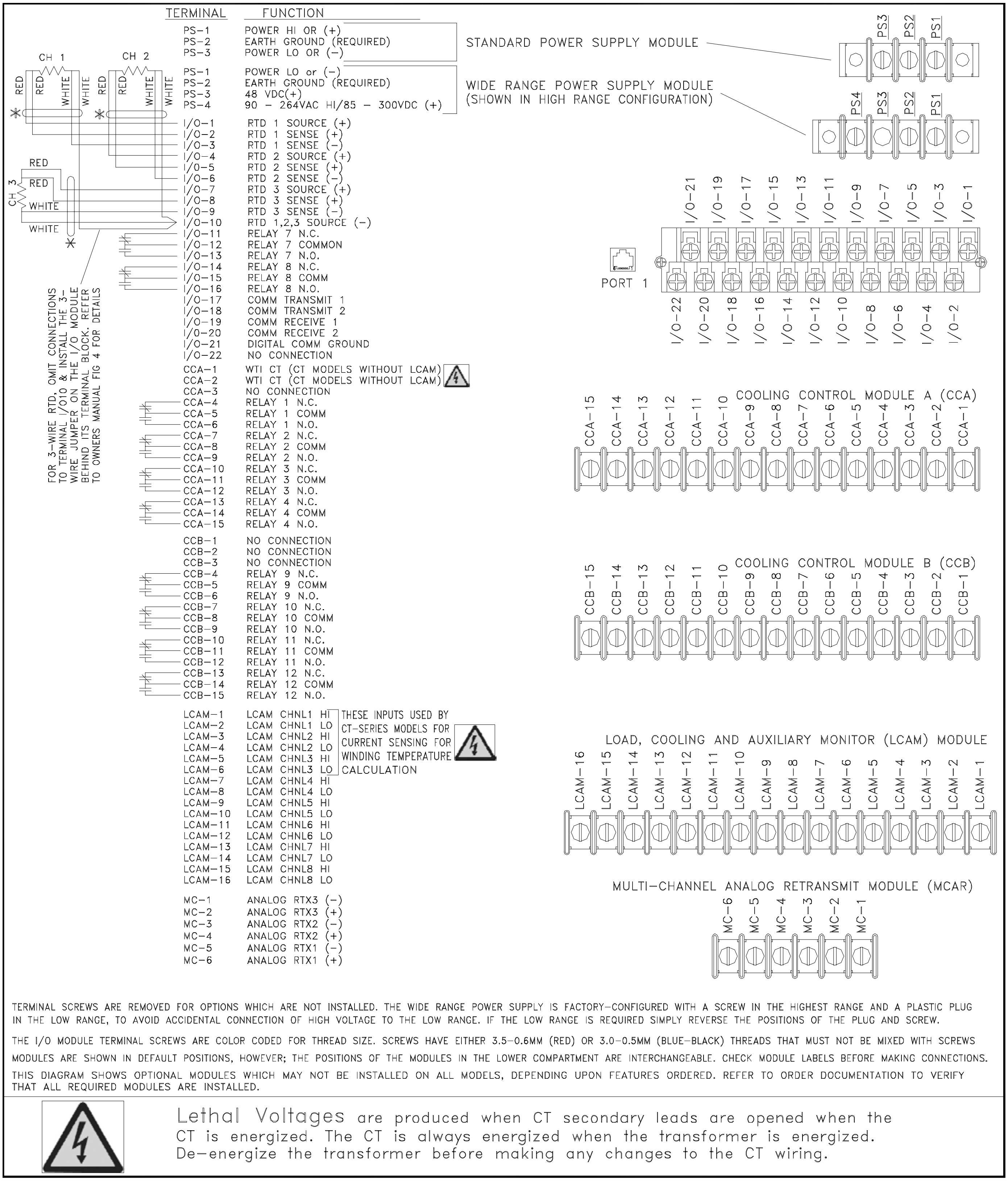
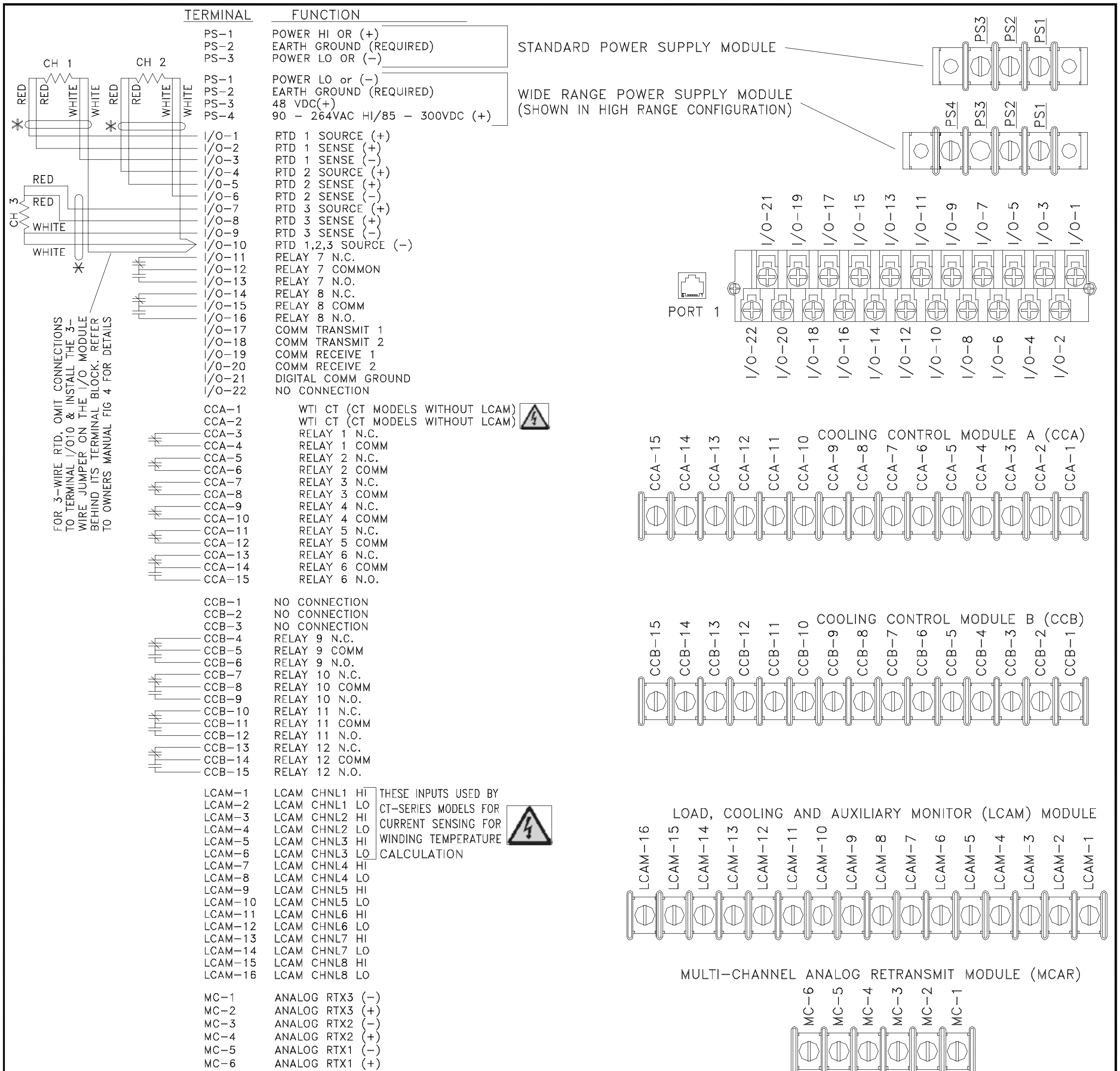


Figure 10C. Terminal Assignments; TC & CT/LTC Models with 4/2/0 or 4/2/4 Relay Module Schemes

Only the CT/LTC model has a WTI CT input. Terminal Screws on all modules except the I/O module have #6-32 threads. Do not mix I/O module screws with screws from another module, or thread damage will result. The actual model may not contain all optional hardware shown.



TERMINAL SCREWS ARE REMOVED FOR OPTIONS WHICH ARE NOT INSTALLED. THE WIDE RANGE POWER SUPPLY IS FACTORY-CONFIGURED WITH A SCREW IN THE HIGHEST RANGE AND A PLASTIC PLUG IN THE LOW RANGE, TO AVOID ACCIDENTAL CONNECTION OF HIGH VOLTAGE TO THE LOW RANGE. IF THE LOW RANGE IS REQUIRED SIMPLY REVERSE THE POSITIONS OF THE PLUG AND SCREW.

THE I/O MODULE TERMINAL SCREWS ARE COLOR CODED FOR THREAD SIZE. SCREWS HAVE EITHER 3.5-0.6MM (RED) OR 3.0-0.5MM (BLUE-BLACK) THREADS THAT MUST NOT BE MIXED WITH SCREWS

MODULES ARE SHOWN IN DEFAULT POSITIONS, HOWEVER; THE POSITIONS OF THE MODULES IN THE LOWER COMPARTMENT ARE INTERCHANGEABLE. CHECK MODULE LABELS BEFORE MAKING CONNECTIONS.

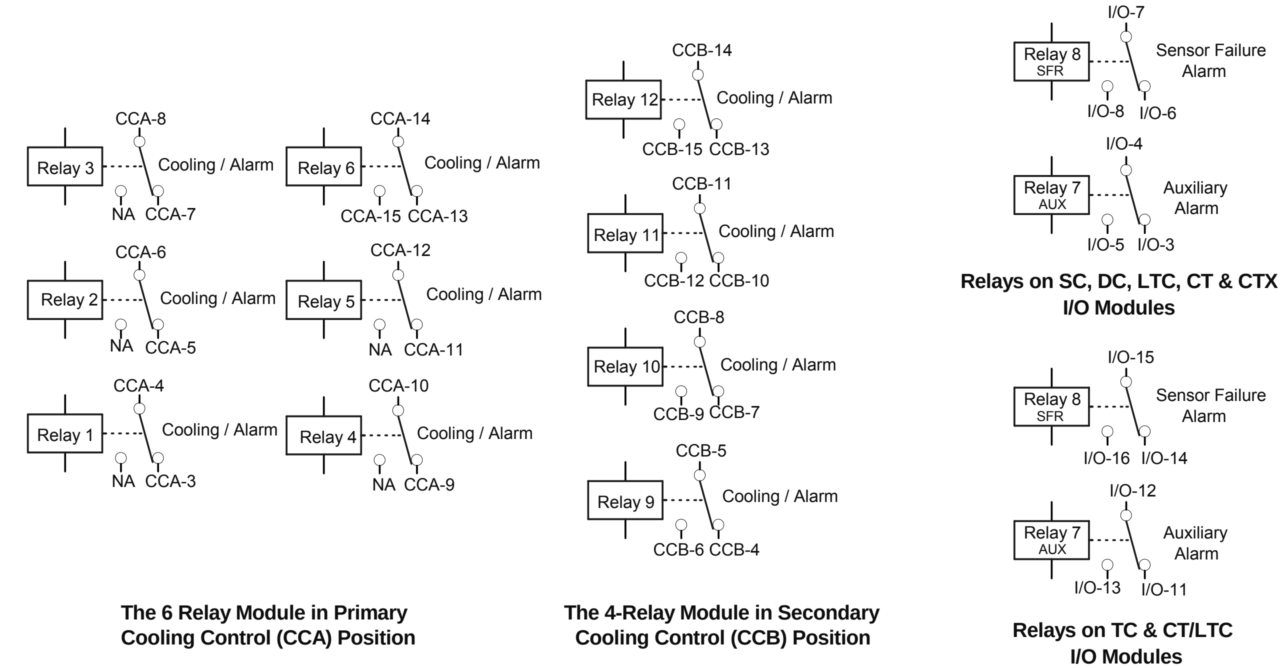
THIS DIAGRAM SHOWS OPTIONAL MODULES WHICH MAY NOT BE INSTALLED ON ALL MODELS, DEPENDING UPON FEATURES ORDERED. REFER TO ORDER DOCUMENTATION TO VERIFY THAT ALL REQUIRED MODULES ARE INSTALLED.

Lethal Voltages are produced when CT secondary leads are opened when the CT is energized. The CT is always energized when the transformer is energized. De-energize the transformer before making any changes to the CT wiring.

Figure 10D. Terminal Assignments; TC & CT/LTC Models with 6/2/0 or 6/2/4 Relay Module Schemes

Only the CT/LTC model has a WTI CT input. Terminal Screws on all modules except the I/O module have #6-32 threads. Do not mix I/O module screws with screws from another module, or thread damage will result. The actual model may not contain all optional hardware shown.

Relay Configurations in the 6 Relay / 2 Relay / 4 Relay (6/2/4) Dual Cooling Control Module Scheme



Relay Configurations in the 4 Relay / 2 Relay / 4 Relay (4/2/4) Dual Cooling Control Module Scheme

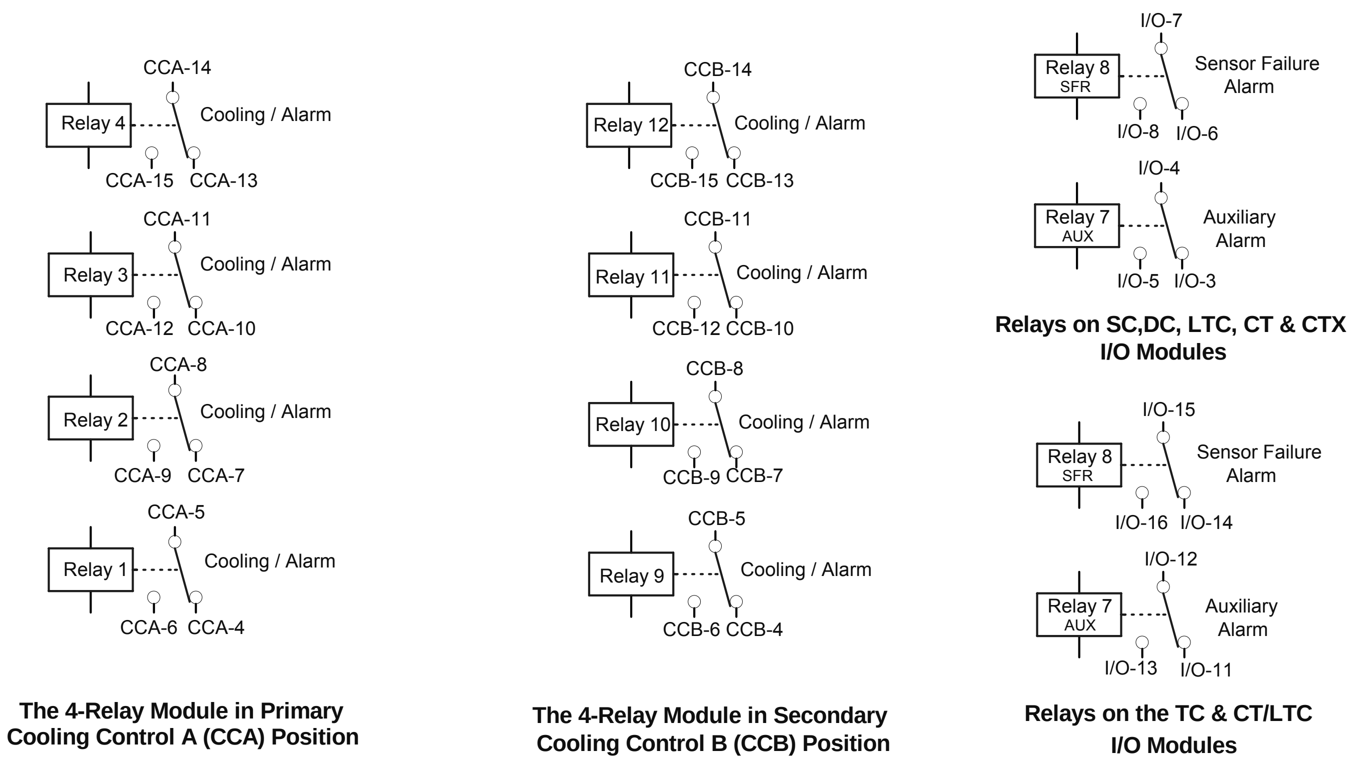
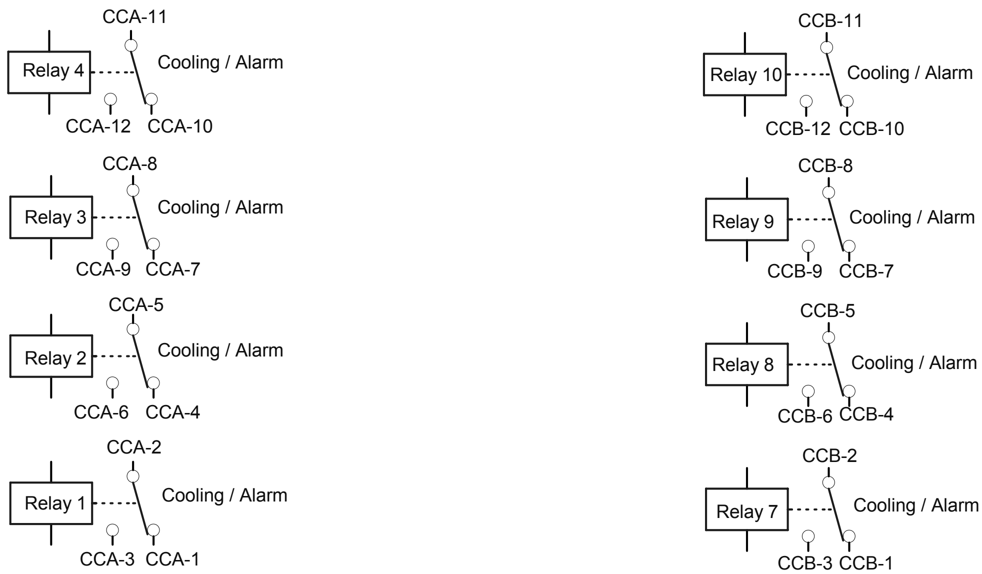


Figure 11. Legacy Relay Map Combinations Using 6-Relay and 4-Relay Cooling Control Modules

Units configured for the legacy relay map will have relays installed on the I/O module.This figure shows both CC Modules and the maximum number of installed relays per module. Different hardware configurations may not be equipped with both cooling control modules nor all relays. Relays 7 and 8 are shown set up for their legacy functions, though they can be configured otherwise. When a single cooling control module is ordered, it is installed in the primary Cooling Control A (CCA) position. All relays are shown in their de-energized states.

Relay Configurations in the 4 Relay / 4 Relay (4 / 4) Dual Relay Module Scheme



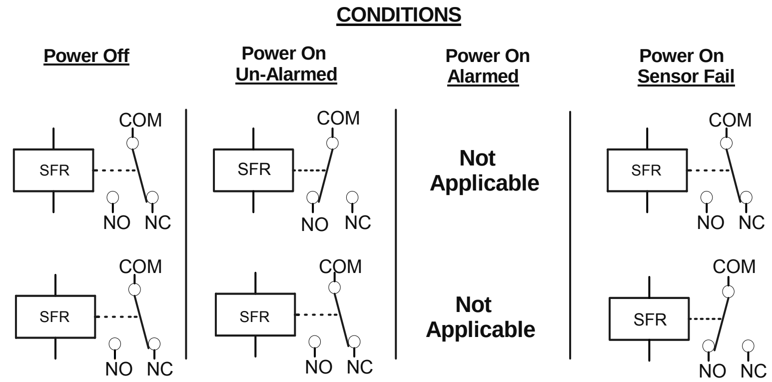
The 4-Relay Module in Primary Cooling Control A (CCA) Position

The 4-Relay Module in Secondary Cooling Control B (CCB) Position

Figure 12. Consolidated Relay Map Combinations Using 4-Relay Cooling Control Modules

Units configured for the consolidated relay map will not have relays installed on the I/O module. This figure shows both CC Modules and the maximum number of installed relays per module. Different hardware configurations may not be equipped with both cooling control Modules nor all Relays. When a single cooling control module is ordered, it is installed in the primary Cooling Control A (CCA) position. All relays are shown in their de-energized states.

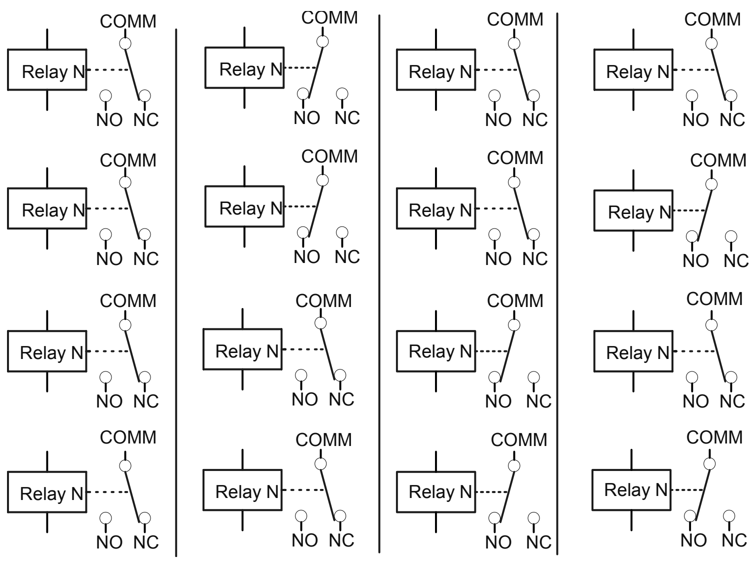
Operation of Sensor Failure Relay



Configuration Set By User

- Normal (Un-Alarmed) State Set to Energized
- Normal (Un-Alarmed) State Set to De-Energized

Operation of All Form C Relays, Other Than the Sensor Failure Relay



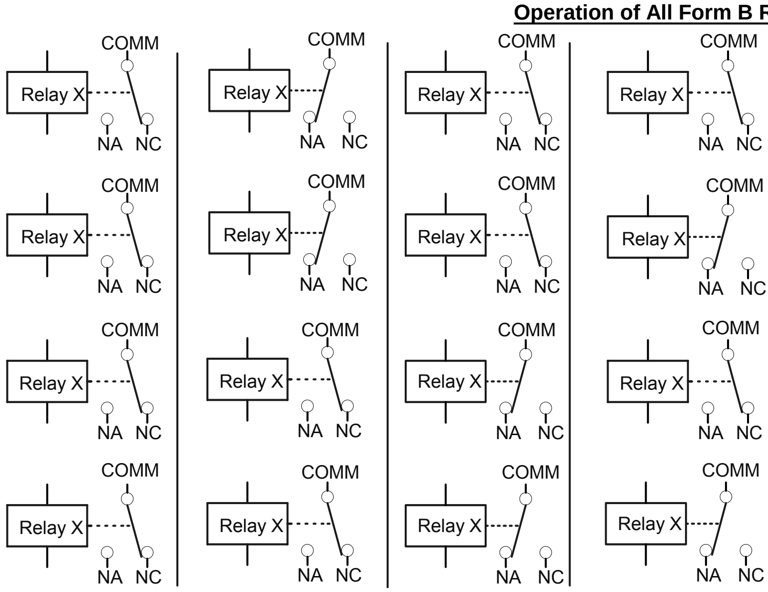
Normal (Un-Alarmed) State Set to Energized (ENRGZ))
Sensor Failure Effect (Prompt SNEFF) Set to De-Energize (DE-EN)
Sensor Failure Function (SNFAL) Set to ON

Normal (Un-Alarmed) State Set to Energized (ENRGZ))
Sensor Failure Effect (Prompt SNEFF) Set to Energize (ENRGZ)
Sensor Failure Function (SNFAL) Set to ON

Normal (Un-Alarmed) State Set to De-Energized (DE-EN)
Sensor Failure Effect (Prompt SNEFF) Set to De-Energize (DE-EN)
Sensor Failure Function (SNFAL) Set to ON

Normal (Un-Alarmed) State Set to De-Energized (DE-EN)
Sensor Failure Effect (Prompt SNEFF) Set to Energize (ENRGZ)
Sensor Failure Function (SNFAL) Set to ON

Operation of All Form B Relays



Normal (Un-Alarmed) State Set to Energized (ENRGZ))
Sensor Failure Effect (Prompt SNEFF) Set to De-Energize (DE-EN)
Sensor Failure Function (SNFAL) Set to ON

Normal (Un-Alarmed) State Set to Energized (ENRGZ))
Sensor Failure Effect (Prompt SNEFF) Set to Energize (ENRGZ)
Sensor Failure Function (SNFAL) Set to ON

Normal (Un-Alarmed) State Set to De-Energized (DE-EN)
Sensor Failure Effect (Prompt SNEFF) Set to De-Energize (DE-EN)
Sensor Failure Function (SNFAL) Set to ON

Normal (Un-Alarmed) State Set to De-Energized (DE-EN)
Sensor Failure Effect (Prompt SNEFF) Set to Energize (ENRGZ)
Sensor Failure Function (SNFAL) Set to ON

Figure 13. Relay Operation for Various Alarm and Power Conditions (Legacy and Consolidated Relay Maps)

Relays “N” and “X” have their sensor failure (SNFAL) value set to “ON”. If the SNFAL value is set to “OFF” the relay will remain in its current state if a sensor failure is detected.

4.0 Configuration

Introduction

The configuration section describes actions the user can take to set up the Advantage for first use, or modify settings as required at other times. This section first presents the steps necessary to enter and navigate through the menus accessible from the front panel, through the use of graphical keystroke diagrams. The diagrams are followed by a textual keystroke-by-keystroke guide to options offered in the keystroke menus.

If digital communications has been ordered, it may be used with the included configuration software to enter set up parameters from a personal computer (PC) as an alternative to the front panel programming method. The configuration software allows users to create and store set-ups such that they can be immediately uploaded to the Advantage, or stored for later use. This feature allows a template file to be created in advance, which can store a user's standard operating parameters and be available for modification to suit a particular transformer installation. **If parameters are supplied to Weschler in advance, the user's default template can be loaded in the factory.**

Also included in the digital communications package is a monitor module which allows for remote viewing of measured quantities on a PC, a firmware update module which provides for firmware upload via PC, and a logged data utility that provides for downloading and visualizing peak and valley data via imbedded graphing and sorting for application to third party spreadsheet software. Once installed, the configuration, monitor and firmware updating software is launched from a mouse click. Refer to the SMAMT200 software manual for more details.

Regardless of input method, the keystroke-by-keystroke guide provides valuable explanations and recommendations for setting up your Advantage.

This manual is written to describe the features and functions of several Advantage models, some of which may not have all of the features described herein. Where a feature is limited to a single model or only a few models, a note will be included to point out the limitation.

Supervisory Setup

The supervisor setup routine, also referred to as the main configuration loop, is used to configure parameters which will fit the advantage to the application and transformer being monitored. The keystroke diagram of figure 14 summarizes the steps required to enter the configuration loop. Figure 15 is the summary keystroke diagram of the main configuration loop. This figure presents the prompts for the menu's top level. Figures 16A - 16G are the detail keystroke diagrams of the main configuration loop. These figures show the menu's top level prompts and the logic that lies beneath them. One should not be intimidated by the menu structure; simply follow the arrows to understand the menu sequence.

Users with other-than CT series models should skip past the CT-Series paragraphs immediately below, to figure 14.

CT, CTX and CT/LTC models Only

When the Advantage is first powered on, if a configuration file has ***not*** been previously entered, the "RELAY SETUP" menu is automatically entered, followed by the ALARM SETUP, then USER SETUP loops. This is done to guide the person performing the configuration to enter parametric information which tailors the winding temperature algorithm to the specific transformer being managed. The normal entry, using the password, is bypassed this one time in order that the necessary values are entered prior to the first usage. **If a user has supplied Weschler with a configuration profile, and it has been installed at the factory, the required values will already have been entered and the automatic RELAY SETUP, ALARM SETUP and USER SETUP entry will be bypassed.** Configuration files created by the configuration software can also be uploaded at startup to satisfy the requirement for initial parameters, instead of entering values from the front panel.

The user may elect to create and load his or her own configuration file, using digital communications. As soon as the file is uploaded, the Advantage will exit the RELAY SETUP, ALARM SETUP and USER SETUP loops and enter the normal operation mode.

Relay Set Up Summary:

It is assumed that CT-series Advantage will operate cooling equipment as part of its winding temperature function, and in order to control the equipment the Advantage must be “told” what type of cooling equipment it is connected to, in the relay set up. In order to exit the RELAY SETUP function, the user must select the type of equipment each active relay will be controlling. The selection is made when the “CNEQP” prompt appears in the RELAY SETUP menu. If the user has not yet decided which alarms to assign to which equipment and source, (s)he may select the “NONE” option and return to this menu later to make final assignments. At least one cooling stage must be declared as connected equipment in order to exit the RELAY SETUP loop. See figure 16A and the “Prompt CNEQP” paragraph in the keystroke-by-keystroke guide for further details.

Alarm Set Up Summary:

The ALARM SETUP menu provides a method to specify alarm sources, set point values and which relay, if any. the alarm will control. See the figure 16A and the keystroke-by-keystroke guide for detailed information on this menu.

User Set Up Summary:

In the USER SETUP menu there are a maximum of 17 values (43 values with LCAM) for the winding temperature function which **may** be entered. Four of these, Fluid Type, Fluid Capacity, Winding Type and Core & Coil Weight are not required, but do provide information that can make the calculation of winding temperature more accurate. Some of the required parameters will not appear in the front panel display because the selections of connected equipment that were made in the RELAY SETUP menu will have made them inapplicable. For example, in RELAY SETUP if you had set the connected equipment for a relay as OFAN (pumps, not directed), then the two prompts and their submenus dealing with directed oil flow (ODAN & ODAF) will not appear. The USER SETUP loop also has required parameters that **must** be entered in order to exit the loop. The actual number of parameters depends upon the type of fluid circulation and whether an LCAM module is installed and how many of its channels have been enabled.

Examples for CT-Series Models without an LCAM Module

There will be three required parameters for a transformer with ONAN cooling

Parameter	Prompt
Full load winding current:	IMAX1
ONAN Rating:	MVA1
ONAN Gradient:	GRAD1

For transformers with ONAN/ONAF/OFAF cooling stages there will be 7 required parameters; ONAN rating and gradient (ONAN MVA1 and ONAN GRAD1), ONAF rating and gradient (ONAF MVA1 and ONAF GRAD1) and OFAF rating and gradient (OFAF MVA1 and OFAF Grad1).

Parameter	Prompt
Full load winding current:	IMAX1
ONAN Rating:	MVA1
ONAN Gradient:	GRAD1
ONAF Rating:	MVA1
ONAF Gradient:	GRAD1
OFAF Rating:	MVA1
OFAF Gradient:	GRAD1

Examples for CT-Series Models with an LCAM Module

If the LCAM module is installed there is an additional set of required parameters for each of the three current measurement channels that is enabled. Thus the list for a transformer with ONAN/ONAF/OFAF ratings with two current measurement channels enabled would be:

Parameter	Prompt	Prompt
Full load winding current:	IMAX1	IMAX2
ONAN Rating:	MVA1	MVA2
ONAN Gradient:	GRAD1	GRAD2
ONAF Rating:	MVA1	MVA2
ONAF Gradient:	GRAD1	GRAD2
OFAF Rating:	MVA1	MVA2
OFAF Gradient:	GRAD1	GRAD2

See figure 16B in this section for a graphic illustration of parametric entry for the USER SETUP menu. The shaded areas of figure 16B indicate items that only apply to LCAM-equipped CT-series models

In order to exit the USER SETUP menu, all required parameters must be entered. If any of the required values are not entered, the user will be returned to the prompt which requests it. This recursion is designed to ensure that intentional values, rather than default values, are entered. Without this information the Advantage cannot function properly. In the detail keystroke diagram of figure 16B, the required values are labeled as “Required Parameters” to highlight their importance. Note that the keystroke diagram shows all required parameters for completeness; however, if the connected equipment declaration shows that certain cooling modes are inapplicable, they will not appear in the actual front panel menu and will not be required. Please visit the keystroke by keystroke guide in this section for further information on required parameters.

After the USER SETUP parameters are entered, the display automatically sequences to the next menu item. If no further action is taken in the main menu, the normal operation mode will be resumed in 45 seconds.

Once the RELAY SETUP, ALARM SETUP and USER SETUP parameters are entered, the user may freely navigate to other set up menus or exit the configuration loop to normal operation.

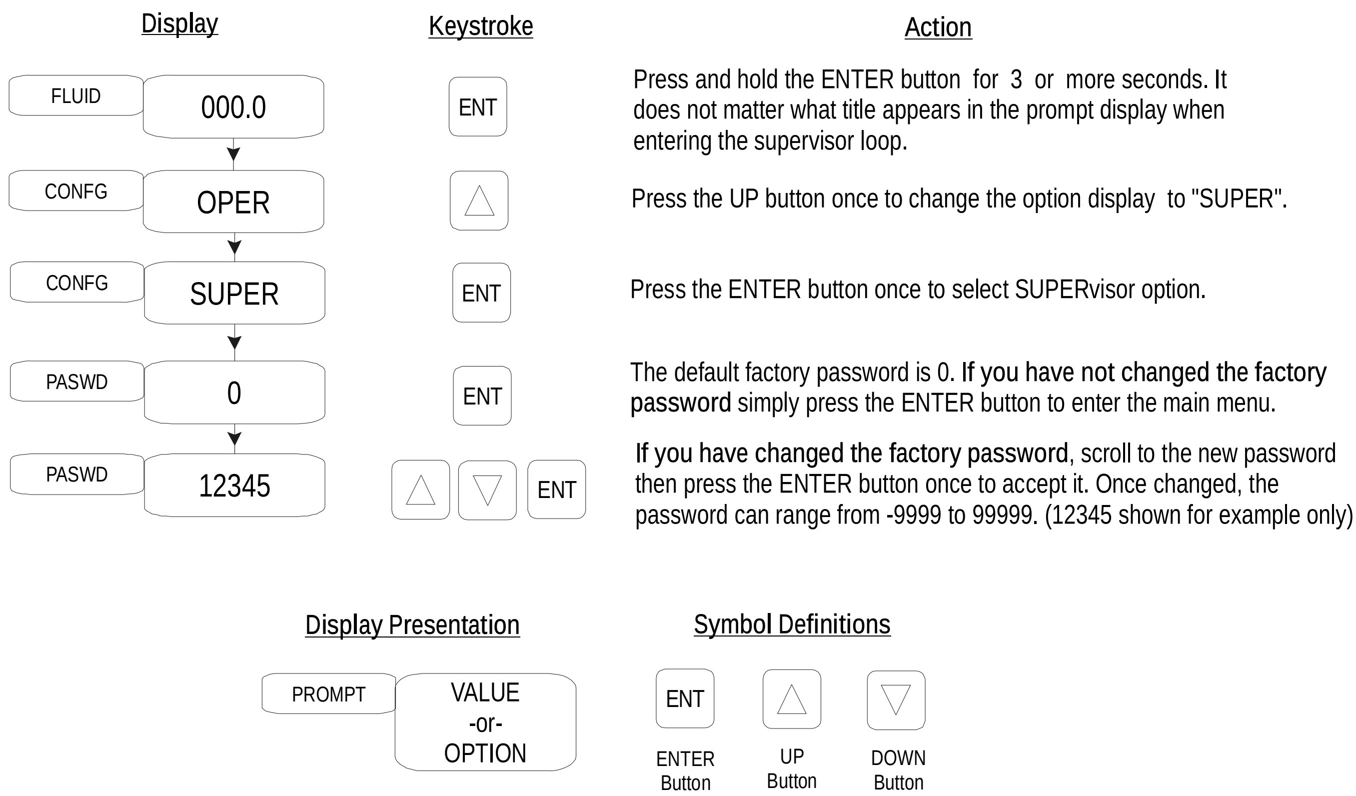


Figure 14. Keystroke Diagram for Supervisor Mode Entry

Figure 14 illustrates the conventions used in all keystroke diagrams. The display presentation corresponds to the actual front panel display, as shown in Figure 1A. In the main configuration loop, the prompt display contains the name of the sub menu below it. When the sub loop menu is entered, the prompt display may change to a units display, showing AMPS, TONS or other units, to guide the user in his or her selection. The value / option display shows a list or range of values the user can select.

The UP and DOWN buttons are used to switch between option choices or increase or decrease numeric values. Using these buttons is referred to as “scrolling” to a value or choice.

The ENTER button is used to accept a value or option and move on to the next menu item. The enter button may also be used to step through the menu items without changing any values. If you want to simply view a value, press the enter button after the value is shown, without pressing an up or down button. If you want to change a value, you must first set the value with the up or down button, then press the enter button to accept it.

As you navigate through the keystroke diagrams, there are some symbols that appear on the diagram, but don’t appear on the front panel. The most common of these is a diamond shaped symbol, with a statement and question mark inside. This is referred to as a decision block. The decision block symbol represents a logical question that the software “asks” itself, in response to a user entry. The “answer” to the question causes the program to decide which of two or more paths to take. The decision blocks were provided to make it clearer to the user how the program logic works, underneath what (s)he can see on the front panel displays.

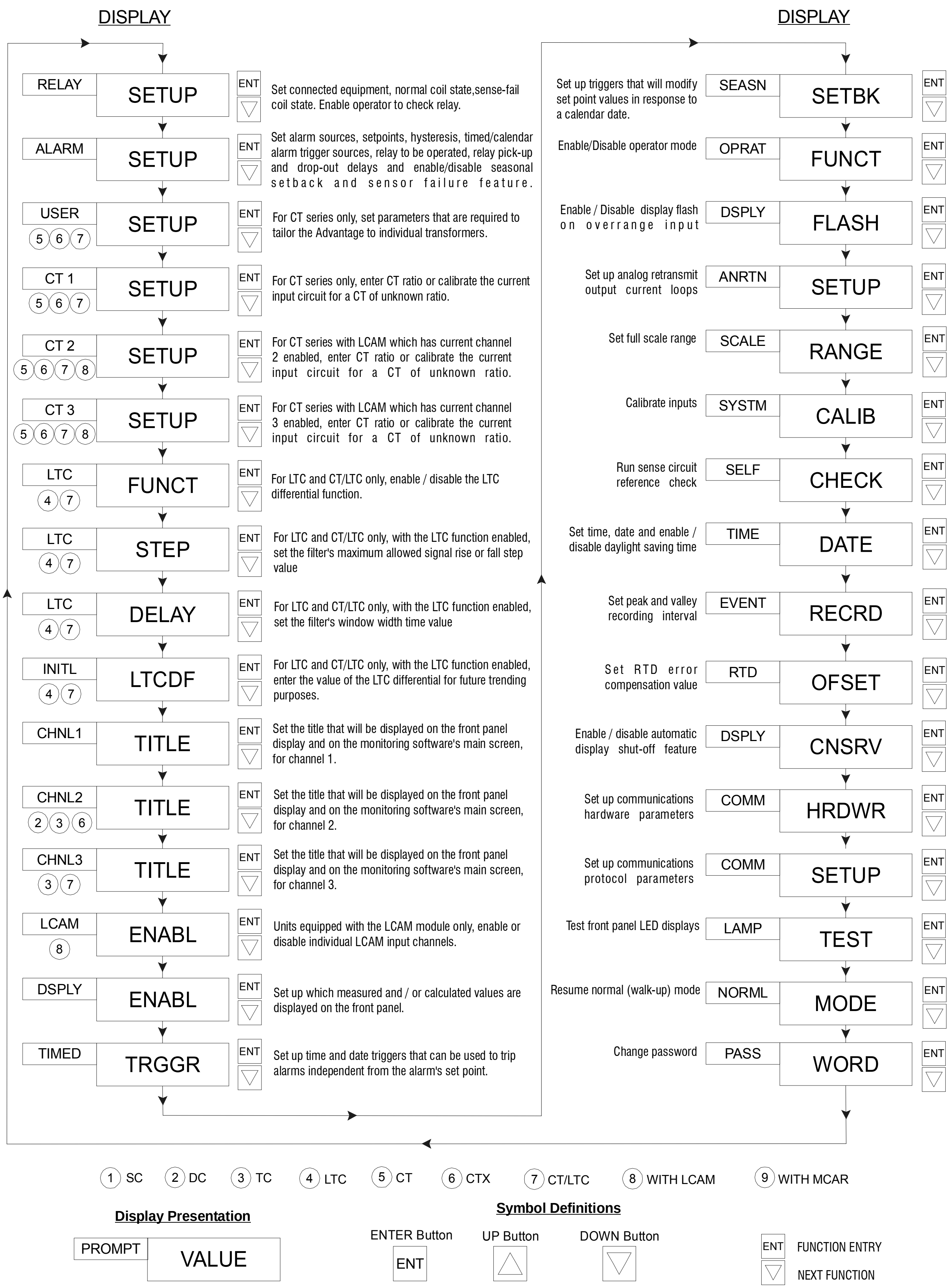


Figure 15. Main Configuration Loop Summary Keystroke Diagram

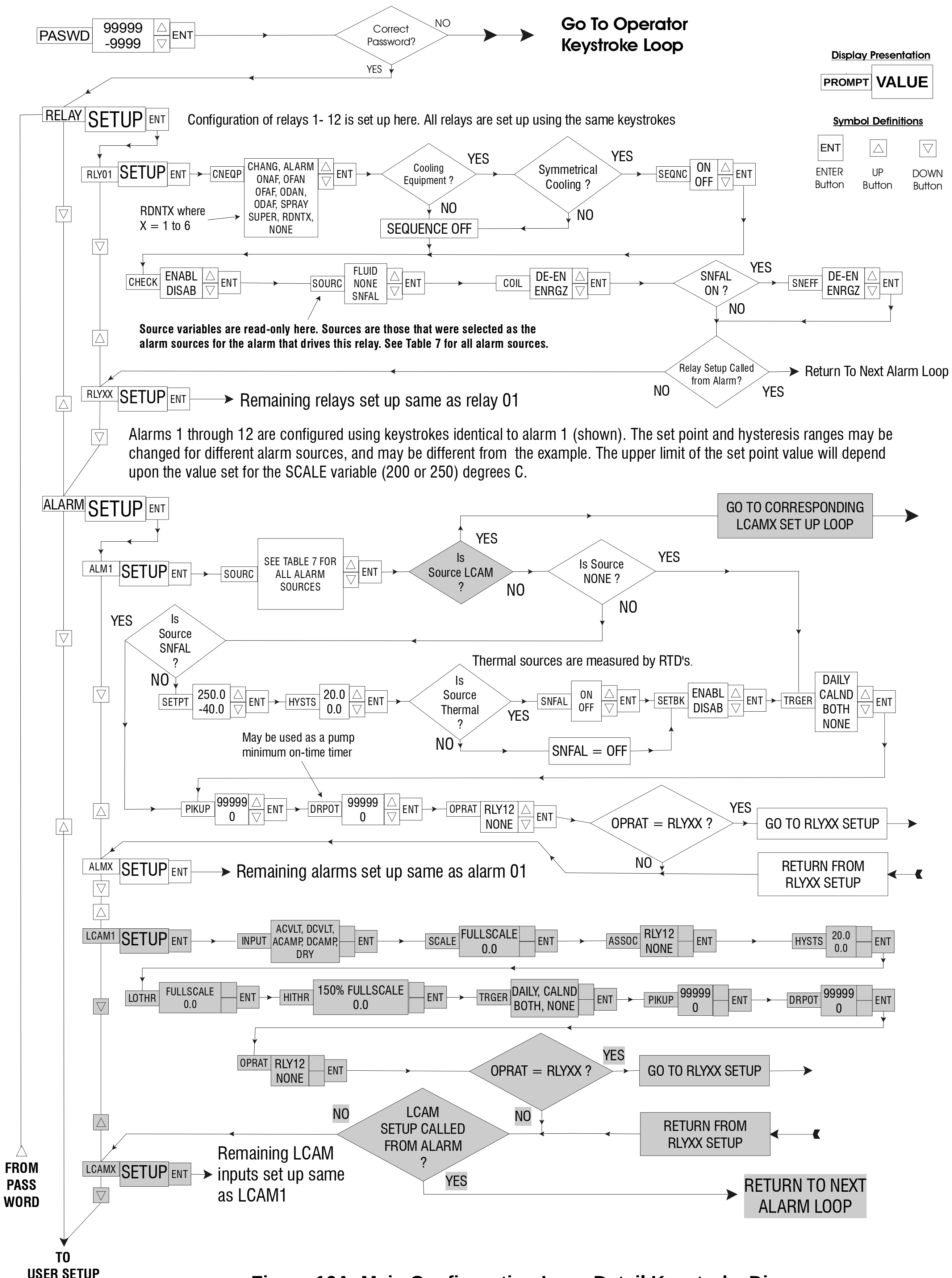


Figure 16A. Main Configuration Loop Detail Keystroke Diagram

USER SETUP loop for CT-series only and shaded areas for LCAM-equipped CT-series models only. Temperatures in degrees Celsius.

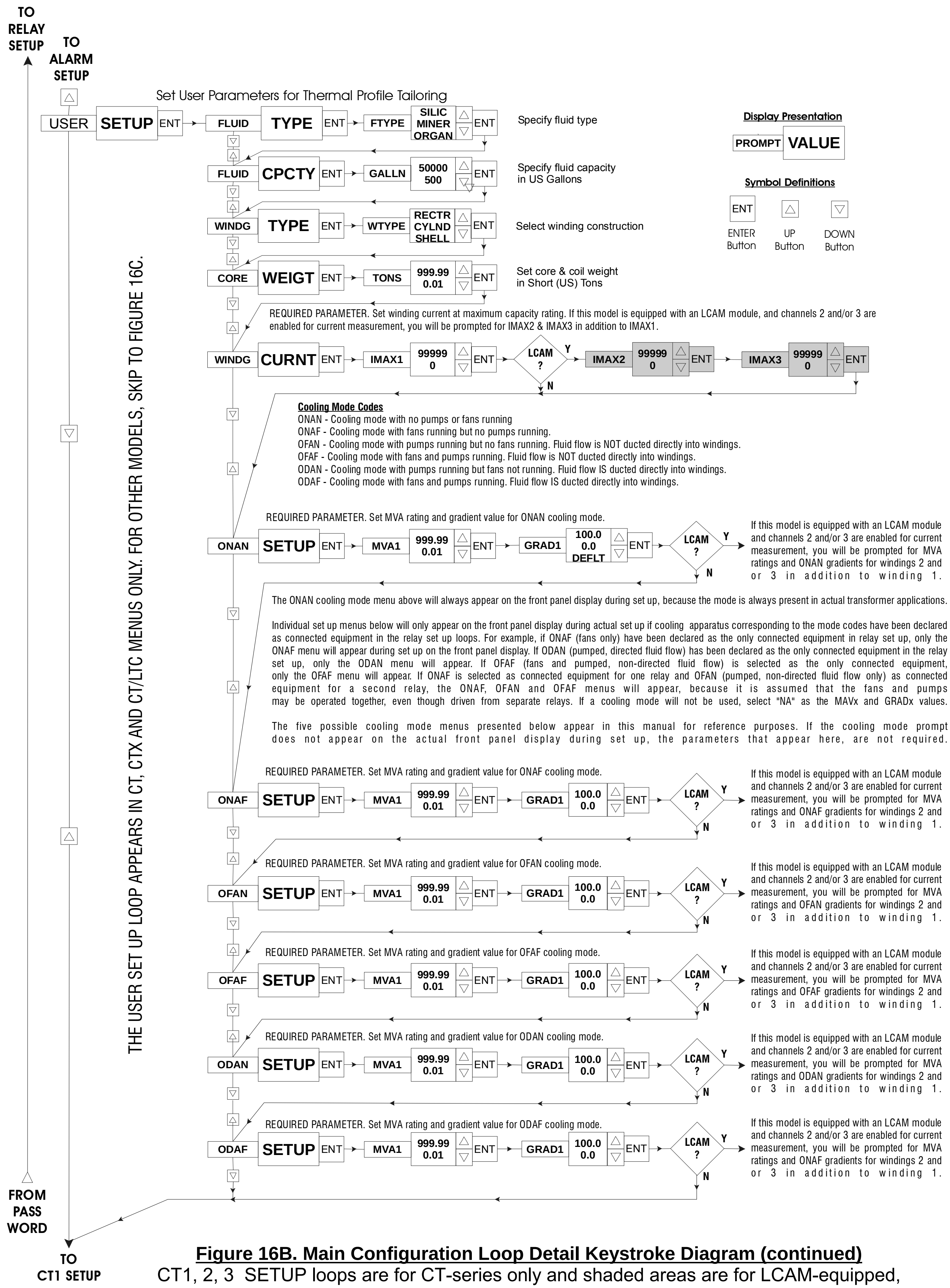
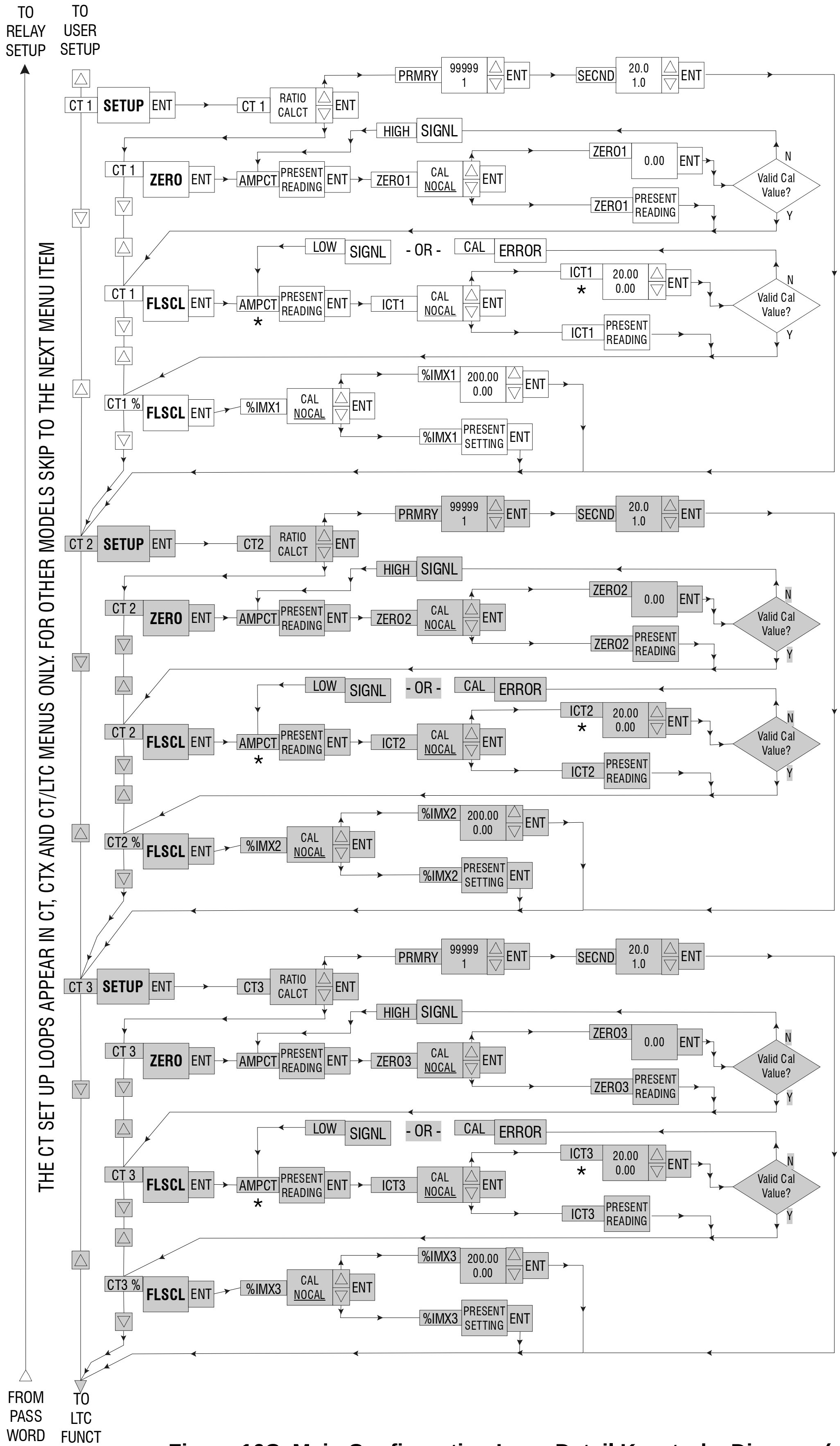


Figure 16B. Main Configuration Loop Detail Keystroke Diagram (continued)

CT1, 2, 3 SETUP loops are for CT-series only and shaded areas are for LCAM-equipped, CT-series only. Temperatures in degrees Celsius



If the primary and secondary ratio factors are known, they can be entered directly at the PRMRY and SECND prompts.

Refer to the CT1, 2 & 3 SET-UP paragraphs in the keystroke-by-keystroke guide to set-up, in the configuration section for details on how to set up the current inputs in the event that the winding temperature indicator (WTI) CT ratio is not known.

* Functions marked with an asterisk are provided with an extended 5 minute time-out if the enter button is not pressed.

The CT2 and CT3 set up loops will only appear if an LCAM module is installed and if channels 2 & 3 have been enabled.

Figure 16C. Main Configuration Loop Detail Keystroke Diagram (continued)
Shaded areas apply to models equipped with LCAM only.

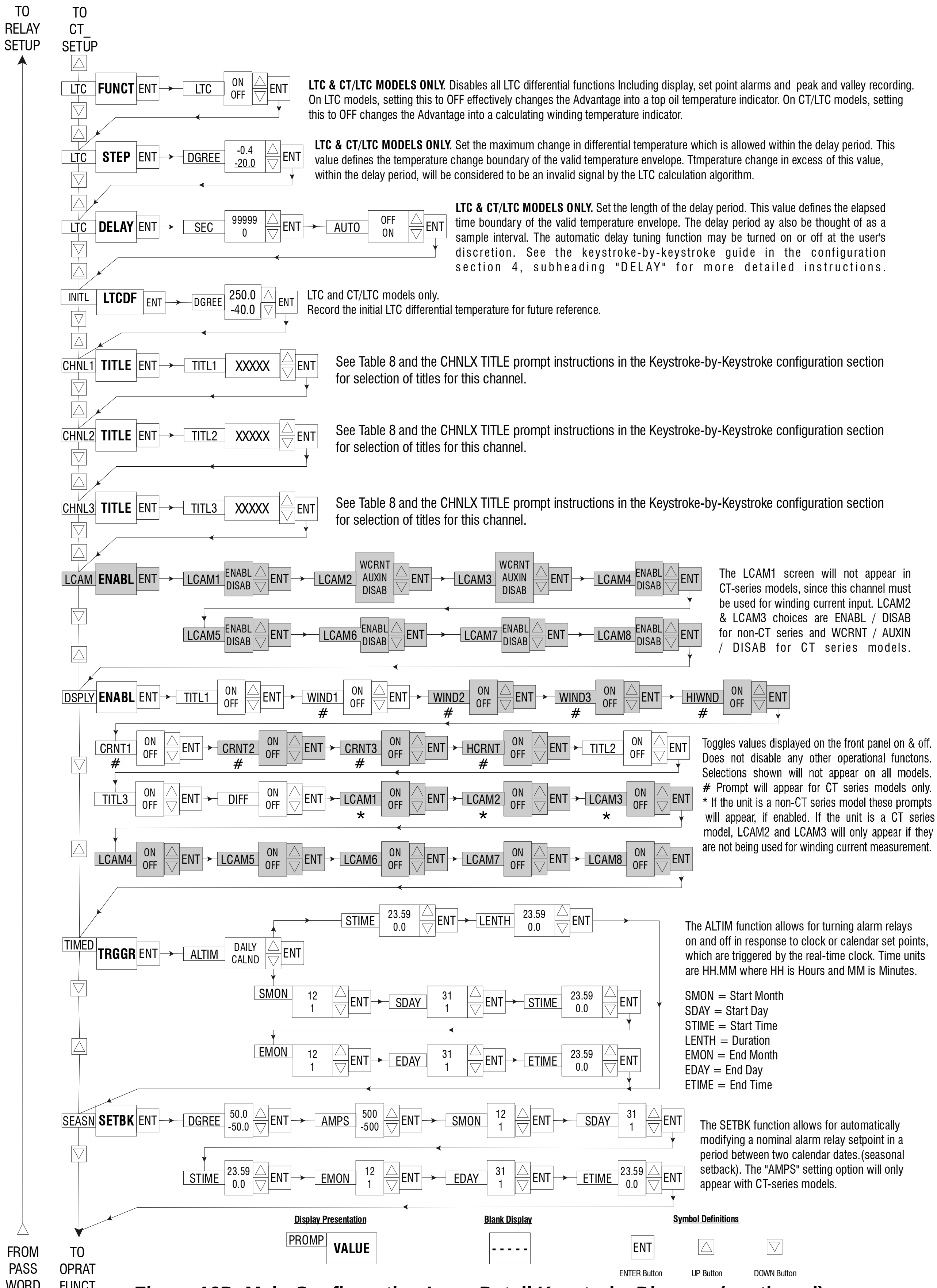


Figure 16D. Main Configuration Loop Detail Keystroke Diagram (continued)

Shaded areas apply to models equipped with LCAM. The alarm source titles shown in figure 16A will reflect title choices made in the CHNL1 TITLE, CHNL2 TITLE and CHNL3 TITLE menus. Temperatures in degrees Celsius.

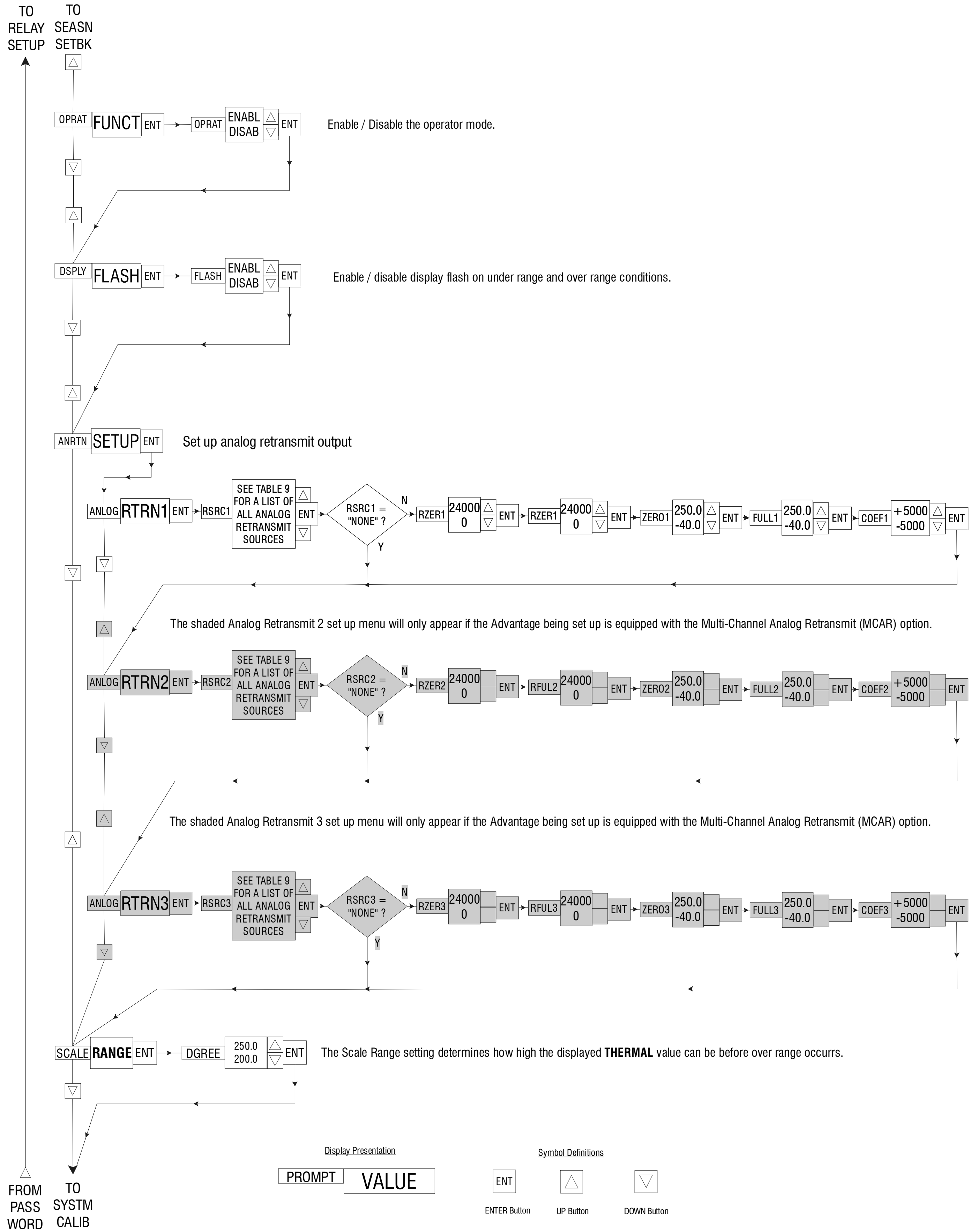


Figure 16E. Main Configuration Loop Detail Keystroke Diagram (continued)
Shaded areas for MCAR-equipped models only. Temperatures in degrees Celsius.

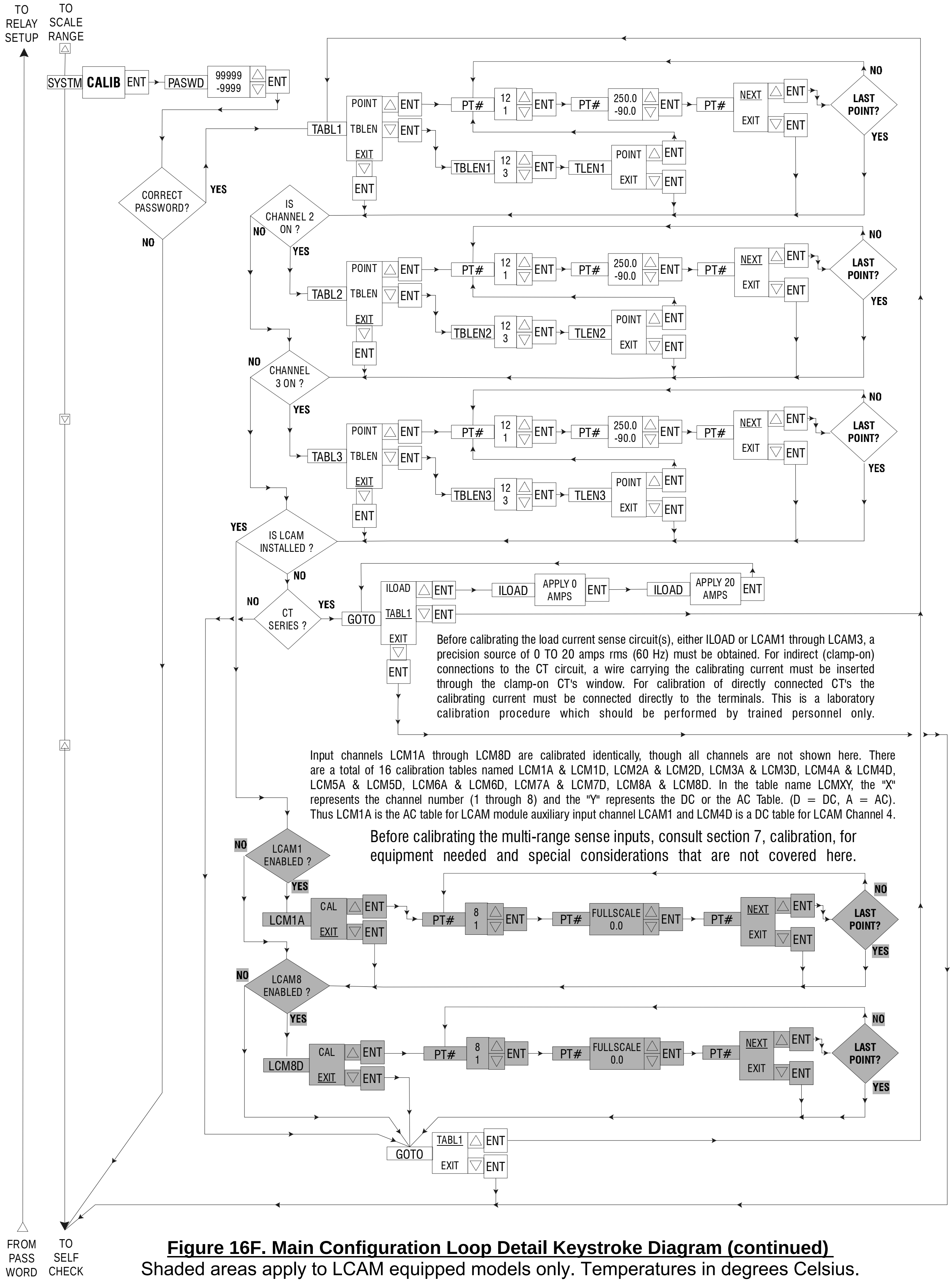


Figure 16F. Main Configuration Loop Detail Keystroke Diagram (continued)

Shaded areas apply to LCAM equipped models only. Temperatures in degrees Celsius.

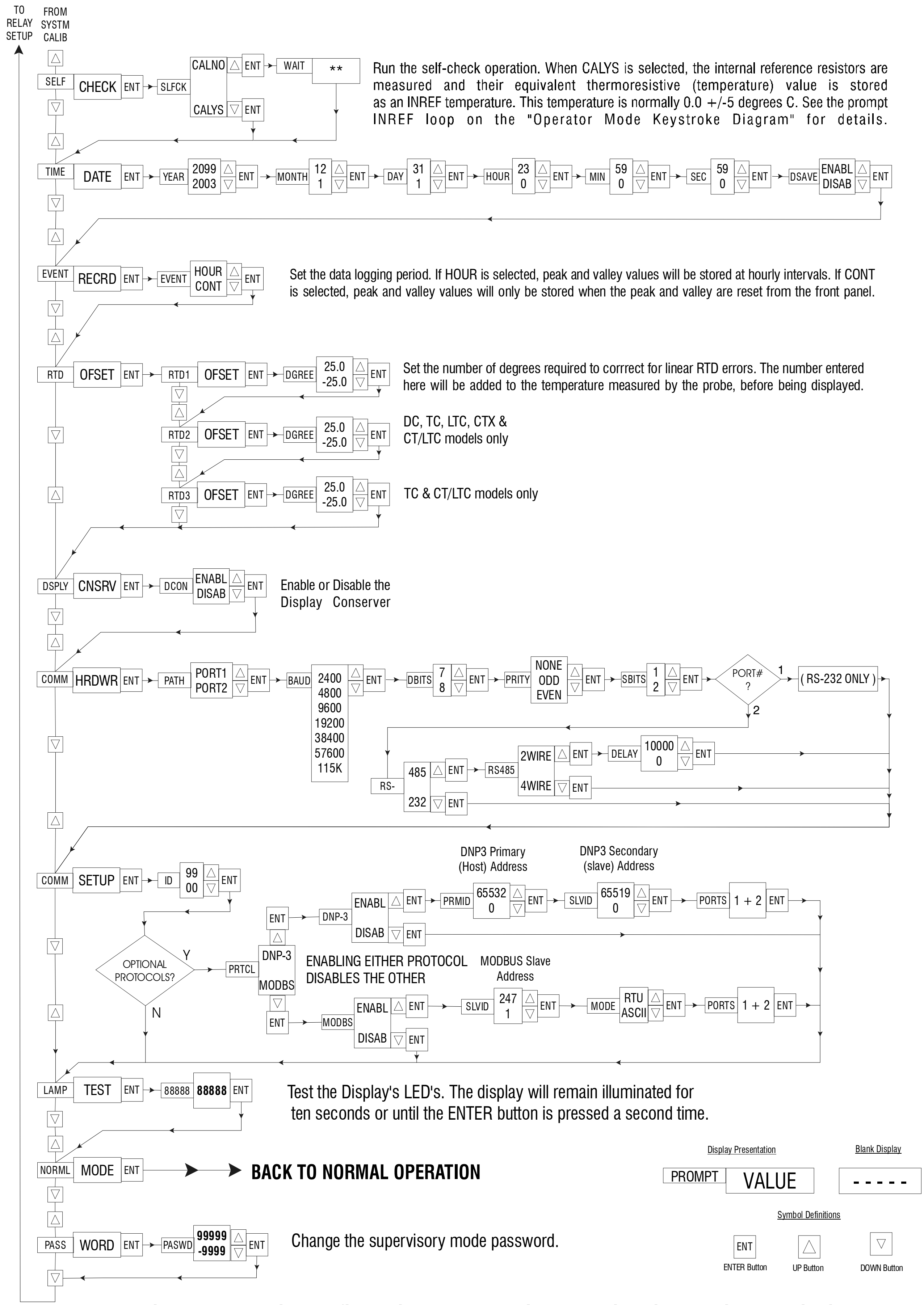


Figure 16G. Main Configuration Loop Detail Keystroke Diagram (conclusion)

Temperatures in degrees Celsius. Time in 24 hour format

Keystroke by Keystroke Guide to Setup

This guide describes operation of the functions and options available in the various front panel menus. It is structured and sequenced in the same order as the keystroke diagrams for a direct reference as values are entered. The paragraphs which describe the prompts in the main menu loop level are placed on the left margin. Sub loop paragraphs are indented below the main loop prompt paragraphs. The descriptions and recommendations are the same for those using the AMTCMF configuration software, but since the software allows the user to enter data in a more random fashion, more attention should be paid to the front panel sequence if using the software for the first time. A software users manual SMAMT200 is provided for software users.

Prompt RELAY SETUP, Relay Configuration Menu
All Models

Introduction

The RELAY SETUP menu is the first step encountered in the supervisory loop after providing the correct supervisory password. The RELAY SETUP configuration loop is provided to enter parameters specific to the relay's operation. Only enabled relays will be offered for configuration in the relay setup menu loop. Relays are enabled or disabled using the AMTCMF configuration software. See the SMAMT200 software manual for details of relay enablement and configuration.

When a non-CT series (SC, DC, TC or LTC) model is powered up, if a configuration file has not been previously entered, the RELAY SETUP menu will be automatically entered to guide the user to configure the relays first. A relay is considered to be configured when the connected equipment option is changed from "CHANG", which is the startup default, to any other option. When attempting to leave the relay set up menu, the menu will be reentered if any ***enabled*** relay still has the connected equipment option declared as "CHANG". The normal entry, using the password, is bypassed in order that the necessary values are entered prior to the first usage.

When a ***CT-series*** Advantage is first powered on, if a configuration has ***not*** been previously entered, the RELAY SETUP menu is automatically entered, followed by the ALARM SETUP, then USER SETUP loops. This is done to guide the person performing the configuration to enter important parametric information which tailors the winding temperature algorithm to the specific transformer being managed. The normal entry, using the password, is bypassed in order that the necessary values are entered prior to the first usage. Users will be guided back into menu loops that contain unconfigured, required parameters.

Relay Maps

The name "relay map" simply refers to a relay numbering scheme and the physical location of the relays, for example, on which modules the relays are installed. The relay map can take two forms; legacy or consolidated, depending upon which hardware complement you have. The two relay map's characteristics are described fully beginning on page 16. The Legacy and Consolidated relay map paragraphs below are summarys of those expanded explanations.

Both relay maps allow any relay to be set up to respond to any of the alarm sources shown on the alarm sources list beginning on page 50.

Legacy Relay Map

The legacy relay map assigns numbers to relays physically located on **C**ooling **C**ontrol Module **A** (CCA), the I/O module and **C**ooling **C**ontrol Module **B** (CCB).

CCA can be a six-relay module or a four-relay module. The six-relay module has 5 form B relays assigned relay numbers 1 - 5 and a form C relay assigned relay number 6. The four-relay module has 4 form C relays assigned relay numbers 1 - 4.

The I/O module has physical positions for two relays, numbered 7 and 8. Relay 7 is an optional form C relay referred to as the Auxiliary relay. Relay 8 is always provided in the legacy relay map and it's software definition is set up at the factory as a sensor failure relay (SFR), for continuity with earlier Advantage models. The software definition of relay 8 can be changed from the SFR definition to any other definition simply by changing its alarm source from sensor failure to any of the sources in the list beginning on page 50, then entering any additional relay parameters.

CCB can only be a four-relay module in the legacy map. Relays on CCB are assigned numbers 9 - 12.

Consolidated Relay Map

The Consolidated relay map consolidates all relays on relay modules CCA and CCB. There are no relays on the I/O module in the consolidated map.

CCA can be a six-relay module or a four-relay module. Presently, the six-relay module has 5 form B relays assigned relay numbers 1 - 5 and a form C relay assigned relay number 6. In the near future a relay module with six form C relays, numbered 1 - 6 will be available. The four-relay module has 4 form C relays assigned relay numbers 1 - 4.

CCB presently can only be the four, form C relay module. The relay numbering is 9 - 12. In the near future a relay module with six, form C relays will be available, numbered 7 - 12.

Thus the present implementation of the consolidated relay map has 10 relays on two modules, and, when the six, form C relay module is available, will have 12 relays on two modules.

Prompt CNEQP, Connected Equipment

The CNEQP (connected equipment) function is provided to inform the relay logic what is connected to it. In non-CT Advantage models such as the SC, the CNEQP variable is used to only to determine if relay sequencing should be used. For users of ***non-CT series models***, the paragraphs in this section should ***only*** be referenced for an explanation of the various types of connected equipment.

In models in the CT series, which have a winding temperature calculation algorithm, the CNEQP variable serves a much more complex function.

The connected equipment function is intended to identify the types of equipment that the Advantage is controlling. The function offers seven effective values and five informative values. The effective values ONAF, OFAN, OFAF, ODAN and ODAF are the most common forms of cooling. These values are important factors that are used in equations that calculate the winding temperature. The values are also used to automatically limit the number of parameters that are required for proper set up. Proper selection is therefore extremely important. The ONAN cooling mode is not present here because this mode does not employ any powered cooling equipment and there is nothing for the Advantage to control.

Cooling Mode Code	Equipment	Characteristics
ONAF	Fans, no Pumps	Air circulated through heat exchangers by fans
OFAN	Pumps, no Fans	Fluid circulated in the tank and heat exchangers by pumps
OFAF	Fans and Pumps	Air circulated through heat exchangers by fans and fluid circulated in the tank and heat exchangers by pumps.
ODAN	Pumps, no Fans	Fluid circulated through the winding and heat exchangers by pumps.
ODAF	Fans and Pumps	Air circulated through heat exchangers by fans and fluid circulated through the winding and heat exchangers by pumps.

Cooling stages are frequently divided such that there are multiple stages of the same equipment or multiple stages, with each stage having its own type of equipment. For example, a common cooling scheme has two stages with fans of each stage. The transformer data plate will identify this type of scheme as ONAN / ONAF / ONAF. In this case the user would simply define two relays that have ONAF connected equipment. Other examples are given below:

Cooling Scheme	Number of Controlled Cooling Stages	Stage Equipment	Relay Connected Equipment Set Up
ONAN/ONAF/OFAF	2	Stage 1 = Fans Stage 2 = Pumps	Relay “1” = ONAF Relay “2” = OFAN
ONAN/ODAN/ODAF	2	Stage 1 = Pumps Stage 2 = Fans	Relay “1” = ODAN Relay “2” = ONAF
ONAN/ODAF/ODAF	2	Stage 1 = Fans & Pumps Stage 2 = Fans & Pumps	Relay “1” = ODAF Relay “2” = ODAF

Note that the relay numbers are just examples; they can be any number from 1 to 12. In the first example above there are fans on the first stage and pumps on the second stage, but when both stages are running there are fans and pumps running, so the stage two cooling mode is coded OFAF. The second example is similar to the first, but with the equipment reversed in the stages and directed oil instead of forced oil. The third example is a straight-forward pairing of equipment on each stage.

The informative values NONE, SUPER and RDNT1 - RDNT6 are provided for user identification purposes only. The NONE value is typically used where there is no equipment connected at the present time or to identify spare relays in the configuration files. The SUPER value should be used when the relay is being used to supervise another relay or process which is not an alarm or cooling apparatus. The RDNT1 to RDNT6 values are provided when it is desired to have relays that are redundant to relays that are operating cooling equipment, to serve as back ups in the event that the relay with defined coling equipment fails. ***It is highly important that the user understands that there must be only one relay per stage with cooling equipment as its connected equipment***. If, for example, you have two relays which control the same cooling equipment, and you have declared cooling equipment as their connected equipment, the Advantage will interpret that as two distinct stages and the resultant winding temperature calculations will be incorrect.

If, for example you have the cooling scheme of example one in the table above and you wanted to have back-up redundancy on both cooling stages, the correct way to configure the connected equipment is:

Relay 1 = ONAF
Relay 2 = ONAF
Relay 3 = RDNT1 (connected to ONAF stage 1)
Relay 4 = RDNT2 (connected to ONAF stage 2)

The informative value SPRAY refers to an emergency method of cooling that is not defined in the Advantage winding temperature algorithm. It is simply provided for identification in configuration files for user convenience.

The informative variable CHANG is the default value which only remains displayed if the connected equipment has never been declared. This is a signal to the Advantage that the value needs to be changed. If you do not change this value to another informative value or an effective value you will be returned to the connected equipment menu item to correct the error. Once a user selects another value the CHANG variable will disappear permanently.

All ***enabled*** relays must have their connected equipment variable declared before normal operation will begin. If the relay is not enabled it will not appear in the menu. If connected equipment is not declared the operation will be held in the “RELAY” display until the connected equipment is selected. The “NONE” option can be chosen for any relay, but the winding temperature algorithm requires that at least one of the alarms must be defined as having some form of cooling equipment, if the cooling mode is ***not*** ONAN. If no cooling equipment is declared the algorithm will assume that the cooling mode is ONAN only. If you exit the relay loop without declaring cooling equipment as connected equipment for at least one relay, the display will flash “NO COOLING” for 3 seconds as a warning, before allowing navigation to another menu.

Prompt SEQNC, Relay Sequencing Variable

The relay sequencing function offers a choice of two options; ON or OFF. As one would expect, the ON option allows the relay to be included in a sequencing scheme and the OFF option prevents the relay from being included in a sequencing scheme. Relay sequencing provides a rotation scheme whereby cooling equipment will alternate duty when alarms at different set point levels turn on and off. The most frequent use of this function is to alternate fan or pump stages during cooler weather such that the duty cycles of all cooling equipment are more equal.

The sequencing function is suppressed, and the SEQNC prompt will not appear, until there are at least two relays with the same type of connected cooling equipment declared. Thus, if you are setting up two relays to be included in a sequencing group, the SEQNC prompt will not appear until the second relay's connected equipment is declared as the same type of equipment as the first relay. Once sequencing is turned on for one of the relays with the same cooling apparatus connected, all relays with the same type of cooling apparatus connected are automatically included in the sequencing group.

The sequencing function is suppressed, and the SEQNC prompt will not appear, if the connected equipment is an alarm. This prevents the inadvertent inclusion of relays which drive alarms, into the cooling equipment sequencing group, which would eventually result in nuisance alarms.

The sequencing function is suppressed, and the SEQNC prompt will not appear if the "SPRAY" source is declared as the connected equipment. The spray source is excluded because it is considered to be an emergency cooling measure with somewhat unpredictable cooling characteristics. Likewise, the sequencing function is suppressed, and the SEQNC prompt will not appear if relays with the SUPER (supervisory) or RDNTX (redundant relays 1 - 6) connected equipment is declared.

Prompt CHECK, Relay Check Variable

The relay check function offers a choice of two options; ENABL (check enable), which allows relay checking and DISAB (check disable) which prevents relay checking. This function allows operators to toggle the relay state temporarily, from the front panel (or remotely if equipped with digital communications) in order to check their operation. If relay check is disabled you will be unable to test relay operation from the front panel or through remote digital communications.

The operator checks the relays from the front panel by entering the operator mode, which is not password protected, scrolling to the appropriate alarm and selecting the TEST option when prompted. The alarm will stay in the alarm state for 45 seconds, or until the operator presses the enter button a second time. Refer to the software manual SMAMT200 for details regarding testing relays using software.

Prompt SOURC, Read-Only Display Alarm Sources

This is a convenience read-only display, which allows users to scroll through the alarm source(s) that drive the relay. It is provided as a reference while setting up the relays.

Prompt COIL, Relay Coil Un-Alarmed State Variable

The COIL function offers a choice of two options; DE-EN, (de-energized) which shuts off power to the relay coil in an un-alarmed condition; and ENRGZ (energize) which applies power to the relay coil in an un-alarmed condition. These two choices are provided in order to be able to set up fail safe relays. The option is available on all alarms.

Fail safe relays are used in several situations where an alarm condition and some otherwise unrelated failures would require the relay to move to its alarm condition. Examples of unrelated failures would be any cause of power interruption to the relay coil, such as hardware or instruments power failure, or some forms of firmware malfunction. If the relay is configured with the COIL variable set to energized, the normal or unalarmed state would be energized, meaning the relay would be picked-up in an unalarmed state. Any interruption in power to the relay coil, due to the above events, will cause the relay to drop out. If the contacts which are normally closed with the relay de-energized, are used for the alarm it will be configured for failsafe operation.

Prompt SNEFF, Sensor Failure Effect Variable

The sensor failure effect function provides a choice of two options; DE-EN (de-energize) or ENRGZ (energize). The options allow the user to specify that a relay coil will de-energize or energize whenever a sensor or internal failure is detected. Normally this option allows a user to coordinate the alarm state of a relay due to a planned event with an unplanned sensor failure event. This function setting will have no effect unless the SNFAL variable, found in the ALARM SETUP loop is set to ON.

Prompt **ALARM SETUP**, Set Point Alarm Configuration Menu, figure 16A
All Models

This section describes alarm set up and function in detail. The first section covers general alarm terminology and operational explanations of the system alarms which the Advantage is equipped with. The second part of the section describes the choices available to the user and their functions. The alarm configuration loops are diagramed in Figure 16A, and this may be used as a map for option sequence. All standard alarms are set up using the same keystrokes and all functions operate the same. Models equipped with the LCAM module offer additional functionality, which will be described separately. Each of the variables discussed in this section are configurable on an individual alarm basis. None of the settings for the any of the standard or LCAM alarms affect the settings of any other standard or LCAM alarm.

Alarm Conventions

The concept followed by this firmware version is that sources and triggers drive alarms; alarms drive relays and relays drive external equipment and remote alarms. In order to implement this concept, the relay set up menus are separated from the alarm set up menus. Aside from being able to drive relays from multiple alarm sources and triggers simultaneously, this separation allows alarms to be more closely associated with the sources to which they respond and the relays to be more closely associated with the equipment they control.

The convention used to describe alarms is two dimensional, meaning alarms can be active or inactive and they may be in or out of an alarm condition. An alarm which is active for a particular set point means that it has a relay assigned to it which will respond physically in the event of an alarm condition. This physical response is typically referred to as relay “operation”; which is any change in contact state, regardless of initial or final position. Relay contact states are diagrammed in Figures 11, 12 and 13 in the Installation section. An ALARMED condition merely means the set point value has been exceeded. An UN-ALARMED condition means the set point value has not been exceeded. Hysteresis plays a part in this definition, and an explanation is presented in the “Prompt HYSTS” section. The operate signal provided by the alarm instructs the relay driver logic to put the relay assigned to the alarm into an alarm state, or take it out of an alarm state.

The relay logic simply takes the signal from the alarm logic which tells it to operate or not, and uses the parameters configured in the relay set up loops to properly control the equipment that is connected to it.

Sensor and Internal Failure Alarm Function

The sensor and internal failure alarm is provided to allow the user to remotely signal a sensor ***or*** internal failure event. Terminal connections are provided for all 3 contacts in the form C configuration. In previous Advantage relay schemes, the sensor failure relay (SFR) was a dedicated relay which resided on the I/O module. In the enhanced relay scheme, any relay can be defined as an SFR. Advantage contains circuitry and logic which continuously monitors the sensor and internal functions for correct operation. If a gross malfunction of the sensor, such as an open or shorted condition occurs, the event causes an alert signal to be sent to the alarm logic indicating that a failure has been detected. This alert signal will cause any alarm with a winding or fluid temperature alarm source and its SNFAL option set to ENABL to operate its assigned relay.

The SFR, and any relays it will supervise, must be set up such that the SFR’s operation will envelope the supervised relay’s operation. This means that the SFR’s contacts will open ***before*** the supervised relay operates, and the SFR’s contacts will close ***after*** its supervised relays reset. It is recommended that for all ***supervised relays*** the PIKUP delay period be 1 second or more and that the DRPOT delay be 0 seconds. For the ***SFR*** the PIKUP delay should be 0 seconds and the DRPOT delay should be more than 1 second.

Prompt **ALM1 - ALM12**, standard alarm set up loops. Figure 16A

This is the first sub menu under the main menu ALARM SETUP prompt. The LCAM alarm set up loops are on this same menu level, but are in sequence after all standard alarms (ALM1 - 12). Scan down to the LCAMX paragraph below for details on these alarm’s set up steps.

Prompt **SOURC**, Alarm Signal Source Variable, Figure 16A
All Models

The SOURC variable option offers a choice of one of many alarm sources. The SOURC function exists in all models and hardware configurations, but the alarm source choices are dependent upon the Advantage model and whether it is equipped with an LCAM module. The full list of sources are tabulated in Table 7.

Table 7. Alarm Sources

Model	Measurement	Channel	Source
SC	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	AUX (note 2)	LCAMX	LCAM1, LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
DC	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		2	
	AUX (note 2)	LCAMX	LCAM1, LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
TC	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		2	
		3	
	AUX (note 2)	LCAMX	LCAM1, LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
LTC (LTC Function ON)	RTD (note 1)	1	MANTK
		2	LTCTK
	LTC Differential	NA	DIFF, DEV
	AUX (note 2)	LCAMX	LCAM1, LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
LTC (LTC Function OFF)	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		2	
	AUX (note 2)	LCAMX	LCAM1, LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
CT (Without LCAM)	RTD (note 1)		TOPO, TOPO1, TOPO2, TOPO3 or FLUID
	Winding Current	Current	CRNT1
	Winding Temp	NA	WIND1
CT (With LCAM)	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
	Winding Current (note 2)	LCAM1-LCAM3	CRNT1, CRNT2, CRNT3, HCRNT
	Winding Temp (note 2)	NA	WIND1, WIND2, WIND3, HIWND
	AUX (note 2,3)	LCAM2-LCAM8	LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
CTX (Without LCAM)	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	Winding Current	Current	CRNT1
	Winding Temp	NA	WIND1
CTX (with LCAM)	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	Winding Current (note 3)	LCAM1-LCAM3	CRNT1, CRNT2, CRNT3, HCRNT
	Winding Temp (note 3)	NA	WIND1, WIND2, WIND3, HIWND
	AUX (note 2, 3)	LCAM2-LCAM8	LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
CT/LTC (LTC Function OFF & Without LCAM)	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		3	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	Winding Current	Current	CRNT1
	Winding Temp	NA	WIND1

Model	Measurement	Channel	Source
CT/LTC (LTC Function ON & Without LCAM)	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	LTCTK
		3 (note 4)	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	LTC Differential	NA	DIFF, DEV
	Winding Current	Current	CRNT1
	Winding Temp	NA	WIND1
CT/LTC (LTC Function OFF & With LCAM)	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		3	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	Winding Current (note 3)	LCAM1-LCAM3	CRNT1, CRNT2, CRNT3, HCRNT
	Winding Temp (note 3)	NA	WIND1, WIND2, WIND3, HIWND
	AUX (note 2, 3)	LCAM2-LCAM8	LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
CT/LTC (LTC Function ON & With LCAM)	RTD (note 1)	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	LTCTK
		3 (note 4)	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	LTC Differential	NA	DIFF, DEV
	Winding Current (note 3)	LCAM1-LCAM3	CRNT1, CRNT2, CRNT3, HCRNT
	Winding Temp (note 3)	NA	WIND1, WIND2, WIND3, HIWND
	AUX (note 2, 3)	LCAM2-LCAM8	LCAM2, LCAM3, LCAM4, LCAM5, LCAM6, LCAM7, LCAM8
ALL	Sensor Failure	NA	SNFAL
ALL	None	NA	NONE

Notes:

1. Alarm sources for RTD channels are the same as the title given to the corresponding channel.
2. LCAM auxiliary range input values are; 0-1 and 0-20 madc; 5, 150 & 300 VDC and 5, 75, 150 and 300 VAC 50/60Hz.
3. CT series models must use LCAM channel 1 (LCAM1) As the winding current input. Users may select LCAM2 and/or LCAM3 as winding current or AUX inputs. If winding current is selected the corresponding CRNTX and WINDX measurements will become available. If AUX is selected the corresponding LCAMX measurement will become available.
4. If channel 3 is being used for LTC differential measurement, only the MANTK source will appear.

When any of these sources except DIFF, NONE or SNFAL is selected, Advantage uses the value for that variable for comparison to the set point value. The DIFF, DEV, NONE and SNFAL alarm sources are discussed in more detail below.

The **DIFF** source shown here is not the same as the DIFF value, which is displayed on the front panel, though they are closely related. The DIFF value that is displayed on the front panel is the simple raw difference between the main tank and LTC tank oil temperatures. The DIFF alarm source is taken ***from*** the simple difference value, but is put through a series of digital filters and logic tests before being fed to the alarm logic. More information on the differential filter can be found in section 6, LTC Application Tailoring.

The **DEV** source reflects the total change in the LTC differential between the time the initial LTC differential (INITL LTCDF) was entered (typically at commissioning) and the present time.

The **NONE** alarm source is intended to allow users to keep the alarm enabled, but designate it as presently unused. The NONE source deactivates the alarm logic, without disabling the alarm. Alarms can only be enabled or disabled using digital communications and therefore, if an alarm is disabled, it will not appear in the front panel menus. If a user desires to use the alarm after initial set up, but has disabled the alarm, (s)he will not be able to set up the alarm unless the (s)he has a computer and the configuration software to re-enable the alarm.

The **SNFAL** alarm source is a special case, which makes an alarm responsive only to sensor or internal failure events. Although the SNFAL alarm source will respond to sensor and internal failures, the incidence of internal failures is far lower than sensor failures and the source is therefore generically referred to as a sensor failure. It must be remembered; however, that both sensor and internal failures will trip this alarm. The sensor failure source's only settings are pick -up delay (prompt PIKUP), drop-out delay (prompt DRPOT) and which relay the alarm will operate (prompt OPRAT). This source is provided for remote signaling of a sensor/internal failure and for retrofit to legacy systems, where supervisory sensor failure relays (SFR) had been set up to intervene to avoid nuisance trips. In all Advantage II models, if a sensor/internal failure is detected, the measurements and calculations that are affected by the failed circuit are frozen to prevent nuisance alarms due to apparent, though erroneously high or low indications. The frozen indication feature and ability to turn the SNFAL function OFF for any relay creates a redundant nuisance trip avoidance scheme that has superceded the need to have a separate SFR to supervise trip relays. The SFR is still widely used for remote signaling, however.

As an example of an SFR application, let's assume a WTI (not an Advantage) is monitoring a temperature through an RTD probe connected to channel 1. Alarm 1 is configured with channel 1 as its source and a set point of 110 °C. This alarm responds to a temperature set point only, and operates relay 1, whose connected equipment is a transformer trip relay. Now, if the channel 1 RTD opens or becomes intermittent, the temperature will ***appear*** to have climbed to a level beyond the 110 °C set point. If relay 1 is unsupervised, it will operate and trip the transformer, even though the actual winding temperature is within process limits. In legacy systems the trip relay's contacts were supervised by connecting the SFR's contacts in series with it and the set point alarm relay. Typically the SFR contacts are set to open before the set point relay's contacts close, and close after the set point relay's contacts open. This arrangement effectively blocks the nuisance alarm, but requires an additional relay.

The SNFAL (sensor failure) alarm source is provided in all alarm set up menus, thus allowing any alarm to be set up as a sensor failure alarm. Like all other alarms, any relay can be operated by an alarm with a sensor failure source. Thus, any relay can be set up as a sensor failure relay.

Advantage models equipped with LCAM modules, whose source has "LCAM" in its name, have separate set up loops. Whenever an alarm source is specified as LCAM1 - LCAM8, the standard alarm set up loop is automatically exited and the respective LCAMX set up loop is entered. Refer to the "**Prompt LCAMX**" paragraphs further below for details.

Prompt **SETPT**, Set Point Value Variable, Figure 16A
All Models

The alarm set point function provides two different ranges of values, depending upon the model and alarm source. SC, DC, TC and LTC models only have temperature set point values while CT, CTX and CT/LTC models have temperature and current set point values. For all temperature measurements the range is -40.0 to 200.0 °C or -40.0 to 250.0 °C depending upon the value set at the SCALE RANGE prompt. For the current alarm source, the range is 0 to the twice the value defined as IMAX (maximum load current) in the USER SETUP loop. An alarm signal will be sent to the relay control logic when the measured or calculated temperature or current is more positive than the set point value.

Prompt **HYSTS**, Alarm Hysteresis Variable, figure 16A
All Models

The hysteresis function allows two ranges of values; from 0.0 to 20.0 °C for temperature measurement or 0 to 200 amps for current measurement.

When referred to set point operation, hysteresis is the magnitude, or amount, that a signal or process value must retreat from an alarm condition, to cause the alarm to reset.

This definition is concise and correct for all types of alarms, but it still may not help visualize the implications of the term. If, for example, an alarm is set for 55 °C and the process temperature reaches 55 °C, you would rightfully expect the alarm to operate. Let's assume that the alarm is connected to a cooling device and when the alarm operates, the cooling equipment turns on and the temperature immediately drops to 54.9 °C, shutting the cooling equipment down. Depending on the heat source, the temperature might immediately rise, the cooling equipment would again operate and the cycle would continue endlessly until the heat generated was greater than the heat removed, the heat source subsided or, of course, the cooling equipment broke down.

Let's now assume that a hysteresis value of 2 degrees was set and that the heat-up rate is 0.1 degree / minute and the assisted cool-down rate is 1 degree / minute. Now when the same 55 °C set point is exceeded the cooling equipment will run for 2 minutes to cool the apparatus to 53 °C and will remain off for 20 minutes as the equipment warms back up to 55 °C. See the connected equipment paragraph above for more information on how pumps affect cooling equipment cycling.

Prompt **SNFAL**, Sensor Failure Enable Variable, Figure 16A
All Models

The sensor failure enable function offers two options, ON and OFF. This function determines whether a relay will or will not respond to a sensor failure or internal failure event. This is used frequently in station trip lock-out schemes to prevent a station trip relay from operating in the event that a sensor or internal failure occurs. Selecting the OFF option for a particular alarm will nullify the effect of the SNEFF variable for the relay that the alarm drives.

Prompt **SEASN SETBK,** Seasonal Setback, Figure 16A
All Models

This variable provides for enabling the seasonal setback function on an individual alarm basis. The parameters that govern the function must be set up in the SEASN SETBK loop, on the main menu level, in order for this function to have an effect on the alarm. See "Prompt SEASN SETBK" paragraph on the main menu level on page 71 for details on setting up the governing parameters.

Prompt **TRGER,** Time-Based Alarm Trip Sources, Figure 16A
All Models

The DAILY and CALND sub-loop names are also used as auxiliary alarm sources in the alarm set up loops. These auxiliary sources are referred to as trigger sources to differentiate them from the auxiliary alarm and the standard alarm sources. A user may elect to set up the DAILY and/or CALND settings globally in the TIMED TRGGR loop and then elect to use either of them as a trigger source.

You can use both the DAILY and CALND variables as trigger sources in the same alarm and these may be used in conjunction with the standard alarm sources. Thus, If the standard alarm source is set to winding and the trigger source is set to "BOTH" the alarm's relay will operate when the winding temperature exceeds its setpoint or the daily trigger time has arrived or the present date is between the start and end dates. This can be used by utilities to turn on one stage during a high daily loading period in a season when load is not generally high, and turn on the same stage 24 hours a day when the seasonal load is generally high.

The default setting for the TRGER variable is "NONE". This setting disables time based alarm operation for the individual alarm.

Prompt PIKUP, Relay Pick up Delay, Figure 16A
All Models

The PIKUP (pick up) function is provided to allow for delaying the operation of a relay in response to an alarm trigger. This is used primarily in alarm schemes to avoid nuisance trips. A secondary use is to prevent excessive pressure in heat exchangers when more than one pump is turned on simultaneously.

In alarm schemes relays are delayed for a certain period to allow an erroneous transient signal to settle, or to give supervisory relays time to intervene in the event of a disturbance which does not reflect the transformers true thermal state.

An example of a transient condition is line charging or cold load pick up, where the line current instantaneously reaches levels which could erroneously trip an alarm with a current level set point which has no pick up delay specified for the relay it operates. The pick up delay can be set to envelope the expected line disturbance period an avoid the nuisance trip.

Using this feature, a set point relay's contacts can be wired in series with a supervisory relay. By setting the PIKUP delay of the set point relay to some period beyond the expected operating time of the supervisory relay, the supervisory relay will have time to open its contacts before the set point relay's contacts close, and prevent a nuisance trip.

If an alarm is set up to provide a supervisory function, such as an alarm with a sensor failure (SNFAL) source, it must not have any PIKUP delay specified for the relay the alarm operates.

Prompt DRPOT, Relay Drop-Out Delay, Figure 16A
All Models

The DRPOT (drop out) function is provided to delay the drop out of a relay from an alarm state. This is used primarily in alarm schemes to avoid nuisance trips. In these schemes ***supervisory*** relays are delayed for a certain period to give alarm relays time to reset before the supervisory period is over.

The feature can also be used as a turn-off timer to hold a controlled process in the alarm state for a defined period after an alarm has cleared. This is frequently used as a pump hold-on timer, to prevent the pump from cycling on and off too quickly.

If a process recovers from a transient, erroneous condition, the supervisory relay will drop out and its contacts will close immediately if no drop out delay is set. If the set point alarm relay is still in the alarm state, even for a fraction of a second, a nuisance alarm could occur. If a dropout delay is added to the supervisory relay's configuration, the supervisory relay is guaranteed to continue its circuit supervision well after the alarm relay drops out.

If an alarm relay is set up to be supervised by, for example, a sensor failure (SNFAL) relay, the supervised alarm relay it must not have any drop out delay specified.

Prompt OPRAT, Relay Selection Option, Figure 16A
All Models

This option is provided to select which relay will be operated when a monitored value exceeds the set point of the alarm. Once a relay is selected, program execution branches immediately to the corresponding relay set up loop automatically.

LCAM Alarm Set Up Menu

If the Advantage is equipped with an LCAM module and at least one input is enabled, the ALARM SETUP menu will continue directly into the LCAM alarm set up. There are a maximum of 8 LCAM set up menus.

The Load and Cooling Apparatus Monitoring (LCAM) module increases the versatility of the Advantage greatly and the keystrokes dedicated to its configuration and integration into the transformer's overall monitoring concept reflect this versatility. The LCAM module can be used in any Advantage model. Using the multi-range analog inputs, alarms can be set up that function as dead band, valid band or simple on-off (digital) alarms. These alarms can be transmitted through digital communications using Weschler's proprietary SA protocol, or the popular DNP-3 or ModBus protocols. In addition, the LCAM inputs can be associated with other Advantage relays such that the process that the other relay controls can be verified as being normal or abnormal. The LCAM sense input channel can be configured to operate an additional relay to take remedial action or generate a separate alarm.

Prompt **LCAMX SETUP,** LCAM Module Input Alarm Set Up, Figure 16A
LCAM Equipped Models Only

The LCAMX SETUP loops are provided to enter alarm set up information for the LCAM alarms, which are similar to, but more advanced than, the standard alarm set up loops. With its associative relay feature and valid banding alarm concept, the LCAM module makes the set up more flexible than the standard alarms. When an LCAM channel is declared to be an alarm source in the standard alarm's source dialog, the menu automatically jumps to this point.

Prompt **INPUT**, Signal Type Selection, Figure 16A
LCAM Equipped Models Only

The INPUT loop allows for the specification of the signal type, for each input channel individually. This can be one of ACVLT (AC volts), DCVLT (DC volts) ACAMP (AC amps), DCAMP (DC amps) or DRY (dry contact excitation). The choice is used by the operating system to specify which calibration table to use with the signal. Once this choice is made, the scale ranges for that signal type will be made available in subsequent set-up steps. This selection also determines which calibration table is selected for calibration, in the rare event that calibration is necessary.

The DRY selection is provided to indicate to the operating system that an un-powered switch or relay contact is to be connected to the LCAM input. The full scale value is set to approximately 10 volts by hardware and the high and low thresholds are automatically set to 5v for ON / OFF signaling, but they may be adjusted by the user.

Prompt **SCALE**, Full Scale Range Selection, Figure 16A
LCAM Equipped Models Only

The SCALE loop provides a means of selecting the range's full scale value. The full scale value will depend upon what the signal type is; AC volts or amps; DC volts or amps or the dry contact. The available choices wil be presented with respect to the signal type that was set in the last step.

It is of paramount importance that the daughterboard jumper on the respective LCAM module channel be set to the range that corresponds to this setting. The LCAM module can be damaged if a voltage or current beyond the full scale rating of the daughterboard is applied to the input terminals.

See the section "Load and Cooling Auxiliary Monitoring (LCAM) Module" in the Installation section (3) for details on hardware set up. The following list tabulates the full scale value choices:

AC Volts	5, 150 or 300
AC Amps	See the paragraph below on the "AC Amps" option.
DC Volts	5, 75, 150 or 300
DC Amps`	1 ma or 20 ma
Dry	See paragraph below on the "Dry" contact option.

AC Amps INPUT signal type Selection, Figure 16A

If the ACAMP selection was made for the signal type at the INPUT prompt, the SCALE function will allow the user to scroll the value from 0 to 9999.9. In order to use this input, the user must supply a current to voltage transducer that converts the maximum primary current rating into a maximum secondary voltage of 5 vac. These transducers are typically constructed from an air-core (Rogowski coil) CT with a resistive shunt across the secondary winding. They are commonly available as "donut" or clamp-on types with ratios specified as amps per volt (A/V).

DRY contact INPUT signal type Selection, Figure 16A

If the DRY selection was made as the INPUT signal type, the SCALE's value window will show 10.0V, and it will not be able to be changed. The advantage LCAM hardware provides contact wetting (excitation) voltage of approximately 10 vdc for these cases. The current-voltage-wetting daughterboard on the LCAM module must be set to "WET" to use the internal wetting voltage. Assuming the LCAM channel is properly configured, when a contact which is connected across the LCAM channel terminals is open, approximately 10vdc is measured by the channel hardware. When the contact closes, approximately 0 vdc is measured by the channel hardware. Thus the "DRY" option is an on-off function whose full scale is 10 vdc. The term “DRY” is the industry-standard term for relay contacts that do not have any source of self-powered excitation voltage. If external voltage is applied to an LCAM input set to “WET”, the LCAM module may be permanently damaged.

Prompt **ASSOC**, Input Signal Association to a Control Relay, Figure 16A
LCAM Equipped Models Only

The ASSOC function is a powerful feature that allows an LCAM multi-range input to monitor the output of an Advantage relay that is driven by another Advantage alarm. The number of the control relay is selected as the ASSOC value, and when the controlled relay trips, the LCAM alarm becomes armed. An armed LCAM alarm compares the measured input signal to a range selected in the LOTHR (low threshold) and HITHR (high threshold) dialog boxes, and if it is outside that defined range, the alarm will trip. The alarm can be set to operate another relay which can perform remedial operations or send an alarm.

This is typically used to monitor cooling apparatus to verify that it has been turned on and that it is running normally. If the equipment that the monitored relay controls is cooling apparatus, the LCAM input will alert the winding temperature algorithm that the cooling apparatus has been turned on, whether or not the Advantage turned it on.

For voltage monitoring, the motor voltage level is set in LCAM hardware and as the full scale value in the SCALE dialog above. The input leads are then connected across the cooling apparatus motor leads. This is mostly an on / off monitoring, but extreme voltage drops due to shorted motor windings or blown fuses can be detected.

For current monitoring, one of the apparatus motor leads is passed through the window of a “donut”, split core or clamp-on CT (see LCAM connections in section 3, “Installation”) and when the control relay that turns on the motor operates, the motor current is measured. This connection has the added function of being able to more accurately determine the health of a motor or motor bank from operating current level. See the “AC Amps INPUT signal type Selection” paragraph on this page, or the LCAM connections section in the installation section 3 for hardware details.

Prompt **LOTHR**, Low Input Signal Alarm Threshold, Figure 16A
LCAM Equipped Models Only

The valid-band alarm concept that the LCAM module offers requires that a lower limit and upper limit of the valid band be defined. The valid band is a range within which the input signal is considered normal. The LOTHR dialog is provided to set the value of the lower limit of the valid band range. Reference Figure 17 for a diagrammatical representation of the valid band alarm concept.

Prompt **HITHR**, High Input Signal Alarm Threshold, Figure 16A
LCAM Equipped Models Only

The valid-band alarm concept that the LCAM module offers requires that a lower limit and upper limit of the valid band be defined. The valid band is a range within which the input signal is considered normal. The HITHR dialog is provided to set the value of the upper limit of the valid band range. Reference Figure 17 for a diagrammatical representation of the valid band alarm concept.

Setting Valid Banded Alarms Using the High and Low Threshold Values

The valid band alarm concept provides a way to define high and low responding and out-of-range responding alarms.

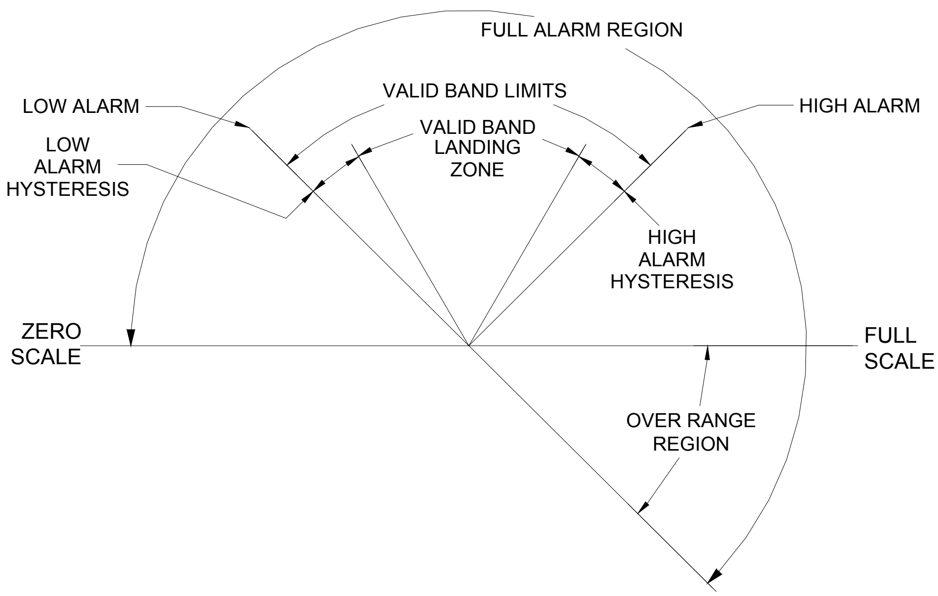
High responding alarms are simply alarms whose logic compares the signal to the range defined by the low and high thresholds and trips the alarm when the signal exceeds the high threshold. These alarms are set up by setting the low threshold to the zero scale value and setting the high threshold to the desired trip point.

Low responding alarms are simply alarms whose logic compares the signal to the range defined by the low and high thresholds and trips the alarm when the signal is below the low threshold. These alarms are set up by setting the low threshold to the desired trip value and setting the high threshold at or above the full scale value.

Out-of-range responding alarms are simply alarms whose logic compares the signal to the range defined by the low and high thresholds and trips the alarm when the signal exceeds the high threshold or is lower than the low threshold. These alarms are set up by setting the low threshold between the zero scale value and the high threshold, and setting the high threshold between the low threshold and the full scale (+100%) value. The low and high thresholds cannot be set to the same value, unless the hysteresis is set to zero. The Advantage will limit the setting value to allow a minimum of the hysteresis value between them.

<u>Prompt **HYSTS**, Alarm Hysteresis, Figure 16A</u>
LCAM Equipped Models Only

The HYSTS function operates differently than the hysteresis function of the standard alarms, due to the entry regions above and below the valid band. The hysteresis function is best described diagrammatically.



<u>Figure 17. LCAM Alarm Hysteresis Diagram</u>

Referring to figure 17, the unalarmed zone in valid band alarms is between low alarm and high alarm set points. Thus, the hysteresis value acts above the lower set point and below the upper set point. For example, assuming a 5 amp hysteresis value, if the value of a measured quantity drops below the lower set point the alarm will trip and it will not reset until the value rises 5 amps above the lower set point. In a similar fashion, if the value of the measured quantity rises above the upper set point the alarm will trip and it will not reset until the measured value drops 5 amps below the upper set point. The area between the hysteresis limits is referred to as the valid band landing zone. This refers to the fact that any value that had been varying, but stopped at a point (landed) above the low alarm hysteresis band or below the high alarm hysteresis band, will turn off an active alarm.

The hysteresis value is set just high enough to prevent controlled equipment (fan, pump alarm etc.) from turning on and off rapidly in response to the monitored process signal varying very near to the value of the set point. The same hysteresis value applies to the high alarm and low alarm thresholds.

<u>Prompt **TRGER**, Time-Based Alarm Trip Sources</u>
LCAM Equipped Models Only

This function operates exactly the same as the standard alarm function of the same name.

Prompt **PIKUP**, Relay Pick-Up Delay
LCAM Equipped Models Only

This function operates exactly the same as the standard alarm function of the same name.

Prompt **DRPOT**, Relay Drop-Out Delay
LCAM Equipped Models Only

This function operates exactly the same as the standard alarm function of the same name.

Prompt **OPRAT**, Driven Relay Definition
LCAM Equipped Models Only

This function operates exactly the same as the standard alarm function of the same name.

Prompt **USER SETUP**, User Loop, Figure 16B **(CT, CTX and CT/LTC Models Only)**

In the USER SETUP menu there are a maximum of 17 values (43 values with LCAM) for the winding temperature function which **may** be entered. Four of these, Fluid Type, Fluid Capacity, Winding Type and Core & Coil Weight are not absolutely required, but do provide information that can make the calculation of winding temperature more accurate. Two of these values, the Core and Coil Weight and Fluid Capacity have the most effect on measurement accuracy. If you do not know their actual values, estimate them to the best available information.

Some of the required parameters will not be appear in the front panel display because the selections of connected equipment that were made in the RELAY SETUP menu will have made them inapplicable. For example, in RELAY SETUP if you had set the connected equipment for a relay as OFAN (pumps, not directed), then the two prompts and their submenus dealing with directed oil flow (ODAN & ODAF) will not appear. The USER SETUP loop also has required parameters that **must** be entered in order to exit the loop. The actual number of parameters depends upon the type of air & fluid circulation, whether an LCAM module is installed and how many of its channels have been enabled.

In all cases the IMAX value that the user enters will be automatically associated with the cooling mode which has the highest MVA rating and maximum currents for the other cooling modes will be calculated automatically.

Examples for CT-Series Models ***without*** an LCAM Module

There will be three required parameters for a transformer with simple ONAN - only cooling

Full load winding current:	IMAX1
ONAN Rating:	ONAN MVA1
ONAN Gradient:	ONAN GRAD1

For transformers with ONAN/ONAF/OFAF cooling stages there will be 7 required parameters;

Full load winding current:	IMAX1
ONAN Rating:	ONAN MVA1
ONAN Gradient:	ONAN GRAD1
ONAF Rating:	ONAF MVA1
ONAF Gradient:	ONAF GRAD1
OFAF Rating:	OFAF MVA1
OFAF Gradient:	OFAF GRAD1

Examples for CT-Series Models ***with*** an LCAM Module

If the LCAM module is installed there is an additional set of required parameters for each of the three current measurement channels that is enabled. Thus the list for a transformer with ONAN/ONAF/OFAF ratings with three current measurement channels enabled would be:

Full load winding current:	IMAX1	IMAX2	IMAX3
ONAN Rating:	ONAN MVA1	MVA2	MVA3
ONAN Gradient:	ONAN GRAD1	GRAD2	GRAD3
ONAF Rating:	ONAF MVA1	MVA2	MVA3
ONAF Gradient:	ONAF GRAD1	GRAD2	GRAD3
OFAF Rating:	OFAF MVA1	MVA2	MVA3
OFAF Gradient:	OFAF GRAD1	GRAD2	GRAD3

See figure 16B in this section for a graphic illustration of parametric entry for the USER SETUP menu. The shaded areas of figure 16B indicate items that only apply to LCAM-equipped CT-series models

The Advantage winding temperature algorithm WTA uses equations which are based on the logic and mathematical relationships which are expressed in the IEEE Guide for Loading Mineral-Oil-Immersed Transformers, IEEE Std C57.91-1995. The Guide considers many more variables than the Advantage WTA for two reasons. Firstly, many of the guide's equations are used to calculate the theoretical top oil temperature. The Advantage measures top oil temperature directly and thus does not need to calculate the equations nor be supplied with their variable values. Secondly, many of the Guide's equations are based on the transformer's design, and the values of the variables used in the equations are not available to the owners of the installed base of transformers. Thus their inclusion in this WTA would render it impractical for general use. The Advantage has been designed with a knowledge-based upgrade path in mind, and as the state-of-the-art in winding temperature advances, so can the Advantage.

The variables which the Advantage WTA uses are discussed below. All are straightforward and only require a brief explanation. Some are included as data plate information, some are contained in the manufacturer's reports and some are part of operating experience. Not all are required, but supplying them will improve the measurement accuracy.

If you are unsure of a value, set it on the conservative side. You can easily change it later if experience shows it to be warranted.

Prompt **FLUID TYPE**, Fluid Type Variable, figure 16B **(CT, CTX and CT/LTC Models Only)**

The fluid type refers to the fluid which the core and coil are immersed in. The choices are mineral, option MINER, silicon, option SILIC or organic, option ORGAN. Generally, silicone fluid is reserved for high temperature transformers such as mobile units where rapid heat transfer and resistance to high temperature fluid degradation is required. Because silicone fluid has a higher viscosity and slightly lower specific heat, it will carry heat away from the winding at a slower rate than mineral oil. This will result in faster heat rise and slower heat decay. The organic fluids are intended for environmentally sensitive installations. Their rate of thermal transfer is generally slower than premium mineral oils, but faster than silicon. If you are unsure what fluid is in use, select MINER.

Prompt **FLUID CPCTY**, Fluid Capacity Variable, figure 16B **(CT, CTX and CT/LTC Models Only)**

The fluid capacity refers to fluid in the main tank and must not include the contents of conservators or other expansion tanks. The value may range from 500 to 50000 short (US) gallons. It should be listed on the transformer's data plate. Fluid capacity is generally in inverse proportion to temperature rise in transformers; as the oil capacity is increased, the rate of heating or cooling is decreased. If the value is not available, accept the default or the capacity from a like-rated transformer of known capacity. The default value varies depending upon the declared capacity and weight of the core and coil. To convert liters to short (US) gallons, multiply liters by 0.2642. To convert Imperial (UK) gallons to short (US) gallons, multiply Imperial gallons by 1.201.

Prompt **WINDG TYPE**, Winding Type Variable, figure 16B **(CT, CTX and CT/LTC Models Only)**

The winding type refers to winding construction. The choices are rectangular, prompt RECTR, cylindrical, prompt CYLND or shell form, prompt SHELL. Rectangular construction is used mostly in transformers rated below 10 MVA and this construction is generally less efficient at removing heat in windings near to the core. Cylindrical windings (disc types) typically used in core-form transformers enjoy an advantage in cooling efficiency because of more numerous cooling ducts and the large winding surface area that is exposed to insulating oil. Shell types have an advantage in reduced heat generation at larger capacity ratings and their large mass contributes to slower heat rise and decay, but the reduced winding surface area exposed to insulating oil reduce cooling efficiency somewhat. These factors are considered in the WTA. If the winding construction is unknown, for initial conditions assume rectangular as the more conservative choice below 10 MVA, cylindrical above 10 MVA, and shell for GSU's and power transformers above 200 MVA.

Prompt **CORE WEIGT**, Core Weight Variable, figure 16B **(CT, CTX and CT/LTC Models Only)**

The core weight refers to the weight of the core and coil, minus fittings. It is generally referred to on data plates as untanking weight. The relationship of the core mass to thermal time constant is an inverse proportion; the greater the mass the longer it takes to respond to a step change in generated heat. The unit of measure on the data plate is frequently pounds but the unit of measure in the menu is tons. This is done to express weights in excess of 99999 pounds, such as may exist in large GSU transformers. If the core weight is not known, use the default or a known core weight from a same-rated transformer of same core construction. To convert pounds to tons, multiply pounds by 0.0005. To convert kilograms to tons, multiply kilograms by 0.001102.

Prompt **WINDG CURNT** Maximum Winding Current Sub-Menu, figure 16B **(Required Parameter)**
(CT, CTX and CT/LTC Models Only)

The WINDG CURNT prompt provides a sub-menu to set the value(s) of maximum winding current passing through the winding being measured. The sub-menu requires a value for each winding being measured. If an LCAM module is not installed, only a single value will be required. If an LCAM module is installed a value will be required for each of the three channels that are enabled for current measurement. The value prompts will be IMAX1, IMAX2 or IMAX3. The value required is the magnitude of the current which will pass through the reference CT when the transformer is at its nameplate (100%) power capacity rating. The reference CT is the CT which supplies secondary current to the current sense input of the Advantage. This may be a bushing or instrument transformer. The electrical location of the CT, on the high side or low side of the transformer is unimportant. Attempting to exit the USER SETUP loop without entering a valid value, between 0 and 99999 Amps will result in a return to this menu item.

In all cases the IMAX value that the user enters will be automatically associated with the cooling mode which has the highest MVA rating and maximum currents for the other cooling modes will be calculated automatically.

Power Rating and Gradient Entry

The power ratings and gradients described below will be used directly by the Winding Temperature Algorithm (WTA) to calculate the winding temperature. If the gradient temperatures entered are for average winding temperature, the indication and alarm set point values will be average winding temperature. If the gradient temperatures entered are for hottest spot temperatures, the indication and alarm set point values will also be winding hottest spot temperature. If the transformer data only contains average winding temperature, but you want to indicate and alarm from hottest spot temperature, the transformer manufacturer must be consulted to get the most accurate gradient of the hottest spot temperature rise over the top oil temperature.

If the data cannot be obtained from the manufacturer, there are approximate values that have been suggested by international standards and used for many years. The IEEE suggests [1] that a hottest spot rise be added to the average winding temperature gradient, regardless of transformer type and size, to obtain the hottest spot rise over top oil temperature. The values that the IEEE suggests are 10 °C for 55 °C rise transformers and 15 °C for 65 °C rise transformers. The IEC suggests [2] that the hottest spot gradient over top oil be calculated by multiplying the winding average gradient, by hot spot factors of 1.1 for distribution transformers and 1.3 for medium and large power transformers. The IEC does, however; indicate that the hot spot factor can range up to 1.5 in some instances.

Prompt **ONAN SETUP**, ONAN cooling mode power and gradient entry menu. Figure 16B **(Required Parameters) (CT, CTX and CT/LTC Models Only)**

The ONAN SETUP menu provides for entry of power ratings and gradient values for the winding(s) being measured for winding temperature. If an LCAM module is not installed there will only be prompts for the power rating (prompt MVA1) and gradient (prompt GRAD1) for the first winding. If an LCAM module is installed you will be prompted for a power rating and gradient for each LCAM channel that is enabled for winding current measurement. There is a maximum of three winding currents that can be measured by the LCAM module.

The ONAN cooling mode is characterized by the lack of any auxiliary cooling apparatus. The flow of fluid through heat exchanger (radiator) piping is accomplished by natural thermal-head convection and the circulation of air around the heat exchangers is provided by the wind. The ONAN mode is most commonly the initial cooling mode of a transformer with additional modes involving forced circulation of air and/or fluid. The ONAN mode, when used as the only cooling mode, is less common.

The prompt for the ONAN power rating(s) are MVA1, MVA2 or MVA3. The prompt for the gradient value(s) are GRAD1, GRAD2 and GRAD3. Since you are in the ONAN SETUP menu, the ONAN prefix is understood. The ONAN power rating is the maximum power that can be demanded for a specific maximum winding temperature rise, with the ONAN cooling scheme. The power rating is typically stated on the data plate.

Since the ONAN mode always exists, the requirement to enter an ONAN power rating and gradient value will always exist. Attempting to exit the USER SETUP loop without entering values for the ONAN power rating and gradient will result in a return to this menu item.

The prompt for the ONAN gradient is GRAD1, GRAD2 or GRAD3. Since you are in the ONAN SETUP menu, the ONAN prefix is understood. The ONAN gradient is the temperature differential between the temperature of the fluid at the top of the tank (top oil temperature) and winding temperature(s), when fluid and air are circulating through heat exchangers without the aid of pumps or fans. The ONAN gradient is typically stated on the transformer reports, either as a stand-alone value or as the lowest gradient in a series of other gradients.

The ONAN value is required regardless of the type of fluid circulation. The reason for requiring this gradient when oil forced (OF) or oil directed (OD) cooling is also provided, is that the transformer heats and cools in response to the ONAN thermal profile, when the pump(s) and/or fans are not running. The ONAN profile is generally considerably steeper with regard to temperature rise per unit time, than the profiles of transformers with running OF or OD equipment. If you attempt to exit the USER SETUP menu without entering ONAN GRADX and ONAN MVAX values, you will be returned to the ONAN SETUP menu to correct the omission.

If an ONAN value is not provided on a test report, the transformer manufacturer should be consulted. If obtaining the data from the manufacturer is unsuccessful, the next best approximation can be determined by operating experience, or comparison to same-series transformers that have been tested and for which data is available. There are, however; no highly accurate methods of calculating the ONAN gradient in the field, if design data and appropriate equations are not available.

Another approximate method, frequently used when no other source is available is to calculate the ONAN gradient by using a ratio of power rating for the highest-rated cooling configuration, to the ONAN cooling configuration.

Example 1. On a transformer with capacity ratings of 125/175/400 MVA, corresponding to ONAN/ONAF/OFAF cooling configurations, there may be only one gradient provided, for the OFAF configuration. Assuming an OFAF gradient of 25 °C, the gradient for the ONAN stage may be approximated as:

$$\text{ONAN} = 25 \times \left[\frac{400}{125}\right]^{0.8} = 63.4\,^{\circ}\text{C}$$

The fractional exponent reflects the fact that OFAF cooling modes typically have a proportionately higher gradient than ONAN and ONAF cooling.

If the transformer has ONAN base cooling with OD oil circulation such as ONAN/ONAF/ODAF, the ONAN gradient may be calculated using the following approximation:

Example 2. On a transformer with the capacity ratings of 150/200/400 MVA corresponding to ONAN/ONAF/ODAF cooling configurations, and assuming an ODAF gradient of 10 °C, the gradient for the ONAF stage may be approximated as:

$$\text{ONAN} = 10 \text{ x} \left[\frac{400}{150}\right]^{1.8} = 58.4\,°\text{C}$$

As can be seen, the general form of the equation is:

$$\text{ONAN GRADIENT} = \text{MAXGRAD x} \left[\frac{\text{MVAMAX}}{\text{ONANMVAX}}\right]^{\text{EXP}}$$

Where:

MAXGRAD	The gradient value provided for the 1 Per Unit (100%) load rating of the winding being measured. This rating will correspond to the all-cooling-on mode.
ONAN MVAX	The load rating for which auxiliary cooling is not needed. The “X” refers to the winding being measured.
MVA MAX	The 1 Per Unit load rating of the winding being measured.
EXP	An exponent that reflects an approximate adjustment for effects not reflected by the simple ratio of the ONAN MVA load rating to the MAX MVA rating.

The EXP (exponent) values may vary widely depending upon transformer design, and it is therefore advisable to analyze the resulting values carefully. In most cases the ONAN gradient will be calculated to be on the conservative side. If you have no idea as to what the EXP value might be, the recommended values are:

Cooling Mode at Maximum Rating	Exponent Value
ONAF	1.0
OFAN	1.0
OFAF	0.8
ODAN	1.5
ODAF	1.8

The Advantage is capable of calculating the ONAN gradient, using the above equation and exponents, as a convenience to users. If you want the Advantage to calculate the ONAN gradient, simply change the value for the ONAN “GRADX” prompt to “DEFLT”. When you exit the ONAN SETUP menu at the NORML MODE prompt, the value will be calculated and stored. If you then return to the ONAN GRADX prompt you will see that the automatically calculated value has replaced the “DEFLT” value.

If you have not entered the transformer’s maximum rating gradient value, or if the transformer being monitored is an ONAN-cooling-only type, the automatic ONAN gradient calculator will not work.

Prompt **ONAF SETUP**, ONAF cooling mode power and gradient entry menu. Figure 16B **(Required Parameter)** **(CT, CTX and CT/LTC Models Only)**

The ONAF SETUP menu provides for entry of power ratings and gradient values for the winding(s) being measured for winding temperature. If an LCAM module is not installed there will only be prompts for the power rating (prompt MVA1) and gradient (prompt GRAD1) for the first winding. If an LCAM module is installed you will be prompted for a power rating and gradient for each LCAM channel that is enabled for winding current measurement. There is a maximum of three winding currents that can be measured by the LCAM module.

The prompt for the ONAF power rating(s) are MVA1, MVA2 or MVA3. The prompt for the gradient value(s) are GRAD1, GRAD2 and GRAD3. Since you are in the ONAF SETUP menu, the ONAF prefix is understood. The ONAF power rating is the maximum power that can be demanded for a specific maximum winding temperature rise, with the ONAF cooling scheme. The power rating is typically stated on the data plate.

The ONAF cooling mode is characterized by the fan-forced flow of air through the heat exchangers. As designated by the cooling code, oil circulates by thermal-head convection and pumps are either not included in the overall cooling scheme or are not running in this mode.

The ONAF SETUP menu will appear in the front panel display only if the cooling mode has been declared as a connected equipment in the RELAY SETUP loop. If the ONAF SETUP menu ***does*** appear, the ONAF MVAX and ONAF GRADX values must be entered. If you attempt to exit the USER SETUP menu without entering ONAF GRADX and ONAF MVAX values, you will be returned to the ONAF SETUP menu to correct the omission.

The ONAF MVAX load capacity rating should be stated on the nameplate and certainly on the transformer report. The Advantage does not have an automatic calculator for ONAF gradients because there are no utilitarian equations that can be used to approximate them.

An ***estimate*** of the ONAF Gradient may be made using a form of the equation above:

$$\text{ONAF GRADIENT} = \text{MAXGRAD } \times \left[\frac{\text{MAX MVA}}{\text{ONAFMVA}X} \right]$$

Where:

MAXGRAD	The gradient value provided for the 1 Per Unit (100%) load rating of the transformer. This rating will correspond to the all-cooling-on mode, for the winding being measured.
ONAF MVAX	The load rating corresponding to the ONAF cooling mode. The “X” corresponds to the winding being measured.
MVA MAX	The 1 Per Unit load rating of the winding being measured.

<u>Prompt **OFAN SETUP**, OFAN cooling mode power and gradient entry menu. Figure 16B</u> **<u>(Required Parameter)</u> (CT, CTX and CT/LTC Models Only)**

The OFAN SETUP menu provides for entry of power ratings and gradient values for the winding(s) being measured for winding temperature. If an LCAM module is not installed there will only be prompts for the power rating (prompt MVA1) and gradient (prompt GRAD1) for the first winding. If an LCAM module is installed you will be prompted for a power rating and gradient for each LCAM channel that is enabled for winding current measurement. There is a maximum of three winding currents that can be measured by the LCAM module.

The prompt for the OFAN power rating(s) are MVA1, MVA2 or MVA3. The prompt for the gradient value(s) are GRAD1, GRAD2 and GRAD3. Since you are in the OFAN SETUP menu, the OFAN prefix is understood. The OFAN power rating is the maximum power that can be demanded for a specific maximum winding temperature rise, with the OFAN cooling scheme. The power rating is typically stated on the data plate.

The OFAN cooling mode is characterized by the pump-forced flow of fluid through the heat exchangers. As designated by the cooling code, air circulates by wind or convection and fans are either not included in the overall cooling scheme or are not running in this mode. This mode is typically used in noise sensitive installations, since fans typically produce much more noise than pumps.

The OFAN SETUP menu will appear in the front panel display only if the cooling mode has been declared as a connected equipment in the RELAY SETUP loop. If the OFAN SETUP menu ***does*** appear, the OFAN MVAX and OFAN GRADX values must be entered. If you attempt to exit the USER SETUP menu without entering OFAN GRADX and OFAN MVAX values, you will be returned to the OFAN SETUP menu to correct the omission.

The OFAN MVAX load capacity rating should be stated on the nameplate and certainly on the transformer report. The Advantage does not have an automatic calculator for OFAN gradients because there are no utilitarian equations that can be used to approximate them.

An ***estimate*** of the OFAN Gradient may be made using a form of the equation above:

$$\text{OFAN GRADIENT} = \text{MAXGRAD} \ \text{x} \left[\frac{\text{MAX MVA}}{\text{OFANMVAX}} \right]$$

Where:

MAXGRAD	The gradient value provided for the 1 Per Unit (100%) load rating of the transformer. This rating will correspond to the all-cooling-on mode, for the winding being measured.
OFAN MVAX	The load rating corresponding to the OFAN cooling mode. The "X" corresponds to the winding being measured.
MVA MAX	The 1 Per Unit load rating of the winding being measured.

For further information, see the application note below in the OFAF SETUP paragraphs describing peculiarities of the OFAF cooling mode.

Prompt **OFAF SETUP**, OFAF cooling mode power and gradient entry menu. Figure 16B **(Required Parameter) (CT, CTX and CT/LTC Models Only)**

The OFAF SETUP menu provides for entry of power ratings and gradient values for the winding(s) being measured for winding temperature. If an LCAM module is not installed there will only be prompts for the power rating (prompt MVA1) and gradient (prompt GRAD1) for the first winding. If an LCAM module is installed you will be prompted for a power rating and gradient for each LCAM channel that is enabled for winding current measurement. There is a maximum of three winding currents that can be measured by the LCAM module.

The prompt for the OFAF power rating(s) are MVA1, MVA2 or MVA3. The prompt for the gradient value(s) are GRAD1, GRAD2 and GRAD3. Since you are in the OFAF SETUP menu, the OFAF prefix is understood. The OFAF power rating is the maximum power that can be demanded for a specific maximum winding temperature rise, with the OFAF cooling scheme. The power rating is typically stated on the data plate.

The OFAF cooling mode is characterized by fan-forced flow of air and pump-forced flow of fluid through the heat exchangers.

The OFAF SETUP menu will appear in the front panel display only if the cooling mode has been declared as a connected equipment in the RELAY SETUP loop. If the OFAF SETUP menu ***does*** appear, the OFAF MVAX and OFAF GRADX values must be entered. If you attempt to exit the USER SETUP menu without entering OFAF GRADX and OFAF MVAX values, you will be returned to the OFAF SETUP menu to correct the omission.

The OFAF MVAX load capacity rating should be stated on the nameplate and certainly on the transformer report. It is typically the cooling mode that corresponds to the 1 per unit load rating of the transformer.

Application Note

Transformers with oil forced (OF) fluid circulation have unique oil flow properties that make accurate field approximation of winding gradient temperatures difficult. The OF cooling mode is different than the oil directed (OD) cooling mode in that the fluid from the heat exchangers in OF cooling is not pumped directly into the winding cooling ducts, using a manifold arrangement. Pumps are used only to accelerate the velocity of the oil through the heat exchangers, without establishing a substantial increase in the flow of oil directly through the windings. The oil circulation within the tank will increase; however, this will simply cause the top oil to mix more quickly with cooler bottom oil and oil that comes more directly from the heat exchangers. This will have the effect of decreasing the top oil temperature more than the winding temperature, and thus will increase the (differential) gradient. Other OF designs may attempt to increase the flow of oil in the winding by aiming nozzles at the heat exchanger outlets in the direction of the winding duct inlets. This arrangement will increase the flow of oil through the winding, but due to a proportional increase in oil flow in the tank around the winding, may not change the gradient much from an ONAF cooling scheme. This is not to say that this form of OFAF design has the same cooling capacity as the same unit with ONAF; just that the gradient will be similar. It is strongly recommended that the transformer manufacturer or their detailed test report be consulted before attempting to approximate an OF gradient

Prompt **ODAN SETUP**, ODAN cooling mode power and gradient entry menu. Figure 16B **(Required Parameter) (CT, CTX and CT/LTC Models Only)**

The ODAN SETUP menu provides for entry of power ratings and gradient values for the winding(s) being measured for winding temperature. If an LCAM module is not installed there will only be prompts for the power rating (prompt MVA1) and gradient (prompt GRAD1) for the first winding. If an LCAM module is installed you will be prompted for a power rating and gradient for each LCAM channel that is enabled for winding current measurement. There is a maximum of three winding currents that can be measured by the LCAM module.

The prompt for the ODAN power rating(s) are MVA1, MVA2 or MVA3. The prompt for the gradient value(s) are GRAD1, GRAD2 and GRAD3. Since you are in the ODAN SETUP menu, the ODAN prefix is understood. The ODAN power rating is the maximum power that can be demanded for a specific maximum winding temperature rise, with the ODAN cooling scheme. The power rating is typically stated on the data plate.

The ODAN cooling mode is characterized by the pump-forced flow of fluid through the heat exchangers. As designated by the cooling code, air circulates by wind or convection and fans are either not included in the overall cooling scheme or are not running in this mode. This mode is typically used in noise sensitive installations, since fans typically produce much more noise than pumps. The ODAN mode differs from the simple oil forced cooling schemes (OFAN, OFAF) in that the fluid that is pumped out of the heat exchangers is directed into the bottom winding ducts using a manifold arrangement. This ensures that the coolest fluid is directly applied to cooling the windings. In this type of cooling mode the fluid leaving the top of the winding is forced directly into the top of the tank and the gradient between the winding and top oil temperature is typically small.

The ODAN SETUP menu will appear in the front panel display only if the cooling mode has been declared as a connected equipment in the RELAY SETUP loop. If the ODAN SETUP menu ***does*** appear, the ODAN MVAX and ODAN GRADX values must be entered. If you attempt to exit the USER SETUP menu without entering ODAN GRADX and ODAN MVAX values, you will be returned to the ODAN SETUP menu to correct the omission.

The ODAN MVAX load capacity rating should be stated on the nameplate and certainly on the transformer report. The Advantage does not have an automatic calculator for ODAN gradients because there are no utilitarian equations that can be used to approximate them.

An ***estimate*** of the ODAN Gradient may be made using a form of the equation above:

$$\text{ODAN GRADIENT} = \text{MAXGRAD} \ \ x \left[\frac{\text{MAX MVA}}{\text{ODANMVAX}} \right]$$

Where:

MAXGRAD	The gradient value provided for the 1 Per Unit (100%) load rating of the transformer. This rating will correspond to the all-cooling-on mode, for the winding being measured.
ODAN MVAX	The load rating corresponding to the ODAN cooling mode. The "X" corresponds to the winding being measured.
MVA MAX	The 1 Per Unit load rating of the winding being measured.

Prompt **ODAF SETUP**, ODAF cooling mode power and gradient entry menu. Figure 16B **(Required Parameter) (CT, CTX and CT/LTC Models Only)**

The ODAF SETUP menu provides for entry of power ratings and gradient values for the winding(s) being measured for winding temperature. If an LCAM module is not installed there will only be prompts for the power rating (prompt MVA1) and gradient (prompt GRAD1) for the first winding. If an LCAM module is installed you will be prompted for a power rating and gradient for each LCAM channel that is enabled for winding current measurement. There is a maximum of three winding currents that can be measured by the LCAM module.

The prompt for the ODAF power rating(s) are MVA1, MVA2 or MVA3. The prompt for the gradient value(s) are GRAD1, GRAD2 and GRAD3. Since you are in the ODAF SETUP menu, the ODAF prefix is understood. The ODAF power rating is the maximum power that can be demanded for a specific maximum winding temperature rise, with the ODAF cooling scheme. The power rating is typically stated on the data plate.

The ODAF cooling mode is characterized by the fan-forced flow of air and pump-forced flow of fluid through the heat exchangers. The ODAF mode differs from the simple oil forced cooling schemes (OFAN, OFAF) in that the fluid that is pumped out of the heat exchangers is directed into the bottom winding ducts using a manifold arrangement. This ensures that the coolest fluid is directly applied to cooling the windings. In this type of cooling mode the fluid leaving the top of the winding is forced directly into the top of the tank and the gradient between the winding and top oil temperature is typically small.

The ODAF SETUP menu will appear in the front panel display only if the cooling mode has been declared as a connected equipment in the RELAY SETUP loop. If the ODAF SETUP menu ***does*** appear, the ODAF MVAX and ODAF GRADX values must be entered. If you attempt to exit the USER SETUP menu without entering ODAF GRADX and ODAF MVAX values, you will be returned to the ODAF SETUP menu to correct the omission.

The ODAF MVAX load capacity rating should be stated on the nameplate and certainly on the transformer report. It is typically the cooling mode that corresponds to the 1 per unit load rating of the transformer.

Prompt **CT1 SETUP, CT2 SETUP, CT3 SETUP**, Current Transformer Ratio Setting Loop, figure 16C
(CT, CTX and CT/LTC Models Only)

The CTx SETUP loops are provided to match the current sense circuit's ranges to the transformer's Winding Temperature Indicator CT (WTI CT), which supplies the load current sense signal for use by the winding temperature algorithm. There are a maximum of three CT configuration loops named CT1 SETUP, CT2 SETUP and CT3 SETUP. If no LCAM module is installed, or if an LCAM module is installed but only one channel is enabled, only the CTx SETUP loop corresponding to the enabled channel will appear in the main menu. If an LCAM module is installed and all three current sense inputs are enabled, all three CTx SETUP loops will appear.

The CTx SETUP loop provides two ways of setting the CT ratio: by providing the primary and secondary current ratings directly in the RATIO loop, or by the calibration method in the CALCT loop. Only one method need be performed. The CT ratio that is stored will depend upon which method is chosen. Either loop will produce the same result on the same WTI CT.

The RATIO loop method should be chosen if the ultimate CT ratio is known. Be careful to include any interposing CT's, such as isolation transformers, in the ultimate ratio.

The CALCT loop method should be chosen if the ultimate CT ratio is not known. This happens frequently when an Advantage is used to replace a simulating winding temperature indicator and the existing WTI CT is used.

Prompt **RATIO** provides entry to the WTI CT's ratio setting loop.

Prompt **PRMRY** allows for entry of the WTI CT's primary current rating.

Prompt **SECND** allows for entry of the WTI CT's secondary current rating.

Prompt **CALCT** provides entry to the WTI CT calibration loop. Detailed information on this function is contained in Section 7, Calibration.

Prompt **LTC FUNCT**, LTC Function Enable, Figure 16D
LTC and CT/LTC Models only

This function is intended to turn off the LTC feature if it is not being used. This disables all LTC functions including front panel display, alarm operation (internal and external), peak & valley logging, retransmit and communications. In addition, the set up prompts that concern the LTC differential feature will not appear in front panel menus if this value is set to "OFF".

Prompt **LTC STEP**, Maximum Differential Temperature Change Variable, figure 16D
LTC and CT/LTC Models only

The LTC STEP variable is used by the differential temperature algorithm to limit the amount the differential temperature can change, during a specific period of time and still be considered valid. Since a normal LTC tank temperature is responsive primarily to the main tank temperature, any large change in the difference between the two tank temperatures in a short period of time, could be due to transient environmental conditions unrelated to a potential LTC failure. The step variable is intended to define the maximum change which the user would expect to see within a similarly defined sample or delay period. It is similar to a signal filter's amplitude attenuation specification. The delay period is defined in the next menu item, immediately below. For an illustration of the relationship between LTC STEP and LTC DELAY, see section 6, "LTC Tailoring".

The step size is entered as a value between -0.4 and -20.00 °C. The values bear negative signs because a valid change in differential temperature is always in the negative direction. This is due to the mathematical relationship of the Main tank to the LTC tank. The differential temperature is calculated as; $TEMP_{MAIN}$ - $TEMP_{LTC}$ = $TEMP_{DIFF}$. For example, given three sequential sample (delay) periods where the LTC temperature has increased by 1 °C per period, while the main tank temperature has remained static the result would be:

	$TEMP_{MAIN}$	-	$TEMP_{LTC}$	=	$TEMP_{DIFF}$
Period 1:	50.0	-	48.0	=	2.0°C
Period 2:	50.0	-	49.0	=	1.0 °C
Period 3:	50.0	-	50	=	0.0 °C

In this example, if the LTC STEP variable was set to 1 °C, the calculation would result as shown. If the LTC STEP value was set to 0.5 °C, however; the differential equation would limit the allowed change to 0.5 °C per delay period. Thus at the end of period 3 above, the differential temperature would only have changed by 2.0 - 0.5 - 0.5 = 1.0 °C.

Because of the many variables associated with LTC monitoring, no meaningful recommendation can be made for a step size value. The transformer manufacturer and operating experience are the best sources of values for this variable. Fortunately, as will be explained in section 6 "LTC Tailoring", the Advantage has an automatic method of gaining operating experience within a relatively short period of time.

Prompt **LTC DELAY**, Differential Temperature Delay Period Variable, figure 16D
LTC and CT/LTC Models only

The LTC DELAY variable is used by the differential temperature algorithm to define the length of the sample period between updates of the differential calculation, which drives the alarm control. During the sample period the instantaneous differential, which appears on the front panel display, is continuously accumulated. When the sample period has expired the accumulated instantaneous differential values are averaged and used to determine alarm status. The longer the sample period, the more values which are averaged. This has a tendency to average out irregularities and spurious excursions which may occur during a 24 hour loading cycle. A shorter cycle has less samples and has a tendency to reflect conditions over the short term. The LTC DELAY variable can have values between 0 and 99999 seconds or effectively 0 to 27.8 hours.

The Advantage includes an adaptive algorithm which "learns" the correct delay period for the corresponding user-specified step size, in response to application conditions. This feature will vary the initial user-entered LTC DELAY period by as much as ± 50% in response to measured signals. Basically, if the end of the delay period is reached and the actual differential value exceeds the step size, the Advantage will shorten the delay period to try and capture a smaller segment of the signal. If the end of the delay period is reached and the actual differential value is less than the step size, the Advantage will lengthen the delay period. When the Advantage changes the step value the new value will be reflected in the step variable value display. The user may elect to turn this feature on or off by selecting the ON or OFF option at the AUTO prompt, which is the second part of the LTC DELAY loop. The default setting for the AUTO variable is "OFF".

It is recommended that this variable be initially set to the middle of the range (50000) seconds to allow the Advantage to settle at a new delay period. This new period can then be used in conjunction with the step size to determine if the values are acceptable, or as a basis for further tuning. Once the final delay and step size are determined, the AUTO feature should be turned off to hold the final delay value.

See section 6, "LTC Tailoring" for details on the differential filter and how the LTC DELAY and LTC STEP function within it.

Prompt **INITL LTCDF** , Initial LTC Differential Value, figure 16D
LTC and CT/LTC Models only

The initial LTC differential value is the value the user sets when (s)he is ready to begin trending the LTC differential temperature. This value is the starting point for the deviation (DEV) value which is a historical log of the peak differential temperature over time.

Prompt **CHNL1 TITLE, CHNL2 TITLE, CHNL3 TITLE**, Channel Titles, figure 16D
All Models

The CHNLX TITLE loops are provided to allow users to define a display name for what is being measured on the RTD inputs. The titles available, and when they are available for various models, are shown in table 8.

Table 8. Channel Titles

<table>
<tr><th>Model</th><th>Channel</th><th>Titles (note 1)</th></tr>
<tr><td>SC</td><td>1</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID</td></tr>
<tr><td rowspan="2">DC</td><td>1</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID</td></tr>
<tr><td>2 (note 2)</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK, FLUID or OFF</td></tr>
<tr><td rowspan="3">TC</td><td>1</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID</td></tr>
<tr><td>2 (note 2)</td><td rowspan="2">TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK, FLUID or OFF</td></tr>
<tr><td>3 (note 2)</td></tr>
<tr><td rowspan="2">LTC
(LTC Function ON)</td><td>1</td><td>MANTK</td></tr>
<tr><td>2</td><td>LTCTK</td></tr>
<tr><td rowspan="2">LTC
(LTC Function OFF)</td><td>1</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID</td></tr>
<tr><td>2 (note 2)</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK, FLUID or OFF</td></tr>
<tr><td>CT</td><td>1</td><td>TOPO, TOPO1, TOPO2, TOPO3, FLUID</td></tr>
<tr><td rowspan="2">CTX</td><td>1</td><td>TOPO, TOPO1, TOPO2, TOPO3, FLUID</td></tr>
<tr><td>2 (note 2)</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK, FLUID or OFF</td></tr>
<tr><td rowspan="3">CT/LTC
(LTC Function ON)</td><td>1</td><td>TOPO, TOPO1, TOPO2, TOPO3, FLUID</td></tr>
<tr><td>2</td><td>LTCTK</td></tr>
<tr><td>3 (note 2,3)</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, MANTK, FLUID or OFF</td></tr>
<tr><td rowspan="3">CT/LTC
(LTC Function OFF)</td><td>1</td><td>TOPO, TOPO1, TOPO2, TOPO3, FLUID</td></tr>
<tr><td>2 (note 2)</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK, FLUID or OFF</td></tr>
<tr><td>3 (note 2)</td><td>TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK, FLUID or OFF</td></tr>
</table>

Notes:

1. Each channel must have a unique title. The firmware will not allow channels to share the same title.
2. If this channel is not being used for measurement of an RTD, the OFF title selection **MUST** be chosen, to disable sense and internal fail alarms.
3. If channel 3 is being used for LTC differential measurement, the MANTK title **MUST** be selected. If channel 3 is not being used for LTC differential measurement, any title shown may be selected.

Prompt **LCAM ENABL, L**oad and **C**ooling **A**pparatus **M**onitoring Module, Figure 16D
LCAM Equipped Models Only

If an LCAM module is not installed, this prompt will not appear. The LCAM ENABL loop is provided to allow for individual enabling / disabling of the LCAM module's input channels, LCAM1 through LCAM8. When an LCAM input channel is disabled, all of the channel's functions will be disabled. Since the LCAM module is treated differently by the firmware of different models, the sub-functions vary per model.

The LCAM module has up to eight inputs. In CT, CTX and CT/LTC models, channels 1 - 3 can be factory-configured as winding-current-only or multi-range auxiliary inputs. For other models LCAM channels 1 - 3 are multi-range auxiliary inputs only. LCAM channels 4 - 8 inputs are always multi-range auxiliary inputs.

On CT, CTX and CT/LTC models the LCAM ENABL loop sub-functions and their treatment are as follows:

- If the LCAM1 channel is disabled, all functions associated with the LCAM1 input will likewise be disabled. The Advantage will, however; look for a current input from the primary cooling control and current input (CCA) module. Generally, the signal from the CCA module will only be available if the LCAM module is a retrofit item. If the Advantage was factory-equipped with an LCAM module, the current input on the CCA module will be omitted. If signal is available from the CCA input, the displays WIND1, HWIND, CRNT1 and HCRNT will display values taken or calculated from that input. If signal is not present from the CCA module, the CRNT1 display will indicate 0 and the WIND1 display will show the same value as measured on the channel one (top oil temperature) input.
- If LCAM2 is disabled, all functions, including alarms, relay operation and communications, associated with the LCAM2 input will likewise be disabled. The DSPLY option for displays WIND2 and CRNT2 is automatically set to "OFF" and the displays WIND2 and CRNT2 will not appear.
- If LCAM3 is disabled, all functions, including alarms, relay operation and communications, associated with the LCAM3 input will likewise be disabled. The DSPLY option for displays WIND3 and CRNT3 is automatically set to "OFF" and the displays WIND3 and CRNT3 will not appear.
- If a multi-range LCAM4 through LCAM8 input is disabled, all functions, including alarms, relay operation and communications, associated with the corresponding LCAM input will likewise be disabled.The DSPLY option for the channel which is disabled is automatically set to "OFF" and the displays for the disabled channels will not appear.

On all other models the LCAM loop sub-functions and their treatment are as follows:

- If a multi-range LCAM1 through LCAM8 input is disabled, all functions, including alarms, relay operation and communications, associated with the corresponding LCAM input will be disabled. The DSPLY option for the channel which is disabled is automatically set to "OFF" and the displays for the disabled channels will not appear.

If an input is being enabled for the first time, or is being re-enabled after being disabled, the channel's display will need to be turned on in the DSPLY ENABL loop in order for it to be seen on the front panel display.

Prompt **DSPLY ENABL**, Channel Display Option Loop, Figure 16D
All Models

The DSPLY ENABL loop is provided to allow users to turn off the display of values on the front panel. This feature does not turn off any other functions, it simply eliminates unnecessary scrolling of the displays in the walk-up mode. Any display can be turned off except the alarm relay, time/date and model identification displays.

Prompt **TIMED TRGGR**, Alarm on Time or Date, Figure 16D
All Models

The TIMED TRGGR menu loop provides for time or calendar-based control of cooling auxiliaries. It has two sub loops, DAILY and CALND.

The DAILY loop is intended for users who want to operate an alarm relay at the same time, and for the same period, each day. The user has controls for trip time in hours and minutes and length of the operate period. This feature is used to exercise fans and pumps to keep bearings and seals in shape, to discourage the ingress of various animals (critter control) and to activate a cooling stage during a known daily high demand period.

The CALND loop is intended for users who need to operate an alarm relay for an extended period of time which typically spans months. This is typically employed when a utility needs to run a cooling stage continuously during a certain period of the year when a high demand is expected day and night. These two features allow a user the choice of running one stage on a daily basis and another on a seasonal basis. The CALND sub loop allows the user to set relay operate periods using start and end times in months (SMON)/EMON), days (SDAY/EDAY) and hours and minutes (STIME/ETIME). The month number is limited to 12 and the day number is limited to the actual number of days in the particular month. For example, If a user enters 31 or a higher number for the day number in month number 4 (April), the firmware will correct the day number to 30. The leap year day of February 29^{th} is similarly not supported. The firmware will enter 28 as the valid day number if “2" is set as the SMON or EMON variable and any number higher than 28 is entered as the day number.

The default settings for times in the TIMED TRGGR loop is zero hundred hours (0.0). This includes the “LENTH” variable in the DAILY sub loop. These settings will guarantee no alarm response if the user inadvertently selects a trigger source in the ALARM SETUP loops but neglects to configure the DAILY and/or CALND settings. The default setting for months and days is “1". The selected start and end months may span the new year without consequence.

It is important to remember that the TIMED TRGGR function is normally used in conjunction with the operation of the cooling apparatus. It is seldom used in conjunction with high temperature alarms. It is also important to note that the timing functions will act in concert with the set point function as far as operating a relay INTO the alarm state, but will not override a set point function with regard to dropping the relay out of the alarm state.

Prompt **SEASN SETBK**, Seasonal Setback, Figure 16D
All Models

The SEASN SETBK function allows users to adjust temperature alarm settings to changing ambient conditions. When enabled in an alarm’s configuration loop, and when the actual date is between the configured start and end dates, the value of the SEASN SETBK function’s DGREE variable will be added to the value of the ALMX SETUP function’s DGREE variable to calculate the new alarm set point value.

If the SEASN SETBK function’s DGREE variable is set to a negative number, the new calculated alarm set point value will be lower than the original. If the SEASN SETBK function’s DGREE variable is set to a positive number, the new calculated alarm set point value will be higher than the original. While the result is the same, the SEASN SETBK function may be used to increase the temperature alarm value during the summer months (positive DGREE value) or decrease the temperature alarm value during the winter months (negative DGREE value).

The SEASN SETBK function also allows for seasonal adjustment of alarm(s) which operate in response to load current (ILOAD) magnitude. The AMP variable of this feature provides for a ± 500 amp range of adjustment, referred to the maximum load current, which is the “IMAX” value declared in the USER SETUP loop. Refer to 16C for the menu location of this variable. This variable operates same as the DGREE variable, above.

The set back function’s time settings are divided into starting and ending specifications which bracket the effective period of operation. The prompts SMON (starting month), SDAY (starting day) and STIME (starting time-of-day) define the instant the period is to begin. The prompts EMON (ending month), EDAY (ending day) and ETIME (ending time-of-day) define the instant the period is to end.

The SETBACK function acts with the set point values and it can therefore be used with the alarm timing functions of the TIMED TRGGR loop with no conflict.

Prompt **OPRAT FUNCT**, Operator Mode Function Enable, Figure 16E

The operator mode function variable can have two values; ENABL (enabled) or DISAB (disabled), which either allow an operator to respectively gain or be denied access to the operator mode. See section 5, Operations for more details on the operator mode.

Prompt **DSPLY FLASH**, Display Flash Enable Variable, Figure 16E

The display flash enable variable has two values; either ENABL (enabled) or DISAB (disabled), which either allow or inhibit display flash when a display variable exceeds its upper or lower limits. This function also allows or inhibits display flash in the event of a sensor or internal failure.

Prompt **ANRTN SETUP**, Analog Retransmit set up menu, Figure 16E

Up to three configuration loops are provided to set up the three corresponding channels of analog retransmit. All three loop variables are set up identically to each other. The analog retransmit outputs provide up to three independent current sources with current levels proportional to the source quantity. The current outputs are independent of load impedance within the compliance window of 0.48 volt-amps, with 20 volts as the compliance voltage limit and 24 ma as the current limit.

If your model has only a single analog retransmit channel, it's hardware and terminals will be located on the I/O module. If your model has multiple outputs they will be located on the MCAR module. Both retransmit methods are optional features that must have hardware installed to support the option. The analog retransmit channel function must be enabled in order for the ANRTN SETUP menu prompt and it's associated sub-menu prompts to appear. The analog retransmit function(s) can be enabled or disabled only through the AMTCMF software. Consult the SMAMT200 software manual for details of how the retransmit enable/disable operation is performed.

The analog retransmit has been factory calibrated to meet 0.5% accuracy requirements for the standard output range of four to twenty milliamps. Factory calibration will be accurate even if the output is changed from the factory default 4 - 20 ma to, for example, 0 - 1 ma. Calibration values are stored in non-volatile memory and are no longer overwritten when new retransmit configuration values are uploaded using the AMTCMF software.

Prompt ANLOG RTRN1, ANLOG RTRN2 or ANLOG RTRN3, Analog Retransmit Set Up Menu, Figure 16E

These are the entry points for the analog retransmit set up menus.

Prompt **RSRC1, RSRC2, RSRC3**, Signal Source Variable, Figure 16E

The signal source variable specifies which signal the firmware will use to transform into a proportional current output. The retransmit sources are shown in table 9. In order to retransmit more than one channel, the model must not be an SC, the MCAR module must be installed and the additional channels enabled. Retransmit channels are enabled or disabled only through the AMTCMF configuration software that ships with all Enhanced Advantages.

Table 9. Analog Retransmit Sources

Model	Measurement	Channel	Source (note 1, 2)
SC	RTD	1	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID
DC	RTD	1	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		2	
TC	RTD	1	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		2	
		3	
LTC (LTC Function ON)	RTD	1	MANTK
		2	LTCTK
	LTC Differential	NA	DIFF, DEV
LTC (LTC Function OFF)	RTD	1	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, WIND1, WIND2, WIND3, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		2	
CT (Without LCAM)	RTD		TOPO, TOPO1, TOPO2, TOPO3 or FLUID
	Winding Current	Current	CRNT1
	Winding Temp	NA	WIND1
CT (With LCAM)	RTD	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
	Winding Current	LCAM1-LCAM3	CRNT1, CRNT2, CRNT3, HCRNT
	Winding Temp	NA	WIND1, WIND2, WIND3, HIWND

Model	Measurement	Channel	Source (note 1, 2)
CTX (Without LCAM)	RTD	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	Winding Current	Current	CRNT1
	Winding Temp	NA	WIND1
CTX (with LCAM)	RTD	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	Winding Current	LCAM1-LCAM3	CRNT1, CRNT2, CRNT3, HCRNT
	Winding Temp	NA	WIND1, WIND2, WIND3, HIWND
CT/LTC (LTC Function OFF & Without LCAM)	RTD	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		3	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	Winding Current	Current	CRNT1
	Winding Temp	NA	WIND1
CT/LTC (LTC Function ON & Without LCAM)	RTD	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	LTCTK
		3	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	LTC Differential	NA	DIFF, DEV
	Winding Current	Current	CRNT1
	Winding Temp	NA	WIND1
CT/LTC (LTC Function OFF & With LCAM)	RTD	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
		3	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	Winding Current	LCAM1-LCAM3	CRNT1, CRNT2, CRNT3, HCRNT
	Winding Temp	NA	WIND1, WIND2, WIND3, HIWND
CT/LTC (LTC Function ON & With LCAM)	RTD	1	TOPO, TOPO1, TOPO2, TOPO3 or FLUID
		2	LTCTK
		3	TOPO, TOPO1, TOPO2, TOPO3, WINDG, XWIND, YWIND, HWIND, BOTTO, AMBNT, LTCTK, MANTK or FLUID
	LTC Differential	NA	DIFF, DEV
	Winding Current	LCAM1-LCAM3	CRNT1, CRNT2, CRNT3, HCRNT
	Winding Temp	NA	WIND1, WIND2, WIND3, HIWND

Notes:

1. The “NONE” source may be selected for any retransmit channel. If the “NONE” source is selected, the analog retransmit output will be disabled (output = 0.0 ma) and the set up menu that you are currently navigating in will be exited to the next set up menu.
2. The retransmit source selection will allow retransmit of the same source on two channels. This may be useful to transmit the same information to devices which have dissimilar signal input scaling, such as an indicator and a DCS.

Prompt **RZER1, RZER2, RZER3**, Retransmit Zero Scale Current Output Variable, Figure 16E

The retransmit zero scale current output variable sets the lower limit of current output. Its range extends from 0 to 24000 microamps DC. The value is expressed in microamps in order to fine-tune the output to within ± 0.010 % of the display value. This value is nominally set to 0.0 for a 0 to 1 ma span or 4000 for 4 to 20 ma span. The RZERx value must be set lower than the RFULx value.

Prompt **RFUL1, RFUL2, RFUL3**, Retransmit Full Scale Current Output Variable , figure 16E

The retransmit full scale variable sets the upper limit of current output. Its range extends from 0 to 24000 microamps DC. The value is expressed in microamps in order to fine-tune the output to within ± 0.010 % of the display value. This value is nominally set to 20000 for a 4 to 20 ma span or 1000 for 0 to 1 ma span. The RFULx value must be set higher than the RZERx value.

Retransmit Application Note:

Retransmit Signal Source Limits

Retransmit signal sources are those shown in table 9. The retransmit signal source range is bounded on the lower end by the ZEROx value and on the upper end by the FULLx value. Between these two boundaries, current which is proportional to the measurement quantity will be output. Beyond these boundaries the output current will neither rise nor fall in response to changing measurements.

Prompt **ZERO1, ZERO2, ZERO3**, Retransmit Zero Scale Display Variable, figure 16E

The retransmit zero scale variable defines the lower limit in the measurement range where proportional current output will end. Below this value the output current will not decrease, even though the source signal may continue to decrease. Above this value proportional current will be supplied. The range for the ZEROx variable is -40.0 to 250.0 for temperature sources and 0 to the twice the IMAXx (maximum winding current) value.

As an example, if the user wants to produce a 4 to 20 ma output, based on the current range between 0 and 1000 amps, (s)he would set this value to 0.0. If, however; the user wanted to produce the same output, but base it on the span of 500 to 1000 amps, this value would be set to 500. This is frequently done to get higher resolution on a smaller part of the display range.

Prompt **FULL1, FULL2, FULL3**, Retransmit Full Scale Display Variable, figure 16E

The retransmit full scale variable defines the upper limit in the measurement range where proportional current output will end. Beyond this value the output current will not increase, even though the source signal may continue to increase. Below this value proportional current will be supplied. The range for this variable is -40.0 to 250.0 for temperature sources and 0 to twice (200% of) the value defined as IMAX (maximum winding current) in the USER SETUP loop. When a CT-series Advantage is equipped with an LCAM module which is monitoring winding current, there may be up to three current values that can be retransmitted.

As an example, if the user wants to produce a 4 to 20 ma output, based on the current range between 0 and 1000 amps, (s)he would set this value to 1000. If, however; the user wanted to produce the same output, but base it on a the span of 250 to 750 amps, this value would be set to 750. This is frequently done to get higher resolution on a smaller part of the display range.

Prompt **COEF1, COEF2, COEF3**, Retransmit User Coefficient

The COEF1, COEF2 and COEF3 variables are used to allow input of the user coefficient. The user coefficient is a value that is used to trim the retransmit output current to compensate for errors in external data transmission loops. The coefficient can be set for up to ± 5% of the endscale value that is set as the RFULX. A COEFX value of 0 provides no offset. See the example below in Retransmit Application Notes.

Retransmit Application Notes:

Reverse Indication:

Unlike the RZERx and RFULx variables, the ZEROx variable can be set to a higher value then the FULLx variable. The result of this capability is that a higher current can be output for lower actual measurement values.

As an example, let's assume you want to retransmit the measurement range from 0 to 160 °C using a 4-20 madc loop current, but you want to drive the output in reverse for one-half of a differential measurement scheme. You would set up your current loop to be 4-20 milliamps by setting RZERx = 4000 and RFULx = 20000 and you would set the ZEROx variable to 160 °C and the RFULx variable to 0 °C. With this configuration you will get a retransmit output of 20 milliamps when the Advantage is indicating 0 °C and 4 milliamps output when the Advantage is indicating 160 °C.

Example of Tuning the Analog Retransmit User Coefficient to Correct for Current Loop Errors:

It is desired to indicate top oil temperature at a remote site, and the local display and retransmit current are correct. The remote display; however, is indicating a lower value than the local display due to conversion and or calibration errors in the remote transmission loop. The top oil temperature proportional signal current is being retransmitted from retransmit channel 1.

The signal being measured has a 0-200 °C range, but it has been decided to make the retransmit range 0-160 °C due to previous instrumentation practice. Therefore ZERO1 is set to 0.0 °C and FULL1 is set to 160.0 °C. The desired output signal span is 4-20 madc and RZER1 is therefore set to 4000 microamps and RFUL1 is set to 20000 microamps. The present temperature is 70 °C and the output current at 70 °C is ((0.016 x (70/160))+0.004) = 0.011 amps. The remote site is indicating only 67 °C, however; which is a ((70-67)/70) x 100) = 4.29% error . Changing the COEF1 value from 0.0% to 4.49% will cause the current loop output to increase to 11.3003 ma, which will correct the remote indication error.

As an alternative to the calculation method, the user can contact the remote facility and adjust the coefficient up or down from the front panel until the remote indication agrees with the local (front panel) indication. After adjusting the coefficient, the enter button must be pressed in order to store the new value into non-volatile memory.

The user coefficient is stored in non-volatile memory, which will not be overwritten when a new configuration file is uploaded. The coefficient may be entered from the front panel or through the AMTCMF software. If you are using the software, when the prompt for the user password appears, enter the same password that is used to access the supervisory mode from the front panel.

Firmware Upgrade

In Advantage with firmware versions prior to AMTSYS0201, the RFULX variable was adjusted to set the current output to within the ±0.5% stated accuracy limits. This method gave installers and operators easy access to adjust current output to compensate for external loop inaccuracy, but also exposed the values to inadvertent change of factory calibration. In order to ensure that the calibrated accuracy was not lost, a calibration coefficient was determined at the factory and printed on a label affixed to an inner wall of the Advantage case. This calibration coefficient is not the same as the user coefficient discussed above. If the Advantage firmware is being upgraded from a version prior to AMTSYS0201, this coefficient must be transferred to the new factory coefficient variable. The retransmit factory calibration coefficient can be entered only through the AMTCMF0201 software. Consult the SMAMT200 software manual for details regarding transferring the coefficient.

Prompt **SCALE RANGE**, Select High Endscale Value, figure 16E

The SCALE RANGE variable is set according to the expected highest measured temperature. The value is used internally, primarily to determine if a sensor failure has occurred. The value is typically set to 200 when the Advantage is being used to monitor stationary transformers with mineral oil insurlating fluid and insulation with a 135 °C threshold loss-of-life temperature. The 250 value is typically set for mobile and other transformers with high threshold insulation and insulating fluid.

Prompt **SYSTM CALIB**, Calibration Loop, figure 16F

The calibration function, as its name implies is used to calibrate the Advantage to reference standards. It is a complex loop to navigate, and special knowledge of calibration operations is required. The loop is covered in detail in section 7, Calibration. Calibration is not normally needed for the life of the Advantage.

Prompt **SELF CHECK**, Internal RTD Sense Circuit Self-Check Calibration, figure 16G

The internal RTD circuit self-check calibration function runs an automatic operation in which each channel re-calibrates itself to a reference resistor value, when the CALYS (calibrate yes) option is selected. If the CALNO (calibrate no) option is selected the self-check function is bypassed. While the self check function is running, a sequencing asterisk will be displayed on the front panel.

The self check circuit detects and warns about potential damage to the circuitry in the signal path between the sensor input and the display. It uses a ultra-low drift, low temperature coefficient reference resistor which is switched into the sensor circuit and measured every 10 minutes. If the value of the resistor appears to have deviated beyond a stored tolerance, the internal failure alarm is activated. When the Advantage is factory calibrated the resistor is automatically measured and the value, along with the computed tolerance is stored. As time passes, some of the components in the sensor measurement circuit may drift slightly. The self-check (SELF CHECK) calibration function has been provided to compensate for this drift. It is not intended to compensate for rapid drift, however; which is a sign of component failure. The self check calibration should be performed once a year, during normal site inspection routines. It requires no tools, just a few keystrokes. An RTD probe or calibrator need not be connected to correctly run the self-check calibration. Do not run the self-check calibration if any sensor failure indication is displayed, without referring to the paragraphs titled “Sensor and Internal Failure Alarm Function” in the configuration section 4 on page 50 and the paragraphs titled “Sensor and Internal Failure Alarm Troubleshooting” in the troubleshooting section 8 on page 99.

- Enter the main configuration loop using the keystrokes of figure 14 on page 37.
- Scroll down to the “SELF CHECK” prompt using repeated depressions of the down button.
- Press the enter button.
- Press the down or up button to toggle to the “CALYS” (calibrate yes) prompt and press the enter button.

The calibration will be performed automatically for all channels and you will be returned to the main configuration loop at the “TIME DATE” prompt. At this point you can scroll to the “NORML MODE” prompt and exit configuration, or scroll to another function or just wait, and in 45 seconds the Advantage will return to normal operation automatically.

Prompt **TIME DATE**, Real Time Clock Setting, figure 16G

As the name implies this loop allows for setting the current time and date on the real time clock. The time is expressed in twenty four hour format, and there is no provision for a 12 hour (am - pm) format. The time is updated as soon as the enter button is pressed after the seconds are entered, therefore the most accurate method of setting the time is to enter all of the time elements (year, month, day hour, minute and second) 30 seconds ahead of the actual time, but wait to press the enter button following seconds entry for the actual time to catch up. The DSAV function provides for automatic adjustment of system time in geographic locations within the United States where daylight savings time (DST) is observed. In 2007 and beyond, the automatic DST calculator sets DST to begin at 02:00 on the second Sunday in March and end on the first Sunday in November. If your location does not observe DST it is advisable to disable the DST feature. Many countries schedules for DST differ from the US. If the start and end dates at your location do not agree with the above schedule, the decision will need to be made whether to enable or disable the feature on an individual basis. If an overlap of a few days or weeks is less of a hardship than visiting the site to change the time twice a year, it may be more fitting to enable the feature. Conversely, if data is being recorded with a time stamp, it may be more applicable to set the time manually.

Prompt **EVENT RECRD**, Peak and Valley Recording Interval, figure 16G

The EVENT RECRD feature provides a way of recording peak and valley values in two ways . The first option is hourly, selected using the prompt HOUR. This method will automatically transfer peak and valley values to the second level peak and valley memory, then clear the old value once within each one hour period. This will allow a user to log hourly values for all measurements with peak and valley capability. It is a data logging feature with a one-hour sample period. The second option , CONT (continuous) stores the peak and valley values in first level memory until the values are cleared manually from the front panel or through digital communications, whereupon the cleared values are placed in second level memory. Second level memory is retained in non-volatile flash rom and can be downloaded using digital communications.

Prompt **RTD OFSET**, RTD Offset LOOP, figure 16G

The RTD OFSET loop contains three sub-loops; RTD1, RTD2 and RTD3 which are used to add offsets to the temperature measurements from channels 1, 2 and 3. This is typically required if there is a known linear probe error or compensation is being made for skin effect errors of magnetically attached probes. The adjustment range is ± 25 °C .

Prompt **DSPLY CNSRV**, Display Conserver Enable, figure 16G

The display conserver function has two options; ENABL (enabled) or DISAB (disabled). If ENABL is selected, the display, except for the radix will blank out 45 seconds after the last button depression. Any subsequent button depression will restore the display for another 45 seconds. If DISAB is selected the display will stay on continuously. This feature is provided to avoid attracting the attention of hunters to a potential practice target.

Digital Communications Set up Menus

All Advantage IIE models are equipped with communications hardware in order that configuration can be done conveniently through digital communications. The COMM HRDWR and COMM SETUP prompts will therefore appear in keystroke menus for all Advantage IIE models.

Prompt **COMM HRDWR**, Communications Port Hardware Set Up Loop, figure 16G

The COMM HRDWR menu is provided to set up parameters associated with the wiring connections and interpretation and timing of communications signals. Upon entry into the loop, the port being set up is selected, followed by the baud rate, framing information and physical protocol selection. Port 1 is intended for connection to a portable PC using an RJ-11 connector at the Advantage end and an RJ-11 to DB-9 adapter at the PC end. See figure 26 for cabling details. Port 1 communicates using the RS-232 protocol only. Port 2 is intended to be hardwired for permanent communications tasks, using RS-232, and RS-485 two or four wire connections. If port 2 is selected for set up, the user will be prompted to select either RS-232 or RS-485 protocols. If RS-232 is selected, no further configuration is required and the menu will be exited. If RS-485 is selected the user will be prompted to select either two or four wire connections. If four wire is selected, no further configuration is required and the menu will be exited. If two wire is selected the user will be prompted to set a turnaround delay period. It is common for RS-485 2-wire comm schemes to require a signal turn-around delay, because many schemes incorporate RS-232 to RS-485 converters. The converters need time to turn off their transmit drivers in order to avoid attenuating the reply signal, and if a delay is not inserted into the timing, some bits of data in the reply are likely to be lost, causing a comm failure.

Prompt **PATH**, Select Port to Set Up, Figure 16G

Two options are offered for the PATH variable; PORT1 and PORT2. Port 1 is the RJ-11 plug-in port and port 2 is the hardwired port.

Prompt **BAUD**, Set Communications Baud Rate, Figure 16G

Seven baud rates are provided; 2400, 4800, 9600, 19200, 38400, 57600 and 115200 bits per second. The typical PC port is auto-negotiating, meaning it will find the correct baud rate for the connected device. This is not always true of applications, however. If difficulty is experienced, be sure the same baud rate is set for both the Advantage, the port through which you are communicating and the application program.

Prompt **DBITS**, Set the Number of Data Bits in the Communications Frame, Figure 16G

The DBITS variable is provided to allow communications with devices that do not use the standard 8 data bits. The options are 7 or 8 data bits. Most communications devices use 8 bits, but if your application requires 7, set this variable to 7.

Prompt **PRITY**, Set the Frame Parity, Figure 16G

The PRITY variable is provided to allow users to select NONE, ODD or EVEN parity to agree with applications that use parity checking for error detection.

Prompt **SBITS**, Set the Number of Stop Bits at the End of the Communications Frame, Figure 16G

The SBITS variable is provided to allow communications with devices that do not use the standard 1 stop bit. The options are 1 or 2 data bits. Most communications devices use 1 bit, but if your application requires 2, set this variable to 2.

If Port 1 was selected at the beginning of the COMM HRDWR menu, the menu will exit after the SBITS has been set. If Port 2 was selected, the COMM HRDWR menu will continue with prompt RS-XXX.

Prompt **RS-XXX**, Select Protocol for Port 2, Figure 16G

The RS-XXX prompt is presented with the “RS-“ in the prompt display and 485 or 232 (represented by “XXX” here) in the value display. The RS-XXX variable is provided to allow the user to select which physical protocol to use when connecting to port 2. The options are XXX = 232 or 485.

If RS-232 was selected, the COMM HRDWR menu will exit to the next menu. If RS-485 was selected, the COMM HRDWR menu will continue with prompt RS-485.

Prompt **RS-485**, Select Connection Type, Figure 16G

The RS-485 prompt allows users to specify 2 wire or 4 wire connections. If the 4 wire connection is selected, the COMM HRDWR menu will be exited, since no more configuration is necessary. If the 2 wire connection is selected, the user will be prompted to set a turnaround delay time.

Prompt **DELAY**, Set Turnaround Delay Period, Figure 16G

The DELAY variable is provided in order that the user may set a value for the turnaround delay period. The RS-485 2-wire mode is bi-directional, but also half-duplex, meaning that devices on the line can transmit and receive, but not simultaneously. Most communications hardware requires a finite period of time during transitions between transmit and receive sessions, to allow the transmit drivers to shut off in order that the receivers can “listen” to the bus. This is most prevalent where converters are used to interface RS-232 devices to RS-485 devices. The DELAY value is used for this purpose. The value is specified in microseconds.

Prompt **COMM SETUP**, Set Communications ID’s, Enable and Set Up Communications Protocols, Figure 16G

Prompt **ID**, Communications Unit Identifier, figure 16G

The communications unit identifier is a two digit number with a range of 00 to 99. It is used when communicating with two or more communicative devices which share the same communications bus (cable). In order for a host device like a PC to communicate with a particular Advantage on the bus, the unit ID on the Advantage must match the unit ID that the host broadcasts when it is “looking for” the Advantage on the bus.

If the Advantage has not been purchased with an optional protocol, the COMM SETUP menu will be exited. If an optional protocol has been purchased, the user will be prompted to select and set up the protocol.

Prompt **PRTCL**, Protocol Selection

The PRTCL prompt is provided to select which protocol to enable and set up. Presently there are two optional communications protocols; DNP-3 level 1 slave and ModBus RTU/ASCII. Enabling of protocols is mutually exclusive; if you enable one, the other will be automatically disabled.

Depending upon which protocol has been selected, the user will be prompted to enable or disable either DNP-3 or ModBus. Refer to the prompt below which suits the application.

DNP-3 Prompt **DNP-3**, Enable / Disable the DNP-3 Protocol

The DNP-3 prompt allows two options; ENABL to enable the protocol and DISAB to disable it. If the DISAB option is chosen, the COMM SETUP menu will be exited. If the ENABL option is chosen, the PRMID prompt will appear next.

DNP-3 Prompt **PRMID**, DNP-3 Protocol Primary Communications ID, figure 16G

This prompt will only appear if the DNP-3 protocol is enabled on the Advantage. The PRMID variable is used by Advantage when it is communicating digitally, using the DNP-3 protocol. It is not required, and will be ignored if DNP-3 communications is not used. The PRMID variable is the address of the host to which the Advantage is communicating. The allowed range is 0-65532.

DNP-3 Prompt **SLVID**, DNP-3 Protocol Primary Communications ID, figure 16G

This prompt will only appear if the DNP-3 protocol is enabled on the Advantage. The SLVID variable is used by Advantage when it is communicating digitally, using the DNP-3 protocol. It is not required, and will be ignored if DNP-3 communications is not used. The SLVID variable is the address of the Advantage in a communications scheme containing many devices. The allowed range is 0-65519.

DNP-3 Prompt **PORTS**, Display / Choose Port, figure 16G

The PORTS prompt is actually a read only display which shows which ports will communicate using the selected protocol, which is this case is DNP-3.

ModBus Prompt **MODBS**, Enable / Disable the ModBus Protoco, figure 16G

The MODBS prompt allows two options; ENABL to enable the protocol and DISAB to disable it. If the DISAB option is chosen, the COMM SETUP menu will be exited. If the ENABL option is chosen, the SLVID prompt will appear next.

ModBus Prompt **SLVID**, ModBus Protocol Primary Communications ID, figure 16G

This prompt will only appear if the ModBus protocol is enabled on the Advantage. The SLVID variable is used by Advantage when it is communicating digitally, using the ModBus protocol. It is not required, and will be ignored if ModBus communications is not used. The SLVID variable is the address of the Advantage in a communications scheme containing many devices. The allowed range is 1-247.

ModBus Prompt **MODE**, Communications Protocol Type, figure 16G

The ModBus communications protocol type variable has two options, RTU or ASCII.

ModBus Prompt **PORTS**, Display / Choose Port, figure 16G

The PORTS prompt is actually a read only display which shows which ports will communicate using the selected protocol, which is this case is ModBus.

Prompt **LAMP TEST**, Lamp Test Function, figure 16G

The lamp test function requires no option selection. When the user presses the enter button with the LAMP TEST prompt displayed, all segments of the display will light for 10 seconds, or until the enter button is pressed a second time. The function will then exit to the NORML MODE prompt.

Prompt **NORML MODE**, Return to Normal Operations Mode, figure 16G

The NORML MODE prompt is the standard exit point of the main configuration set-up loop. When the user presses the enter button with the NORML MODE prompt displayed, normal mode is resumed. Normal mode can also be resumed automatically by waiting 45 seconds from the last keystroke.

Prompt **PASS WORD**, Password Loop, figure 16G

The password function is the gateway which protects the entry to the main loop. This security feature is intended to prevent unauthorized alteration of critical applications data. The factory default password is 0 (zero). When the user first powers the unit the password function will be bypassed. After setting up the user and alarm items, the user can return to the password loop and change the password if desired.

The password can be any numerical value between -9999 and 99999. To change the password you must first gain access to the main loop. Refer to Figure 15 for access to the main loop. If the password has not been changed, it will be zero, the factory default. Simply press enter when the “0" appears in the value display. If the password has been changed, and you know what it is, scroll to that value and press enter. If you do not know the password, contact Weschler sales (440) 238-2550 and request the password key. Once the password has been accepted, the prompt display will show “RELAY SETUP”. Press the UP button to scroll back to the PASS WORD function, then press the ENTER button. Using the UP or DOWN button, scroll to the new password, record the new password and press enter to accept it.

Any time after the password has been changed the user will need to enter the correct password to gain access to the main loop.

5.0 Operation

Walk-up Functions

The walk-up functions are those which can be performed while in the normal operating mode, with single keystrokes or dual simultaneous keystrokes. The functions affect the display and storage of measurement information. Any of the titles in the walk-up display loop may be stepped through and the PEAK and VALLEY values and corresponding time stamp may be viewed and reset. The displays are stepped through by repeatedly pressing and releasing the ENTER button.

A measurement's historical peak value can be viewed by pressing the up button once when the display shows the desired measurement title. A second press of the up button will display the date that the peak value occurred. A third press of the up button will display the time, in 24 hour format, that the peak value occurred. The valley values can be viewed using the same sequence, except by pressing the down button instead of the up button. The values which are shown are those which have occurred since the last time the peak or valley values were reset.

Figure 18, on page 81, shows the keystroke steps available in the normal operation mode.

Displays

The full list of display titles are:

- RTD Input Channel Titles listed in Table 8
- WIND1 (calculated winding temperature of the first winding, CT series only)
- WIND2 (calculated winding temperature of the second winding, CT series with LCAM only and LCAM2 set for "WCRNT")
- WIND3 (calculated winding temperature of the second winding, CT series with LCAM only and LCAM3 set for "WCRNT")
- HIWND (highest of three winding temperatures, CT series with LCAM only and at least two winding current measurements enabled)
- CRNT1 (current in one or the first winding, CT series only)
- CRNT2 (current in second winding, CT series with LCAM only and LCAM2 set for "WCRNT")
- CRNT3 (current in third winding, CT series with LCAM only and LCAM3 set for "WCRNT")
- HCRNT (highest winding current, CT series with LCAM only and at least two winding current measurements enabled)
- MANTK (main tank oil temperature, typically taken with a magnetically attached probe, LCT & CT/LTC only)
- LTCTK (LTC tank oil temperature, LCT & CT/LTC only)
- DIFF (LTC tank / main tank differential oil temperature, LCT & CT/LTC only)
- LCAM1 (Multi-range LCAM module input, Non-CT series with LCAM only)
- LCAM2 (Models with LCAM only; Multi-range LCAM module input, Non-CT series or CT series with LCAM2 set to "AUXIN")
- LCAM3 (Models with LCAM only; Multi-range LCAM module input, Non-CT series or CT series with LCAM3 set to "AUXIN")
- LCAM4 (Multi-range LCAM module input, all models with LCAM installed and channel enabled)
- LCAM5 (Multi-range LCAM module input, all models with LCAM installed and channel enabled)
- LCAM6 (Multi-range LCAM module input, all models with LCAM installed and channel enabled)
- LCAM7 (Multi-range LCAM module input, all models with LCAM installed and channel enabled)
- LCAM8 (Multi-range LCAM module input, all models with LCAM installed and channel enabled)

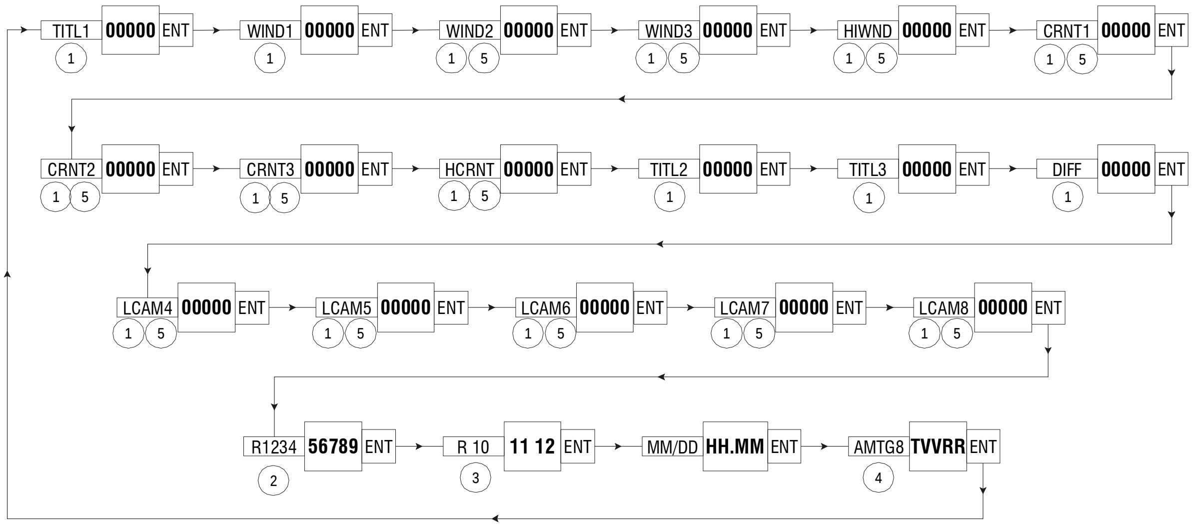
The DIFF display has unique properties that need further explanation.

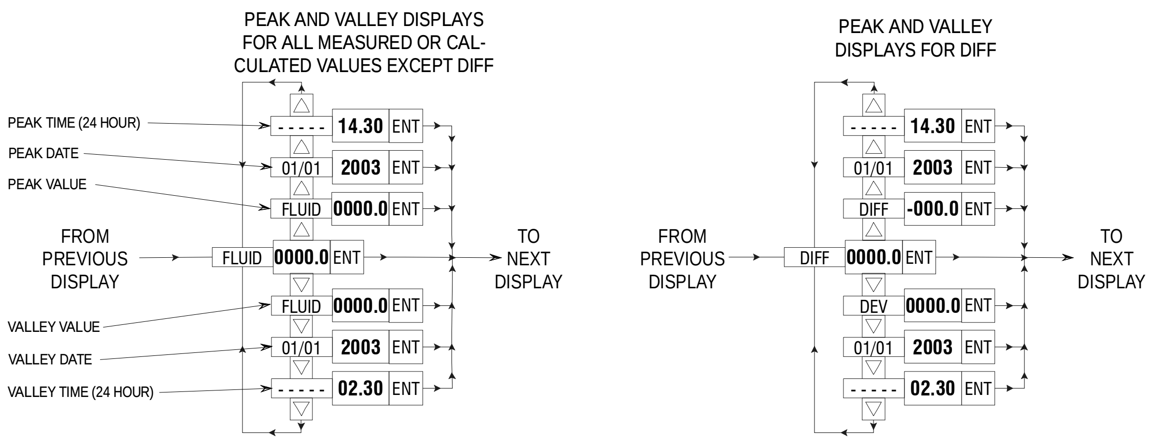
The DIFF display is the instantaneous LTC differential temperature. This value is calculated by simply subtracting the LTC tank temperature from the main tank temperature, without applying any filtering. The DIFF display value must not be confused with the filtered differential value, which drives the differential alarms directly. When there is a difference in value between the instantaneous and filtered differential values, that is larger than the STEP size, a "D" character will appear in the display to the right of the least significant digit of the value display. This signals that the filter logic has delayed the update of the filtered differential, in accordance with the STEP and DELAY settings. The filtered differential value is discussed in section 6 under the heading "Differential Value Measurements and Determining the LTC STEP and LTC DELAY Values". Two related but unique displays are available when the DIFF display is shown and the UP (peak) or DOWN (valley) button is pressed. The UP button will display the maximum differential value which was recorded since it was last reset. The DOWN button will display the maximum deviation value recorded since it was last reset. The maximum deviation value is the change in differential value from the time the value was initially stored (presumably at start-up) to the time the highest differential value is recorded. Do not clear this value unless you are sure you want to, because the stored value will be replaced by the current value and the deviation recorded since start up will only be available by downloading the peak and valley memory.

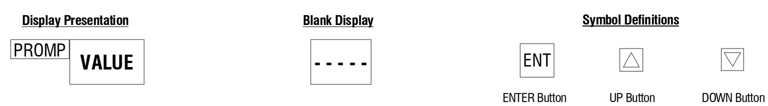
The TITL1 and TITL2 screens shown on figure 18 are simply the selections made during setup for the CHNL1 TITLE and CHNL2 TITLE prompts, respectively. The eleventh display in the selection loop of figure 18 shows "TITL3" in the value display. This particular display can take on one of several titles, depending upon the model and type of sensor site which is available. Reference Prompt "CHNL3 TITLE" on Figure 16D and the paragraph headed "Prompt CHNL1 TITLE, CHNL2 TITLE & CHNL3 TITLE" and table 8 on page 69 for more details.

Other titles may be added to the firmware for a small customization fee. Please consult the Weschler Sales Department for details.

WALK-UP DISPLAY SEQUENCE. SHOWN WITH ALL DISPLAYS ON. TITLES MAY VARY, DEPENDING UPON USER PREFERENCES







1. Display of these titles can be suppressed by setting their DSPLY value to OFF, in the DSPLY set up loop. See figure 17C and Prompt DSPLY in the configuration section for details.

2. If no relays are tripped, the display will look like this > R NONE ENT

3. This display only appears if relays 10, 11 or 12 are tripped.

4. This display shows the firmware version and revision. In this example, AMT indicates Enhanced firmware, G8T = CT/LTC MODEL, VV = VERSION and RR = Revision Level. To view firmware revision date and time press the down button while this display is being shown This is the same display that appears at start up.

5. This display will only appear if an LCAM module is installed and if the channel is enabled. See the LCAM set up loop on Figure 17C and the "Prompt LCAM" paragraph in the configuration section for further details.

△ ENT — To Reset the Peak Values for the Displayed Data, Press and Hold the UP, Then the ENTER Key. Values for Each Measurement Must be Cleared Separately.

▽ ENT — To Reset the Valley Values for the Displayed Data, Press and Hold the DOWN, Then the ENTER Key. Values for Each Measurement Must be Cleared Separately.

Figure 18. Walk-Up Menu Keystroke Diagram

All temperatures in degrees Celsius. Time in 24 hour format.

Relay Annunciator Displays

The relay display is designed to inform the operator of which relays are currently active. It is a two-page display, meaning that if a relay higher than number 9 is active, a second relay display will appear when the ENTER button is pressed with the first relay display shown. If only relays 9 and below are active, only the first display will be shown. If only relays 10, 11 and/or 12 are active, the first page will be skipped and only the second page will appear. If no relays are active the first page of the relay display will show the word NONE, and the second page will not appear.

Time and Date Display

The Advantage is equipped with a real time clock (RTC) which keeps track of time of day, month, day and year. The clock conforms to the 24 hour standard, displaying 0:00 to 23:59. There is no 12 hour clock provision. The date is shown as month / day on the prompt (small) display and year on the value (large) display. See the configuration, section (4) for more technical details on the RTC.

Effect of Resetting Peak and Valley Values:

There are two levels of peak and valley memory. The first level is what is displayed when the up or down buttons are pressed to view the peak and valley values, when in the walk-up or normal operation mode. This is typically referred to as drag-hand peak and valley, with respect to legacy instrumentation where the indicating pointer would physically push a peak or valley pointer into a highest or lowest deflected position. The drag-hand peak and valley values are stored in non-volatile memory, which means if the power fails, the values will still be retrievable at the front panel display when power is restored. The drag-hand values that were stored in non-volatile memory are overwritten each time the values are reset.

The second level is historical memory, which stores peak and valley values over a period of time. This period is programmable to be either hourly or continuous. The hourly mode causes the peak and valley values which occur within ***each*** hourly period to be recorded into non-volatile memory. The values can be retrieved at a later time through digital communications. The continuous mode is analogous to the first level drag-hand feature described above, in that the values are stored into non-volatile memory ***only*** when the peak and valley values are reset. The differences between the first level (drag-hand) peak and valley memory and the second level continuous mode is that the user can choose when to store the viewed peak and valley values into non-volatile memory by simply resetting the value and all values that are stored this way may be retrieved at a later time through digital communications.

The entire tabulation of peak and valley data can be downloaded from the memory if the unit is equipped with digital communications. See the SMAMT200 software manual for details. No provision for stepping backwards through the memory, using the front panel controls is available.

Peak and Valley Memory Endurance

The peak and valley memory endurance is inversely related to the number of values that are recorded; the more records that are made, the fewer days remain for more records. The worst case memory usage is created by a CT/LTC model with 12 relays (all in alarm state), LCAM channels 1-3 used for winding current measurement (includes winding temperatures) drag-hand values being recorded each hour and event recording set to hourly. In this worst case example the memory will fill in 83 days. When the memory fills, smaller portions of the total memory with the oldest data will be overwritten. If the AMTSYS0201 firmware is loaded on Advantage models manufactured before October 15, 2008, approximately 28 days worth of the oldest data will be overwritten when the total memory is filled, leaving 55 days of the most recent data intact. Thus each 28 days after the memory is first filled, the oldest 28 days worth of data will be erased to make room for new data. If the AMTSYS0201 firmware is loaded on Advantage models manufactured after October 15, 2008, approximately 7 days worth of the oldest data will be overwritten when the total memory is filled, leaving 76 days of the most recent data intact. Thus each 7 days after the memory is first filled, the oldest 7 days worth of data will be erased to make room for new data.

Operator mode

Operator mode allows for checking the various set-up parameters associated with the alarm set points, and provides a means of operating the set point relays in order to check the operation of the cooling and alarm circuits and equipment.

Refer to Figure 20 for details regarding features available and navigating in the operator mode. In order to access the operator mode, it must have been enabled when the unit was configured. You must enter the configuration loop (see figure 15) and enable it (see figure 16E) in the “OPRAT FUNCT” sub-loop.

The relay check is the only feature in the operator mode which allows a walk-up user to cause a control action to be performed. This feature allows the user to temporarily toggle a relay state to verify operation of the relay and connected equipment. The toggled relay will resume its normal operation after a 45 second period has expired, or the enter button is pressed a second time. In order to allow an operator to use the relay check function, the function must have been previously enabled. The relay check function is enabled in the main configuration loop, within the RELAY SETUP configuration sub-loop. Refer to figure 16E for the keystrokes CHECK ENABL or DISAB necessary to enable or disable the function.

The INTNL REFNC function is used to manually check the condition of the RTD circuit internal to the Advantage. It is used primarily as a diagnostic tool to determine if the internal RTD circuit is functioning properly. When the INTNL REFNC function is entered, an internal reference resistor’s value is measured and converted to its equivalent temperature display. All three RTD channels may be checked this way. The value displayed must be between + 5 degrees and -5 degrees. When the values drift beyond this point, the internal failure alarm will activate.

Figure 19 illustrates how the various alarm displays look when sensor and internal failure events occur. For a more detailed treatment of alarm function, refer to the paragraphs beginning with “Alarm Conventions” in section 4 and the “Sensor and Internal Failure Alarm Troubleshooting” paragraph of section 8.

SC and CT Models; DC and CTX Models with Channel Two Turned OFF; LTC Model with the LTC function turned OFF,
TC Models with Channels Two & Three Turned OFF and CT/LTC Models with Channel Three & the LTC Function Turned Off

Internal Failure Display > INT1 FAIL

Failed Channel > CHANNEL ONE

Sensor Failure Display > SENS1 FAIL

DC, CTX and LTC Models and TC, CT/LTC Models with Channel Three Turned OFF

Internal Failure Display > INT1 FAIL INT2 FAIL

Failed Channels > CHANNEL ONE CHANNEL TWO

Sensor Failure Display > SENS1 FAIL SENS2 FAIL

TC and CT/LTC Models

Internal Failure Display > INT1 FAIL INT2 FAIL INT3 FAIL

Failed Channels > CHANNEL ONE CHANNEL TWO CHANNEL THREE

Sensor Failure Display > SENS1 FAIL SENS2 FAIL SENS3 FAIL

Figure 19. Sensor and Internal Failure Alarm Displays

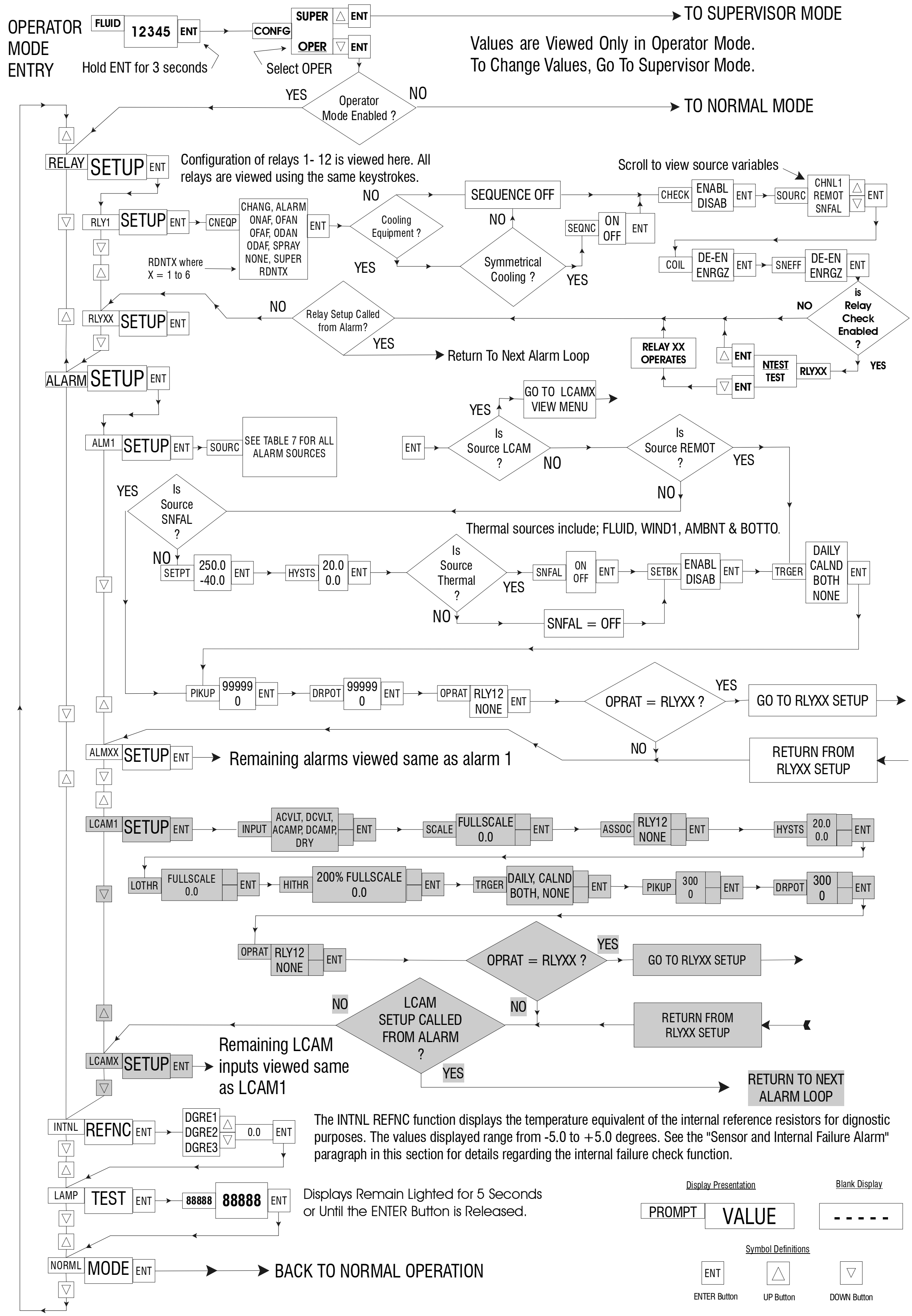


Figure 20. Operator Menu Keystroke Diagram

6.0 LTC Tailoring (LTC and CT/LTC Models Only)

Why Measure LTC Differential Temperature?

When the contacts of the LTC switch age or become worn, resistance to current passage increases. Since heat is created when a current is passed through a resistance (I^2R), the heat developed in the contact increases as the contact wears. The terms “age” and “wear” are used here to describe any of the processes which result in higher resistance. For example, deposits which form on the contacts as a result of oil polymerization, due to switching-arc creation, is one process. This is commonly referred to as “coking”. Mis-aligned contacts are another cause of higher resistance, when a smaller contact area is available for conduction.

The main tank contains the working windings of the transformer, which produce large I^2R and eddy current heating whenever the transformer is energized. The temperature differential between the main and LTC tanks is more or less constant when the main windings and LTC are functioning normally. To calculate the differential temperature, the LTC tank temperature is subtracted from the main tank temperature. Because a “healthy” LTC switch generates little heat when it is not switching, the temperature of the LTC tank is typically lower than and follows the main tank temperature, when the transformer is energized and that is the reason “good” LTC differentials frequently have positive signs. When an LTC switch goes bad the LTC tank temperature climbs above the main tank temperature, which is why “bad” differentials have negative signs. There is an error band surrounding the “normal” differential due to per unit loading but this is predictable once a thermal history is developed on the transformer.

At some point in the life of the LTC switch the generated I^2R heat becomes too great for the surrounding fluid to dissipate, and the contacts begin a process of more rapid degradation and eventual failure. The action at the end of the process may be spectacular, with fire being a very real possibility. Long before this type of process comes to its close the temperature of the fluid in the LTC tank begins to rise abnormally. This abnormal rise is translated into an abnormal differential by comparison to the normal differential between the main and LTC tanks which had been established over a long period of time.

LTC Monitor’s Mission

The mission of the LTC Differential Temperature Indicator (DTI) is to alarm when the true differential temperature exceeds a pre-set magnitude, while rejecting false signals.

The algorithm which drives the measurement system is seemingly simple; measure two temperatures directly, subtract one from the other, and display a choice of the result; the first measurement or the second measurement. This is deceptive; however, because there are several mechanisms and mathematical twists to be handled.

The electrical and physical effects of the environment, unusual and aberrant service conditions and the uncertain nature of LTC degradation mechanisms themselves make accurate measurement a real challenge. Fortunately the Advantage has been designed to mitigate a good deal of the uncertainty caused by the environment, and provide an automatic tuning feature allowing the user to apply his or her knowledge of the application conditions on a “clean slate”.

Probe Effects and Influences

The LTC differential temperature varies very, very slowly in a transformer experiencing normal aging. There are several influences which can effect the accurate measurement of true differential temperature. They are listed below, by probe type:

Thermowell Probe:

1. Electrical noise.
2. RTD sensor offset error.

Wall Temperature Sensing:

1. Electrical Noise.
2. RTD sensor offset error.
3. External environment (rain, sun, ice, wind etc)
4. Position
5. Wall coating variation
6. Wall material and thickness differences
7. Vibration

It is easy to see which probe has the higher probability of making an accurate measurement. Because the thermowell probe is isolated from the external environment it can be relied upon to provide accurate absolute as well as relative measurements. Not surprisingly then, this type of probe is the most desirable for both main and LTC tank temperature measurement. Unfortunately, the thermowell probe requires a thermowell, which was not a popular OEM accessory in years past, for LTC tanks. Fortunately the LTC True differential temperature measurement is a relative measurement (one probe to the other) rather than an absolute one. This makes the task a bit easier, but the accuracy of the measurement still depends upon the user placing the tank wall temperature sensing probes in positions and exposures which are as close to identical as possible. It also requires that a period of tuning be allowed in which the “normal” profile can be established, followed by correct selection of filter values to reject invalid measurement inputs.

Regardless of probe type selected, the probes must be of the same type; thermowell or wall temperature sensing and should be as identical as possible. If the two types are mixed, the errors due to skin effects and environment will render the measurement nearly useless.

If tank wall temperature sensing probes are used they must be placed in nearly identical relative positions with respect to side of the transformer proximity to corners, supports and other appurtenances on the main and LTC tanks. The contact point of the probe and the tank wall must be coated heavily with heat conductive paste and the sealed against the environment with a high quality silicone RTV. The outside of the probe should be shielded with a insulated cup which must also be sealed to the transformer wall with the same silicon RTV as was used on the probe.

Service Conditions

Several situations may arise which may cause nuisance triggering of alarms, in the absence of a good LTC differential algorithm. Some are aberrant and some are unusual. Rain or Icing with or without wind in combination is not considered unusual nor aberrant because they normally exist in the environment. Loss of excitation, due to load shedding or source drop-out, while the cooling equipment is running, will cause the main tank to cool faster than the LTC tank. This is again not unusual. A driving rain which, by virtue of its direction and wind swirl, cools one probe but not the other is unusual, but not overly so. A shadow which is cast on one probe, but not the other, at a particular time of day and year, is unusual, but not aberrant. Cooling of an over-capacity transformer with water sprayed on the tank walls is an aberrant condition as is a bird or animal nesting or perching on one of the probes. None of these conditions apply to thermowell type probes; they are all related to the degree of exposure which the tank wall probe experiences.

Due to the nature of this measurement, we can mitigate the errors presented by unusual conditions but it may be impossible to reject all effects of the aberrant conditions. The first defense is to create the best possible interface between the probe and the tank wall, and to isolate and protect the interface as much as possible from external influence. Again, isolation and protection is accomplished by probe design and application of a high quality sealing compound between the probe and the clean tank walls. Interface enhancement is accomplished by probe design and the application of a stabile, thermally conductive compound between the clean tank wall and the sensor pad.

The second line of defense is selection of the correct step and magnitude values. These values must be selected by the user, since each application is unique.

The third defense against erroneous alarms is to create a solid algorithm which is capable of filtering out obvious and insidious spurious signals, based on their rate and direction of change and the logical relationship of multiple dynamic conditions.

Direct Measurements

Direct measurements of main and LTC tank temperatures are taken like the other models in the Advantage line. A measurement is taken and processed through hardware and digital filters to determine if its magnitude and rate of change are reasonable. If it meets the criteria, it is processed through, displayed and stored for use in the differential calculations.

Differential Value “Measurements” and Determining the LTC STEP and LTC DELAY Values

As the quotes in the heading imply, these are not true measurements, but are rather calculations *based* on direct measurements. The instantaneous LTC differential is, in pure terms, the value which results from subtracting the LTC tank temperature from the main tank temperature ($T_{MAIN} - T_{LTC}$). This is the value which is displayed on the front panel as the differential temperature.

The filtered differential measurement is a much more complex calculation because the signals are more dynamic. The two measurements which support this calculation may experience an erroneous rise or fall in opposite directions. This signal rise or fall may be acceptable to the measurement probes individual filter parameters, as a single measurement, but when the difference between the measurements is taken, the result may be twice as large, in the same sample period. Since the LTC True differential temperature is typically only a few degrees in magnitude, this instantaneous rise or fall could trigger an alarm erroneously.

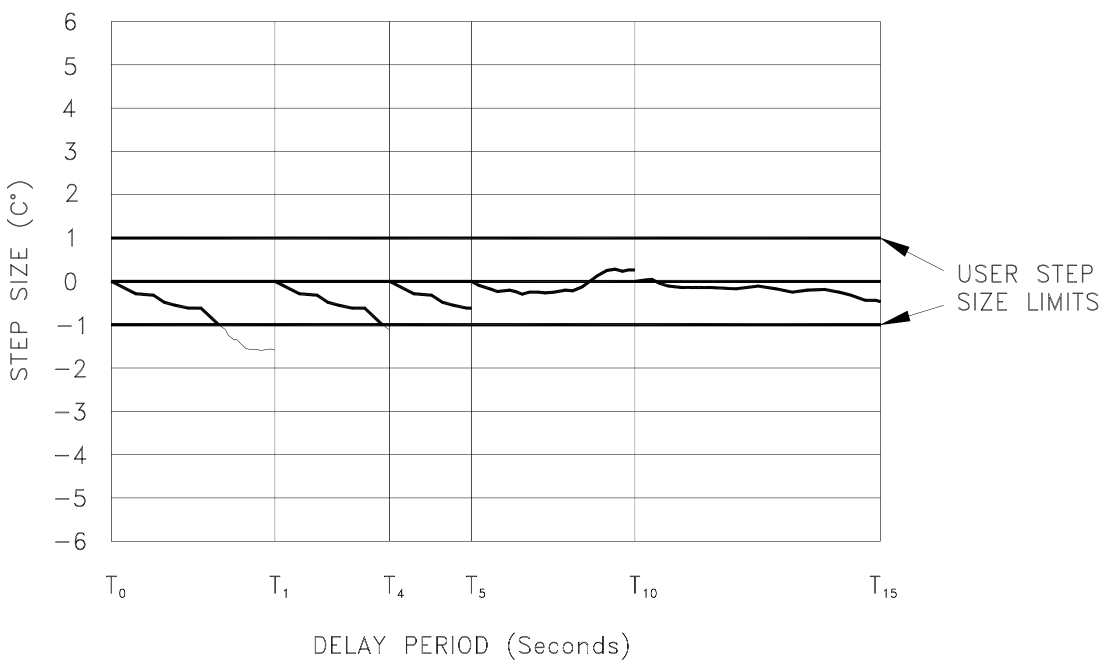
The result of the instantaneous differential calculation is therefore processed through a second digital filter, with its own pair of user-adjustable parameters and then the value is subjected to several logical tests. The two parameters are sample period (prompt LTC DELAY) and allowed change magnitude (prompt LTC STEP). These parameters are programmed by the user, who must set up the profile based on his unique installation. The delay period units are in seconds, with a range of 0 to 99999 (0 - 27.8 hours). The allowed (LTC STEP) change magnitude is in degrees, with a range of -0.4 to -20 degrees in 0.01 degree increments.

Refer to section 5, Configuration, prompts LTC STEP and LTC DELAY for more information and recommended initial values for LTC DELAY. The real challenge to effective LTC monitoring is selecting the correct LTC STEP and LTC DELAY values for the filtered differential measurement. The best way to overcome this challenge is to understand the relationship of LTC STEP and LTC DELAY values to each other, and how the LTC DELAY function’s auto-tune feature helps arrive at reasonable values rapidly.

Relationship of LTC STEP and LTC DELAY

The step and delay variables of the differential software filter are analogous to the gain and time constant of an analog filter. The delay period auto-tune feature of the software filter is analogous to an automatically adjustable time constant of the analog filter. In diagrammatical form the relationship would look like the graph of figure 21.

Figure 21. Relationship Between LTC STEP and LTC DELAY Variables



In Figure 21, T_0 through T_{15} are delay periods which have been shortened or lengthened by the auto-tune feature of the delay function, in response to similar signal traces. The traces are plots of the instantaneous differential which is continuously measured. The traces all originate at the zero differential point because the previous delay period's instantaneous differential measurements are averaged, added to the existing differential and a new floor value is established at zero.

In the trace between T_0 and T_1, the differential signal increases, eventually exceeds the user step-size limit and is clipped at the negative limit. Thus approximately ⅓ of the differential signal will be averaged into the delay period's differential offset at a value of -1 and the measurements between -1 and -2 °C will be lost. This is not necessarily bad, because we had decided in advance that signals which exceeded -1 °C within time T_0-T_1 are likely to be spurious.

In the time between T_1 and T_4 three delay periods have expired and the auto-tune feature has shortened the delay period by 30%. Note how almost the entire signal fits into the filter's delay time and step magnitude window. When the accumulated instantaneous differential measurements are averaged for this period, they will more accurately reflect what occurred during the period. In the period between T_4 and T_5 the final adjustment to 40% was made and the entire signal trace fits easily into the filter window. In the periods between T_5 to T_{10} and T_{10} to T_{15}, the auto-tune feature has lengthened the delay period in response to minimal signal activity.

In practice a user would pick a median delay period and observe what the auto-tune feature has changed it to after 10 delay periods. If the delay period has not changed much, the step value selected is close to ideal. If the delay period has lengthened significantly, the step size should be reduced slightly and monitored for another 10 delay periods. If the delay period has been shortened significantly the step size should be increased slightly and monitored for another 10 delay periods. Once the delay period - step size relationship has stabilized the auto-tune feature should be turned off.

Determining the Differential Temperature Set Point

The filtered differential temperature is the value which operates the DIFF set point alarm. The instantaneous differential temperature, as noted above, is the result of taking the difference between the main and LTC tank temperatures. The difference is taken after the RTD probe offsets are added to the measured temperatures. The probe offsets are typically used to correct for wall temperature sensing probe errors due to tank wall skin effects. While the actual relative error of 2 essentially identical type probes is small, the skin effects for two different tanks may be significant. The RTD offset is intended to compensate for these errors. In some cases, when the operator is using wall temperature sensing probes for the main and LTC tanks, (s)he may not care what the actual temperature of the individual tank wall is. The measurement of the relative differential only may be important. In this case the operator can use the RTD probe offset to set both of the measured temperatures to the same value, thus setting the “normal” differential temperature to 0.0 °C .

The probe offsets are assigned on a per-channel basis, with RTD1 assigned to channel 1, RTD2 assigned to channel 2 and RTD3 assigned to channel 3. See the channel assignments table (6) on page 24 for actual probe / channel / functional assignment

The actual “normal” differential temperature must be set using operating experience. Remember, tuning the settings as experience is gained is a simple matter of a few keystrokes.

7.0 Calibration

The calibration of all Advantage models requires 2 distinct operations; self-check reference calibration and linearizing table entry. The self-check operation can be easily performed from the front panel, with just a few keystrokes. The linearizing table calibration operation can be performed from the front panel programming buttons or, with the communications feature, from a personal computer using Weschler configuration, monitor and flash (CMF) software. The software method is much quicker and less tedious than the front panel method, though both achieve the same goal. The software provides step-by-step calibration instructions on its various calibration screens.

CT, CTX and CT/LTC models have two additional operations; current transformer calibration and current memory calibration that can be performed.

Calibration is generally not required for the life of the Advantage. The calibration of Advantage models should be ***checked*** at five year intervals, by running the self-check function, and examining the resultant INTNL REFNC values.

Current Transformer (CT) Calibration
CT, CTX and CT/LTC models Only

If the CT ratio is known, it should be set directly by entering the CT1SETUP, CT2 SETUP or CT3 SETUP menu and setting the CT's primary and secondary current ratings directly. Reference figure 16C, prompt CT1SETUP, CT2 SETUP or CT3 SETUP , sub-menu prompt RATIO and the paragraph "Prompt **CT1SETUP, CT2 SETUP or CT3 SETUP**, Current Transformer Ratio Setting Loop, figure 16C" in the configuration section for more details.

The CT calibration method is intended for instances where the CT ration is not known, or where the CT's accuracy class in inadequate for the desired current measurement accuracy.

The CT calibration operation is intended to "tell" the Advantage what level of current is flowing from the bushing CT and what percentage of the full load current it is. For example, if you measure 6 amps in the CT secondary, and you know that at full load the current is 10 amps, then the current flow you are measuring is 60% of full load. This calculation is used in conjunction with the "IMAX" variable(s) value set in the "USER SETUP" application tailoring menu to display the actual load current being supplied by the transformer.

The maximum line current that the transformer is capable of carrying can be calculated from data plate information for rated maximum power capacity and line voltage. The line current at the present time can be read from the station ammeter or may be obtained from the dispatch center.

If you don't have a way of determining the value of the CT current at full load, or it is more convenient, you may be able to call the dispatch center to provide the percent loading at the present time. With that information the percent of full load is a direct entry and the CT current is a simple calculation.

The Advantage current sense circuit may also be bench calibrated using an AC standard ammeter and a variable AC current source. If you know the CT ratio of the transformer that the unit will be installed on, you can preset the Advantage and simply install it on-site without further set up calibration.

The Advantage CT current measurement hardware includes a feature which will measure current in the CT secondary and display its value directly. This ammeter has an accuracy of ± 1% of full scale above 20% of scale. If better accuracy is required, a higher accuracy AC ammeter, connected either in-line or equipped with a clamp-on probe, may be used to measure the CT secondary current. This more accurate data can be used to override the automatic ICT value entry.

While executing this procedure, refer to Figure 16C, prompt CT1SETUP, CT2 SETUP or CT3 SETUP for CT calibration keystroke details. If the Advantage is equipped with a polyphase current input (PCI) module, or an LCAM module, refer to their sections in the installation section (3) for connection details.

Caution! Lethal voltages are generated when the secondary circuits of transformer CT's are opened, while the transformer is energized. Take all precautions to ensure personnel safety before disturbing CT wiring. Best practice is to de-energize the transformer while working on CT circuits.

1.0 Setting the zero input point.

1.1 If the Advantage is equipped with a clamp-on CT:

If the current input is on the CCA module, connect a jumper between terminals CCA1 and CCA2.

If the current input is a PCI module which uses clamp-on CT's, a jumper must be placed across each of its three pair of input terminals. Refer to one of the diagrams of figure 11 for terminal assignments.

1.2 If the current sense circuit is connected to the bushing CT:

If the current input is on the CCA module, shunt the bushing CT's leads to terminals CCA1 and CCA2 **in the control cabinet**, then disconnect the lead with the lowest potential from terminal CCA1 or CCA2.

If the current input is a PCI module, safety shunt each pair of the bushing CT's leads to the module's three pair of terminals **in the control cabinet**.

1.3 Enter the main configuration loop using the keystrokes of figure 14.

1.4 Scroll down to the desired CT calibration prompt (CT1, 2 or 3 SETUP) using repeated depressions of the down button. Press enter, then scroll to the CALCT value. For the purposes of this instruction we will assume you want to calibrate CT1.

1.5 Press the enter button. The CT1 ZERO prompt will appear on the display.

1.6 Press the enter button. The title AMPCT will appear in the prompt display and the present CT secondary current will be displayed in the value display. No current should be flowing in the CT secondary at this time. The displayed value should be at zero or within 0.01 to 0.03 amps of zero.

1.7 Press the enter button and toggle the value display to CAL. Press the enter button to accept the zero measurement. If the value is too high (> 0.8 amps) the entry will be rejected and the words HIGH SIGNL will appear on the displays. This indicates that there is current flowing in the CT circuit. Check the circuit and correct the cause before continuing. Once the problem is rectified, repeat step 1.7.

Note: If the user only needs to know what the current zero setting is, without changing it, (s)he may perform step 1.7 and simply toggle the display to NOCAL before pressing enter. The present setting will be displayed for 3 seconds.

2.0 Setting the high endscale point:

2.1 Remove the jumper installed between the current input terminals of the CCA module, or the middle pair of current input terminals of the PCI module.

2.2 If you are bench-calibrating, connect the current source in series with an ammeter standard at this time, but do not energize the source. For current input to an I/O module, connect to terminals CCA1 and CCA2. For current input to a PCI module, connect to the middle pair of terminals (PCI-8 and PCI-9). If you are bench calibrating with a clamp-on CT, run the current source lead through the CT's window and ensure that the CT's jaw is closed.
If you are calibrating from a bushing CT, reconnect the lead disconnected in step 1.2.

2.3 Verify the current circuit integrity.

2.4 If you are calibrating to a bushing CT, remove the safety jumper from the terminals in the control cabinet which is connected to terminals CCA1 and CCA2 of the Advantage I/O module, or terminals PCI-8 and PCI-9 of the Advantage PCI module. If you are bench calibrating, turn on the current source and adjust it to the value of the target transformer's maximum CT secondary current.

2.5 Enter the main configuration loop using the keystrokes of figure 14.

2.6 Scroll down to the "CT1 SETUP" prompt using repeated depressions of the down button. Press enter, then scroll to the CALCT value

2.7 Press the enter button. The CT1 ZERO prompt will appear on the display.

2.8 Press the down button once. "CT1 FLSCL" should now be shown on the display. Press and release the enter button and the title AMPCT will appear in the prompt display and the present CT secondary current will be displayed in the value display.

2.9 Read the current level shown on the value display and press the enter button. Toggle the value display to CAL and press the enter button again. If you elect to accept the Advantage's reading, press the enter button. If you are using a high accuracy ammeter as a standard, and wish to use that value, scroll the Advantage display to the ammeter's value using the up or down button. When the correct value is displayed, press the enter button.

If you are unsure what to do at any point, simply wait 45 seconds and the CT1 SETUP menu will be automatically exited. Any settings which have not been accepted by pressing the enter button will not be changed.

2.10 The CT1 % FLSCL (CT1 percent fullscale) prompt will then be displayed. Press the enter button, then toggle the value display from "NOCAL" to "CAL" and press the enter button again.

2.11 Scroll the value display to the correct percent-of-load. If you are performing a bench calibration the display should be scrolled to 100.00. If you are using a value that was calculated or provided by the dispatch center, scroll the display to that value. Press the enter button. The CT1 SETUP menu will be exited and you will be advanced to the next prompt.

If the UUT is equipped with an LCAM module, and LCAM2 is enabled, the next prompt will be CT2 SETUP. Calibration of this channel (and CT3 SETUP) are performed the same as in the CT1 SETUP menu.

This completes CT calibration. As the keystroke chart of Figure 16C shows, you can step through the CTx Setup loop using the enter button alone, if you only want to check (not change) values.

Linearizing Table Calibration

The linearizing table is designed to provide a means of calibrating the scale end points and correcting measurements for non-linearities due to sensor characteristics. Platinum RTD's of the type used by Advantage are extremely linear over the limited transformer operating temperature range, but other linearity errors can also be corrected using this process. Each channel has its own table, and each table must be entered separately. The CT model has one linearizing table, the CTX has two linearizing tables and the LTC and CT/LTC models each have three linearizing tables.

On LCAM equipped models, the linearizing tables are stored on the module. These tables are not intended to be field calibrated.

Since the linearizing table contains the calibration data, it must not be altered unless a calibration check shows an indication error which is not due to a sensor or input circuit malfunction. To prevent the table from inadvertent alteration, the function is protected by a password which is not the same as the supervisory password. The password may be obtained by calibration technicians, by contacting the sales office at the phone number or website printed on the front cover of this document.

The calibration operation simply allows the technician to “tell” Advantage what value to display at up to 12 defined points within the scale range. The measurement logic then interpolates between the defined points to determine what the intermediate values are. The technician is simply filling in cells of a look-up table. The number of points calibrated or checked depends upon the user’s calibration program requirements. Weschler recommends a minimum of 5 calibration points. Factory calibration is performed at the table maximum of 12 points.

To prepare for calibration, an adjustable precision resistance standard (decade resistor) or RTD calibrator must be connected to the RTD terminals corresponding to the type (3 or 4 wire) of RTD which is to be used. Note that the precision resistance standard can be used to simulate temperatures typically to within ± 0.01 °C. Several hand-held calibrators Weschler has tested use solid state circuitry to simulate the resistance of the RTD. In our experience, these devices cannot match the accuracy of the resistance standard.

A calibration check using a resistance standard is performed by setting the resistance standard to the values shown on Table 10 and comparing the actual indication to the tabulated temperature value. The indicated temperature should match the tabulated temperature within ± 0.1 °C. A calibration check using a calibrator requires simple comparison of the calibrator’s display value, with the Advantage display value. Bear in mind that the Advantage may be more accurate than the calibrator, especially if it is a hand held device.

If the communications option has been installed, and a PC is available, the Advantage Configuration software automates the following steps and simplifies calibration to simple resistance or temperature selections and mouse clicks. The software is available from Weschler. Contact the Sales Department for ordering details.

For manual calibration, refer to the SYSTM CALIB keystroke diagram of Figure 16F and follow the steps below.

1. Enter the main configuration loop using the keystrokes of Figure 14.
2. Scroll down to the “SYSTM CALIB” prompt using the keystrokes of Figure 15.
3. Enter the password per factory instructions.
4. If you want to check or change the number of table points, scroll to the TBLEN value and press the enter button, otherwise, scroll to the POINT value, press ENTER and skip to step 6.
5. By default the length of the table is 12 points. The table can have as few as 3 points but it is more accurate to use the default. If the number is set to other than 12 points, use the up or down buttons to set the value to 12. Press the enter button to store the value.
6. With the “PNT1” prompt showing, press the enter button to access the table edit loop. The “PNT1" will remain in the prompt display and the temperature for point 1 (-90.0 °C) will appear in the value display.
7. Set the RTD calibrator to -90 °C or set the decade to 64.30 Ω. Increment the value on the Advantage display to -89.9 °C and back to -90.0 °C, using the up, then down button. This is a very important step. If the value isn’t changed the Advantage will assume you only wanted to view it. As far as the Advantage is concerned, a desire to calibrate a point is signaled by any change, even if it is changed back to the original value.
8. Press the enter button twice more to display the value for point 2, -40.0 °C.
9. Set the RTD calibrator to -40 °C or set the decade to 84.27 Ω. Increment the value to -39.9 °C and back to -40.0 °C, using the up, then down button. Remember to perform this very important step.
10. Perform steps 4 through 9 for the remaining 10 points on the table. All of the temperature and resistance equivalents are listed below in Table 10. When the last point is calibrated the TABL1 loop will exit. If the unit under test is a CT model, calibration continues at step 13.
11. If the unit under test is a DC, TC, CTX, LTC or CT/LTC, and channel 2 is not turned off, the “TABL2” prompt will appear. Channel 2 is turned off by setting its title to “OFF” in the CHNL2 TITLE loop. See the CHNL2 TITLE function on Figure 16D. The operation for loading table 2 is identical to table 1, except the prompts referred to as TABL1 above will be TABL2. Perform steps 4 through 9 for the 12 points on table 2. When the last point is calibrated the TABL2 loop will exit. If the unit under test is a CTX, calibration continues at step 13.
12. If the unit under test is a TC or CT/LTC, and channel 3 is not turned off, the “TABL3” prompt will appear. Channel 3 is turned off by setting its title to “OFF” in the CHNL3 TITLE loop. See the CHNL3 TITLE function on Figure 16D. The operation for loading table 3 is identical to table 1, except the prompts referred to as TABL1 above will be TABL3. Perform steps 4 through 9 for the 12 points on table 3. When the last point is calibrated the TABL3 loop will exit.

13. If the unit under test does not have an LCAM module installed and enabled, calibration is completed. If this is a non-CT series model the "GOTO" prompt will appear, which will allow you to scroll to a navigation choice of exiting the calibration menu or going back into the menu starting at table 1. If this is a CT-series model without LCAM you will be able to scroll to a navigation choice of calibrating the current memory, exiting the calibration menu or going back through the calibration menu, starting at table 1. If you need to calibrate current memory, skip down to the Current Memory Calibration procedure below. If an LCAM module is installed and at least one channel is enabled, calibration will continue at step 14.

14. If an LCAM module is installed on any model, the LCAM calibration sequence will automatically be entered at this point. Like the temperature linearizing tables, the LCAM linearizing tables should not need calibration for the life of the Advantage. Also like the temperature channels, the LCAM channels can be calibrated using the configuration-monitor-flash (CMF) software. The only reason to re-calibrate a channel is if the signal from a non-linear source is to be linearized for a special purpose. This might be the case with a transducer which has a logarithmic output signal that must be displayed on a linear display device.

    In CT, CTX and CT/LTC models ***with*** LCAM and single-current sensing, winding current sense always comes from channel LCAM1. In CT, CTX and CT/LTC models with three-current sensing, current sense comes from the LCAM1, LCAM2 and LCAM3 channels. In order to sense current from any of these channels the channel must be enabled.

    The LCAM module stores two linearizing tables for each channel. One table is for AC inputs and the other is for DC inputs. Since there are eight inputs there are therefore sixteen tables; eight for AC and eight for DC. The tables are named LCM1A / LCM1D to LCM8A / LCM8D. The table names are logically arranged with the first three characters "LCM" meaning LCAM, the fourth character the channel number and the last character either A for AC or D for DC.

    When the calibration is performed, the table that will be calibrated, and the signal required depends upon the signal type and full scale values, which were configured in the INPUT and SCALE dialogs in the ALARM SETUP > LCAMX SETUP menus. For example, if you set the LCAM1 "INPUT" type to AC volts and the "SCALE" value to 150, you would need to apply calibration signals in the range of 0 to 150 volts AC to the LCAM1 inputs to perform the calibration properly. It is always recommended to use the highest full scale value as a signal during calibration.

    The LCAM1, LCAM2 and LCAM3 channels have dedicated signal input type, scale and tables when they are configured as current inputs with a CT-series Advantage. The signal; type is AC Amps, the scale 10 amps and the table is AC..

    Any LCAM channel that is not enabled will be skipped in the calibration sequence. To prepare for the calibration, a signal source with suitable accuracy (better than 0.5%) and range to agree with the full scale setting must be connected and warmed up.

15. A table name such as LCM1A will appear in the prompt display. Press enter and the EXIT prompt will appear. If the channel is to be calibrated, scroll to the CAL prompt and press enter. PNT1 will appear in the prompt display signifying that this is the first point in the calibration table. The number in the value display is the signal level to be set on the signal source. Set the signal level, scroll the value display up one count then back to the original value, then press enter. After a second the next point number and signal level value will appear. Again set the signal level, scroll the value display up one count then back to the original value, then press enter. Repeat these actions for the remaining points on the table. When all points have been calibrated the next table name will appear in the prompt display.

16. Repeat step 15 for all of the enabled LCAM channel tables. When the last table is completed, the calibration procedure will be exited and the GOTO prompt will appear. Scroll to the navigation choice of exiting the calibration menu or returning to the calibration menu starting at table 1.

Table 10 Temperature / Resistance RTD Equivalence

Calibration Point Number	Temperature (°C)	Resistance (Ω)	Calibration Point Number	Temperature (°C)	Resistance (Ω)
1	-90.0	64.30	7	110.0	142.29
2	-40.0	84.27	8	140.0	153.58
3	-10.0	96.09	9	170.0	164.76
4	20.0	107.79	10	200.0	175.84
5	50.0	119.40	11	230.0	186.8
6	80.0	130.89	12	250.0	194.1

Current Memory Calibration
CT-Series Models without LCAM Only

Current memory holds the factory calibration values of the full 10 amp span of the CT current measurement logic. These values are used to calibrate the CT circuit and to determine if a CT circuit calibration error is being made. It is normally unnecessary to perform this calibration, but it is a simple procedure and if the unit is in for calibration it may be performed at the same time. This calibration will be bypassed when the LCAM module is installed.

A precision (better than 0.25% uncertainty) ammeter and a variable AC current source are required.

1. If the current sense input is connected to the I/O module, connect an ammeter standard and an AC source in series with Advantage terminals CCA1 and CCA2.

   If the current sense input is connected to an optional PCI module, connect the ammeter standard and AC current source in series with Advantage terminals OM-8 and OM-9.

   Turn on the Advantage and the ammeter, but not the AC source. Allow the Advantage to warm up for ½ hour, if not already warm.

2. From the GOTO prompt, select the ILOAD prompt option and press enter. Verify that there is no current flowing in the current circuit. Press the enter button a second time. The ILOAD prompt will appear.

3. Turn on and set the AC source to 10.00 amps exactly. Allow the source to stabilize and verify on the ammeter that 10.00 amps is flowing in the current circuit. Readjust the current source as necessary. Press the enter button to accept the value.

4. The GOTO prompt will again appear on the prompt display. Scroll to the EXIT option and press enter. The memory re-write function will be run automatically for a few seconds, then the SELF CHECK prompt will appear, indicating exit of the calibration loop.

Calibration of Analog Retransmit Outputs (Single channel and MCAR)

Configuration files created by the configuration software include analog retransmit settings for zero and full scale source and output range, and user coefficient. See the section covering analog retransmit setup, beginning with “Prompt ANRTN SETUP” in the keystroke-by-keystroke set up guide for details of these values. When configuration files are uploaded using digital communications, the values for these settings are overwritten. It is therefore advisable to check to be sure that the new analog retransmit settings are as desired prior to uploading new configuration settings.

Factory calibration values are stored in non-volatile (flash) memory, which is not overwritten when new configuration files are uploaded. The factory calibration value for any particular retransmit channel is simply a coefficient that is used to adjust the raw current output to an exact value which meets factory accuracy specifications.

Calibration

Calibration of the analog retransmit outputs is accomplished through the use of the AMTCMF software and a precision DC milliammeter. The milliammeter method requires that a known endscale input signal be applied to the source channel while the milliammeter monitors the output. The factory coefficient for the respective channel is then adjusted to cause the milliammeter to indicate precisely the same output current, as was set for the RFULx value.

It is important to remember that the analog output's accuracy is stated as a percentage of the fullscale value that is displayed on the front panel, not the signal that is being applied to the source channel.

The method is the same for both the single output channel on the I/O module as well as the 3 outputs of the MCAR module; however, if the UUT is a TC or CT/LTC model, there is no analog retransmit output on the I/O module.

1. Connect the appropriate standard to the terminals of the input that is being used as an analog retransmit source. The type of standard used to generate the calibration signal will depend upon the retransmit source. If the source is a thermal quantity such as fluid or winding temperature, an RTD simulator or decade resistance box is appropriate. If a winding current is the source, an AC current source/standard is appropriate. It is not necessary to apply a current and thermal signal input to CT series models in order to simulate calculated winding temperature; you simply need the display to indicate the fullscale winding temperature that was set as the FULLx value. Thus, for example, the winding temperature display of a CT-series model can be set to an appropriate value by simply raising the top oil temperature signal (channel 1 RTD input), without the need to apply a current input.

2. Connect a standard milliammeter to the I/O module's analog retransmit terminals IO-1 and IO-2, or the MCAR module's terminals MC-1 and MC-2.

3. Turn on the Advantage and allow it to warm up for 30 minutes. Adjust the signal input standard to cause the desired full scale value to be indicated on the front panel display.

4. Start the AMTCMF0201 software, connect to the UUT, then open the configuration and calibration module. Click on the "Communication" item on the menu bar then click the "Analog Retransmit Calibration" drop-down menu item. Enter the factory calibration password and click "OK" to open the calibration screen.

5. Click the "Factory Coefficient - Milliammeter" radio button then click the appropriate channel check box. Note, then enter the standard milliammeter indication in the "Reading" text box. The coefficient will be automatically calculated and recorded in the "Factory Coefficient" text box. When the "Apply" or "OK" buttons are clicked the new coefficient will be stored to non-volatile memory.

6. If the MCAR is being calibrated, repeat steps 1 - 5 for the next channel to be calibrated.

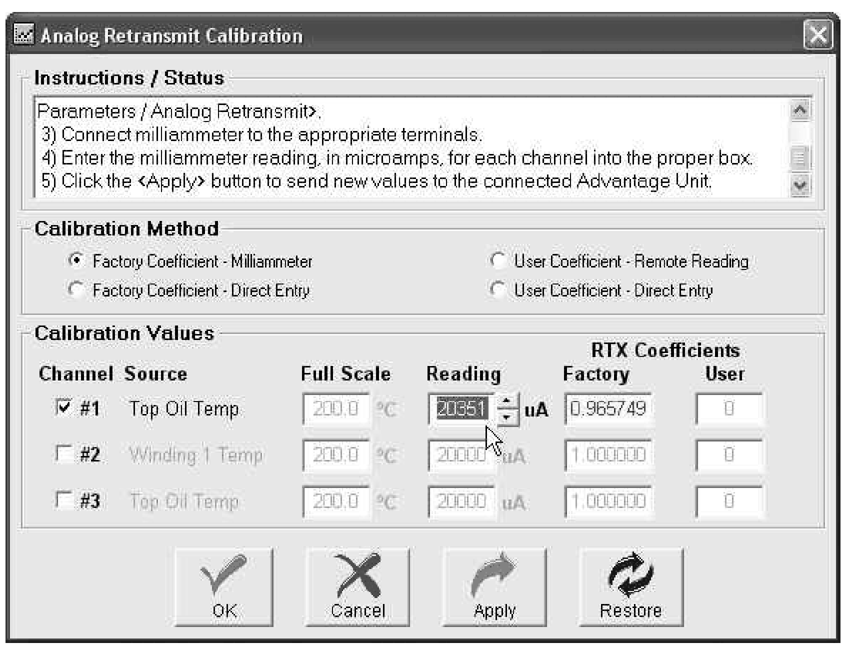


Figure 22. AMTCMFSoftware Analog Retransmit Calibration Screen

Firmware Upgrade; Direct Coefficient Entry

The direct method of coefficient entry is not a true calibration operation; it is the transfer of a coefficient that was determined during a previous calibration operation. In Advantage models with firmware versions prior to AMTSYS0201, the RFULX variable was adjusted to set the current output to within the ±0.5% stated accuracy limits. This method gave installers and operators easy access to adjust current output to compensate for external loop inaccuracy, but also exposed the values to inadvertent change of factory calibration. In order to ensure that the calibrated accuracy was not lost, a calibration coefficient was determined at the factory and printed on a label affixed to an inner wall of the Advantage case. If the Advantage firmware is being upgraded from a version prior to AMTSYS0201, this coefficient must be transferred to the new factory coefficient variable. The retransmit factory calibration coefficient can be entered only through the AMTCMF0201 software.

1. Turn on the Advantage and allow it to warm up for 30 minutes.

2. Start the AMTCMF0201 software, connect to the UUT, then open the configuration and calibration module. Click on the “Communication” item on the menu bar then click the “Analog Retransmit Calibration” drop-down menu item. Enter the factory calibration password and click “OK” to open the calibration screen.

3. Click the “Factory Coefficient - Direct Entry” radio button then click the appropriate channel check box. Note, then enter the coefficient from the label in the “Factory RTX, Coefficient” text box. When the “Apply” or “OK” buttons are clicked the new coefficient will be stored to non-volatile memory.

8.0 Troubleshooting

Digital Communications Troubleshooting

It has been found, from experience, that more than 90% of communications problems are due to cabling deficiencies and configuration errors. The remaining 10% of problems are typically divided into application problems (6%), hardware failures (2%) documentation errors (2%).

Before condemning the Advantage hardware, use substitution methods and ohmic measurements for cabling and triple check all configuration settings. Protocol standard, bit rates, number of data and stop bits, turn-around delay times and converter settings are the most typical sources of error. Signal reflection and noise problems exist, but to a much lesser degree.

Be careful with regard to the arbitrary use of terminating resistors on RS-485 data lines. They are typically needed only on long lines. Refer to the installation section for details of their use.

Please note that some brands of RS-232 to RS-485 converters use dual labeling of their terminals. For example, one manufacturer uses “A” and “B” as well as (+) and (-). Within this manufacturer’s converter lines, one model uses A (+) for the one terminal and B (-) for the other. Another of this manufacturer’s converter models uses A (-) for one terminal and B (+) for the other. While you cannot depend on letter marking, experience has shown that you can depend on the polarity markings. If there are problems with RS-485 communications, try reversing the (+) and (-) polarities. There will be no damage to the Advantage nor the host device with this trial.

There are also many RS-232 to RS-485 converters which have multiple jumper settings, some of which may not be clear. For example, we have seen where one converter manufacturer refers to a state where the receivers are always on as being an “echo enable”. This “echo enable” term is only true for two-wire operation. In fact, the “echo enable” or “receivers always on” selection is definitely not desirable for two wire operation, but is definitely desirable for four wire operation.

The period that the Advantage waits, between receiving a query and issuing a reply is referred to as the turnaround delay. It is important to know how long this period is, because it impacts the host’s ability to communicate. If the period is too short the host may not have time to change from a talking to a listening mode and some characters in the data stream may be cut off. If the period is too long the host may signal a transmission error believing that communications had been lost. The Advantage’s minimum nominal delay period is 50 microseconds.

Frequently hardware protocol converters and repeaters which are inserted in the data path contribute to the total data path loop delay, requiring that adjustments be made. This is especially true for converters that change any full duplex protocol to a half duplex protocol such as RS-485 2-wire. In these devices the transmit drivers must turn off to allow the receivers to “listen” and other drivers to become active. This switching action requires a finite period of time, also referred to as turnaround delay. In some devices the delay time cannot be adjusted, and in some others it is only adjustable by changing hardware components such as resistors. The Advantage provides a convenient software configuration function named the DELAY function, which can be found in the COMM HRDWR submenu (figure 16G). This function provides a convenient way to lengthen the delay period beyond the 50 microsecond nominal delay.

It has been found that one of the popular RS-232 to RS-485 2/4 wire converters in 2-wire mode requires 1000 microseconds of turnaround delay. Below 1000 microseconds this particular converter was unable to reliably pass the data stream along. With some Fiber Optic-to-RS-485 2-wire converters, communications have been unreliable until the turnaround delay was increased to 4000 microseconds. As a result, the default delay value for Advantage has been set to 5000 microseconds, in an attempt guarantee successful communications “out of the box”. If the default turnaround delay period is objectionable, it can be simply decreased (see figure 16G for details) until the minimum period, which also achieves reliable communications, is reached.

In applications where full duplex protocols are being used throughout the communications link, it is unnecessary to add any delay. Thus, when RS-232, RS-422 or RS-485 4-wire hardware protocols are being used, the Advantage setup does not prompt for, nor apply any delay time.

RS-485 2-wire Bus Biasing

RS-485, 2-wire systems must be properly biased to provide reliable communications. If not properly biased, when all drivers are in the tristate (listen) mode, the state of the bus may be unknown. If the voltage difference between the lines is not greater than ±200mv, the last bit transmitted will be interpreted to be the state of the line. This may result in communications errors if the last bit transmitted is low, because the receivers must be idle in the logic high state, in order to determine when a communication has begun. If the logic state is low continuously, framing errors will result, causing communications to fail. If communications are poor or are not functioning and an RS-485 2-wire scheme is in use, bus bias could be the problem. There are two excellent tutorial documents, AN-847 and AN-1057 available from National Semiconductor on their website, www.national.com.

Sensor and Internal Failure Alarm Troubleshooting

The Advantage has been designed to detect failures in itself and its sensors and report the failures in the form of unique display annunciation.

Sensor Failure Events

Sensor failures typically fall into the category of one or more open or shorted leads, and more rarely an open sensor chip. All of these failures would result in very high or low erroneous indications if not detected. The Advantage contains circuitry and logic which traps these types of indications and displays the message SENS1 FAIL, SENS2 FAIL or SENS3 FAIL, depending on model and which channel's sensor failed. Refer to figure 18 in section 5, Operation, for an illustration of the actual displays. When the failed sensor is replaced, the display will resume normal indication. Recalibration of the Advantage after sensor replacement is not necessary, but it would be wise to check the new sensor's function after it is replaced.

Internal Failure Events

Internal failures may be due to damage caused by exceptionally high transient surge levels or component random failure or drift. The entire sense circuit, from the amplifiers and filters through the A/D converter is checked every 10 minutes for errors. The check is performed by automatic comparison to a known reference resistance (100 ohms) corresponding to the zero °C resistance of the platinum RTD. If the resulting measurement falls outside of a set ± 5 °C tolerance band, the Advantage displays the flashing message INT1 FAIL, INT2 FAIL or INT3 FAIL depending on the model and which channel has failed. Refer to figure 19 in section 5, "Operation" for an illustration of the actual displays. If this display appears, the INTNL REFNC function in the operator mode loop should be run to determine the magnitude of the error. Reference Figure 20 in section 5, Operation, for details on accessing the INTNL REFNC function.

The temperature displayed when running INTNL REFNC should be between -5.0 and +5.0 °C. The resistance tolerance of the internal reference resistor is 0.1%, and it is normal for the INTNL REFNC value to be within ±0.3 °C. Values beyond ± 0.3 °C indicate a corresponding calibration drift. After many years in service without recalibration, component value drift may result in the INTNL REFNC value changing slightly. If the temperature is within the ± 5 °C limits, the error is minor and it can be corrected, if desired, through recalibration, or compensated for by applying an RTD offset. Reference figure 16E for the RTD OFSET feature. Set the offset to the same value, but opposite sign, to compensate for the error. For example, if the INTNL REFNC value for channel 1 (fluid temperature) is +1.2 °C , set the RTD1 offset value to -1.2 °C. If there is already an RTD offset value (other than 0.0) applied, simply add the compensation offset, including the sign to the old offset, to determine the new offset. For example, if a magnetic probe has an RTD offset of +2.3 °C , and the calibration compensation offset is -1.2 °C, the new offset would be 2.3 + (-)1.2 = +1.1 °C.

If the INTNL REFNC value is between ± 5 and ± 10 °C, the unit should be recalibrated, SELF CHECK run and the new INTNL REFNC value checked. If, after recalibration, the INTNL REFNC value is still between ± 5 and ± 10 °C on one or more channels, it is probable that the reference resistor or the self-check relay for that channel is at fault.

If the INTNL REFNC values are beyond the ±10 °C limits for all channels it is likely that one or more modules have become dislodged, or the A/D converter on the CPU module has failed. First check that all modules are firmly seated in their slots. If re-seating the modules does not solve the problem, the CPU module should be substituted with a new one. The CPU module is the top-most module in the upper cavity, behind the display module. Shut off power, replace the CPU module, re-power the unit and run the INTNL REFNC function. If the problem is resolved, run the SELF CHECK function, check the Advantage's calibration and return it to service. Return the failed CPU module to the factory for analysis and repair.

If the INTNL REFNC value is beyond the ±10 °C limits for one or two channels, it is likely that component failure in the lower signal path is at fault. To isolate the cause of the problem, shut off power to the Advantage, substitute the I/O module with a new one and re-run INTNL REFNC to see if the problem is solved. Note that the connector block can be unplugged from the I/O module without removing the wiring to the block. Loosen the small screws on either end of the block and unplug it. Remember to re-tighten the screws after reinstalling the block. If the problem is not resolved, shut off power, replace the original I/O module, substitute the Input Conditioning and Data Display module and run INTNL REFNC again. If the problem is resolved, run the SELF CHECK function, check the Advantage's calibration and return it to service. Modules which are not the failure cause may be left in place. Return failed modules to the factory for repair.

Mode Troubleshooting

Powers up with "TIME DATE" on the display

If an Advantage has been without power for more than approximately 5 days (30 days with optional extended clock back-up power), the back-up power source for the real-time clock may have discharged. In this case, simply press the enter button to enter the Time and Date setting loop, set the time and date, then scroll out to the NORML MODE prompt and press the enter button. Reference the keystroke diagram of figure 16G for Time and Date setting details.

9.0 Specifications

Table 11A Advantage Detail Specifications

Accuracy:

Display	
Temperatures (Measured)	± 0.1 °C [1]
Calculated Winding Temperature	± 1.0 °C [2]
Current	± 1.0 % Fullscale[3]
LTC (Thermowell / Mag Probe)	± 0.1 °C [1] / ± 1.0 °C [6]
DIFF, DEV	Note 7
Setpoints	
Alarm	Same as Display
Auxiliary	"
Analog Retransmit	± 0.5% of Source Range [11]

Displays:

Type:	Layout:
Prompt & Units	14 Segment Alphanumeric
Value & Option	14 Segment Alphanumeric
Height:	
Prompt & Units	0.5 Inches
Value & Option	0.8 Inches
Resolution	
Temperatures	0.1 °C
Voltages / Currents (LCAM)	0.1 Volt / 0.1 Amps
Milliamps (LCAM)	0.01 Amps
Winding Current	1 Amp

Real Time Clock:

Accuracy	± Sec / Day
Memory Retention	5 Days Standard, 30 Days Optional

Setpoint Relays:

Contact Ratings	10A @ 125Vac[4]
	10A @ 240Vac[4]
(All Relays)	½HP @120/240Vac
	10A @ 30VDC [4, 5]
	1A @ 125 VDC [4, 5]
Contact Protection:	
Metal Oxide Varistors (MOV)	250 vac, 6500A I PK (8 x 20 μs)
Temperature Trip Sources	
SC	RTD1
DC, LTC	RTD1, RTD2
TC	RTD1, RTD2, RTD3
CT	RTD1, Windings 1-3 [8]
CTX	RTD1, RTD2, Windings 1-3 [8]
CT/LTC	RTD1, RTD2, RTD3, Windings 1-3 [8]
Utility Trip Sources	Winding Currents 1-3 [9]
	Remote, Clock, Calendar
	LCAM Multirange Channels [10]
Hysteresis	Selectable 0-20°C

EMC

IEEE C37.90.1-1989	Oscillatory 4KV
	Fast Transient 4KV

Environment:

Operating Temperature	-40 to 70°C
	-55 to 70°C (with Heater)
Storage Temperature	-40 to 85°C
Enclosure	Nema 4X+

Power Requirements:	Burden:
2000001307	
120vac/125vdc	10.3 va / 0.12 amps
2000001308	
240vac/250vdc	10.3 va / 0.09 amps
Wide Range 32vdc ± 25%	0.30 amps
Wide Range 48vdc ± 18%	0.25 amps
Wide Range 85 - 300 vdc	0.225 - 0.062 amps
Wide Range 90 - 264 vac	21 - 30 va

Communications:

Port 1	
Physical Protocol	RS-232 only
Connection	RJ-11 6P6C, to I/O Module
Cabling	See Figure 26
Port 2	
Physical Protocols	RS-232, RS-485 2 & 4-wire Bi Di RS-422 4-wire Bi Di
Connections & Cabling	To I/O Module Terminal Block. See figures 10A - 10D
Software Protocols	Weschler SAP Standard Optional DNP3 / ModBus
Bit Rates	Software Selectable 2400, 4800, 9600, 19.2K, 38.4K, 57.6K 115.2K
Fiber Communications	VIA Fiber-to-RS-232 converter. Tested with SEL-2812 and 2814.

Inputs:

Temperatures	Three 100Ω Platinum RTD's, α=0.385 Ω/°C per DIN 43760-1980
Current	0-10 Amps, 50-60 Hz Burden 0.05 VA

Outputs:

Analog Retransmit	
Current Output Range	Software selectable zero and fullscale between 0 and 24 madc
Source Ranges	-40 to 250 °C 0 to 200% IMAX Amps
Load Capability	20vdc max compliance current
Setpoints	Settable Range
Relays 1-6, 9-12	-40 to 250 °C
Auxiliary Relay (Relay 7)	-40 to 250 °C
Sensor Failure Relay (Relay Number Assignable)	Not User Settable

Table 11B. Load and Cooling Auxiliary Monitoring Module Specifications

Channel Description:

CT, CTX and CT/LTC Models	Signal Type:	Ranges (0 - full scale):	Accuracy (above 5% of full scale):	Temperature Coefficient
LCAM1, LCAM2, LCAM3 [9]	Dedicated AC Amps with internal CT	0-10 amps	± 1% Full Scale	± 0.03% / °C
	Dedicated AC Amps with external CT	0 - 5 volts AC [12]	± 1% Full Scale [14]	± 0.03% / °C

All Models:				
LCAM1 - LCAM8 [10]	Multi-range AC Volts	0 - 5, 150, 300 volts	± 1% Full Scale	± 0.03% / °C
	Multi-range AC Amps	0 - 5 volts AC [12]	" [14]	"
	Multi-range DC Volts	0 - 5, 75, 150, 300 volts	± 0.5 % Full Scale	± 0.023% / °C
	Multi-range DC Amps	0 - 1, 20 ma	"	"
	Dry Contact [13]	0-10vdc [13]	N/A	N/A

Channel Input Impedances:

CT, CTX and CT/LTC Models:	Input Type:	Burden or Impedance:
LCAM1, 2, & 3	Dedicated AC Amps with internal CT	0.1 VA
	Dedicated AC Amps with external CT	49K Ω [15]

All Models:		
LCAM1, LCAM2, LCAM3 [10]	5 Volts AC/DC	49K Ω
LCAM4 - LCAM8, multi-range inputs	75 Volts DC	750K Ω
	150 Volts AC/DC	1.5M Ω
	300 Volts AC/DC	3.0M Ω
	1 madc	1K Ω
	20 madc	50 Ω
	Contact Wetting	N/A

Isolation:

Signal to Power Supply:	Type:	Voltage:
Winding Current (Ch 1-3, CT Series)	Magnetic / Optical	3000V
Auxiliary	Optical / Magnetic	3000V

Channel to Channel:		
Winding Current (Ch 1-3, CT Series)	Magnetic	3000V
Auxiliary	Optical	3000V

Measurement Accessories:

Device:	Input Type:	Input Range:	Output:	Output Accuracy:
Weschler Clamp-on CT	AC Amps	0 - 50 Amps	0-5 vac	± 35 microvolts Volts / amp (better than ± 0.10%)

Notes for Tables 11A and 11B:

1. Accuracy is based on reference to a precision resistance standard set for the absolute values of resistance specified in DIN 43760-1980. Accuracy of the system depends on the tracking of the RTD element in comparison to the DIN standard curve. The RTD error is additive to the instrument error. The maximum uncertainty of Weschler probes is ± 1 °C .

2. Winding temperature accuracy is stated with relation to a standard curve as calculated by an internal algorithm, in response to test-standard user variable values, precision current and RTD resistance values. The ultimate winding temperature accuracy will depend upon the accuracy of field calibration of the current circuit and RTD and the accuracy of the values of the user-entered variables.

3. The current accuracy is stated with relation to precision current standards. Field calibration, using non-precision equipment will effect the absolute accuracy of the measurement.

4. Resistive Load

5. DC voltages above 30 volts may require contact protection in addition to the MOV's supplied. This protection is usually provided by clamp diodes connected in shunt to the load in a polarity which will block conduction to energizing current.

6. The accuracy of the sensor in magnetically attached probes is the same as for the thermowell-mounted probes, however; the panel to which the probe mounts will introduce significant skin effects due to its exposure to the elements. The accuracy stated is based on the basic accuracy of the sensor as it measures the temperature of a panel under laboratory conditions. Errors can be reduced in the field by installing weather shields on the probes. Relative probe-to-probe error when both probes are magnetically attached will be approximately the same. This error can normally be compensated for using the RTD offset functions.

7. Difference (DIFF) and deviation (DEV) errors are the result of the sum of the errors of the probes used to make the measurements. The worst case under laboratory conditions for magnetically attached probes is ± 2.0 °C and for thermowell probes ± 0.2 °C .

8. Winding temperatures for windings 2 and 3 are available only if the unit is equipped with an LCAM module and channels 2 and 3 are enabled for winding current measurement.

9. Winding currents for windings 2 and 3 are available only if the unit is equipped with an LCAM module and channels 2 and 3 are enabled for winding current measurement.

10. In non-CT series models all 8 LCAM channels are available as multirange inputs / relay trip sources. In CT series models, LCAM1 must be used for winding current measurement, but LCAM 2 & 3 when ***not*** used for winding current measurement may be used as multirange inputs / relay trip sources.

11. Accuracy is stated as a percentage of output current with respect to full scale current.

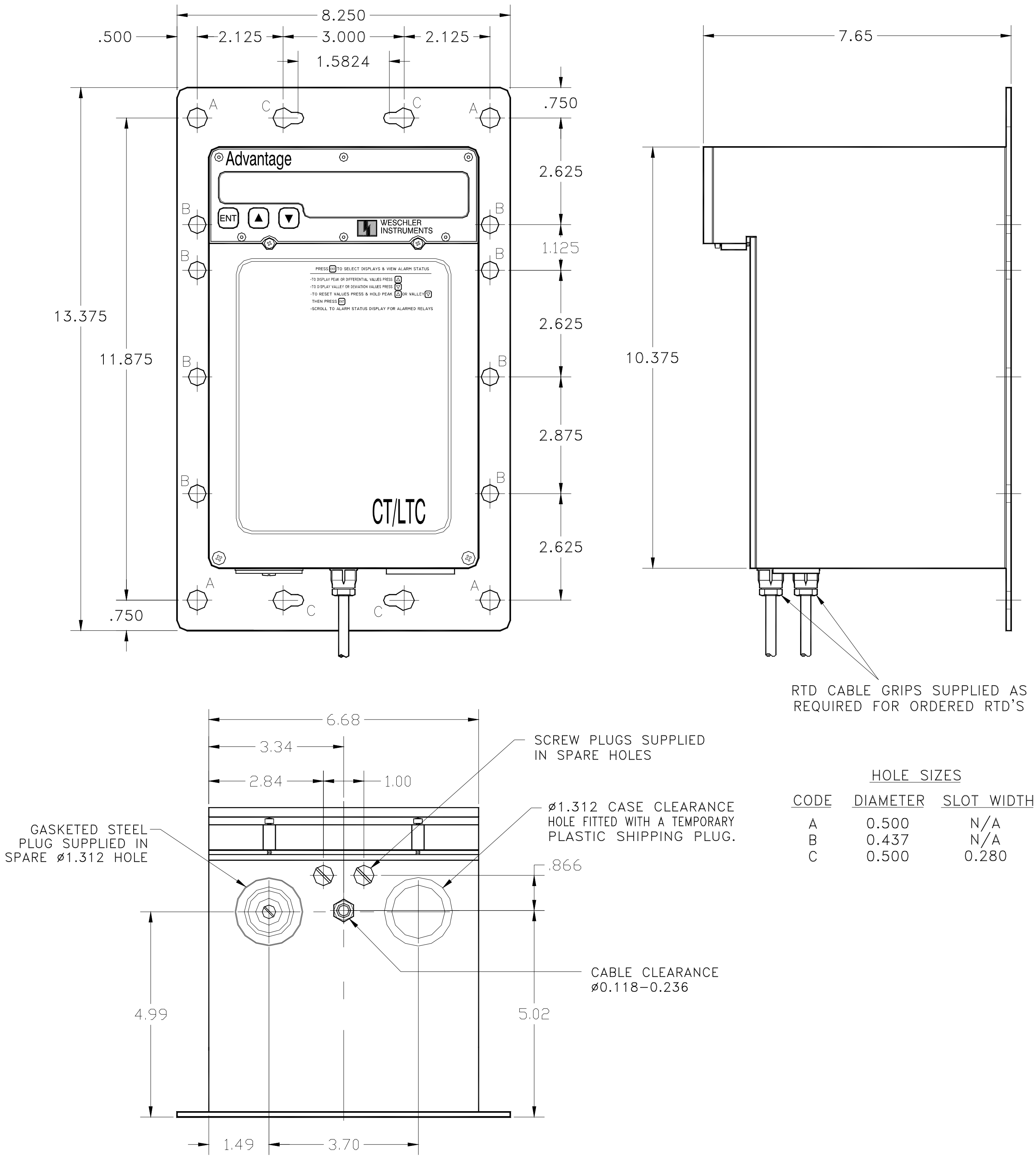
12. This input is intended to be used with an external current-to-voltage transducer with a 5 volt full scale rating. This type of transducer is essentially a CT with the secondary shunted with the appropriate resistance. The displayed value can be set to the primary rating of the transducer in the SCALE dialog.

13. This input range is intended to be used with external contacts that **do not have a source of excitation. It must not be used** where any external source of voltage or current passes through or is applied to the contacts, or permanent damage may occur. The hardware produces approximately 10 vdc for wetting of the dry contact of a relay or switch.

14. The accuracy shown is related to the 5 vac signal. Errors associated with the external CT must be added to the uncertainty stated.

15. The impedance shown is actual terminal impedance. This value is supplied for CT matching purposes.

Figure 23. Surface Mount Outline and Drilling



HOLE SIZES

CODE	DIAMETER	SLOT WIDTH
A	0.500	N/A
B	0.437	N/A
C	0.500	0.280

Figure 24. Recommended Mounting Methods for Surface-Mount Cases

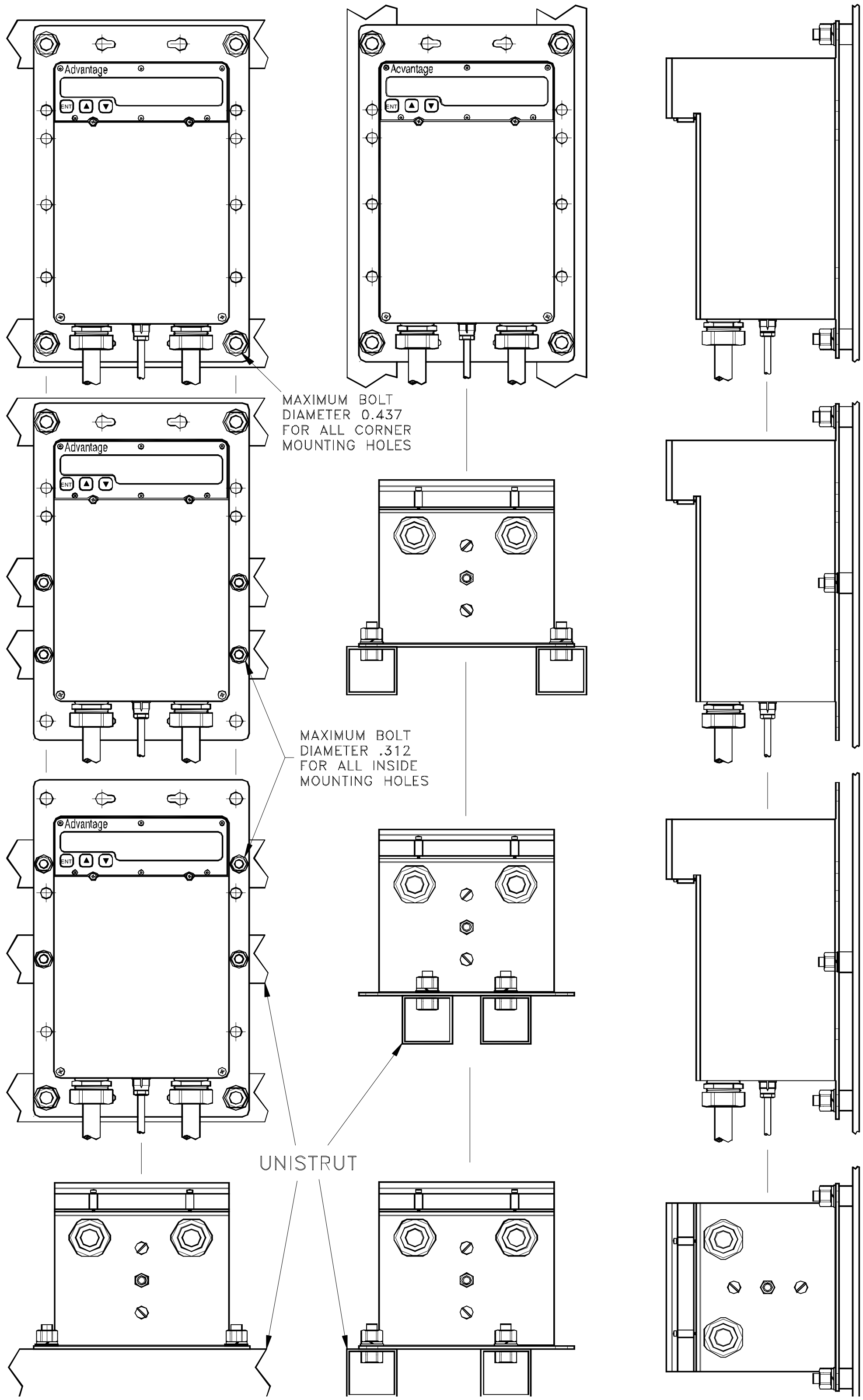


Figure 25. Prohibited Mounting Methods for Surface-Mount Cases

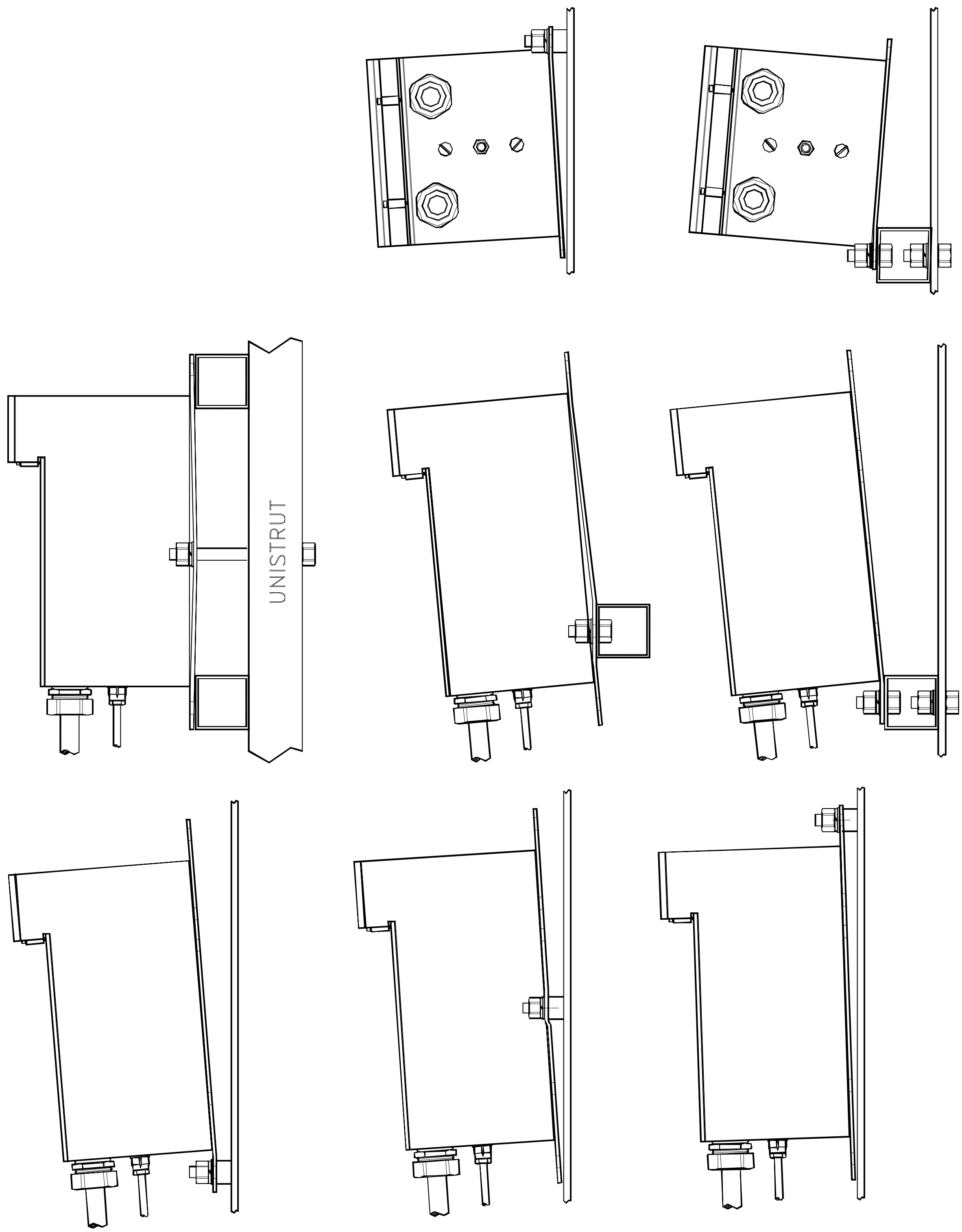


Figure 26. Cut-Out and Drilling Dimensions for Through-Panel Mount Cases

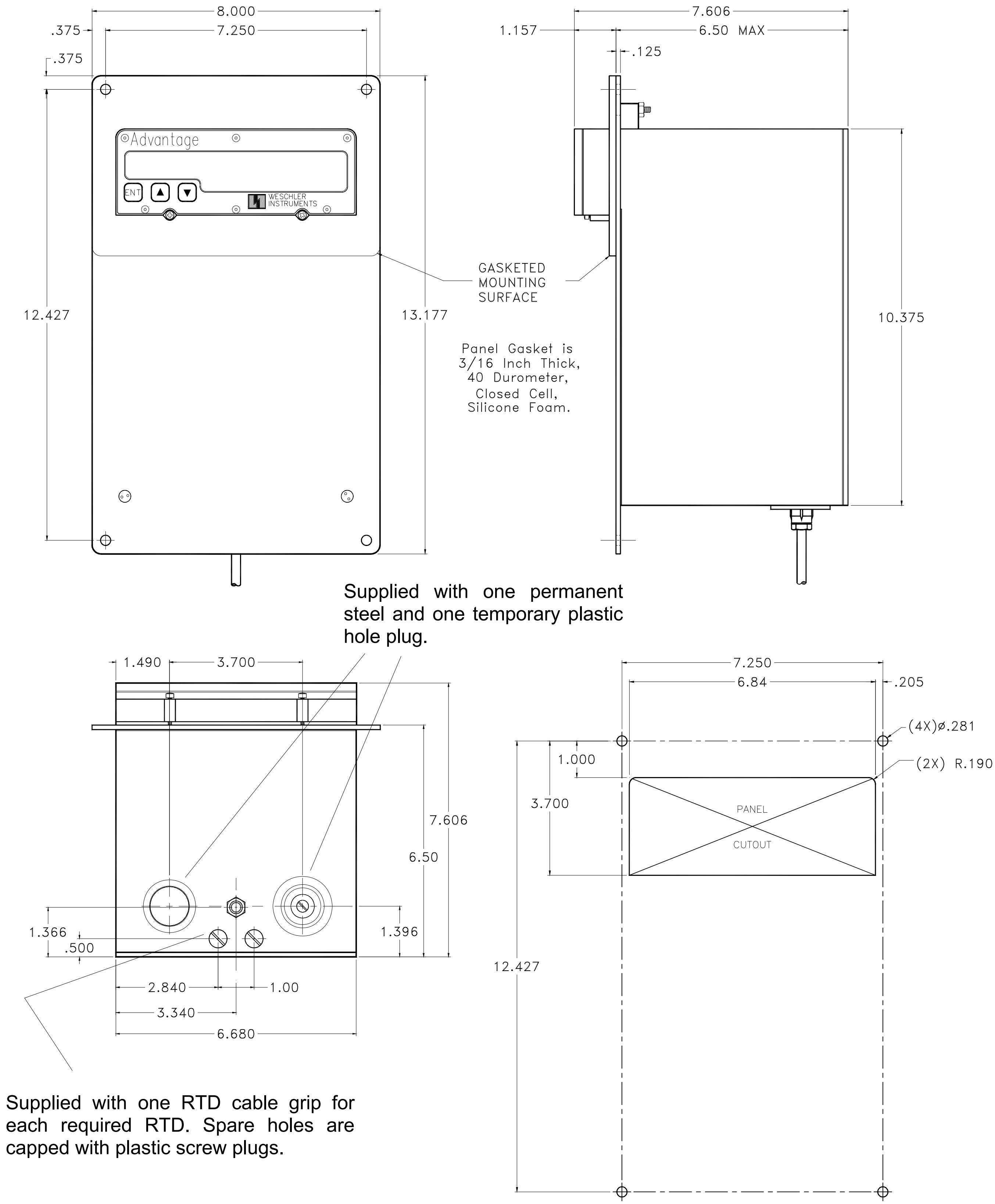
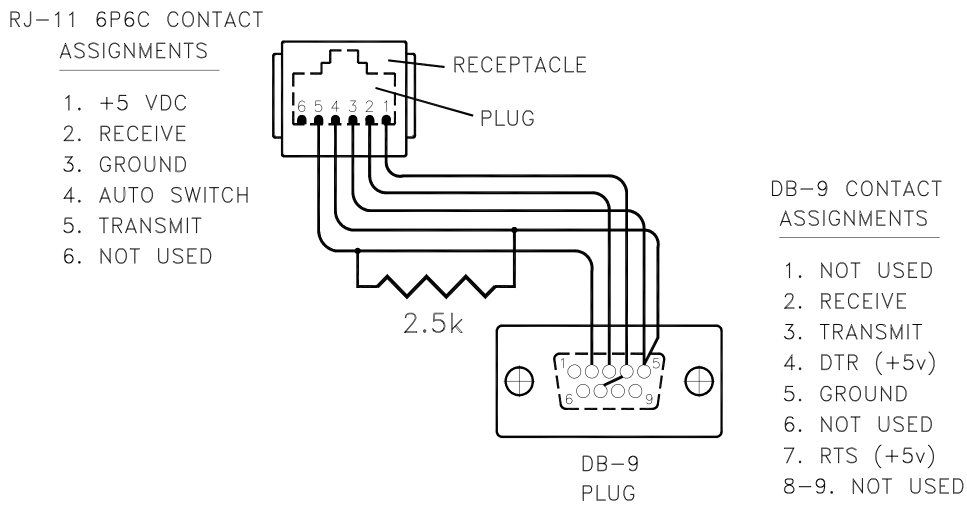


Figure 27. Digital Communications Port 1 Adapter Cabling

The receptacle shown is the port 1 receptacle mounted on the I/O module. The plug is represented as if it were plugged into the module. The connections shown are therefore with respect to the rear view of the RJ-11plug. The DB-9 is viewed from the front and numbered per industry standard.



WARRANTY

All Weschler Instruments Transformer Advantage products are warranted against defects in material and workmanship for a period of **five years** from date of delivery. Weschler Instruments, at its option, will repair or replace any defective product returned to it during the warranty period without charge, provided there is no evidence that the equipment was mishandled or abused. Any repairs or modifications not performed by an authorized factory representative are not warranted by Weschler Instruments. Field service is only available on a contract basis.

Customers must contact Weschler Instruments for an RMA number and shipping instructions BEFORE returning any product.

All products returned to Weschler Instruments must be insured by sender and carefully packed to prevent breakage from shock and rough handling.

WESCHLER INSTRUMENTS
DIVISION OF HUGHES CORPORATION

Correction to *Transformer Advantage II* Enhanced Series Owners Manual

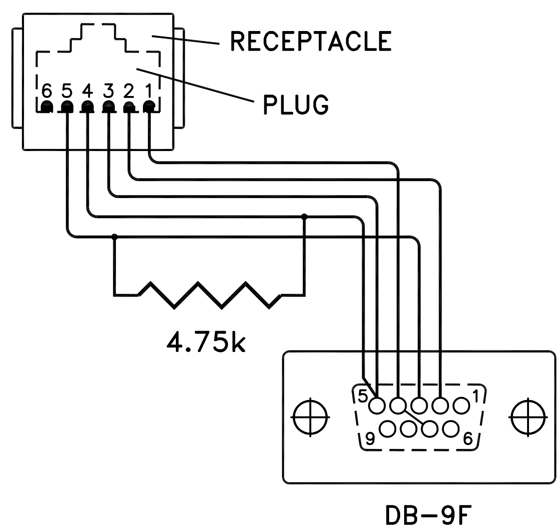
Document: OMAMT200

The diagram for the Digital Communications Port 1 Adapter Cabling is incorrect. The correct information is shown below.

This information replaces: Figure 21 in Revision 2,
Figure 26 in Revision 4,
Figure 27 in Revision 5,
Figure 25 in Revision 6.

RJ-11 6P6C CONTACT ASSIGNMENTS

1. +5 VDC
2. TRANSMIT
3. AUTO SWITCH
4. GND
5. RECEIVE
6. NOT USED



DB-9F CONTACT ASSIGNMENTS

1. NOT USED
2. RECEIVE
3. TRANSMIT
4. DTR (+5v)
5. GROUND
6. NOT USED
7. RTS (+5v)
8. NOT USED
9. NOT USED

This correction also applies to earlier Owners Manuals:
OMGVT200 Rev. 2, Fig. 13
OMG4T200 Rev. 1, Fig. 13
OMG8T200 Rev. 3, Fig. 14

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