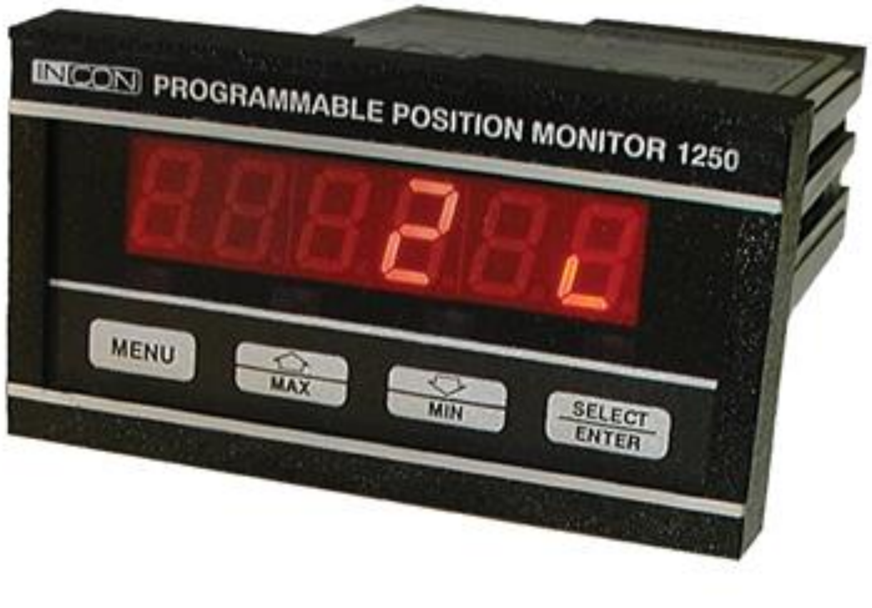

INSTALLATION AND PROGRAMMING MANUAL FOR MODEL

1250-LTC

PROGRAMMABLE POSITION MONITOR

Solid State Indicator for SynchroTransmitter

(For use with firmware revision 4.03 or higher)

000-2072 Rev. F

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This manual applies to all INCON model 1250-LTC monitors with firmware revision 4.03 or higher.

TABLE OF CONTENTS

Section: **Page:**

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The Model 1250-LTC Programmable Position Monitor is a highly advanced solid-state instrument, which measures the absolute position of a synchro transmitter. It provides both a user definable visual panel indication, analog and digital signal outputs suitable for a variety of monitoring and control applications.

The INCON 1250-LTC series is unique in its capability to monitor up to 40 user-definable position segments. It is specifically designed for monitoring power transformer load tap changer position, where the desired readout is in whole tap numbers. Its transmitter can be attached to any operating shaft on the LTC and the 1250-LTC programmed to read out in tap positions. The display and all outputs can follow a “stair step” function defined in the program. The INCON 1250 has become the industry standard for LTC position monitoring.

In addition to basic LTC tap position, the 1250-LTC can provide useful information about the movement of the LTC. Beginning with a momentary (optional) relay closure after each successful tap change, the 1250-LTC keeps records on seven important issues relating to LTC movement, including: total number of tap changes; number of days since last “pass through neutral”; number of changes “up to” and “down to” each tap; and more.

Most LTC’s rotate about 9 to 11 degrees with each tap change. The 1250-LTC can measure in increments of 1/10th of a degree. A special feature of the 1250-LTC is its ability to monitor small discrepancies in tap position. A programmable limit can be set to give an alarm when the discrepancy in tap position reaches the limit. Inaccurate tap position can be an early indicator of wear in the LTC mechanism or possible impending failure.

The 1250-LTC may be wired in parallel with existing synchro transmitter/receiver pairs or wired directly to the synchro transmitter. Additional 1250’s may be wired to the same transmitter without compromising the accuracy or reliability of the system.

1.0 INSTALLATION

- The Model 1250-LTC is designed for use in any 50/60 Hz, five-wire synchro system compatible with electrical specifications given in Section 6.0. These devices include CX, TX, CDX, and TDX function synchros, as well as Self-Synchronous Indicator devices. (INCON’s model 1292 Synchro is a highly specified robust transmitter with a history of proven performance.)
- The panel-mount case is designed to snap-fit into a **standard 1/8 DIN rectangular cut-out of 44mm (1.73 in.) by 92mm (3.62 in.)**
- Wiring is done to the rear of the case. #16 AWG (min.) type THHN, THWN, TFFN, or equivalent wire is recommended for the five AC synchro lines. #20 AWG (min.) shielded twisted pair wire is recommended for analog output wiring. Use appropriate spade lugs (provided) when connecting to the case terminals.
- Contact INCON Technical Service (1-207-571-1202) for application assistance if the synchro transmitter and the 1250-LTC monitor are separated by a wire run of more than 1200 feet.

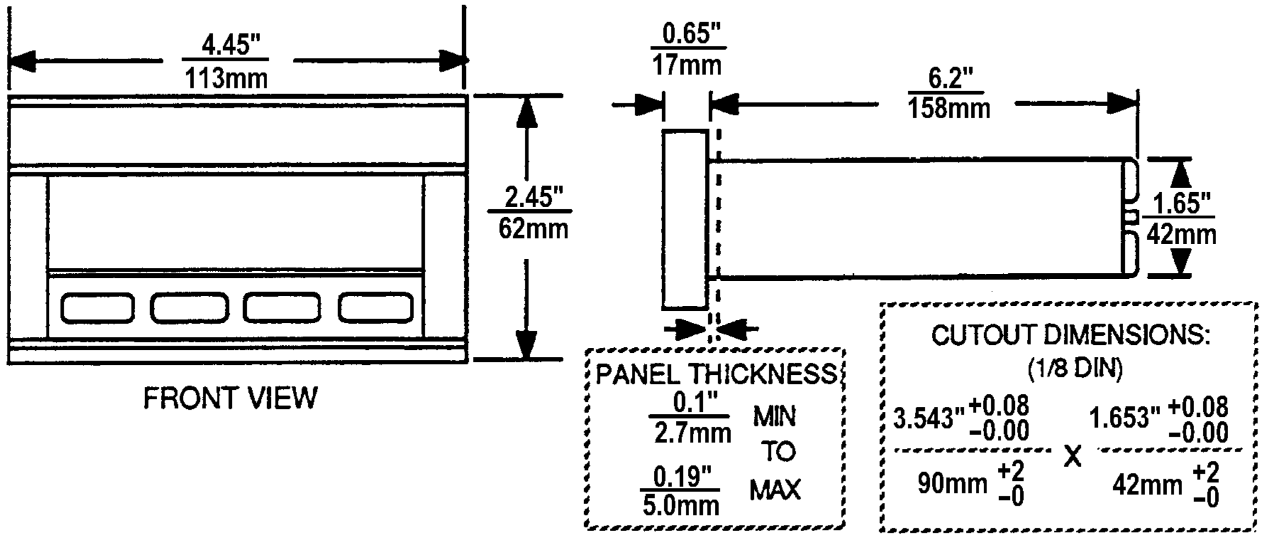

Figure 1.1 Mechanical Dimensions

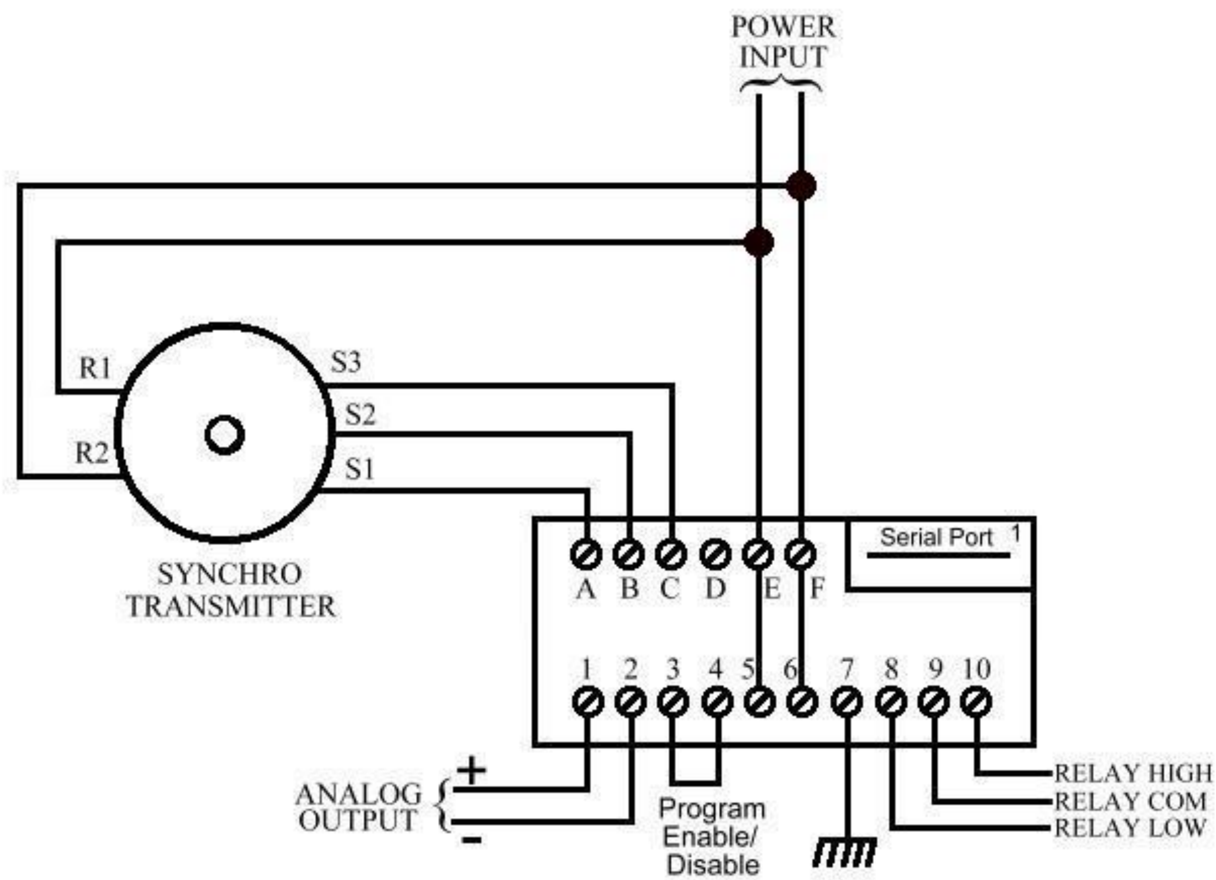

Figure 1.2 Field Wiring Diagram

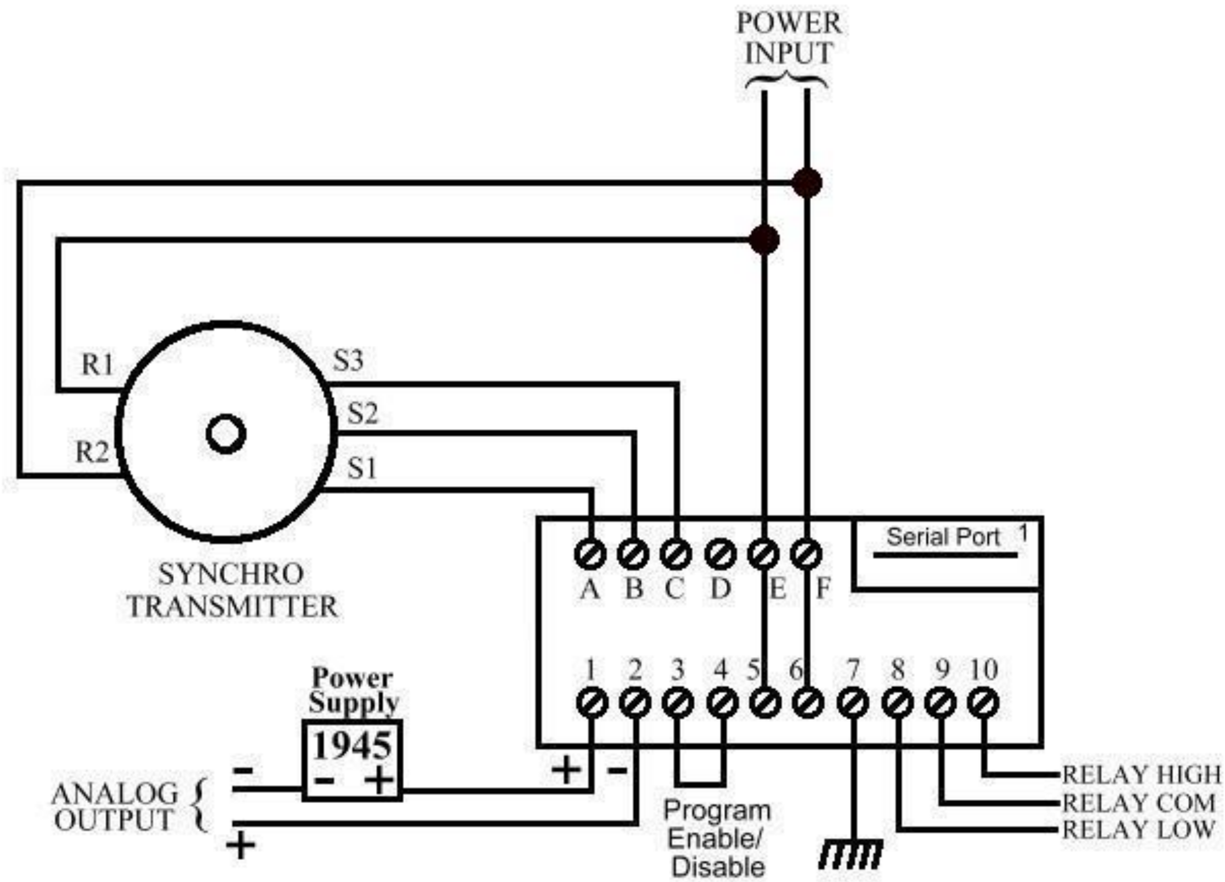

Figure 1.3 Field Wiring Diagram with 4-20mA Output

Table 1.1 Terminal Functions

Terminal	Function	Terminal	Function
A	S1	1	Analog Output +
B	S2	2	Analog Output –
C	S3	3	Program Mode Inhibit
D	(Spare)	4	Inhibit Return
E	R1 *	5	Line L1 *
F	R2 *	6	Line L2 *
		7	Chassis Ground
	* Terminals E & F are	8	Relay Low Contact N.O.
	jumpered to 5 & 6	9	Relay Common
	respectively	10	Relay High Contact N.O.

A DIP switch tells the firmware which hardware options are installed, so their function can be enabled. It is located on the top PCB, above the power transformer and is accessible through a slot in the left side of the case, towards the rear of the instrument.

Table 1.2 DIP Switch Functions

Switch #	Function
1	Serial Communications Option Enable
2	MODBUS Protocol Enable
3	Spare
4	High / Low Relay Limit Option Enable
5	Analog Output Option Enable
6	Spare
7	Spare
8	Spare

Table 1.3 Digital Communication Connector Pin-Out

1250-LTC Pin#	DB-9 Pin#	RS-232 Function	RS-485 Comm Port Adapter Pin #	RS-485 Function
3	2	Transmit (O)	5	Data A(I/O) +
5	3	Receive (I)	4	Data B(I/O) -
7	N/C	RTS (Jumped to CTS)	3	Not Used
9	N/C	CTS (Jumped to RTS)	2	Not Used
13	5	Signal Gnd.	1	Signal Gnd.

Installation Notes:

1) A resistor may be wired remotely across the analog output terminals to convert analog output milliamp current to a voltage. Use Ohm's Law to calculate the proper resistance for the desired voltage based upon the 1250-LTC's rated output current.
2) Maximum analog output load resistance: 0-1mA = 10K ohms; +/-1mA = 10K ohms; 0-2mA = 5K ohms; 4-20mA = (See Table 3.1).
3) Models with 4-20 mA analog output options must have an EXTERNAL LOOP POWER SOURCE of 10.0 VDC minimum, 24.0 VDC maximum, in series with the current loop. The INCON Model 1945 Power Supply is recommended for these installations.
4) When additional remote indication is needed, several 1250s may be wired in parallel to the same transmitter, or a Newport RD4 Remote Indicator can be used.
5) The 1250 and the synchro transmitter MUST BE WIRED TO THE SAME AC SOURCE. Do not remove the jumpers from terminals E and F.
6) A provided jumper or keyswitch may be installed between terminals 3 & 4 to prevent the program from being changed. When these terminals are jumpered the menu will read "**EP**-x" instead of "**OP**-x", which indicates that you can Examine each Parameter, but not change them.
7) After installation and programming, install the rear terminal guard with screws provide
8) Analog outputs of 0-1mA, +/-1mA, and 0-2mA can be changed in the field to any one of the other two. Set the appropriate switches on Switch A and B per the table below. See Table 1.4 and Figure 1.4

Table 1.4 Analog Output Switch Positions

Model:	0	1	2
Switch A-1	OFF	ON	OFF
Switch A-2	OFF	OFF	OFF
Switch A-3	ON	OFF	OFF
Switch B-1	OFF	OFF	OFF
Switch B-2	ON	ON	ON
Switch B-3	ON	ON	ON

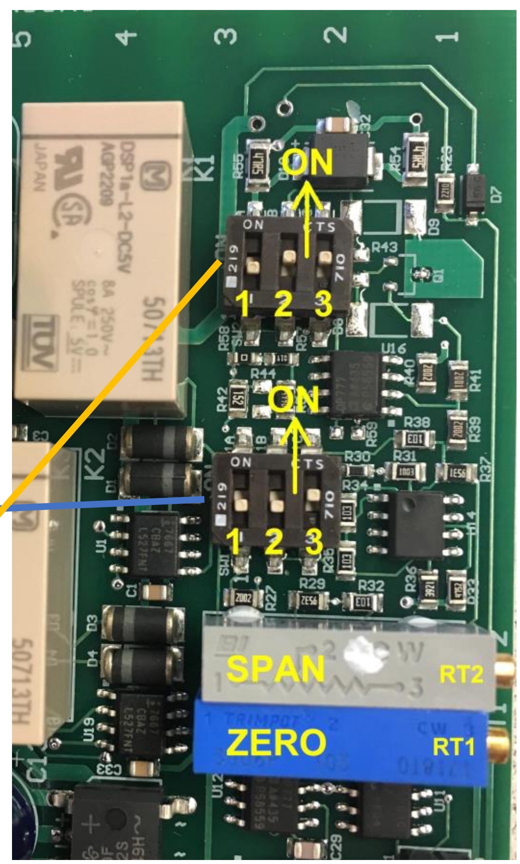

Figure 1.4 Analog Switches &Trim-Pots

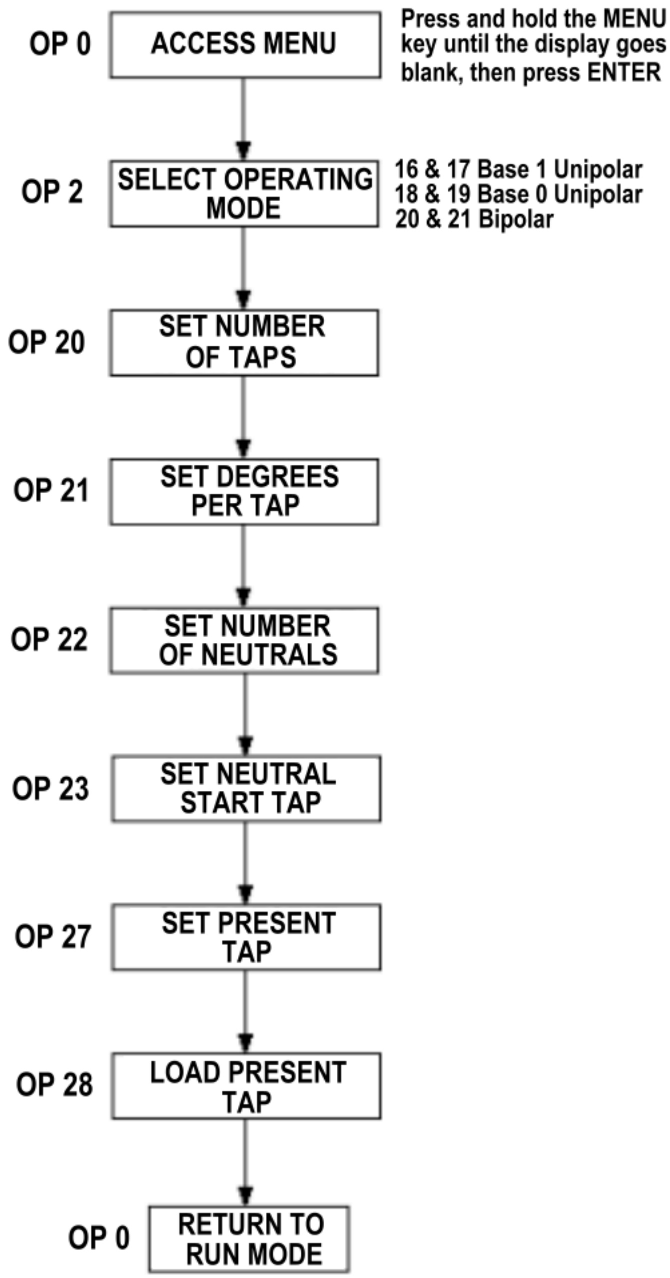

Figure 2.1 Simplified Programming Flowchart

2.0 PROGRAMMING

The Model 1250-LTC has three methods of programming: numeric menu; alpha-numeric menu; and serial port programming commands. The 1250-LTC can be ordered with either RS-232 or RS-485 serial port hardware. The serial programming commands can be in the form of ASCII characters or MODBUS packets, depending upon the position of DIP switch #2. See Tables 2.1, 2.2 & 2.3 for a full listing of all programming menu items, commands, and syntax. (See Figure 2.1 Simplified Programming Flowchart.)

2.1 Front Panel Programming

To access the numeric or alphanumeric programming menu, press the MENU key for several seconds until the display goes blank, then press the SELECT/ENTER key. The display should read “OP 0”. The default menu is the numeric menu. To choose the alphanumeric menu, press the DOWN key to select OP 99. Press the SELECT/ENTER key, the display should read “to OP”. Press the UP key. The display should read “run”. You are now in the alphanumeric menu mode.

To change a parameter using the numeric or alphanumeric menus, select the parameter to be changed from the menu, press the SELECT/ENTER key. The parameter’s present setting will now be displayed. You can change the setting by pressing the UP or DOWN key. To store the new setting, press the SELECT/ENTER key, the display will return to the menu.

Table 2.1 Numeric and Alphanumeric Menu Items:

Num-eric	Alpha-numeric Protocol	Function:	Default Value:	Programmable Range:
OP 0	run	Press the SELECT/ENTER key to exit the Program mode		
OP 2	Func	Select Operating Mode (see Section 2.4)	21	16, 17, 18, 19, 20, 21
OP 3	tCrLY	Selects which relay will assert momentarily, after each tap change	OFF	OFF, LO, HI
OP 4	tCrdL	Sets the delay time before Tap Change Acknowledge Relay turns on (Seconds)	0.10	0.00 to 9.90
OP 5	tCrLt	Sets duration of time the Tap Change Acknowledge Relay stays on (Seconds)	1.00	0.00 to 9.90
OP 6	dHF-L	Selects which visit to the Draghand positions (first time or last time) will begin the day counters	LASt	“FirSt”, “LASt”
OP 10	LtCLr	Low Tap Alarm Clear		CL
OP 11	HtCLr	High Tap Alarm Clear		CL
OP 15	rL Lt	Sets low relay limit tap	-16	Any valid tap number
OP 16	LtrLY	Selects which relay will assert when the “Low Tap” alarm limit is reached	DIS	DIS, OFF, LLO, LHI, ALO, AHI
OP 17	rL Ht	Sets high relay limit tap	+16	Any valid tap number
OP 18	HtrLY	Selects which relay will assert when the “High Tap” alarm limit is reached	DIS	DIS, OFF, LLO, LHI, ALO, AHI

Num-eric	Alpha-numeric Protocol	Function:	Default Value:	Programmable Range:
OP 19	dEGrE	Displays absolute synchro position in degrees with one decimal place resolution		
OP 20	tAPS	Number of taps	33	2 to 40
OP 21	d SEG	Degrees per tap	10.00	-99999 to +99999
OP 22	nEu	Number of neutral taps	1	0 to 8
OP 23	n St	Sets neutral start tap	0-1	Any valid tap number
OP 27	S Pt	Sets present tap position	0-1	Any valid tap number
OP 28	L Pt	Loads present tap position into memory		Ld
OP 29	dSPrL	Enables display of "r" or "L" in Function Modes 20 and 21	OFF	On or OFF
OP 30	CAL E	Enables analog output Calibration Mode	OFF	On or OFF
OP 31	L CAL	Forces the analog output to its lowest signal output		LO
OP 32	H CAL	Forces the analog output to its high scale signal output		HI
OP 33	d CAL	Forces the analog output to its mid scale signal outputs		- -
OP 34	t CAL	Forces the analog output to alternate between high and low scale signal outputs		LO then HI
OP 39	dOG t	Forces a Watchdog Reset (Factory use only)		<<Press ENTER>>
OP 40	LED t	Display LED Test: Turns on all LED's		-8.8.8.8.8.
OP 41	rS t	RS-232 Echo Test: Re-transmits characters received through the RS-232 serial port		rS
OP 42	InCAL	Calibrates synchro input circuitry		CAL
OP 43	rLY t	Relay Test: UP and DOWN keys toggle between LO and HI relays		LO then HI
OP 50	dSPbL	Causes the display to go blank after 60 sec.	OFF	On or OFF
OP 51	SEr	Serial Communication Mode: 0=Serial Disabled, 1=Data Logger Mode, 2=Polled Mode, 3=Sampled Mode, 4=Serial Command Mode, 5=Reserved, 6= MODBUS Mode, 7=Remote Display Driver Mode	4	0 to 4, 6 and 7
OP 54	25rLY	Selects which relay will assert when the "FA 25" error is active	OFF	OFF, LLO, LHI, ALO, AHI
OP 55	ttCLt	Sets Total Tap Change Counter alarm limit in **THOUSANDS**	000.00	000.01 to 999.99
OP 56	ttrLY	Selects which relay will assert when the Total Tap Change Counter limit is reached	DIS	DIS, OFF, LLO, LHI
OP 57	ttPrE	Presets the Total Tap Change Counter in **THOUSANDS**	000.00	000.00 to 999.99
OP 58	ttdtE	Total Tap Change Counter reference date Enter day, month, year	01–01–08	
OP 59	ttCdS	Displays Total Tap Change Count and reference date Press ENTER to exit		

Num-eric	Alpha-numeric Protocol	Function:	Default Value:	Programmable Range:
OP 61	27rLY	Selects which relay will assert when the "FA 27" error is active	OFF	OFF, LLO, LHI, ALO, AHI
OP 62	OtGLt	Sets On-Tap Guard Gand limit (Degrees)	0.10	0.10 to 999.90
OP 63	OtrLY	Selects which relay will assert when the On-Tap Guard Gand limit is reached	DIS	DIS, OFF, LLO, LHI, ALO, AHI
OP 64	OtdtE	On-Tap reference date Enter day, month, year	01–01–08	
OP 65	OtdIS	Scrolls through the list of taps, to select, Press ENTER to display the highest measured deviation, for that tap Press MENU to escape back to the menu		Any valid tap number
OP 66	Otdtd	Scrolls through the list of taps which have exceeded the On-Tap Alarm limit to select, Press ENTER to display the highest measured deviation, for that tap Press MENU to escape back to the menu		Any valid tap number
OP 67	OtCLr	Clears the On-Tap Alarm		CL
OP 68	OtrSt	Resets all On-Tap logs & alarm		rESEt
OP 70	udCLt	Sets the alarm limit for the number of changes **UP TO** any tap in **THOUSANDS**	000.00	000.01 to 999.99
OP 71	udrLY	Selects which relay will assert when the "UP TO" Change Alarm limit is reached	DIS	DIS, OFF, LLO, LHI
OP 72	uddtE	UP TO & DOWN TO Change Counter reference date: Enter day, month, year	01–01–08	
OP 73	uddIS	Scrolls through the list of taps to select, Press ENTER to display the Change Up-To count Press ENTER to display the Change Down-To count, for that tap Press MENU to escape back to the menu	0	Any valid tap number
OP 74	udCLr	Clears an active Up-To and Down-To Change alarm		CL
OP 75	udrSt	Resets all Change Up-To and Down-To counters and alarm		rESEt
OP 80	POrt	Sets serial port parameters: (press the UP or Down key to select a value, press the enter key to move to the next parameter) Baud rate Word length Parity (n=none, E=even, O=odd) Stop bits Address (for RS-485 Multi-drop)	 9600 8 n 1 128	2400, 4800, 9600, 14400, 19200, 28800,38400, 57600, 76800 7 or 8 n, E, O 1 or 2 1 to 255
OP 85	PtnLt	Sets the limit for number of days without a "Pass Thru Neutral"	0.00	Off, 0.00 to 365.00
OP 86	PtrLY	Selects which relay will assert when the "Pass Thru Neutral" time limit is reached	DIS	DIS, OFF, LLO, LHI, ALO, AHI
OP 87	PtdIS	Displays the number of days since the last "Pass-Through-Neutral"		

Num-eric	Alpha-numeric Protocol	Function:	Default Value:	Programmable Range:
OP 88	PtrSt	Resets the "Pass-Through-Neutral" counter & alarm		rESEt
OP 90	1dCLt	Sets the limit for number of consecutive tap changes in One Direction	2	2 to 30
OP 91	1drLY	Selects which relay will assert when the "One Direction Change" limit is reached	DIS	DIS, OFF, LLO, LHI, ALO, AHI
OP 92	1ddIS	Displays the number of days since the "One Direction Alarm" was asserted		
OP 93	1dCLr	Clears "One Direction Change" alarm		CL
OP 99	tO OP	Toggles between Numeric and Alphanumeric menus	tO OP	

To prevent accidental or unwanted changes to the program parameters, a "jumper" provided with each monitor may be installed across terminals 3 & 4. With this jumper installed, the numeric menu will read "EP *nn*" instead of "OP *nn*". All parameters can be viewed but no changes can be made.

2.2 Serial Port Programming - ASCII:

These commands require the RS-232 (-S) hardware option. To use the serial port programming commands, connect a computer terminal to the serial port cable. The terminal must have the proper Comm port settings to communicate to the 1250-LTC (see Sections 3.3 and 3.4). See Table 2.2 for a full listing of all Serial Programming Commands and syntax. At the command prompt, type a command followed by the new parameter setting, using proper syntax as shown in Table 2.2. **Typing the command only, without a new para-meter setting, will cause the 1250-LTC to transmit the present setting for that parameter.**

Table 2.2 Serial Programming ASCII Commands:
◊=space ⬇=enter

Command Syntax:	Function:	Explanation:
SETUP⬇	Enter the Setup Mode	This command must be entered before any other commands can be made.
EXIT⬇	Re-starts the serial connection	Changes to comm. port settings will take effect
RUN⬇	Return to the Run Mode	Changes to settings will take effect
DISP⬇	Displays all setup parameters	Each setup parameter command is dis-played with the current value following it
DUMP⬇	Displays all measured LTC information (See Figure 2.2)	Lists: Total tap change count, Days since Pass-Through-Neutral, High & Low Draghand positions, Change Up-To and Down-To counts for each tap, Maximum On-Tap deviations for each tap, etc…
POS⬇	Displays present tap #, synchro position (in degrees) and current On-Tap deviation degrees	Reads Tap #, 0.0 to 359.9 degrees, with one decimal place of resolution Press ⬇ (enter) to exit
MODE◊*nn*⬇	Segmented modes	See Section 2.4 for details
ACKRLY◊*LO*⬇	Selects which relay will assert momentarily after each tap change	Choose "*OFF*", "*LO*" or "*HI*" relay to assert momentarily after each tap change
ACKDLY◊*n.nn*⬇	Sets the delay time, in seconds, before the ACK relay asserts	*n*= a number from 0.10 to 9.90 with two decimal places resolution
ACKHOLD◊*n.nn*⬇	Sets the duration, in seconds, that the ACK relay remains on	*n*= a number from 0.10 to 9.90 with two decimal places resolution
DHCOUNT◊*FIRST*⬇	Selects which visit to the Draghand position to begins the day counter	Choose "*FIRST*" or "*LAST*" visit. The number of days since the LTC visited that extreme position the ***first*** or ***last*** time
DHLRST	Low Draghand Reset	Draghand value becomes present tap
DHHRST	High Draghand Reset	Draghand value becomes present tap
LTLMT◊*nn*⬇	Set Low Tap alarm limit	*n*= an integer, any valid tap number
LTRLY◊*ALO*⬇	Selects which relay (or neither) is associated with the Low Tap alarm, or DISables the alarm.	Choose "*DIS*", "*OFF*", "*LLO*", "*LHI*", "*ALO*" or "*AHI*" relay to assert when the alarm limit is reached
LTCLR⬇	Clears Low Tap Alarm	Also resets "Days Since Alarm" counter
HTLMT◊*nn*⬇	Set High Tap alarm limit	*n*= an integer, any valid tap number
HTRLY◊*ALO*⬇	Selects which relay (or neither) is associated with the High Tap alarm, or DISables the alarm.	Choose "*DIS*", "*OFF*", "*LLO*", "*LHI*", "*ALO*" or "*AHI*" relay to assert when the alarm limit is reached
HTCLR⬇	Clears High Tap Alarm	Also resets "Days Since Alarm" counter

Command Syntax:	Function:	Explanation:
TAPS◊*nn*⬇	Set number of taps	*n*= an integer from 2 to 40
DEGSEG◊*nnn.nn*⬇	Set degrees per segment	*n*= a floating-point number, 5 digits max, average number of degrees between taps
NEUTRALS◊*n*⬇	Set number of neutral taps	*n*= an integer from 0 to 9
NSTART◊*nn*⬇	Set neutral start tap number	*n*= an integer, any valid tap number
SETTAP◊*nn*⬇	Set present tap position	*n*= an integer, any valid tap number
LDTAP⬇	Load present tap pos. into memory	Must be done for SETTAP to take effect
DISPRL◊*ON*⬇	Enables the display of "r" (raised) and "L" (lowered) tap numbers	"*ON*" or "*OFF*", when enabled causes the display to show "r" and "L" in function modes 20 and 21 only
ANACAL⬇	Enter analog calibration mode, the 1250 analog output will be forced to Low / Mid / High signal output	Press the space bar to toggle between Low / Mid / High analog output. Press the enter key to stop calibration
PROGDIS⬇	Displays Status of program disable input	0=Open 1=Closed
LEDTEST⬇	Turns on all display segments	Press the enter key to stop the LED test
INCAL⬇	Self-calibrates the input circuitry	Outputs "Pass" or "Fail" calibration result
RLYTEST⬇	Forces Hi / Lo relay output to close	Press the Space Bar to toggle between Lo or Hi relay Press ⬇ (enter) to exit
DSPBL◊*ON*⬇	Enables the display blanking feature	"*ON*" or "*OFF*" When enabled causes the display to go blank after 60 sec.
SERIAL◊*n*⬇	Set serial communication mode	0=Serial Disabled, 1=Data Logger Mode, 2=Polled Mode, 3=Sampled Mode, 4=Serial Command Mode, 5= Reserved, 6=MODBUS Mode, 7=Remote Display Driver
FA25RLY◊*ALO*⬇	Selects which relay (or neither) is associated with the "FA 25" Error	Choose "*OFF*", "*LLO*", "*LHI*", "*ALO*" or "*AHI*" relay to assert when the FA 25 Error is active
TTCLMT◊*nnn.nn*⬇	Sets the Total Tap Change count alarm limit **in THOUSANDS**	*n*= a number from 0.00 to 999.99 with two decimal places of resolution
TTCRLY◊*ALO*⬇	Selects which relay (or neither) is associated with the Total Tap Change count alarm, or DISables	Choose "*DIS*", "*OFF*", "*LLO*" or "*LHI*" relay to assert when the alarm limit is reached
TTCPRE◊*nnn.nn*⬇	Presets the Total Tap Change counter **in THOUSANDS** and clears the alarm	*n*= a number from 0.00 to 999.99 with two decimal places of resolution
TTCDATE◊*mm–dd–yyyy*⬇	Sets the Total Tap Change counter reference date	*mm–dd–yyyy* = Month <hyphen> Day <hyphen>Year (4 digits)
FA27RLY◊*ALO*⬇	Selects which relay (or Neither) is associated with the "FA 27" Error	Choose "*OFF*", "*LLO*", "*LHI*", "*ALO*" or "*AHI*" relay to assert when the FA 27 Error is active
OTGDLMT◊*nnn.n*⬇	Sets the On-Tap guard band limit **in DEGREES**	*n*= a number of degrees from 0.0 to 999.9 with one tenth degree resolution
RESETALL⬇	Resets all logged data to default	Program settings are not changed
OTRLY◊*ALO*⬇	Selects which relay (or neither) is associated with the On-Tap alarm, or DISables the alarm	Choose "*DIS*", "*OFF*", "*LLO*", "*LHI*", "*ALO*" or "*AHI*" relay to assert when the alarm limit is reached
OTDVTN⬇	Displays the tap with the greatest On-Tap Deviation	Displays Tap Number and Deviation

Command Syntax:	Function:	Explanation:
OTDATE◊*mm*–*dd*–*yyyy*⬇	Sets the On-Tap reference date	*mm*–*dd*–*yyyy* = Month <hyphen> Day <hyphen>Year (4 digits)
OTCLR⬇	Clears the On-Tap alarm	Data is retained, the alarm is cleared
OTRST⬇	Resets all On-Tap logs & alarm	All On-Tap data is erased, alarm cleared
UPDNLMT◊*nnn.nn*⬇	Sets the alarm limit for the number of changes "Up-To" and "Down-To" any tap **in THOUSANDS**	*n*= a number from 0.00 to 999.99 with two decimal place resolution
UPDNRLY◊*LO*⬇	Selects which relay (or neither) is associated with the "Up-To / Down-To" Change alarm, or DISables it	Choose "*DIS*", "*OFF*", "*LLO*", "*LHI*", "*ALO*" or "*AHI*" relay to assert when the alarm limit is reached
UPDNDATE◊*mm*–*dd*–*yyyy*⬇	Sets the Up To / Down To Change counter reference date	*mm*–*dd*–*yyyy* = Month <hyphen> Day <hyphen>Year (4 digits)
UPDNCLR⬇	Clears an active Up-To or Down-To Change alarm	If a tap with an Up-To or Down-To Change counter exceeding the programmed limit is re-visited, the alarm will re-activate
UPDNRST⬇	Resets all Change Up-To and Down-To counters and alarm	All Up-To and Down-To counters are reset to zero and an active alarm is turned off
PORT◊*bbbb*◊*w*◊*p* ◊*s*◊*a*⬇	Set comm. port settings: baud rate, word length, parity, stop bits, and address	*b*= 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 76800 baud *w*= 7 or 8 bit word *p*= n, E, O *s*= 1 or 2 stop bits *a*= 0 to 255
SITEID◊*Abcd-Xyz & 123*⬇	Identifies installation site on the "DUMP" header	40 ASCII Characters – Upper / lower case letters, numbers, punctuation marks
PTNLMT◊*nnn.nn*⬇	Sets the alarm limit for the number of **DAYS** without a "Pass Through Neutral"	*n*= a number from 0.00 to 365.00 with two decimal places resolution
PTNRLY◊*LO*⬇	Selects which relay (or neither) is associated with the "Pass-Through-Neutral" alarm, or DISables it	Choose "*DIS*", "*OFF*", "*LLO*", "*LHI*", "*ALO*" or "*AHI*" relay to assert when the alarm limit is reached
PTNRST⬇	Resets the "Pass-Through-Neutral" counter & alarm	
1DTCLMT◊*nn*⬇	Sets the alarm limit for the number of consecutive tap changes in One Direction	*n*= an integer from 2 to 30 or "0" to disable.
1DTCRLY◊*LO*⬇	Selects which relay (or neither) is associated with the "One Direction" alarm, or DISables it	Choose "*DIS*", "*OFF*", "*LLO*", "*LHI*", "*ALO*" or "*AHI*" relay to assert when the alarm limit is reached
1DTCCLR⬇	Clears a "One Direction" alarm	
MENU◊1⬇	Set the keyboard button menu type	*"1"* = Numeric "OP" menu or *"2"* = Alpha-numeric menu
HELP◊*(command)* ⬇	Provides on-line help on the specific command entered or lists all available commands	An explanation of a command and the proper entry syntax is given. If no command is entered, all commands will be listed with syntax but no explanations

Site ID: Maplewood Sub LTC #2
INCON 1250-LTC Firmware Revision *X.xx*

Total Tap Changes: 268408 Since 01-01-2007
Present Tap: 5
Low Draghand: -7 35.4 Days Since LAST Visit
High Draghand: 8 17.6 Days Since LAST Visit

ALARMS:

Status		Since activated - Days:	Limit:	RefDate:
Clear	On-Tap Deviation	--	3.00	01-01-2007
Clear	Instability	7.02	--	--
Clear	Synchro Signal Lost	--	--	--
Clear	1 Direction Change	19.92	04	--
Active	Up Down Count	53.77	40000	01-01-2007
Clear	Total Tap Changes	--	300000	01-01-2007
Clear	Low Tap	34.16	-6	--
Clear	High Tap	16.86	6	--
Clear	Pass Through Neutral	3.95	30	--

TAP STATISTICS:

Tap Num:	Max. Dev. Degrees:	Change Up-To:	Change Dn-To:
-16	+ 0.0	0	0
-15	+ 0.0	0	0
-14	+ 0.0	0	0
-13	+ 0.0	0	0
-12	- 0.4	0	1
-11	- 0.4	1	2
-10	- 0.3	2	3
-9	+ 0.4	3	9
-8	+ 0.5	9	85
-7	+ 0.8	85	215
-6	+ 0.9	215	608
-5	+ 0.9	608	1935
-4	+ 1.1	1935	5564
-3	+ 1.2	5564	6258
-2	+ 1.1	6258	7145
-1	+ 1.3	7145	5199
0-1	+ 0.0	5199	5199
0-2	- 1.3	5199	8064
0-3	+ 0.0	8064	8064
1	+ 1.4	8064	40792
2	+ 2.2	40792	22186
3	+ 1.9	22186	9420
4	+ 1.4	9420	7384
5	+ 1.2	7384	4008
6	+ 0.9	4008	1523
7	+ 0.7	1523	407
8	- 0.6	407	115
9	- 0.6	115	11
10	+ 0.5	11	4
11	- 0.3	4	2
12	- 0.4	2	1
13	+ 0.4	1	0
14	+ 0.0	0	0
15	+ 0.0	0	0
16	+ 0.0	0	0

Figure 2.2 Serial Data Dump Example

2.3 Serial Port Programming - MODBUS:

This type of serial communication requires the RS-232 (-S) or RS-485 (-M) hardware option. To communicate to the 1250-LTC with MODBUS protocol, connect a computer with the appropriate MODBUS communication software and serial port hardware to the 1250-LTC's serial port cable. The computer must have the proper Comm port settings to communicate to the 1250-LTC (see Section 3.3). See Table 2.3 for a full listing of all MODBUS Registers, the definition and binary format for each.

In the following Table 2.3 the meanings of the columns are as follows:

Register: MODBUS register address as seen in a MODBUS command beginning with register 40001 and ending with 48712. These addresses are in **decimal**.

Hex: The same register's address in **hexadecimal**, this value is calculated by subtracting 40001 from the register number. Thus register 40001 in decimal becomes 0000 in hex, and 40257 in decimal becomes 0100 in hex.

Function: Defines what each register contains or does when written. Some registers are read only and have no meaning when written. Others can be written or read. Others are "write only" special functions and cause actions to be performed when they are written.

Format: This column defines what a register contains bit-by-bit in **binary**. A row of 16 symbols shows what each of the 16 bits of the register contain MSB first and LSB last. A BCD formatted floating point register is shown as follows (two 16 bit binary words):

Bcdabcdbbcdcbcdd bcde000000vspppp

bcda, bcdb, bcdc, bcdd, bcde are each four-bit BCD digits, as it would be seen on a display.
000000 are 6 unused bits that report as 0 when read and must be 0 when written.
v is an overflow bit that indicates that the number in the register is too big to display when it is a 1. 0 indicates a valid register value.
s is the sign bit and is 1 when the value in the register is negative. 0 indicates a positive number.
pppp is the position of the decimal point within the bcd digits.
Most registers are not as complex as a floating-point register.

The IEEE floating-point format, as follows (two 16 bit binary words), is the only format supported:
seeeeeeeemmmmmmm mmmmmmmmmmmmmmmm

The format of the IEEE floating-point number is as follows:
s is the sign bit,
e is the exponent bits, and
m are the mantissa bits.

The MODBUS protocol is a master/slave packet based protocol with the 1250-LTC operating as a RTU slave. The MODBUS function commands recognized by the 1250-LTC are "**3**" (read multiple registers) and "**16**" (write multiple registers). By supporting these two commands the 1250-LTC is in level 0 compliance. Using these two commands it is possible to configure the 1250-LTC as well as monitor it for current position. MODBUS RTU command and response packets are formatted as follows:

2.3.1 MODBUS Packet Format - Read

Reading from Holding Registers:

GAP = A gap in transmission of 3.5 character frames indicates to the slaves that a new packet is to follow. No transmission gaps within a packet may exceed 1.5 character frames.

Byte 1 = Device Address: Address 0 is a broadcast address that all units respond to regardless of programmed address. All other addresses can be programmed and used in this mode.

Byte 2 = Function Code: When reading holding registers, this byte is "**03h**"

Data Block = Begins with the number of the first register (two bytes) in a command packet, or data from the first register (two bytes) in a response packet. Followed by the number of registers to be read (two bytes) in a command packet, or by data from subsequent registers.

Last 2 Bytes = Error Checking CRC – Lo Byte & Hi Byte

Table 2.3 Read Registers Command Format

GAP 3.5 Char Min.	Device Address	Function Code	# of First Register Hi	# of First Register Lo	# of Registers to Read Hi	# of Registers to Read Lo	CRC Lo	CRC Hi
	80h	03h	01h	03h	00h	04h	xx	xx

Table 2.4 Read Registers Response Format

GAP 3.5 Char Min.	Device Address	Function Code	Byte Count	Data from First Register Hi	Data from First Register Lo	Data from Second Register Hi	Data from Second Register Lo
	80h	03h	08h	01h	03h	00h	03h

……	……	Data from Last Register Hi	Data from Last Register Lo	CRC Lo	CRC Hi
……	……	00h	02h	xx	xx

2.3.2 MODBUS Packet Format - Write

Write to Holding Registers:

GAP = A gap in transmission of 3.5 character frames indicates to the slaves that a new packet is to follow. No transmission gaps within a packet may exceed 1.5 character frames.

Byte 1 = Device Address: Address 0 is a broadcast address that all units respond to regardless of programmed address. All other addresses can be programmed and used in this mode.

Byte 2 = Function Code: When writing to holding registers, this byte is "**10h**"

Data Block = Begins with the number of the first register to be written (two bytes), followed by the number of registers to be written (two bytes), in either command or response packets. In a command packet the programming data for the first register will be the next two bytes followed by programming data for subsequent registers.

Last 2 Bytes = Error Checking CRC – Lo Byte & Hi Byte

Table 2.5 Write Registers Command Format

GAP 3.5 Char Min.	Device Address	Function Code	# of First Register to be written to Hi	# of First Register to be written to Lo	# of Registers to Write Hi	# of Registers to Write Lo
	80h	10h	10h	00h	00h	04h

Byte Count	Program Data for First Register Hi	Program Data for First Register Lo	Program Data for Second Register Hi	Program Data for Second Register Lo
08h	00h	01h	03h	60h

……	……	Program Data for Last Register Hi	Program Data for Last Register Lo	CRC Lo	CRC Hi
……	……	00	01	xx	xx

Table 2.6 Write Registers Response Format

GAP 3.5 Char Min.	Device Address	Function Code	# of First Register to be written to Hi	# of First Register to be written to Lo	# of Registers to Write Hi	# of Registers to Write Lo	CRC Lo	CRC Hi
	80h	10h	01h	00h	00h	04h	xx	xx

2.3.3 MODBUS Packet Format – Error Exception Response

When the master sends a command, the MSB bit in the Function Code is always clear. When a slave responds to the command, the slave leaves the MSB bit in the Function Code clear if the response is a normal response and sets MSB bit on if the response is an error exception response.

GAP = A gap in transmission of 3.5 character frames indicates to the slaves that a new packet is to follow.

Byte 1 = Device Address: Address 0 is a broadcast address that all units respond to regardless of programmed address. All other addresses can be programmed and used in this mode.

Byte 2 = Function Code: This byte will be the last command sent plus the MSB set on.

Exception Code = Illegal Command = 01
Illegal Register = 02

Last 2 Bytes = Error Checking CRC – Lo Byte & Hi Byte

Table 2.7 Error Exception Response Format

GAP 3.5 Char Min.	Device Address	Function Code	Exception Code	CRC Lo	CRC Hi
	80h	90h	02	xx	xx

Table 2.8 RS-485 MODBUS Register Definitions

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
40001 [0000]	Class: Configuration Type: Read\write	Setup / run mode select	000000000000000**s** LSB (**s**) 0 – run mode 1 – setup mode This bit must be 1 before any program parameter can be changed
40002 [0001]	Class: AlarmClearing, AlarmStatus Type: Read\write, Write 0 to clear	Synchro input signal status	000000000000000**s** LSB (**s**) 0 – OK input signal is present 1 – ALARM input signal is lost
40257, 40258 [0100, 0101]	Class: State Type: Read-only	Angle (cumulative) [The value can exceed +\- 360.0 degrees]	seeeeeeeemmmmmmm MSW mmmmmmmmmmmm LSW IEEE 754-1985 single precision float MSW = [0100] LSW = [0101]
40264 [0107]	Class: State Type: Read-only	Tap, neutral	**tttttttt**0000**nnnn** ["0000" are unused bits] "**t**"= 8-bit tap number "**n**"= 4-bit neutral number (both in binary, 2's compliment)
40513 [0200]	Class: Configuration Type: Write-only, Write one to clear	Draghand reset control	00000000000000**HL** "**H**"= high draghand "**L**"= low draghand 0 ignored 1 = reset
40516 [0203]	Class: State Type: Read-only	High tap draghand	**tttttttt**0000**nnnn** ["0000" are unused bits] "**t**"= 8-bit tap number "**n**"= 4-bit neutral number (both in binary)

Register Address: Decimal [hex]	**Class & Type**	**Function:**	**Binary Format:**
40519 [0206]	Class: State Type: Read-only	Low tap draghand	**tttttttt**0000**nnnn** ["0000" are unused bits] "**t**"= 8-bit tap number "**n**"= 4-bit neutral number (both in binary)
40520 [0207]	Class: Configuration Type: Read\write	Draghand counter start visit	000000000000000**s** LSB (**s**) 0 – First 1 – Last Selects whether time since first or last draghand visit to a tap is reported.
40769 [0300]	Class: State Type: Read-only	Internal relay states	00000000000000**HL** "**H**"= high relay "**L**"= low relay If relay is on, bit = 1, else bit = 0
40777, 40778 [0308, 0309]	Class: State Type: Read\write	Total tap change count	**ssssssssssssssss** MSW **ssssssssssssssss** LSW MSW = [0308] LSW = [0309] [NOTE: Always write both the high (MSW) and low (LSW) words with consecutive writes; do not write any other register address between these two writes.]
40785 [0310]	Class: State Type: Read-only	Tap, neutral with greatest on-tap deviation	**tttttttt**0000**nnnn** ["0000" are unused bits] "**t**"= 8-bit tap number "**n**"= 4-bit neutral number (both in binary)
40786, 40787 [0311, 0312]	Class: State Type: Read-only	Max measured on-tap deviation	seeeeeeeemmmmmmm MSW mmmmmmmmmmmmmm LSW IEEE 754-1985 single precision float MSW = [0311] LSW = [0312]
40801	Class:	On-tap alarm	000000000000000**s**

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
[0320]	AlarmClearing, AlarmStatus Type: Read\write, Write 0 to clear	state	LSB (**s**) 0 – OK 1 – ALARM
40802 [0321]	Class: AlarmClearing, AlarmStatus Type: Read\write, Write 0 to clear	One-direction alarm state	000000000000000**s** LSB (**s**) 0 – OK 1 – ALARM
40803 [0322]	Class: AlarmClearing, AlarmStatus Type: Read\write, Write 0 to clear	Instability alarm state	000000000000000**s** LSB (**s**) 0 – OK 1 – ALARM
40804 [0323]	Class: AlarmClearing, AlarmStatus Type Read\write, Write 0 to clear	Loss-of-signal alarm state	000000000000000**s** LSB (**s**) 0 – OK 1 – ALARM
40805 [0324]	Class: AlarmClearing, AlarmStatus Type: Read\write, Write 0 to clear	Change up-to \ down-to alarm state	000000000000000**s** LSB (**s**) 0 – OK 1 – ALARM
40806 [0325]	Class: AlarmClearing, AlarmStatus Type: Read\write, Write 0 to clear	Pass-through-neutral alarm state	000000000000000**s** LSB (**s**) 0 – OK 1 – ALARM
40808 [0327]	Class: AlarmClearing, AlarmStatus	Low tap alarm state	000000000000000**s** LSB (**s**) 0 – OK

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
	Type: Read\write, Write 0 to clear		1 – ALARM
40809 [0328]	Class: AlarmClearing, AlarmStatus Type Read\write, Write 0 to clear	High tap alarm state	000000000000000**s** LSB (**s**) 0 – OK 1 – ALARM
40833 [0340]	Class: AlarmStatus Type: Read-only	Days since asserting On-tap alarm	**dddddddddddddddd** “d” = 10ths of a day
40834 [0341]	Class: AlarmStatus Type: Read-only	Days since asserting One-direction alarm	**dddddddddddddddd** “d” = 10ths of a day
40835 [0342]	Class: AlarmStatus Type: Read-only	Days since asserting Instability Alarm	**dddddddddddddddd** “d” = 10ths of a day
40836 [0343]	Class: AlarmStatus Type: Read-only	Days since asserting Loss-of –Signal Alarm	**dddddddddddddddd** “d” = 10ths of a day
40837 [0344]	Class: AlarmStatus Type: Read-only	Days since asserting Up-to\down-to alarm	**dddddddddddddddd** “d” = 10ths of a day
40838 [0345]	Class: AlarmStatus Type: Read-only	Days since last Pass–through-neutral	**dddddddddddddddd** “d” = 10ths of a day
40839 [0346]	Class: AlarmStatus Type: Read-only	Days since asserting Total tap changes alarm	**dddddddddddddddd** “d” = 10ths of a day
40840 [0347]	Class: AlarmStatus Type: Read-only	Days since asserting Low tap alarm	**dddddddddddddddd** “d” = 10ths of a day
40841 [0348]	Class: AlarmStatus Type: Read-only	Days since asserting High tap alarm	**dddddddddddddddd** “d” = 10ths of a day
40842	Class: AlarmStatus	Days since Low	**dddddddddddddddd**

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
[0349]	Type: Read-only	draghand hit new extremum	"d" = 10ths of a day
40843 [034A]	Class: AlarmStatus Type: Read-only	Days since High draghand hit new extremum	**<u>dddddddddddddddd</u>** "d" = 10ths of a day
40865 [0360]	Class: AlarmClearing, StatisticsResetting Type: Write-only, Write 0 to clear	On-tap reset	000000000000000**<u>s</u>** LSB (**<u>s</u>**) 0 = reset 1 = ignored
40869 [0364]	Class: AlarmClearing, StatisticsResetting Type: Write-only, Write 0 to clear	Up-to/down-to reset	000000000000000**<u>s</u>** LSB (**<u>s</u>**) 0 = reset 1 = ignored
40870 [0365]	Class: AlarmClearing, StatisticsResetting Type: Write-only, Write 0 to clear	Pass-through-neutral reset	000000000000000**<u>s</u>** LSB (**<u>s</u>**) 0 = reset 1 = ignored
41025 [0400]	Class: state Type: Read-only	Analog output	0000**<u>aaaaaaaaaaaa</u>** 12-bit number (in binary)
44097 [1000]	Class: Configuration Type: Read\write	Operating mode	00000000000**<u>mmmmm</u>** LSBs (**<u>mmmmm</u>**) (see list of modes on page 34)
44353 [1100]	Class: Configuration Type: Read\write	Number of taps	000000000**<u>nnnnnnn</u>** 7-bit number (in binary)
44354,	Class:	Degrees per	seeeeeeeemmmmmmm MSW

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
44355 [1101, 1102]	Configuration Type: Read\write	segment	mmmmmmmmmmmm LSW IEEE 754-1985 single precision float MSW = [1101] LSW = [1102]
44356 [1103]	Class: Configuration Type: Read\write	Number of neutrals	000000000000**<u>nnnn</u>** LSBs (**<u>nnnn</u>**) Up to 8 neutrals, in binary. If field value > 8, clamps to 8
44357 [1104]	Class: Configuration Type: Read\write	Neutral start segment	**<u>ssssssssssssssss</u>** 16 bits, first neutral tap
44358 [1105]	Class: Configuration Type: Read\write	Display "r"&"L"	000000000000000**<u>d</u>** LSB(**<u>d</u>**) 0 = disabled 1 = enabled
44867 [1302]	Class: Configuration Type: Read\write	Preset tap	**<u>ssssssssssssssss</u>** 16 bits, preset tap no.
44868 [1303]	Class: Configuration Type: Write-only	Load/clear preset control	00000000000000**<u>cc</u>** LSBs (**<u>cc</u>**) 00 – no operation 01 – clear offset 10 – load preset
45121 [1400]	Class: Configuration Type: Read\write	Display blank	000000000000000**<u>b</u>** LSB(**<u>b)</u>** 0 = disabled 1 = enabled [display will blank]
45122 [1401]	Class: Configuration Type: Read\write	Menu mode	000000000000000**<u>m</u>** LSB (**<u>m</u>**) 0= numeric 1=alphanumeric

Register Address: Decimal [hex]	**Class & Type**	**Function:**	**Binary Format:**
45633 [1600]	Class: Configuration Type: Read\write	RS-232 mode	0000000000000**rrr** LSBs (**rrr**) 000 = Serial disabled 001 = datalogger mode 010 = polled mode 011 = sampled mode 100 = command 101 = reserved N/A 110 = RS485 Modbus 111 = remote display driver
45634 [1601]	Class: Configuration Type: Read\write	Baud	000000000000**bbbb** LSBs (**bbbb**) 0000 = 300 0001 = 1200 0010 = 2400 0011 = 4800 0100 = 9600 0101 = 14400 0110 = 19200 0111 = 28800 1000 = 38400 1001 = 57600 1010 = 76800
45635 [1602]	Class: Configuration Type: Read\write	Word length	000000000000000**w** LSB (**w**) 0 = 7 bits 1 = 8 bits
45636 [1603]	Class: Configuration Type: Read\write	Parity	00000000000000**pp** LSBs (**pp**) 00 = none 01 = even 10 = odd
45637 [1604]	Class: Configuration Type: Read\write	Stop bits	000000000000000**s** LSB (**s**) 0 = 1 bits 1 = 2 bits
45638 [1605]	Class: Configuration Type: Read\write	Address	00000000**aaaaaaaa** LSBs (**aaaaaaaa**) 8-bit serial multidrop address

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
45889, 45890 [1700, 1701]	Class: Configuration Type: Read\write	Total tap change counter limit	seeeeeeeemmmmmmm MSW mmmmmmmmmmmmm LSW IEEE 754-1985 single precision float MSW = [1700] LSW = [1701] (in thousands of counts)
45891 [1702]	Class: Configuration Type: Read\write	Total tap change count alarm relay	0000000000000 **rrr** LSBs (**rrr**) 000 – Alarm Disabled 001 – Relays OFF 010 – 011 – 100 – LO Relay – Latching 101 – HI Relay – Latching
45892 [1703]	Class: Configuration Type: Read\write	Reference year for Total tap change counter	0000**yyyyyyyyyyyy** "y" = Year (in binary)
45893 [1704]	Class: Configuration Type: Read\write	Reference date for Total tap change counter	0000**mmmm** 000**ddddd** "m" = Month (January = 1) "d" = Day (1-31) (in binary)
46145 [1800]	Class: Configuration Type: Read\write	On-tap guard band limit	**dddddddddddddddd** "d" = tenths of a degree (in binary)
46146 [1801]	Class: Configuration Type: Read\write	On-tap alarm relay	0000000000000 **rrr** LSBs (**rrr**) 000 – Alarm Disabled 001 – Relays OFF 010 – LO Relay – Auto-Reset 011 – HI Relay – Auto-Reset 100 – LO Relay – Latching 101 – HI Relay – Latching
46147 [1802]	Class: Configuration Type: Read\write	Reference year for On-tap counter	0000**yyyyyyyyyyyy** "y" = Year (in binary)

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
46148 [1803]	Class: Configuration Type: Read\write	Reference date for On-tap counter	0000**mmmm** 000**ddddd** "m" = Month "d" = Day (in binary)
46401, 46402 [1900, 1901]	Class: Configuration Type: Read\write	Change up-to / down-to counter limit	seeeeeeeemmmmmmm MSW mmmmmmmmmmmm LSW IEEE 754-1985 single precision float MSW = [1900] LSW = [1901] (in thousands of counts)
46403 [1902]	Class: Configuration Type: Read\write	Change up-to / down-to counter alarm relay	0000000000000 **rrr** LSBs (**rrr**) 000 – Alarm Disabled 001 – Relays OFF 010 – 011 – 100 – LO Relay – Latching 101 – HI Relay – Latching
46404 [1903]	Class: Configuration Type: Read\write	Reference year for up-to / down-to counter	0000**yyyyyyyyyyyy** "y" = Year (in binary)
46405 [1904]	Class: Configuration Type: Read\write	Reference date for up-to / down-to counter	0000**mmmm** 000**ddddd** "m" = Month "d" = Day (in binary)
46657 [1A00]	Class: Configuration Type: Read\write	Pass-through-neutral limit	**dddddddddddddddd** "d" = tenths of a day (in binary)
46658 [1A01]	Class: Configuration Type: Read\write	Pass-through-neutral counter alarm relay	0000000000000 **rrr** LSBs (**rrr**) 000 – Alarm Disabled 001 – Relays OFF 010 – LO Relay – Auto-Reset 011 – HI Relay – Auto-Reset 100 – LO Relay – Latching 101 – HI Relay – Latching

Register Address: Decimal [hex]	**Class & Type**	**Function:**	**Binary Format:**
46913 [1B00]	Class: Configuration Type: Read\write	One-direction counter limit	**0000000000ssssss** LSBs(**ssssss**) 6-bits, number of taps
46914 [1B01]	Class: Configuration Type: Read\write	One-direction counter alarm relay	0000000000000 **rrr** LSBs (**rrr**) 000 – Alarm Disabled 001 – Relays OFF 010 – LO Relay – Auto-Reset 011 – HI Relay – Auto-Reset 100 – LO Relay – Latching 101 – HI Relay – Latching
47169 [1C00]	Class: Configuration Type: Read\write	Low tap relay limit	**ssssssssssssssss** 16-bit signed word, low tap limit
47170 [1C01]	Class: Configuration Type: Read\write	Low tap alarm relay	0000000000000 **rrr** LSBs (**rrr**) 000 – Alarm Disabled 001 – Relays OFF 010 – LO Relay – Auto-Reset 011 – HI Relay – Auto-Reset 100 – LO Relay – Latching 101 – HI Relay – Latching
47425 [1D00]	Class: Configuration Type: Read\write	High tap relay limit	**ssssssssssssssss** 16-bit signed word, high tap limit
47426 [1D01]	Class: Configuration Type: Read\write	High tap alarm relay	0000000000000 **rrr** LSBs (**rrr**) 000 – Alarm Disabled 001 – Relays OFF 010 – LO Relay – Auto-Reset 011 – HI Relay – Auto-Reset 100 – LO Relay – Latching 101 – HI Relay – Latching
47938 [1F01]	Class: Configuration Type: Read\write	Tap change acknowledge relay	00000000000000 **rr** LSBs (**rr**) 00 – 01 – OFF 10 – LO Relay 11 – HI Relay

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
47939 [1F02]	Class: Configuration Type: Read\write	Acknowledge relay delay time	000000000**sssssss** "s" = Delay in tenths of a second
47940 [1F03]	Class: configuration Type: Read\write	Acknowledge relay duration time	000000000**sssssss** "s" = Duration in tenths of a second
48193 [2000]	Class: Configuration Type: Read\write	"FA 25" error relay	0000000000000 **rrr** LSBs (**rrr**) 000 – 001 – Relays OFF 010 – LO Relay – Auto-Reset 011 – HI Relay – Auto-Reset 100 – LO Relay – Latching 101 – HI Relay – Latching
48194 [2001]	Class: Configuration Type: Read\write	"FA 27" error relay	0000000000000 **rrr** LSBs (**rrr**) 000 – 001 – Relays OFF 010 – LO Relay – Auto-Reset 011 – HI Relay – Auto-Reset 100 – LO Relay – Latching 101 – HI Relay – Latching
48705 [2200]	Class: State Type: Read\write	Tap index select	00000000 **uuuuuuuu** Unsigned byte Zero-based index of tap (value <= 39 decimal) ** NOTE: ALWAYS initially write the tap index select register before reading any of the tap attribute registers 0x3001 through 0x3007; that single write will suffice until it's desired to select a different tap index, at which time another write of the new tap index to this register is required. Also write this register if a restart may have occurred since the last write; i.e. the value of tap index select is not retained over a reset.

Register Address: Decimal [hex]	Class & Type	Function:	Binary Format:
48706 [2201]	Class: State Type: Read-only	Tap number corresponding to Tap index select	**ssssssssssssssss** Signed 16-bit word
48707 [2202]	Class: State Type: Read-only	Neutral number corrresponding to Tap index select	**uuuuuuuuuuuuuuu** Unsigned 16-bit word
48708 [2203]	Class: State Type: Read-only	Max On-Tap deviation corresponding to Tap index select	**ssssssssssssssss** Signed 16-bit word denoting tenths of a degree
48709, 48710 [2204, 2205]	Class: State Type: Read-only	Upper and lower words of Up-to count corresponding to Tap index select	**uuuuuuuuuuuuuuuu** MSW **uuuuuuuuuuuuuuuu** LSW Unsigned 32-bit longword denoting up-to count. MSW = [3004] (upper) LSW = [3005] (lower) ** NOTE: To obtain a consistent 32-bit value, ALWAYS read 0x3004 BEFORE 0x3005; DO NOT read or write any other register address between these reads.
48711, 48712 [2206, 2207]	Class: state Type: Read-only	Upper and lower words of Down-to count corresponding to Tap index select	**uuuuuuuuuuuuuuuu** MSW **uuuuuuuuuuuuuuuu** LSW Unsigned 32-bit longword denoting down-to count MSW = [3006] (upper) LSW = [3007] (lower) ** NOTE: To obtain a consistent 32-bit value, ALWAYS read 0x3006 BEFORE 0x3007; DO NOT read or write any other register address between these reads.

2.4 Operating Modes:

The model 1250-LTC has six operating modes. Each mode causes the 1250-LTC to function differently. Determine which of the following operating modes is best suited to your application. The proper mode will depend upon the desired numbering of the taps and where the neutral taps are located:

16 = Base 1 Uni-polar Segmented Linear Analog
17 = Base 1 Uni-polar Segmented Stepped Analog
18 = Base 0 Uni-polar Segmented Linear Analog
19 = Base 0 Uni-polar Segmented Stepped Analog
20 = Bi-polar Segmented Linear Analog
21 = Bi-polar Segmented Stepped Analog

Modes 16 & 17: Base 1 Uni-polar Segmented

These modes are used for LTC monitoring when the lowest tap number is **1**. There may be multiple neutral taps. They can be located anywhere between the lowest and highest taps as long as they are grouped together in one section. Mode 16 has a linear analog output that continuously varies with LTC shaft position. Mode 17 has a stepped analog output that jumps with each tap change. To select this operating mode use the **OP 2, Func, MODE** command to change the value to **"16"** or **"17"**.

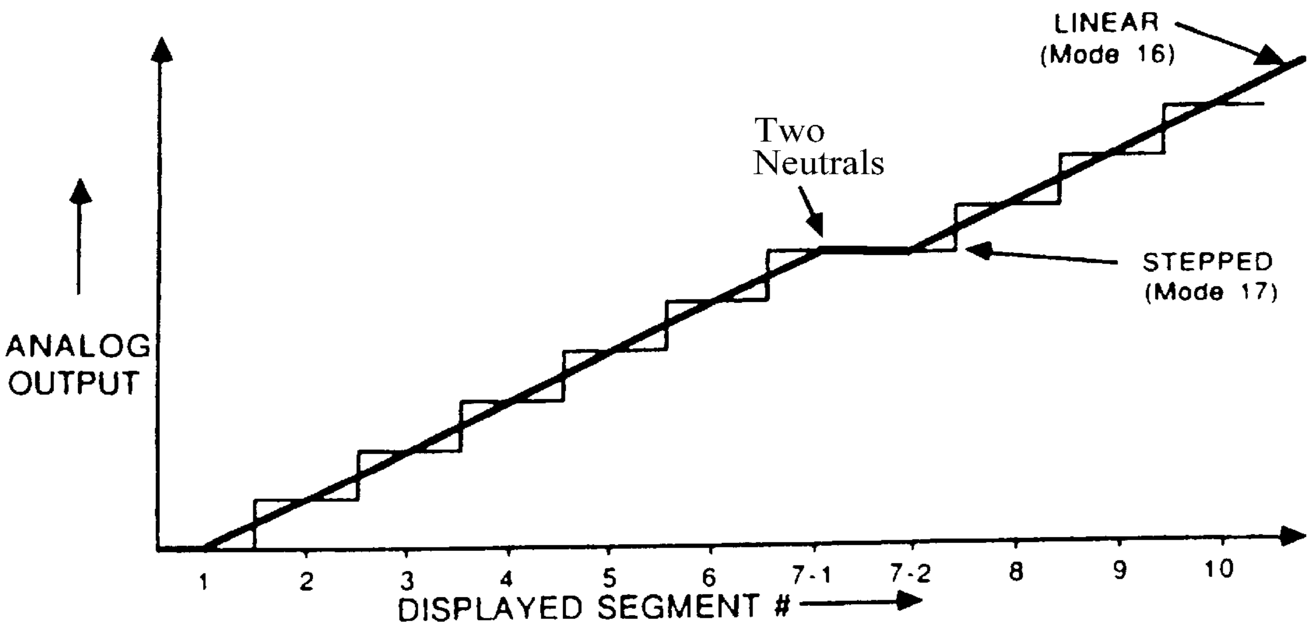

Figure 2.3 Base 1 Uni-polar Mode Analog Output

Programming Example:

A typical transformer Load Tap Changer application with taps numbered 1 to 32, 2 neutral taps (17-1 and 17-2), with 9.5° per tap, presently set on tap "18" would be programmed as follows:

OP 2 Operating mode = 17
OP 20 Number of taps = 33
OP 21 Degrees per tap = 9.5000
OP 22 Number of neutrals = 2
OP 23 Neutral start tap = 17
OP 27 Present tap = 18
OP 28 Load present tap

Modes 18 & 19: Base 0 Uni-polar Segmented These modes are used for LTC monitoring when the lowest tap number is **0**. There may be multiple neutral taps, but they can only be located at tap **0**. Mode 18 has a linear analog output that continuously varies with LTC shaft position. Mode 19 has a stepped analog output that jumps with each tap change. To select this operating mode use the **OP 2, Func, MODE** command to change the value to **"18"** or **"19"**.

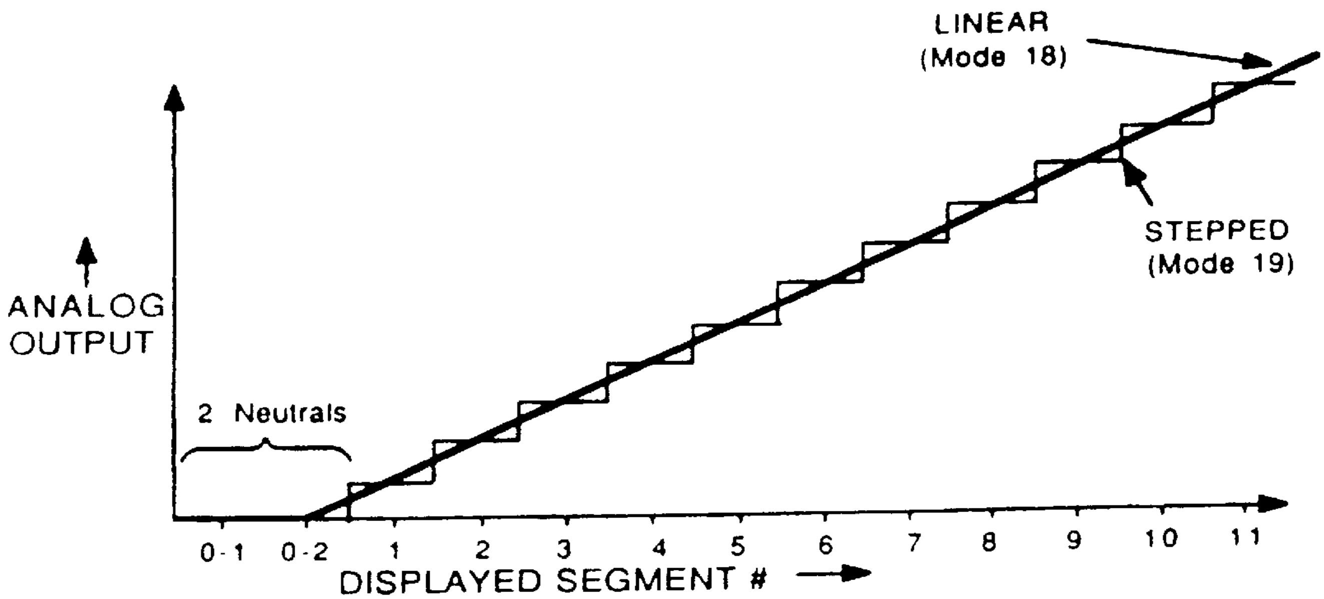

Figure 2.4 Base 0 Uni-polar Mode Analog Output

Programming Example:

A typical transformer Load Tap Changer application with taps numbered 0 to 16, 2 neutral taps, with 10.5° per tap, presently set on tap "9" would be programmed as follows:

OP 2 Operating mode = 19
OP 20 Number of taps = 18
OP 21 Degrees per tap = 10.500
OP 22 Number of neutrals = 2
OP 23 Neutral start tap = 0
OP 27 Present tap = 9
OP 28 Load present tap

Modes 20 & 21: Bi-polar Segmented These modes are used for LTC monitoring when the neutral tap(s) are in the center of the dial and there is an equal number of raised and lowered taps. There may be multiple neutral taps, which can be located anywhere between the lowest and highest taps as long as they are grouped together in one section. Mode 20 has a linear analog output that continuously varies with LTC shaft position. Mode 21 has a stepped analog output that jumps with each tap change. To select this operating mode use the **OP 2, Func, MODE** command to change the value to **"20"** or **"21"**.

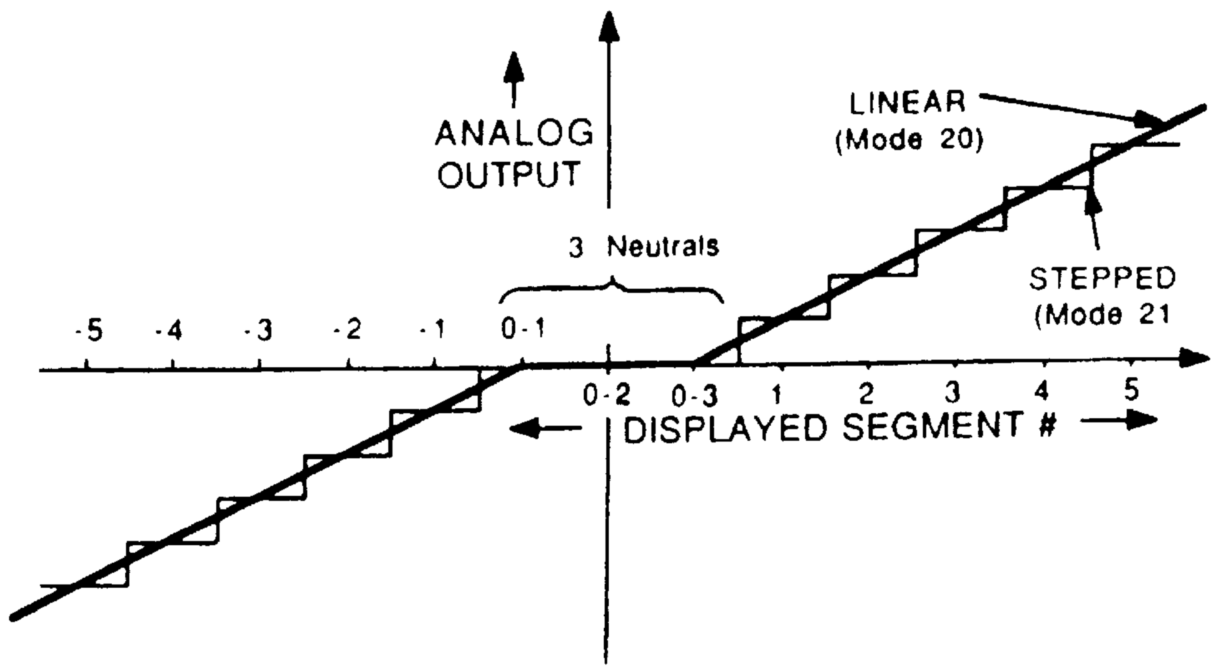

Figure 2.5 Bi-polar Mode Analog Output

Programming Example:

A typical transformer Load Tap Changer application with 16 raised and 16 lowered taps, 3 neutral taps, with 10° per tap, presently set on tap "2L" would be programmed as follows:

OP 2 Operating mode = 21
OP 20 Number of taps = 35
OP 21 Degrees per tap = 10.000
OP 22 Number of neutrals = 3
OP 23 Neutral start tap = 0
OP 27 Present tap = -2
OP 28 Load present tap

2.5 Programming Notes:

If the Degrees Per Tap value is not known, the 1250-LTC can be used to determine this value. Follow these steps to determine the Degrees Per Tap value:

1) Enter the Programming Menu and select OP 19 (Degrees Mode) and press the ENTER key.
2) The 1250-LTC should read a number from 0.0 to 359.9 with 1 decimal place.
3) Move the LTC to as many taps as possible. Record each tap number and the corresponding degree reading displayed on the 1250-LTC in the table below.
4) Subtract one degree reading from the next, for each tap, and write it in the “Difference” column in the table.
5) The differences should all be approximately the same. Take an average of the numbers in the Difference column. The result is the Degrees Per Tap number that the 1250-LTC needs for the OP 21, D SEG, or DEGSEG command.
6) Press the ENTER key to return to the Programming Menu.

Tap Number	Degrees	Difference		Tap Number	Degrees	Difference

There is no programming required for the Analog Output. It automatically spans the full range of taps, lowest tap to low output, highest tap to high output.
Programming for the High/Low Relays option is covered in Section 3.2.
Programming for the Serial ASCII Communication option is covered in Section 2.2.
Programming for the Serial MODBUS Communication option is covered in Section 2.3.

3.0 OPTIONS

The standard Model 1250-LTC is configured with three options – Analog Output, Hi/Lo Relays, and a Serial Port (RS-232 or RS-485). One more option is available – Input Isolation. This section describes general use of each option, including wiring and programming for each option.

3.1 Analog Output Option "-0", "-1", "-2", "-4"

The analog output on the 1250-LTC may be used to feed position information to an LTC Controller, a remote monitoring system such as SCADA, RTU or a remote indicator such as the INCON model 1511-LTC. In all modes, the analog output automatically spans between the highest and lowest taps.

Wiring:

The 4-20mA analog output option must be wired with an external power supply of 10.0 to 24.0 volts DC in series with the analog output current loop. (See Figure 1.3.) The INCON Model 1945 is available for this purpose. All other analog output options are self-powered. Refer to Table 3.1 below for analog output load limits.

Table 3.1 Analog Output Load Limits

Analog Output:	Load Minimum	Load Maximum
0 to 1 mA	Zero Ohms	10K Ohms
+/- 1 mA	Zero Ohms	10K Ohms
0 to 2 mA	Zero Ohms	5K Ohms
4-20 mA	Zero Ohms	400 Ohms with 10-volt power supply
4-20 mA	Zero Ohms	1100 Ohms with 24-volt power supply

Note:

If the presence of high voltage AC "ripple" is found on the analog output terminals, it is generally not a problem with the 1250-LTC itself. Check the isolation of all field wiring with respect to earth ground. All wiring should be completely isolated from ground. (See Section 3.2 Input Isolation Option.) Contact INCON Technical Service for assistance if the problem persists.

3.2 Input Isolation Option "-I"

The 1250-LTC may be ordered with isolated synchro input terminals. In cases where there is a compromise of the (Controller, SCADA, etc…) analog input's isolation to earth ground, this Isolation Option will prevent AC voltage from becoming impressed upon the 1250-LTC's analog output signal to that device. (See Note at the end of Section 3.1) This option consists of two signal isolation transformers installed in the signal input circuitry. Performance and reliability are not affected when this option is installed.

3.3 High / Low Relay Limits Option "-R"

In the 1250-LTC, the High / Low Relays serve as alarm enunciators for the many programmable limits associated with expanded LTC monitoring. The (two) relays are normally open, dry contacts. Each relay may have one or more of the alarm limits assigned to it. They may be used as feedback in a control system or as an alarm when the parameter has reached its desired limits.

When the Tap Change Acknowledgement is not used, it is recommended that the desired alarms be divided into two groups: Warning (LO) and Danger (HI). Less important parameters should cause one relay (Warning) to turn on and more important parameters should cause the other relay (Danger) to turn on. This way, the level of seriousness of an alarm could be communicated, when remotely monitored. When the Tap Change Acknowledgement is assigned to one relay (HI or LO), all other desired alarms must be assigned to the other relay (LO or HI).

When the LO relay is asserted, the LED above the DOWN button, below the digital display, will light up. When the HI relay is asserted, the LED above the UP button, below the digital display, will light up. **Note that the LED's will light up even if the "-R" Relay Option is not installed. This will alert an operator that an alarm limit has been reached, even on an instrument without Relays.** In addition to lighting the HI & LO Relay LED's, an alarm code(s) will be momentarily displayed, to explain which specific alarm(s) is causing the alarm condition.

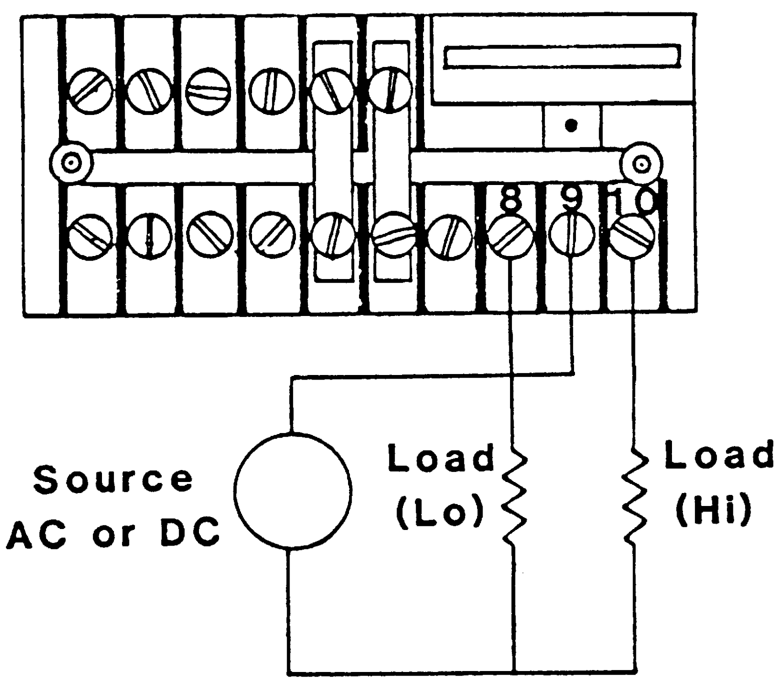

Figure 3.1 Relay Field Wiring Diagram

Since the instrument has only two relays, and eight possible uses for those two relays, there may be times when a relay is being asserted by more than one alarm. The relay actions fall into three categories: **Momentary; Transient; and Persistent**. A Momentary action, as the name implies, closes the relay for only a moment, then opens the relay. A Transient action is one that keeps the relay closed as long as the provoking condition remains valid. As soon as the condition goes away, the relay will open. A Persistent action is one in which the relay remains closed until it is manually reset by the operator.

The **Tap Change Acknowledge** is the only Momentary use of a relay. It can be programmed to activate the "LO" or "HI" relay momentarily. It can also be turned "OFF".

The **Total Tap Change Count Alarm** and **Up-To & Down-To Change Alarms** are the only uses of the relays that are purely Persistent. They can be programmed to activate the "LLO" (latching low) relay or the "LHI" (latching high) relay. They can be programmed with the relays "OFF", in which case the alarm will show on the display but no relays will be activated. These alarms can be disabled completely by programming them to "DIS".

The **High Tap & Low Tap Alarms, On-Tap Alarm, Pass Through Neutral Alarm, One Direction Change Alarm, FA 25** and **FA 27 Error Alarms** can be programmed to be Persistent or Transient actions. They can be programmed to activate the "LLO" (latching low) relay or the "LHI" (latching high) relay in a Persistent manner. They can be programmed to activate the "ALO" (auto-reset low) relay or the "AHI" (auto-reset high) relay in a Transient manner. They can be programmed with the relays "OFF", in which case the alarm will show on the display but no relays will be activated. These alarms (except for FA 25 & FA 27) can be disabled completely by programming them to "DIS".

Relay Assertion Priority: Any Persistent relay action takes priority over any Transient or Momentary action. The Tap Change Acknowledgement Relay can not be assigned to the same relay as another alarm.

3.3.1 Tap Change Acknowledgement Relay

The 1250-LTC can momentarily close a relay contact following every detected tap position change. The user can program a delay time of 0.1 to 9.9 seconds, which causes the relay to wait before asserting. The user can also program a duration time of 0.1 to 9.9 seconds, which causes the relay to hold its assertion before turning off.

Use the **OP 3, tCrLY, ACKRLY** command to choose which relay output (OFF, LO or HI) will be asserted following every tap position change. When this value is set to "OFF" this function is disabled. **Do not assign another alarm to the same relay assigned to for Tap Change Acknowledgement**. Use the **OP 4, tCrdL, ACKDLY** command to set the delay time. Use the **OP 5, tCrLt, ACKHOLD** command to set the duration time.

3.3.2 High Tap Relay and Low Tap Relay

The 1250-LTC can close a relay contact when the LTC moves beyond programmable upper and lower position limits. When the LTC tap position value reaches the Low Relay limit, the assigned Low Tap Relay turns on, the appropriate Relay LED will light up, and the alarm code "**LOtAP**" will be displayed momentarily. When the position value rises above the Low Relay limit, the Low Tap Relay & LED will turn off and the alarm code will not be displayed. When the tap position value reaches the High Relay limit the assigned High Tap Relay turns on, the appropriate Relay LED will light up, and the alarm code "**HItAP**" will be displayed momentarily. When the value falls below the High Relay limit, the High Tap Relay & LED turn off and the alarm code will not be displayed. The user can separately program which relays will assert for the upper and lower position limits.

Use the **OP 15, rL Lt, LTLMT** command to set the Low Tap Relay Limit and the **OP 17, rL Ht, HTLMT** command to set the High Tap Relay Limit. Use the **OP 16, LtrLY, LTRLY** command to select which relay (DIS, OFF, ALO, AHI, LLO or LHI) asserts when the Low Tap Relay Limit is reached. Use the **OP 18, HtrLY, HTRLY** command to select which relay (DIS, OFF, LO or HI) asserts when the High Tap Relay Limit is reached. These are Transient relay actions. When the value is set to "OFF" the alarm will still be indicated, but the relay operation is disabled.   When the value is set to "DIS" the alarm is disabled altogether.

3.3.3 Total Tap Change Count Relay

The 1250-LTC can count the number of tap position changes and turn on a relay and LED when a programmed limit (10 to 999,990 counts) is reached. The alarm code "**ttCLt**" will also be displayed momentarily. The counter can be pre-set to any number. A date can be entered for reference purposes when the count is preset. (This date is stored in memory for reference only, it will not increment as time passes. It can be read through the Front Panel or the serial port.) The user can program which relay will assert when the Total Tap Change Count limit is reached. **Please note that the counter limit and pre-set values are set in THOUSANDS of tap changes.** For example, if an alarm is required at 125,000 operations, set the alarm limit to "125.00". If it is known that the LTC already has 2,300 operations, pre-set the counter to "002.30".

Use the **OP 55, ttCLt, TTCLMT** command to set the Total Tap Change Count Limit. Use the **OP 56, ttrLY, TTCRLY** command to select which relay (DIS, OFF, LLO or LHI) asserts when the Total Tap Change Count Limit is reached. When this value is set to "OFF" the alarm will still be indicated, but the relay operation is disabled.   When this value is set to "DIS" the alarm is disabled altogether. Use the **OP 57, ttPrE, TTCPRE** command to pre-set the Total Tap Change Counter value. If the alarm relay is asserted, it will be cleared when the counter is preset to a value lower than the alarm limit. Use the **OP 58, ttPdt, TTCDATE** command to enter a reference date. To do this using the programming menu: Select **OP 58, ttPdt** and press the ENTER key. First, set the Day of the month value and press the ENTER key. Next, set the Month value and press the ENTER key. Finally, set the Year value and press the ENTER key. Use the **OP 59, ttCdS, DUMP** command to display the present counter value and the reference date. The counter value will be displayed for 2 seconds, and then the date will scroll across the display. This will repeat until the ENTER key is pressed, which will exit the command.

3.3.4 On-Tap Alarm Relay

The 1250-LTC has the accuracy and resolution to monitor minute differences in LTC tap position. Ideally, the LTC should always stop in the exact center of each tap position. A properly functioning LTC should consistently stop within a tolerable band of degrees, with every tap change. As the mechanism wears or if something breaks, the LTC may begin to stop in positions further from the center of the tap position, on one or more taps.

The 1250-LTC can be programmed to give an alarm when it detects that the LTC has stopped in a position that is outside the tolerable band of degrees. The width of this band of tolerable error is programmable in degrees, with 0.1 degree resolution.

A three second time window is given for the LTC to be outside of the acceptable Guard Band area. After three seconds, if the LTC is found in the “Error Zone”, the On-Tap Alarm Relay will assert.

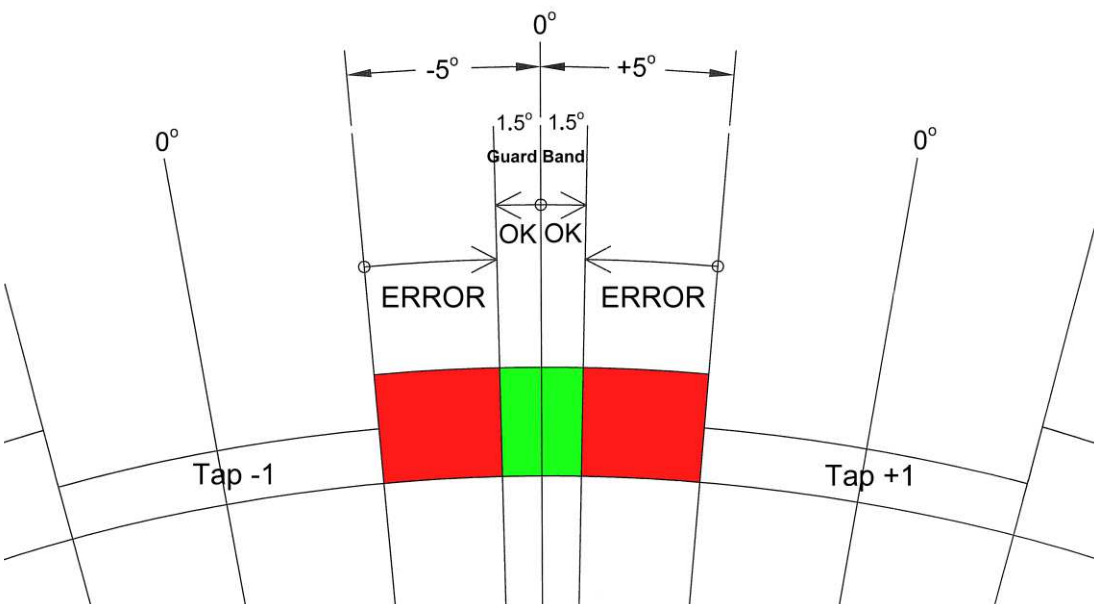

Figure 3.2 On-Tap Example

Figure 3.1 is an example of an LTC with 10.0 degrees per tap position. This LTC should stop at the “zero degrees” center point on every tap, plus or minus a programmable tolerance (“Guard Band”) of 1.5 degrees (green area). If the LTC ever stops more than 1.5 degrees from the center (red area) of any tap, the On-Tap Alarm Relay will be asserted and an LED will flash. The alarm code “**OtGLt**” will be displayed momentarily.

Use the **OP 62, OtGLt, OTGDLMT** command to set the On-Tap Guard Band tolerance in degrees, +/- from zero. Use the **OP 63, OtrLY, OTRLY** command to select which relay (DIS, OFF, ALO, AHI, LLO or LHI) asserts when the On-Tap Guard Band is reached. When this value is set to “OFF” the alarm will still be indicated, but the relay operation is disabled. When this value is set to “DIS” the alarm is disabled altogether. Use the **OP 63, OtdtE, OTDATE** command to enter a reference date.

Use the **OP 65, OtdIS, DUMP** command to display each tap and the highest measured deviation for that tap. Use the UP and DOWN keys to scroll through the list of taps. Press the ENTER key to select a tap and display its highest measured deviation in degrees with 1/10th degree resolution and (-) sign (example: 1.3 or -0.9). Press the ENTER key to return to the list of taps. Press the MENU key to escape back to the programming menu.

Use the **OP 66, Otdtd,** command (menu only) to display all taps that exceed the deviation limit. Press the ENTER key to display the measured deviation for each. Use the UP and DOWN keys to scroll through the list of taps. Press the ENTER key to select a tap and display its highest measured deviation. Press the Enter key to return to the programming menu. Use the **OP 67, OtrSt, OTRST** command to reset all On-Tap logs. This command will also clear an active On-Tap alarm.

3.3.5 Up-To / Down-To Count Alarm Relay

Contacts in the LTC wear proportionately to the number of changes they endure. In most LTC's the contact surface used in changing Up-To a tap is different than the surface used in changing Down-To the same tap. As the 1250-LTC is monitoring the movement of the LTC, it will keep a log of how many times the LTC changes Up-To and Down-To each tap. A programmable alarm limit (10 to 999,990 counts) can be set, which will assert the assigned Alarm Relay output and light up the associated LED, if the number of logged changes Up-To or Down-To any tap reaches the limit. The alarm code "**udCLt**" will be displayed momentarily. **Please note that the counter limit value is set in THOUSANDS of tap changes.** A date can be entered for reference purposes. (This date is stored in memory for reference only, it will not increment as time passes. It can be read through the Front Panel or the serial port.)

Use the **OP 70, udCLt, UPDNLMT** command to set the Up-To / Down-To Change Alarm Limit. Use the **OP71, udrLY, UPDNRLY** command to select which relay (DIS, OFF, LLO or LHI) asserts when the Up-To / Down-To Change Alarm Limit is reached. When this value is set to "OFF" the alarm will still be indicated, but the relay operation is disabled. When this value is set to "DIS" the alarm is disabled altogether.

Use the **OP 73, uddIS, DUMP** command to display each tap, the Change Up-To Count, and the Change Down-To Count for that tap. Use the UP and DOWN keys to scroll through the list of taps. Press the ENTER key to select a tap and display its Change Up-To Count. Press the ENTER key to display its Change Down-To Count. Press the ENTER key to return to the list of taps. Press the MENU key to escape back to the programming menu.

The alarm relay will remain asserted until cleared or the counters are reset. Use the **OP 74, udCLr, UPDNCLR** command to clear an active alarm without resetting the counters. Use the **OP 75, udrSt, UPDNRST** command to clear the alarm and reset all Change Up-To and Change Down-To counters. The display will read "rESEt". When using the keyboard command, press the UP and DOWN keys at the same time to confirm that you want to reset these counters to zero. Press the MENU key to escape back to the programming menu without clearing the counters.

3.3.6 Pass-Through-Neutral Alarm Relay

It is important that an LTC pass through the neutral tap(s) on a regular basis. As the 1250-LTC monitors LTC position, it knows when the LTC passes through the neutral tap(s).

The 1250-LTC is intelligent enough to know the difference between stopping at neutral and reversing direction, and stopping at neutral and continuing on to the tap on the opposite side of neutral. A timer is started each time a complete "Pass-Through-Neutral" occurs. It counts the number of days since that event. When the LTC passes through neutral again, the timer is reset and counting starts over. A programmable limit is set, which will cause an assigned Alarm Relay output to assert and associated LED to light up, if the number of days since a "Pass-Through-Neutral" reaches this limit. The alarm code "**PtnLt**" will be displayed momentarily.

Use the **OP 85, PtnLt, PTNLMT** command to set the "Pass-Through-Neutral" Alarm Limit (0.1 to 365.0 days with 0.1 day resolution). Use the **OP86, PtrLY, PTNRLY** command to select which relay (DIS, OFF, ALO, AHI, LLO or LHI) asserts when the "Pass-Through-Neutral" Alarm Limit is reached. When this value is set to "OFF" the alarm will still be indicated, but the relay operation is disabled. When this value is set to "DIS" the alarm is disabled altogether. Use the **OP 87, PtdIS, DUMP** command to display the number of days since the last "Pass-Through-Neutral" occurred – NOT THE NUMBER OF DAYS SINCE THE ALARM ACTIVATED. The relay will remain asserted until the alarm is cleared. Use the **OP 88, PtnCL, PTNCLR** command to reset the "Pass-Through-Neutral" counter. This command will also clear an active "Pass-Through-Neutral" alarm.

3.3.7 One-Direction Change Alarm Relay

Typically, an LTC will move a few taps up or down, then reverse direction and move a few taps, and reverse direction again. In most cases, it is unusual that the LTC will move very many taps consecutively in one direction. If this occurs, it may indicate some sort of failure in the position control system. The consequences of an out-of-control LTC could be serious – especially in the case of parallel transformers.

As the 1250-LTC monitors LTC position, it can be programmed to assert an alarm relay if it sees the LTC move too many taps consecutively in one direction, up or down. A programmable alarm limit (2 to 50) can be set, which will cause an assigned Alarm Relay output to assert and associated LED to light up, if the number of consecutive tap changes in one direction reaches this limit. The alarm code "**1dCLt**" will be displayed momentarily.

Use the **OP 90, 1dCLt, 1DTCLMT** command to set the "One Direction Change" Alarm Limit. Use the **OP 91, 1drLY, 1DTCRLY** command to select which relay (DIS, OFF, ALO, AHI, LLO or LHI) asserts the FIRST TIME the "One Direction Change" Alarm Limit is reached. When this value is set to "OFF" the alarm will still be indicated, but the relay operation is disabled. When this value is set to "DIS" the alarm is disabled altogether. Use the **OP 93, 1ddIS, 1DTCDIS** command to display the number of days since the "One Direction Change" alarm was asserted. The relay will remain asserted until the alarm is cleared. To clear the alarm, use the **OP 93, 1dACL, 1DACLR** command.

3.3.8 FA 25 and FA 27 Alarm Relays

The 1250-LTC continuously performs sophisticated analysis of the input signal. If it detects a loss of signal, it will display an error code "FA 25". If it detects that the input signal has been unstable (caused by noise or continuous LTC movement) for more than 5 seconds, it will display an error code "FA 27". These alarms "automatically reset" when the provoking conditions are no longer valid. The alarms cannot be disabled. The 1250-LTC can be programmed to assert an alarm relay when each of these errors occurs. These are Transient relay actions.

Use the **OP 54, 25rLY, FA25RLY** command to select which relay (OFF, ALO, AHI, LLO or LHI) asserts while the FA 25 error is being displayed. When this value is set to "OFF" the alarm will still be indicated, but the relay operation is disabled. Use the **OP 61, 27rLY, FA27RLY** command to select which relay (OFF, ALO, AHI, LLO or LHI) asserts while the FA 27 error is being displayed. When this value is set to "OFF" the alarm will still be indicated, but the relay operation is disabled.

3.4 Serial RS-232 "-S"

The Serial RS-232 option on the Model 1250-LTC can be used to program the instrument or to retrieve position data from the instrument. **It is a full-duplex, DCE configuration.**

The communication port settings: baud rate, word length, parity, stop bits, and address are programmable using the **OP 80, POrt, PORT** command. (See Table 2.1 and 2.2 for command protocol and choices.)

NOTE: When the port is programmed for 2 Stop Bits, the Parity must be "NONE".

There are seven operating modes for the serial RS-232 port:

Serial Disabled This mode stops all serial communication. To select this mode, use the **OP 51, RS232, SERIAL** command to choose mode **"0"**. If you are programming the instrument through the serial port, using the serial command mode, this "disabled" mode will not take effect until the command "**EXIT**" is entered. The only way to de-select this "disabled" mode is to use the menu command **OP 51, RS232**, and select another mode.

Data Logger Mode This mode causes the 1250-LTC to transmit the present position value on the display (including sign) once a second. To select this mode, use the **OP 51, RS232, SERIAL** command to choose mode **"1"**. If you are programming the instrument through the serial port, using the serial command mode, this mode will not take effect until the command "**RESTART**" is entered.

Polled Mode When this mode is selected, the 1250-LTC can be interrogated at any time via the RS-232 port for the current position. This is done by first instructing the 1250-LTC to latch the current position by transmitting an asterisk (*) to the unit. The position is then extracted, one character at a time, by transmitting the digits 0 through 6. Zero causes the sign character to be transmitted, 1 through 6 causes each position digit to be sent. The decimal point, wherever it may be positioned, is considered to be a digit. To select this mode, use the menu command **OP 51, RS232, SERIAL** command to choose mode **"2"**.

Sampled Mode When this mode is selected, the 1250-LTC can be interrogated at any time via the RS-232 port for current position by transmitting a question mark (?) to the 1250-LTC. When the 1250-LTC receives a question mark, it responds by latching the current position and transmitting the value on the display in ASCII form. To select this mode, use the menu command **OP 51, RS232, SERIAL** command to chose mode **"3"**.

Serial Command Mode This mode enables programming the instrument through the serial port. To select this mode, use the menu command **OP 51, RS232** to choose mode **"4"**. When this mode is selected, no other serial communication can occur. In addition, if another Serial mode is chosen it will not be activated until the "**EXIT**" command is given through the serial port command line.

MODBUS Mode When this mode is selected, the 1250-LTC will respond to MODBUS commands via the serial port. This option requires the RS-485 (-M) or RS-232 (-S) hardware option be installed. To select this mode, use the menu command **OP 51, RS232** command to choose mode **"6"**. (See Section 2.3 for programming instructions.)

Remote Display Driver Mode This mode must be used when the 1250-LTC is connected to an INCON model RD4 Remote Display. It causes the 1250-LTC's RS-232 output to transmit the proper protocol and timing for the RD4 to mimic what is on the 1250-LTC's display. To select this mode, use the menu command **OP 51, RS232** command to choose mode **"7"**.

3.5 Serial RS-485 Multi-Drop Option "-M"

The Serial RS-485 option on the Model 1250-LTC can be used to program the instrument and to retrieve position data from the instrument, very much like the RS-232 option. **It is a half-duplex configuration.**

MODBUS is the most likely protocol to use for a 1250-LTC equipped with RS-485, but the 1250-LTC with RS-485 will operate in all of the same serial modes listed above in Section 3.3. Certain restrictions apply due to the nature of the half-duplex configuration: The device communicating to the 1250-LTC must be able to turn off its transmitter very quickly so that the 1250-LTC can respond over the same transmission lines. The Remote Display Driver mode is not useful, since the model RD-4 will only accept an RS-232 signal.

Table 3.8 Digital Communication Connector Pin-Out

1250-LTC Pin#	DB-9 Pin#	RS-232 Function	RS-485 Comm Port Adapter Pin #	RS-485 Function
3	2	Transmit (O)	5	Data A(I/O) +
5	3	Receive (I)	4	Data B(I/O) -
7	N/C	RTS (Jumped to CTS)	3	Not Used
9	N/C	CTS (Jumped to RTS)	2	Not Used
13	5	Signal Gnd.	1	Signal Gnd.

4.0 FIELD CALIBRATION & TEST

Calibration: The Model 1250-LTC should not require field calibration. However, there are provisions in the menu to facilitate Analog Output Calibration. The analog output may be adjusted in the field. A calibrated multi-meter should be used to measure the output signal during calibration.

To enable analog calibration, select the **OP 30, CAL** menu command and choose the "On" mode. If you are using the RS-232 serial port, use the **ANACAL** command. The analog output may be forced to LOW, MID, and HIGH output signal states.

If menu commands are being used, select the **OP 31, L CAL** command to force the analog output to LOW scale output. If you are using the RS-232 serial port, press the space bar on the computer terminal. This toggles the output between LOW, MID, and HIGH outputs. The display on the 1250-LTC should read "LO". The analog output low scale may now be adjusted by turning the "ZERO" pot, accessible through the slot in the right side of the case (see Figure 4.1), until the output signal is reading properly on the multi-meter.

If menu commands are being used, select the **OP 32, H CAL** command to force the analog output to HIGH scale output. If you are using the RS-232 serial port, press the space bar on the computer terminal. The display on the 1250-LTC should read "HI". The analog output high scale may now be adjusted by turning the "SPAN" pot (see Figure 4.1) until the output signal is reading properly on the multi-meter. Repeat analog LOW and HIGH calibration steps several times to assure proper output signal calibration of both. Some interaction may occur between the ZERO and SPAN adjustments.

If menu commands are being used, select the **OP 33, D CAL** command to force the analog output to MID scale output. If you are using the RS-232 serial port, press the space bar on the computer terminal. The display on the 1250-LTC should read "**--**". The analog output should read a mid-scale signal on the multi-meter. There is no adjustment for this mid-scale output.

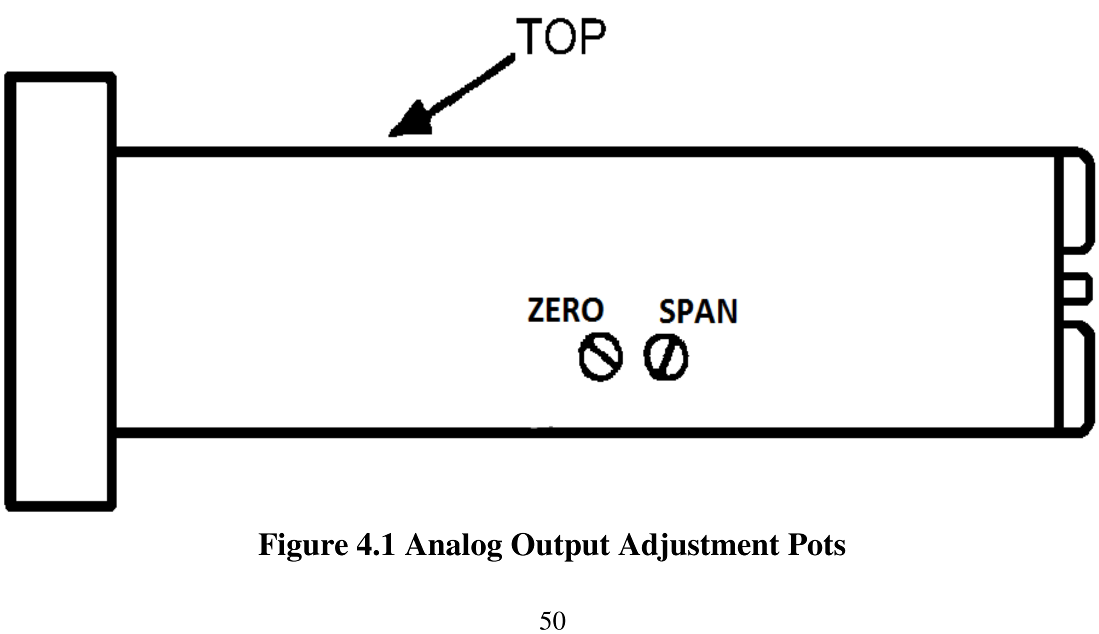

Figure 4.1 Analog Output Adjustment Pots

Self-Diagnostic Tests: The Model 1250-LTC regularly performs a number of self-check diagnostic tests and generates error codes in the form “FA *n*” and “ERR *n*” if it detects an internal fault. The “*n*” number indicates the type of failure detected. See Section 5.0 for a full list of error codes and their explanation.

Power Fail: The 1250-LTC is designed to shut its microprocessor off when it detects the line voltage falling below a fixed threshold, typically 85 to 105. This feature enables the microprocessor to properly store its data before the power is lost completely. The 1250-LTC will automatically re-start itself when the line voltage rises above the Power Fail Threshold voltage.

Firmware Revision: The revision number can be displayed by pressing the “SELECT/ENTER” key while turning on the power to the 1250-LTC.

Cold Boot: The 1250-LTC has the capability to delete all user-programmed values and restore all factory default program values. This “cold boot” is accomplished by pressing the “MENU” key while turning on the power to the 1250-LTC. There is no way to undo the effects of a cold boot.

LED Test: The display can be tested. Use the **OP 40, LED t, LEDTEST** command to turn on all display LED’s. Press the ENTER key to stop the test.

RS-232 Port Test: The RS-232 port can be tested. Use the **OP 41, RS t** menu command to enter the RS-232 Echo Test mode. With a computer terminal connected to the serial port, type in some characters. The 1250-LTC should receive these characters and re-transmit them back to the terminal. The characters typed should appear on the terminal display. Press the ENTER key to stop the test.

Relay Test: The High / Low relays can be tested. Use the **OP 43, RLY t, RLYTEST** command to turn on one of the relays. The UP and DOWN keys will cause the 1250-LTC to toggle between the High and Low relay. If you are using the RS-232 serial port, press the space bar on the computer terminal to toggle between the High and Low relay.

5.0 ERROR CODES

Table 5.1 Error Codes

DISPLAY	DESCRIPTION
FA 2	Watchdog Re-start (Processor Crash. If the condition recurs, call Technical Service.)
FA 3	Memory Error at start-up (User programming is erased. Factory program defaults are re-loaded.)
FA 5	Keyboard Error at start-up (UP or Down Key, or more than one key is being pressed during power-up.)
FA 20	Input Calibration Error (Input signal differential too large. Factory use only)
FA 25	Synchro input signal not present (Measure voltages at terminals A-C and B-C.)
FA 27	Synchro input signal is not stable - never stops changing (The LTC is repeatedly changing taps, or there is noise present on the signal.)
Err 30	Analog output calibration mode not enabled (Change OP 30 to “On”.)
Err 80	Serial Port Parameter Conflict (Change Stop Bits or Parity setting.)
LOtAP	Alarm condition: The Low Tap position limit has been reached. (The LTC position is lower than the Low Tap alarm limit.)
HItAP	Alarm condition: The High Tap position limit has been reached. (The LTC position is higher than the High Tap alarm limit.)
ttCLt	Alarm condition: The Total Tap Change counter limit has been reached. (There have been too many tap changes – total Up and Down.)
OtGLt	Alarm condition: The On-Tap Guard band limit has been reached. (One or more tap changes have stopped outside the acceptable position limit.)
udCLt	Alarm condition: The Up-To / Down-To tap change counter limit has been reached. (There have been too many changes up or down to one or more taps.)
PtnLt	Alarm condition: The Pass Through Neutral limit has been reached. (There have been too many days without a Pass Through Neutral.)
1dCLt	Alarm condition: The One Direction tap change counter limit has been reached. (There have been too many consecutive tap changes in one direction.)

6.0 SPECIFICATIONS

(All values are typical, unless otherwise specified)

ENCLOSURE:	RECTANGULAR PANEL MOUNTED INSTRUMENT
MATERIAL	PLASTIC
SIZE	89mm W X 41.3mm H X 178mm D
BEZEL	112mm W X 62mm h X 17.5mm D
MOUNTING	INTEGRAL SNAP-IN TABS
POWER INPUT:	
CONNECTOR	SCREW TERMINALS L1, L2, GND
VOLTAGE	115 VAC +/- 10%
FREQUENCY	47 TO 63 Hz
POWER CONSUMPTION	8 VA MAX
FUSE	INTERNAL (3/8 AMP)
ISOLATION	TRANSFORMER (1000 VAC)
TEMPERATURE RANGE	
OPERATING	0 TO 55 DEG. C
DISPLAY	5-DIGIT, 7 SEGMENT LED WITH SIGN, RED
HEIGHT	0.56 INCHES
STATUS INDICATION	FOUR DISCRETE LED'S, RED
VIEWING DISTANCE	23 FEET
UPDATE RATE	10 TIMES PER SECOND
ACCURACY (25 DEG. C)	+/- 10 ARC MINUTES W/ TYPICAL SYNCHRO
RESOLUTION	6 ARC MINUTES
TEMPERATURE DRIFT	+/- 0.2 ARC MINUTES PER DEG. C WITH TYPICAL SYNCHRO
ELECTRICAL INPUTS	
SIGNAL INPUT	3 PHASE, 0 TO 90 VAC (INPUT ISOLATION OPTIONAL)
PROGRAM DISABLE	CONNECT TERMINAL #3 TO #4
ELECTRICAL OUTOUTS	
OPTIONAL HI/LO RELAYS	2 ea. FORM 1A N.O. 3A @ 250 VAC (RESISTIVE) 1/10 HP @250VAC 3A @30 VDC (RESISTIVE)
TOTAL ISOLATION	1000 VAC
ANALOG OUTPUT	
RESOLUTION	12 BITS (+/- 0.025% OF F. S.)
NON-LINEARITY	+/-0.1% OF FULL SCALE

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Model 1250-LTC

Installation & Programming Manual