M1150 Mini •PLS™ Miniature Programmable Limit Switch (PLS)

Instruction & Operation Manual

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MAN-M1150-MINI
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MINI•PLS™ Model M1150

Instruction Manual

1. Introduction

The objective of this manual is to explain the operation, installation, wiring, programming, and servicing of the M1150 Mini•PLS (Programmable Limit Switch.) It is suggested that the user read this manual in its entirety before applying power to the unit. If, after reading the manual, there are any unanswered questions, call Technical Support at the **AVG Application Hotline 1 (800) TEC-ENGR.** You may void your warranty if the instructions in this manual are not followed.

1.1 The M1150 Mini•PLS

The PLS (programmable limit switch) is an enhanced, electronic replacement for original standard rotary cam switch assemblies. The PLS has many features that a simply rotary cam switch cannot support, such as, remote programming, all-channel-offsets, and on-the-fly programming. The M1150 has many of the features found on its powerful complimentary units, the M1250 and the M1450-PLS: high speed, built-in tachometer and on-the-fly programming. The M1150 Mini•PLS also features an extremely small size (1/8 DIN) requiring very little panel space and allowing several units to be mounted adjacent to each other. Another key feature of the M1150 Mini•PLS is the simple self-explanatory 5-key keyboard: no programming cards are needed, or lengthy key sequences to remember. Any operator should be able to master programming the M1150 in a matter of minutes.

1.2 Principle of Operation

The M1150 Mini•PLS consists of two parts; a rotary position transducer (resolver) mounted on the machine, and a programmable unit mounted in the machine control panel. The resolver produces an exact analog signal corresponding to an absolute shaft angle. The programmable unit converts this signal into digital format, displays the position and tachometer readings, and compares this position to the dwell set points programmed into the M1150. If the shaft angle falls within a programmed dwell set point, its corresponding output channel turns "ON". This process repeats every 130 microseconds for 8 channel units, and every 240 microseconds for 16 channel units.

2. Functional Description

2.1 The M1150 Mini•PLS

The M1150 is a 10-bit, absolute position PLS with maximum displayed positions (Scale Factor) of either 359 or 999 (programmable). The shaft position and speed are displayed simultaneously when in the default position/tach mode. Either 8 or 16 individual outputs are available. Additionally, these units may be ordered with either "N" (sinking) or "P" (sourcing) type outputs. The M1150 Mini•PLS has the built-in capability to store 4 completely different setups (programs) in its memory. Each setup programmed by the operator, may have different scale factor (counts per turn), offset, dwell set points, and tachometer low and high limit settings The 8th output (8 channel units) or the 16th output (16 channel units), is designated as a motion output. This output turns "ON" when the RPM of the resolver falls within the lower and upper motion limit settings.

2.2 Front Panel Indicators and Controls

See the following page, figure 1 for an illustration of the front panel indicators and controls

2.2.1 Display Windows

The following table, table 1, provides an explanation of the M1150 Mini•PLS display windows.

2.2.2 Run Indicator Lights

Status LED — Indicates the current "ON/OFF" output status of the selected channel. This indicator is active in all 6 modes.

Figure 1. Front Panel Indicators and Controls

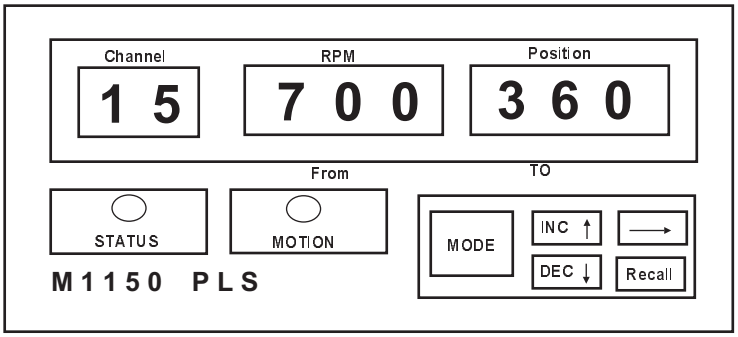


Table 1. Display Windows

Mode	Display Window		
	Channel	RPM	Position
Position/Tach (default)	*P1-P4	Current Shaft Speed	Current Shaft Position
Scale Factor	SF	blank	Current Scale Factor
Offset	OF	Current Offset	Current Shaft Position
Dwell Set Point	01–07 01–15	From (Start)	To (End)
Low Limit Motion	LO	Low Limit	blank
High Limit Motion	HI	High Limit	blank
* Note: Current operation program displayed for first			

Motion LED — Illuminates when the current shaft RPM is within the option high and motion low limits programmed by the operator. It exactly matches the status of the 8th (8 channel units) or the 16th (16 channel units) output designated as the "Motion Output" of the M1150 Mini•PLS. This indicator is active in all 6 modes.

2.2.3 Keyboard

MODE Key — Each key press steps the operator through each of the 6 programming modes:

- Program Number and Default Position/Tach Mode Change
- Scale Factor Programming Mode
- Offset Programming Mode
- Dwell Set Point Programming Mode
- Motion High Limit Programming Mode
- Motion Low Limit Programming Mode

When in any of the programming modes, pressing the MODE Key will terminate the mode currently being programmed, store any changes that have been made, and switch to the next mode.

INC Key (↑) — Used in all programming modes to increment the value of the setting or limit of the current programming mode.

DEC Key (↓) — Used to decrement the value of the setting or limit of the current programming mode.

Arrow Key (→) — While in the dwell set point limit programming mode, this key changes the current operating window. When in the dwell set point programming mode, all 3 display windows are programmable, but the INC and DEC Keys will correspond to only one window at a time. The (→) key selects which of the 3 display windows may be acted upon the INC and DEC Keys. This key is ignored during all other programming modes.

Recall Key — During dwell set point programming mode, this key will step the display through each of the dwell set points that have been programmed for this channel. This key is ignored for all other programming modes.

3. Specifications

Input Power:
105–135 VAC, 50/60 Hz 2 Watts
(optional 220 VAC)

Fuse:
2 AG 1/2 A

Operating Temperature:
–10 to +130 °F (–23 to +55 °C)

Position Transducer:
Autotech's Series RL100, E6R, RI101 or equivalent

System Resolution:
1024 counts per turn

Scale Factor:
360 or 1000 counts per turn

Offset:
Programmable "0" to Scale Factor

Resolver Cable:
2500 ft. shielded maximum

Maximum Resolver Shaft Speed:
3600 RPM

Resolver-to-Digital Tracking Speed:
1800 RPM

Output Scan Time — 8 Channel:
130 µs

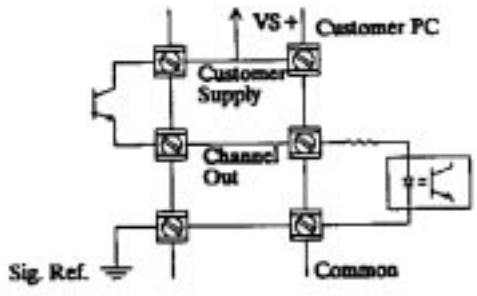
Output Scan Time — 16 Channel:
240 µs

3.1 Outputs

Optical Isolation:
Standard on all 8 or 16 outputs

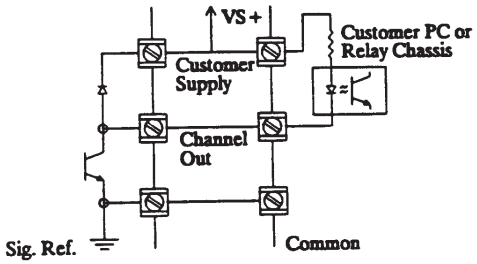
Number of Outputs:
7 or 15 outputs
1 motion limit output

"P" Type Outputs: Source Transistor



Positive True Logic:
Vmax = 28 V
Logic 1: (cust VCC-1.7 V) @ 100 mA
Logic 0: (high impedance) @ 0.2 mA leakage

"N" Type Outputs: Sink Transistor



Negative True Logic:
Vmax = 28 V
Logic 1: (high impedance) @ 0.2 mA leakage
Logic 0: 1.1 V @ 100 mA

Program Enable:
Enable = 0.8 V max @ 10 mA
Disable = open circuit
Optically Isolated

Output Enable:
Output Enable = 1.3 V max @ 11 mA or tie to cust. common
(2.2K internal pull-up resistor)
Output Disable = open circuit

4. Installation and Wiring

4.1 Position Transducer Mounting and Wiring

See the Installation and Operation Manual for the position transducer used in your particular application.

4.2 M1150 Mini•PLS Mounting

The M1150 Mini•PLS is housed in a 1/8 DIN panel mount case. It will fit inside a 6-inch deep enclosure, and requires a rectangular panel cutout only (mounting holes not required).

Slide the unit in through the panel opening with gasket, insert the two right-angle mounting brackets into the openings on either side of the M1150 housing and slide brackets 1/4-inch towards the back of the unit to secure the brackets to the housing. Tighten the pair of screws on the right-angle brackets to hold the unit to the panel. DO NOT OVERTIGHTEN (80 inch-oz torque max.)! Attach the pre-wired rear terminal blocks to the M1150 unit to complete the installation.

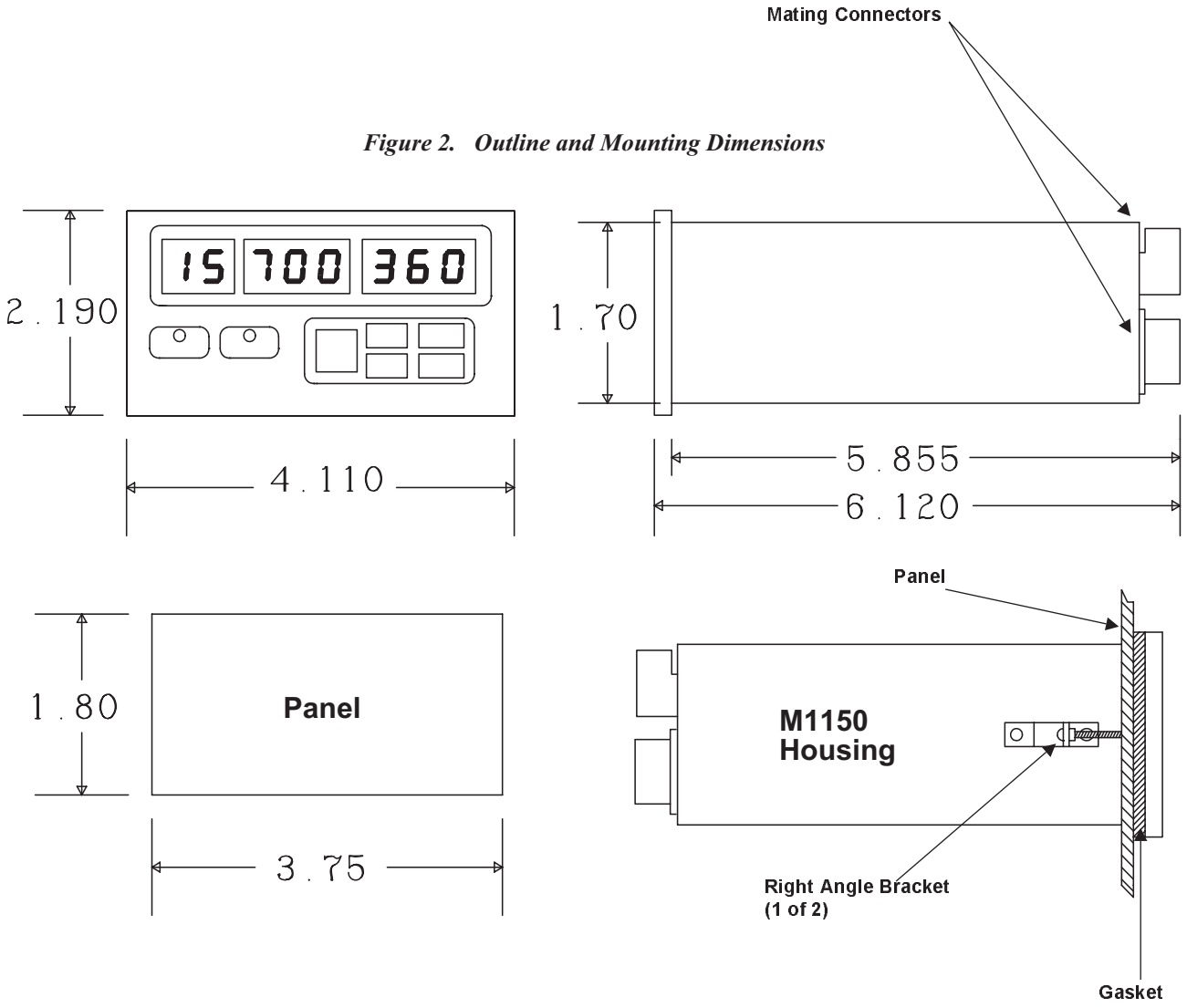
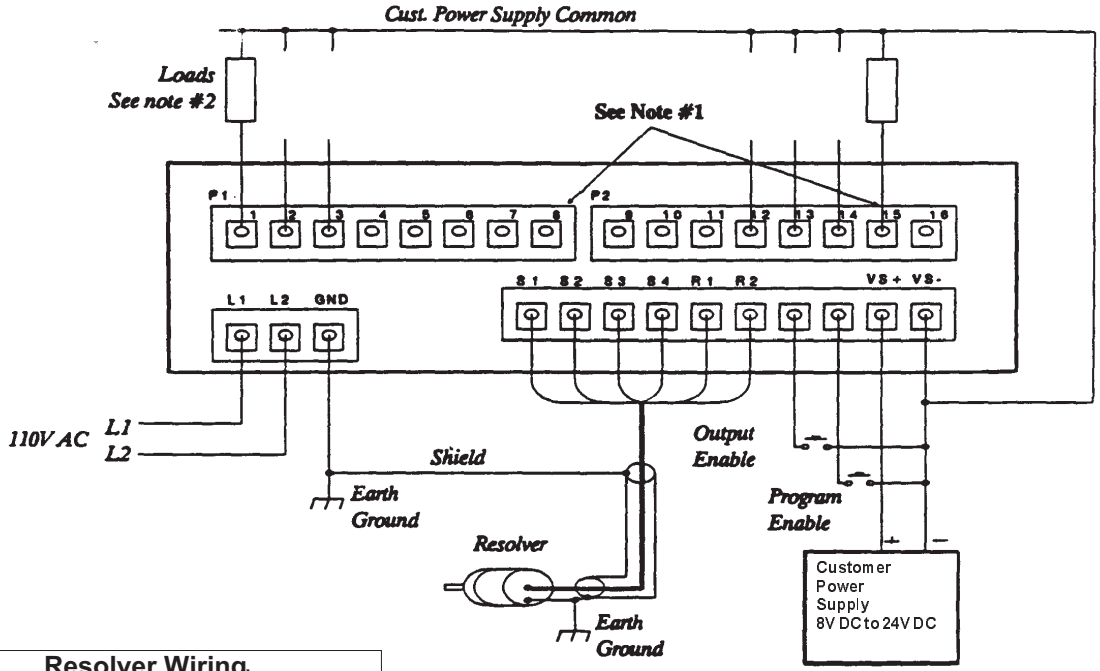


Figure 2. Outline and Mounting Dimensions

4.3 M1150 Mini•PLS Wiring

Figure 3. Typical "P" Outputs Wiring Diagram

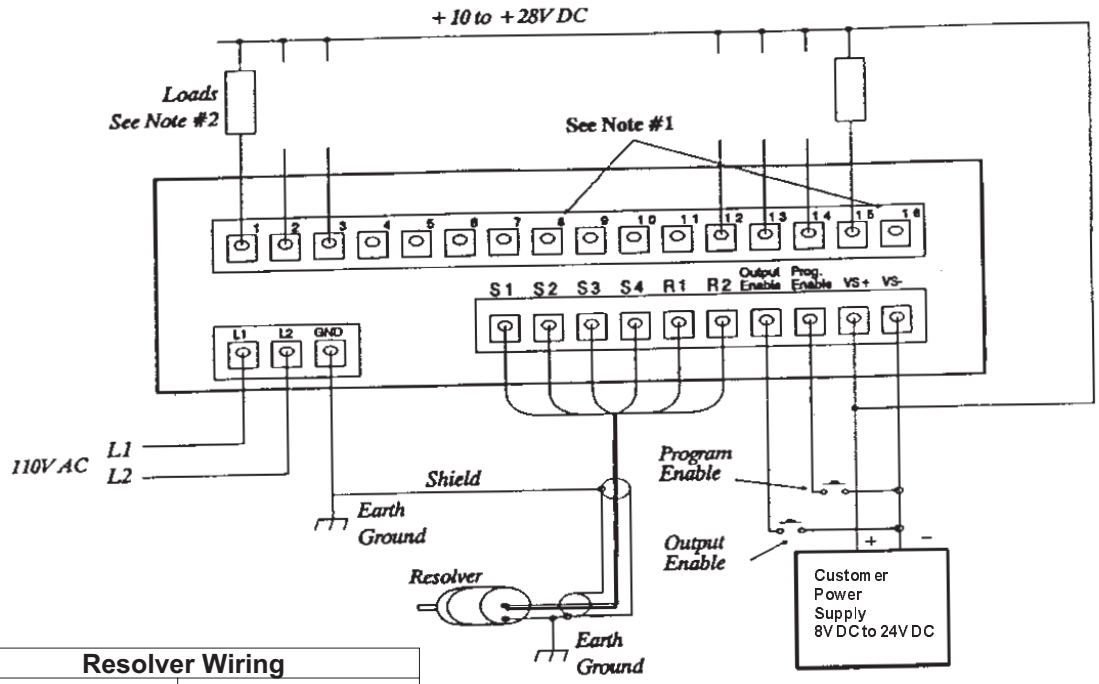


Resolver Wiring		
S4	Blue	Twisted Pair
S2	Black	
S3	Yellow	Twisted Pair
S1	Black	
R2	Green	Twisted Pair
R1	Black	

NOTES:

1. Output (Channel) #8 in eight output unit and output #16 in sixteen output unit are motion outputs.
2. Output wiring to other electronic devices (programmable controls) must use shielded cable, with shield connected to good earth ground at both ends.
3. No special tools are required for wiring input/output devices to the M1150 Mini•PLS.
4. Pre-wire terminal blocks before attaching them to M1150 Mini•PLS for easier installation.
5. Switch S1 and S3 wires to reverse the direction of ascending counts.

Figure 4. Typical "N" Outputs Wiring Diagram



Resolver Wiring		
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R2	Green	Twisted Pair
R1	Black	

NOTES:

1. Output (Channel) #8 in eight output unit and output #16 in sixteen output unit are motion outputs.
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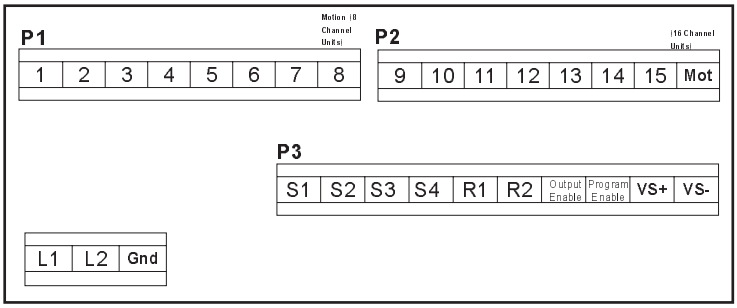
3. No special tools are required for wiring input/output devices to the M1150 Mini•PLS.
4. Pre-wire terminal blocks before attaching them to M1150 Mini•PLS for easier installation.
5. Switch S1 and S3 wires to reverse the direction of ascending counts.

4.4 Grounding and Shielding

Figure 5. Rear View Assembly Drawing



1) Follow shielding and grounding techniques as shown in the wiring diagrams.

2) When the M1150 Mini•PLS is mounted in an enclosure or a control panel, use separate conduit entrances for low voltage and 120V AC inductive wiring.

3) **CAUTION**: This equipment has an isolated Sig. Ref. (terminal R2). Resolver wiring must be isolated from earth ground. Failure to maintain this isolation may cause electrical noise interference resulting in unpredictable operation of this equipment. However, the customer power supply common (VS-) may be tied to earth ground due to the optical isolation internal to the M1150 Mini•PLS.

4) The resolver and the input/output devices' ground planes must be held to the same RF potential by metallic connections (e.g., building frame, conduit, wire trays). These ground places should be connected to a good earth ground.

5) It is recommended that the resolver shielded cable is run in its own separate conduit.

6) Every shielded cable run must be grounded to a good earth ground at both ends.

7) All shielded cable runs must be routed separate from 120/240/440V AC lines and other high current inductive wiring. All shielded cable must be continuous (no splices).

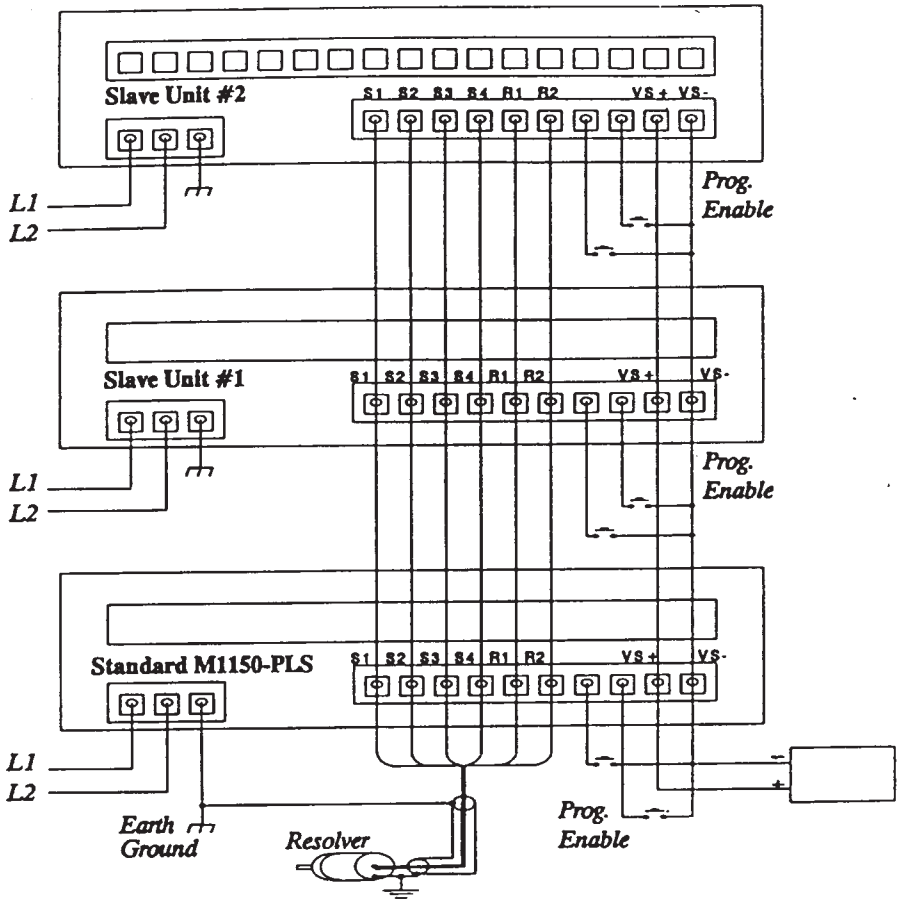
8) Unshielded portion of the shielded resolver cable must be kept to a minimum with at least 2 inches separation from any other wiring.

9) When using electromechanical relays driven directly from the M1150 outputs, inductive transients may pass transients onto the output lines resulting in periodic unpredictability in PLS operation. Proper grounding and shielding along with limiting transients below 1000V DC with transient suppressors (such as GE MOV V130L10) is recommended in such cases.

10) The resolver transducer connections to the M1150 must be made with twisted pair, overall foil shielded cable, such as Autotech's CBL-10T22-XXXX. Substitution of another cable may result in degraded performance.

4.5 Slave M1150 Mini•PLS Wiring

Figure 5. Slave M1150 Mini•PLS Wiring Diagram



Slave M1150 units are special factory supplied M1150 units. DO NOT attempt to slave together two standard M1150 units — improper operation will result.

5. Programming the M1150 Mini•PLS

IMPORTANT:

1. Programming may be enabled in one of two ways:
- **connection of programming enable terminal to VS–**
- **absence of customer power (VS+, VS–)**

2. All decimal points (illuminated on power-up) is an alert to check program. In the unlikely event that a power loss is experienced while in the process of programming, the program entered at power loss may be lost. The M1150 alerts the operator to this fact.

3. A flashing status indicator while programming indicates the M1150 is entering the item programmed. Changing Modes may be inhibited for this short period.

Because of the menu-driven style of key sequences, the M1150 does not have error modes. Illegal key sequences are simply ignored. Incrementing or decrementing past specific boundaries (as in motion limit programming being limited to 999 RPM) is automatically inhibited by the M1150.

Pressing the MODE Key will step the operator through one of 6 different programming modes:

- Scale Factor
- Offset
- Dwell Set Point and Channel Select/Review
- Motion High Limit Setting
- Motion Low Limit Setting
- Change current operating program and Default Position/Tach Display

The MODE Key will terminate any programming operation and switch to the next programming mode in the loop. *Note: there is no "get-back" or "erase" key for programming errors — all limit/program changes occur immediately as the operator keys them in or as limit values are INC'd or DEC'd.* ***Always use CAUTION when changing limit settings.***

When in any programming mode, if the keyboard is not pressed during a 1 to 2 minute time-out period, the M1150 will switch back to the default Position/Tach Display Mode. This is to prevent the unit from being accidentally left in any programming mode for any length of time. If the time-out occurs while programming, simply use the MODE Key to return to the mode you were previously in.

All values, limits, program numbers, and set points will retain their information indefinitely with, or without, power applied to the unit, in EEPROM memory. The only item changed on loss of power is the current channel number — it will default back to channel 1.

IMPORTANT:

If the M1150 unit is operating on program (or setup) number P3 and power is removed from the unit, when power returns to the unit, it will remain operating in program (or setup) number P3.

The subsequent paragraphs are arranged to follow the steps most often used when installing the M1150 Mini•PLS.

NOTE: *Position, Tack and Limit values in the following examples are simply typical values, and do not mean to show any specific default, or standard limits or values.*

5.1 Scale Factor Mode

Upon power-up, the unit will be in the default Position/Tach Display Mode. The channel number (and status LED) will be set for channel 1. The channel display will briefly identify the current operating program number (P1–P4) and then go blank. The RPM window will display the current shaft speed, and the position window will show the current shaft angle plus offset.

Channel	RPM	Position
--	110	035

Press the MODE Key to switch to Scale Factor Mode. The display will indicate:

SF		359

If programming is enabled, press the INC Key to change the Scale Factor to 999 (1000 counts/revolution). Press the DEC Key to change the Scale Factor back to 359 (360 counts/revolution).

5.2 Offset Mode

From the Scale Factor Mode, press the MODE Key to switch to Offset Mode. The offset is the value added to the current shaft angle to align the machine zero with the resolver zero (avoiding the old practice of mechanically zeroing the shaft encoder/cam switches). The display shows "OF" (offset) in the Channel window, the current offset value in the RPM

window, and the current shaft angle position in the Position window.

OF	000	035

If programming is enabled, pressing the INC or the DEC Keys will add or subtract from the current value. Holding the INC or DEC Keys down will repeat the increments at a rapid cycle. Note that as the offset value changes, the current position and corresponding outputs also change accordingly.

OF	011	046

5.3 Channel/Dwell Set Point Mode

Pressing MODE Key will step the operator into the Dwell Set Point Programming Mode. The current channel number is in the Channel display, the "From" set point value is in the RPM display, and the "To" set point value is shown in the Position display:

0.2.	136	180

Here, the first set point dwell for channel 2 will turn "ON" at 136°, and turn "OFF" at 180°. If another dwell set point exists for this channel, pressing the RECALL Key will display the next set point dwell:

0.2.	225	250

This dwell turns "ON" at 225° and turns "OFF" at 250°. Assume that there are only 2 set point dwells on channel 2. Pressing RECALL a third time will display a NULL set point:

0.2.	o	o

This pair is not an actual set point dwell, but is used to create more set point dwells, as described later. Pressing the RECALL a fourth time will again display the first set point dwell:

0.2.	136	180

At this point, some clarification is needed about the decimal points that are illuminated in the channel window. Consider these as a cursor, or pointer, to indicate the window the INC and DEC Keys will act upon when pressed. When in the channel window, the decimal points indicate that pressing the INC Key will switch us to channel 3:

0.3.	76	260

Notice that the M1150 has automatically recalled the first set point dwell for channel 3 as it is selected. Pressing the DEC Key will bring the display back to channel 2:

0.2.	136	180

***NOTE**: The following key sequences for Section 5.3 will be ignored by the M1150 if programming is not enabled.*

Now press the → Key. This will move the cursor (pointer) to the "From" window:

02	1.3.6.	180

If the INC Key is activated, the "From" part of this dwell will be incremented:

02	1.3.7.	180

Press the → Key again. The cursor (pointer) is now in the "To" window:

02	137	1.8.0.

In the INC or DEC Keys are pressed, the "To" value of this set point dwell will be incremented or decremented accordingly:

02	137	1.8.2.

Repeated pressing of the → Key will continue to cycle the cursor through all three windows.

5.3.1 Removing a Set Point Dwell

Using the → Key, the INC or DEC Key, and the RECALL Key, display the set point dwell that is to be deleted or erased. For example, to remove the channel 2 pair 137–182:

0.2.	137	182

Press the → Key to activate the "From" window. Press and hold the INC Key until the "From" value is the same as the "To" value:

0.2.	1.8.2.	182

This set point dwell is now deleted. Pressing the RECALL Key will prove that this set point dwell has been deleted.

5.3.2 Adding a New Set Point Dwell

Using the → and the INC and DEC Keys, select the channel number that is to receive the new set point dwell (i.e., channel 7):

0.7.	244	247

Use the → Key to activate the "From" window:

07	2.4.4.	247

Press the RECALL Key until the display shows the NULL set point pair:

07	..o.	o

Press the INC or DEC Key to set the "From" window to the desired set point beginning "From" value. Notice that the "To" window will always equal the "From" window. Assuming this set point should start at 150°:

07	1.5.0.	150

So far, this set point turns ON at 150° and turns OFF at 150°, meaning that it doesn't turn ON at all, and that we have not yet created a set point dwell. If the MODE Key is pressed, these two values will be lost. Press the → Key to activate to "To" window:

07	150	1.5.0.

Use the INC Key to begin increasing the dwell of this set point. Assume that this dwell was to turn OFF at 350°:

07	150	3.5.0.

Now we have created another set point that turns ON at 150° and switches OFF at 350°. If the MODE Key is pressed, the set point will still exist as it has now been stored in EEPROM memory.

5.3.3 Merging Two Existing Set Point Dwells

Assume that the M1150 is set on channel 2 and there are two set point dwells: 137 - 182 and 244 - 247. Use the →, INC, or DEC, and RECALL Keys to recall the first set point dwell and set the cursor on the "To" window:

02	137	1.8.2.

Press and hold the INC Key to expand the dwell of the first set point. If you stop just short of overlapping the second set point, the display will show:

02	137	2.4.3.

Now, pressing the INC Key once will change the display to:

02	137	2.4.4.

The set points are now merged. Pressing the RECALL Key will now show only 1 set point dwell (137 - 247).

5.3.4 Separating One Set Point Dwell into Two Separate Dwells

The only way to separate one large dwell into two smaller dwells is to shrink the "To" value of the large dwell to form one of the smaller set point dwells, then add a second dwell set point later.

Assume that we wish to separate the large set point dwell of 137 - 247 into two separate dwell of 137 - 150 and 200 - 247. Use the →, INC and DEC, and RECALL Keys to display the large dwell:

02	137	2.4.7.

Press the DEC Key to reduce the value of the "To" set point value:

02	137	1.5.0.

Use the → Key to activate the "From" window and press RECALL to bring up the NULL set point pair:

02	..o.	o

Press and hold the INC Key to move the "From" value up to the "From" value of the second dwell set point:

02	2.0.0.	200

Move the cursor (pointer) to the "To" window using the → Key and INC the "To" value to the required "To" value of this second set point dwell:

01	200	2.4.7.

Pressing the RECALL Key will show that there are now two set point dwells 137 - 150 and 200 - 247.

5.3.5 Turning a Channel Fully ON

A specific channel may not be turned fully ON, but one degree will always be OFF.

Add a set point dwell as in section 5.3.3. Continue to INC the "To" set point value until it is one degree (1°) less that the "From" set point value:

02	225	2.2.4.

This set point turns ON at 225° and remains ON for 359° until 224° is reached. If the INC Key is pressed again, both the "From" and the "To" windows will increment, preventing the channel from ever being ON for a full 360° (or 1000 counts if scale factor = 999). If a full 360° is needed, two output channels with overlapping set point dwells may be wired together to keep the output fully ON.

5.4 Motion High Limit Setting Mode

From any of the programming steps in section 5.3, pressing the MODE Key will step the M1150 unit into the Tach Motion High Limit Setting Mode. "Hi" will appear in the Channel window, and the current tachometer High Limit will be displayed in the RPM window.

Hi	900	

The position display is blank. Pressing INC or DEC Keys will change this setting if programming is enabled. The M1150 will not INC up past 999 RPM, nor will it DEC lower than the Motion Low Limit Setting. The motion output and corresponding LED will turn OFF if the shaft RPM exceeds this limit.

5.5 Motion Low Limit Setting Mode

Pressing the MODE Key will step the M1150 unit into the Motion Low Limit Setting Mode. Use the INC or DEC Keys to adjust this lower motion limit. The M1150 will not allow a lower limit of less than zero, nor will it allow the limit to be INC'd higher that the current motion high limit setting. The motion output and corresponding g motion LED will be ON if the current shaft RPM is greater than this limit setting, otherwise the output and LED will be OFF.

5.6 Program Number Change and Default Position/RPM Display

Pressing the MODE switch will set the unit temporarily into a mode that will allow the operator to change the current operating program or setup (1–4). The Channel display will indicate the current program number and the Position and RPM displays will show position and RPM respectively. **Once in this mode, the operator has only 15 seconds to use the INC or DEC Key to switch to the next operational setup.** This changes all parameters, all scale factors, offsets, dwell set points, and motion limits, to those values programmed in by the operator for this program number. In this manner, 4 completely different setups may be stored in the M1150 and selected by the press of a button. Changing programs is not allowed if: 1) programming is not enabled, or 2) if the machine is in motion (>3 RPM). The INC or DEC Key step through each of the 4 setups stored in the unit (P1–P4).

IMPORTANT:

Disable all outputs before switching program numbers to avoid activating outputs accidentally.

After the 15 second time-out, the program number in the channel display will blank out and changing of the program number will be inhibited. To reactivate program selection, simply cycle the MODE switch 6 times to reactivate program number change mode.

In the default Position/RPM Display Mode, all keys except for the MODE Key are disabled.

5.7 Power Loss During Programming

Under unusual circumstances, if power is removed from the M1150 unit before the EEPROM has completed programming, parts of the final programming steps may be lost. When power returns, the M1150 does a memory test and will illuminate all decimal points if loss of power caused a program error. The operator must recheck the most recent values programmed into the unit, in order to correct the problem.

6 Special Features

The M1150 Mini•PLS Controllers with Serial Numbers 1330 and up (8 Channel units) and 755 and up (16 Channel units), have the following special features added:

6.1 Speed Compensation

Individual Speed Compensation — if this feature is not desireable for your application, program the speed compensation values to zero.

Relays and solenoids, because of their mechanical nature, have inherent fixed delays when activating. This may vary from 10 ms. to as much as 30 ms. A relay with a 10 ms. turn-on delay will cause as much as a 55° shift in operation at 600 RPM. Each channel may be programmed with individual speed-dependent advances to compensate for fixed delays attributed to relays and solenoids. Speed compensation is fully adjustable from 0 to 35.9°advance per 10 RPM.

6.1 Scale Factor

Scale Factor incrementation of 17–999 has been added.

6.2 Self-Diagnostics

Self-Diagnostics Detection — when a broken wire or internal fault is detected, an error message, “CABLE,” will be displayed.

7 Troubleshooting

M1150 Mini•PLS Troubleshooting Guide	
Symptom	***Check***
Unable to program unit parameters (Scale Factor, Offset, etc.)	Program Enable (Term. 8) is tied to Vs– (Term. 10) Customer DC power is correctly wired: +10 to +28V DC (VS+) on Term. 9, Common (Vs–) on Term. 10 Machine must be at rest — several parameters (Scale Factor, Offset) are locked out if the resolver is turning faster than 3 RPM Customer VS+ is below +10 V
Program memory is changing by itself	Program enable input is not enabled. While this will not cause the program to change by itself, removing the Program Enable jumper when not actually programming the unit ensures that the memory cannot be programmed. Sig. Ref. (R1) and Earth Ground must not be tied together: 1) turn power off to the M1150, 2) using an ohm meter, measure from Term 5 (lower terminal block) to Earth Ground, 3) reading should be higher than 500k ohms. Inductive loads on outputs must have external voltage suppression. The unit program number has not been changed to a different number (P1–P4). Check to ensure that proper grounding and shielding has been applied.

M1150 Mini•PLS Troubleshooting Guide	
Symptom	***Check***
Position and Tach readings are incorrect	Resolver is correctly wired: 1) Turn power off to M1150 unit. 2) With main terminal block removed from unit, measure with an ohm meter the following: Term. 5 to Term 6 (R1 to R2) = about 30 ohms Term. 1 to Term. 3 (S1 to S3) = about 55 ohms Term. 2 to Term 4 (S2 to S4) = about 55 ohms Resolver cable is properly grounded and shielded.
Mechanical Zero drifts	Mechanical resolver linkage is not loose. Offset value has not been changed.

WARRANTY

Autotech Controls warrant their products to be free from defects in materials or workmanship for a period of one year from the date of shipment, provided the products have been installed and used under proper conditions. The defective products must be returned to the factory freight prepaid and must be accompanied by a Return Material Authorization (RMA) number. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Autotech Controls harmless from, defend, and indemnify Autotech Controls against damages, claims, and expenses arising out of subsequent sales of Autotech Controls' products or products containing components manufactured by Autotech Controls and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or subcontractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (p.l. 93-637), as now in effect or as amended hereafter.

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CAUTION

Autotech Controls' products are carefully engineered and rigorously tested to provide many years of reliable operation. However any solid-state device may fail or malfunction sometime. The user must ensure that his system design has built-in redundancies if Autotech Controls' product is being used in applications where a failure or malfunction of the unit may directly threaten life or cause human injury. The system should be so designed that a single failure or malfunction does not create an unsafe condition. Regularly scheduled inspections, at least once a week, should be made to verify that the redundant circuits are fully functional. All faults should be immediately corrected by repair or replacement of the faulty unit. In addition, the user may have to comply with OSHA, ANSI, state or local standards of safety. The user of Autotech Controls' products assumes all risks of such use and indemnifies Autotech Controls against any damages.

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Autotech Controls does not recommend the use of its products in applications wherein a failure or malfunction of the unit may directly threaten life or cause human injury. The user of Autotech Controls' products assumes all risks of such use and indemnifies Autotech Controls against all damages.