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MicroLogix™ HM1530E Resolver Input Module

Revision Date: 11-14-08

Force Measurement and Control Solutions

NOTES ON HM-1530E PRODUCT REVISION

MARCH 31, 2008 REVISION (MCR105E FIRMWARE)

Helm Model HM1530 has been obsoleted and replaced with HM1530E.

The HM1530E is a direct replacement for the HM1530 with the same functionality.

The DIP switch locations and nomenclature have been changed. Please refer to illustration on Page 10.

The HM1530E features enhanced Fault Detection which will require additional ladder logic to implement. Please reference Chapter 3 - RESOLVER MODULE FAULT DETECTION for detailed information on the application of the enhanced Fault Detection.

AUG. 18, 2008 REVISION (MCR106E FIRMWARE, HM1530E.RSS LADDER LOGIC FILE)

The latest 8-18-08 revision involves modules with MCR106E Firmware, and with associated HM1530E.RSS Ladder Logic File.

The revision incorporates both Firmware and Hardware changes.

Functionally, the revision includes enhancements to the Resolver Module Fault Detection, outlined below on page 15 and page 16.

NOV. 14, 2008 REVISION (MCR107E FIRMWARE, HM1530E.RSS LADDER LOGIC FILE)

The latest 11-14-08 revision involves modules with MCR107E Firmware, and with associated HM1530E.RSS Ladder Logic File.

The revision incorporates both Firmware and Hardware changes.

Functionally, the revision includes enhancements to the Resolver Module Fault Detection, outlined below on pages 14-16.

IMPORTANT USER INFORMATION

Solid state equipment has operational characteristics differing from those of electromechanical equipment. “Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls” (Allen-Bradley Publication SGI-1.1) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will the Helm Instrument Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, the Helm Instrument Company cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Helm Instrument Company with respect to use of information, circuits, equipment, or software described in this manual.

Throughout this manual we use notes to make you aware of safety considerations.

ATTENTION: Identifies information about practices or circumstances that can lead to property damage, identifies information that is especially important for successful application and understanding of the product.

Attentions help you:

- Identify a hazard
- Avoid the hazard
- Recognize the consequences

PREFACE

Read this preface to become familiar with the rest of this manual. This preface covers the following topics:

- Who should use this manual
- The purpose of this manual
- Terms and abbreviations
- Conventions used in this manual
- Helm Instrument support

WHO SHOULD USE

Use this manual if you are responsible for the design, installation, programming, or maintenance of an automation control system that uses Allen-Bradley small logic controllers.

You should understand electronic process control and be able to interpret the ladder logic instructions required to generate the electronic signals that control your application. If you do not, contact your local Helm representative for the proper training before using this product.

PURPOSE OF THIS MANUAL

This manual is a learning and reference guide for the Helm Compact I/O Resolver Module. It contains the information you need to install, wire, and use the module.

RELATED DOCUMENTATION

The following documents contain information that may be helpful to you as you use Allen-Bradley products. To obtain a copy of any of the Allen-Bradley documents listed, contact your local Allen-Bradley office or distributor.

For	Read this Document	Document Number
A more detailed description of how to install and use your Compact I/O with MicroLogix 1500 programmable controllers.	MicroLogix 1500 Programmable Controllers User Manual	1764-UM001A-US
A more detailed description of how to install and use your Compact I/O with CompactLogix controllers.	CompactLogix Programmable Controllers	1768-IN0048-EN-P
More information on proper wiring and grounding techniques.	Industrial Automation Wiring and Grounding Guidelines	1770-4.1
A complete listing of current Automation Group documentation, including ordering instructions. Also indicates whether the documents are available on CD-ROM or in multi-languages	Automation Group Publication Index	SD499
A glossary of industrial automation terms and abbreviations	Allen-Bradley Industrial Automation Glossary	ICCG-7.1
An article on wire sizes and types for grounding electrical equipment	National Electrical Code	Published by the National Fire Protection Association of Boston, MA.

TERMS AND ABBREVIATIONS

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here refer to *Allen-Bradley's Industrial Automation Glossary, Publication ICCG-7.1.*

Calibration - Procedure, performed by trained personnel, to set the RMS (mean square root) voltages of the resolver.

Chassis - A hardware assembly that houses devices such as I/O modules, adapter modules, processor modules, and power supplies.

Configuration Word - Contains the configuration information needed by the module to configure and operate. Information is written to the configuration word through the logic supplied in your ladder program.

Data Word - A 16-bit integer that represents the value of the analog input channel. The channel data word is valid only when the channel is enabled.

LSB - (Least Significant Bit) Refers to a data increment defined as the full scale range divided by the resolution. This bit represents the smallest value within a string of bits.

Master/Slave Operation - Selectable mode of module operation. Default is Master when module is wired to a Helm Model HR1101 resolver. Mode is Slave when module receives input by tapping off of an existing resolver.

Monitor Mode - Normal run state.

Multiplexer - A switching system that allows several input signals to share a common A/D converter.

Offset - A value represented in degrees to restore resolver to zero at the top of the stroke. Required when resolver has not been mechanically set to zero.

Resolution - The smallest detectable change in a measurement, typically expressed in engineering units (e.g. 0.15C) or as a number of bits. For example a 12-bit system has 4,096 possible output states. It can therefore measure 1 part in 4096.

Resolver - Sometimes called encoder. Device attached on a machine to determine machine stroke position. Sine/cosine based resolver required for Helm Resolver Input Module.

TERMS AND ABBREVIATIONS (CONTINUED)

Sampling time - The time required by the A/D converter to sample an input channel.

Scale - Value used to describe the press/machine overall tonnage. Set for maximum value of one channel. For example, settings for a 150 ton press = 75.

Setup Mode - Status condition of module. Normally enabled to perform calibration and setup procedures.

Status Word - Contains status information about the channel's current configuration and operational state. You can use this information in your ladder program to determine whether the channel data word is valid.

Strokes per Minute (SPM) - Value calculated when a machine cycles through a complete rotation (0 to 360 degrees).
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Update Time - The time required for the module to sample and convert the input signals of all enabled input channels and make the resulting data values available to the PLC controller.

TECHNIQUES USED IN THIS MANUAL

The following conventions are used throughout this manual:

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.

PRODUCT SUPPORT

Contact your Helm representative or call Helm direct at 419/893-4356:

- sales and order support
- product technical training
- warranty support
- support service agreements

Your Questions or Comments on this Manual

If you have any suggestions for how this manual could be made more useful to you, please send us your ideas.

OVERVIEW

You have just purchased the most advanced high speed resolver input module available. HELM INSTRUMENT COMPANY, INC. manufactures a complete line of monitoring control solutions for use on metal stamping, forging, compaction and assembly presses; cold forming, cold heating, injection molding and die cast machines. Resolvers, standard or custom transducers and load cells are available for in-die monitoring of transfer or progressive tooling.

At HELM, quality is inherent not only in the design of our products but in the attitudes of our employees as well. We're working together to give you the best. After all, that's what our business is all about - providing innovative instrumentation to help make your manufacturing process more productive and your operation more effective.

The HM1530E Resolver Module - is an intelligent module designed for applications requiring high-speed input to output response. This module accepts sine/cosine resolver input at speeds up to 1200 strokes per minute.

The HM1530E Module is configured through the PLC controller where it performs its algorithm independent of the controller scan time.

The Helm Resolver module is compatible with 1769 Compact I/O. The system is comprised of several parts; the input module, a sine/cosine based resolver (*such as the Helm Model HR-1101-F resolver*) and the Helm 6117 resolver cable.

The HR-1101-F sine/cosine Resolver is housed in a rugged enclosure designed especially for industrial applications. The resolver is a very accurate absolute position shaft encoder known for its extreme durability. Helm resolvers are passive devices which consist of brushless rotary transformers with one rotor and two stator windings. These windings are positioned at 90 degrees apart from one another thus providing a sine and cosine analog output signal corresponding to the shaft position.

HARDWARE OVERVIEW

The HM1530E resolver module is a Class 1 module (uses eight input words and eight output words).

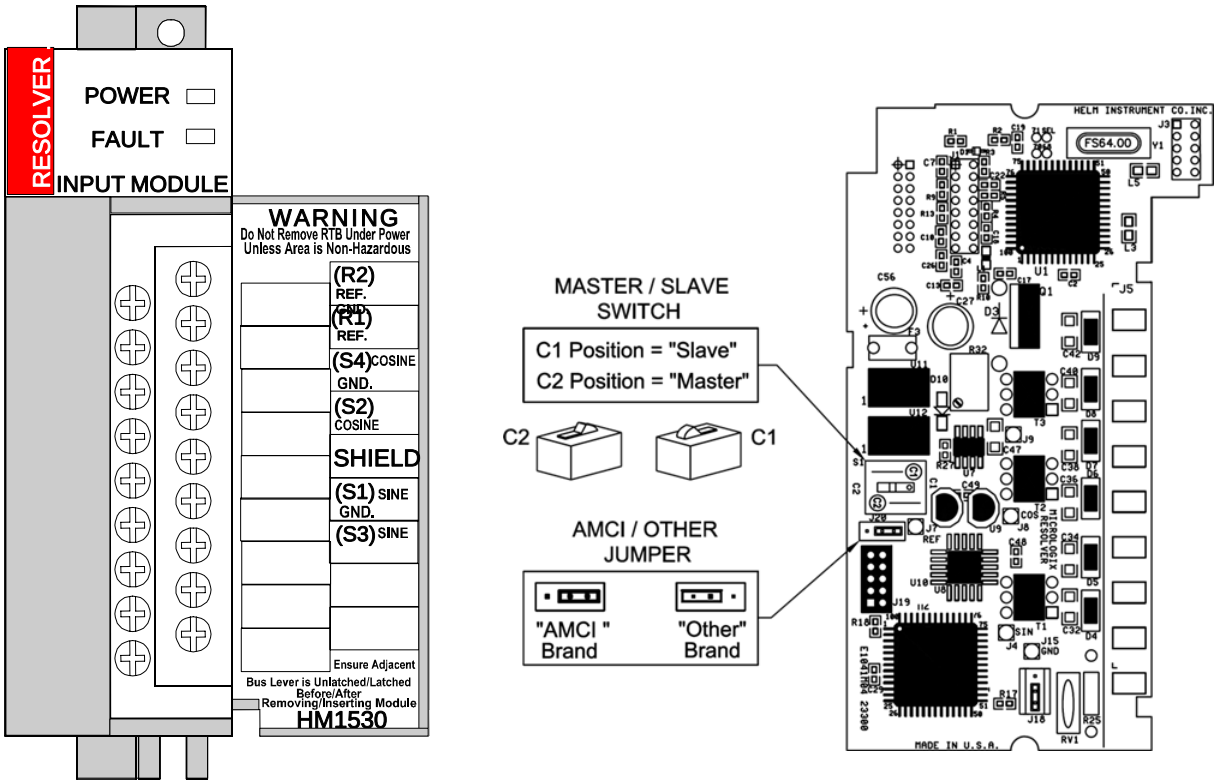
The Helm resolver module can accept input from one resolver.

Module configuration requires manual and user programmable setup. The resolver module receives and stores digitally converted analog data into its image table for retrieval by the PLC controller.

HM-1530E SPECIFICATIONS

SPECIFICATION	VALUE
Dimensions	118 mm (height) x 87 mm (depth) x 35 mm (width) height including mounting tabs is 138 mm 4.65 in. (height) x 3.43 in (depth) x 1.38 in (width) height including mounting tabs is 5.43 in.
Approximate Shipping Weight (with carton)	300g (.065 lbs.)
Storage Temperature	-40ºC to +85ºC (-40ºF to 185ºF)
Operating Temperature	0ºC to +60ºC (32ºF to 140ºF
Operating Humidity	5% to 95% non-condensing
Operating Altitude	2000 feet, 610 meters
Hazardous Environment Class	Class 1, Division 2, Hazardous Location, Groups A, B, C, D (UL 1604, C-UL under CSA C22.2 No. 213)
Vibration	Operating: 15Hz to 200Hz, 30G, 2.00 in. Peak-to-peak.
Radiated and Conducted Emissions	EN50081-2 Class A
Electrical /EMC:	The module has passed testing at the following levels with HM-FR1500 Filter Card:
Electrical Isolation	500 VDC continuous between inputs and chassis ground, and between inputs and backplane
ESD Immunity (IEC1000-4-2)	4 kV Contact, 8 \kV Air, 4 kV indirect
Analog Operating Range	Vref = 7Vrms, 5000 hz nominal
Analog Input	Sine/cosine resolver
Bus Current Draw (max.)	186ma at 5V 48ma at 24V
Heat Dissipation	2.082 Total Watts
Response Speed	200µ (Total response time dependent on PLC scan rate, depends upon program or application. Maximum RPS/SPM operation limited by (200µ) update time, 200µ or 3000 RPM/SPM. 1% error at 800 SPM)
Resolution	12 Bits, .1 degree 3599 counts full scale
Converter Type	Resolver to Digital
Input Impedance	600
Overall Accuracy	.2 degree or 2/3599 = .05%

HM-1530E CONFIGURATION AND DIP SWITCH/JUMPER SETTINGS



HM-1530E DIP SWITCH SETTINGS

Transmit LED	Indicates a resolver cable fault
Door Label	Resolver wiring diagram
18-Pin Connector	For resolver input wiring
Master/Slave Dip Switch S1	Switch for Master/Slave operation
AMCI/Other Resolver Type Jumper	Jumper to select AMCI/other type of resolver

Note: The AMCI position should be used for the Helm Model HR-1101-F (AMCI-HT20) resolver. Use the OTHER position setting for resolver types including Ametek-Gemco.

GETTING STARTED

This chapter can help you to get started using the Helm Resolver input module. The procedures included here assume that you have a basic understanding of Compact I/O products. You should understand electronic process control and be able to interpret the ladder logic instructions required to generate the electronic signals that control your application.

Because it is a start-up guide, this chapter does not contain detailed explanations about the procedures listed. It does, however, reference other chapters in this book where you can get more information about applying the procedures described in each step. It also references other documentation that may be helpful if you are unfamiliar with programming techniques or system installation requirements. If you have any questions or are unfamiliar with the terms used or concepts presented in the procedural steps, always read the referenced chapters and other recommended documentation before trying to apply the information.

This chapter will:

- tell you what equipment you need
- explain how to install and wire the module
- show you how to set look windows for resolver input

REQUIRED TOOLS AND EQUIPMENT

Have the following tools and equipment ready:

- small blade screwdriver
- appropriate resolver cable
- programming equipment (All programming examples shown in this manual demonstrate the use of Rockwell Software's Logic's 500 version 4.10 on a PC.)

SYSTEM OPERATION

The resolver module communicates to the PLC through the serial backplane interface and receives +5Vdc and +24Vdc power from the PLC power supply through the backplane. No external power supply is required. You may install as many Resolver modules in your system as the power supply can support. Any modules, other than the primary module set to MASTER, must be set to SLAVE mode.

NOTE: If resolver output is in opposite direction of desired operation switch SINE & SINE GND. signal wires on the resolver module screw terminal.

RESOLVER WIRING

The module contains an 18-pin screw terminal connector for wiring the resolver. The wiring code at the module is shown in Helm Drawing T-3233-51C, in Appendix C.

Wiring details for the HR-1101-F (AMCI HT-20) and resolver cable are shown in Helm drawing T-3233-52 in Appendix C.

Note: Slave modules must be wired in parallel with a Master module.

DATA AND STATUS

This chapter explains how the Resolver Input module and the PLC communicate through the module's input and output image. It lists the preliminary setup and operation required before the module can function in a 1764 I/O system.

INTEGER FILES USED FOR COMPACT I/O RESOLVER MODULE

		Last Address
1)	Timers	T4:3
2)	Common integer	N12:14

Common integer file for Compact I/O Resolver Module

N12:2/7	Press in Motion Trigger Bit
N12:4/2	Resolver Fault MAP IN Bit
N12:4/5	Press in Motion MAP IN Bit
N12:4/6	Compact I/O Resolver Module Mode (0=Setup,1=Run)
N12:4/7	Zero Resolver MAP IN Bit
N12:6	Resolver Angle (xxx.x)
N12:7	SPM Value

COMPACT I/O RESOLVER MODULE I\O IMAGE

Inputs

I:x.0/0	Resolver Fault Bit
I:x.0/1	Setup Mode Bit
I:x.0/2	Run Mode Bit
I:x.1	Resolver Degree Value (xxx.x)
I:x.2	Reference Signal Counter
I:x.3	SPM
I:x.4	Motion Counter

Outputs

O:x.0/0	Put into Setup Mode
O:x.0/1	Put into Run Mode
O:x.0/2	Download Offset Bit
O:x.1	Resolver Offset
O:x.4	Motion Counter Preset

START UP

The following files are located on the distribution disk.

RESOLVER.RSS MicroLogix 1500 Ladder Logic

Before attempting to load software, reserve the following files.

	Last Address
Timers	T4:3
Common integer	N12:14

Using RSLogix software, install the required RSS software in the SLC processor.

RESOLVER MODULE FAULT DETECTION

Note: Refer to correct Revision Version below.

3-18-08 REVISION VERSION (MCR105E FIRMWARE)

Open Wire Fault Detection

Module faults (Fault LED on and Fault bit set) from an open resolver wire condition consisting of the Sine or Sine GND wire open, and when motion occurs.

Additional Pulse Counter Fault Detection

Module counts pulses based on a fixed internal time segment through a pulse counter.

For slower motion, fewer pulses are counted resulting in a lower pulse counter value.

For faster motion, more pulses are counted resulting in a higher pulse counter value.

The module pulse counter value is shown in the ladder logic as Word 2 of the input image.

The pulse counter value is compared to a preset value, shown as Source B N12:2 in the ladder logic. This sets the Additional Fault Detection bit designated as N12:5.

Based on performance tests, an open wire condition (Sine, Sine GND, Cosine, Cosine GND) when motion starts creates an excessively high pulse counter value. This is especially useful at slower speeds. For example, at 60 SPM with no open wires, the counter value is approximately 100. With an open wire condition, the counter jumps to 2000, triggering a fault.

8-18-08 REVISION VERSION (MCR106E FIRMWARE, HM1530E.RSS LADDER LOGIC)

Open Wire Fault Detection

Module faults (Fault LED on and Fault bit set) from an open wire condition consisting of the Sine or Cosine wire open.

Fault detection is based on a pulse counter function, which counts pulses related to resolver angular velocity within a fixed internal time segment. The detection method looks at the rate of change of resolver angular velocity; an excessive or abnormal rate of change results from an open wire, which makes the module fault.

The rate of change pulse counter Preset value is Word Input 4 in the ladder logic. The entered Preset Value is compared to the actual reported pulse counter value.

Fault detection is an optional feature, and can be enabled or disabled as desired. To enable the feature, enter a Preset Value (Word Input 4) that is slightly higher than the actual reported value. To disable the feature, enter a Preset Value of “9999”.

Additional Optional Motion Counter

In addition to the pulse counter open wire fault detection, module includes an optional motion counter. For reference, see the ladder logic on page 20 below.

The Motion Counter Value is Word Input 2 in the ladder logic. It is based on the resolver reference operating frequency and on the resolver speed (RPM). Slower RPM gives fewer counts, and faster RPM gives more counts.

The motion counter feature can be enabled or disabled as desired. To disable the feature, enter a Motion Counter Value (Word Input 2) of "9999".

11-14-08 REVISION VERSION (MCR107E FIRMWARE, HM1530E.RSS LADDER LOGIC)

Open Wire Fault Detection

The "Open Wire Fault Detection" features and operation are the same as for the previous 8-18-08 Revision Version, except for the Motion Counter operation. The Motion Counter operation and Motion Counter value (Word Input 4), which are used to detect an open Sine (S1, S2) or Cosine (C1, C2) wire condition, have been changed to include the following:

"No Fault" Condition

- Under a "No Fault" condition, with all Sine (S1, S2) and Cosine (C1, C2) wires intact, the Motion Counter value (Word Input 4) is "0"

"Fault" Condition

- Under a "Fault" condition, with any Sine (S1, S2) or Cosine (C1, C2) wire open, the red fault L.E.D. turns on, and the Motion Counter value (Word Input 4) changes from "0" to the actual value that caused the fault (example value 10)
- The Motion Counter fault value (example value 10) stays in memory at Word Input 4 until power is off and on to reset the value
- Since the fault L.E.D. is non-latching, if power is not cycled for reset and the fault is not corrected, Word Input 4 will continue to update to the current Motion Counter fault value (for example, value of 10, 9, 11, etc.)

New Open Reference Wire Fault Detection

A "New Open Reference Wire Fault Detection" feature has been added. This replaces the "Additional Optional Motion Counter" feature, which was previously included in the last 8-18-08 Revision Version. With the deletion of the Additional Optional Motion Counter, Rungs 0004 and 0005 of the ladder logic are still included, but are no longer needed. Reference page 19 in the manual under "LADDER".

The New Open Reference Wire Fault Detection feature uses additional hardware and firmware items. From a hardware standpoint, an additional voltage comparator circuit has been added to both the Sine and Cosine resolver signals to the R/D (Resolver to Digital) chip. Those comparator circuits generate timed pulses, that relate to the normal and proper Sine and Cosine signals. The firmware upgrade includes the counting and monitoring of those pulses, by a Reference Signal Counter. As long as the two resolver Reference Signal Supply wires (R1, R2) are intact, the Sine (S1, S2) are Cosine (C1, C2) connections have proper signals, and the voltage comparators generate normal pulses. This occurs when the resolver is in motion and not in motion. For reference, under normal operation, the new Input Word I:x.2 Reference Signal Counter (see page 14 under Inputs) value in the Image Table is typically 42-44.

For fault detection, if either or both of the resolver Reference Signal Supply wires (R1, R2) become open, the Sine (S1, S2) and Cosine (C1, C2) connections lose their proper signals. The voltage comparators then stop generating pulses. That abnormal "No Pulse" condition is detected by the Reference Signal Counter, as the I:x.2 Input value goes from the typical 42-44 to 0. A fault is instantly generated.

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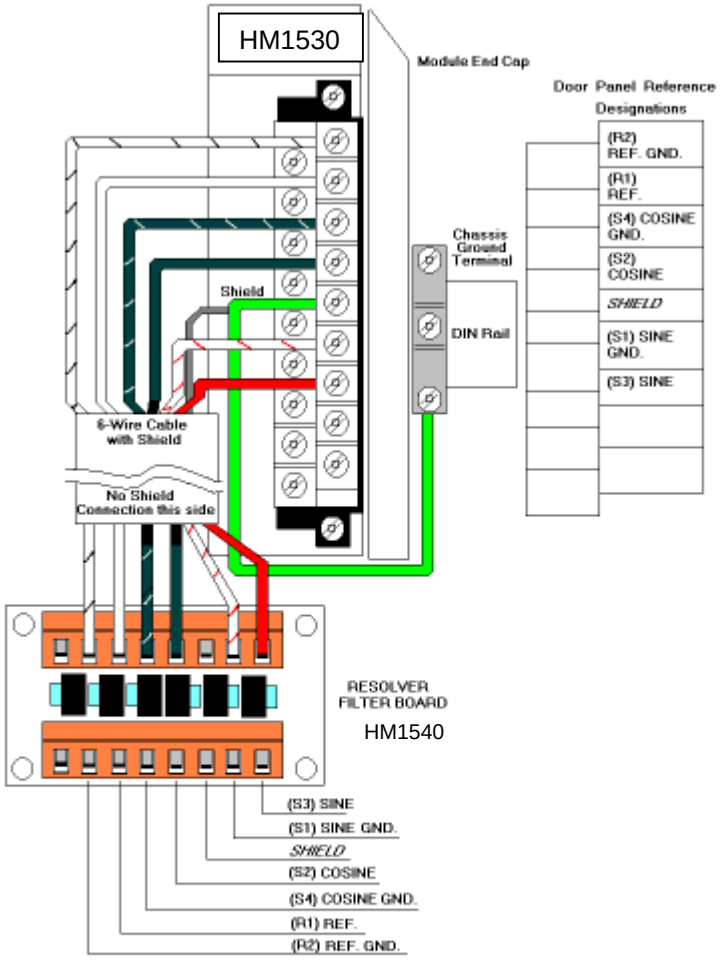
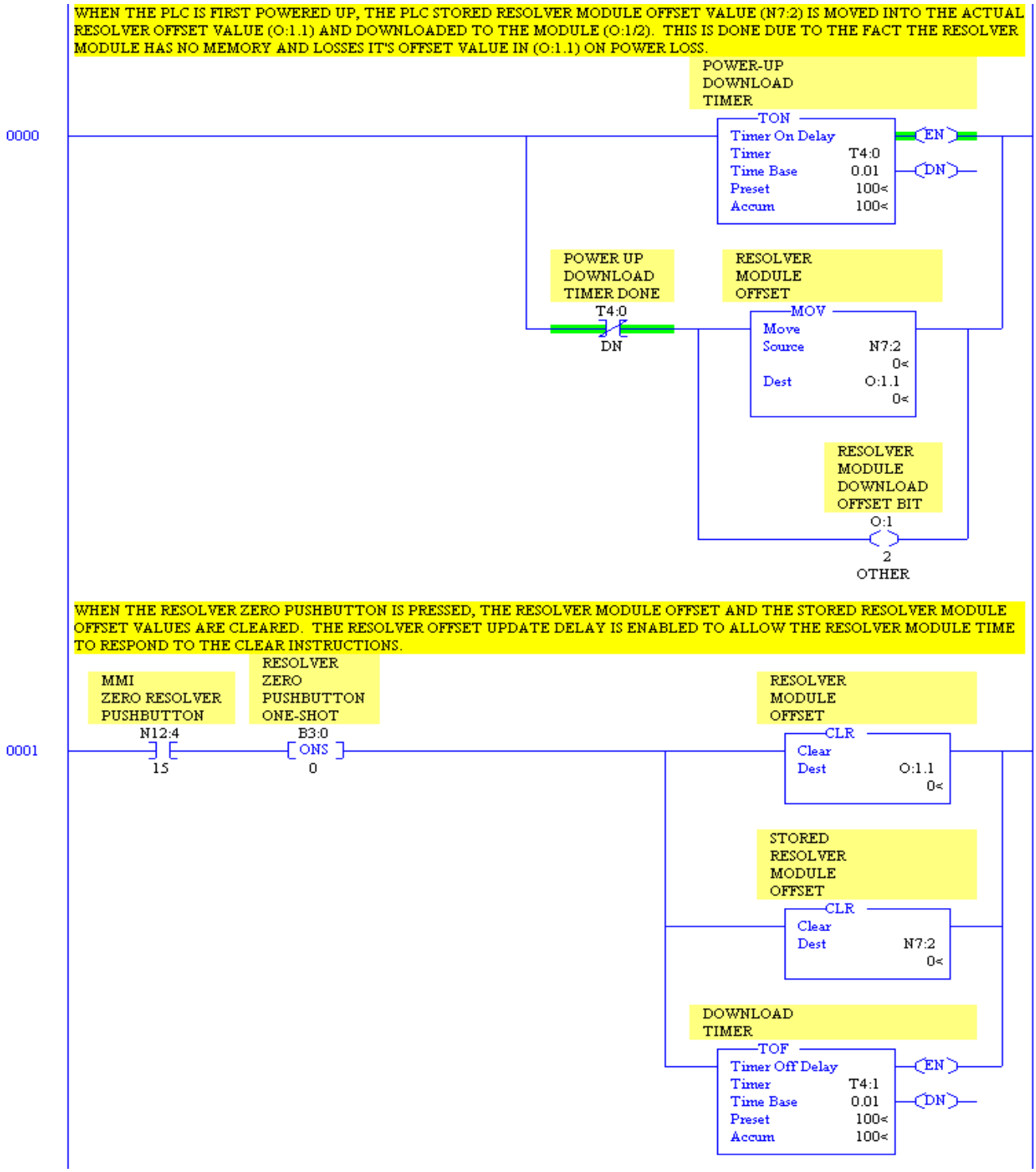
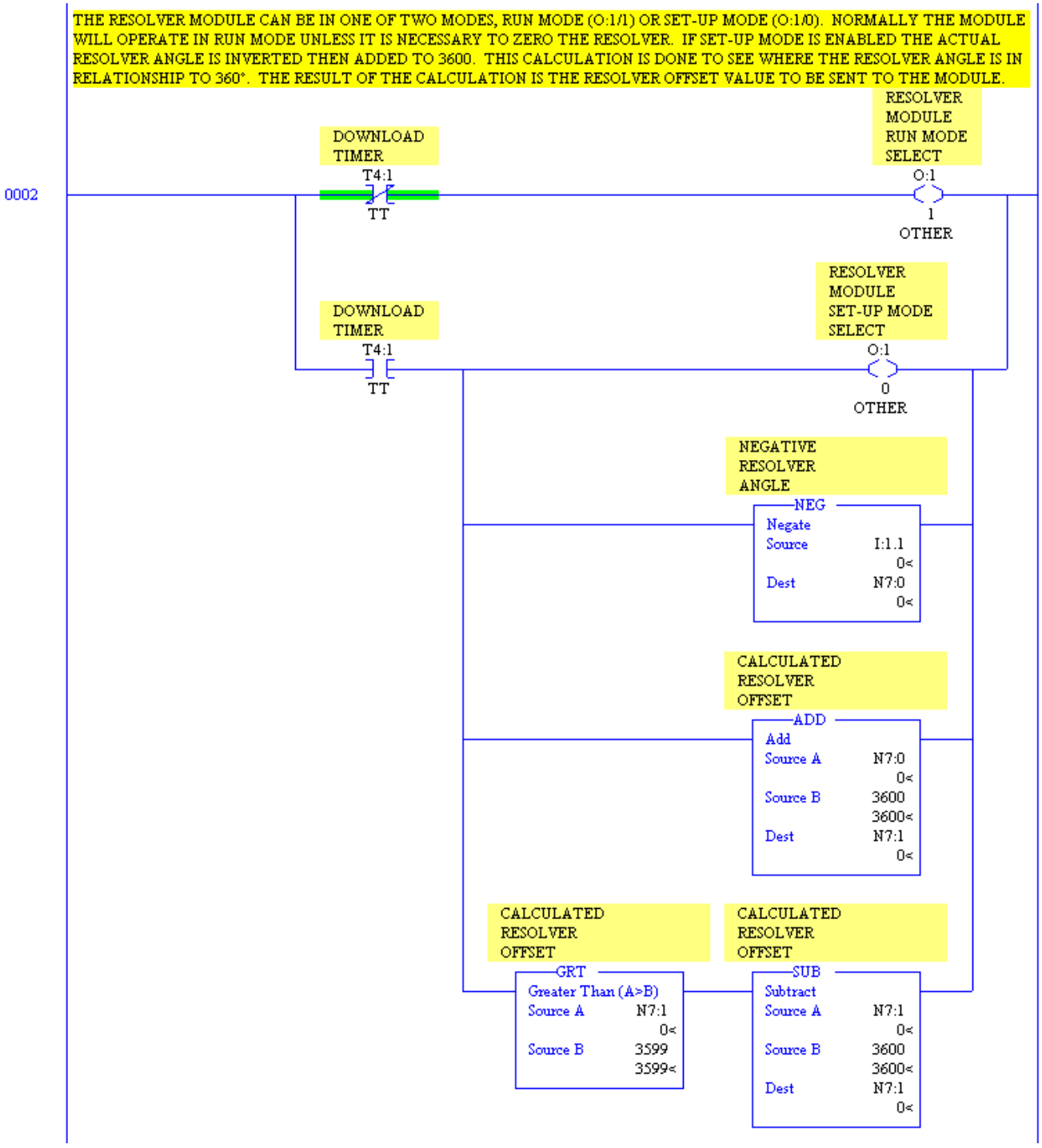
HM1530E WITH OPTIONAL HM1540 FILTER CARD WIRING DIAGRAM



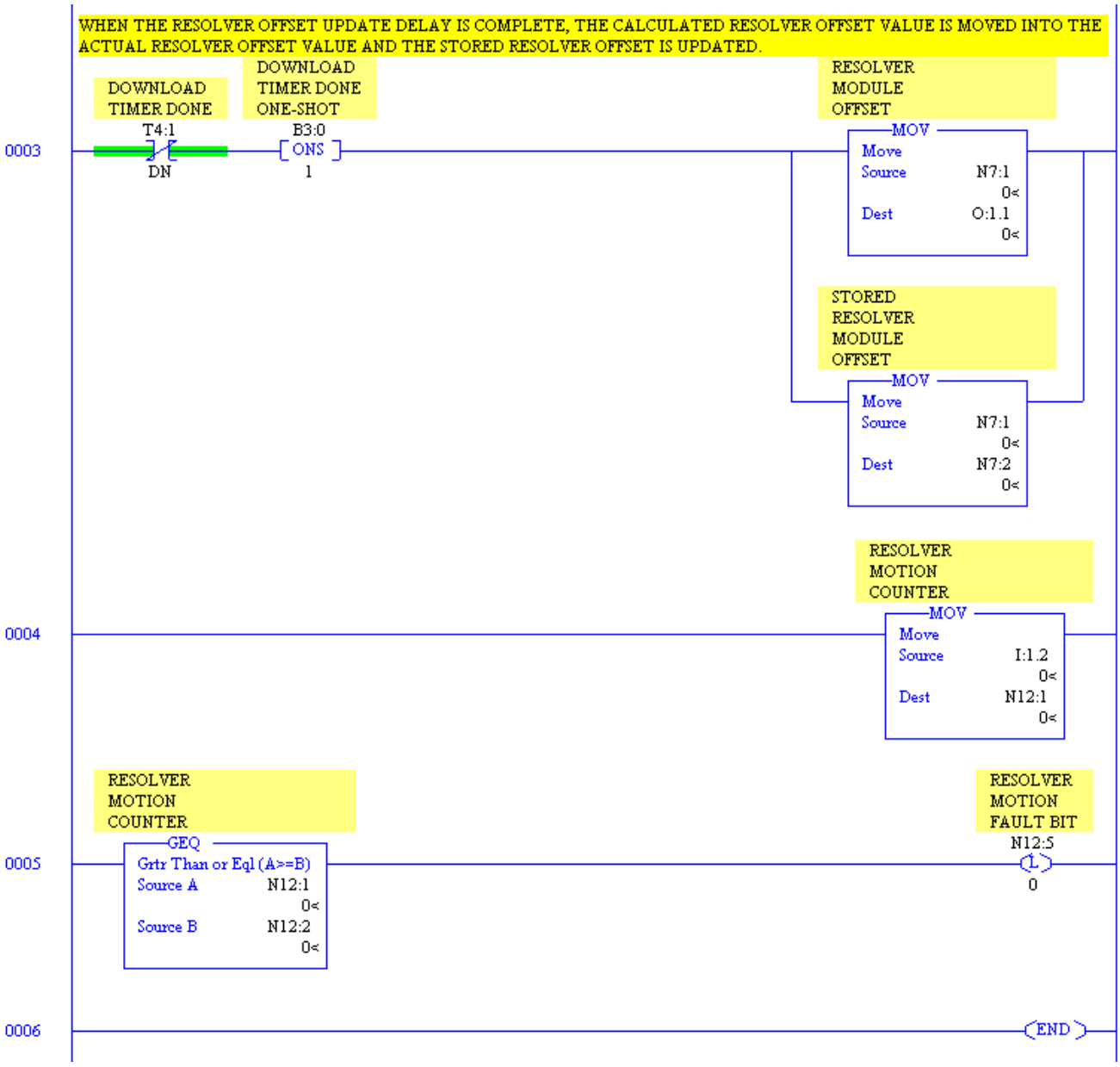
LADDER


WHEN THE PLC IS FIRST POWERED UP, THE PLC STORED RESOLVER MODULE OFFSET VALUE (N7:2) IS MOVED INTO THE ACTUAL RESOLVER OFFSET VALUE (O:1.1) AND DOWNLOADED TO THE MODULE (O:1/2). THIS IS DONE DUE TO THE FACT THE RESOLVER MODULE HAS NO MEMORY AND LOSSES IT'S OFFSET VALUE IN (O:1.1) ON POWER LOSS.
POWER-UP DOWNLOAD TIMER
0000
TON
Timer On Delay
Timer T4:0
Time Base 0.01
Preset 100
Accum 100
EN
DN
POWER UP DOWNLOAD TIMER DONE
T4:0
DN
RESOLVER MODULE OFFSET
MOV
Move
Source N7:2
0
Dest O:1.1
0
RESOLVER MODULE DOWNLOAD OFFSET BIT
O:1
2
OTHER
WHEN THE RESOLVER ZERO PUSHBUTTON IS PRESSED, THE RESOLVER MODULE OFFSET AND THE STORED RESOLVER MODULE OFFSET VALUES ARE CLEARED. THE RESOLVER OFFSET UPDATE DELAY IS ENABLED TO ALLOW THE RESOLVER MODULE TIME TO RESPOND TO THE CLEAR INSTRUCTIONS.
MMI ZERO RESOLVER PUSHBUTTON
N12:4
15
RESOLVER ZERO PUSHBUTTON ONE-SHOT
B3:0
ONS
0
0001
RESOLVER MODULE OFFSET
CLR
Clear
Dest O:1.1
0
STORED RESOLVER MODULE OFFSET
CLR
Clear
Dest N7:2
0
DOWNLOAD TIMER
TOF
Timer Off Delay
Timer T4:1
Time Base 0.01
Preset 100
Accum 100
EN
DN

LADDER


THE RESOLVER MODULE CAN BE IN ONE OF TWO MODES, RUN MODE (O:1/1) OR SET-UP MODE (O:1/0). NORMALLY THE MODULE WILL OPERATE IN RUN MODE UNLESS IT IS NECESSARY TO ZERO THE RESOLVER. IF SET-UP MODE IS ENABLED THE ACTUAL RESOLVER ANGLE IS INVERTED THEN ADDED TO 3600. THIS CALCULATION IS DONE TO SEE WHERE THE RESOLVER ANGLE IS IN RELATIONSHIP TO 360°. THE RESULT OF THE CALCULATION IS THE RESOLVER OFFSET VALUE TO BE SENT TO THE MODULE.
0002
DOWNLOAD TIMER
T4:1
TT
RESOLVER MODULE RUN MODE SELECT
O:1
1
OTHER
DOWNLOAD TIMER
T4:1
TT
RESOLVER MODULE SET-UP MODE SELECT
O:1
0
OTHER
NEGATIVE RESOLVER ANGLE
NEG
Negate
Source I:1.1 0
Dest N7:0 0
CALCULATED RESOLVER OFFSET
ADD
Add
Source A N7:0 0
Source B 3600 3600
Dest N7:1 0
CALCULATED RESOLVER OFFSET
GRT
Greater Than (A>B)
Source A N7:1 0
Source B 3599 3599
CALCULATED RESOLVER OFFSET
SUB
Subtract
Source A N7:1 0
Source B 3600 3600
Dest N7:1 0

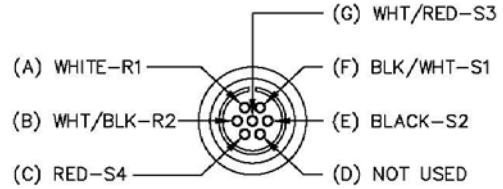
LADDER


WHEN THE RESOLVER OFFSET UPDATE DELAY IS COMPLETE, THE CALCULATED RESOLVER OFFSET VALUE IS MOVED INTO THE ACTUAL RESOLVER OFFSET VALUE AND THE STORED RESOLVER OFFSET IS UPDATED.
0003
DOWNLOAD TIMER DONE
T4:1
DN
DOWNLOAD TIMER DONE ONE-SHOT
B3:0
ONS
1
RESOLVER MODULE OFFSET
MOV
Move
Source N7:1 0
Dest O:1.1 0
STORED RESOLVER MODULE OFFSET
MOV
Move
Source N7:1 0
Dest N7:2 0
0004
RESOLVER MOTION COUNTER
MOV
Move
Source I:1.2 0
Dest N12:1 0
0005
RESOLVER MOTION COUNTER
GEQ
Grtr Than or Eql (A>=B)
Source A N12:1 0
Source B N12:2 0
RESOLVER MOTION FAULT BIT
N12:5
L
0
0006
END

HELM Model HR 1101-F

Resolver Cable Wiring

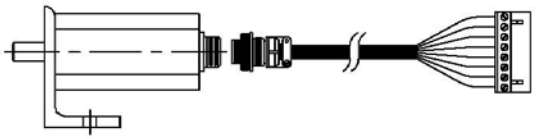
(AMCI Model HT-20)



Connector FRONT View

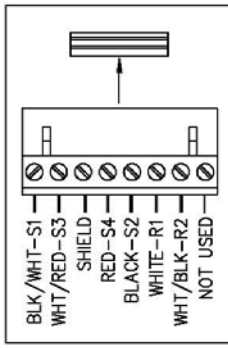
NOTES:

1.) 6-CONDUCTOR SHIELDED CABLE, HELM STOCK# 27081
2.) CONNECTOR IS 7-PIN AMPHENOL, HELM STOCK# 46035
3.) IF READOUT SHOWS REVERSE ROTATION, REVERSE S1 & S3 LEADS.

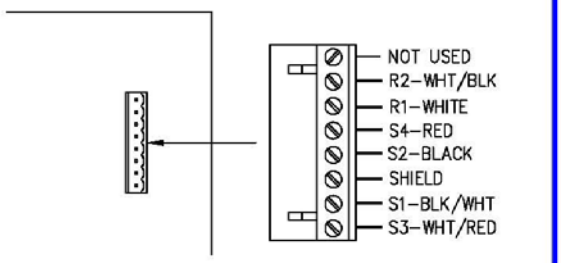


REV.	DESCRIPTION	DATE	BY
A	1.) UPDATE WIRING CODE, & DRAWING, NEW SUPPLIER AMCI	08/09/04	M.H.L.
B	1.) UPDATE WIRING CODE, FOR QUABBIN CABLE, STK.#27081	11/05/04	N.F.N.
C	1.) ADD AMCI 1241, 1642, AND 8213 WIRING INFO.	12/29/05	D.L.D.

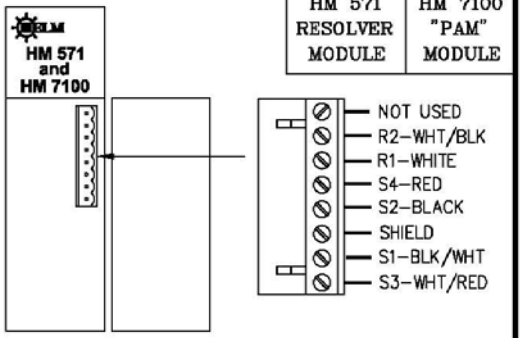
TLG SERIES UNITS



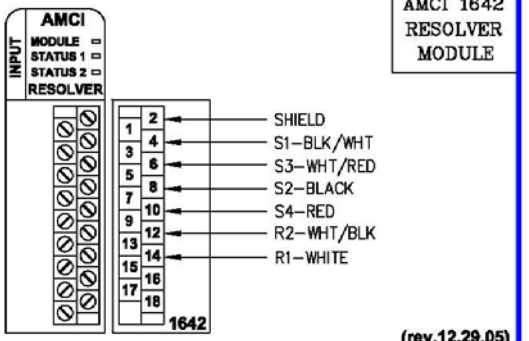
SCM AUTO-GRAPH



HM 571 RESOLVER MODULE / HM 7100 "PAM" MODULE

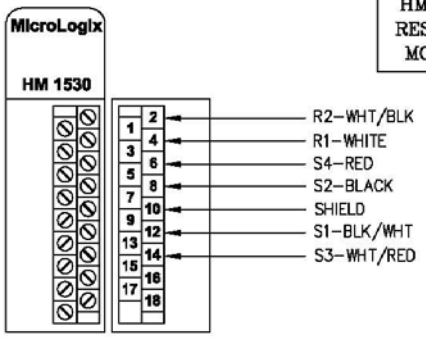


AMCI 1642 RESOLVER MODULE

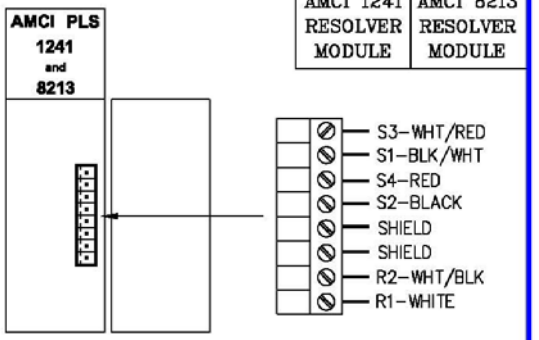


(rev.12.29.05)

HM 1530 RESOLVER MODULE



AMCI 1241 RESOLVER MODULE / AMCI 8213 RESOLVER MODULE



HELM INSTRUMENT CO., INC.
MAUMEE, OHIO USA

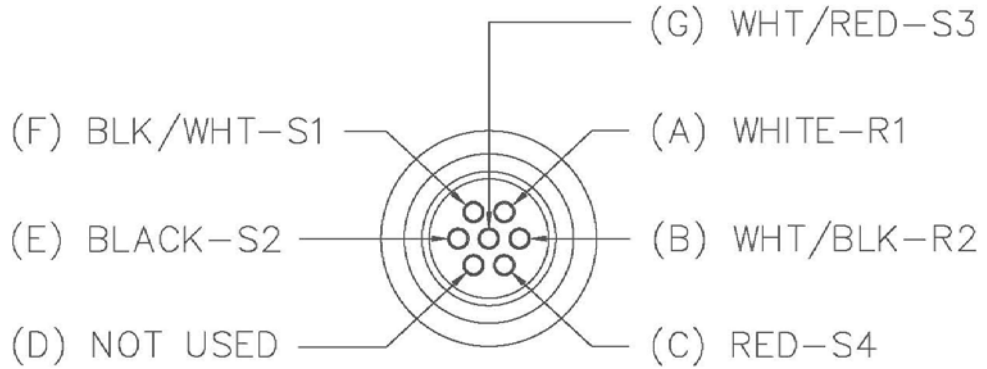
SCALE:	FULL	DESIGNED BY:	M.H.L.	DRAWN BY:	M.H.L.
DATE:	7/10/02	CHECKED BY:	R.J.G.	APPROVED BY:	R.J.G.
TITLE:	HR 1101-F RESOLVER CABLE WIRING (HELM)				
DRAWER:		DRAWING NUMBER:	T-3233-51C		

HELM Model HR 1101–F, Resolver Cable Wiring

(AMCI Model HT–20)

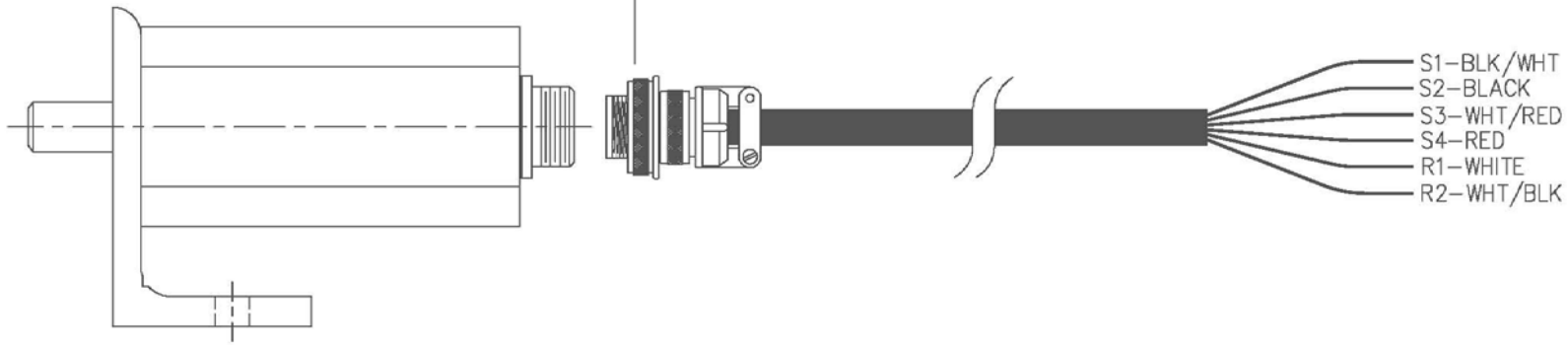
NOTES:

1.) 6–CONDUCTOR SHIELDED CABLE, HELM STOCK# 27081.
2.) CONNECTOR IS 7–PIN AMPHENOL, HELM STOCK# 46035.
3.) IF READOUT SHOWS REVERSE RO–TATION, REVERSE S1 & S3 LEADS.
4.) THIS WIRING IS CURRENT AS OF 11/05/04, WHEN WE SWITCHED TO QUABBIN CABLE STK# 27081.



Connector REAR View

(for Assembly of a New Cable)



HELM INSTRUMENT CO., INC. MAUMEE, OHIO USA

SCALE:	NONE	DESIGNED BY:	N.F.N.	DRAWN BY:	M.H.L.
DATE:	12/29/05	CHECKED BY:	R.J.G.	APPROVED BY:	R.J.G.
TITLE:	RESOLVER CABLE WIRING, REAR VIEW (HELM)				
DRAWER:		DRAWING NUMBER:	T–3233–52		