User Manual for the
HE693THM665, HE693THM666,
HE693THM667, HE693THM668

Isolated Thermocouple Module

Twelfth Edition
19 April 2004

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PREFACE

This manual explains how to use the Horner Isolated Thermocouple Module.

For user manual updates, contact Technical Support at the following locations:

North America:
(317) 916-4274
www.heapg.com

Europe:
(+) 353-21-4321-266
www.horner-apg.com

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Horner APG, LLC. ("HE-APG") warrants to the original purchaser that the Isolated Thermocouple Module manufactured by HE-APG is free from defects in material and workmanship under normal use and service. The obligation of HE-APG under this warranty shall be limited to the repair or exchange of any part or parts which may prove defective under normal use and service within two (2) years from the date of manufacture or eighteen (18) months from the date of installation by the original purchaser whichever occurs first, such defect to be disclosed to the satisfaction of HE-APG after examination by HE-APG of the allegedly defective part or parts. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR USE AND OF ALL OTHER OBLIGATIONS OR LIABILITIES AND HE-APG NEITHER ASSUMES, NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR HE-APG, ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF THIS Isolated Thermocouple Module. THIS WARRANTY SHALL NOT APPLY TO THIS Isolated Thermocouple Module OR ANY PART THEREOF WHICH HAS BEEN SUBJECT TO ACCIDENT, NEGLIGENCE, ALTERATION, ABUSE, OR MISUSE. HE-APG MAKES NO WARRANTY WHATSOEVER IN RESPECT TO ACCESSORIES OR PARTS NOT SUPPLIED BY HE-APG. THE TERM "ORIGINAL PURCHASER", AS USED IN THIS WARRANTY, SHALL BE DEEMED TO MEAN THAT PERSON FOR WHOM THE Isolated Thermocouple Module IS ORIGINALLY INSTALLED. THIS WARRANTY SHALL APPLY ONLY WITHIN THE BOUNDARIES OF THE CONTINENTAL UNITED STATES.

In no event, whether as a result of breach of contract, warranty, tort (including negligence) or otherwise, shall HE-APG or its suppliers be liable of any special, consequential, incidental or penal damages including, but not limited to, loss of profit or revenues, loss of use of the products or any associated equipment, damage to associated equipment, cost of capital, cost of substitute products, facilities, services or replacement power, down time costs, or claims of original purchaser's customers for such damages.

To obtain warranty service, return the product to your distributor with a description of the problem, proof of purchase, post paid, insured and in a suitable package.

ABOUT PROGRAMMING EXAMPLES

Any example programs and program segments in this manual or provided on accompanying diskettes are included solely for illustrative purposes. Due to the many variables and requirements associated with any particular installation, Horner APG cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the Isolated Thermocouple Module to appropriately design the end system, to appropriately integrate the Isolated Thermocouple Module and to make safety provisions for the end equipment as is usual and customary in industrial applications as defined in any codes or standards which apply.

Note: The programming examples shown in this manual are for illustrative purposes only. Proper machine operation is the sole responsibility of the system integrator.

REVISIONS TO THIS MANUAL

1. Revised Table 1.1.
2. Revised Section 3.1 Example
3. Revised Table 3.2.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

1.1 Description

The Isolated Thermocouple Input Modules allow thermocouple temperature sensors to be directly connected to the PC without external signal processing (transducers, transmitters, etc.). All analog and digital processing of the thermocouple signal is performed by the module. These backplane-isolated (or bus-isolated) modules report temperature values to the PLC I/O table in increments of 0.5°C, 0.5°F, 0.1°C, or 0.1°F respectively. The module features six thermocouple channels whose temperature values are reported to 6 %AI input registers. Each channel can be individually configured for a specific type of sensor wire. There are 6 %I alarm bits and one setpoint alarm for each channel. (The HE693THM667 has 12 alarm bits and two setpoints per channel.) Alarm setpoints are configured for each channel using 6 %AQ registers. An available feature on the isolated thermocouples is the use of external AD592 cold junction compensation. This allows cold junction compensation to be accomplished in a remote isothermal terminal strip with standard copper wire run from the remote terminal strip to the module.

There are four versions of the Horner APG Isolated Thermocouple Input Module: HE693THM668, HE693THM667, HE693THM666 and HE693THM665. The HE693THM668 is a six-channel module with +/-1500V AC isolation to the PLC backplane and +/-250V AC isolation channel-to-channel. The HE693THM667 is similar to the HE693THM668 except that the HE693THM667 has 2 setpoints per channel. The HE693THM666 is equivalent to the HE693THM668 with the addition of a 60Hz notch filter. The HE693THM665 is also equivalent to the HE693THM668 with addition of a 50Hz notch filter. The purpose of these filters is to eliminate noise generated by power lines in the United States (60Hz) and Europe (50 Hz).

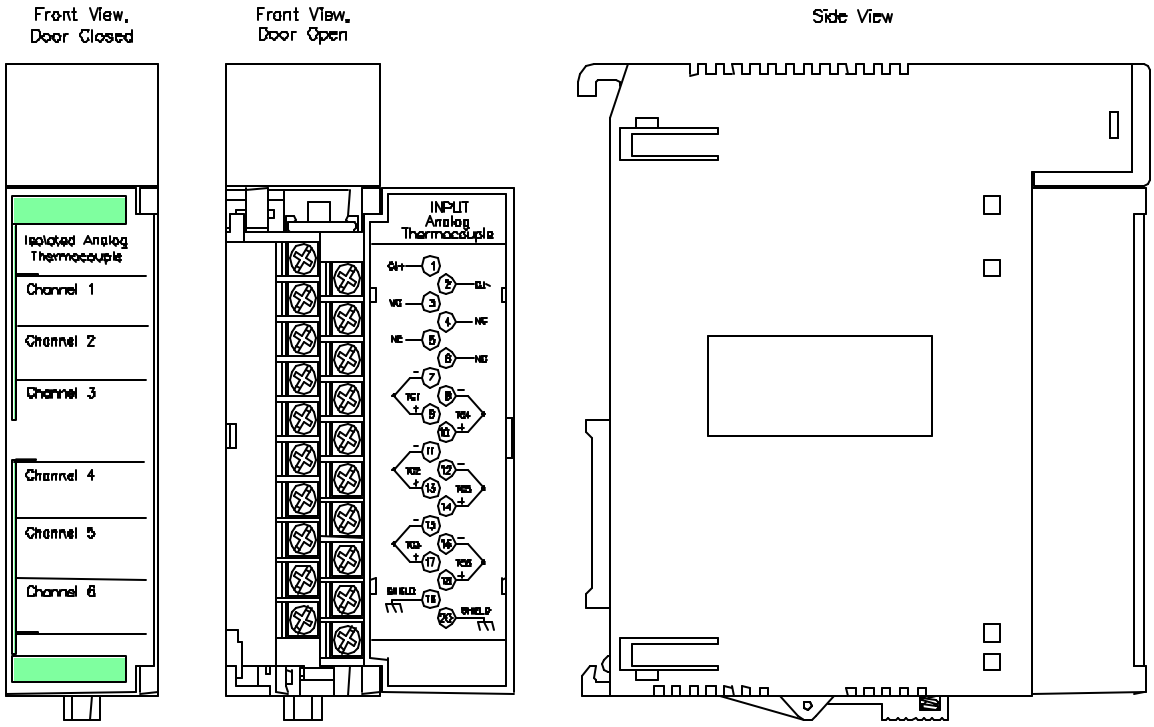

Figure 1.1 – View of Isolated Thermocouple Module

1.2 Specifications

Table 1.1 - Specifications					
Specification	**THM668, THM667, THM666, THM665**		**Specification**	**THM668, THM667, THM666, THM665**	
Power Consumption	200mA @ 5VDC		I/O Points Required	6%AI, 6%AQ, 16%I	
Number of Channels	6		Input Impedance	1000M ohms @ < 100mV	
Types Supported	J,K,N,T,E,R,S,B,C		Maximum Sustained Differential O/L	±35V	
Backplane Isolation	±1500 VAC to PLC backplane		Common Mode Rejection	>100dB	
Channel Isolation	±250V AC channel-to-channel		A/D Conversion Type	18-bit integrating	
A/D Conversion Time	5ms		Scan Rate	40 channels per second	
Common Channel Points	NONE		Open Thermocouple Response	Programmable Upscale or Downscale	
Operating Temperature	0 to 60°C (32 to 140°F)		Relative Humidity	5% to 95% non-condensing	
Operating Mode	Self-Scan		Resolution	0.5°C, 0.5°F, 0.1°C, 0.1°F	
Input Range (Temp)	J: -210 to +760°C	T: -270 to +400°C	Accuracy	J: ± 1.0°C	S: ± 2.0°C
	E: -270 to +1000°C	N: -270 to +1300°C		T: ± 1.0°C	E: ± 2.0°C
	K: -270 to +1372°C	S: 0 to +1768°C		K: ± 1.0°C	B: ± 2.0°C 100 to 1820°C
	C: 0 to +2320°C	B: +45 to +1820°C		N: ± 1.0°C	R: ± 2.0°C
	R: 0 to +1768°C			C: ± 4.0°C	

CHAPTER 2: INSTALLATION

2.1 Wiring

The following figures illustrate the connections for proper thermocouple use. **Figure 2.1** depicts normal connections. **Figure 2.2** depicts the proper connections with the use of the optional remote terminal strip.

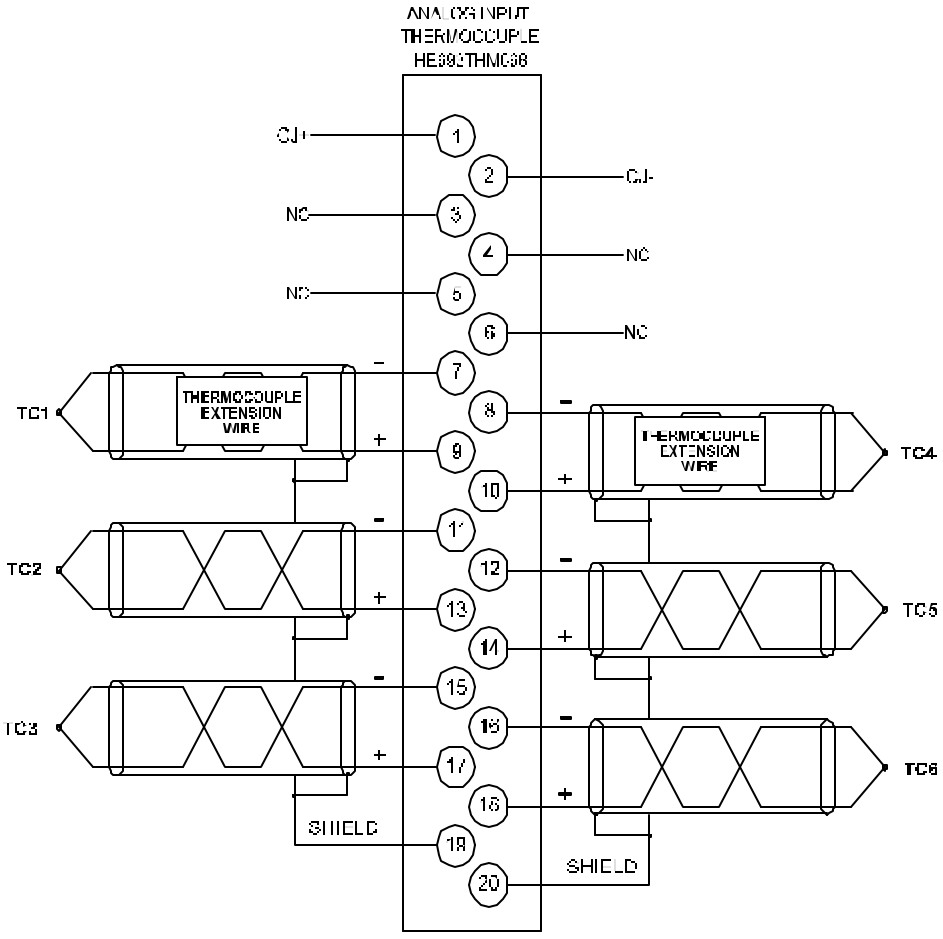

Figure 2.1 – Normal Wiring Connections

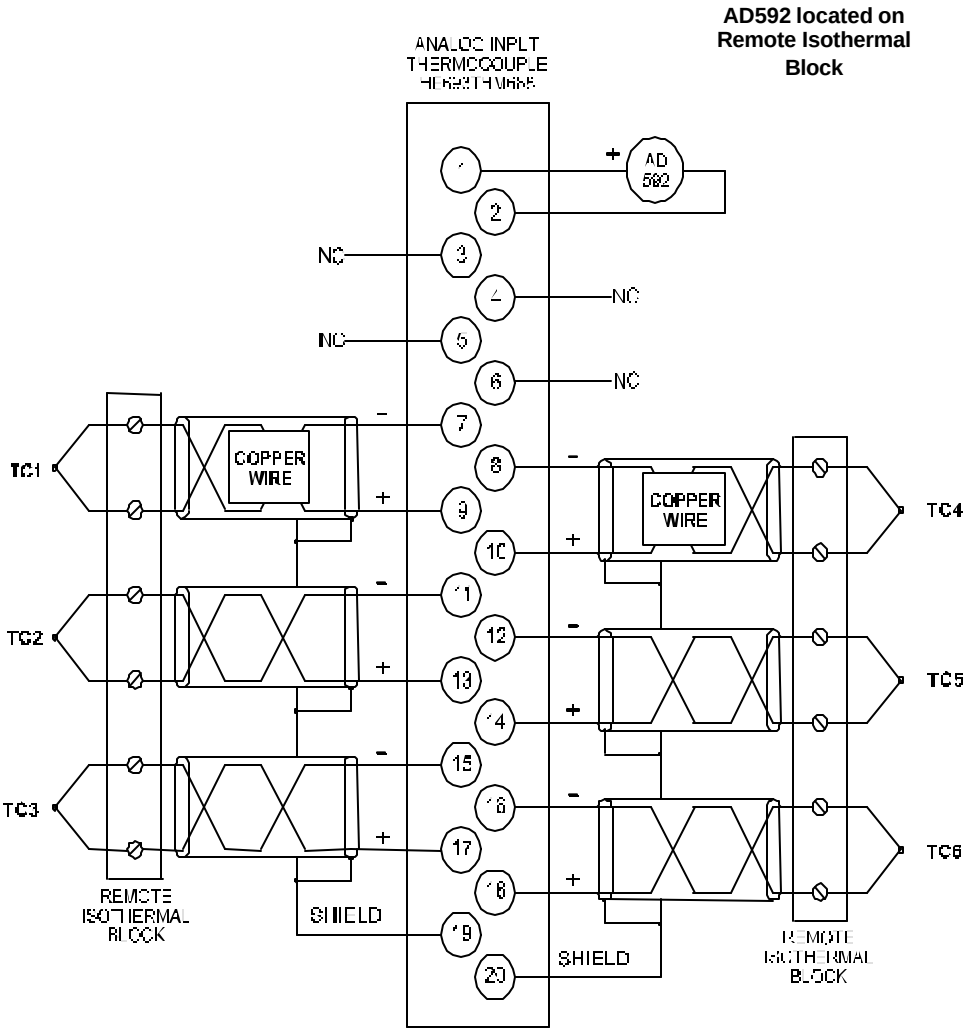

Figure 2.2 – Wiring Connections for Optional Remote Terminal Strip

2.2 External Cold Junction Compensation

The THM668 supports remote cold junction compensation. This allows the thermocouple sensors to be connected to a remote terminal strip. Standard shielded copper wiring can then be run between the remote terminal strip and the module terminal strip. The remote terminal strip must be "isothermal" in nature. It should be constructed with a built-in AD592 temperature sensor and even thermal characteristics. The module can detect the presence of an external AD592 temperature sensor and perform cold junction compensation based upon the remote sensor instead of the module's on-board AD592. Horner APG offers an isothermal remote terminal strip (HE693ISOBLK). See **Section 2.3** for more information on the HE693ISOBLK.

Table 2.1 – Connections Between Remote Terminal Strip and ISOBLK Module								
THM668 THM667, THM666, THM665	**Isothermal Block Screw Terminal**	**Isothermal Block DB25 Pin**	**Module Terminal**		**THM668 THM667, THM666, THM665**	**Isothermal Block Screw Terminal**	**Isothermal Block DB25 Pin**	**Module Terminal**
Channel 1	TC-1	3	7		**Channel 5**	TC-5	7	12
	TC+1	16	9			TC+5	20	14
Channel 2	TC-2	4	11		**Channel 6**	TC-6	8	16
	TC+2	17	13			TC+6	21	18
Not Connected	NC	1	2			SHIELD	25	19
	NC	14	1			SHIELD	13	20
Channel 3	TC-3	5	15		**Not Used**	TC-7	9	NC
	TC+3	18	17			TC+7	22	NC
Channel 4	TC-4	6	8		**Not Used**	TC-8	10	NC
	TC+4	19	10			TC+8	23	NC

2.3 Remote Terminal Strip (Isothermal Block).

The Horner APG HE693ISOBLK is a remote terminal strip which can be used in conjunction with the HE693THM668/667/666/665. It features an isothermal terminal strip, with integrated AD592 temperature sensor. Connections between the remote terminal strip and the isolated thermocouple module are accomplished through a DB25 connector. Pinouts for the ISOBLK screw terminals, DB25 connector, and the isolated thermocouple terminal strip are shown as follows. Cabling constructed by the customer connects the ISOBLOCK's DB25 female connector and the THM668/667/666/665 module's terminal strip.

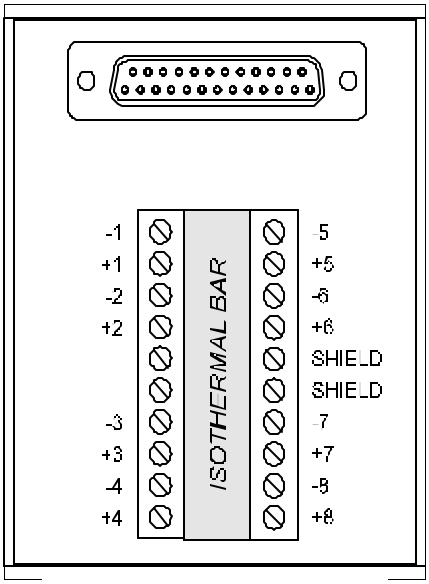

Figure 2.3 - Pinouts

NOTES

CHAPTER 3: CONFIGURATION

3.1 Foreign Module Configuration

Figure 3.1 depicts the Foreign Module Screen.

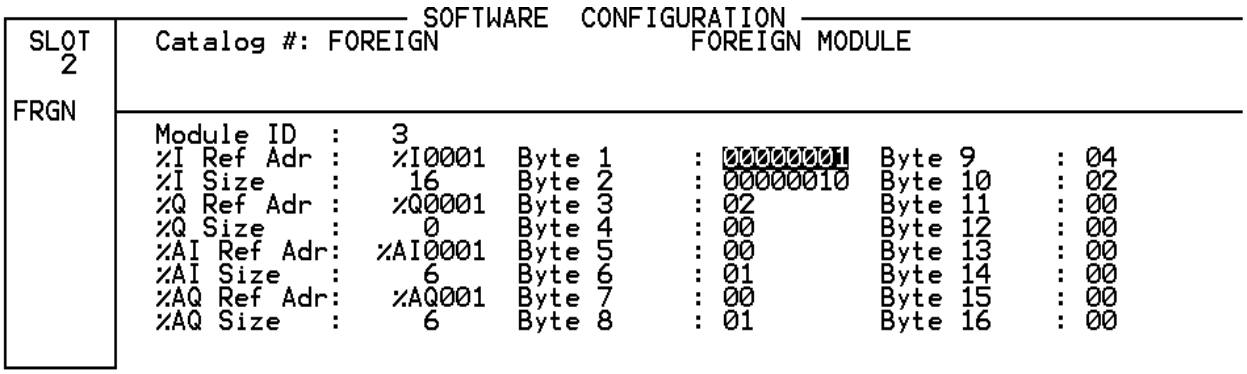

Figure 3.1 – Foreign Module Screen

To reach this screen, select I/O Configuration (F1), cursor over to the slot containing the module and select Other (F8), and Foreign (F3).

Example. The example screen above defines the following configuration parameters:

%I Ref. Adr	: %I1	Starting reference for 16 %I bits.
%I Size	: 16	Alarm bits (first six successive bits used for the six channels).
	32 (for THM667)	
%Q Ref. Adr.	: 0	Not Used.
%Q Size	: 0	Not Used.
%AI Ref. Adr	%AI1	Starting reference for 6 %AI words.
%AI Size	: 6	Registers used to store temperatures.
%AQ Ref. Adr.	:%AQ1	Starting reference for 6 %AQ words.
%AQ Size	: 6	Registers used to store setpoint values for alarm bits.
	12 (for THM667)	
Byte 1	: 1	Smart Module.
Byte 2	: 10	Digital filter set to 4 samples (Binary numbers only).
Byte 3	2	Resolution format set to 0.1 degrees Celsius.
Byte 4	: 0	Open thermocouple response set to Upscale.
Byte 5	: 0	Channel 1 configured to use J-type sensor wire.
Byte 6	: 1	Channel 2 configured to use K-type sensor wire.
Byte 7	: 0	Channel 3 configured to use J-type sensor wire.
Byte 8	: 1	Channel 4 configured to use K-type sensor wire.
Byte 9	: 4	Channel 5 configured to use E-type sensor wire.
Byte 10	: 2	Channel 6 configured to use N-type sensor wire.
Byte 11	: 0	Use internal cold junction compensation.

3.2 Configuration Parameters

Necessary parameters are %I Size, %AI Size, %AQ Size, and Bytes 1-11.

Table 3.2 – Configuration Parameters

%I Size	%AI Size	%AQ Size	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5-10	Byte 11
			Smart Module	Digital Filter	Format Resolution	Up/Down Break	T/C Type	Cold Junction
16 *32 (*THM667)	6	6 *12 (*THM667)	1		00: 0.5°C	00: Upscale Break	00: Type J 01: Type K 02: Type N 03: Type T 04: Type E	00: Internal
					01: 0.5°F			
					02: 0.1°C	01: Downscale Break	05: Type R 06: Type S 07: Type B 08: Type C	01: External
					03: 0.1°F		09: OFF	

3.3 Temperature Scaling

Temperature values are written to the %AI registers in 0.1°C, 0.1°F, 0.5°C or 0.5°F increments depending upon the value of Byte 3.

Table 3.4 – Temperature Scaling

BYTE 3	Format Resolution	Formula
00	0.5°C	0.5°C = %AI / 2
01	0.5°F	0.5°F = %AI / 2
02	0.1°C	0.1°C = %AI / 10
03	0.1°F	0.1°C = %AI / 10

CHAPTER 4: DIGITAL FILTERING

4.1 THM 668 and THM667 Digital Filtering

The effect of digital filtering (set with Byte 2) on module response to a temperature change. The THM665 and THM666 are approximately 4 times slower due to the effects of the filtering. (% Temp Change Completed vs. Time).

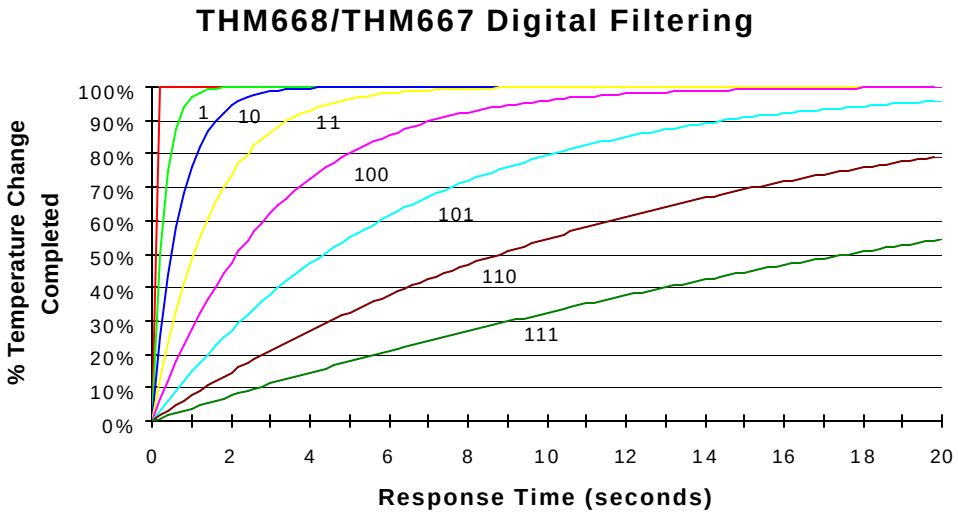

Figure 4.1 – Digital Filtering of the HE693THM668 & HE693THM667

4.2 THM666 and THM665 Digital Filtering

The effect of digital filtering (set with Byte 2) on module response to a temperature change. The THM665 and THM666 are approximately 4 times slower due to the effects of the filtering. (% Temp Change Completed vs. Time).

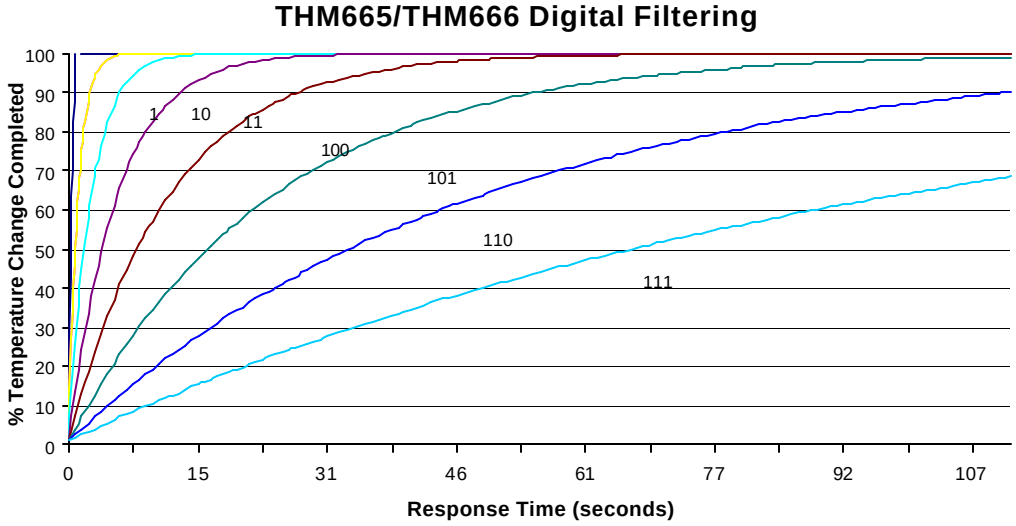

Figure 4.2 – Digital Filtering of the HE693THM666 & HE693THM665

NOTES

CHAPTER 5: ALARMS & SETPOINTS

5.1 Alarms

Table 5.1 indicates the alarm bits (16 %I) and setpoints (6 %AQ) for the THM668,THM666,and THM665. Also shown are the alarm bits (32%I) and setpoints (12%AQ) for the THM667.

Table 5.1 – Alarm Bits and Setpoints

THM668, THM666, & THM665		THM667	
%AQ 1-6	**%I 1-16**	**%AQ 1-12**	**%I 1-32**
%AQ1 = ch. 1 setpoint	%I1 = ch. 1 open alarm	%AQ1 = ch. 1 high	%I = ch. 1 open alarm
%AQ2 = ch. 2 setpoint	%I2 = ch. 2 open alarm	%AQ2 = ch. 2 high	%I2 = ch. 2 open alarm
%AQ3 = ch. 3 setpoint	%I3 = ch. 3 open alarm	%AQ3 = ch. 3 high	%I3 = ch. 3 open alarm
%AQ4 = ch. 4 setpoint	%I4 = ch. 4 open alarm	%AQ4 = ch. 4 high	%I4 = ch. 4 open alarm
%AQ5 = ch. 5 setpoint	%I5 = ch. 5 open alarm	%AQ5 = ch. 5 high	%I5 = ch. 5 open alarm
%AQ6 = ch. 6 setpoint	%I6 = ch. 6 open alarm	%AQ6 = ch. 6 high	%I6 = ch. 6 open alarm
N/A	%I7 = Not Used	%AQ7 = ch. 1 low	%I7 = Not Used
	%I8 = Not Used	%AQ8 = ch. 2 low	%I = Not Used
	%I9 = ch. 1 setpoint alarm	%AQ9 = ch. 3 low	%I9 = ch. 1 setpoint alarm
	%I10 = ch. 2 setpoint alarm	%AQ10 = ch. 4 low	%I10 = ch. 2 setpoint alarm
	%I11 = ch. 3 setpoint alarm	%AQ11 = ch. 5 low	%I11 = ch. 3 setpoint alarm
	%I12 = ch. 4 setpoint alarm	%AQ12 = ch. 6 low	%I12 = ch. 4 setpoint alarm
	%I13 = ch. 5 setpoint alarm		%I13 = ch. 5 setpoint alarm
	%I14 = ch. 6 setpoint alarm		%I14 = ch. 6 setpoint alarm
	%I15 - %I 6 = Not Used		%I15 - %I6 = Not Used
			%I17 - %I 4 = Not Used
			%I 5 = ch. 1 low alarm
			%I26 = ch. 2 low alarm
			%I 7 = ch. 3 low alarm
			%I 8 = ch. 4 low alarm
			%I29 = ch. 5 low alarm
			%I 0 = ch. 6 low alarm
			%I31 = Not Used
			%I32 = Not Used

5.2 Alarm Setpoints

There are three reference types used with the THM668/667/666 and 665:

a) %I
b) %AI
c) %AQ

The 6 %AI registers report the temperature in the selected format. The 6 %AQ registers (or 12 %AQ for the THM667) can be used to configure the alarm setpoint registers. The 16 %I bits (or 32 %I bits for the THM667) display the alarm conditions. The first six %I are set (1) if the respective thermocouple channel is over the maximum readable temperature or is open. The ninth through the fourteenth %I bits are set while the temperature is above the value specified in the respective %AQ. The setpoint is in the same format as the temperature.

The THM667 uses 6 additional %AQ registers (12 %AQ total) and 16 additional %I bits (32 %I total). The first 6 %AQ registers are used to store the corresponding high alarm setpoints while the second 6 %AQ registers store the low alarm setpoints. The first 6 %I bits are allocated for open-channel alarm status. %I 7 and 8 are not used. %I 9-14 are used as a high alarm status bit for each of the six corresponding thermocouple channels. %I 17-24 are not used. The 25th through the 30th %I bits are set while the temperature is below the specified value in the respective %AQ. %I 25-30 are used as a low alarm status bit for each of the six corresponding thermocouple channels. %I30 and 31 are not used. See **Table 5.1** for more details.

a) Example:

Module Configuration is %I1-16, %AI1-6, %AQ1-6 with temperature format = 0.5°C. %AQ1 (channel 1 setpoint) is set to a value of 200 (100°C). %I 1 will remain open (0) unless the temperature reaches the maximum readable value or is open *and* %I9 will be set high (1) while the temperature is equal to or above 100°C. In other words, if %AI1 is greater than or equal to %AQ1, then %I9 = 1 and %I1 = 0 unless open or maximum readable value is reached.

CHAPTER 6: CONFORMANCE STANDARDS

6.1 CE Mark and Compliance with EMC Directive

The Isolated Analog Input Thermocouples are CE-marked to indicate compliance with the EMC Directive. The EMC Directive is concerned with the immunity of electrical equipment to a variety of interference sources and the emissions from electrical equipment which could interfere with the operation of other equipment. The EMC Directive applies to complete installations, and since Horner APG products are included in the installation, Horner APG is supporting the EMC Directive by testing and CE-marking a subset of our equipment

Horner APG meets the following criteria covered under the EMC Directive including:

a) 89/336/EMC
b) 92/31/EEC
c) 93/68/EEC

CE

Figure 6.1 – CE Mark

In order to meet CISPR (EN 55011) Group 1, Class A Radiated Emissions levels, all components in the PLC system require the following:

a) General

1) All components must be mounted in a metal enclosure or the equivalent. The wiring must be routed in metal conduit or the equivalent. All surfaces of the enclosure must be adequately grounded to adjacent surfaces to provide electrical conductivity.

2) The metal conduit (flexible conduit is acceptable) for all wiring external to the cabinet must be mounted to the enclosure using standard procedures and hardware to ensure electrical conductivity between the enclosure and the conduit.

3) An external EMI filter must be wired to the AC Main for the PLC. Sprague Electric Part Number 259A9098P3 (available from GE Fanuc), or any other EMI filter which provides equivalent performance, may be used.

4) An external ground wire (16 AWG (1.32 mm2), 6" (15.24 cm) maximum length) must be wired from the Series 90-30 power supply safety ground wire terminal to the metal enclosure

5) On AC Main Ports connected to PLC's, MOVs shall be connected Line to Line and Line to Ground.

6) All cables and Analog signals must use shielded cable with a minimum of overall foil.

b) Specifics

1. The thermocouple sensor wire(s) must be fully shielded and grounded to pin 19 and/or 20.

2. The thermocouple sensor wire(s) must have external clamps on Ferrites added when the cable length is greater than or equal to 3 meters.

CHAPTER 7: RECOMMENDATIONS & APPROVALS

7.1 UL Approved

The THM668 has met the requirements for Underwriters Laboratories, Inc. Class I Div 2.

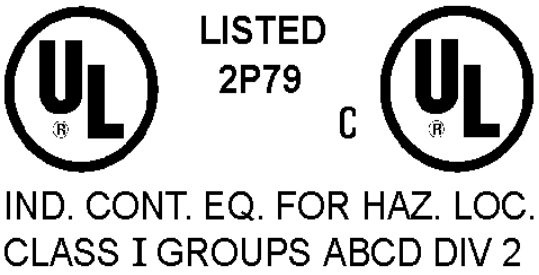

Figure 7.1 – UL Approval

7.2 Installation Hints and Recommendations

a) Use fully-shielded high-grade thermocouple sensor wire. Shielded, twisted pair extension wire offers the best noise immunity.
b) Extension wiring must be routed in its own conduit.
c) A good earth ground is critical for the shielded wire.
d) Do not expose the module(s) to excessive EMI or RF interference.
e) Do not expose the module(s) to extreme temperature variations.
f) Module(s) must be allowed to stabilize for at least 15 minutes after complete connection and power-on.
g) Module(s) must be in the upright position (panel-mounted position).
h) Special care must be taken with grounded junction sensors to avoid applying a voltage potential to the thermocouple junction.
i) Extension wire of the proper sensor type must be used.
j) Keep wire lengths to a minimum.

NOTES