

# MAGNI SYSTEM USER MANUAL



Version 1.00

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## Table of Contents

Introduction .....	5
Technical Specifications.....	6
Hardware List.....	7
cRIO Module Configuration & Interfacing.....	8
RTD Inputs Channel Pinout.....	9
Circular Connector Diagram.....	17
Assembly Instructions OMEGA (MTC-41-FF).....	21
Assembly Instructions 97 Series (10SL-3).....	23
Additional Technical Documentation.....	24
Valkyrie Warranty & Support.....	25

## List of Figures

Figure 1. Wiring Diagram & Specifications for NI-9216 Module.....	9
Figure 2. 3-Wire and 4-Wire RTD Input Connections .....	10
Figure 3. Circular Connector layout on the MAGNI System.....	17
Figure 4. Labelling convention for 40-pin connectors .....	18
Figure 5. Labelling convention for 3-pin connector .....	20
Figure 6. Inserting Stripped Wire into the Contact .....	21
Figure 7. Locating Contact into Insertion Tool .....	22
Figure 8. Aligning Contact.....	22

## List of Tables

Table 1. MAGNI System's Technical Specifications .....	6
Table 2. MAGNI System - cRIO Module Configuration Summary.....	8
Table 3. NI-9216 Signal Descriptions.....	10
Table 4. NI-9216 Module Pinout Labels.....	11
Table 5. Pinout for Connectors 1 through 4 .....	18
Table 6. Pinout for connector 9.....	20
Table 7. Wire crimping for Amphenol 97 Series.....	23
Table 8. MAGNI System - Additional Technical Documentation.....	24

# Introduction

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The MAGNI System is a high-end RTD measurement industrial panel (enclosure) which can measure up to 32 channels of 3- and 4-wire RTD configurations ranging from 0Ω to 400Ω at 400S/s with less than ±1.0 °C accuracy error over its entire operating temperature range.

The MAGNI system features a National Instruments 4-Slot Embedded Real-Time Controller with Reconfigurable FPGA. This CompactRIO can be programmed using the LabVIEW Programming Environment.

The MAGNI system is fully connectorized to allow for quick and fast on-site installation. A total of 5 industrial circular connectors are used to interface with the 32 different I/O channels. Corresponding plugs, cable claps, pins, and circular metal dust caps included with the system.

Additional connectors include (x1) Cat6a RJ45 inline coupling connector for Ethernet TCP/IP interfacing. This port allows for direct interfacing with the National Instruments CompactRIO controller.

The MAGNI system is ideal for:

- Collecting High Speed Data from PT100 RTD (0Ω to 400Ω)
- High Accuracy Temperature Measurement
- Measuring a large number RTDs sensors
- Ideal for Research and Testing Facilities

For inquiries or technical support please contact us directly at [info@valkyriecontrols.com](mailto:info@valkyriecontrols.com)

# Technical Specifications

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The MAGNI System's technical specifications may vary from version to version. The MAGNI System's specifications are listed in the following table. The following specifications are for the range of -40 °C to 85 °C unless otherwise noted.

**Table 1.** MAGNI System's Technical Specifications

RTD Inputs	(x32) 0 Ω to 400 Ω, 24 Bit, 400 S/s Aggregate (per 8-Channels), PT100
Ethernet Connectivity	(x2) RJ45 CAT6a GbE IEEE 802.3 Compatibility (Half/Full Duplex)
Power Input	18-30VDC 24VDC Nominal
Power Consumption	14-18W (min to max)
cRIO Configuration	(x1) 4-Slot Embedded Real-Time Controller with Reconfigurable FPGA; NI-9064  (x4) 8-Ch RTD, 0 Ω to 400 Ω, 24 Bit, 400 S/s Aggregate (PT100) Module; NI-9216
Operating Temperature	-4 to 131 °F (-20 to 55 °C)
Storage Temperature	-40 to 185 °F (-40 to 85 °C)
Physical Dimensions	36" x 36" x 8"
I/O Interface	Omega MTC Series Circular Connectors; (x4) MTC-41-FF + Dust Covers (x4) MTC-41-SHL (Included) Amphenol Industrial Circular Connectors: (x1) 97-3102A-10SL-3P + Dust Cover (x1) 97-3106A-10SL-3S (Included)

# Hardware List

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(x1) 4-slot Embedded Real-Time Controller; NI-9064



(x4) 8-Ch RTD, 0  $\Omega$  to 400  $\Omega$ , 24 Bit, 400 S/s Aggregate Module; NI-9216



(x4) Omega MTC Series Circular Connectors; MTC-41-FF



(x1) 3-pin circular 97 Series connector; 97-3102A-10SL-3P



(x1) CONEC Series Cat6a RJ45 Inline Coupler; 17-150134



(x1) Hubbell-Wiegmann Ultimate series enclosure, NEMA 4/12/13, 36 x 36 x 8in (HxWxD), wall mount, carbon steel



(x6) Omega MTC Series Accessories & pins; MTC-41-SHL



(x10) 97 Series Amphenol Standard Plug Assembly; 97-3102A-10SL-3S



# cRIO Module Configuration & Interfacing

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The following tables and associated figures describe the CompactRIO (cRIO) module configuration for the MAGNI System. The module slot order & module wiring details are described in this section.

The following table describes the cRIO module configuration of the MAGNI System:

**Table 2. MAGNI System - cRIO Module Configuration Summary**

<b>Chassis 1</b>			
<b>Chassis</b>	<b># of Slots Used</b>	<b>Channel Count (Chassis I/O)</b>	<b>Associated Circular Connectors</b>
NI-9064	4	-	1-4
<b>Chassis 1 Modules</b>			
<b>Module</b>	<b>Slot #</b>	<b>Channel Count</b>	<b>Associated Circular Connectors</b>
NI-9216	1	8	1
NI-9216	2	8	2
NI-9216	3	8	3
NI-9216	4	8	4



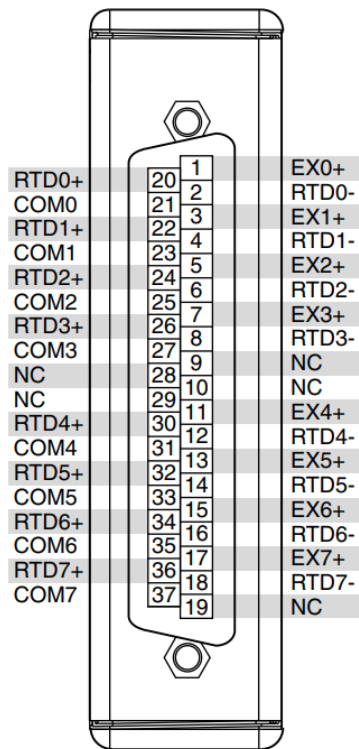
## RTD Inputs Channel Pinout

*8 RTD, 0  $\Omega$  to 400  $\Omega$ , 24 Bit, 400 S/s Aggregate, PT100 (NI-9216):*

The NI-9216 is a resistance temperature detector (RTD) input module. You can configure the NI-9216 for two sample rate modes: high sample rate or high resolution. The NI-9216 is compatible with 3- and 4-wire RTD measurements, and it automatically detects the type of RTD (3--or 4-wire) connected to the channel and configures each channel for the appropriate mode. The module provides per channel current excitation. The NI-9216 features calibration and includes a channel-to-earth ground double isolation barrier for safety, noise immunity, and a high common-mode voltage range.

The following figure shows the wiring pinout & specifications for the National Instruments NI-9216 module:

**Figure 1.** Wiring Diagram & Specifications for NI-9216 Module



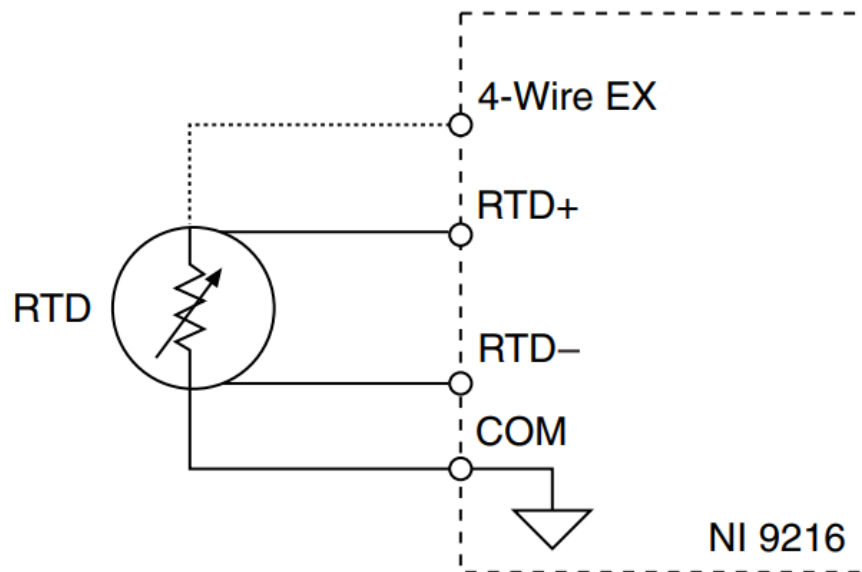
For additional information & specifications on the NI-9216 module see [NI-9216 Datasheet.pdf](#)

**Table 3. NI-9216 Signal Descriptions**

NI-9216 Module	
Signal	Description
COM	Common reference connection to isolated ground
EX+	Positive sensor excitation connection
NC	No connection
RTD+	Positive resistance temperature detector connection
RTD-	Negative resistance temperature detector connection

The following figures show typical RTD wiring to the NI-9216 module:

**Figure 2. 3-Wire and 4-Wire RTD Input Connections**



All NI-9216 modules are directly connected to Amphenol circular connectors. The following table shows the associated circular connector pinout labels for all input channels for slots 1-4 of chassis 1:

**Table 4.** NI-9216 Module Pinout Labels

NI-9216 Modules			
Slot #	Channel #	Module Pinout Labels	Associated Circular Connector
1	1	Slot 1-1-EX+ Slot 1-1-RTD+ Slot 1-1-RTD- Slot 1-1-COM Slot 1-1-GND	1 (Pins 1 & 2 & 3 & 4 & 5)
1	2	Slot 1-2-EX+ Slot 1-2-RTD+ Slot 1-2-RTD- Slot 1-2-COM Slot 1-2-GND	1 (Pins 6 & 7 & 8 & 9 & 10)
1	3	Slot 1-3-EX+ Slot 1-3-RTD+ Slot 1-3-RTD- Slot 1-3-COM Slot 1-3-GND	1 (Pins 11 & 12 & 13 & 14 & 15)
1	4	Slot 1-4-EX+ Slot 1-4-RTD+ Slot 1-4-RTD- Slot 1-4-COM Slot 1-4-GND	1 (Pins 16 & 17 & 18 & 19 & 20)

<b>NI-9216 Modules (Continued)</b>			
<b>Slot #</b>	<b>Channel #</b>	<b>Module Pinout Labels</b>	<b>Associated Circular Connector</b>
1	5	Slot 1-5-EX+ Slot 1-5-RTD+ Slot 1-5-RTD- Slot 1-5-COM Slot 1-5-GND	1 (Pins 21 & 22 & 23 & 24 & 25)
1	6	Slot 1-6-EX+ Slot 1-6-RTD+ Slot 1-6-RTD- Slot 1-6-COM Slot 1-6-GND	1 (Pins 26 & 27 & 28 & 29 & 30)
1	7	Slot 1-7-EX+ Slot 1-7-RTD+ Slot 1-7-RTD- Slot 1-7-COM Slot 1-7-GND	1 (Pins 31 & 32 & 33 & 34 & 35)
1	8	Slot 1-8-EX+ Slot 1-8-RTD+ Slot 1-8-RTD- Slot 1-8-COM Slot 1-8-GND	1 (Pins 36 & 37 & 38 & 39 & 40)
2	1	Slot 2-1-EX+ Slot 2-1-RTD+ Slot 2-1-RTD- Slot 2-1-COM Slot 2-1-GND	2 (Pins 1 & 2 & 3 & 4 & 5)
2	2	Slot 2-2-EX+ Slot 2-2-RTD+ Slot 2-2-RTD- Slot 2-2-COM Slot 2-2-GND	2 (Pins 6 & 7 & 8 & 9 & 10)

<b>NI-9216 Modules (Continued)</b>			
<b>Slot #</b>	<b>Channel #</b>	<b>Module Pinout Labels</b>	<b>Associated Circular Connector</b>
2	3	Slot 2-3-EX+ Slot 2-3-RTD+ Slot 2-3-RTD- Slot 2-3-COM Slot 2-3-GND	2 (Pins 11 & 12 & 13 & 14 & 15)
2	4	Slot 2-4-EX+ Slot 2-4-RTD+ Slot 2-4-RTD- Slot 2-4-COM Slot 2-4-GND	2 (Pins 16 & 17 & 18 & 19 & 20)
2	5	Slot 2-5-EX+ Slot 2-5-RTD+ Slot 2-5-RTD- Slot 2-5-COM Slot 2-5-GND	2 (Pins 21 & 22 & 23 & 24 & 25)
2	6	Slot 2-6-EX+ Slot 2-6-RTD+ Slot 2-6-RTD- Slot 2-6-COM Slot 2-6-GND	2 (Pins 26 & 27 & 28 & 29 & 30)
2	7	Slot 2-7-EX+ Slot 2-7-RTD+ Slot 2-7-RTD- Slot 2-7-COM Slot 2-7-GND	2 (Pins 31 & 32 & 33 & 34 & 35)
2	8	Slot 2-8-EX+ Slot 2-8-RTD+ Slot 2-8-RTD- Slot 2-8-COM Slot 2-8-GND	2 (Pins 36 & 37 & 38 & 39 & 40)

<b>NI-9216 Modules (Continued)</b>			
<b>Slot #</b>	<b>Channel #</b>	<b>Module Pinout Labels</b>	<b>Associated Circular Connector</b>
3	1	Slot 3-1-EX+ Slot 3-1-RTD+ Slot 3-1-RTD- Slot 3-1-COM Slot 3-1-GND	3 (Pins 1 & 2 & 3 & 4 & 5)
3	2	Slot 3-2-EX+ Slot 3-2-RTD+ Slot 3-2-RTD- Slot 3-2-COM Slot 3-2-GND	3 (Pins 6 & 7 & 8 & 9 & 10)
3	3	Slot 3-3-EX+ Slot 3-3-RTD+ Slot 3-3-RTD- Slot 3-3-COM Slot 3-3-GND	3 (Pins 11 & 12 & 13 & 14 & 15)
3	4	Slot 3-4-EX+ Slot 3-4-RTD+ Slot 3-4-RTD- Slot 3-4-COM Slot 3-4-GND	3 (Pins 16 & 17 & 18 & 19 & 20)
3	5	Slot 3-5-EX+ Slot 3-5-RTD+ Slot 3-5-RTD- Slot 3-5-COM Slot 3-5-GND	3 (Pins 21 & 22 & 23 & 24 & 25)
3	6	Slot 3-6-EX+ Slot 3-6-RTD+ Slot 3-6-RTD- Slot 3-6-COM Slot 3-6-GND	3 (Pins 26 & 27 & 28 & 29 & 30)

<b>NI-9216 Modules (Continued)</b>			
<b>Slot #</b>	<b>Channel #</b>	<b>Module Pinout Labels</b>	<b>Associated Circular Connector</b>
3	7	Slot 3-7-EX+ Slot 3-7-RTD+ Slot 3-7-RTD- Slot 3-7-COM Slot 3-7-GND	3 (Pins 31 & 32 & 33 & 34 & 35)
3	8	Slot 3-8-EX+ Slot 3-8-RTD+ Slot 3-8-RTD- Slot 3-8-COM Slot 3-8-GND	3 (Pins 36 & 37 & 38 & 39 & 40)
4	1	Slot 4-1-EX+ Slot 4-1-RTD+ Slot 4-1-RTD- Slot 4-1-COM Slot 4-1-GND	4 (Pins 1 & 2 & 3 & 4 & 5)
4	2	Slot 4-2-EX+ Slot 4-2-RTD+ Slot 4-2-RTD- Slot 4-2-COM Slot 4-2-GND	4 (Pins 6 & 7 & 8 & 9 & 10)
4	3	Slot 4-3-EX+ Slot 4-3-RTD+ Slot 4-3-RTD- Slot 4-3-COM Slot 4-3-GND	4 (Pins 11 & 12 & 13 & 14 & 15)
4	4	Slot 4-4-EX+ Slot 4-4-RTD+ Slot 4-4-RTD- Slot 4-4-COM Slot 4-4-GND	4 (Pins 16 & 17 & 18 & 19 & 20)

<b>NI-9216 Modules (Continued)</b>			
<b>Slot #</b>	<b>Channel #</b>	<b>Module Pinout Labels</b>	<b>Associated Circular Connector</b>
4	5	Slot 4-5-EX+ Slot 4-5-RTD+ Slot 4-5-RTD- Slot 4-5-COM Slot 4-5-GND	4 (Pins 21 & 22 & 23 & 24 & 25)
4	6	Slot 4-6-EX+ Slot 4-6-RTD+ Slot 4-6-RTD- Slot 4-6-COM Slot 4-6-GND	4 (Pins 26 & 27 & 28 & 29 & 30)
4	7	Slot 4-7-EX+ Slot 4-7-RTD+ Slot 4-7-RTD- Slot 4-7-COM Slot 4-7-GND	4 (Pins 31 & 32 & 33 & 34 & 35)
4	8	Slot 4-8-EX+ Slot 4-8-RTD+ Slot 4-8-RTD- Slot 4-8-COM Slot 4-8-GND	4 (Pins 36 & 37 & 38 & 39 & 40)

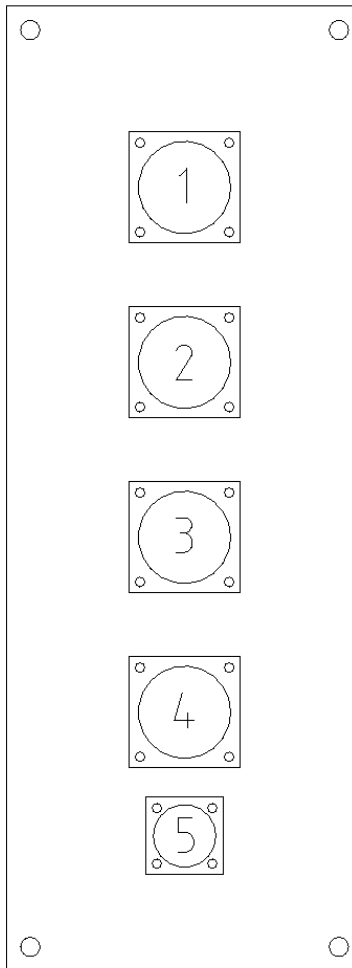


# Circular Connector Diagram

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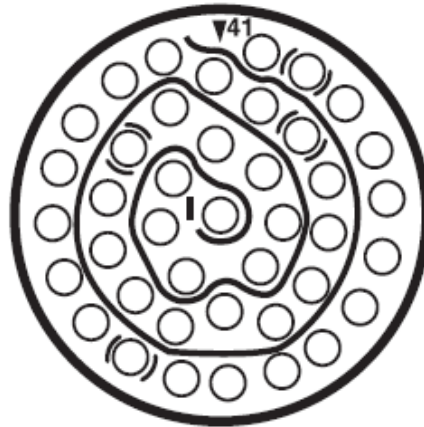
The MAGNI System's interface is comprised of Omega circular connectors with an aluminum shell. The following layout illustrated in [Figure 3](#) will be referred to throughout the documentation. There are four 41-pin connectors (labelled 1 through 4), and one 3-pin connectors (labelled 5).

**Figure 3.** Circular Connector layout on the MAGNI System



Each connector has its pins labelled according to [Figure 4](#) & [Figure 5](#). Further details on the wiring for individual pins are provided in [Table 5](#).

**Figure 4.** Labelling convention for 40-pin connectors



## 41 Pin

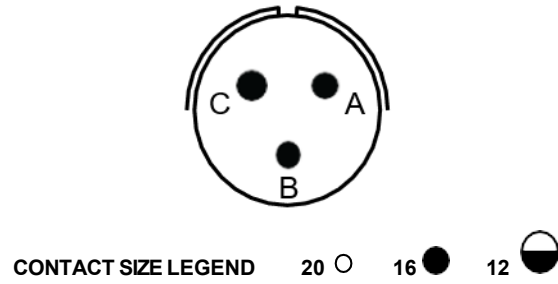
**Table 5.** Pinout for Connectors 1 through 4

Pin	Connector #			
	1	2	3	4
1	Slot 1-1-EX+	Slot 2-1-EX+	Slot 3-1-EX+	Slot 4-1-EX+
2	Slot 1-1-RTD+	Slot 2-1-RTD+	Slot 3-1-RTD+	Slot 4-1-RTD+
3	Slot 1-1-RTD-	Slot 2-1-RTD-	Slot 3-1-RTD-	Slot 4-1-RTD-
4	Slot 1-1-COM	Slot 2-1-COM	Slot 3-1-COM	Slot 4-1-COM
5	Slot 1-1-GND	Slot 2-1-GND	Slot 3-1-GND	Slot 4-1-GND
6	Slot 1-2-EX+	Slot 2-2-EX+	Slot 3-2-EX+	Slot 4-2-EX+
7	Slot 1-2-RTD+	Slot 2-2-RTD+	Slot 3-2-RTD+	Slot 4-2-RTD+
8	Slot 1-2-RTD-	Slot 2-2-RTD-	Slot 3-2-RTD-	Slot 4-2-RTD-
9	Slot 1-2-COM	Slot 2-2-COM	Slot 3-2-COM	Slot 4-2-COM
10	Slot 1-2-GND	Slot 2-2-GND	Slot 3-2-GND	Slot 4-2-GND
11	Slot 1-3-EX+	Slot 2-3-EX+	Slot 3-3-EX+	Slot 4-3-EX+
12	Slot 1-3-RTD+	Slot 2-3-RTD+	Slot 3-3-RTD+	Slot 4-3-RTD+
12	Slot 1-3-RTD-	Slot 2-3-RTD-	Slot 3-3-RTD-	Slot 4-3-RTD-
14	Slot 1-3-COM	Slot 2-3-COM	Slot 3-3-COM	Slot 4-3-COM
15	Slot 1-3-GND	Slot 2-3-GND	Slot 3-3-GND	Slot 4-3-GND

**Table 6. Pinout for Connectors 1 through 4 (Continued)**

<b>Pin</b>	<b>Connector #</b>			
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>16</b>	Slot 1-4-EX+	Slot 2-4-EX+	Slot 3-4-EX+	Slot 4-4-EX+
<b>17</b>	Slot 1-4-RTD+	Slot 2-4-RTD+	Slot 3-4-RTD+	Slot 4-4-RTD+
<b>18</b>	Slot 1-4-RTD-	Slot 2-4-RTD-	Slot 3-4-RTD-	Slot 4-4-RTD-
<b>19</b>	Slot 1-4-COM	Slot 2-4-COM	Slot 3-4-COM	Slot 4-4-COM
<b>20</b>	Slot 1-4-GND	Slot 2-4-GND	Slot 3-4-GND	Slot 4-4-GND
<b>21</b>	Slot 1-5-EX+	Slot 2-5-EX+	Slot 3-5-EX+	Slot 4-5-EX+
<b>22</b>	Slot 1-5-RTD+	Slot 2-5-RTD+	Slot 3-5-RTD+	Slot 4-5-RTD+
<b>23</b>	Slot 1-5-RTD-	Slot 2-5-RTD-	Slot 3-5-RTD-	Slot 4-5-RTD-
<b>24</b>	Slot 1-5-COM	Slot 2-5-COM	Slot 3-5-COM	Slot 4-5-COM
<b>25</b>	Slot 1-5-GND	Slot 2-5-GND	Slot 3-5-GND	Slot 4-5-GND
<b>26</b>	Slot 1-6-EX+	Slot 2-6-EX+	Slot 3-6-EX+	Slot 4-6-EX+
<b>27</b>	Slot 1-6-RTD+	Slot 2-6-RTD+	Slot 3-6-RTD+	Slot 4-6-RTD+
<b>28</b>	Slot 1-6-RTD-	Slot 2-6-RTD-	Slot 3-6-RTD-	Slot 4-6-RTD-
<b>29</b>	Slot 1-6-COM	Slot 2-6-COM	Slot 3-6-COM	Slot 4-6-COM
<b>30</b>	Slot 1-6-GND	Slot 2-6-GND	Slot 3-6-GND	Slot 4-6-GND
<b>31</b>	Slot 1-7-EX+	Slot 2-7-EX+	Slot 3-7-EX+	Slot 4-7-EX+
<b>32</b>	Slot 1-7-RTD+	Slot 2-7-RTD+	Slot 3-7-RTD+	Slot 4-7-RTD+
<b>33</b>	Slot 1-7-RTD-	Slot 2-7-RTD-	Slot 3-7-RTD-	Slot 4-7-RTD-
<b>34</b>	Slot 1-7-COM	Slot 2-7-COM	Slot 3-7-COM	Slot 4-7-COM
<b>35</b>	Slot 1-7-GND	Slot 2-7-GND	Slot 3-7-GND	Slot 4-7-GND
<b>36</b>	Slot 1-8-EX+	Slot 2-8-EX+	Slot 3-8-EX+	Slot 4-8-EX+
<b>37</b>	Slot 1-8-RTD+	Slot 2-8-RTD+	Slot 3-8-RTD+	Slot 4-8-RTD+
<b>38</b>	Slot 1-8-RTD-	Slot 2-8-RTD-	Slot 3-8-RTD-	Slot 4-8-RTD-
<b>39</b>	Slot 1-8-COM	Slot 2-8-COM	Slot 3-8-COM	Slot 4-8-COM
<b>40</b>	Slot 1-8-GND	Slot 2-8-GND	Slot 3-8-GND	Slot 4-8-GND

**Figure 5.** Labelling convention for 3-pin connector



**Table 6.** Pinout for connector 9

Pin	Connector #
	9
A	24VDC
B	0VDC
C	GND

# Assembly Instructions OMEGA (MTC-41-FF)

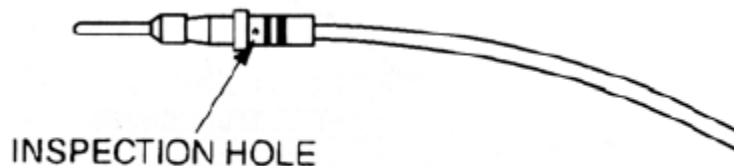
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## CONTACT TERMINATION

Contacts are crimp terminated onto the wire outside the connector assembly. A specially designed MS standard crimping tool (OMEGA® MTC-CT) must be used to properly crimp wires to the pins or sockets.

1. Strip the wire (20 to 24 gage) .170" to .201"; avoid nicking the wires or damaging the insulation as it is a functional part of the sealing system.
2. Insert the stripped wire into the contact pocket until it is visible through the inspection hole (see [Figure 6](#)).
3. Fully seat contact in crimp tool positioner.
4. Crimp in one full stroke. (Ratchet action ensures a complete crimp every time.)
5. Inspect crimp for wire visibility through inspection hole.

**Figure 6.** Inserting Stripped Wire into the Contact

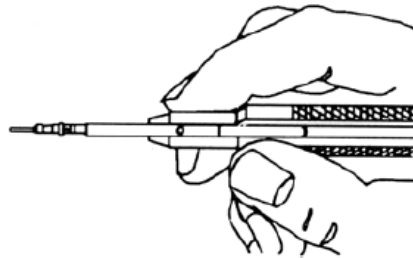


## CONTACT INSERTION

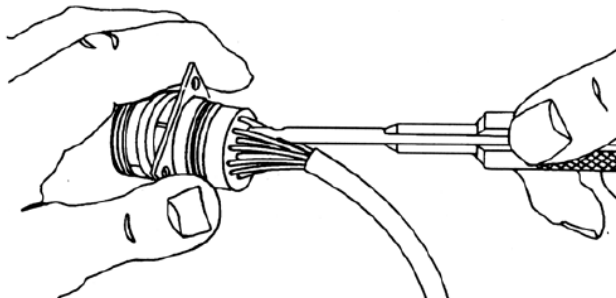
Once the contacts are properly crimped onto the wire, they are inserted into the appropriate cavity of the connector by means of an insertion tool (OMEGA's MTC-IT). Assembly of the contacts into the connector must be made with reasonable care to avoid damage to the insulation.

1. Lubricate the wire cavities in the back face of insert (on the connectors) with a very thin film of silicone oil, or equal, before inserting contacts.
2. Locate contact in insertion tool as shown in [Figure 7](#).
3. Align contact with the hole in the rear face of the insert (see [Figure 8](#)). The alignment of the insertion tool with contact must be coaxial with the axis of the connector. When the contact has entered the rear seal portion of the insert, maintain alignment of contact and tool parallel to and in line with the hole. Insert the contact to full depth. User will hear contact click-in when seated fully in retention collet.
4. Remove insertion tool, keeping it aligned with the hole.

**Figure 7.** Locating Contact into Insertion Tool



**Figure 8.** Aligning Contact



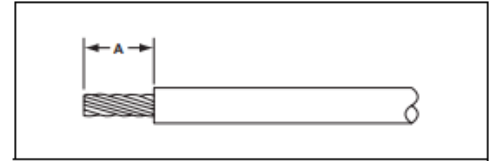
For additional information & specifications on the wire crimping see pages 8-14 of [MTC Series Connectors.pdf](#)

# Assembly Instructions 97 Series (10SL-3)

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## WIRE STRIPPING

1. Strip wire to required length. (See Figure at right). When using hot wire stripping do not wipe melted insulation material on wire strands; with mechanical strippers do not cut or nick strands.
2. See [Table 7](#) for proper finished outside wire dimensions.
3. Twist strands together to form a firm bundle.
4. Insert stripped wire into contact applying slight pressure until wire insulation butts against wire well. Check inspection hole to see that wire strands are visible. If there are strayed wire strands, entire wire end should be re-twisted. When wire is stripped and properly installed into contact, the next step is to crimp the wire inside the contact by using the proper crimping tool.



For additional information & specifications on the 97 series connector assembly see pages 27-29 of [97 series catalog.pdf](#)

**Table 7.** Wire crimping for Amphenol 97 Series

Contact size	Wire range	Stripping Length "A"	Contact part number	Crimping tool part number	Insertion/Extraction Tool part number
	AWG	Inch			
16	20-16	0.140 - 0.160	9755-1622X-X	357-578	M81969/14-03

# Additional Technical Documentation

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Additional technical documentation for smart hardware components used in the MAGNI System can be found and downloaded from the following table:

**Table 8.** MAGNI System - Additional Technical Documentation

Hardware	OEM Part #	Technical Document
4-slot Embedded Real-Time Controller	NI-9064	<a href="#">View Datasheet</a>
8-Ch RTD, 0 $\Omega$ to 400 $\Omega$ , 24 Bit, 400 S/s Aggregate Module	NI-9216	<a href="#">View Datasheet</a>
Omega MTC Series Circular Connectors	MTC-41-FF	<a href="#">View Catalog</a>
CONEC Series Cat6a RJ45 Inline Coupler	17-150134	<a href="#">View Datasheet</a>
Amphenol 97 Series Circular Connectors	97-3102A-10SL-3P	<a href="#">View Catalog</a>



# Valkyrie Warranty & Support

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The MAGNI System comes with a 1-year replacement warranty that covers any defective hardware as specified by the original OEM. All control panels including the MAGNI system undergo an extensive quality control & assurance process. All panels are UL508A certified (Standard). CSA General purpose certification is available upon request.

Our Engineers are available to answer any technical or troubleshooting questions regarding products, installation and future design updates. Contact us directly at [info@valkyriecontrols.com](mailto:info@valkyriecontrols.com) or through LinkedIn at [www.linkedin.com/in/valkyrie-controls](http://www.linkedin.com/in/valkyrie-controls).

You can learn more about our other pre-engineered systems or request a free industrial panel design at [www.valkyriecontrols.com](http://www.valkyriecontrols.com)

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