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AM-9898 HART Communications CompactRIO Module

AM-9898

Getting Started (LabVIEW Help) Manual

Revision 1.6

April 24, 2015

Amtec Solutions Group, Inc.

Revision History

Version	Date	Description
1.0	04/30/2014	Initial version
1.1	07/15/2014	Added safety and installation information
1.2	10/07/2014	Added information based on conformance and beta testing
1.3	12/02/2014	Updated certification date of issue; added latch composition
1.4	01/08/2015	Updated module image; updated text and French verbiage
1.5	01/19/2015	Added ingress protection rating to specifications
1.6	04/24/2015	Added ATEX information and updated standards table

Drawing Number

STD-HART-30001 UM

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Important Information

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Contents

List of Figures

About This Manual

Use this manual to configure the AM-9898 CompactRIO module hardware and software. This manual will also help in learning the basics of HART communications, as well as how to develop an application.

Related Documentation

The following links contain information that you might find helpful as you read this manual.

How HART Works
http://en.hartcomm.org/hcp/tech/aboutprotocol/aboutprotocol_how.html

About HART
http://www.analogservices.com/about_part0.htm

What is NI CompactRIO?
http://www.ni.com/compactrio/whatis

Please note the previous links (and any other links throughout the manual) are valid at time of publication but not maintained by ASG.

Introduction

This chapter provides an introduction to the HART Communications, National Instruments CompactRIO system, and the ASG AM-9898 cRIO module.

Warning – If the equipment is used in a manner not specified by the manufacturer, the overall safety may be impaired.
Avertissement – Si l'équipement est utilisé d'une manière non spécifiée par le fabricant, la sécurité d'ensemble peut être réduite.

HART Communications

The HART (Highway Addressable Remote Transducer) Protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring system.

More specifically, HART is a bi-directional communication protocol that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a plant's process control, asset management, safety or other system using any control platform.

Refer to the HART Communication Foundation <www.hartcomm.org> for a more detailed summary of the HART Communication Standard.

CompactRIO System

National Instruments CompactRIO is an advanced embedded control and acquisition system powered by NI reconfigurable I/O (RIO) technology. CompactRIO combines low power consumption, real-time embedded processor with a high-performance RIO FPGA chipset. The RIO core has built-in data transfer mechanisms to pass data to the embedded processor for real-time analysis, post processing, data logging, or communication to a networked host computer. CompactRIO provides direct hardware access to the I/O circuitry of each I/O module using LabVIEW FPGA I/O functions. Each I/O module includes built-in connectivity, signal conditioning, conversion circuitry (such as ADC or DAC), and an optional isolation barrier.

Refer to National Instruments <www.ni.com/compactrio> for more information about CompactRIO.

AM-9898 Module

The ASG AM-9898 is a single slot HART communication and current input module for the CompactRIO platform. Each module has four (4) HART communication channels and four (4) 4 to 20 mA current inputs. The AM-9898, as well as the CompactRIO controller, is intended for use in industrial locations.

> Note – The nominal voltage range across each 4 to 20 mA loop is 1 to 5 VDC.

AM-9898 Software

The ASG AM-9898 module includes all software necessary to operate without any knowledge of the LabVIEW development environment. All code is written in LabVIEW 2012 and is not backwards compatible.

The software architecture is broken up into two (2) main parts.

> **FPGA -** The FPGA application is designed to handle all communication with the AM-9898 module. This communication is handled through the RT application. The FPGA code can be modified to accommodate other cRIO modules or other functionality as needed by the user.
>
> **Real-Time -** There are several RT applications that are included. The main applications included are as follows:
>
> > **AI Read Currents** – reads currents as well as read the module serial number, vendor ID and module ID.
> >
> > **HART Scan Devices** – scans all HART short addresses (0 – 15) on a specific channel (0 – 3)
> >
> > **HART Multidrop** – continually scans a list of HART long addresses for their primary variable values
> >
> > **HART Echo** – will receive any cRIO RS-232 characters and transmit via HART as well as receive any HART characters and transmit via RS-232.

Supported Hardware Platforms

The AM-9898 module is fully compliant with MDK 2.0 therefore is compatible with any NI CompactRIO System.

Installation

This section explains how to install and remove the ASG AM-9898 module from a CompactRIO (cRIO) chassis.

Installing the Module

Complete the following steps to install the AM-9898 module in the chassis.

1. Make sure that no I/O-side power is connected to the module. If the system is in a non-hazardous location, the chassis power can be on when you install module(s).
2. Align the module with an I/O module slot in the chassis as shown in Figure 1. The module slots are labeled 1 to 8, left to right.
3. Squeeze the latches and insert the module into the module slot.
4. Press firmly on the connector side of the module until the latches lock the module into place.
5. Repeat these steps to install additional modules.

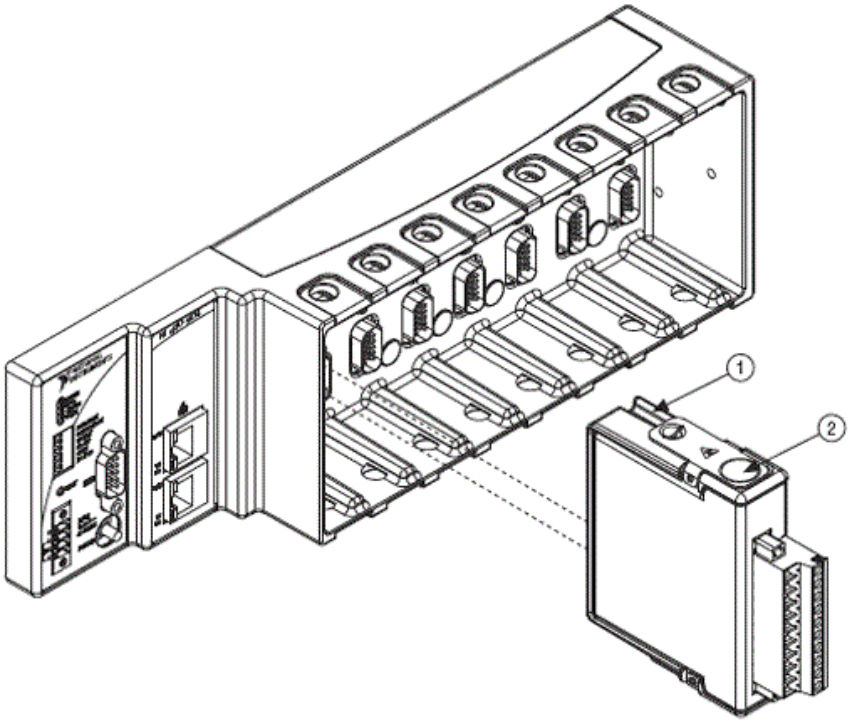


Figure 1 – Installing Module

Warning – The module is intended to be installed in an Approved chassis powered from a source rated Limited-Energy Circuit or Limited Power Source.

Avertissement *– Le module est destiné à être installé dans un châssis approuvé et alimenté par un circuit à énergie limitée ou par une source à puissance limitée.*

Condition of Safe Use

The enclosure for the equipment shall provide a degree of protection not less than IP54 in accordance with IEC 60529 unless the equipment is intended to be afforded an equivalent degree of protection by location.

Removing the Module

Complete the following steps to remove the AM-9898 module from the chassis.

1. Make sure that no I/O-side power is connected to the module. If the system is in a non-hazardous location, the chassis power can be on when you remove module(s).
2. Squeeze the latches on both sides of the module and pull the module out of the chassis.

Wiring for High-Vibration Applications

If an application is subject to high vibration, ASG recommends that you either use ferrules to terminate wires to the detachable screw-terminal connector or use the National Instruments NI-9932 backshell kit to protect the connections. Refer to Figure 2 for an illustration of using ferrules.
Si une application est soumise à de fortes vibrations, ASG recommande que soit vous utilisez les embouts sur le connecteur à bornes à vis amovible soit vous utilisez le kit de raccord arrière NI-9932 de National Instruments afin de protéger les connexions . Reportez- vous à la figure2 pour une illustration de l'utilisation de viroles.

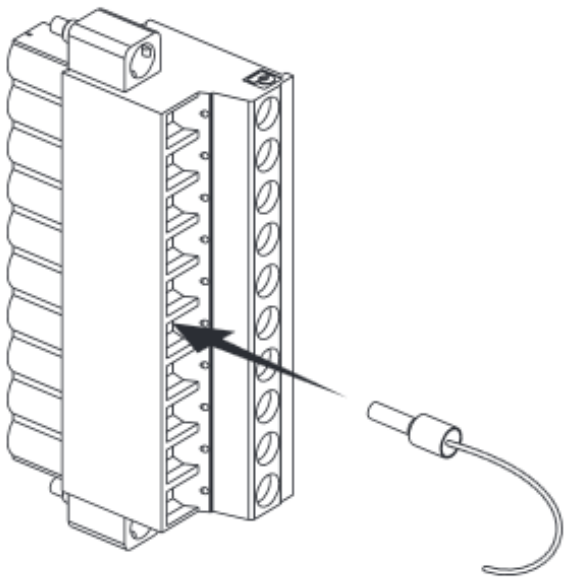


Figure 2 – Connecting Ferules

Safety Guidelines

WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS;
AVERTISSEMENT *- RISQUE D'EXPLOSION -AVANT DE DECONNECTER L'EQUIPEMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DESIGNE NON DANGEREUX.*

The AM-9898 module is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class 1, Zone 2, AEx nA IIC T4 and Ex nA IIC T4 hazardous locations; and non-hazardous locations only. Follow these guidelines if you are installing the AM-9898 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.
Le module AM-9898 est adapté pour une utilisation en les emplacements dangereux T4 de Classe I, Division 2, Groupes A, B, C, D; en les emplacements dangereux AEx nA IIC T4 et Ex nA IIC T4 de Classe 1, Zone 2; et en les emplacements non dangereux. Suivez ces instructions si vous installez l'AM-9898 dans un environnement potentiellement explosif. Ne pas suivre ces directives peut entraîner des blessures graves ou la mort.

Warning Do not disconnect the power supply wires and connectors from the controller unless power has been switched off;
Avertissement *Ne débranchez pas les câbles d'alimentation et les connecteurs du contrôleur à moins que l'alimentation soit coupée.*

Warning Do not remove module unless power has been switched off or the area is known to be non-hazardous;
Avertissement *Ne retirez pas le module à moins que l'alimentation soit coupée ou que la zone soit connue d'être non dangereux.*

Warning Substitution of components may impair suitability for Class I, Division 2;
Avertissement La substitution de composants peut nuire à la conformité de Classe I, Division 2.

Warning For Zone 2 applications, install the CompactRIO system in an enclosure rated to at least IP 54 as defined by IEC 60529 and EN 60079-0;
Avertissement *Pour les applications de Zone 2, installez le système CompactRIO dans un boîtier classé au moins IP 54 selon les normes IEC 60529 et EN 60079-0.*

Safety Standards

The AM-9898 module meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:
Le module AM-9898 répond aux exigences suivants des normes de sécurité pour appareils électriques de mesure, de régulation et de laboratoire:

Standard of Safety	Issue Date
EN 60079-0. Edition 6.0 2012	10/15/2014
EN 60079-15 Edition 4.0 2010	10/15/2014
UL 60079-0 Sixth Edition, Dated July 26, 2013	10/15/2014
CAN/CSA-C22.2 No.60079-0:11, December 2011	10/15/2014
UL 60079-15, Edition Date: February 15, 2013	10/15/2014
CAN/CSA-C22.2 No. 60079-15:January 2012	10/15/2014
UL 61010-1, 3rd Ed., 2012-05-11	10/15/2014
CAN/CSA-C22.2 No. 61010-1-12, 3rd Ed, 2012-05-11	10/15/2014

Conforms to ANSI/ISA Std. 12.12.01 & UL Stds 61010-1, 60079-0, 60079-15
Certified to CAN/CSA Std. C22.2 Nos. 213, 61010-1, 60079-0 & 60079-15

Intertek
4010888

ATEX Certificate
ITS14ATEX18145X

II 3 G
Ex nA IIC T4 Gc
AEx nA IIC T4 Gc
ITS14ATEX18145X

Enclosure Material Grade

The AM-9898 module housing meets the requirements of the IECEx (Hazardous Location) standard with the following composition.
Le boîtier du module AM-9898 répond aux exigences des normes de l' IECEx (emplacements dangereux) avec la composition suivante.

Part	Material
Blue Die Cast Enclosure Part	A380 Aluminum
Silver Enclosure Part	1100-H25 Aluminum
Latches	301/304 Stainless Steel

Application Development

This chapter describes how to implement and utilize the AM-9898 module quickly and efficiently within your application.

As described before, the software supplied with the AM-9898 module is broken up into two (2) parts. Both sections will be described in detail. Please note that the top level VI's for each section can be modified according to the user's needs.

- cRIO FPGA application – Interface with the HART hardware
- cRIO RT application – Handles all AM-9898 configuration and communication

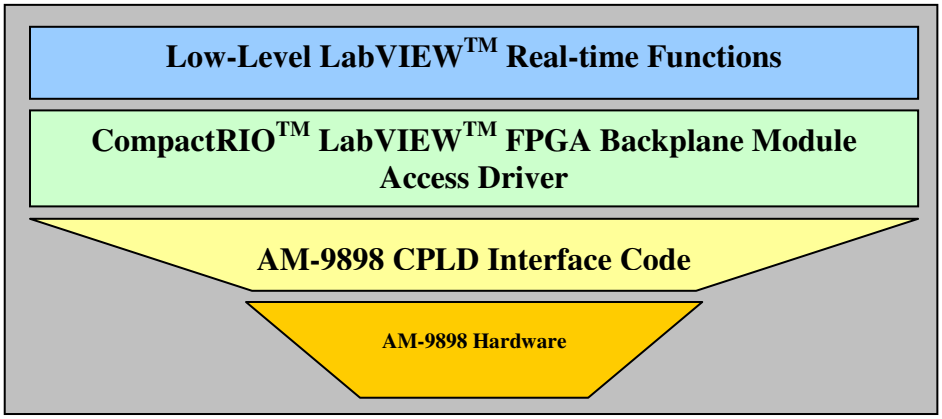


Figure 3 – Application Architecture

Software Configuration

Step 1. Open the AM-9898 HART Module Project file (.lvproj).

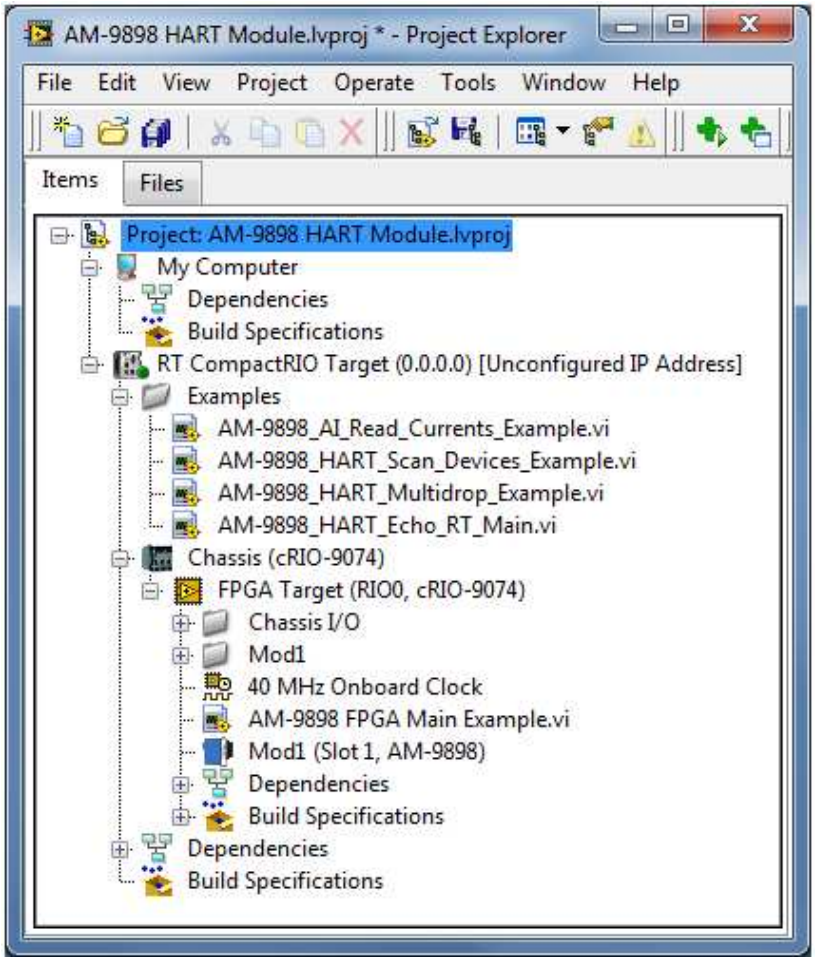


Figure 4 – HART Module Project

Step 2. Configure the CompactRIO IP address in the project to match your cRIO IP address. The example code is configured for the cRIO-9074 but can be modified for other cRIO chassis. Refer to **Appendix A** for instructions on changing targets.

Step 3. Verify the AM-9898 HART module is placed in the first slot of the cRIO chassis. Refer to **Appendix B** for instructions on changing module slot position.

Step 4. Open the top-level FPGA example (AM-9898 FPGA Main Example.vi) and compile the FPGA code.

Step 5. Open one of the Real-Time examples, make sure the FPGA reference is pointing to the correct FPGA, then save and run.

FPGA Example

The FPGA application is designed to communication with the AM-9898 hardware, onboard CPLD, and EEPROM. The FPGA code need not be opened and/or run separately as the RT application handles opening, running, and configuring the FPGA as needed.

The FPGA application need only be modified if other modules are added or other FPGA operations need be performed.

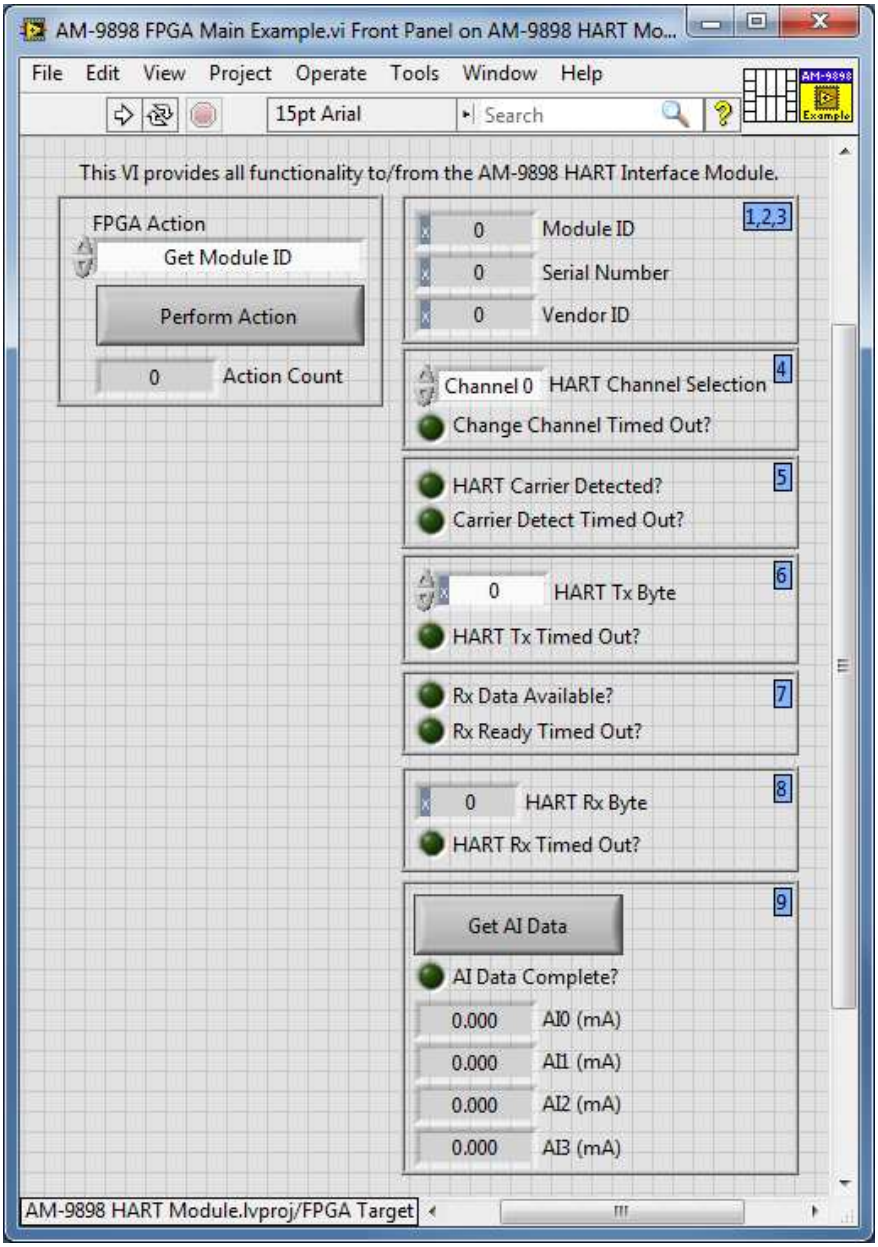
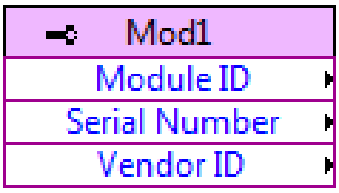


Figure 5 – FPGA Example

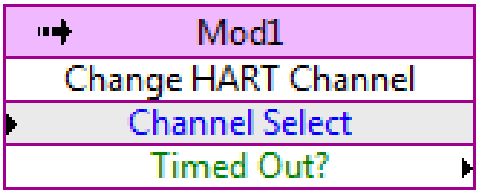
FPGA Functions

The FPGA example is comprised of all FPGA functions.

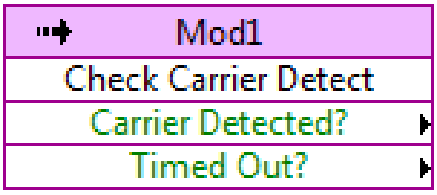
Module ID – returns the module ID (ex. 77A2)
Serial Number – returns the module serial number
Vendor ID – returns the vendor ID (ex. 414D)



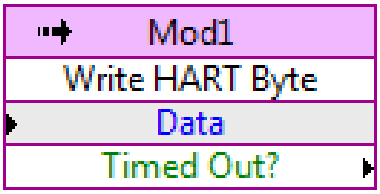
Change HART Channel – changes the current HART channel. Available channels are Ch 0, 1, 2, and 3.



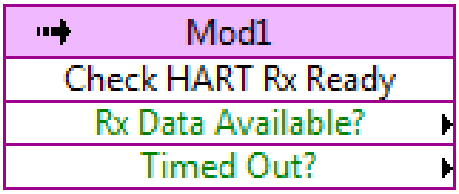
Check Carrier Detect – determines if a HART device is transmitting on the currently connected HART channel



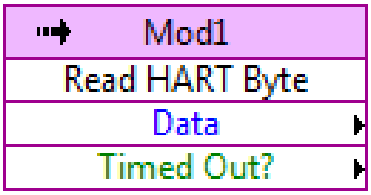
Write HART Byte – transmits a HART character on the currently connected HART channel



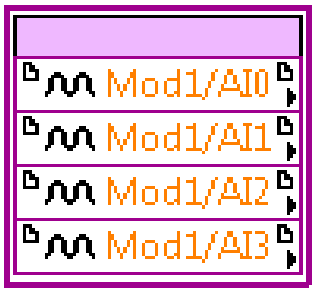
Check HART Rx Ready – determines if a HART character is available to be read from the CPLD buffer (CPLD buffer can hold a maximum of 10 characters)



Read HART Byte – receives a HART character from the CPLD buffer



Read Analog Input – reads current loop value (maximum rate of 80 samples / second is throttled by the FPGA)



RT Example – Read AI Current

The AI Read Currents example is designed to get the module ID, serial number, and vendor ID as well as continually acquire all four (4) current input channels.

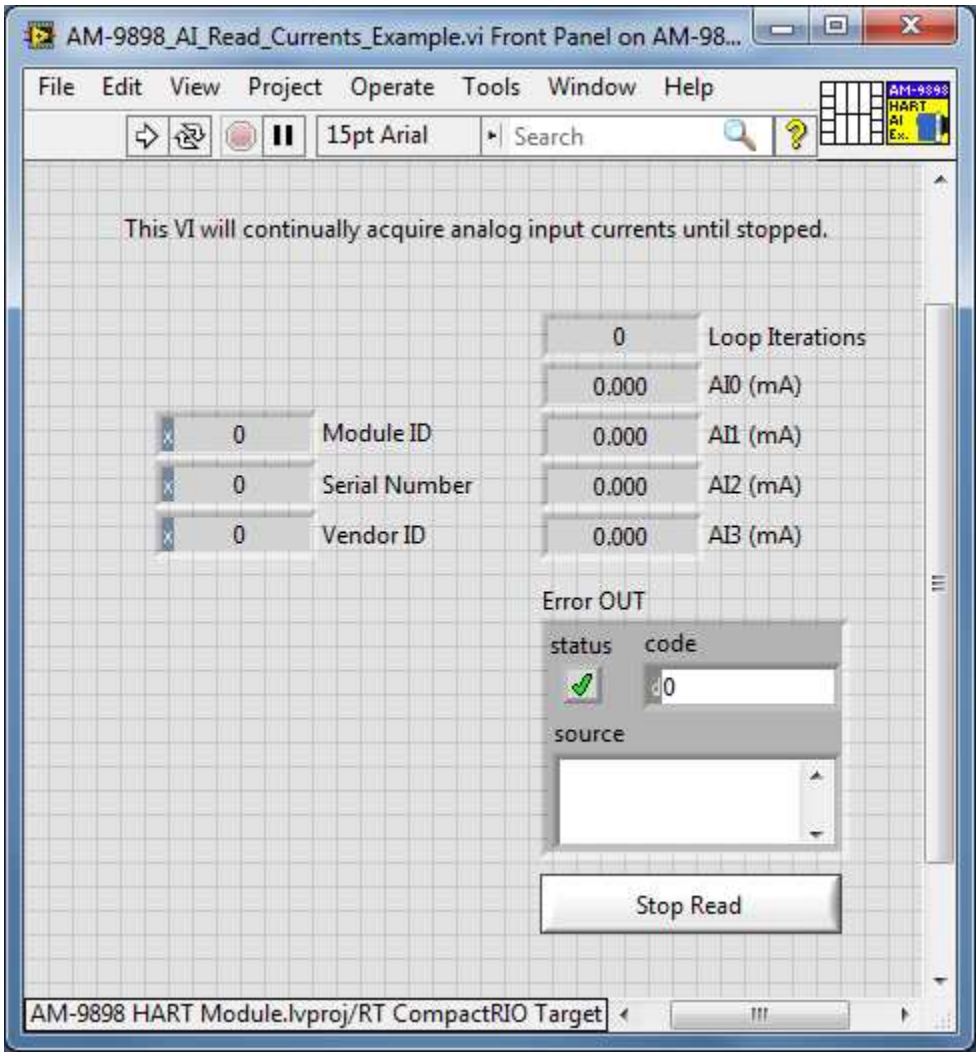


Figure 6 – RT Example (Read AI)

RT Example – HART Scan

The HART scan devices example will connect to a specific HART channel, then poll up to sixteen (16) short addresses and display the connected devices data. This example serves as a great "getting started" example as the user can simply press run and connected devices will be populated in the table.

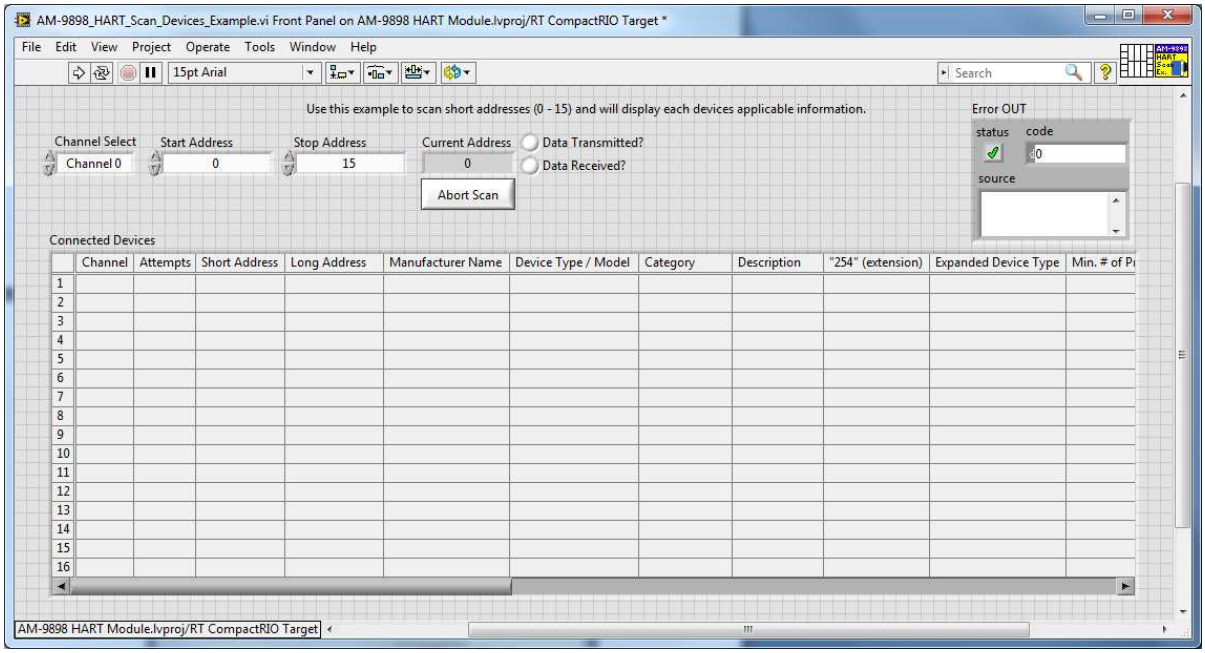


Figure 7 – RT Example (HART Scan)

RT Example – HART Multidrop

The HART multidrop example will continually acquire the primary variable data for a selected list of connected devices. This example is intended to be run after the previous (Scan Devices) example. Refer to **Appendix C** for information on connecting multiple sensors.

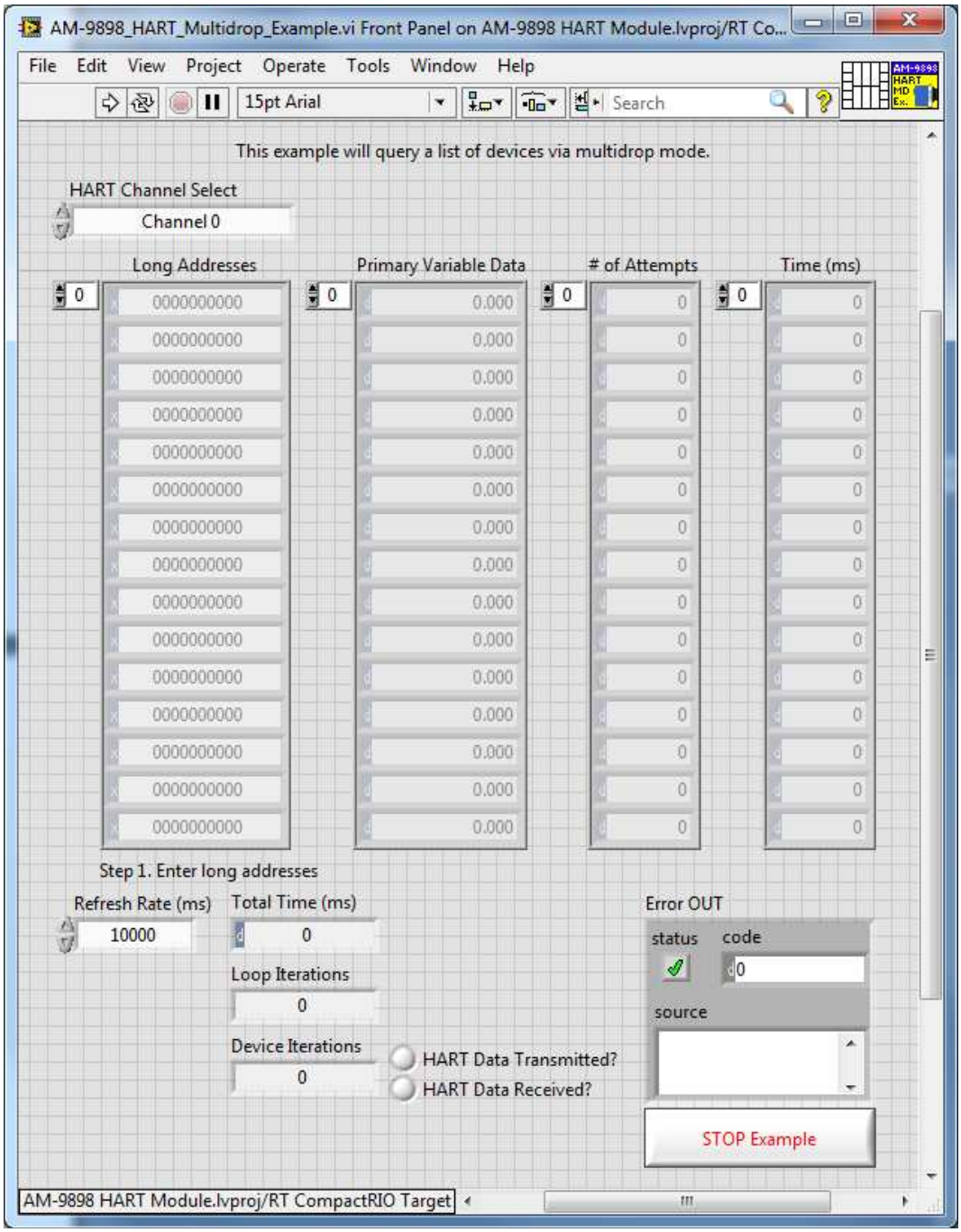


Figure 8 – RT Example (HART Multidrop)

RT Example – RS-232 Echo

The RS-232 to HART emulator example's purpose is to allow the AM-9898 module (and cRIO) to be used with an off-the-shelf RS-232 HART master application. The emulator will continually read the RS-232 port on the cRIO and will echo any data through the AM-9898 module, and vice versa. This emulator has been thoroughly tested using HART Server v3.1 master application and is delivered as is.

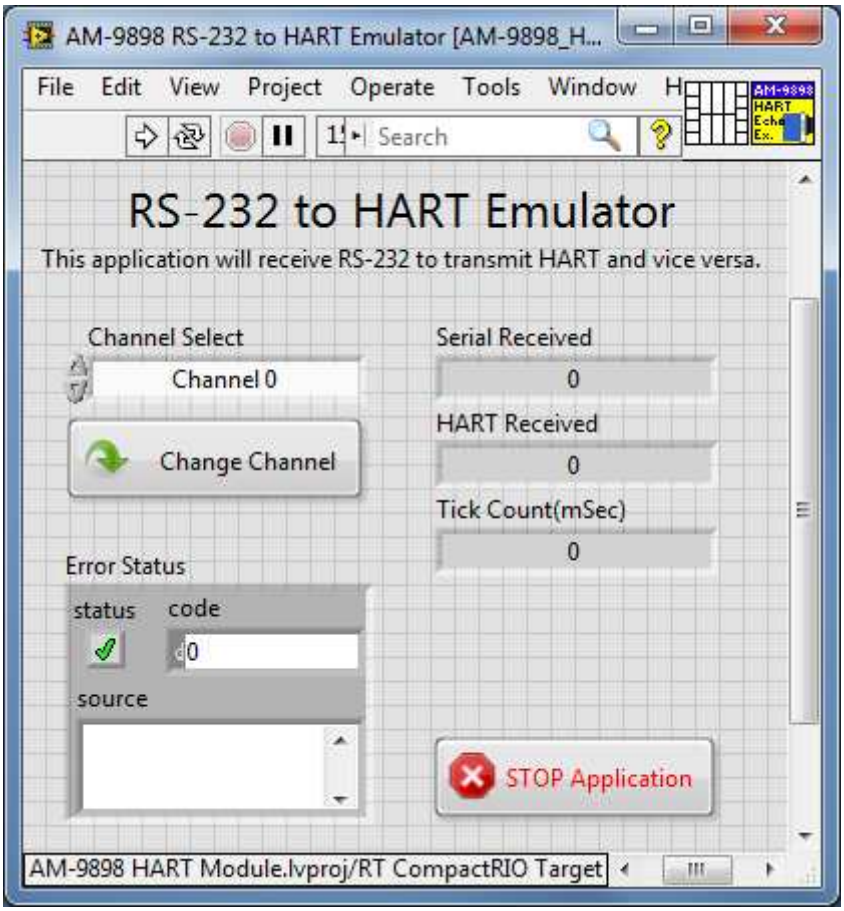


Figure 9 – RT Example (RS-232 Echo)

Appendix A – Changing cRIO Targets

The AM-9898 Project example includes support for the cRIO-9074 real-time controller and FPGA target. If another cRIO target is used (example cRIO-9073), you must add your target to the AM-9898 Project. After adding your target, you can move the contents from the cRIO-9074 target to your new target.

Create a new real-time target in the **Project Explorer** window.

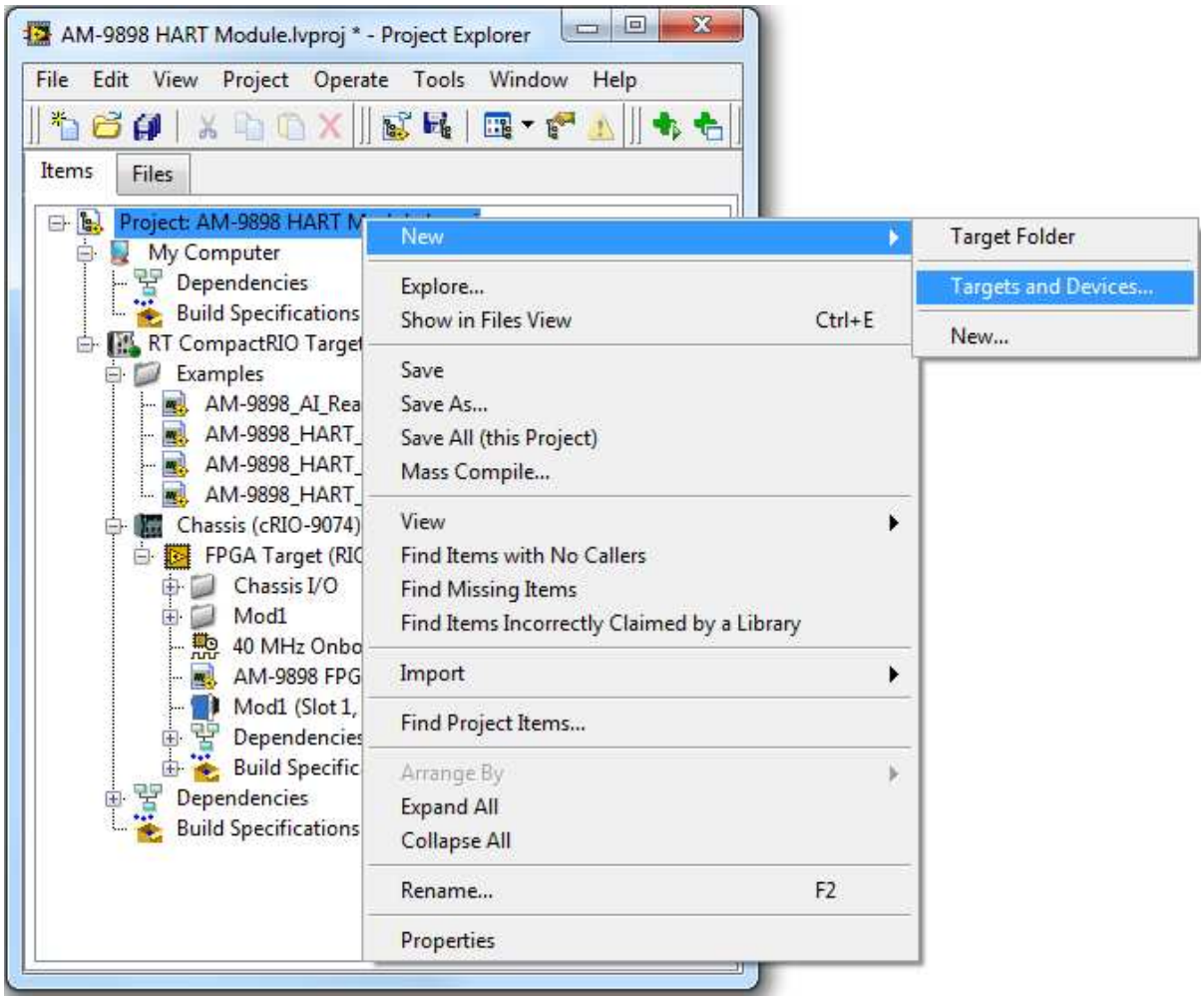


Figure 10 – Changing cRIO Targets

Supporting Links:

Moving Examples to Another FPGA Target
http://zone.ni.com/devzone/cda/tut/p/id/5075

Reusing FPGA VIs and FPGA Items among Multiple FPGA Targets
http://zone.ni.com/reference/en-XX/help/371599B-01/lvfpgahelp/reusing_fpgaio/

Appendix B – Changing Module Slots

The example project is configured to have the module inserted into the first cRIO slot but the module can be inserted in any available slot. This appendix describes how to change the slot position.

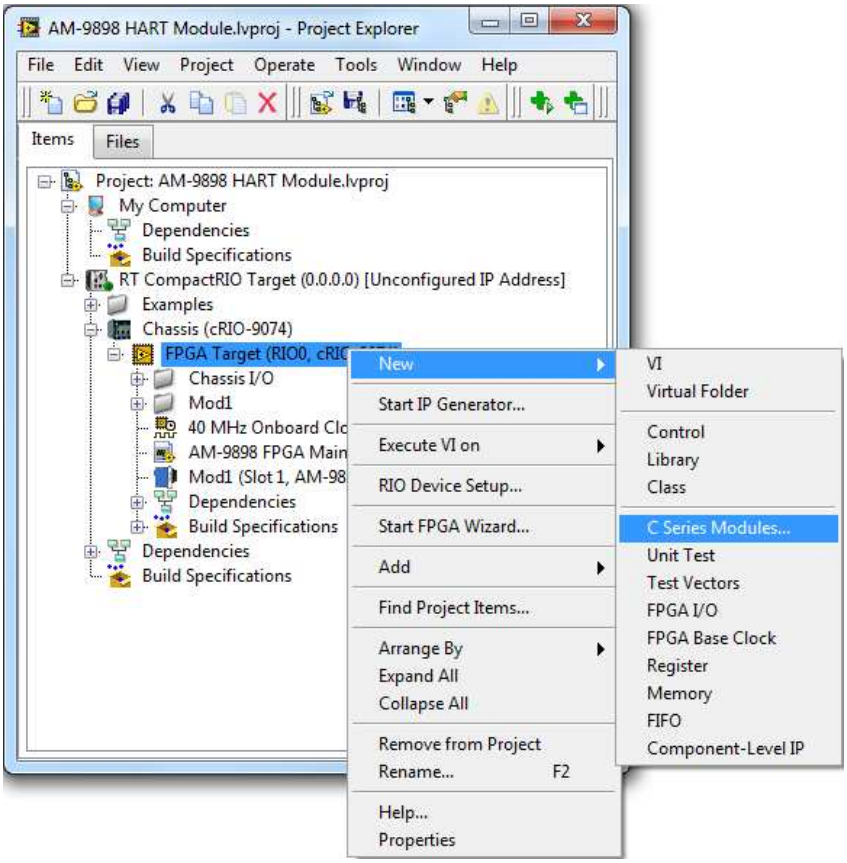
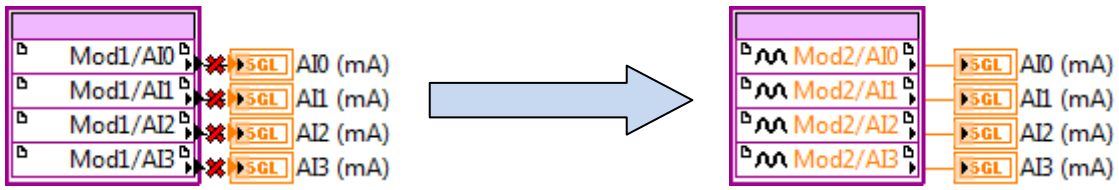


Figure 11 – Changing Module Slots

Step 1. Insert the module into the desired cRIO slot
Step 2. Right-click the FPGA Target and add New…C Series Modules
Step 3. Click *Existing target or device* in order to scan for inserted module
Step 4. Remove the previous Mod1 module as well as the Mod1 virtual folder
Step 5. Open the AM-9898 FPGA Main Example.vi
Step 6. Link all nodes to new module (AI, property nodes, etc…)



Appendix C – Multidrop Mode

The AM-9898 module is designed for a normal 4-20 mA input loop range. To use the module for more than 5 sensors in multidrop mode, each set to its minimum (assuming 4 mA), an external component is required to limit the current through the loop to a maximum of 20 mA. The recommended component is a 100 mH inductor rated for the maximum expected current (60 mA for 15 sensors). Refer to Figure 14 when wiring a multidrop network.

Recommended Inductor

Digikey P/N	M8337-ND
Bourns Mfg. P/N	5900-104-RC
Description	100 mH Hi current choke, 65 mA

Appendix D – Terminal Assignment

The AM-9898 module consists of a 10-position screw-terminal as shown below. There are a total of four (4) channels that can be wired for the AM-9898 module (Ch 0, Ch 1, Ch 2, and Ch 3). The input for each channel shall be wired to the + side while the return shall be wired to the – side. The N/C (pin 2 and pin 7) are not used.

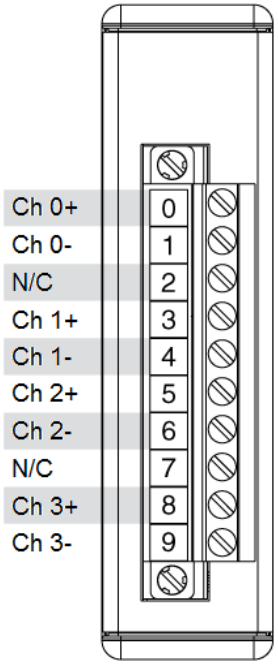


Figure 12 – Terminal Assignment

Appendix E – Specifications

This appendix describes the physical characteristics of the AM-9898 hardware, along with the recommended operating conditions.

Power Requirements

Power Consumption (from chassis)

Active Mode	325 mW max
Sleep Mode	5 mW max
Operating Voltage	5 ± 5 % VDC

Thermal Dissipation (at 70 °C)

Active Mode	657 mW max
Sleep Mode	466 mW max

Physical

Form Factor	NI CompactRIO module
Height	3.5 inches (88.9 mm)
Depth	2.8 inches (71.1 mm)
Width	0.9 inches (22.86 mm)
Weight	138.5 grams

Environmental

AM-9898 modules are intended for indoor use only, but may be used outdoors if installed in a suitable enclosure. Refer to the installation instructions for the CompactRIO chassis you are using for more information about meeting these specifications.

Operating Temperature	-40 to 70 °C
Humidity	10 to 90 % RH, non-condensing
Pollution Degree (IEC 60664)	2
Maximum Altitude	2,000 meters

Analog Input Accuracy Specification

Max Accuracy over Temp at Full Scale	1.0 %
Typical Accuracy at 25 Deg C	0.1 %

HART Specification

RX Impedance	272 Ω
Capacitance	13 nF
Max Input Current per Channel	20 mA

Ingress Protection

AM 9898	IP 30
AM 9898 with screw connector attached	IP 40

Appendix F – Network Connections

This appendix describes how to make point to point as well as multidrop network connections.

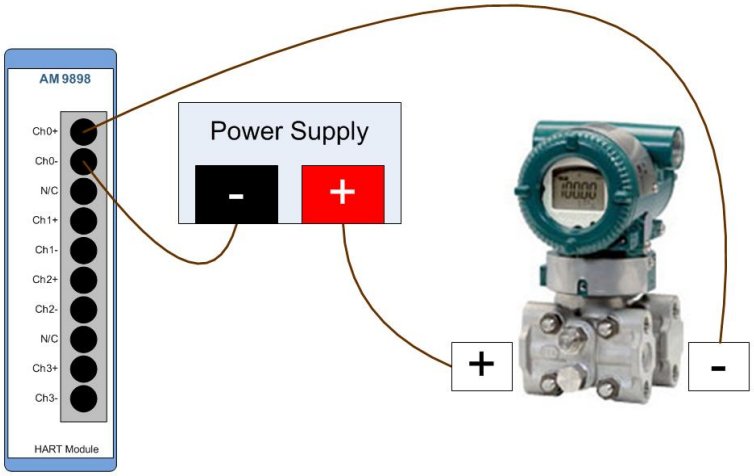


Figure 13 – Point to Point Network

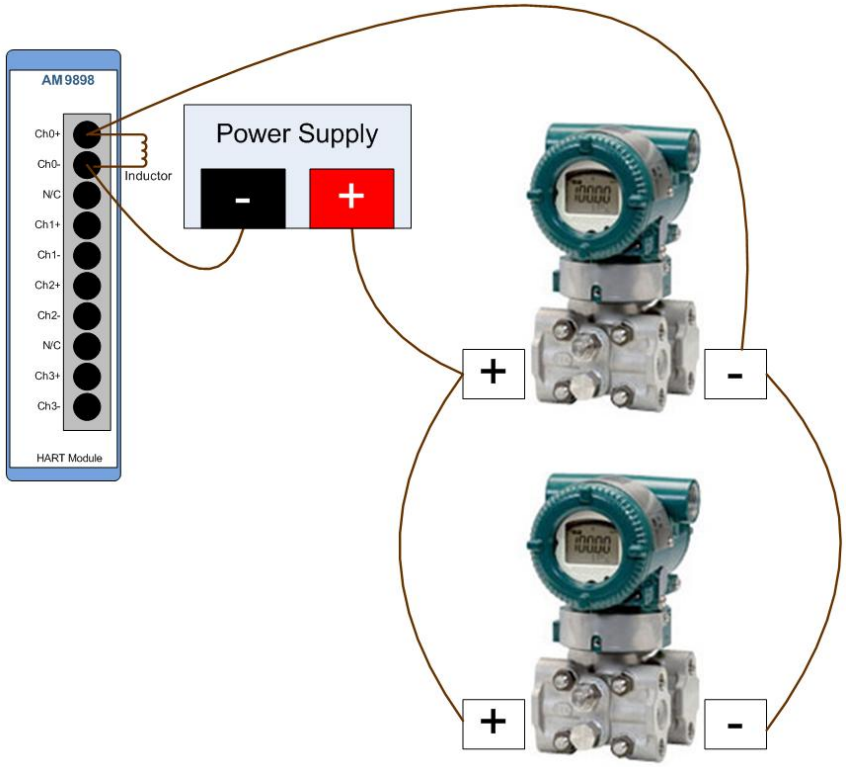


Figure 14 – Multidrop Network

Continue adding devices as shown for multidrop mode. As noted in Appendix C, **ensure an inductor is in place if using multidrop with more than five (5) devices otherwise damage to the module can occur.**