METTLER TOLEDO

IND780
Q.iMPACT
Terminal
Technical Manual

www.mt.com

64068643
(01/2010) R00

FCC Notice

This device complies with Part 15 of the FCC Rules and the Radio Interference Requirements of the Canadian Department of Communications. Operation is subject to the following conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his or her expense.

- Declaration of Conformity is located on the documentation CD, part number 64057241.

RoHS Compliance Statement.

- The majority of our products fall within categories 8 and 9. Those categories currently do not fall within the scope of the Directive 2002/95/EG (RoHS) of January 27, 2003. If our products are intended for use in other products which themselves fall within the scope of the RoHS Directive, compliance requirements have to be separately negotiated contractually.
- Those products which fall within categories 1-7 and 10 will be in compliance with the EU RoHS Directive from no later than July 1, 2006.
- If it is not possible for technical reasons to replace any non-RoHS-compliant substances in any of the above products as required, we plan to inform our customers in a timely manner

Statement regarding harmful substances.

- We do not make direct use of harmful materials such as asbestos, radioactive substances or arsenic compounds. However, we purchase components from third party suppliers, which may contain some of these substances in very small quantities.

CUSTOMER FEEDBACK

Your feedback is important to us! If you have a problem with this product or its documentation, or a suggestion on how we can serve you better, please fill out and send this form to us. Or, send your feedback via email to: quality_feedback.mtwt@mt.com. If you are in the United States, you can mail this postpaid form to the address on the reverse side or fax it to (614) 438-4355. If you are outside the United States, please apply the appropriate amount of postage before mailing.

Your Name:		Date:
Organization Name:		METTLER TOLEDO Order Number:
Address:		Part / Product Name:
		Part / Model Number:
		Serial Number:
		Company Name for Installation:
Phone Number: ( )	Fax Number: ( )	Contact Name:
E-mail Address:		Phone Number:

Please check the appropriate box to indicate how well this product met your expectations in its intended use?	
	Met and exceeded my needs
	Met all needs
	Met most needs
	Met some needs
	Did not meet my needs

Comments/Questions:

DO NOT WRITE IN SPACE BELOW; FOR METTLER TOLEDO USE ONLY

☐ Retail ☐ Light Industrial ☐ Heavy Industrial ☐ Custom

RESPONSE: Include Root Cause Analysis and Corrective Action Taken.

FOLD THIS FLAP FIRST

NO POSTAGE
NECESSARY
IF MAILED IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 414 COLUMBUS, OH

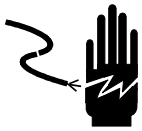
POSTAGE WILL BE PAID BY ADDRESSEE

Mettler-Toledo, Inc.
Quality Manager - MTWT
P.O. Box 1705
Columbus, OH 43216
USA

Please seal with tape

PRECAUTIONS

- READ this manual BEFORE operating or servicing this equipment and FOLLOW these instructions carefully.
- SAVE this manual for future reference.



WARNING!

FOR CONTINUED PROTECTION AGAINST SHOCK HAZARD CONNECT TO PROPERLY GROUNDED OUTLET ONLY. DO NOT REMOVE THE GROUND PRONG.

WARNING!

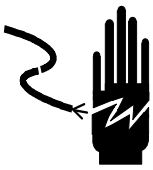
NOT ALL VERSIONS OF THE IND780 ARE DESIGNED FOR USE IN HAZARDOUS (EXPLOSIVE) AREAS. REFER TO THE DATA PLATE OF THE IND780 TO DETERMINE IF A SPECIFIC TERMINAL IS APPROVED FOR USE IN AN AREA CLASSIFIED AS HAZARDOUS BECAUSE OF COMBUSTIBLE OR EXPLOSIVE ATMOSPHERES

WARNING!

IN ORDER TO INSTALL THE DIVISION 2 APPROVED IND780 TERMINAL UTILIZING THE U.S. APPROVAL, METTLER TOLEDO CONTROL DRAWING 174020R MUST BE FOLLOWED WITHOUT EXCEPTION. IN ORDER TO INSTALL THE CATEGORY 3 MARKED IND780 UTILIZING THE EUROPEAN APPROVAL, THE DEMKO APPROVAL CERTIFICATE 07ATEX0520819X AND ALL LOCAL REGULATIONS MUST BE FOLLOWED WITHOUT EXCEPTION. FAILURE TO DO SO COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE. REFER TO THE IND780 DIVISION 2 AND ZONE 2/22 INSTALLATION GUIDE 64063214 FOR ADDITIONAL INFORMATION.

WARNING!

IF THE KEYBOARD, DISPLAY LENS OR ENCLOSURE IS DAMAGED ON A DIVISION 2 APPROVED OR CATEGORY 3 MARKED IND780 TERMINAL THAT IS USED IN A DIVISION 2 OR ZONE 2/22 AREA, THE DEFECTIVE COMPONENT MUST BE REPAIRED IMMEDIATELY. REMOVE AC POWER IMMEDIATELY AND DO NOT REAPPLY AC POWER UNTIL THE DISPLAY LENS, KEYBOARD OR ENCLOSURE HAS BEEN REPAIRED OR REPLACED BY QUALIFIED SERVICE PERSONNEL. FAILURE TO DO SO COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE.



WARNING!

WHEN THIS EQUIPMENT IS INCLUDED AS A COMPONENT PART OF A SYSTEM, THE RESULTING DESIGN MUST BE REVIEWED BY QUALIFIED PERSONNEL WHO ARE FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF ALL COMPONENTS IN THE SYSTEM AND THE POTENTIAL HAZARDS INVOLVED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE.

CAUTION

BEFORE CONNECTING/DISCONNECTING ANY INTERNAL ELECTRONIC COMPONENTS OR INTERCONNECTING WIRING BETWEEN ELECTRONIC EQUIPMENT ALWAYS REMOVE POWER AND WAIT AT LEAST THIRTY (30) SECONDS BEFORE ANY CONNECTIONS OR DISCONNECTIONS ARE MADE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN DAMAGE TO OR DESTRUCTION OF THE EQUIPMENT AND/OR BODILY HARM.

CAUTION

OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES.

IND780 Q.iMPACT Terminal

ServiceXXL
Tailored Services

Essential Services for Dependable Performance

Congratulations on choosing the quality and precision of METTLER TOLEDO. Proper use of your new equipment according to this Manual and regular calibration and maintenance by our factory-trained service team ensures dependable and accurate operation, protecting your investment. Contact us about a ServiceXXL agreement tailored to your needs and budget. Further information is available at www.mt.com/serviceXXL.

There are several important ways to ensure you maximize the performance of your investment:

1. **Register your product:** We invite you to register your product at www.mt.com/productregistration so we can contact you about enhancements, updates and important notifications concerning your product.
2. **Contact METTLER TOLEDO for service:** The value of a measurement is proportional to its accuracy – an out of specification scale can diminish quality, reduce profits and increase liability. Timely service from METTLER TOLEDO will ensure accuracy and optimize uptime and equipment life.
    a. **Installation, Configuration, Integration and Training:** Our service representatives are factory-trained, weighing equipment experts. We make certain that your weighing equipment is ready for production in a cost effective and timely fashion and that personnel are trained for success.
    b. **Initial Calibration Documentation:** The installation environment and application requirements are unique for every industrial scale so performance must be tested and certified. Our calibration services and certificates document accuracy to ensure production quality and provide a quality system record of performance.
    c. **Periodic Calibration Maintenance:** A Calibration Service Agreement provides on-going confidence in your weighing process and documentation of compliance with requirements. We offer a variety of service plans that are scheduled to meet your needs and designed to fit your budget.

Contents

Chapter 1.0

Introduction

IND780 Q.iMPACT

Overview

Congratulations and thank you for purchasing the IND780 Q.iMPACT terminal as your material transfer controller. Q.iMPACT is a unique and advanced application package for the IND780 terminal, engineered exclusively for:

- Feed measurement
- Feed management
- Feed cutoff control

The IND780 Q.iMPACT is a successor to the JAGXTREME®-based Q.iMPACT. The second generation Q.i combines years of material transfer application excellence with the processing power, user interface advances and TaskExpert™ programming flexibility found in the IND780 terminal.

This manual provides an overview of the IND780 Q.iMPACT terminal, and instructions for setup, maintenance and troubleshooting.

Note: For all IND780 information not specifically Q.iMPACT-related, please refer to the IND780 **Installation Guide**, **User's Guide** and **Technical Manual**, provided on the documentation CD-ROM.

Terminology

As you proceed through this and other Q.iMPACT documentation, the following product terms will be used:

- **IND780** refers to the standard hardware terminal. You may be asked to reference the standard IND780 documentation if the subject matter applies directly.
- **Q.i780** refers to the Q.iMPACT software and firmware designed to function with the IND780 hardware terminal. This is also referred to as an application Pac for the IND780.
- **IND780 Q.iMPACT** refers to the combination of the IND780 hardware terminal with the Q.iMPACT software and firmware application.

Q.i is short for **Q.iMPACT**, which is short for **Quantum Impact**. Each of these has a similar meaning:

	Quality Product Improvement
+	Quicker Ingredient Addition
+	Quantifiable Results
=	**Quantum Impact**

"Material Transfer" is one of many terms used to describe the process phase, or manufacturing step, that moves a material from one location to another. The following processes are all types of material transfer, each of which can be optimized using the Q.i technology:

Filling — **Single** movement of a specified amount of product from one single location to another location

Dosing — **Single** movement of a specified amount of product from one location into a continuous process

Formulation — **Multiple** movements of specified amounts of products from various locations into a single location

Blending — **Multiple** movements of specified amounts of products from various locations into a single location, plus an additional mixing phase

Batching — **Multiple** movements of specified amounts of products from various locations into a single location plus multiple additional process phases, such as heating, cooling, waiting, mixing, agitating, dumping, etc.

Many additional terms and definitions can be found in the **Glossary** provided in Appendix F of this manual.

Process Variations

A critical manufacturing challenge is to compensate rapidly and accurately for dynamic variations that always exist in a material feed process. These process variations contribute to material waste, inconsistencies in quality, and reduced throughput. Q.i is able to respond in real time to many different process variations, including (but not limited to):

- Variability caused by raw material inconsistency:
    - Material variation between various suppliers or lots
    - Moisture content in the material
    - Material viscosity changes due to temperature
- Variability generated by pumps, valves and Control Systems, that result in flow rate changes and valve closure times
- Material head pressure variation

Role of Q.i in Process Control

Q.iMPACT works together with your PLC or DCS system to manage and control your process. Q.iMPACT is dedicated to time-critical material feed, material measurement, material management and material cut-off control functions, freeing the host system's processing power for other tasks.

Taking advantage of distributed control architecture, IND780 Q.iMPACT is engineered to orchestrate the entire material transfer control process. Q.i bundles and moves the time-critical material transfer functions into the IND780 terminal, which takes control of the material transfer closer to the actual process.

To accomplish this, each IND780 Q.iMPACT terminal monitors measurement information directly from field devices including scales, load cell systems or flow meters. Because Q.i has direct control of the final control element (FCE), it can time the feed cut-off to assure on-target accuracy.

Q.i Features

As a professionally-engineered material transfer package, each Q.i terminal is fully configurable, documented, supported and deployed globally. Depending on the options selected for the application, the Q.i terminal combines powerful feed algorithms with best-practice material feed features, including:

- K1 predictive adaptive control algorithm
- K2 predictive adaptive control algorithm
- Spill only algorithm
- Dump-to-Empty control algorithm
- Task Expert function block programming
- Material type (Gain-in-weight/Loss-in-weight)
- Control target management (fixed bias)
- Target type (absolute, additive)
- Tolerance check
- Pre-feed condition checks (stable scale, vessel overflow)
- Flow alarm management
- Drain time management
- Instrument zero shift management
- Interface driver for data communication between instrument and controller
- Abnormal situation management
- Reasonableness checking
- Hand add
- Slow Step Timer
- Command states (status, error handling)
- Material feed states (status, error handling, overflow)
- Weigh/flow digital filtering
- Diagnostics
- Multiple Modes (Setup, Manual, Automatic and Maintenance)
- Reset Capability
- Group feed
- Estimated time to complete
- Post-feed check and report (for accurate & reliable data)
- Overlapping feed management
- Enhanced 2 speed feed control
- Instrument cross check maintenance
- Standard and Enhanced communication modes
- Up to 999 material paths
- Clustering capability
  (up to 20 terminals, 198 channels maximum)

Q.i System Capabilities

The IND780 Q.iMPACT system can accommodate the following:

- 6 Option board slots in one IND780 Q.iMPACT Terminal:
  - 4 Scale or Load Cell interfaces per IND780 Q.iMPACT
  - 6 Flow Meter Interface Boards (for 12 flow meters) per IND780 Q.iMPACT
  - Combination of 4 Scale or Load Cells and 2 Flow Meter Interface Boards (4 flow meters)
- Space for 1 PLC/DCS interface board – select from EtherNet/IP™, ControlNet and PROFIBUS® DP; for limited connectivity, Modbus TCP, DeviceNet™ and Allen-Bradley RIO may also be used.
- 20 IND780 Q.iMPACT Terminals in one cluster, with remote console, data and interface sharing
- 198 Equipment Channel Modules
- 12 Equipment Channel Modules per Bridge Terminal using the Enhanced Q.i Message Interface
- 24 Equipment Modules per Bridge Terminal using the Classic Qi Message Interface
- 198 Concurrent Phases
- 999 Material Paths

IND780 Q.iMPACT Hardware

IND780 Terminal Models

The Q.i780 application is available in the IND780 IP69K harsh environment or panel mount IND780 enclosures with color display.

Figure 1-1: IND780 Harsh Environment Enclosure, Desktop or Wall-Mount

Creating a Q.iMPACT Terminal

The intrinsic hardware security key feature found within every IND780 enables the Q.i780 application.

Figure 1-2: IND780 Hardware Key Socket on Mother Board

There are two ways to create an IND780 Q.iMPACT terminal:

- The Q.i780 application can be purchased with a new IND780, installed, tested and labeled from the factory.
- The Q.i780 application hardware security key can be purchased separately as an upgrade to an existing IND780 terminal.

Both approaches produce the same result. There are no differences in exterior appearance between an IND780 and an IND780 Q.iMPACT.

Determining the Terminal Type

The simplest way to determine the type of IND780 is to access its information recall screens:

1. From the home screen (Figure 1-3), press the INFORMATION RECALL softkey (typically in the second row of softkeys).

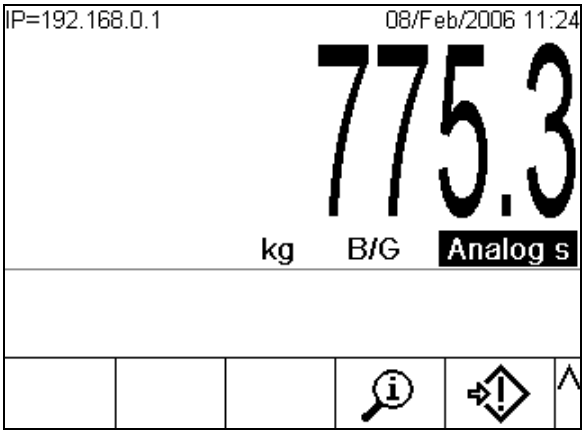


Figure 1-3: IND780 Home Screen Showing Information Recall Softkey

2. The information recall screen will display.

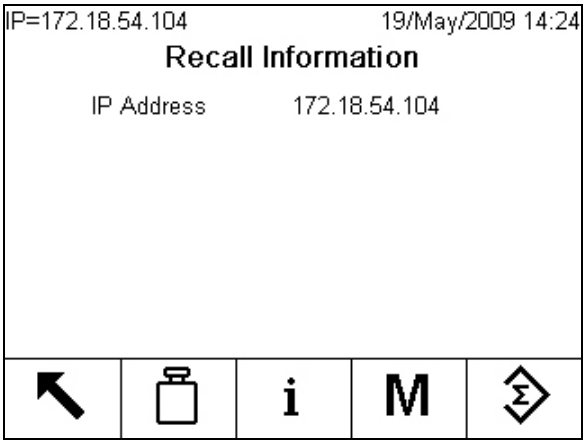


Figure 1-4: System Recall Information Screen

3. Press the INFORMATION softkey **i**.
4. Scroll down using the DOWN arrow key. In the ID column of the information screen, one of the following will appear, indicating that the terminal is a Q.iMPACT IND780:
   - 780Qi+*x*Lic (where x indicates the number of PAC Licenses, 1 to 12)

Upgrade Note

When upgrading to Q.i 780 from a standard IND780 terminal, check any installed option boards against the list of boards compatible with Q.i780, provided in the **Options** section on page 1-13. Once the IND780 is transformed into an IND780 Q.iMPACT, only the option boards listed will be recognized by the Q.i780 application.

Also, please refer to Figure 1-5 for the appropriate slot locations for option boards in an IND780 Q.iMPACT terminal.

IND780 Q.iMPACT Model Identification

The IND780 model number is located on the data plate on the back of the terminal along with the serial number. Refer to this data plate to verify the IND780 Q.iMPACT that was ordered.

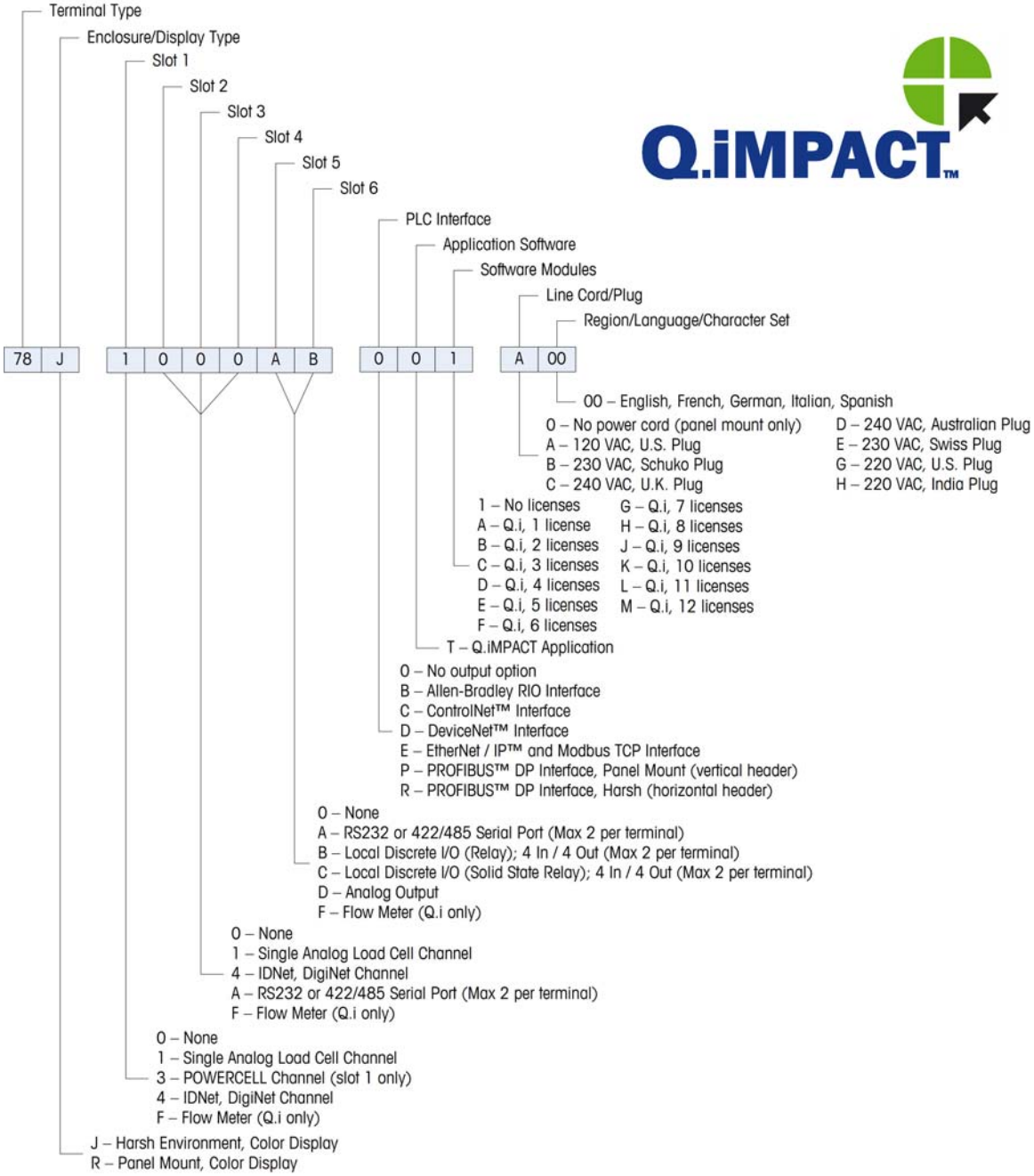


Figure 1-5: IND780 Q.iMPACT Configurations

IND780 Q.iMPACT Terminal Specifications

Physical Dimensions

The physical dimensions of the panel mount and harsh environment IND780 terminals are shown in Figure 1-6, Figure 1-7 and Figure 1-8. All measurements are given in inches and [mm].

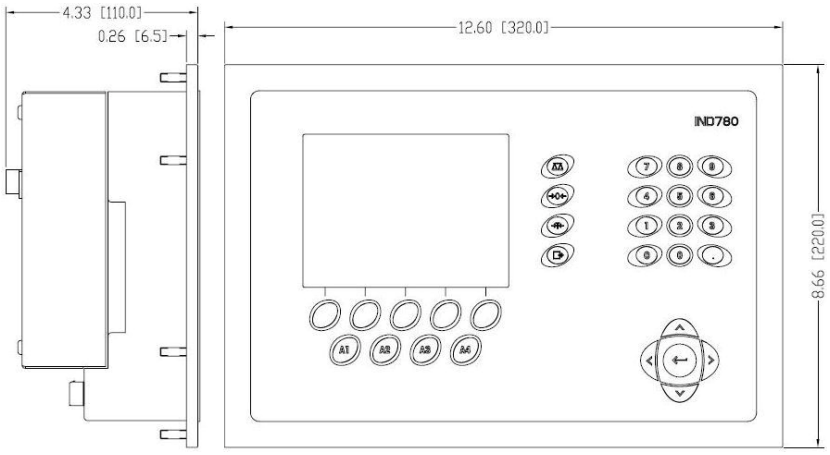


Figure 1-6: IND780 Panel Mount Terminal Dimensions

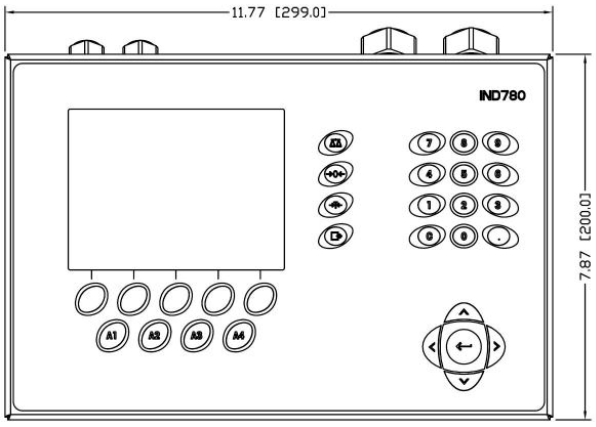


Figure 1-7: IND780 Harsh Enclosure Terminal Dimensions, Front

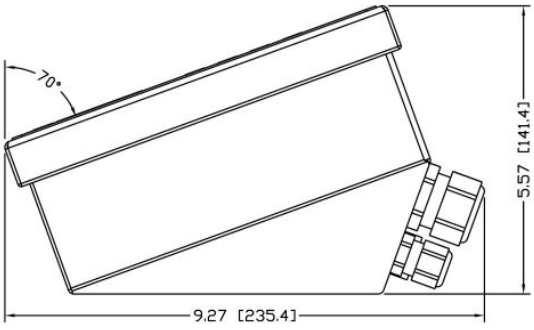


Figure 1-8: IND780 Harsh Enclosure Terminal Dimensions, Side

Specification table

The IND780 terminal conforms to the specifications listed in Table 1-1.

Table 1-1: IND780 Specifications

IND780 Specifications	
Enclosure Type	Panel Mount – stainless steel front panel
	Harsh environment desk/wall/column-mount – type 304 L stainless steel enclosure
Dimensions (l × w × d)	Panel Mount: 320 mm × 220 mm × 110 mm (12.6 in. × 8.7 in. × 4.3 in.)
	Harsh Environment: 299 mm × 200 mm × 141 mm (11.8 in. × 7.9 in. × 5.6 in.)
Shipping Weight	5 kg (11 lb)
Environmental Protection	Panel Mount front panel sealing provides Type 4x and Type 12 protection – comparable to IP65 rating
	Harsh Environment meets IP69K requirements
Operating Environment	The terminal (both enclosure types) can be operated at temperatures ranging from -10° to 40° C (14° to 104°F) at 10% to 95% relative humidity non-condensing
Hazardous Areas	Not all versions of the IND780 can be operated in areas classified as Hazardous by the National Electrical Code (NEC) because of the combustible or explosive atmospheres in those areas. Contact an authorized METTLER TOLEDO representative for information about hazardous applications
Power	Operates at 100–240 VAC, 49–61 Hz, 400 mA (both enclosure types)
	Panel Mount version provides a terminal strip for AC power connections
	Harsh environment version includes a power cord configured for the country of use
	Note: When an IND780 is installed in an area classified as Division 2 or Zone 2/22, special AC wiring requirements must be met. See document 64063214, IND780 Division 2, Zone 2/22 Installation Guide
Display	320 x 240 pixel dot-matrix graphic backlit monochrome LCD or 320 x 240 pixel backlit graphic, active, TFT color LCD with the capability of displaying weight in 34-mm high characters; alternate multiple channel display
Weight Display	Displayed resolution of 1,000,000 counts for analog load cell scales Display resolution for high-precision IDNet bases is determined by the specific base used

IND780 Specifications	
Number of Scales	Interface for up to four scale channels plus a sum
Number of Flow Meters	Interface up to twelve flow meters
Keypad	30 keys; 1.22-mm thick polyester overlay (PET) with polycarbonate display lens
Communications	**Serial Interfaces** **Standard**: Two serial ports COM1 (RS-232) and COM2 (RS-232/RS-422/RS-485), 300 to 115,200 baud; Ethernet 10/100 Base-T **Protocol** **Serial Inputs**: ASCII characters, ASCII commands for CTPZ (Clear, Tare, Print, Zero), SICS (most level 0 and level 1 commands) **Serial Outputs**: Continuous or Demand with up to ten configurable print templates or SICS host protocol, report printing, interfaces with external ARM100 Input/Output modules, and DeviceNet Bridge
Approvals	**Weights and Measures** USA: NTEP CoC # 06-017 Class II, 100,000d Class III, IIIL, 10,000d Canada: AM-5592 Class II 100,000d Class III 10,000d and Class IIIHD 20,000d Europe: TC6944 Class II, approved divisions determined by platform Class III, IIII, 10,000e **Product Safety** UL, cUL, CE

System Hardware

Main PCB

The IND780 terminal's main printed circuit board (PCB) includes provisions for the microprocessor, main memory, battery, application module key, Ethernet, USB and serial communications, and mounting of option boards.

The main board contains the COM1 and COM2 serial ports. COM1 provides RS-232 communication, while COM2 supports RS-232, RS-422, or RS-485 communication. These ports are bidirectional and can be configured for various functions such as demand output, SICS host communications, continuous output, ASCII command input (C, T, P, Z), ASCII character input, report printing, totals printing, or connection to a remote ARM100 module.

Scale Bases

The IND780 Q.iMPACT supports Analog, IDNet, SICS and POWERCELL PDX bases.

Analog Load Cell Scale Base

The IND780 Q.iMPACT supports this scale type through an analog load cell interface. The terminal can drive up to sixteen 350-ohm analog load cells, with up to eight 350-ohm load cells on one channel.

IDNet™ Scale Base

The IND780 Q.iMPACT supports both the newer T-brick style of high-precision base and the older "PIK-brick" transducers, through the IDNet scale interface. For T-brick bases, the interface provides the +12 volts and communication required to operate this newer style of base. The port also provides +30 volts, to support PIK-brick high-precision bases. The base's cable determines which voltage is used.

SICS Scale Base

The IND780 Q.iMPACT supports Mettler Toledo high precision scales and balances that utilize the SICS communications protocol. These scales and balances are branded as the Mettler Toledo Excellence balances, X-bases/platforms, WM/WMH and 4-series scales (BBx4xx, IND4xx). The SICS scales are connected to the IND780 via the serial interfaces. Four SICS scales can be supported per terminal, when optional Serial boards are installed. Depending on the type of SICS scale connected, different configuration settings will be available in the IND780 terminal setup screens.

POWERCELL® PDX® Scale Base

The IND780 Q.iMPACT supports scales that use the POWERCELL PDX communications network found in large hopper / tank applications as well as vehicle scales that use PDX® load cells. This interface also supports the use of the RAAD Box, which converts analog load cell signals into digital ones.

Flow Meter Interface Board

The Flow Meter Interface Board is a two-channel isolated Counter/Flow Meter board for use in the IND780 Q.iMPACT terminal. It is intended to provide a flow-meter totalizer target comparison to directly control on-board discrete outputs. The module is capable of counting input pulses at up to 50 kHz on each of two isolated input channels, as well as measuring the frequency of the input signal. A jumper-selectable switching threshold for each input channel is available, as well as a jumper-selectable 15 kHz analog filter. The input level range for the AC mode is 50mV to 50Vrms. The input level range for DC mode is 2.5 volts to 42 volts.

The outputs are 7407 open-collector drivers. Each module provides 150 mA of 5V power to drive opto-22 or similar devices. A total of two flow meters may be connected to a single flow meter card. Up to six flow meter cards can be installed

in a single Q.iMPACT terminal, so that each terminal can connect to as many as 12 flow meters.

PLC/DCS Interfaces

IND780 Q.iMPACT PLC/DCS interface options include :

- PROFIBUS® DP
- ControlNet™
- EtherNet/IP®
- Modbus TCP *
- DeviceNet™*
- Allen-Bradley RIO*

* Due to the limited amount of data that can be transmitted per message, or in a given amount of time, these three interfaces will not provide the same level of integration as PROFIBUS DP, ControlNet or EtherNet/IP. Please consult your METTLER TOLEDO Q.iMPACT representative for more information.

- The PLC/DCS option board mounts in a dedicated socket on the IND780 main board, and does not occupy one of the "option board" slots described in **Q.I System Capabilities** on page 1-4.

For detailed information on configuring these interfaces, please refer to the **IND780 Technical Manual** and the **IND780 PLC Interface Manual**, provided on the IND780 documentation CD.

PROFIBUS DP

The IND780 Q.iMPACT Terminal communicates to a PROFIBUS-DP master according to DIN 19 245. The PROFIBUS option consists of a module, together with firmware that resides in the IND780 Terminal to implement the data exchange.

ControlNet and EtherNet IP

The IND780 Q.iMPACT supports ControlNet communications or EtherNet / IP interface options and the appropriate driver software.

Modbus TCP

Modbus TCP is used to establish master-slave/client-server communication between intelligent devices. It is an open standard network protocol, widely used in the industrial manufacturing environment. The Modbus TCP protocol takes the Modbus instruction set and wraps TCP/IP around it. The Modbus TCP protocol is supported by the Ethernet / IP interface board, version 1.32 or higher.

DeviceNet™

DeviceNet is an RS-485 based network using CAN chip technology. This network was created for bit- and byte-level devices. The network can be configured to run up to 500kbits per second depending on cabling and distances. Messages are

limited to 8 unfragmented bytes. The network can include up to 64 nodes including the master, which is commonly called the scanner.

Allen-Bradley RIO

The A-B RIO option enables data exchange by bi-directional communications using the Discrete Data Transfer or Block Transfer mode. The IND780 Terminal initiates a communication exchange with the PLC approximately 20 times per second utilizing the Allen-Bradley Discrete Data Transfer protocol. This communication is a high-speed, real-time message interface between the IND780 Terminal and the PLC for process control. Division, integer, and floating point values are supported.

The IND780 A-B RIO interface also supports Block Transfer mode for transmission of larger amounts of data. Additional details about this interface can be found in the IND780 PLC Interface Manual on the IND780 documentation CD.

Options

The following additional options are available for the IND780. Only options compatible with the IND780 Q.iMPACT terminal are listed here.

- Predictive Adaptive Control (PAC) algorithms
- Discrete I/O
- Serial Communications
- Mounting hardware – brackets for wall and column mounting of the harsh enclosure

The scale measurement channel, flow meter measurement channel, serial and discrete I/O options are connected to the IND780 through six internal option slots. Various combinations of options may be ordered to match the application solution requirements.

Predictive Adaptive Control Algorithms

The powerful Predictive Adaptive Control (or PAC) Algorithms automatically compensate for natural process variations and adjust the material feed cutoff accordingly. Patented and exclusively available from METTLER TOLEDO, the PAC algorithms were developed to reduce material fill variation, increase throughput and lower capital equipment costs. The algorithms can be applied to scale equipment channel modules and flow meter equipment channel modules. The PAC Algorithms are enabled on the IND780 Q.iMPACT terminal when you select the appropriate software module along with the Q.i application module.

Discrete I/O

The discrete I/O interface options include both internal and remote I/O.

The internal version is available with dry-contact relay or solid state relay outputs. Both types will switch up to 30 volts DC or AC and up to 1 amp of current. The inputs are switch-selectable as either active (for simple pushbutton control) or

passive (for connection to PLCs or other devices that supply their own power for the I/O). Each internal board supports four inputs and four outputs.

The remote I/O is supported with the ARM100 remote module that provides dry-contact outputs. The inputs are passive on the ARM100. Each ARM100 supports four inputs and six outputs. An external 24-volt DC supply is required to operate the ARM100.

A total of two internal Discrete I/O boards (each providing 4 inputs and 4 outputs) are supported, with an additional 32 inputs and 48 outputs in up to eight remote I/O modules.

Serial Communications

Additional communications cards provide RS-232, RS-422 or RS-485 communication at rates from 300 to 115.2k baud. A maximum of two serial communications cards may be installed in the IND780.

Mounting Hardware

Please refer to Chapter 4, **Parts and Accessories**, of the **IND780 Technical Manual**.

TaskExpert™

TaskExpert is included with the Q.iMPACT application. TaskExpert is the custom programming language for the IND780 and IND780 Q.iMPACT terminals. Enabled by selecting the appropriate software module, TaskExpert allows for custom application specific programming to reside in the IND780 Q.iMPACT terminal to meet your needs.

Q.i Material Transfer Control Strategy

Before setting up and using the IND780 Q.iMPACT terminal, it is important to understand:

- How the Q.i material transfer control strategy works
- The role Q.i plays in your process control operation
- When to apply the Q.i material transfer control strategy

Overview

Predictive Control Algorithms

At the heart of the Q.iMPACT application, patented predictive adaptive control algorithms (PACs) build a real-time mathematical model of the material transfer process for each material. These algorithms learn and compensate for process variations in each active material transfer – a function known as auto-tuning. The point in time at which the terminal will stop adding material is adjusted continuously during the transfer, as the terminal learns to predict how the delivery

system will react. This allows the system to adapt to changes in the flow rate of the material while the transfer is in progress.

This produces a very high degree of accuracy in controlling material transfer, using only a single fast feed. Each material transfer is treated as a separate transaction, initiated when the Host system (normally a PLC or DCS) sends a target value to the Q.iMPACT terminal for a particular scale or flow meter feed. The Q.iMPACT terminal then controls the addition of the material and, when the transfer is complete, sends the result to the Host system.

The result is a material transfer system that delivers optimal performance, by producing significant reductions in costly raw material over-feed, unacceptable under-feed and material feed time.

Material Feeds

A material feed is the most basic and most frequently used operation in a batch control system or filling operation. To complete a batch recipe, two or more material feed phases must occur. For a filling or packaging cycle, typically one feed phase occurs repeatedly.

The most challenging and critical part of any material feed occurs at the end of a phase, when the feed is cut off in accordance with a recipe, formulation or filling operation. Virtually all material feed inconsistencies result from inaccurate cut-off, making this a significant area for process improvement.

Normally, a number of material transfers must take place in order to create a batch. The exact order, sequence and quantity of each material transfer is determined by the "Recipe".

Components of an IND780 Q.iMPACT System, and Terminal Clustering

Each IND780 Q.iMPACT terminal can support up to four scales or twelve flow meters, or a combination of these. Each scale or flow meter is referred to as an Equipment Channel Module. If more scales or flow meters are required, more terminals can be added. To create a single manageable system, as many as twenty IND780 Q.iMPACT terminals may be connected via an Ethernet network, to create a "cluster".

All members of a cluster share a single common database, maintained in an IND780 Q.iMPACT terminal assigned to be the master. All other terminals in the cluster are configured as remote. The master terminal is responsible for distributing the database variables to all remote terminals in the cluster.

For each instrument (scale, load cell system or flow meter,) the sequence of events occurs in parallel. For example, if a Q.iMPACT terminal has two scale inputs and three flow meter inputs, then it can control five material transfers simultaneously.

Not all of the IND780 Q.iMPACT terminals in a cluster require a direct communications link (ControlNet, for example) to a Host system. Depending on system configuration, in a cluster of three Q.iMPACT terminals only one terminal

may require the ControlNet interface board. The Q.iMPACT terminal with the interface board is referred to as containing a "bridge".

Any IND780 Q.i terminal in a cluster, whether master or remote, can serve as a bridge terminal to the host PLC or DCS system. Please use best practices when configuring your cluster to distribute the processing load evenly between the master database and your equipment channel modules, I/O and communications.

Material Paths

Each control valve, feed conveyor, etc. is assigned a Material Path (MP) number. This number identifies a unique path that a material will take from a source container to its destination container.

Example A

A scale with two valves controls the addition of materials A and B. The scale also has a discharge valve. This system has a single equipment channel (the scale) and three material paths – two for addition to the scale, one for discharge from the scale. Each is a unique path that the material must follow, and each has its own characteristics, such as flow rate. These three material paths can be referred to as MP1, MP2 and MP3.

Equipment Channel Module	Material Path	Function
1 (scale)	MP1	Addition of material A
1 (scale)	MP2	Addition of material B
1 (scale)	MP3	Discharge from scale

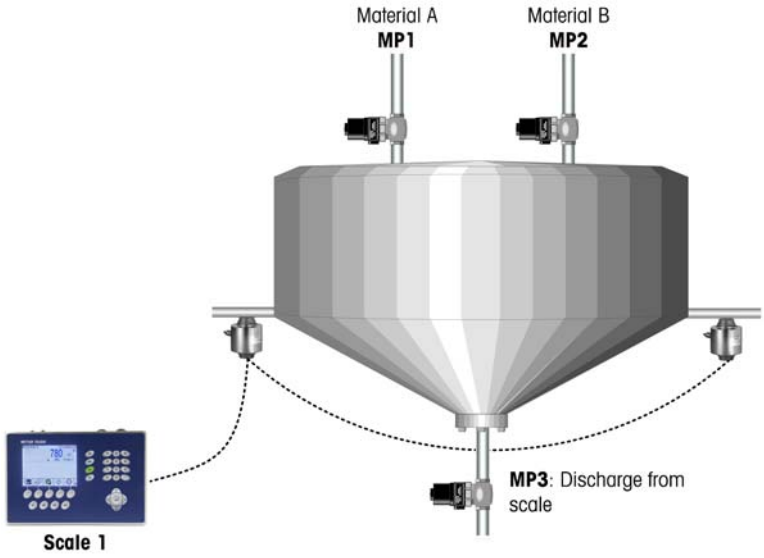


Figure 1-9: Example A

Example B

Suppose that demand for the product being manufactured in this operation has increased, and now exceeds the capacity of the system in Example A. To increase production, a second scale is added. It uses the same raw materials from the same bulk storage container, and discharges the resulting mixture into the same bulk storage tank. However, it has its own control valves, allowing throughput to be doubled. This means that, even though it uses the same sources of raw materials, three new unique material paths associated with the second scale have been added to the system:

Equipment Channel Module	Material Path	Function
1 (scale 1)	MP1	Addition of material A
1 (scale 1)	MP2	Addition of material B
1 (scale 1)	MP3	Discharge from scale 1
2 (scale 2)	MP4	Addition of material A
2 (scale 2)	MP5	Addition of material B
2 (scale 2)	MP6	Discharge from scale 2

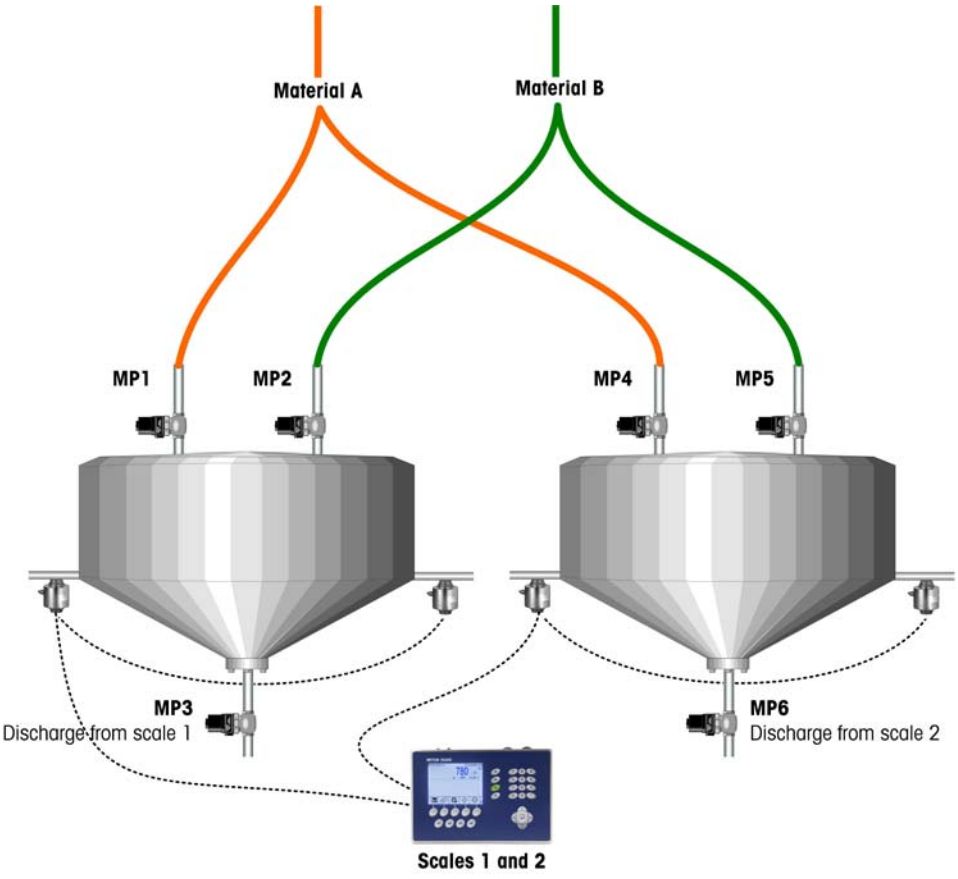


Figure 1-10: Example B

Example C

Colorant is now added to the system described in Example B above, using a flow meter to control the addition for each scale. This system includes two more channels (flow meters 1 and 2) and two more material paths (one for each flow meter). It is important not to increase the batch cycle time, so the Q.i strategy's advanced overlapping feed capabilities can be used to add the colorant at the same time as material A. Batch cycle time is not increased, and the system now looks like this:

Equipment Channel Module	Material Path	Function
1 (scale 1)	MP1	Addition of material A
1 (scale 1)	MP2	Addition of material B
1 (scale 1)	MP3	Discharge from scale 1
2 (scale 2)	MP4	Addition of material A
2 (scale 2)	MP5	Addition of material B
2 (scale 2)	MP6	Discharge from scale 2
3 (Flow meter 1)	MP7	Addition of colorant
4 (Flow meter 2)	MP8	Addition of colorant

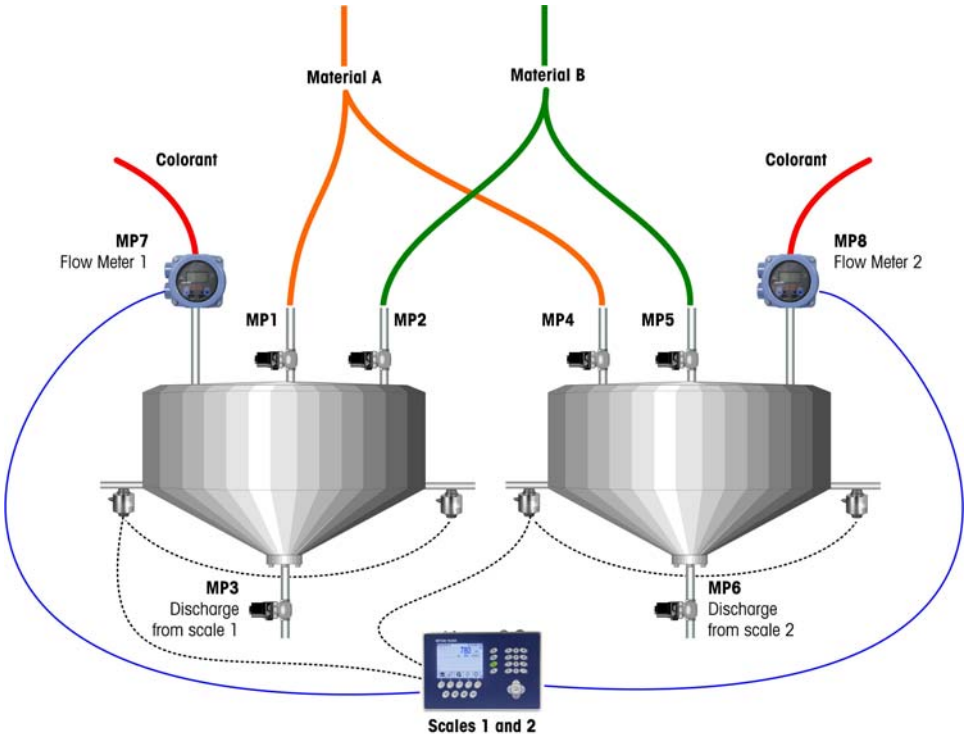


Figure 1-11: Example C

Examples of IND780 Q.i Systems

One Q.iMPACT terminal can be used for systems requiring up to four scale or load cell measurement channels, twelve flow meter measurement channels, or some combination of these. Larger systems, with up to one hundred ninety eight measurement channels, can take advantage of the Q.i clustering capability. Figure 1-12, Figure 1-13 and Figure 1-14 give three examples of Q.iMPACT systems.

IND780-based Q.iMPACT Systems

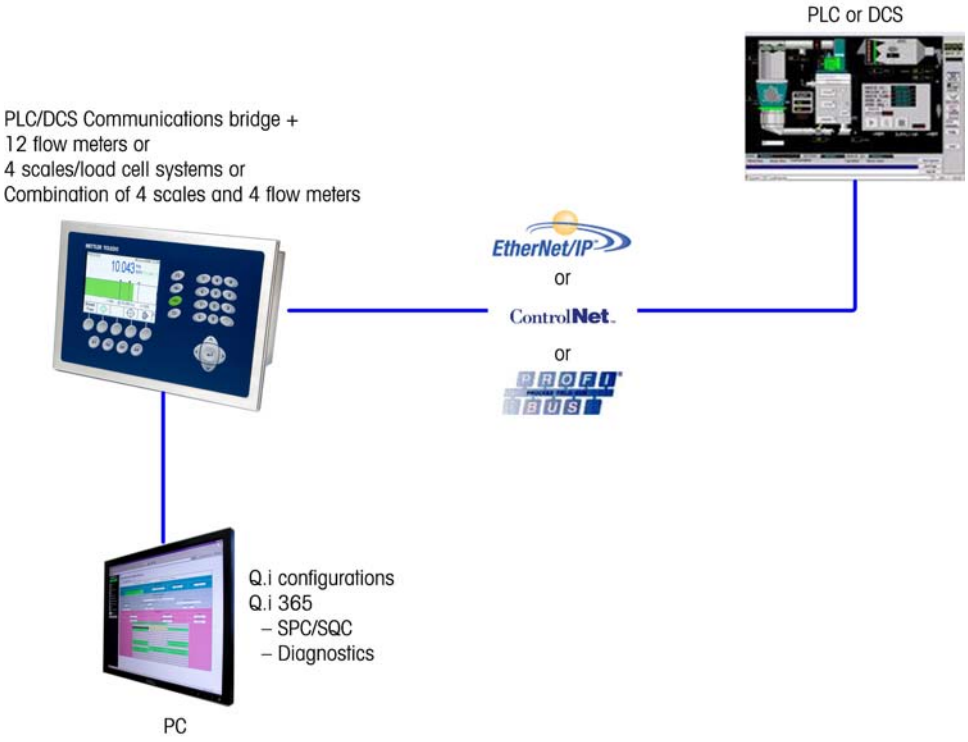


Figure 1-12: Single Terminal System

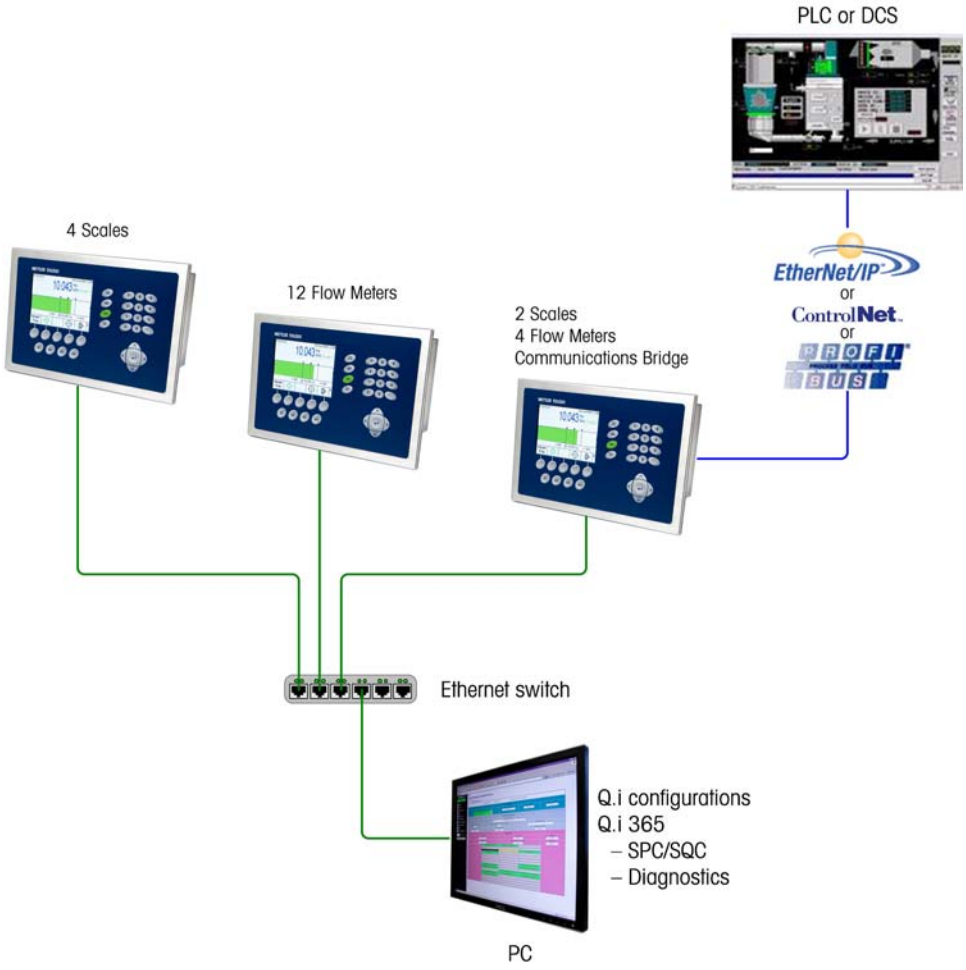


Figure 1-13: Multi-Terminal System

Using IND780- and JagXtreme-based Q.iMPACT Terminals in the Same System

It is not necessary to replace existing JagXtreme Q.i matrollers in order to use the greater functionality of the IND780 Q.iMPACT.

However, the JagXtreme-based Q.i and IND780-based Q.i can share the same PLC and the same process, as shown in Figure 1-14.

- The JagXtreme-based Q.i and the IND780-based Q.i cluster in similar ways, but they cannot share a cluster. This is because the newer IND780 platform communicates over the Ethernet using multi-cast, which is more open and has better reliability than the discrete messaging protocol used by the JagXtreme.

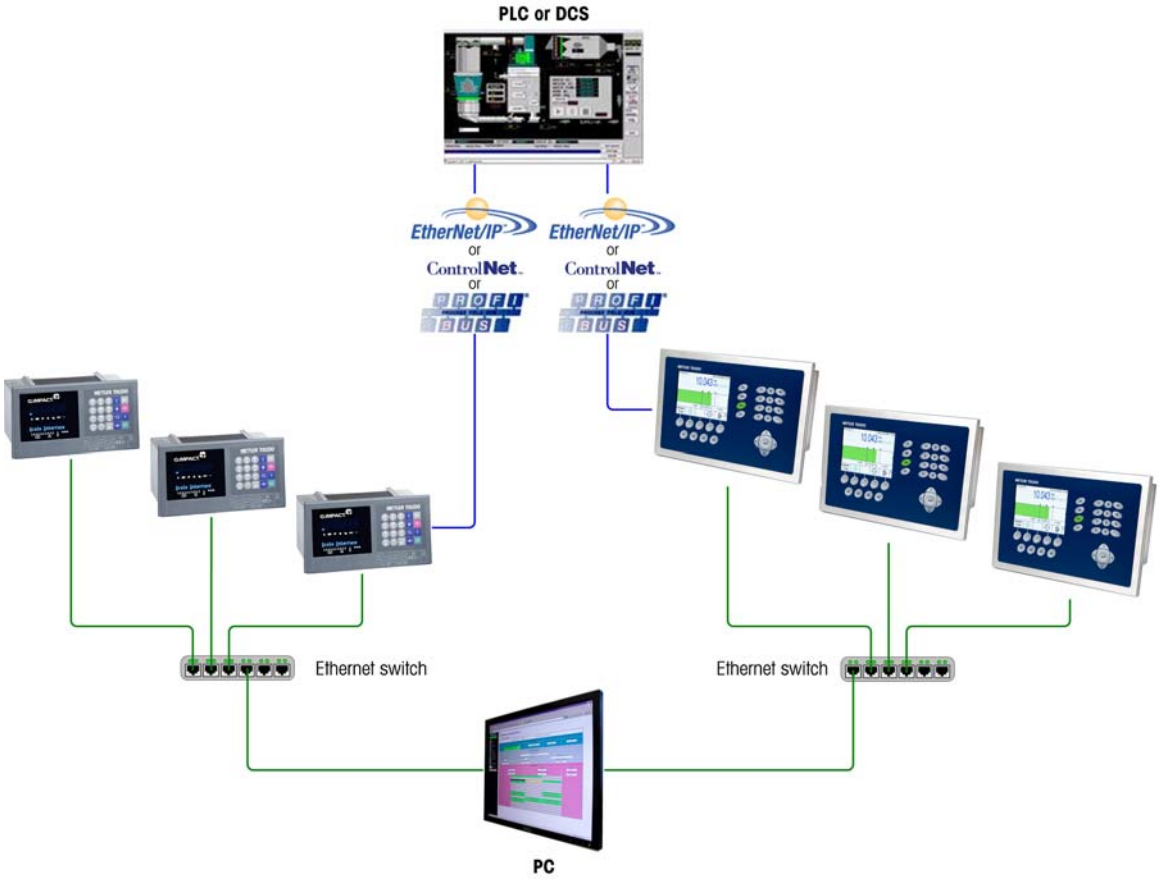


Figure 1-14: Multi-Terminal System Including JAGXTREME and IND780 Q.iMPACT Terminals

Components of an IND780 Q.iMPACT System

Figure 1-15 illustrates the relationship between components of an IND780 Q.iMPACT system that includes one equipment channel (scale) input and one final control element (FCE) output.

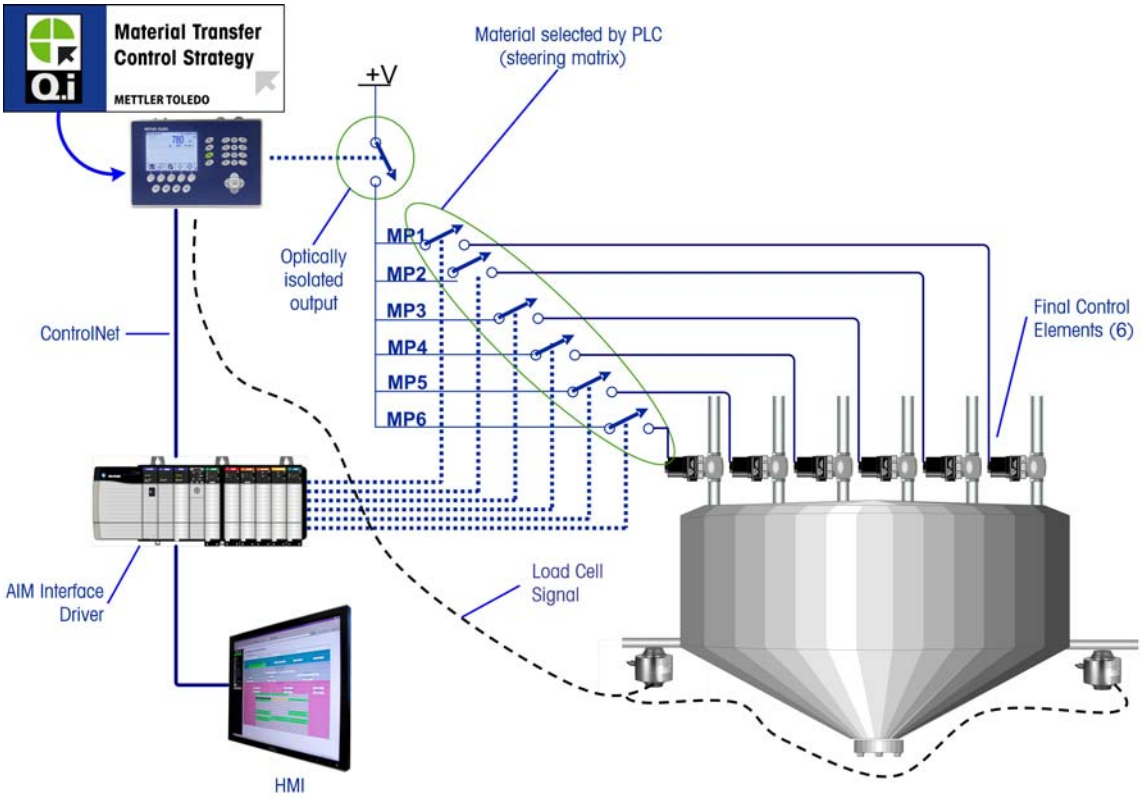


Figure 1-15: Wiring Example – Q.i with 6 Material Paths and One Measurement Channel

Communicating with the IND780 Q.iMPACT Terminal

There are three ways to communicate with the IND780 Q.iMPACT:

- The IND780 terminal control panel
- The PC-based Q.i Configuration Tool
- The IND780's web-based server

The elements of each communication type are detailed in Chapter 3 of this manual, **Configuration**.

Terminal Control Panel

Q.iMPACT parameters can be viewed, set up and modified from the IND780 Q.iMPACT terminal's front panel. The setup menu tree is shown in Figure 1-16, with the **Q.i Configuration** branch expanded.

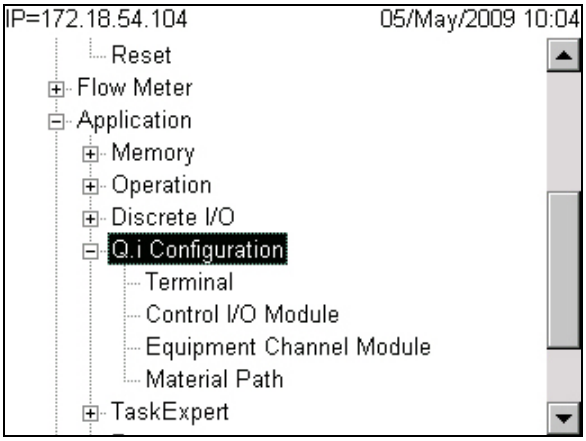


Figure 1-16: Setup Menu Tree, Q.i Configuration Branch Expanded

Q.i Configuration Tool

The Q.i Configuration tool is a PC-based HMI utility developed exclusively for the IND780 Q.iMPACT terminal. To use this utility:

- The tool must be loaded on your PC
- The PC must be equipped with a standard Ethernet connection
- The IP address of the IND780 Q.iMPACT terminal must be known

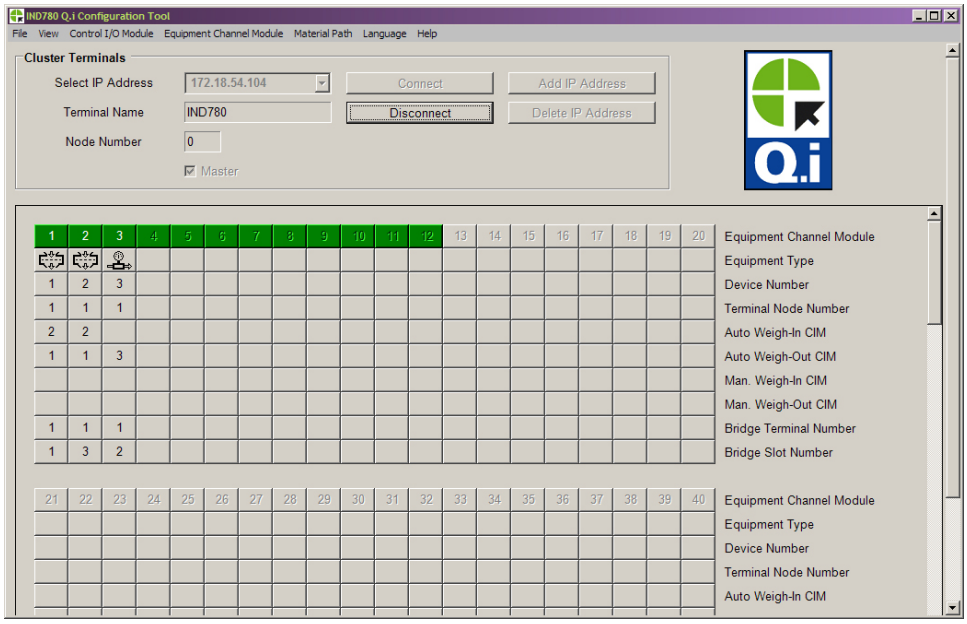


Figure 1-17: Q.i Configuration Tool Main Page

Web Pages

A standard Ethernet connection to the IDN780 Q.iMPACT terminal allows access to its external diagnostics feature, a series of web pages that permit the current configuration to be viewed and, in some cases, modified. To access the web pages:

- The PC must be equipped with a standard Ethernet connection
- The IP address of the IND780 Q.iMPACT terminal must be known

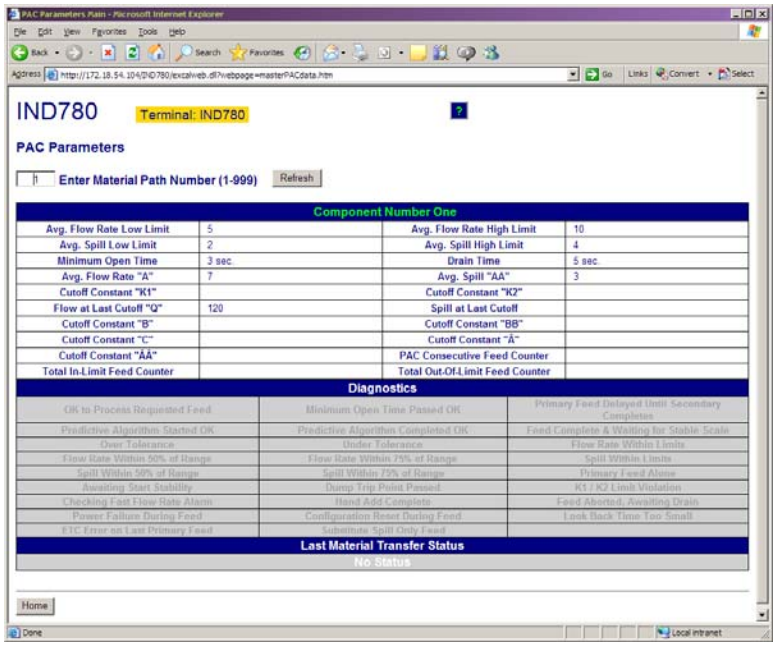


Figure 1-18: IND780 External Diagnostics, PAC Parameters Page

IND780 Q.iMPACT/Host Controller Communications

Fieldbus Types

Three forms of Fieldbus communications provide **full** connectivity with the Q.iMPACT terminal:

- ControlNet
- EtherNet/IP
- Profibus DP

In addition, three types of Fieldbus provide **limited** connectivity with the Q.iMPACT terminal:

- Modbus TCP
- Allen-Bradley RIO
- DeviceNet

Communication Modes

Two types of communication modes are available for the Q.iMPACT terminal. This selection is made in the **Q.i Configuration** section of setup.

Classic Communication Mode

This was the only communication mode available with the first generation Q.iMPACT application on the JAGXTREME®-based terminal. This form of communication uses Explicit Shared Data messages over ControlNet or Ethernet IP communications protocol.

New users can choose to use this mode of communication. Q.i customers upgrading from the JAGXTREME-based Q.i platform may select this mode to avoid or minimize modifications to communication between the Q.i terminal and the Host Controller.

Enhanced Communication Mode

The Enhanced Communication Mode is new for the IND780 Q.iMPACT terminal. This mode uses only cyclic messaging to communicate between the Host Controller and the Q.iMPACT terminal.

For further details on communications modes, refer to Appendix D of this manual, **Communications**.

Chapter 2.0

Configuration and Operation

There are two HMI options for configuring IND780 Q.i – from the Q.i PC-based configuration tool unique to Q.iMPACT, and from the IND780's operator interface. This chapter will review both options, starting with the PC-based Q.i configuration tool.

Note: Default values are listed in Appendix B.

The Operation section (2-37) follows the configuration section and includes information on the IND780 web pages specific to the Q.i application.

Q.i Power-Up Configuration

When power is applied to the IND780 Q.iMPACT, or when power is cycled, the system starts in **automatic feed** and **classic communication** mode.

Q.i Configuration Tool

Introduction

The PC-based configuration tool is a Q.i-specific utility used exclusively to set up and configure the IND780 Q.iMPACT system. The tool can interface with a single terminal or with a cluster of up to twenty terminals. When the tool is used with a cluster of terminals, maximum flexibility is available when communicating with the Master terminal, rather than with a Remote terminal.

- The configuration tool is a true HMI, and has no database of its own. Changes made and saved using the Save button at the bottom left (Figure 2-1) of each configuration screen are saved **only** to the connected Master Terminal. To propagate changes to other terminals in a cluster, a Synchronize process (refer to **File** on page 2-4) must be run **while the system is off-line**.

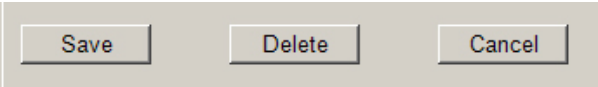


Figure 2-1: Save, Delete and Cancel Buttons

The Q.i configuration tool was built and tested on a Microsoft Windows XP operating system. When it is installed, a shortcut is automatically placed on the PC's desktop:

Click on this shortcut to run the tool. The main screen (Figure 2-2) displays.

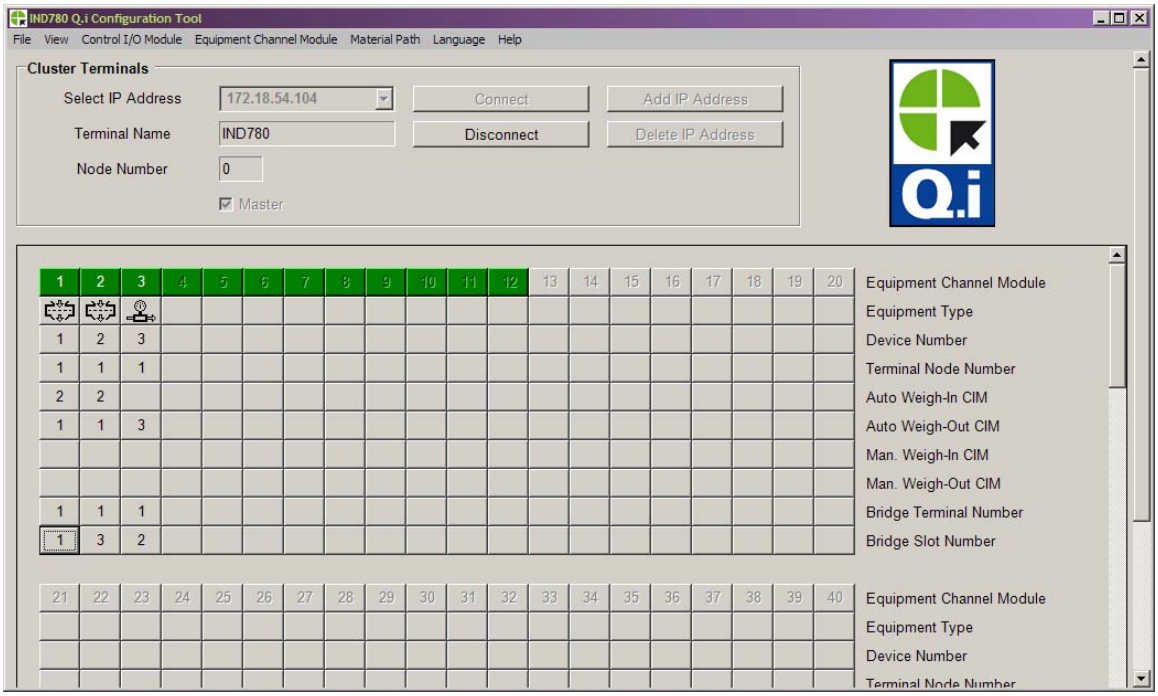


Figure 2-2: Q.i Configuration Tool Main Screen, No Connection

This screen is organized into three main areas:

- The **menu** bar at the top
- The **Cluster Terminals** connection area below the menu bar
- The array of **Equipment Channel Modules** (ECMs) in the scrolling area that occupies the rest of the screen. In the example shown, ECMs 1 and 2 show the scale icon, while ECM 3 shows a flow meter icon.

Connecting

To make a connection to an IND780 Q.i terminal, the PC must be connected directly to the Ethernet port of the IND780 (Figure 2-3) or to a network to which the IND780 Q.i is also connected.

Figure 2-3: IND780 Ethernet Port

To connect to the terminal:

1. **Either** enter the terminal's IP address in the **Select IP Address** field at top left of the screen **or**, if a previous connection has been made to the terminal and saved, select the IP address from the drop-down list.
2. With the IP address entered, and before making the connection, click on the **Add IP Address** button to store the address for future use.

- Addresses can be deleted from the list by selecting them in the drop-down list and then clicking the **Delete IP Address** button.

3. Click on the **Connect** button to establish communication with the terminal. Once the terminal is connected, the Configuration tool's screen will update and resemble the screen shown in Figure 2-4. All menu bar items will now be active and the Terminal Name and Node Number will now be displayed. Each configured Equipment Channel Module (ECM) column is populated with module numbers.

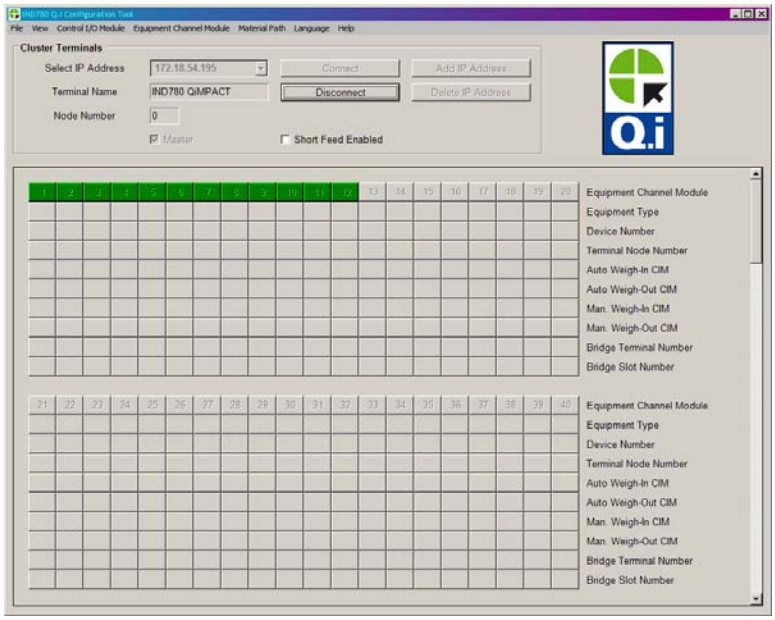


Figure 2-4: Q.i Configuration Tool Main Screen, Connected

Table 2-1 explains the main components of this screen. Detailed descriptions of each row are provided in the following (**Menus**) section.

Table 2-1: Elements of the Configuration Tool Screen

Element	Explanation
Menu bar	The menu bar is arranged in a sequence from left to right that reflects the logic of configuring your IND780 Q.i system. Each menu is detailed in the sections that follow.
Terminal Name	This is read from the connected terminal, where it is configured in setup.

Element	Explanation
Short Feed Enabled	If **any** of the materials have a feed time that is 5 seconds or less, this option should be enabled. The PAC algorithms need 5 seconds or more feed time with the flow rate within limits, in order to predict the cut-off with a high degree of accuracy.
Green boxes	The green boxes – 1 to 12 in this case – represent ECMs for which the optional Predictive Adaptive Control (PAC) algorithms are available.
ECM Array	198 columns in scrolling blocks of 20, each column representing an Equipment Channel Module. A number appears in each currently configured item. Each row is labeled at right. For each ECM, only those rows that are relevant to it are populated (indicated by a number)

Menus

Note: The **File** and **View** menus are useful once the various Control I/O Modules, Equipment Channel Modules and Material Paths are configured.

File

The file menu (Figure 2-5) offers three options.

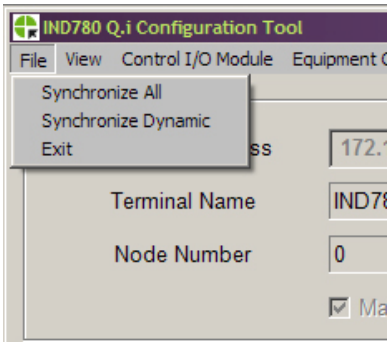


Figure 2-5: File Menu

Synchronize actions should be performed when the system is off-line.

Synchronize All	Updates all configuration data for the currently connected cluster. This process make take some time to complete. Do this while the system is off-line.
Synchronize Dynamic	Updates only dynamic data for the currently connected cluster. This procedure takes less time than **Synchronize All**, as less data is transferred. Do this while the system is off-line.
Exit	Closes the configuration tool

View

The View menu includes three elements – View Control I/O Module List, View Equipment Channel Module List and **View Material Path List**. Selecting one of these items displays a window like the Material Path List shown in Figure 2-6. In this example two material paths have been defined.

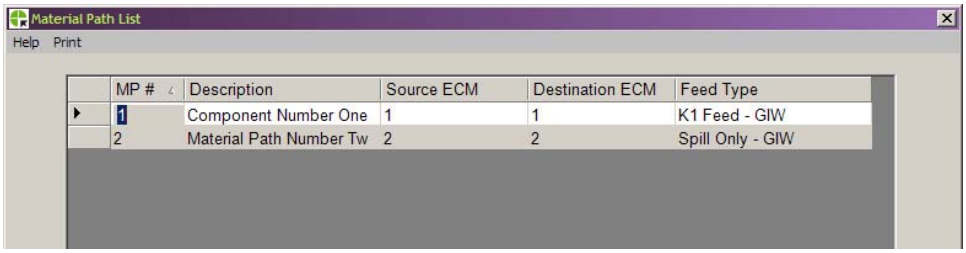


Figure 2-6: Material Path List Display

The list for all three elements shows the all the configured information for each element. If nothing has been configured, nothing will be displayed. You can double click on any configured item to open the associated configuration page.

Control I/O Module

The Control I/O Module menu includes three elements, representing the three types of Control I/O Modules that can be configured, Scale Control I/O Module, Flow Meter Control I/O Module and Hand Add I/O Module. The Control I/O Module defines the I/O that controls the material flow if a flow path. Click on the element to open a configuration display, in which a previously configured Control I/O Module number can recalled (Figure 2-7) to view that module's details or a new, unused number entered to create a new element.

Scale Control I/O Module

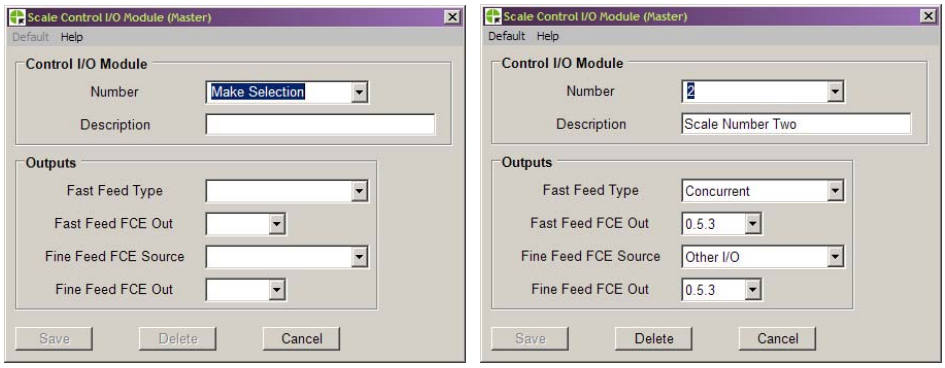


Figure 2-7: Scale Control I/O Module, Initial View (left), Module Selected (right)

Control I/O Module		
Number	The Control I/O Module number assigned to the fast feed and fine feed discrete outputs that are the Final Control Elements (FCE) for turning on or off the material flow into or out of a scale vessel. Assign a unique number to each Control I/O Module from 1 to 297.	
Description	Name or details of the control I/O module, 40 characters maximum	
Outputs		
Fast Feed Type	None	Only fine feed is used
	Independent	Fast and fine feeds are used sequentially, and independent of one another

	Concurrent	Fast and fine feeds are used simultaneously, until near the end of the feed when fast feed is turned off, and fine feed continues till cut-off.
Fast Feed FCE Out	The discrete output assigned to the fast feed. This output can be either from an internal discrete I/O PCB or from a remote ARM100 communication module. Internal discrete I/O addresses start with a zero (e.g. 0.5.1) and remote I/O addresses start with the port number (e.g. 3.0.1)	
Fine Feed FCE Source	**Scale Board**	The discrete output on the scale PCB is used to control the fine feed
	Other I/O	Either an internal discrete I/O PCB output or a remote ARM100 module output is used to control the fine feed (refer to **Fine Feed FCE Out**, below)
GIW/LIW Selector Out	If the Scale Board is selected to control the fine feed, this output is used to route the fine feed of material into (GIW) or out of (LIW) a scale, or to the scale through a switching matrix in the PLC/DCS system.	
Fine Feed FCE Out	The discrete output assigned to the fine feed.	
Buttons		
Save	Saves changes to the Master Terminal	
Delete	Deletes this I/O module	
Cancel	Ignores changes and exits to the Configuration Tool's main screen	
Default	**Save**	Saves the settings of this control I/O module as a default Control I/O module template. Note that performing this action over-writes the factory defaults for this type of module.
	Recall	After a control I/O module number is entered or selected, use **Recall** *either* to load the factory default parameters with the default Control I/O Module data (if no new template has been **Saved**), *or* to load the values saved in a Control I/O template. To restore the factory defaults after they have been over-written by creating and saving a template, backup all terminal data and settings, then perform a Master Reset. Refer to the **IND780 Technical Manual** for details on these procedures.

Flow Meter Control I/O Module

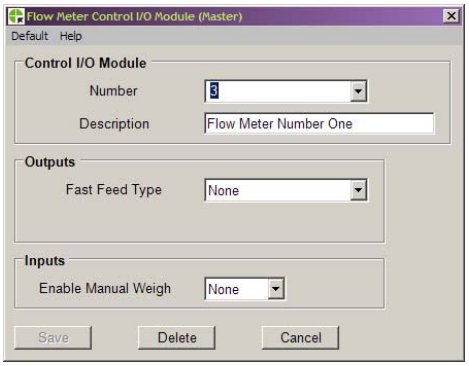


Figure 2-8: Flow Meter Control I/O Module

Control I/O Module		
Number	The Control I/O Module number assigned to the discrete output that is the Final Control Elements (FCE) for turning on or off the fast feed material flow in a flow meter path. The fine feed output is automatically assigned to one of the discrete outputs on the flow meter PCB. Assign a unique number to each Control I/O Module from 1 to 297.	
Description	Name or details of the control I/O module, 40 characters maximum	
Outputs		
Fast Feed Type	None	Only fine feed is used
	Independent	Fast and fine feeds are used sequentially, and independent of one another
	Concurrent	Fast and fine feeds are used simultaneously, until near the end of the feed when fast feed is turned off, and fine feed continues till cut-off.
Inputs		
Enable Manual Weigh	This discrete input enables a flow meter manual weigh operation	
Buttons		
Save	Saves changes to the Master Terminal	
Delete	Deletes this I/O module	
Cancel	Ignores changes and exits to the Configuration Tool's main screen	
Default	Save	Saves the settings of this control I/O module as a default Control I/O module template. Note that performing this action over-writes the factory defaults for this type of module.
	Recall	After a control I/O module number is entered or selected, use **Recall** *either* to load the factory default parameters with the default Control I/O Module data (if no new template has been **Saved**), *or* to load the values saved in a Control I/O template. To restore the factory defaults after they have been over-written by creating and saving a template, backup all terminal data and settings, then perform a Master Reset. Refer to the **IND780 Technical Manual** for details on these procedures.

Hand Add Control I/O Module

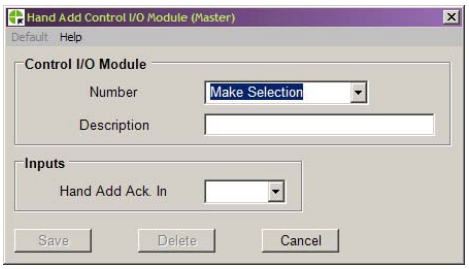


Figure 2-9: Hand Add Control I/O Module

Control I/O Module		
Number		The Control I/O Module number assigned to the input used to acknowledge the addition of a hand add material.
Description		Name or details of the control I/O module, 40 characters maximum
Inputs		
Hand Add Ack. In		A discrete input assigned to the hand add acknowledge operation
Buttons		
Save		Saves changes to the Master Terminal
Delete		Deletes this I/O module
Cancel		Ignores changes and exits to the Configuration Tool's main screen
Default	**Save**	Saves the settings of this control I/O module as a default Control I/O module template. Note that performing this action over-writes the factory defaults for this type of module.
	Recall	After a control I/O module number is entered or selected, use **Recall** *either* to load the factory default parameters with the default Control I/O Module data (if no new template has been **Saved**), *or* to load the values saved in a Control I/O template. To restore the factory defaults after they have been over-written by creating and saving a template, backup all terminal data and settings, then perform a Master Reset. Refer to the **IND780 Technical Manual** for details on these procedures.

Equipment Channel Module

The Equipment Channel Module menu includes three elements, representing the three types of hardware that may be included in a Material Path, Scale Equipment Channel Module, Storage Scale Equipment Channel Module and Flow Meter Equipment Channel Module.

Click on the element to open a configuration display, in which a previously configured Equipment Channel Module number can recalled (Figure 2-7) to view that module's details, or a new, unused number entered to create a new element.

Scale Equipment Channel Module

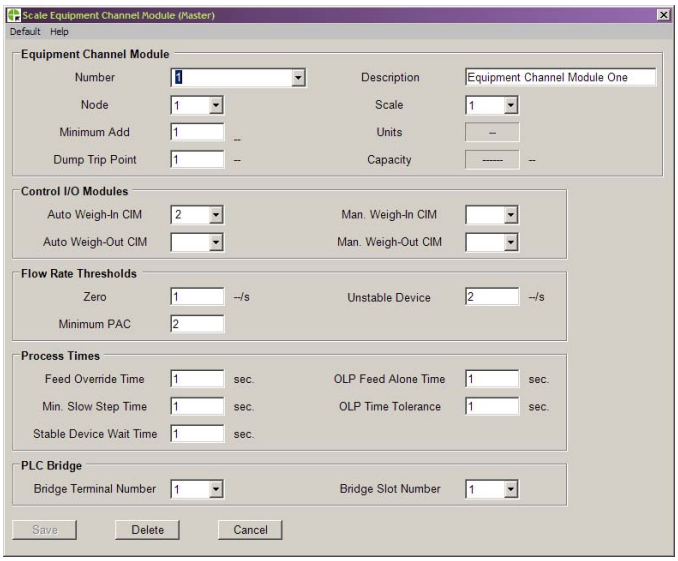


Figure 2-10: Scale ECM View, Scale 1 Selected

Equipment Channel Module	
Number	The equipment channel module number assigned to the scale unit device
Description	Name or details of the equipment channel module, 40 characters maximum
Node	Terminal node number where the scale interface/PCB resides
Scale	Scale number 1 to 4
Minimum Add	Sets the smallest amount of material that the system can attempt to transfer with this scale
Units	Primary units of this scale configured in scale setup – field is not editable
Dump Trip Point	Sets the level at which the PAC process starts the drain timer in a dump-to-empty operation. After the drain timer expires, the PAC process shuts off the dump-to-empty operation with it detects zero flow
Capacity	Calibrated capacity of the scale unit configured in scale setup – field is not editable
Control I/O Modules	
Auto Weigh-In CIM	Number of the control I/O module assigned to automatically control the flow of material into the scale unit
Man Weigh-In CIM	Number of the control I/O module assigned to manually control the flow of material into the scale unit
Auto Weigh-Out CIM	Number of the control I/O module assigned to automatically control the flow of material out of the scale unit
Man Weigh-Out CIM	Number of the control I/O module assigned to manually control the flow of material out of the scale unit

Flow Rate Thresholds	
Zero	Sets the flow rate below which the system assumes a zero flow. The PAC process uses this value to determine when material transfer operations are ready to start and when they are complete
Unstable Device	Sets the flow rate threshold above which the PAC process generates a "noisy measuring device" condition while waiting for a stable scale reading for the "Stable Device Wait Time"
Minimum PAC	Sets the flow rate above which the PAC process begins to apply the predictive algorithm
Process Times	
Feed Override Time	Time, in seconds, before completion of a material transfer when the PAC process inhibits the external logic from removing the permissive on the enabling logic for the Final Control Element (FCE). Examples of this type of external logic are slow step timers or an operator changing operational modes
Overlap Feed Alone Time	The controller can issue commands to start concurrent overlapped feeds to a single scale. There is always one primary overlapped feed. There may be one or more secondary overlapped feeds. The scale controls the primary overlapped feed. In order for the PAC process to have time to accurately predict the cutoff, this time must be set to allow the primary overlapped feed to feed alone before cutoff. Typical feed alone time before cutoff is 10 seconds
Minimum Slow Step Time	The PAC process uses this value when its computed slow step time value is less than this minimum value. The slow step time is the timeout value for the material transfer
Overlap Time Tolerance	The additional time tolerance allowed for a primary overlapping feed to complete. May be used to compensate for time variations that may occur when completing secondary feeds
Stable Device Wait Time	The number of seconds to wait after the drain timer has expired for a stable scale reading before returning an unstable measuring device failure status. If the flow rate is above the "Unstable Device" threshold, the PAC process returns a failure status at the completion of this wait time. If the flow rate is between the "Zero" flow threshold and the "Unstable Device" threshold, the PAC process returns a success status at the completion of this wait time
PLC/DCS Bridge	
Bridge Terminal Number	The terminal node number of the IND780 terminal that contains the PLC/DCS interface board
Bridge Slot Number	The number assigned to the assembly data packet that contains input data for this equipment channel module. There are a maximum of 24 assembly slot numbers for **Q.i Classic mode** and a maximum of 12 assembly slot numbers for **Q.i Enhanced mode**. Only available slot numbers are listed. Once a slot number is assigned, it will not be available in another equipment channel module
Buttons	
Save	Saves changes to the Master Terminal

Delete		Deletes this I/O module
Cancel		Ignores changes and exits to the Configuration Tool's main screen
Default	**Save**	Saves the settings of this Equipment Channel Module as a default ECM template. Note that performing this action over-writes the factory defaults for this type of module.
	Recall	After an ECM number is entered or selected, use **Recall** *either* to load the factory default parameters with the default Equipment Channel Module data (if no new template has been **Saved**), *or* to load the values saved in an ECM template. To restore the factory defaults after they have been over-written by creating and saving a template, backup all terminal data and settings, then perform a Master Reset. Refer to the **IND780 Technical Manual** for details on these procedures.

Storage Scale Equipment Channel Module

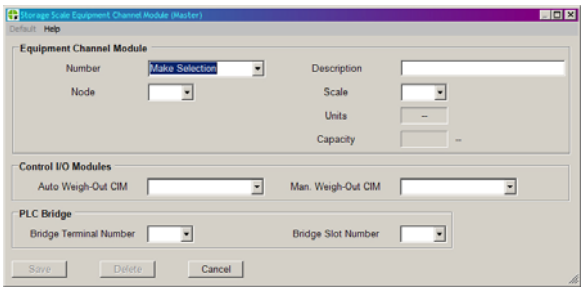


Figure 2-11: Storage Scale ECM View

Equipment Channel Module	
Number	The equipment channel module number assigned to the storage scale device
Description	Name or details of the equipment channel module, 40 characters maximum
Node	Terminal node number where the scale interface/PCB resides
Scale	Scale number 1 to 4
Units	Primary units of this scale – field is not editable
Capacity	Calibrated capacity of the scale unit – field is not editable
Control I/O Modules	
Auto Weigh-Out CIM	Number of the control I/O module assigned to automatically control the flow of material out of the scale unit
Man Weigh-Out CIM	Number of the control I/O module assigned to manually control the flow of material out of the scale unit
PLC Bridge	
Bridge Terminal Number	The terminal node number of the IND780 terminal that contains the PLC interface

Bridge Slot Number	The number assigned to the assembly data packet that contains input data for this equipment channel module. There are a maximum of 24 assembly slot numbers for **Q.i Classic mode** and a maximum of 12 assembly slot numbers for **Q.i Enhanced mode**. Only available slot numbers are listed. Once a slot number is assigned, it will not be available in another equipment channel module

Buttons		
Save		Saves changes to the Master Terminal
Delete		Deletes this I/O module
Cancel		Ignores changes and exits to the Configuration Tool's main screen
Default	**Save**	Saves the settings of this control I/O module as a default Control I/O module template. Note that performing this action over-writes the factory defaults for this type of module.
	Recall	After a control I/O module number is entered or selected, use **Recall** *either* to load the factory default parameters with the default Control I/O Module data (if no new template has been **Saved**), *or* to load the values saved in a Control I/O template. To restore the factory defaults after they have been over-written by creating and saving a template, backup all terminal data and settings, then perform a Master Reset. Refer to the **IND780 Technical Manual** for details on these procedures.

Flow Meter Equipment Channel Module

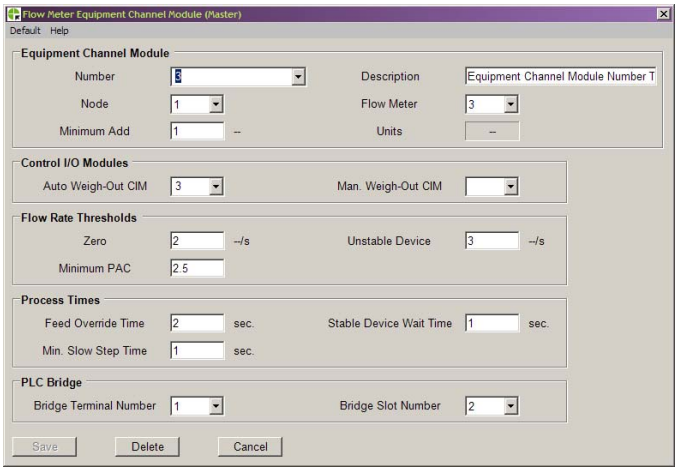


Figure 2-12: Flow Meter ECM View, Flow Meter 3 Selected

Equipment Channel Module	
Number	The equipment channel module number assigned to the flow meter device
Description	Name or details of the equipment channel module, 40 characters maximum
Node	Terminal node number where the scale interface/PCB resides

Flow Meter	Flow Meter number 1 to 12
Minimum Add	Sets the smallest amount of material that the system can attempt to transfer with this flow meter
Units	Measurement units of this flow meter – field is not editable
Control I/O Modules	
Auto Weigh-Out CIM	Number of the control I/O module assigned to automatically control the flow of material out of the scale unit
Man Weigh-Out CIM	Number of the control I/O module assigned to manually control the flow of material out of the scale unit
Flow Rate Thresholds	
Zero	Sets the flow rate below which the system assumes a zero flow. The PAC process uses this value to determine when material transfer operations are ready to start and when they are complete
Unstable Device	Sets the flow rate threshold above which the PAC process generates a "noisy measuring device" condition while waiting for a stable scale reading for the "Stable Device Wait Time"
Minimum PAC	Sets the flow rate above which the PAC process begins to apply the predictive algorithm
Process Times	
Feed Override Time	Time, in seconds, before completion of a material transfer when the PAC process inhibits the external logic from removing the permissive on the enabling logic for the Final Control Element (FCE). Examples of this type of external logic are slow step timers or an operator changing operational modes
Overlap Feed Alone Time	The controller can issue commands to start concurrent overlapped feeds to a single scale. There is always one primary overlapped feed. There may be one or more secondary overlapped feeds. The scale controls the primary overlapped feed. In order for the PAC process to have time to accurately predict the cutoff, this time must be set to allow the primary overlapped feed to feed alone before cutoff. Typical feed alone time before cutoff is 10 seconds
Minimum Slow Step Time	The PAC process uses this value when its computed slow step time value is less than this minimum value. The slow step time is the timeout value for the material transfer
Overlap Time Tolerance	The additional time tolerance allowed for a primary overlapping feed to complete. May be used to compensate for time variations that may occur when completing secondary feeds
Stable Device Wait Time	The number of seconds to wait after the drain timer has expired for a stable scale reading before returning an unstable measuring device failure status. If the flow rate is above the "Unstable Device" threshold, the PAC process returns a failure status at the completion of this wait time. If the flow rate is between the "Zero" flow threshold and the "Unstable Device" threshold, the PAC process returns a success status at the completion of this wait time
PLC Bridge	
Bridge Terminal Number	The terminal node number of the IND780 terminal that contains the PLC interface

Bridge Slot Number		The number assigned to the assembly data packet that contains input data for this equipment channel module. There are a maximum of 24 assembly slot numbers for **Q.i Classic mode** and a maximum of 12 assembly slot numbers for **Q.i Enhanced mode**. Only available slot numbers are listed. Once a slot number is assigned, it will not be available in another equipment channel module
Buttons		
Save		Saves changes to the Master Terminal
Delete		Deletes this I/O module
Cancel		Ignores changes and exits to the Configuration Tool's main screen
Default	**Save**	Saves the settings of this Equipment Channel Module as a default ECM template. Note that performing this action over-writes the factory defaults for this type of module.
	Recall	After an ECM number is entered or selected, use **Recall** *either* to load the factory default parameters with the default Equipment Channel Module data (if no new template has been **Saved**), *or* to load the values saved in an ECM template. To restore the factory defaults after they have been over-written by creating and saving a template, backup all terminal data and settings, then perform a Master Reset. Refer to the **IND780 Technical Manual** for details on these procedures.

Material Path

This menu includes a single item – Material Path. Click on the element to open a configuration display, in which a previously configured Material Path number can recalled (Figure 2-7) to view that module's details, or a new, unused number entered to create a new element.

This opens a screen where a Material Path number can be selected in order to display configuration information specific to that material path.

From this screen, parameters (such as the Feed Algorithm associated with the Material Path) can be modified. Changes can be saved (**Save** button) or discarded (**Cancel** button), and the Material Path can be deleted (**Delete** button). Note that the Delete operation is ***not*** preceded by a warning or confirmation.

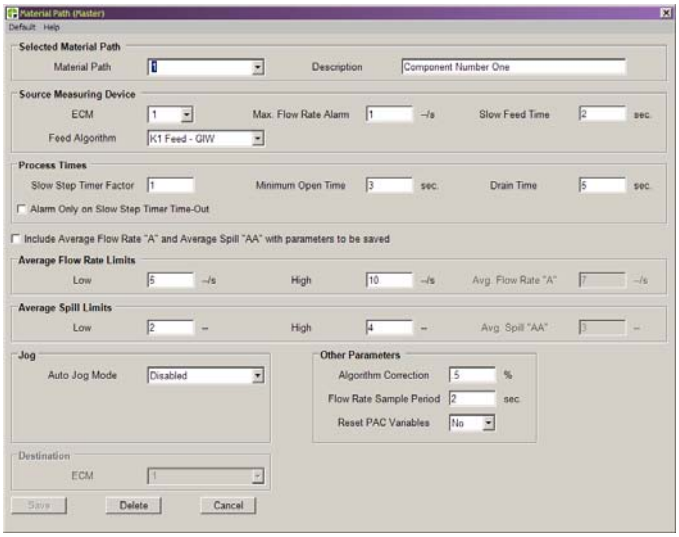


Figure 2-13: Material Path Configuration View

Selected Material Path		
Material Path	Number assigned to this material path	
Description	Name or details of the material path, 40 characters maximum	
Source Measuring Device		
ECM	The equipment channel number assigned to the source measuring device, scale or flow meter	
Feed Algorithm	Spill Only - GIW	Simple Gain-In-Weight feed to cutoff. No predictive algorithm applied. Use for very slow feeds or feeds with very erratic, unpredictable flow rates
	Spill Only – LIW	Simple Loss-In-Weight feed to cutoff. No predictive algorithm applied. Use for very slow feeds or feeds with very erratic, unpredictable flow rates
	K1 Feed – GIW	A Gain-In-Weight feed that predicts the cutoff for feeds that have constant, very predictable flow rates. For example, use it with horizontal feeds that do not have any initial downward velocity
	K1 Feed – LIW	A Loss-In-Weight feed that predicts the cutoff for feeds that have constant, very predictable flow rates
	K2 Feed – GIW	A Gain-In-Weight feed that predicts the cutoff for feeds that are variable but predictable. For example, use it with vertical feeds through valves where the variation in head pressure can cause variable flow rates
	K2 Feed – LIW	A Loss-In-Weight feed that predicts the cutoff for feeds that are variable but predictable
	Dump to Empty	An algorithm to completely empty a tank or vessel
Max. Flow Rate Alarm	Sets the flow rate at which the PAC process terminates the feed and sets an alarm. If this value is set to zero, the PAC process will not check the maximum flow rate	

Slow Feed Time	In a two-speed feed, this is the amount of time needed for the slow feed. A value of 0 disables the two-speed feed and the entire feed proceeds at slow feed
Process Times	
Slow Step Timer Factor	Sets the Slow Step Timer calculation factor. For automatic feeds, the Slow Step Timer is the Factor * target / average flow. The Slow Step Timer measures when a material transfer is taking too long and aborts the process when the process exceeds the timer value. Typical factor values are 1.5 - 2.0. For hand add feeds, the Slow Step Timer is Factor * 60 seconds
Minimum Open Time	Time in seconds during which the PAC process does NOT apply spill compensation immediately following the start of the feed. It allows the material flow to come up to speed before beginning to apply the predictive algorithm. A feed must be active for this length of time before the PAC process considers it successful and automatically updates the PAC parameters
Drain Time	This sets the time in seconds that the system will wait for material to drain into or from a vessel after the PAC process has cutoff the feed and before it tests the material delivery tolerance
Alarm Only on Slow Step Timer Time-Out	Normally when the Slow Step Timer expires, the PAC process terminates the feed. Checking this box will cause the PAC process to generate an alarm when the Slow Step Timer expires **without** terminating the feed. The Controller application must then decide how to process the alarm
Average Flow Rate Limits	
Include Average Flow Rate "A" and Average Spill Rate "AA" with parameters to be saved	When this box is checked, Average Flow Rate "A" and Average Spill "AA" editing is enabled, and values entered for the Average Flow Rate "A" and "Average Spill "AA" will be saved when the **Save** button is pressed
Low	Sets the lower limit for the Average Flow Rate
High	Sets the upper limit for the Average Flow Rate
Avg. Flow Rate "A"	Typically, displays the average flow rate at cutoff in weight per second. Optionally, this field may also be used initially for setting new seed values for the PAC process
Average Spill Limits	
Low	Sets the lower alarm limit for the Average Spill
High	Sets the upper alarm limit for the Average Spill
Avg. Spill "AA"	Typically, displays the average spill in weight at cutoff. Optionally, this field may also be used initially for setting new seed values for the PAC process
Jog	
Auto Jog Mode	Controls the auto jog operation
	Disabled Auto Jog is disabled
	Jog to Tolerance Jog the feed until it reaches the tolerance value
	Jog to Target Jog the feed until it reaches the target value
Jog On Time	Time in fractional seconds the feeder is ON during a jog cycle

Jog Off Time	Time in fractional seconds the feeder is OFF during a jog cycle
Auto Jog Mode	Controls the auto jog operation
Other Parameters	
Algorithm Correction	Value used by the PAC process in calculating the Average Flow Rate and the Average Spill, to control how quickly the system responds to a change in operating conditions. The range is usually 10% to 40% in material transfer processes that change slowly and infrequently. Use values from 70% to 90% for processes that change quickly or frequently
Flow Rate Sample Period	Set this value to specify the period of time in seconds (from 1 to 60) over which the rate is calculated. Smaller values allow the PAC process to respond more quickly to changes in rate, while larger values permit the rate to change more smoothly. In most cases, lower values give better cutoff results
Reset PAC Variables	Resets the PAC variables to a default state when the Save button is pressed
Destination	
ECM	The equipment channel module number of the scale device for the destination vessel to which material is being fed. Selct Out-of-Cluster if the destination is not in the cluster
Buttons	
Save	Saves changes to the Master Terminal
Delete	Deletes this I/O module
Cancel	Ignores changes and exits to the Configuration Tool's main screen

Language

The Language menu provides a list of languages from which to select:

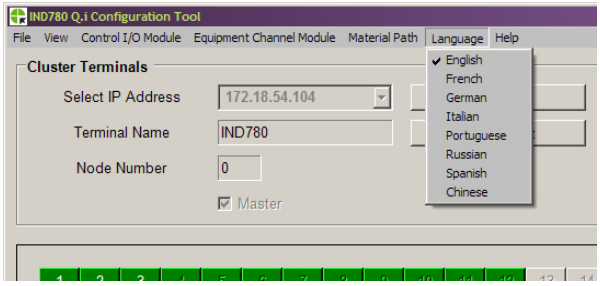


Figure 2-14: Language Options

Help

The help menu offers a choice of two items – access to the browser-based Help system (Figure 2-15), and an "About" screen (Figure 2-16) that shows version information.

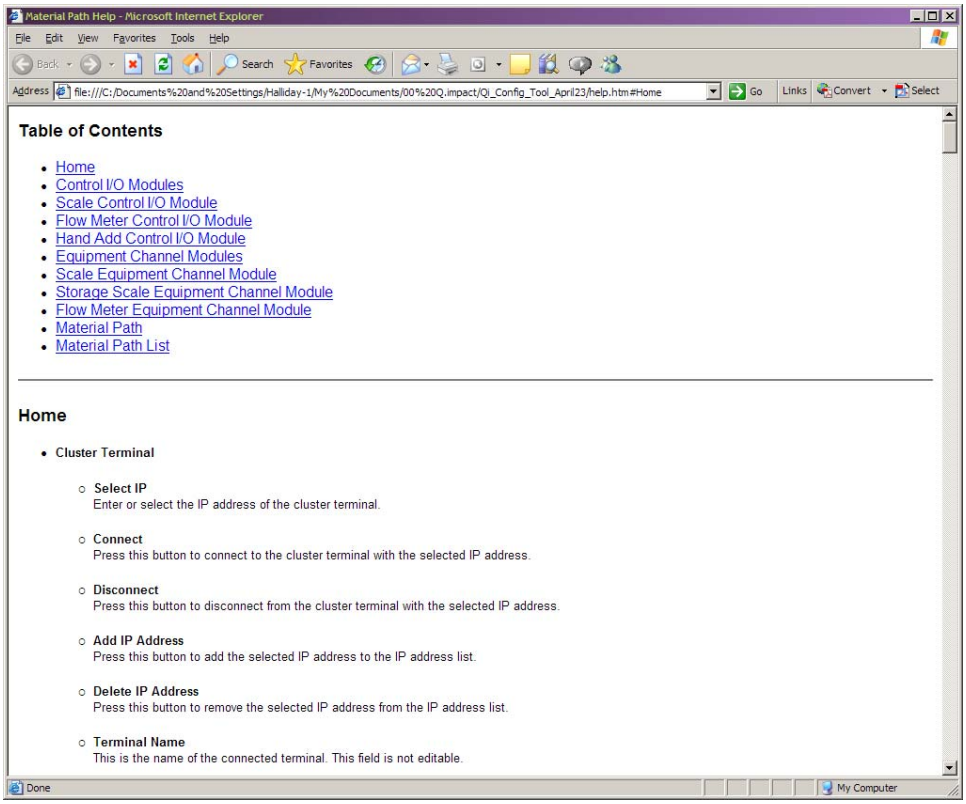


Figure 2-15: Help System, Initial Page

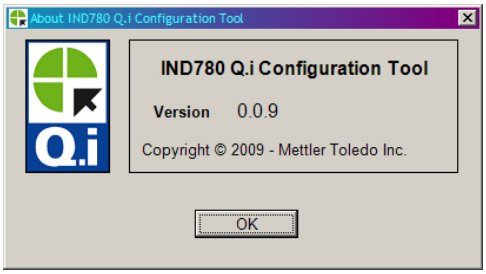


Figure 2-16: Help System, IND780 Q.i Configuration Tool "About" Screen

IND780 Operator Interface

Figure 2-17 shows the standard IND780 home page, indicating that the terminal is on-line in control mode. Note that, in this case, the Q.iMPACT softkey, has been assigned to the fourth position at the bottom of the screen. Refer to Appendix E, **Softkey Mapping and Application Key Configuration**, in the **IND780 Technical Manual**, for information on how to assign softkeys.

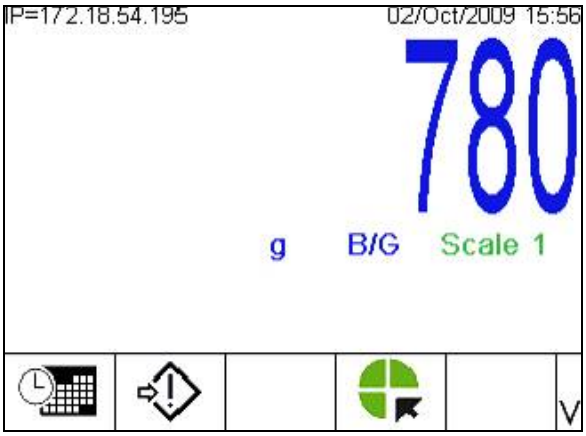


Figure 2-17: IND780 Main Screen with Q.iMPACT Softkey

Press the SETUP softkey to display the setup menu tree, shown below in Figure 2-17. If prompted enter a valid user name and password to access setup.

Viewing Q.i Configuration Information from the Home Screen

To see the current configuration of any module or path without accessing setup, press the VIEW Q.i CONFIG softkey. (This procedure assumes that the softkey has been assigned to the home screen. Refer to Appendix E, **Softkey Mapping and Application Key Configuration**, in the **IND780 Technical Manual**.) The screen shown in Figure 2-18 will display. In this illustration, the View list box has been selected, to show the options.

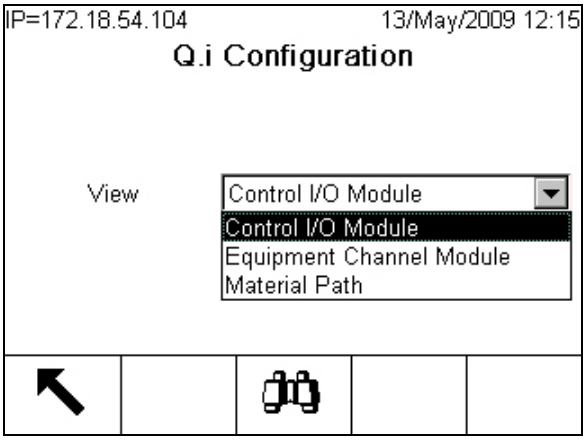


Figure 2-18: Q.i Configuration View Selection Screen

Use the UP and DOWN arrows to highlight the desired selection, then press ENTER to confirm it.

Press the VIEW softkey to open the view screen. A screen like the one shown in Figure 2-19 will display.

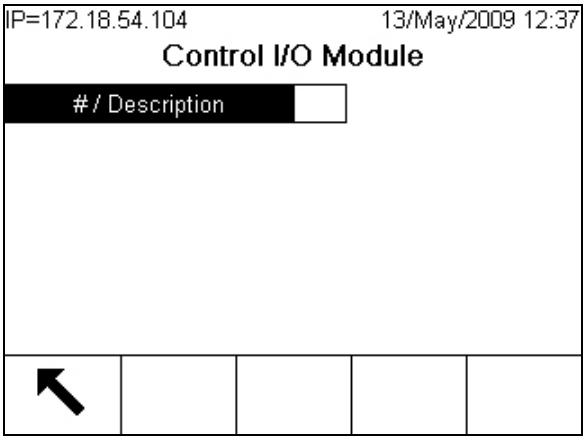


Figure 2-19: Module Number Selection Screen

- Press the EXIT softkey to return to the home screen.
- Press ENTER to select the module number entry field, type the desired module number, and press ENTER again. The requested information will display, but cannot be edited.

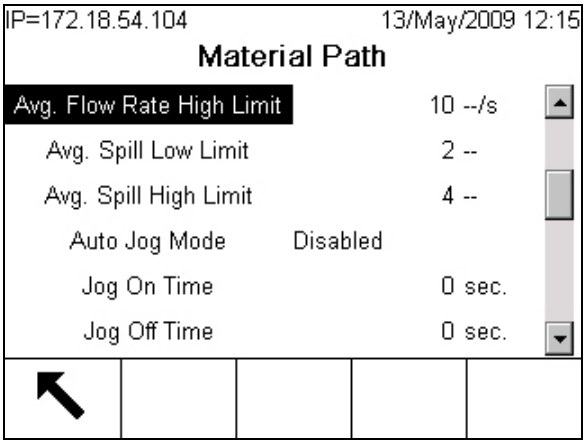


Figure 2-20: Typical Configuration Display Screen

IND780 Q.i Menu Trees

Once in setup, the setup menu tree displays. Use the terminal's front panel UP and DOWN arrow keys to scroll through the tree, and use the RIGHT arrow to expand a branch. To enter a configuration screen at the end of a branch (a leaf node), press the terminal's ENTER key. In Figure 2-17, note the **Flow Meter** and **Q.i Configuration** branches, which are unique to Q.iMPACT.

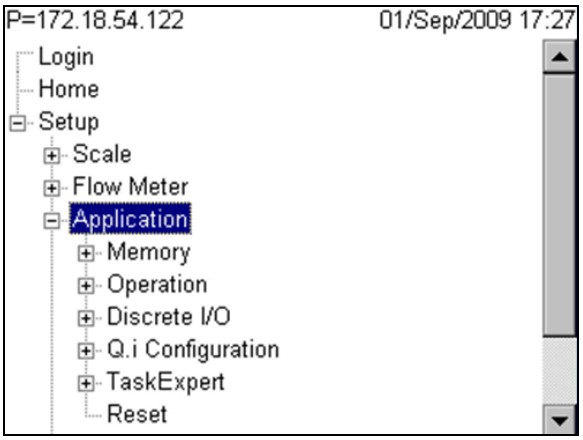


Figure 2-21: Application Branch of Setup Menu Tree, Expanded

Select the **Q.i configuration** branch and expand it:

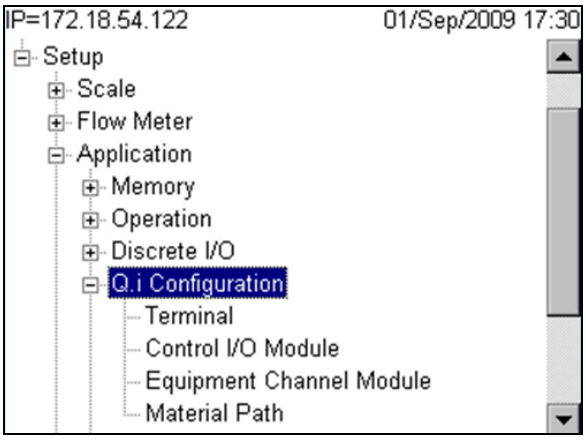


Figure 2-22: Q.i Configuration Branch of Application Menu Tree, Expanded

The following sections detail the information and settings available in the **Q.i Configuration** branch of the setup menu tree.

Application: Q.i Configuration

Terminal

This section covers the Q.iMPACT-specific menus that are added to the standard IND780 control panel setup menu tree. All other IND780 menu items that are not unique to the Q.i application pac on the IND780 terminal are detailed in Chapter 3, **Configuration**, of the **IND780 Technical Manual**

Move the highlight to select the first item on the list – **Terminal**:

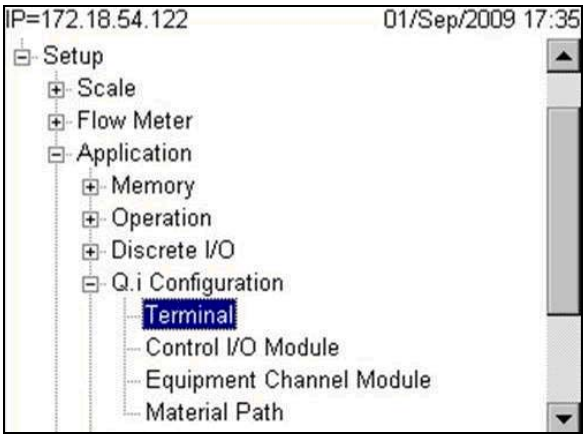


Figure 2-23: Q.i Configuration | Terminal Branch Expanded

With **Terminal** selected, press the ENTER key. The following screen will appear, indicating that the terminal's node has been identified, and offering the option of defining this terminal as the master:

Figure 2-24: Q.i Configuration | Terminal Setup Screen

If Master Terminal is set to **No**, to create a Remote Terminal, this screen displays the Master Terminal's name, and shows the **Q.i Configuration** and **Short Feed** settings defined in the master. These cannot be changed from a remote terminal. For the master terminal itself, the **Master Terminal** field reads "This Terminal."

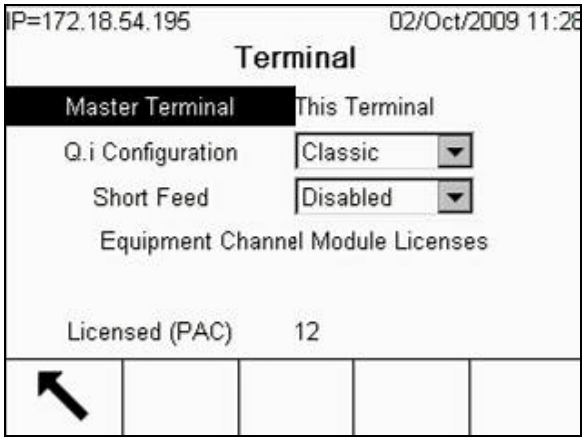


Figure 2-25: Master Terminal - This Terminal Screen

In Q.i systems that contain a single terminal, the terminal is the master by default. In Q.i systems consisting of more than one terminal (a cluster of one master terminal with up to nineteen remote terminals) then the terminal currently accessed could be the master ("This Terminal") or one of the remote terminals.

Note: The Control I/O Modules, Equipment Channel Modules and Material Paths can all be **configured** and **edited** using the Master Terminal setup screens, but they can only be **viewed** in the setup menus of a remote terminal.

Table 2-2: Elements of the Control I/O Module Configuration Screen

Field	Description
Master Terminal	Determines if this terminal will be a Master Terminal or a Remote Terminal. Select **Yes** if this is a single IND780 Q.i system. The Master Terminal is where the system configuration database is located. **Note**: Node numbers are assigned in setup at **Communication > Network > Cluster > This Terminal**.
Q.i Configuration	Q.i configuration options refer to the type of PLC communication you wish to use – **classic mode** or **enhanced mode**. Classic mode is the default. **Classic Mode**: PLC or DCS communications which use explicit shared data messages over ControlNet or Ethernet IP communications protocol, similar to the first generation Q.i application on the JAGXTREME terminal platform. **Enhanced Mode**: This mode of PLC or DCS communications is new for the Q.i application in the IND780 terminal and uses only cyclic messaging to communicate between the host controller and the Q.iMPACT terminal.
Short Feed	The Mettler-Toledo Q.i PAC algorithms require at least 5 seconds of fill time in order to build an accurate model of the feed and adjust the FCE cutoff point appropriately. Short feed options are include: **Enabled**: Select if any of your material feeds are less than 5 seconds **Disabled**: Select if none of your material feeds are less than 5 seconds
Equipment Channel Module Licenses	The number next to the **Licensed (PAC)** label indicates how many equipment channel modules are licensed to use the patented Predictive Adaptive Control (PAC) algorithms. This value is read from a bit on the hardware security key, indicating how many licenses were purchased and enabled on this terminal (or in the cluster, if viewing the master terminal control panel).

Control I/O Module (Master)

Use the arrow key to return to the main menu tree and move to the next item on the list, the Control I/O Module:

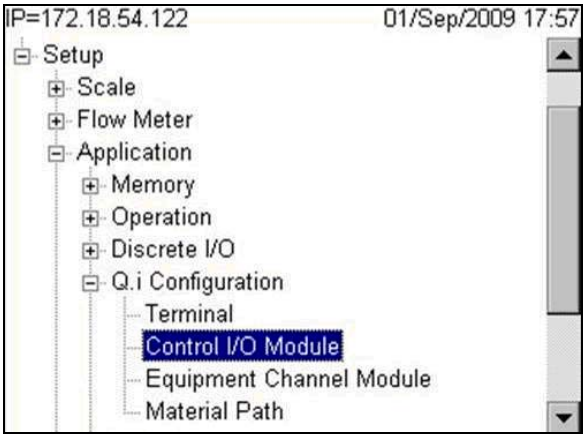


Figure 2-26: Control I/O Module Node of Setup Menu Tree

Select the Control I/O Module branch and press ENTER to display a screen like the one shown in Figure 2-27.

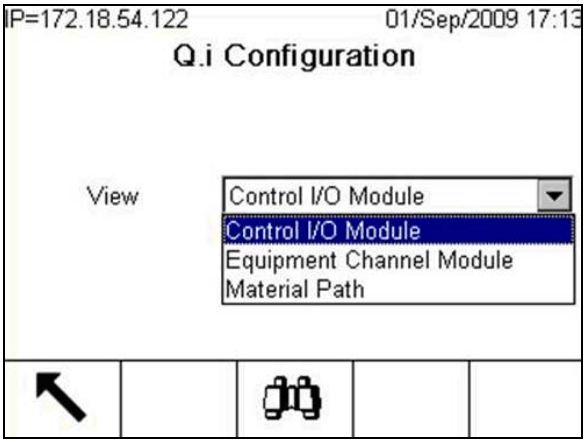


Figure 2-27: Q.i Configuration View Selection Screen

Generally, Control I/O Modules should be configured first, then Equipment Channel Modules. Finally, the Material Paths can be constructed. For further details on the logic of Q.iMPACT function and configuration, please refer to Chapter 1 (**Introduction**) of this manual for further details.

Select Control I/O Module from the Q.i Configuration page, and the following screen shown in Figure 2-28 will appear.

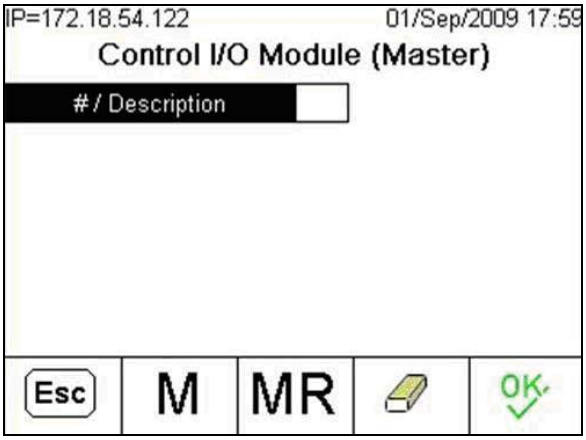


Figure 2-28: Control I/O Module Screen

Enter a Control I/O Module number in the **# / Description** field. If the module number is already assigned, the values for that module will appear in fields on the screen. If the number has **not** been assigned, **Description** and **Equipment Type** fields will appear. Once a selection is made in the **Equipment Type** drop-down, a variety of other fields appear on the screen.

Table 2-3 describes the options available for each field in these screens.

Table 2-3: Elements of the Control I/O Module Configuration Screen

Field	Description
# / Description	1-297 Enter the number of an existing Control I/O Module, or define a new one. When the Description field is selected, the softkeys become alphanumeric entry keys.
Type	Scale, Flow Meter, Hand Add This selection determines the type of module you wish to configure.
Fast Feed Type [If Type ≠ Hand Add]	Concurrent, Independent, None **None**: Only fine feed is used **Independent**: Fast and fine feeds are used sequentially, and independent of one another **Concurrent**: Fast and fine feeds are used simultaneously, until near the end of the feed when fast feed is turned off, and fine feed continues till cut-off.
Fast Feed FCE Out [If Type = Flow Meter and Fast Feed Type ≠ None]	0.0.0 Sets the address for the fast feed discrete output to be controlled using this output. This will only be visable/configurable if you choose independent or concurrent fast feed type above.

Field		Description
Fine Feed FCE Source [If Source = Scale]		Other I/O, Scale Board Determines the source of the Fine Feed control element that controls the Fine Feed.
Enable Manual Weigh [If Type = Flow Meter]		0.0.0 Sets an address for the discrete input used to enable manual weighing.
Fine Feed FCE Out [If Type = Scale]		0.0.0 Sets a discrete output address to be used by the fine feed device to be controlled.
GIW / LIW Selector Out [If Type = Scale and Fine Feed FCE Source = Scale Board]		0.0.0 Sets a discrete output address for the Gain/Loss In Weight selector. If the Scale Board is selected as the Fine Feed FCE Source, then this output is used to route the fine feed of material into (GIW) or out of (LIW) of a scale
Hand Add Ack.In [If Type = Hand Add]		0.0.0 Sets a discrete input address for the device used by the operator to acknowledge manual addition of material.
Esc	ESCAPE	Exits the menu and returns to the setup tree.
M	Memory	Saves the currently displayed values to memory.
MR	Memory Recall	Populates fields for new or existing module with factory defaults (if no custom configuration has been performed) or with values most recently saved to memory (if custom configuration has been performed).
	DELETE	Deletes the selected record.
	OK	Confirms the entry and returns to the menu tree.

As you complete the fields on this screen, it will resemble Figure 2-29.

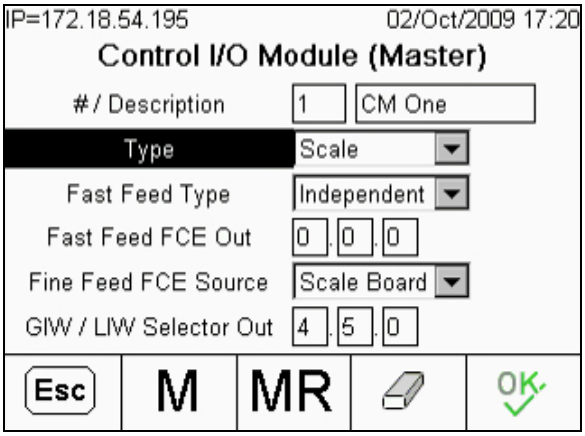


Figure 2-29: Control I/O Module Screen, Parameters Set

Equipment Channel Module (Master)

To access the Equipment Channel Module screen, expand the Q.i Configuration branch of the setup menu and select the appropriate node (Figure 2-30).

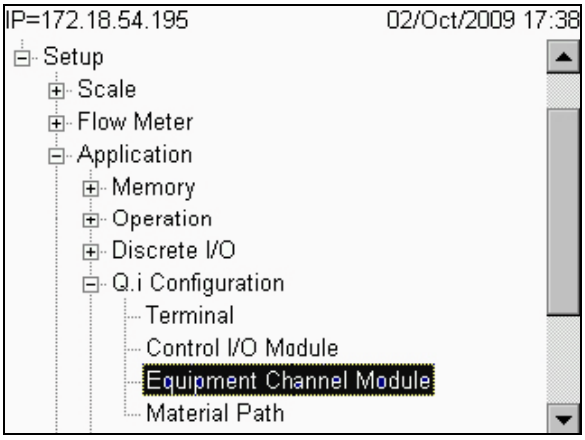


Figure 2-30: Setup Menu, Equipment Channel Module Branch Selected

Press ENTER to open the Equipment Channel Module configuration screen (Figure 2-31).

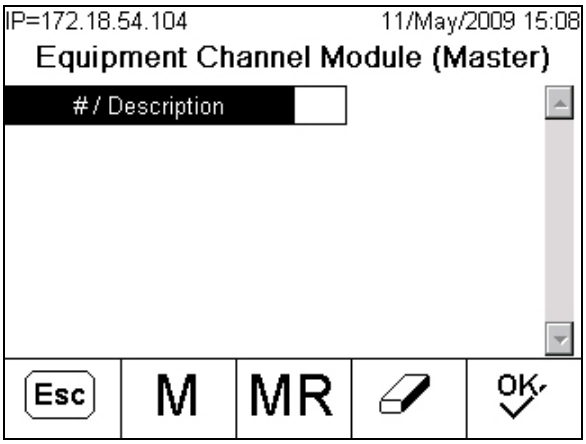


Figure 2-31: Equipment Channel Module, Default View

Enter an Equipment Channel Module number in the **# / Description** field. If the module number is already assigned, the values for that module will appear in fields on the screen. If the number has **not** been assigned, **Description** and **Equipment Type** fields will appear, as in Figure 2-32. In this figure, the **Description** field is selected, and the softkey alphanumeric entry fields are displayed at the bottom of the screen.

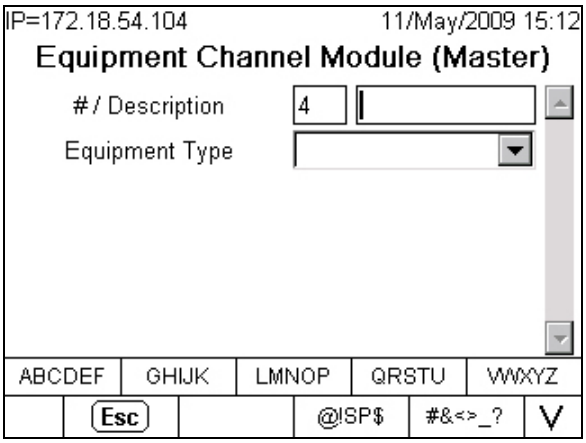


Figure 2-32: Creating a New Equipment Channel Module

Once a selection is made in the **Equipment Type** drop-down, a variety of other fields appear on the screen (Figure 2-33). The display of fields depends on the type of equipment selected. Note the scroll bars at right, indicating additional fields that can be accessed by scrolling down

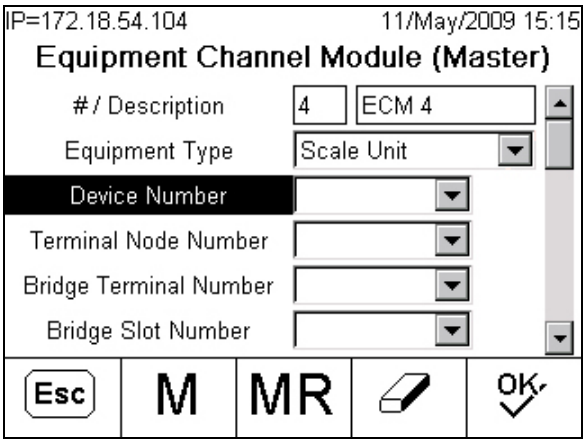


Figure 2-33: Equipment Channel Module, Page1, Scale Unit Selected as Type

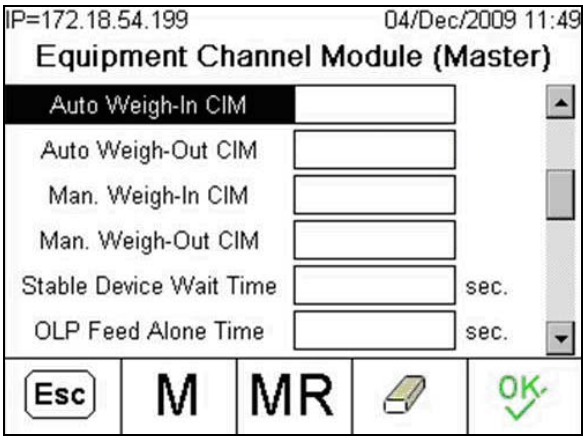


Figure 2-34: Equipment Channel Module, Page 2

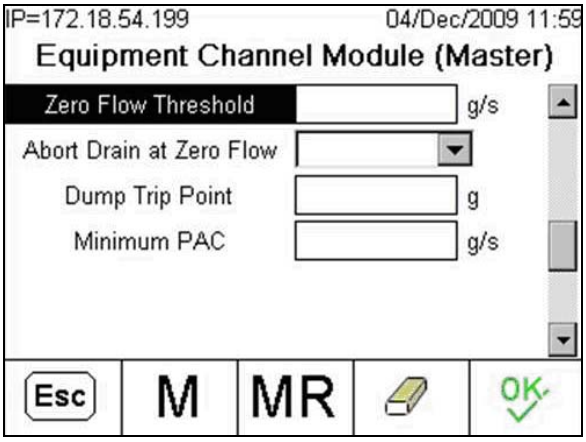


Figure 2-35: Equipment Channel Module, Page 3

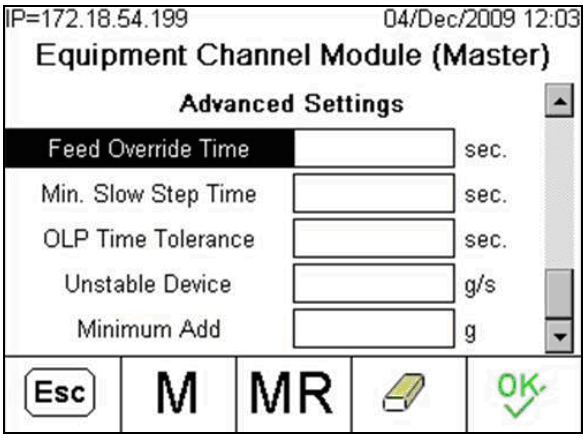


Figure 2-36: Equipment Channel Module, Page 4

Table 2-4 describes the options available for each field in these screens.

Table 2-4: Elements of the Control I/O Module Configuration Screen

Field	Description
# / Description	1-198 Enter the number of an existing Equipment Channel Module, or define a new one. When the Description field is selected, the soft keys become alphanumeric entry keys.
Equipment Type	Scale Unit, Storage Scale, Flow Meter This selection determines the type of module you wish to configure
Device Number	1 – 4 or 1-12 Choose 1-4 for Scale Unit and Storage Scale. Choose 1-12 for Flow Meter
Terminal Node Number	1-20 Identify which terminal corresponds to this Equipment Channel Module number/description
Bridge Terminal Number	1-20 Identify which bridge terminal corresponds to this Equipment Channel Module number/description
Bridge Slot Number	1-24 or 1-12 Identify 1-24 for Classic Communications Mode Identify 1-12 for Enhanced Communications Mode
Auto Weigh-In CIM [Only if Equipment Type = Scale Unit]	1-297 The number of the Control I/O Module assigned to automatically control the flow of material into the scale unit
Auto Weigh-Out CIM	1-297 The number of the Control I/O Module assigned to automatically control the flow of material out of the scale unit
Man. Weigh-In CIM [Only if Equipment Type = Scale Unit]	1-297 The number of the Control I/O Module assigned to manually control the flow of material into the scale unit
Man. Weigh-Out CIM	1-297 The number of the Control I/O Module assigned to manually control the flow of material out of the scale unit
Stable Device Weight Time [Only if Equipment Type = Scale Unit or Flow Meter]	Seconds Sets the amount of time, in seconds, that the device will wait for a stable weight value
OLP Feed Alone Time [Only if Equipment Type = Scale Unit]	Seconds Time that primary overlapping feed is feeding alone, without **any** secondary feeds
Zero Flow Threshold	Units/second Flow rate below which the system assumes zero flow

Field	Description
Abort Drain at Zero Flow	Enabled or Disabled Enable this feature to stop the drain when the system detects zero flow
Dump Trip Point [Only if Equipment Type = Scale Unit]	Units The level that the PAC process starts the drain timer in a dump-to-empty operation
Minimum PAC [Only if Equipment Type = Scale Unit] or Flow Meter	Units/second Sets the flow rate above which the PAC process begins to apply the Predictive Adaptive Control algorithm
Advanced Settings	
Feed Override Time	Seconds The time before the completion of a material transfer when the PAC process inhibits the external logic from removing the permissive on the enabling logic for the final control element (FCE).
Min Slow Step Time	Seconds The timeout value for the material transfer
OLP Time Tolerance	Seconds The additional time tolerance allowed for a primary overlapping feed to complete
Unstable Device	Units/Second The flow rate threshold below which the PAC process generates a "noisy measuring device" condition while waiting for a stable scale reading for the "Stable Device Wait Time"
Minimum Add	Units The smallest amount of material that the system can attempt to transfer with this Equipment Channel Module

These screens display five softkeys, which function as follows:

Esc	ESCAPE	Exits the menu and returns to the setup tree.
M	Memory	Saves the currently displayed values to memory.
MR	Memory Recall	Populates fields for new or existing module with factory defaults (if no custom configuration has been performed) or with values most recently saved to memory (if custom configuration has been performed).
	DELETE	Deletes the selected record.
OK	OK	Confirms the entry and returns to the menu tree.

Material Path (Master)

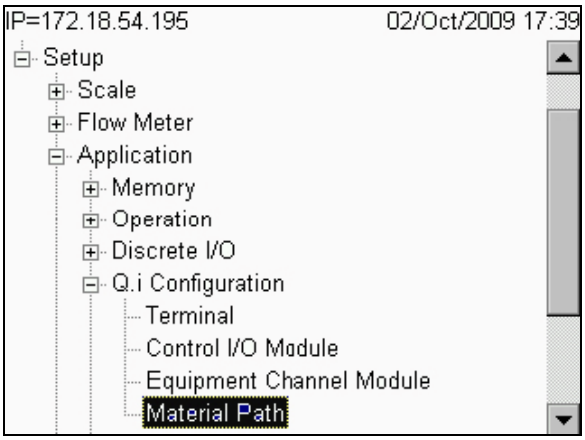


Figure 2-37: Setup Menu, Material Path Branch Selected

The Material Path screen allows a logical feed structure to be assembled, using the equipment channel modules and control I/O modules configured in the previous sections of the Q.i configuration branch of setup.

Error! Reference source not found. Figure 2-38 through Figure 2-41 show the four views of the Material Path (Master) configuration screen. The views show the factory default settings that can be obtained by selecting the MR soft key (unless you have previously saved over the factory default settings. If the number of an existing Material Path is entered in the # screen, the Description and various parameter values for that path appear in the remaining fields. If the number entered is not already an existing Material Path, then the cursor will mover to the Description field and allow you to proceed. Note the scroll bars at right, indicating additional fields that can be accessed by scrolling down.

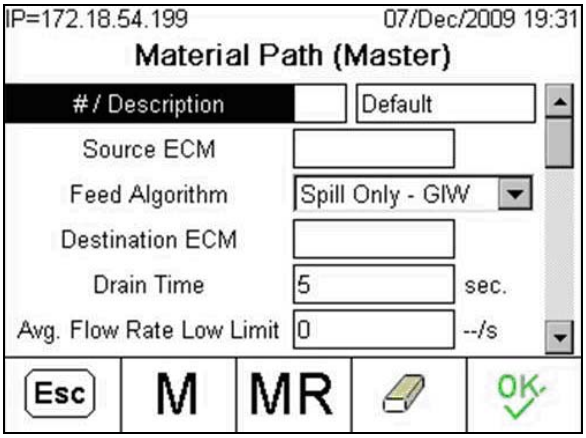


Figure 2-38: Material Path Configuration Screen 1, Basic Settings

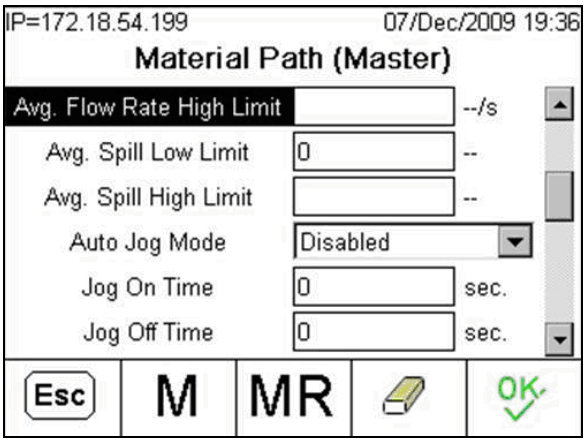


Figure 2-39: Material Path Configuration Screen 2, Basic Settings

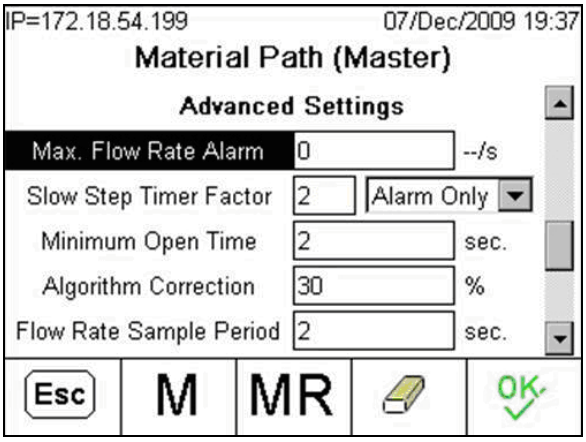


Figure 2-40: Material Path Configuration Screen 3, Advanced Settings

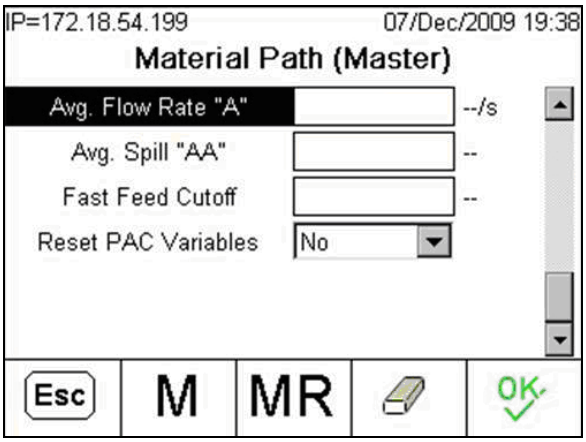


Figure 2-41: Material Path Configuration Screen 4, Advanced Settings

Table 2-5 describes the options available for each field in these screens.

Table 2-5: Elements of the Material Path Configuration Screen

Field	Description
# / Description	1-999 Enter the number of an existing Material Path, or define a new one. When the Description field is selected, the softkeys become alphanumeric entry keys. The description can be a maximum of 40 characters
Source ECM	1-198 Specifies, by number, the Equipment Channel Module to be used with this Material Path as the source measuring device, scale or flow meter..
Feed Algorithm	Spill Only GIW, Spill Only - LIW, K1 Feed - GIW, K1 Feed - LIW, K2 Feed - GIW, K2 Feed - LIW, Dump to Empty, Hand Add Selects the algorithm to use for this Material Path, depending on the function the path will perform.
Destination ECM	1-198 Specifies, by number, the Equipment Channel Module to be used with this Material Path as the destination measuring device, scale or flow meter.
Drain Time	Seconds Sets the time in seconds that the system will wait for a material to drain into or from a vessel after the PAC process has cutoff the feed and before it tests the material delivery tolerance
Avg. Flow Rate Low Limit	Units/Second Rate, in primary weight units per second, that defines the lowest acceptable average flow weight for the material.
Avg. Flow Rate High Limit	Units/Second Rate, in primary weight units per second, that defines the highest acceptable average flow weight for the material.
Avg. Spill Low Limit	Units Sets the alarm limit for the minimum acceptable Average Spill
Avg. Spill High Limit	Units Sets the alarm limit for the maximum acceptable Average Spill
Auto Jog Mode	Disabled, Jog to Tolerance, Jog to Target Selects the mode that controls the Auto Jog operation
Jog On Time	Tenths of Seconds Time that the feeder is ON during a jog cycle
Jog Off Time	Tenths of Seconds Time, that the feeder is OFF during a jog cycle

Field	Description
Advanced Settings	
Max Flow Rate Alarm	Units/Second Sets the flow rate at which the PAC process terminates the feed and sets an alarm. Setting this value at 0 will disable this alarm
Slow Step Timer Factor	Tenths of Seconds, Alarm Only, Alarm and Abort Sets the Slow Step Timer calculation. For automatic feeds, the Slow Step Timer is the Factor *Target/Average Flow. The Slow Step Timer measures when a material transfer is taking too long and aborts the process when the material transfer exceeds the timer value. Typical factor values are 1.5-2.0. For hand add feeds, the Slow Step Timer is a Factor * 60 seconds.
Minimum Open Time	Seconds Time in which the PAC process does NOT apply spill compensation immediately following the start of a feed. It allows the material flow to come up to speed before beginning to apply the PAC process. A feed must be active for this length of time before the PAC process considers it successful and automatically updates the PAC parameters
Algorithm Correction	Percent The PAC process uses this value in calculating the Average Flow Rate and Average Spill to control how quickly the system responds to a change in operating conditions. The range is usually 10% - 40% in material transfer processes that change slowly or infrequently. Use values from 70% to 90% fir processes that change quickly or frenquently.
Flow Rate Sample Period	1-60 Seconds Specifies the time over which the Flow Rate is calculated. Smaller values allow the PAC process to respond more quickly to changes in rate, while larger values permit the rate to change more smoothly. In most cases, lower values give better cutoff results.
Avg. Flow Rate "A"	Units/Second This displays the average flow rate at cutoff. As an option, you may elect to use this field initially for setting new seed values for the PAC process.
Avg. Spill "AA"	Units This displays the average spill at cutoff. As an option, you may elect to use this field initially for setting new seed values for the PAC process.
Fast Feed Cutoff	Units In a two-speed feed, the Fast Feed Cutoff is the weight at which Qi terminates the fast feed and begins the slow feed. The fast feed cutoff weight must be large enough value to allow the PAC algorithm to have time to adjust the spill before ending of the feed. Typically, (the fast feed cutoff weight / the average slow feed flow rate) must be six seconds or more. In the two-speed feed, the min open time is the time it takes to switch over from the fast feed to the slow feed rate calculation, typically, two seconds or more.

Field	Description
Reset PAC Variables	No, Yes Reset PAC Variables resets the Qi algorithm runtime variables to zero in the Q.i algorithm tables (not the Average Flow Rate "A" and the Average Spill "AA").

The five softkeys visible in these screens function as follows:

Esc	ESCAPE	Exits the menu and returns to the setup tree.
M	Memory	Saves the currently displayed values to memory.
MR	Memory Recall	Populates fields for new or existing module with factory defaults (if no custom configuration has been performed) or with values most recently saved to memory (if custom configuration has been performed).
	DELETE	Deletes the selected record.
OK	OK	Confirms the entry and returns to the menu tree.

PLC Configuration

For the configuration of an installed PLC option board, please refer to the **IND780 Technical Manual**, Chapter 3, **Configuration** and this Manual, Appendix TME Communications

Note that, while Allen-Bradley RIO and DeviceNet options are available, due to their restricted message size they do not provide true fieldbus integration capability.

ControlNet, Ethernet/IP and PROFIBUS all provide full fieldbus integration. The only Q.i-specific setting that must be configured for these PLC/DCS interfaces is the selection of Classic or Enhanced mode, in Setup at **Application > Q.i Configuration > Terminal** (Figure 2-42).

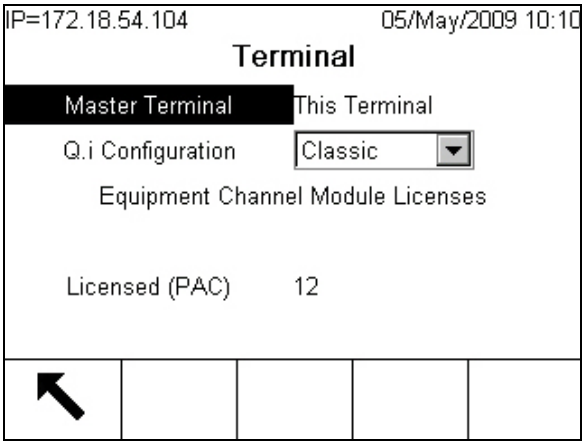


Figure 2-42: Q.i Terminal Configuration – Classic/Enhanced

Operation

The IND780 Q.i terminal is a material transfer controller engineered to function as an integrated part of your control system. There are two basic ways to operate an IND780 Q.i terminal:

- Control the operation of the Q.i terminal from your PLC or DCS system
- Control the operation of the Q.i terminal from an internal TaskExpert program

These two options make it possible to take advantage of the powerful Predictive Adaptive Control (PAC) algorithms, regardless of the size and complexity of the material transfer system.

PAC Web Pages

Overview

The figures in the following sections show web pages from the web server embedded in the IND780. These pages are available only when the Q.i application is active in the IND780 terminal. For all other standard IND780 Web Page descriptions, please refer to the External Diagnostics section of the **IND780 Technical Manual**.

Specify the IP address (for example, http://172.18.55.136) of the IND780 Q.iMPACT terminal in your URL browser window and press ENTER to connect. Make sure the Q.iMPACT terminal has a unique IP address. Once the IP address of the IND780 Q.i terminal is entered in the web browser, the IND780 index page will appear (Figure 2-43). Select PAC from the View menu – the selection will be highlighted in green, as shown in the example below.

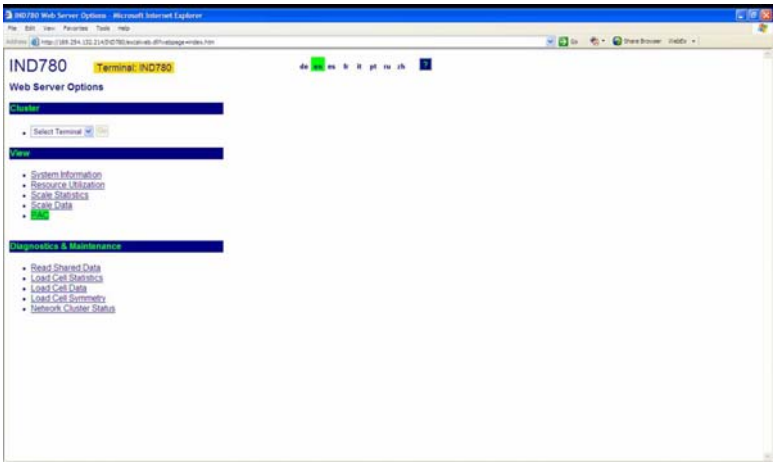


Figure 2-43: IND780 Web Server, Index Page

PAC Parameters

The first option under the PAC selection (Figure 2-44) is called PAC Parameters.

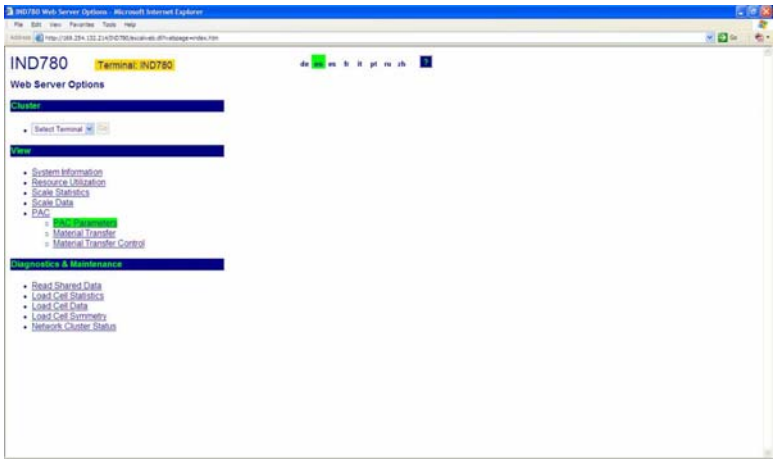


Figure 2-44: PAC View Options

Click on PAC Parameters to open the screen shown in Figure 2-45.

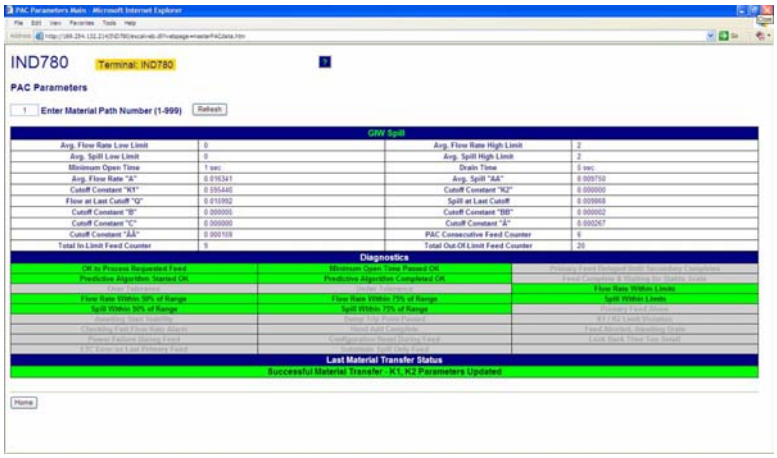


Figure 2-45: PAC Parameters

The PAC Parameters page is separated into three sections:

- Top section: Displays configured parameters and calculated values associated with the specific material path entered in the control field at the top left of the page. Only configured material paths will appear when entered. To enter a new material path, please use the Q.i Configuration Tool, or access the IND780 setup menu from the terminal's front panel interface.

- Diagnostics: A diagnostics summary of the material transfer process. It identifies parameters and values that are within programmed tolerances, and those that are outside of programmed tolerances.

- Last Material Transfer Status: Shows an update of the last material transfer, indicating whether it was successful (i.e., was within the

acceptable limits and tolerances) and whether the PAC parameters updated as a result of this successful material transfer.

Please note that this page is for updated parameter and feed algorithm information only. Please use the Q.i Configuration Tool or the IND780 setup menu for modification or configuration. The only user-modifiable field on this Web Page is the selection of the Material Path number to view. Click on the Refresh button, immediately to the right of the Material Path selection box, to update the values. Click on the Home button at bottom left to return to the index page.

Material Transfer View

The next Q.iMPACT web page option is the Material Transfer view (Figure 2-46). In the field at top left, enter the Equipment Channel Module (Scale, Flow Meter or Storage Scale) to view. Like the PAC Parameters page, the Material Transfer page displays status and results for the selected Equipment Channel Module (ECM). Access the Material Transfer Control view (Figure 2-47) by clicking the button to the right of the ECM entry field, or return to the Index view by clicking the Home button at bottom left.

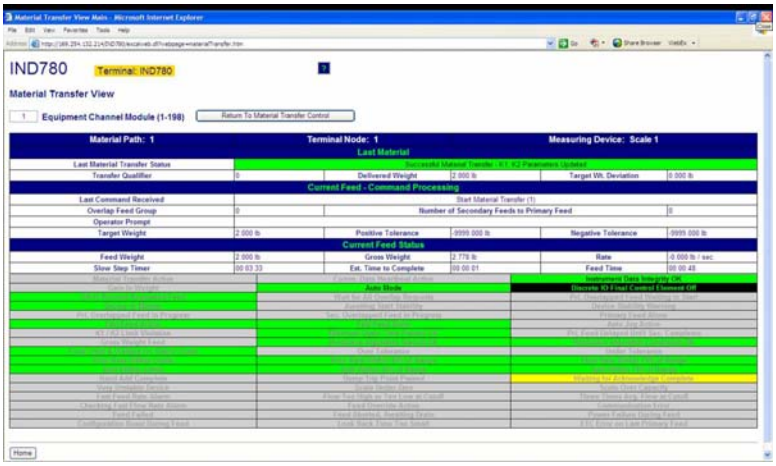


Figure 2-46: Material Transfer View

Material Transfer Control

The final web page unique to the Q.i application on the IND780 Terminal is the Material Transfer Control view (Figure 2-47).

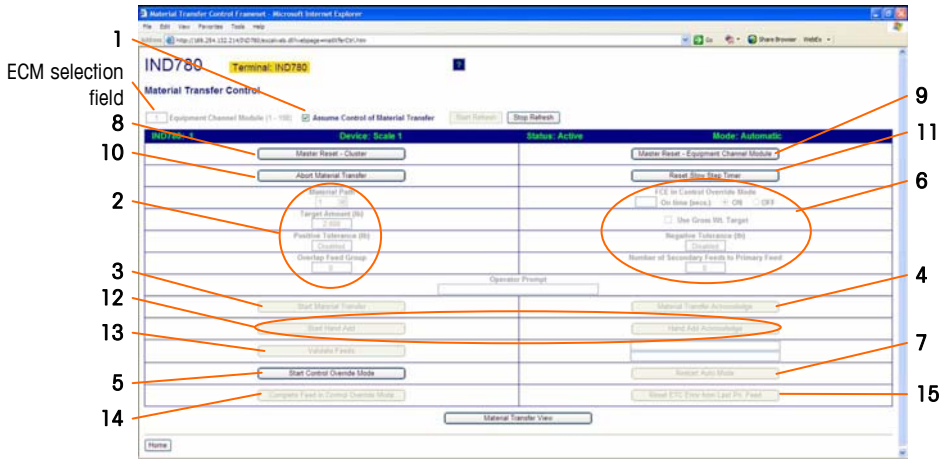


Figure 2-47: Material Transfer Control

Material Transfer Check, Automatic Mode

Figure 2-47 shows the system in Automatic Mode. This view is particularly useful during startup and commissioning. From here, it is possible to perform a material transfer independent of the host PLC or DCS control system. All the necessary parameters can be entered and the transfer started.

- The host PLC or DCS control system will normally have an interlock in series with the IND780 Q.i final control element (FCE). In order to perform a material transfer from this view, this associated output in the host PLC or DCS system probably will have to be turned on.

Enter the Equipment Channel Module (ECM) number for the material transfer. The ECM can be a Scale, a Flow Meter or Storage Scale. Next, check the **Assume Control of Material Transfer** box (**# 1**, in Figure 2-47). Enter the desired Material Path, target amount and, optionally, the tolerances (**2**).

Once the minimum amount of parameters necessary for a material transfer have been entered, the **Start Material Transfer** button (**3**) will become active. Click on this button to start the transfer.

When a material transfer is completed successfully, the **Material Transfer Acknowledge** button (**4**) will become active. This button must be clicked in order to complete the process.

Material Transfer Check, Manual Mode

When **Start Control Override Mode** (**5**) is selected, it is possible to perform a material transfer in manual mode. The Equipment Channel Module Final Control Element (FCE) can be turned on for a preset number of minutes – enter the desired value in the control field and then select ON (**6**). No Material Acknowledge commands are required during or after this process, and it can be repeated as desired. The **Material Transfer Acknowledge** button (**4** must be clicked in order to complete the process.

It is advisable to return the controller to the Auto mode (**7**) upon completion.

- The state of the buttons corresponds to the state of the material transfer. If either **Material Transfer Acknowledge** or **Hand Add Acknowledge** fields are active (not grayed out), they must be clicked before continuing.

Further elements of the Material Transfer Control page

#	Label	Function
8	Master Reset - Cluster	Use to recover from errors and inconsistencies – stops any active feeds and resets all Equipment Channels to automatic/ready mode. Does **not** re-set configured parameters for channels in the cluster.
9	Master Reset - Equipment Channel Module	Same as **Master Reset - Cluster**, but only affects currently selected ECM.
10	Abort Material Transfer	Stops current material transfer.
11	Reset Slow Step Timer	Refer to the Equipment Channel Module and Material Path sections earlier in this chapter.
12	Start Hand Add Hand Add Acknowledge	**Start Hand Add** button is available in Control Override (manual) Mode. Once hand-addition of material is complete, it must be acknowledged clicking the **Hand Add Acknowledge** button.
13	Validate Feeds	Used only during system validation. Crosschecks the accuracy of Flow Meters with a Scale. The Flow meters must feed into the scale which is doing the validating.
14	Complete Feed in Control Override Mode	When an automatic feed is aborted, click this button to complete the feed in Control Override (manual) mode.
15	Reset ETC Error from Last Pri. Feed	When a primary feed exceeds the Estimated Time to Complete (ETC), click this button to clear the error.

Chapter 3.0

Service and Maintenance

This chapter contains information to assist in troubleshooting, and in interpreting error codes and messages that may appear on the IND780 Q.i terminal's screen and in its Error and Maintenance logs.

Troubleshooting

Power-Up State

When power is applied to the IND780 Q.iMPACT, or when power is cycled, unless otherwise configured (e.g., in PLC/DCS setup) the system starts in **automatic feed** and **classic communication** mode.

Error Log File and Error Code Structure

The IND780 error log can be viewed in setup at **Maintenance > Configure > Error Log**. The IND780 Error Log is Enabled by default. For further details about this log file, refer to Appendix C, **Table and Log File Structure**, in the **IND780 Technical Manual**.

Table 3-1 uses a typical record to show the structure of the Error Log file. The commas used to separate fields are not shown in this example.

Table 3-1: Error Log File Record Structure

Timestamp	Severity	Source	Error Code	Message
2006/08/29 08:35:57	E	A	0018	COMMUNICATION_TIMEOUT

Severity

Table 3-2 explains the Severity codes used in a log entry. These codes do not appear in the Error Log Search View.

Table 3-2: Error Log File Record Structure

Severity Code	Explanation
F	**Fatal error** requiring system halt. On detection, an "F" error will immediately initiate a flush of the memory buffers to their associated log files.

Severity Code	Explanation
C	**Critical error** signaling a serious condition that will affect overall performance or functionality of the system. An example would be loss of an option card.
E	**Error** that in general is recoverable, or which the system is able to handle. Note: It is likely that a persistent error condition may result in a critical error.
I	**Message** that is intended to provide information to help service personnel resolve issues.

Critical errors (F, C) generate a message box that must be dismissed by pressing ENTER. The message indicates corrective action that must be taken to restore the Terminal to normal operation. Non-critical errors (E, I) are displayed, typically for 10 seconds, in the System Line at the top of the home screen. Some errors stay on the System Line for 3-5 seconds and then reappear periodically if the error is not resolved – for example, POWERCELL No Response errors. The System Line View settings do not affect the display of these errors.

Source

Error sources by device type are detailed in Table 3-3, together with their formats – refer to the following section.

Table 3-3: Error Log Source and Format, by Device Type

Source Code	Device Type	Format
A	Measurement Adapter (scale, flow meter, temperature)	PCCx
C	COM port Adapter	xxxx
D	Discrete I/O Adapter	Cxxx
E	Main CPU / Baseboard	xxxx
F	Template errors	xxxx
H	HMI (display, keypad, keyboard) Adapter	xxxx
I	Interpreter (Task Expert)	xxxx
N	Network Adapter (Ethernet, USB, PLC)	xxxx
P	PLC or PC – a network partner	xxxx
S	Shared Data	xxxx
T	Terminal – a network partner	xxxx
U	Application software	xxxx

Format of Error Code

Error codes are device-specific, and each code is associated with an explanatory message. Error codes are constructed as follows:

X	X	X	X
If more than one instance is possible, the first digit identifies it.	If there is more than one instance, and it has 'children', these two digits identify the child, in hexadecimal notation.		Error number. Corresponds to the Message that appears in the Error Log and the System Message Line.
Example			
2xxx = Scale Channel 2	x**03**x = error affecting load cell at address 3		xxx**8** = no response from POWERCELL

Thus, an error code will have one of the following configurations:

xxxx One instance, all digits represent the error

Pxxx Multiple instances; first digit (**P**) represents instance to which the error applies

PCCx Multiple instances with subordinate items; first digit (**P**) represents the parent instance, next two digits (**CC**) identify the child

Interpretation of Errors

The error message only gives a general indication of source, so to interpret errors arising from sources with multiple instances it is useful to know the structure of the four-digit code. In the example used above – **2038** – the error message displayed in the system message line and recorded in the error log would be

POWER_CELL_NO_RESPONSE

The code comprises a parent (the scale channel or network of POWERCELLS), a 2-digit child (the specific POWERCELL affected) and an error number, but only the information from the final digit is reflected in the error message. The error log, however, will include all four digits. Thus, the structure of the code (Table 3-3) allows the channel and cell affected to be determined.

Q.i-Specific Errors

Table 3-4 lists error messages specific to the Q.i 780 system. The terminal puts these messages in the System Line of the Operator Display and saves them in the error log.

Table 3-4: Q.iMPACT Error Messages

Error Message	Source	Description	Probable Cause/s	Remedy
CALIBRATION_ERROR	A	The flow meter driver detected a problem with the flow meter calibration parameters.	One likely cause is that the increment size is too small for the number of counts per weight unit (or K-factor) of the flow meter device. The Flow Meter must have at least one count per weight increment.	Increase the increment size in flow meter calibration.

Error Message	Source	Description	Probable Cause/s	Remedy
FLOW_METER_RESPONSE_ERROR	A	The flow meter driver detected an error in accessing a flow meter board.	The flow meter configured in the CP Setup is not responding; it probably does not exist.	Correct error in flow meter setup.
NETWORK_ERROR	N	Qi has detected a problem communicating between Q.i terminals in Ethernet cluster network.	An Ethernet network problem.	Check Ethernet network connections and wiring.
			A problem with the network node setup.	Check the node setup definition in the Qi tables and the CP Setup.
BATCH_LOCAL_TABLES_NOT_UPDATED	U	Upon power up or reset, each Qi terminal attempts to refresh its tables from the Master terminal. This error alerts the operator that this operation failed.	Too much Ethernet cluster network traffic.	Cycle power at the failed Qi terminal.
MULTIPLE_BATCH_MASTER_TERMINALS	U	More than one terminal is configured as the Qi master terminal.		Correct the setup.
PLC_NOT_COMMUNICATING	P	The IND780 terminal is not communicating with the Host PLC.	Problem with physical connection between the Qi bridge terminal and the PLC	Check the physical wiring and connections.
			Problem with communications definition at the Qi bridge terminal or the PLC.	Check the definition of the communications at the IND780 and the PLC.
ECM_CONFIG_ERROR	U	Error in the ECM configuration. Message contains the ECM number.		Correct the identified entry in the ECM table.
ECM_SCALE_ERROR				
ECM_FLOW_METER_ERROR				
ECM_VESSEL_CONFIG_ERROR	U	Error in configuring a scale vessel in the ECM configuration. Message contains the ECM number.		Correct the identified entry in the ECM table.
ECM_UNSTABLE_SCALE	U	Qi has aborted a feed attempt because the scale remained unstable after the feed completed. Message contains the ECM number.	Problem with the hardware operation, such as a leaky valve.	Check valves and piping.
ECM_OVERLAP_FEED_ERROR	U	Qi has aborted a feed attempt because it detected in an error in an overlapping feed request. Message contains the ECM number.	Incorrect Material Path definition.	Check Material Path table definition.
ECM_HIGH_FLOW_RATE_ERROR	U	Qi has aborted a feed attempt because the Qi detected a feed that was flowing too fast. Message contains the ECM number.	Problem with the hardware operation.	Check valves and piping.
ECM_COMMUNICATION_ERROR	U	Qi has aborted a feed attempt because Qi detected an error communicating between terminals. Message contains the ECM number.	Ethernet network problem.	Check Ethernet network connections and wiring.
ECM_INSTRUMENT_ERROR	U	Qi has aborted a feed attempt because Qi detected a scale or flow meter error. Message contains the ECM number.	Operational problem with a scale or flow meter device.	Check the hardware instrument.
ECM_VESSEL_CAPACITY_ERROR	U	Qi has aborted a feed attempt because the feed would exceed the capacity of the vessel. Message contains the ECM number.	Too much material already in the vessel.	Drain some material from the vessel. Run a smaller feed.

Error Message	Source	Description	Probable Cause/s	Remedy
ECM_TRANSFER_ABORTED_ERROR	U	Qi has aborted a feed attempt because the operator aborted the feed. Message contains the ECM number.	Operator aborted the feed.	
ECM_SLOW_STEP_TIMER_ERROR	U	Qi has aborted a feed attempt because the feed was taking too long. Message contains the ECM number.	Not enough material in the source vessel to complete the feed.	Check material quantity in the source vessel.
			Problem with the hardware operation or the instrument.	Check valves, piping, and instruments.
ECM_START_FAILED_UNSTABLE_DEVICE	U	Qi did not start a feed attempt because the scale was unstable before the feed started. Message contains the ECM number.	Problem with the hardware operation, such as a leaky valve.	Check valves and piping.

Maintenance Log File Structure

The IND780 maintenance log can be viewed in setup at **Maintenance > Configure > Maintenance Log**. For further details about this log file, refer to Appendix C, **Table and Log File Structure**, in the **IND780 Technical Manual**.

The IND780 Maintenance Log is Disabled by default. To enable the log, and start recording maintenance event codes for each attached scale, access **Maintenance > Configure > Error Log** (Figure 3-1).

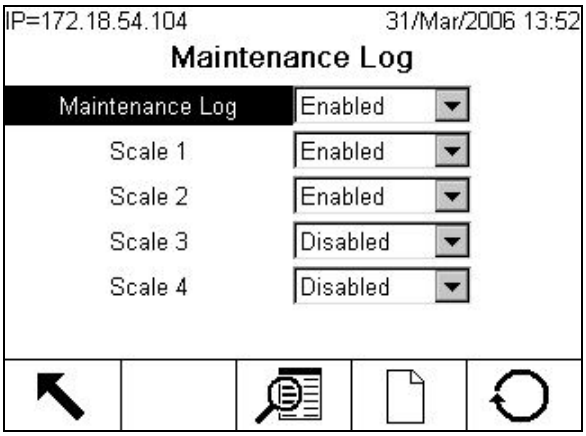


Figure 3-1: Maintenance Log Configuration Screen

The Maintenance Log file is available as a comma-delimited file that can be exported to the InSite program or any FTP client PC. Table 3-5 shows the structure of a maintenance log record, together with an example record showing that Zero Calibration has been performed successfully. The commas used to separate fields are not shown in this example.

Table 3-5: Maintenance Log File Record Structure.

Timestamp	Username	Channel	Cell	Event Code	Status
2006/02/16 11:48:52	System	01	027	02	SUCCESS

The value in the Channel column refers to the source of the maintenance log information. Sources include scales and option boards. Cell refers to the load cell for which the log entry is generated; if the channel does not represent a cell, the value is left blank.

Table 3-6 lists all maintenance event and status codes the IND780 terminal may display.

Table 3-6: Maintenance Log Events and Status Codes

Device	Event	Description	Status Code(s)
Scale	1	Calibration test failed	STEP # 1-N
Scale	2	Zero Calibration	1=SUCCESS; 0=FAILED; 2=MOTION
Scale	3	Span Calibration	1=SUCCESS; 0=FAILED; 2=MOTION
Scale	4	CALFree Calibration	1=SUCCESS; 0=FAILED
Scale	5	POWERCELL Shift Adjust	1=SUCCESS; 0=FAILED
Cell	6	POWERCELL (re)addressed	1=SUCCESS; 0=FAILED
Terminal	7	File Defragmentation	1=SUCCESS
Terminal	8	Log File FTP export	1=Maintenance, 2=Change, 3=Error, 4=Alibi
Terminal	9	Shared Data Setup FTP export	1=Flash, 2=BRAM, 3=MEEPROM, 4=Cal Test Base File Name + scale instance
Terminal	10	Metrology switch / electronic seal broken	1=SUCCESS
Scale	11	Calibration Expiration *	1=DAYS, 2=WEIGHOPS
Scale	12	Run flat operation manual start	SUCCESS
Scale	13	Run flat operation stopped	SUCCESS
Scale	14	Run flat operation autostart *	SUCCESS
Varies	15	Option Component Added	Manually-entered text
Varies	16	Option Component Removed	Manually-entered text
Varies	17	Option Component Replaced	Manually-entered text
Terminal	18	Log Initialized	MAINT, CHANGE, ERROR, ALIBI
Scale	19	Cal Edit Manual	SUCCESS
Scale	20	Shift Edit Manual	SUCCESS
Terminal	21	Date & Time Set	SUCCESS
Varies	22	Table Exported	A0, A2,.....A9
Varies	23	Calibration Test Passed	SUCCESS
Varies	24	Table Imported	A0, A2.....A9
Terminal	25	Replace Battery	Manually-entered text
Scale	26	Monitor Scale Overload	Overload weight, in cell counts
Scale	27	Monitor Weighment	Weight
Scale	28	Monitor Successful Zero Command	None

Device	Event	Description	Status Code(s)
Scale	29	Monitor Zero Failure	None
Scale, Cell	30	Monitor Cell Overload	None
Scale, Cell	31	Monitor Zero Drift Success	Current cell zero
Scale, Cell	32	Monitor Zero Drift Failure	Current cell zero
Scale, Cell	34	Monitor Symmetry Drift Failure	Deviation
Scale, Cell	35	Monitor Symmetry Comm Success	None
Scale, Cell	36	Monitor Symmetry Comm Failure	None
Scale, Cell	37	Monitor Symmetry Check Success	None
Scale	39	Monitor Cal Complete	Calibration counter
Scale	40	Standard Calibration	1=SUCCESS, 0=FAILED, 2=MOTION
Scale,Cell	41	Monitor PDX Enclosure Break	None

* These are automatic operations logged by the IND780 terminal.

Chapter 4.0

Parts and Accessories

IND780 Q.iMPACT

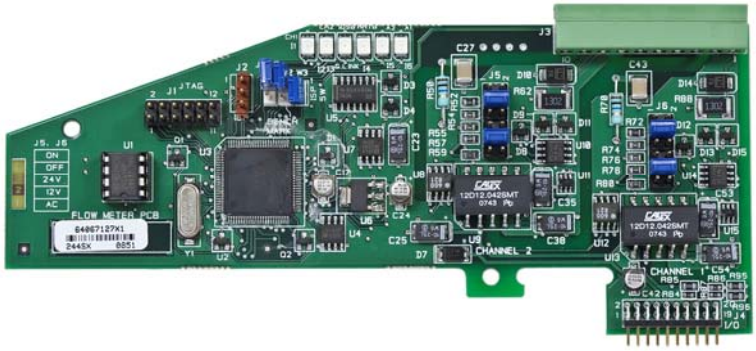
For additional accessories, please refer to Chapter 5 of the **IND780 Technical Manual**.

Hardware Keys

The table below lists hardware keys that are available as accessories for the IND780 Q.iMPACT. TaskExpert™ is included with all selections. **n**Lic indicates that **n** licences are included.

Part Description	Part Number
IND780Qi	64068309
IND780Qi 1Lic	64068310
IND780Qi 2Lic	64068311
IND780Qi 3Lic	64068312
IND780Qi 4Lic	64068313
IND780Qi 5Lic	64068314
IND780Qi 6Lic	64068315
IND780Qi 7Lic	64068316
IND780Qi 8Lic	64068317
IND780Qi 9Lic	64068318
IND780Qi 10Lic	64068319
IND780Qi 11Lic	64068320
IND780Qi 12Lic	64068321

Flow Meter



Part Description	Part Number
Flow Meter Board	64068605

Appendix A

Installation

This appendix covers

- Opening the Enclosures
- Mounting the Terminal
- Harsh Enclosure Cable Openings
- Wiring Connections
- PLC Interface Modules
- PCB Switch Settings
- PCB Jumper Positions
- Sealing the Enclosure

This appendix provides installation instructions for the IND780 Q.iMPACT terminal, and connecting its external wiring.

- Because IND780 Q.iMPACT is part of a larger system, its installation is likely to be affected by other components of the system. Please refer to any additional information supplied with optional interface boards provided by METTLER TOLEDO, or any documentation supplied by vendors of other components used in the system (PLC systems, DCS platforms, flow meters, etc.). Operation and configuration information is provided elsewhere in this manual.

Precautions

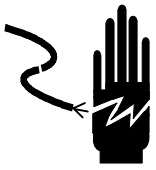
- READ this manual BEFORE operating or servicing this equipment
- FOLLOW these instructions carefully.
- SAVE this manual for future reference.

WARNING!

ONLY PERMIT QUALIFIED PERSONNEL TO SERVICE THE TERMINAL. EXERCISE CARE WHEN MAKING CHECKS, TESTS AND ADJUSTMENTS THAT MUST BE MADE WITH POWER ON. FAILING TO OBSERVE THESE PRECAUTIONS CAN RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE.

WARNING!

NOT ALL VERSIONS OF THE IND780 ARE DESIGNED FOR USE IN HAZARDOUS (EXPLOSIVE) AREAS. REFER TO THE DATA PLATE OF THE IND780 TO DETERMINE IF A SPECIFIC TERMINAL IS APPROVED FOR USE IN AN AREA CLASSIFIED AS HAZARDOUS BECAUSE OF COMBUSTIBLE OR EXPLOSIVE ATMOSPHERES.



WARNING!

WHEN THIS EQUIPMENT IS INCLUDED AS A COMPONENT PART OF A SYSTEM, THE RESULTING DESIGN MUST BE REVIEWED BY QUALIFIED PERSONNEL WHO ARE FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF ALL COMPONENTS IN THE SYSTEM AND THE POTENTIAL HAZARDS INVOLVED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE.

CAUTION!

RISK OF EXPLOSION IF BATTERY IS REPLACED WITH WRONG TYPE OR CONNECTED IMPROPERLY. DISPOSE OF BATTERY ACCORDING TO LOCAL LAWS AND REGULATIONS.

CAUTION

OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES.

CAUTION

BEFORE CONNECTING/DISCONNECTING ANY INTERNAL ELECTRONIC COMPONENTS OR INTERCONNECTING WIRING BETWEEN ELECTRONIC EQUIPMENT ALWAYS REMOVE POWER AND WAIT AT LEAST THIRTY (30) SECONDS BEFORE ANY CONNECTIONS OR DISCONNECTIONS ARE MADE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN DAMAGE TO OR DESTRUCTION OF THE EQUIPMENT AND/OR BODILY HARM.

Unpacking and Inspection

To verify the configuration of the IND780 Q.iMPACT terminal, refer to its data label and to the Model Identification chart in Chapter 1 of this manual, Introduction.

The IND780 Q.iMPACT should include the following items:

- IND780 Q.iMPACT terminal
- Option board/s with ferrite kits, depending on system specification
- Q.iMPACT Documentation CD-ROM (64068642)
- IND780 Documentation CD-ROM (64057241)
- Hardware Kit of Parts (64057809)
- Printed IND780 Q.iMPACT Installation Manual
- Printed IND780 Installation Manual (64057253)

Opening the Enclosure

Procedures for opening the IND780 terminal panel mount and harsh enclosures differ and are described in the following sections.

Only qualified personnel should perform installation, programming and service. Please contact a local METTLER TOLEDO representative for assistance.

In general, once the IND780 is installed, programmed and calibrated for a given application, only routine calibration service is required.

Panel Mount Enclosure

The panel mount enclosure is designed to allow the system integrator or installer to have easy external access to connectors, minimizing the need to access the interior of the unit. On some occasions, the rear cover must be removed to add option cards or to set internal switches. The Panel Mount version of the IND780 is opened by removing the four Phillips head screws on the back panel, circled in Figure A-1. The rear panel can then be removed.

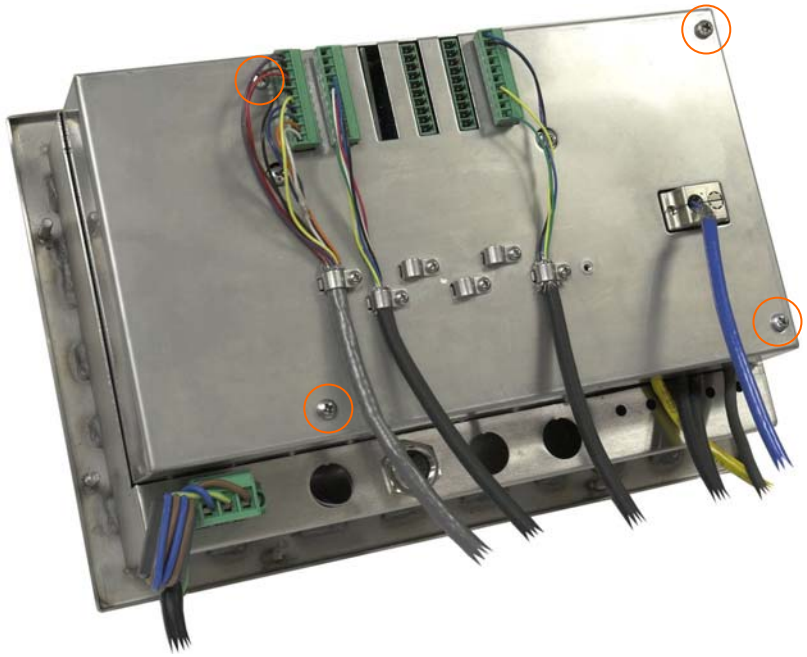


Figure A-1: Opening the Panel Mount Enclosure

Harsh Enclosure

The front panel of the harsh enclosure IND780 terminal is locked in place by four spring clips attached to the enclosure body. To gain access to the terminal's PCB for internal wiring and setting switches, separate the front panel from the enclosure as follows:

1. Place the terminal on a stable, flat surface, with its front panel facing up.

Figure A-2: Opening the Harsh Enclosure

2. Insert the tip of a flat blade screwdriver into one of the two slots located on the edge of the front panel assembly (see Figure A-2). Squeeze the top of the front panel firmly down against the enclosure, in order to relieve the pressure on the retaining clip, and push the screwdriver in toward the enclosure until a "pop" sound is heard.
3. Repeat Step 2 for the other slot, freeing the bottom of the cover from the spring retaining clips.
4. Once the panel is released, lift the bottom of the panel firmly up and out until it clears the edge of the enclosure.
5. Press down on the top of the front panel and push the panel upward, relative to the enclosure, until the spring retaining clips unsnap. The cover will then be free to swing down, hinged by two wire cables at its bottom edge.

Mounting the Terminal

The Panel Mount enclosure is designed to mount into a cutout of a flat surface such as an instrument panel or industrial enclosure or door. The harsh enclosure is designed to be placed on a desktop or can be mounted to a vertical surface with the optional mounting brackets. Mount the terminal where viewing is optimal and the terminal keypad is easily accessible. Observe location and environment considerations as described in Chapter 1.0, Introduction.

Panel Mount Enclosure

The Panel Mount enclosure comes with a gasket and a backing plate, used to mount the unit to a panel. The enclosure will mount and seal properly on panel thicknesses from 16 GA to 11 GA (1.52 mm to 3.04 mm).

Install the Panel Mount enclosure by following these steps:

Cut an opening and holes in the panel or industrial enclosure as indicated in the panel cutout dimensions shown in Figure A-3 in inches and [mm].

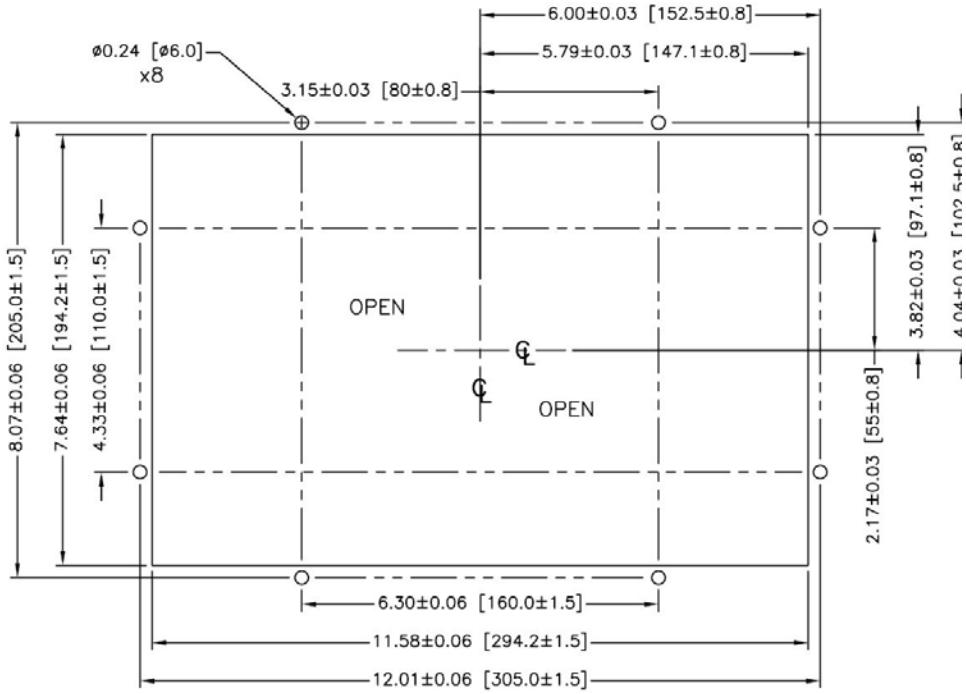


Figure A-3: Panel Cutout Dimensions

Loosen and remove the eight, 8 mm shoulder nuts holding the backing plate to the enclosure. The gasket should remain in position on the terminal. Figure A-4 shows two images of the enclosure, one with the backing plate removed to show the gasket, the other with the backing plate installed.

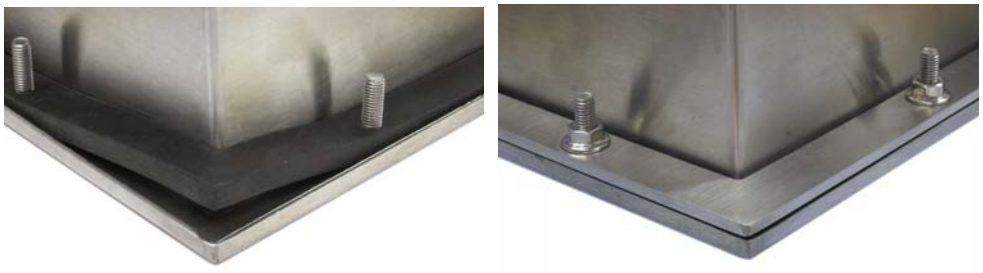


Figure A-4: Gasket on Enclosure (left) and Backing Plate Installed (right)

Place the terminal through the cutout from the front and secure by fitting the backing plate over the back of the terminal, then installing and tightening the eight nuts until secure. Figure A-5 shows a side view of a panel installation.

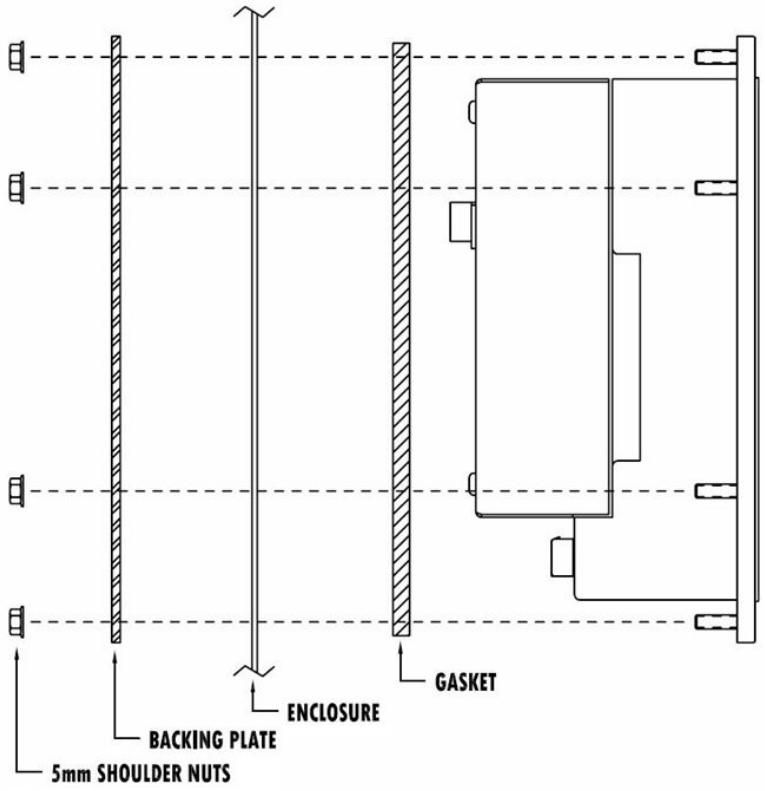


Figure A-5: Panel Mounting, Side View

Harsh Enclosure

The harsh enclosure is made of stainless steel and designed to rest on a flat surface such as a table or desk top, or to be mounted to a vertical surface with optional mounting brackets. In desktop configuration, the front panel angle is approximately 70 degrees from vertical. In wall mount configuration, the front panel is approximately 40 degrees from vertical, and reversible (angled up or down).

Desktop Mounting

If the IND780 terminal is to be placed on a flat surface, the four rubber feet included with the terminal should be adhered to the bottom of the enclosure to prevent sliding. Peel each foot from the protective paper and press it onto one corner of the bottom of the enclosure, as shown in Figure A-6.

Figure A-6: Rubber Feet for Desktop Mounting

Preparation for Wall Mounting

An optional wall bracket kit is available for wall mounting the IND780 harsh enclosure to a vertical surface. To prepare the enclosure for wall mounting, follow these steps:

1. Establish orientation of enclosure (above or below eye level)
2. Install enclosure on brackets
3. Mark attachment points
4. Install mounting hardware
5. Mount terminal hardware

Setting Front Panel Orientation

Establish whether the terminal will be mounted above or below eye level. If it will be mounted at or below eye level, the orientation of the front panel must be reversed. Follow these steps:

1. Open the enclosure as described in the Opening the Enclosures section.
2. Loosen and remove the two nuts securing the two metal cables (Figure A-7) that hinge the front cover to the rear housing.

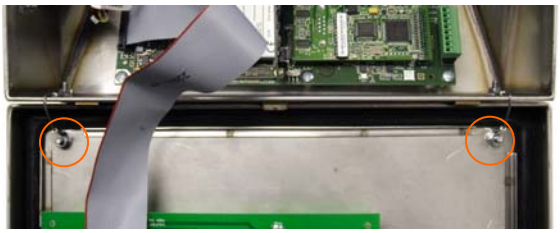


Figure A-7: Ground Strap Attachment Locations

3. Carefully rotate the front cover 180 degrees and reattach the two grounding straps to the two studs near the grip bushings using the two nuts removed in the previous step. Figure A-8 shows one of the studs. Tighten the two nuts.

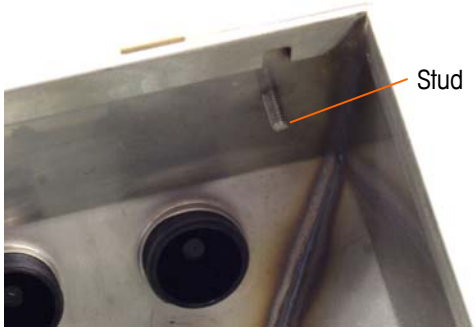


Figure A-8: Stud for Attaching Reversed Front Panel

Attaching the Enclosure to the Brackets

Once the brackets are securely fastened to the wall surface, the enclosure can be mounted to them using the four supplied M5 screws. One bracket is shown in Figure A-9, with the slotted holes indicated. The screws are tightened by fitting the screwdriver through the slotted holes.

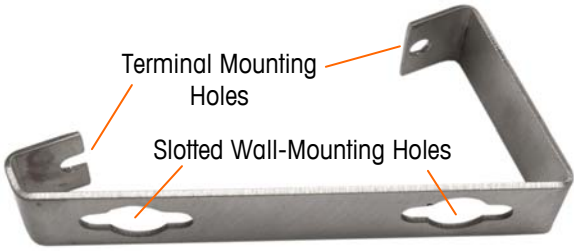


Figure A-9: Wall-Mounting Bracket

Figure A-10 shows the brackets attached to an enclosure. Note the orientation of the enclosure relative to the brackets.

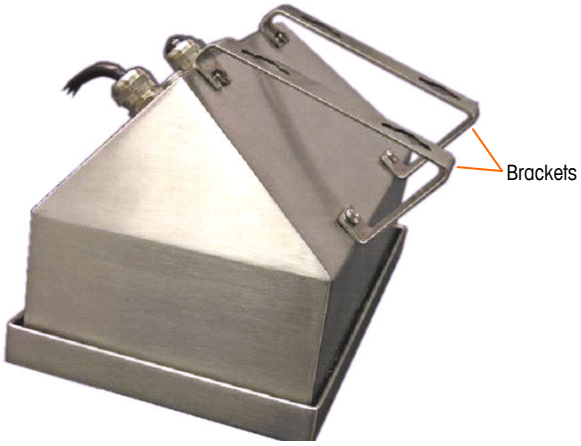


Figure A-10: Attaching the Wall-Mounting Brackets

Marking Mounting Hole Position

Mark the position of the mounting holes on the vertical surface per the dimensions shown in Figure A-11 in inches and [mm], or by holding the terminal up to the surface and marking through the bracket holes.

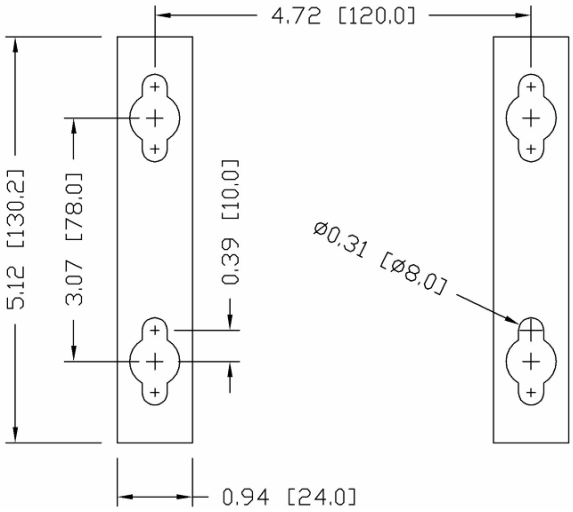


Figure A-11: Mounting Hole Pattern

Once the mounting hole positions are established, perform one of the following procedures, depending on the type of wall surface.

- The hardware to mount the terminal to the vertical surface is not included with the terminal – it must be supplied locally. Ensure that the mounting hardware is capable of supporting the weight of the terminal, which is approximately 11 lb (5 kg).

CAUTION: When carrying out the following procedures, wear proper bodily protection, such as approved safety goggles, ear protectors and gloves.

Wall Mounting, Wallboard or Drywall

When mounting the IND780 on wallboard, drywall or a similar surface, the anchor should be sized according to the recommended bolt size of 1/4″ (6 mm). The recommended mounting hardware is:

- Four Toggle Bolts, 1/4″ (6 mm), minimum length 2-1/2″ to 3″ depending on wall thickness, with a pullout force of 900 lb (450 kg)
- Four flat washers, minimum 1/2″ (12 mm) outside diameter

Figure A-12 shows an example of mounting hardware.

Figure A-12: Sample Mounting Hardware, Wallboard or Drywall

1. Drill a hole through each of the measurements/locations marked while preparing for wall mounting. Use a bit with the same size bit as anchor diameter (typically 5/8″ (16 mm)). The depth of the hole should penetrate the wallboard.
2. Clean the holes with a cloth moistened with water.
3. Unthread each toggle bolt and add a 1/4″ (6 mm) inside diameter, flat washer with an outside diameter of 1/2″ (12 mm).
4. Push the washers to the inside of the heads of all four bolts.
5. Replace each toggle nut and thread onto each bolt approximately 1″ (25 mm). Insure that the ends of the nut fold toward you when you squeeze them.
6. Press the toggle nuts through each opening you created in the wall. You should hear a "click" sound when each snaps open on the other side.
7. Tighten the bolts down until you feel the toggle nut contact the inside of the wall. Tighten each with a wrench (use a screwdriver for flat/round heads), approximately two or three full turns or until the toggle nuts are against the base material on the inside of the wall.
8. Back each bolt out enough to leave space for its head and the flat washer to engage the top center of one of the slotted holes in the mounting brackets (see Figure A-9 and Figure A-11).
9. Turn the screws, by hand, until they are snug against the mounting plate. Figure A-13 shows the nut, washer and bolt installed.

Wall Mounting, Concrete and Cement Blocks

When mounting the IND780 to a cement block, poured concrete or similar wall, the recommended mounting bolt is:

- UL-listed concrete sleeve anchor, size 1/4″ (6 mm), minimum embed 1/2″ (12.7 mm), minimum pullout force of 500 lb (266 kg).

Figure A-13 shows an example of mounting hardware.

Figure A-13: Sample Mounting Hardware, Concrete or Cement

1. Drill a hole through each of the measurements/locations you marked in the Preparation for Wall Mounting section. Use a carbide bit conforming to ANSI B94, 12-77 with the same size bit as anchor diameter (typically 5/16″ (8 mm)). The depth of the hole should be deeper than 1/2″ (12 mm).
2. Clean the holes with a wire brush.
3. Make sure the head of the bolt is flush with the top threaded part of the anchor then insert the anchor assembly through the mounting holes and into the base material.
4. Push anchor assembly until washer is snug against the wall.
5. Tighten each bolt with a wrench (use a screwdriver for flat/round heads), approximately three or four full turns or until anchor is tightly secured to the base material.
6. Back the bolts out sufficiently to allow them and their washers to engage the top center of one of the slotted holes in the mounting brackets (see Figure A-9 and Figure A-11).

Wall Mounting, Wood Surface

When mounting the IND780 to a wooden wall or similar surface, use four #12 screws of at least 1 1/4″ (30 mm) length, each with a flat washer of minimum 1/2″ (12 mm) diameter.

Install the screw and washer, leaving sufficient gap to accommodate the slotted hole in the bracket – see Figure A-9 and Figure A-11.

Periodically inspect the terminal to insure that it is securely anchored to the wall. If not, remove the terminal and retighten the mounting anchor bolts.

Positioning Terminal on Fasteners

Place the holes in the terminal brackets over the fasteners, and slide the terminal down firmly so that each fastener and washer engages the slots in the bracket (see Figure A-9).

For wallboard or drywall mounting, after engaging the brackets pull them away from the wall until the toggle nuts are felt to contact the inside of the wall. If necessary, unmount the terminal and tighten the bolts slightly. Figure A-14 shows the relationship between bracket, hardware and wall.

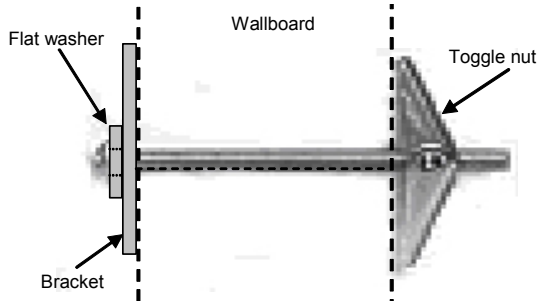


Figure A-14: Wallboard or Drywall Installation

Periodically inspect the terminal to insure that it is securely anchored to the wall. If not, remove the terminal and retighten the mounting anchor bolts.

Ferrites and Option Board Cabling

Ferrites

In order to meet certain electrical noise emission limits and to protect the IND780 from external influences, it is necessary to install a ferrite core on each cable connected to the terminal. Two types of ferrites are supplied with the basic terminal, and additional ferrites may be supplied with each of the options.

- The large clamp ferrites can be attached to larger cables such as Ethernet, USB and some PLC cables.
- The large core ferrite is used with the panel mount power cable, serial interface and analog load cell cable.

To install the large core ferrite on the panel mount power cord, remove the insulation and shielding from the end of the cable. Before attaching the power connector, route the blue and brown wires through the center of the core and take two wraps around the outside of the core, each time routing the cables through again. Note that the striped green and yellow ground wire does not pass through the core. Similarly, on the analog load cell cable, wrap the individual wires around the ferrite core twice to reduce the effects of electrical noise and interference.

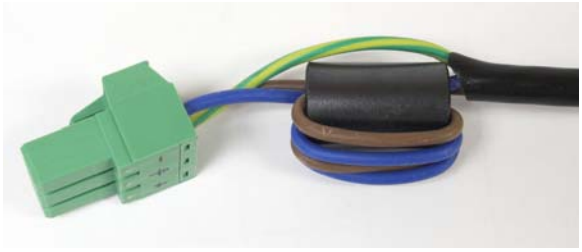


Figure A-15: Ferrite Core on Panel Mount Power Cord

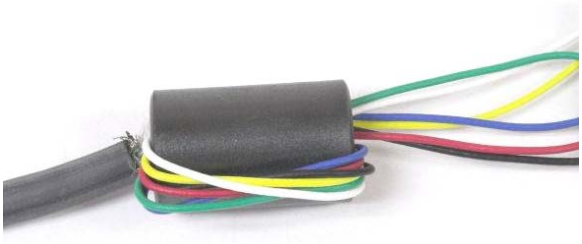


Figure A-16: Ferrite Core on Analog Load Cell Cable

When using a clamp type ferrite, a loop can be made in the cable and the ferrite snapped over the spot where the cable overlaps itself. Either the complete cable or individual wires can be wrapped through the ferrite.

Figure A-17: Installing Clamp Ferrite

Wrapping should be done as close to the enclosure as possible.

Option Board Cabling

In order to prevent electromagnetic interference, when installing option boards (especially Analog Load Cell boards) in the terminal, twist the loose wires together, as shown in Figure A-18, before attaching the green connector to the board.

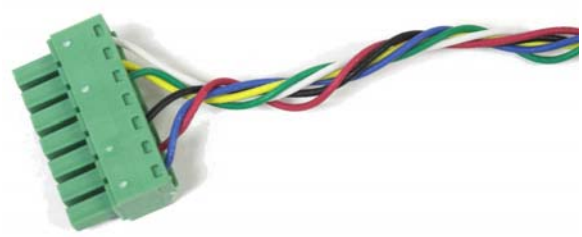


Figure A-18: Option Board Wires Twisted

On the IND780 panel mount enclosure, cable shield terminations can be made using the strain relief cable clamp provided on the back cover. Fold the shield braid back evenly over the cable's insulation sheath and then fasten down the cable and shield with the clamp and screw onto the back cover (Figure A-19).

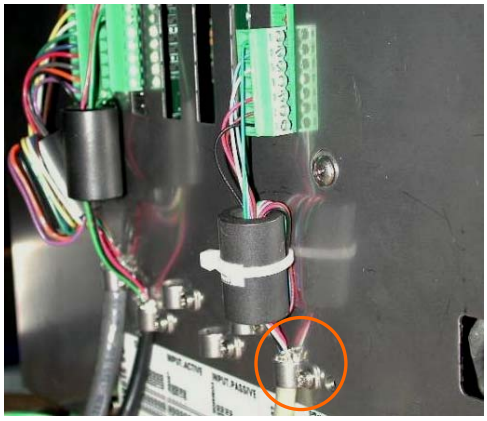


Figure A-19: Shield Wire Termination, Panel Enclosure

Analog load cell and POWERCELL PDX cable shield termination on the IND780 harsh enclosure can be made using the metal cable gland and grommet as shown in Figure A-24 and Figure A-48, respectively. Other cables' shield termination can be made on the ground stud inside the enclosure (Figure A-20).

Figure A-20: Shield Wire Termination, Harsh Enclosure

Harsh Enclosure Cable Glands and Cable Assignments

On the IND780 panel mount enclosure, cable shield terminations can be made using the strain relief cable clamp provided on the back cover. Fold the shield braid back evenly over the cable's insulation sheath and then fasten down the cable and shield with the clamp and screw onto the back cover (Figure A-19).

Harsh Enclosure Cable Openings

Figure A-21 and Table A-1 show the uses and cable size limits of the various openings in the back of the harsh enclosure. The pattern code is included for ease of reference.

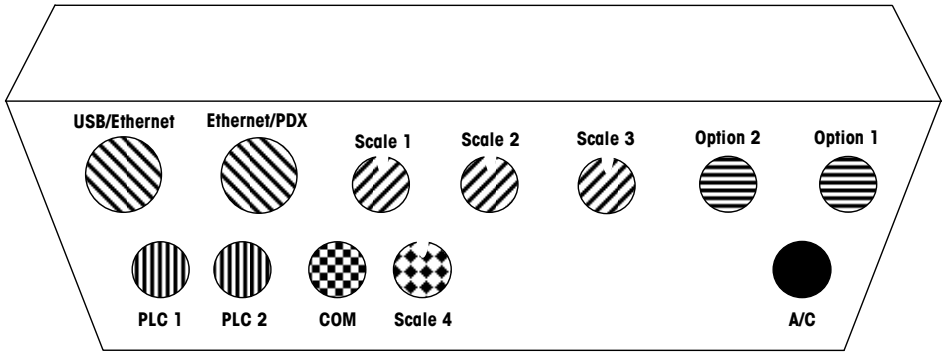


Figure A-21: Harsh Enclosure Cable Opening Assignments

Table A-1: Harsh Enclosure Cable Openings

Pattern	Description/Use	Cable Size Limits inches and [mm]
	USB and Ethernet connections. 25 mm plastic cable gland	0.20–0.43 [5–11] 0.51–0.71 [13–18]
	POWERCELL PDX. 16 mm metal cable gland	0.24–0.31 [6–8]
	Analog Load Cell. 16 mm metal cable gland	0.24–0.31 [6–8]
	POWERCELL PDX. 16 mm metal cable gland	0.31–0.39 [8–10]
	Scales 1-4, IDNet (proprietary connector)	N/A
	Discrete I/O and Serial cables. 16 mm plastic cable gland	0.16–0.32 [4–8]
	Analog Output. 16 mm metal cable gland	0.24–0.31 [6–8]
	A-B RIO / PROFIBUS connectors – one in, one out	N/A
	COM1 or COM2	0.16–0.32 [4–8]
	Fourth scale connector or, with insert, COM2	0.16–0.32 [4–8]

Once any scale interfaces are installed and cabled, flow meters can use any of the Scale and Option openings.

Installing Cables

The IND780 harsh environment terminal is designed to withstand severe washdown environments. However, care must be taken when installing cables and/or connectors that enter the terminal enclosure. To ensure a watertight seal:

- Disassemble an appropriately sized cable grip. Figure A-22 shows the components, including the blank used when no cable is present.

Figure A-22: Cable Gland Components

- Before connecting the wires, pass the cable through an appropriately sized cable grip and into the enclosure. Then, if required, place a grommet around the cable as shown in Figure A-23.

Figure A-23: Cable Inserted Through Grommet, Nut, and Cable Grip

- A metal cable gland is provided with the Analog Load Cell and POWERCELL PDX options. To further protect the IND780 from external influences, the cable's shield wire can be spread out and pressed into cable gland by the grommet, as shown in Figure A-24.

Figure A-24: Installing Metal Cable Gland with Shield Wire

- Press the grommet into the body of the cable grip, as shown in Figure A-25.

Figure A-25: Grommet in Body of Cable Grip

- Move the cable through the grommet to adjust its length within the enclosure. When making cable terminations inside the harsh enclosure, ensure that the cable length from the terminal strip/connector to the terminal housing is sufficient so that no strain is placed on the connector assembly when the housing is in the fully open position.
- Finally, tighten the nut onto the body of the cable grip. Figure A-26 shows the assembled cable grip.

Figure A-26: Cable Grip Assembled

- After making the wiring connections as described in the next section, check that the nut on the cable gland is tightened properly to seal around the cable. Ensure that this seal is watertight.

Main PCB

Main Board Wiring Connections

The following connections are made to the IND780 main board:

- Ethernet
- USB
- COM1
- COM2
- Optional scale interface boards
- Optional serial communications boards
- Optional discrete Input / Output boards
- Optional Flow Meter interface boards
- Optional PLC interface board

The harsh enclosure must be opened to make the connections, as shown in Figure A-27. The rear cover of the panel mount enclosure (Figure A-28) needs to be removed in order to make these connections. Note that the option board sockets shown at the top of these figures represent the locations where option cards (Discrete I/O, Serial Communications, Flow Meters, IDNet, Analog Load Cell and POWERCELL PDX Interfaces) would be installed. These may not be present in your unit.

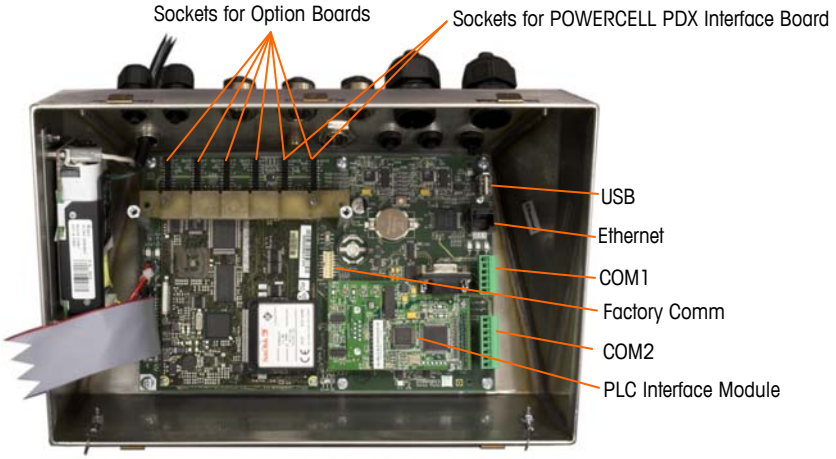


Figure A-27: Wiring Connections, Top View, Harsh Enclosure

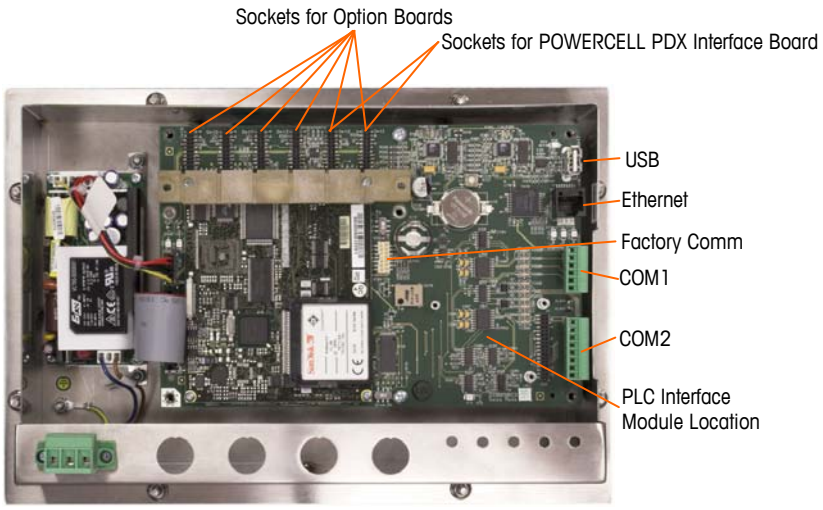


Figure A-28: Wiring Connections, Top View, Panel Mount Enclosure

Power Connection

A permanently attached line cord supplies AC power to the harsh enclosure version of the IND780 terminal. The panel mount enclosure does not provide an AC power cord – it is designed to have AC wiring connected to the AC power connector, which is plugged into the mating connector on the rear of the chassis. Figure A-29 shows the connector and indicates the correct assignments for neutral, ground and line wires.

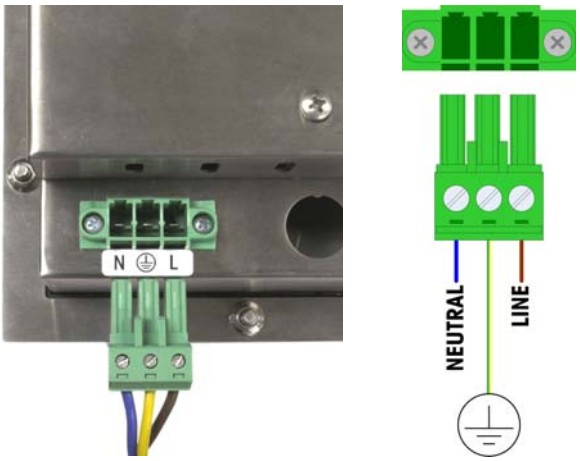


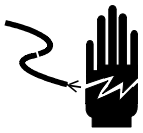
Figure A-29: Power Connector, Panel Mount Enclosure

Power connector screws should be tightened to between 4.4 and 5.3 inch-pounds (0.5 and 0.6 Newton-meters) of torque.

No voltage or frequency settings are required since the terminal includes a universal power supply that operates from 100 to 240 VAC.

The integrity of the power ground for equipment is important for both safety and dependable operation of the terminal and its associated scale base. A poor ground can result in an unsafe condition should an electrical short develop in the equipment. A good ground connection minimizes extraneous electrical noise pulses. The IND780 Q.IMPACT should not share power lines

with noise-generating equipment. To confirm ground integrity, use a commercial branch circuit analyzer. If adverse power conditions exist, a dedicated power circuit or power line conditioner might be required.



WARNING

FOR CONTINUED PROTECTION AGAINST SHOCK HAZARD CONNECT TO PROPERLY GROUNDED OUTLET ONLY. DO NOT REMOVE THE GROUND PRONG.

Power Requirements

The terminal requires 100 to 240 VAC (at 400 mA maximum) with a line frequency of 49 to 61 Hz of power.

Ethernet and USB Connections

The IND780 Q.IMPACT's Ethernet connection provides a 10/100 base T connection (10/100 Mb) via a standard RJ45 connector.

The standard ST30 USB connector allows USB-supported peripherals, such as keyboards, to be attached to the IND780 Q.IMPACT.

Figure A-30 shows the locations of the Ethernet and USB connectors on the main PCB. In this case, the PCB is mounted in a Panel enclosure.

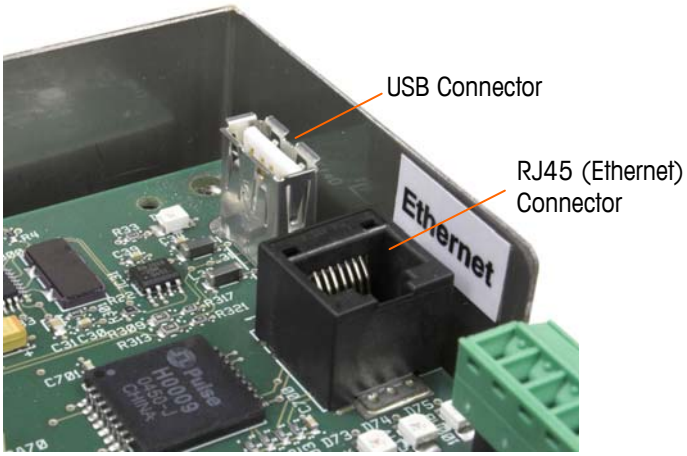


Figure A-30: Ethernet and USB Connections

COM1 and COM2 Serial Port Connections

The COM1 port includes connections for RS232, while COM2 supports connections for RS-232, RS-422 and RS-485. The Interface parameter (in Setup at Communication > Serial) must be set to match the hardware connection used. This parameter controls how the transmit and receive lines are controlled.

COM1 Serial Port

Figure A-31 indicates which terminal represents which signal on the COM1 Port, and Figure A-32 shows how the port is wired for an RS232 connection. Make the

connections as necessary. Table A-2 describes the functions for each signal in the COM1 port connector.

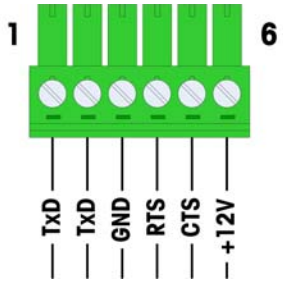


Figure A-31: COM1 Port Connector

Table A-2: COM1 Port Connections

Pin	Signal	Function
1	TxD	RS-232 Transmit data
2	RxD	RS-232 Receive data
3	GND	RS-232 Signal ground
4	RTS	RS-232 Request to send
5	CTS	RS-232 Clear to send
6	+12V	+12V Out, <0.5 A

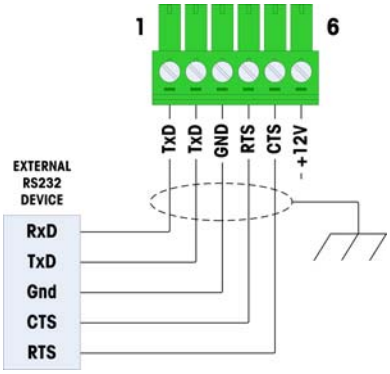


Figure A-32: COM1 Wiring for RS232

COM2 Serial Port

Details for COM2 are provided in Figure A-32 and Table A-3.

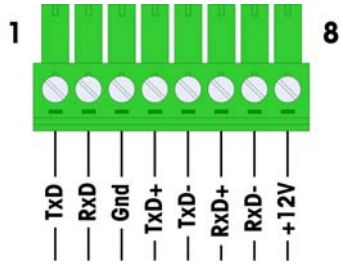


Figure A-33: COM2 Port Connections

Table A-3: COM2 Port Connections

Pin	Signal	Function	Notes
1	TxD	RS-232 Transmit data	
2	RxD	RS-232 Receive data	
3	GND	RS-232 Signal ground	
4	TxD+	RS-422/485 Transmit +	Jumper to RxD+ for RS-485
5	TxD-	RS-422/485 Transmit -	Jumper to RxD- for RS-485
6	RxD+	RS-422/485 Receive +	Jumper to TxD+ for RS-485
7	RxD-	RS-422/485 Receive -	Jumper to TxD- for RS-485
8	+12V	+12V Out, <0.5 A	

Some examples of connecting external equipment are shown in Figure A-34.

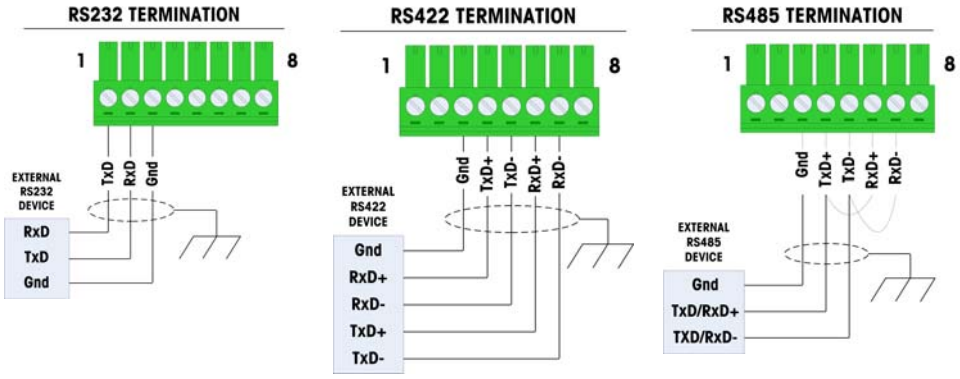


Figure A-34: COM2 Wiring for External Equipment

RS-485 Transmission Line Termination

The RS-485 network should include a terminating resistor, installed between the two lines at or on the last node. The terminating resistor should match the characteristic impedance of the transmission line, approximately 120 ohms. This terminating resistor is required when connecting ARM100 modules to the port.

Switch Settings

Two switches are located on the main PCB in the positions indicated in Figure A-35. These switches' functions are explained in Table A-4.

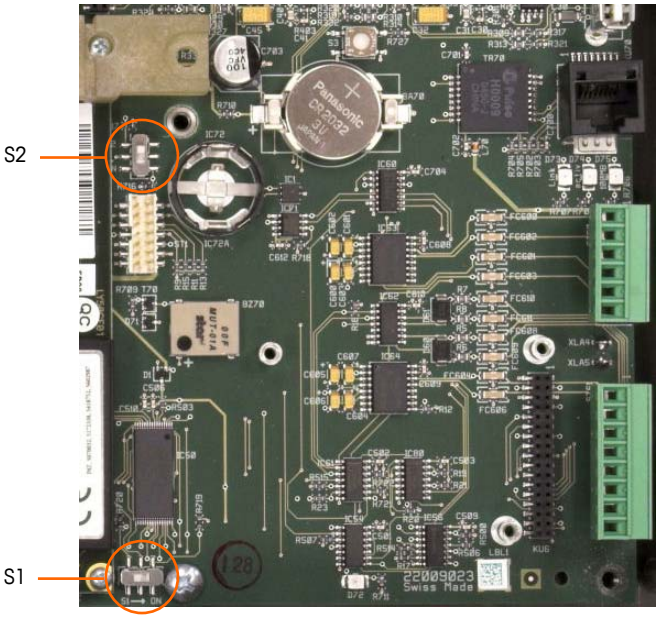


Figure A-35: Main PCB Switch Locations

Table A-4: Main PCB Switch Functions

Switch	Function
S-1	Metrology Security Switch. When in the ON (right) position, this switch prohibits access to Scale settings in the menu and other metrologically significant areas.
S-2	Task Expert Disable Switch. When in the ON (down) position, disables the task expert auto-start feature. This is used primarily for maintenance purposes.

Note that the switches shown in Figure A-35 are both in their OFF position.

Master Reset Button

To erase all programming in the terminal and reset all settings (except metrologically significant scale calibration data) to their factory default values, press the master reset button adjacent to the battery. Figure A-36 indicates the location of this button. This process is described in the **IND780 Technical Manual**, Chapter 4.0, **Service and Maintenance**.

- To reset scale data as well, S2 (shown in its OFF position in Figure A-36) must be set to ON before the master reset.

Figure A-36: Main PCB Master Reset Button Location

LED Interpretation

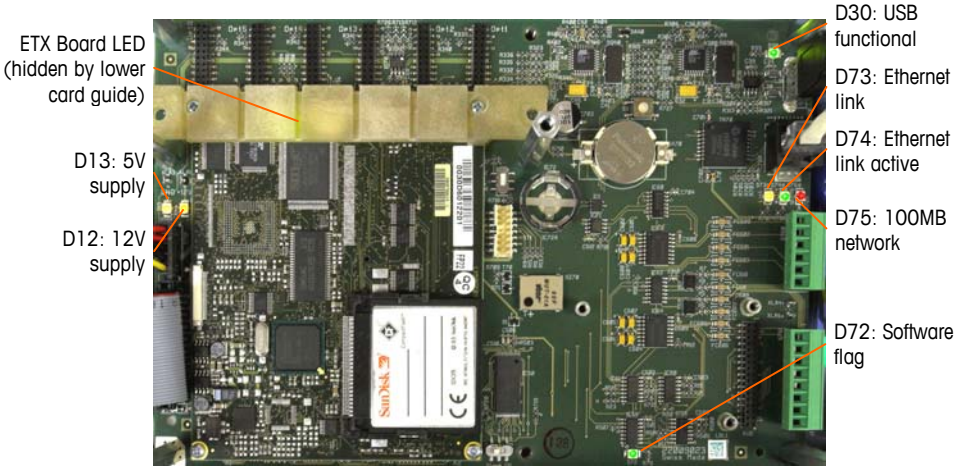


Figure A-37: Main PCB LEDs

Table A-5: Main PCB LEDs

LED	Color	Function
D12	Yellow	Indicates 12V supply is present.
D13	Yellow	Indicates 5V supply is present.
D30	Green	When lit, indicates USB port has been identified and is functional. Note that this LED remains lit whether or not a USB device is connected.
D72	Amber	Used for software development purposes; blinking during normal system operation.
D73	Yellow	Indicates that an Ethernet connection exists.
D74	Green	When blinking, indicates that the Ethernet connection is actively receiving or transmitting data.
D75	Red	When lit, indicates that Ethernet connection is 100 MB. D73 lit, D75 off, indicates that Ethernet connection is 10 MB.

ETX Board

The ETX board features a single, green LED, mounted beneath the lower card guide. Its approximate location is indicated in Figure A-37. When power is supplied to the board, this LED is lit steadily, indicating that the core power supply is on. This in turn indicates that both on-board regulators are functioning correctly.

Option Boards

Configuration and Connection of Options

Options available for the IND780 Q.IMPACT terminal include the following:

- Analog Load Cell
- POWERCELL® PDX®
- IDNet interface
- Flow Meter Interface
- FCE Wiring with Analog Load Cell
- Serial Communications
- DeviceNet
- PROFIBUS (Harsh Enclosure)
- PROFIBUS (Panel Enclosure)
- ControlNET
- Ethernet/IP and Modbus TCP
- Rockwell (Allen-Bradley) RIO
- Discrete I/O (Relay) and Solid State Relay

Figure A-38 shows each of these options, together with its location in the terminal. The connections and board settings for each option are described in the following sections.

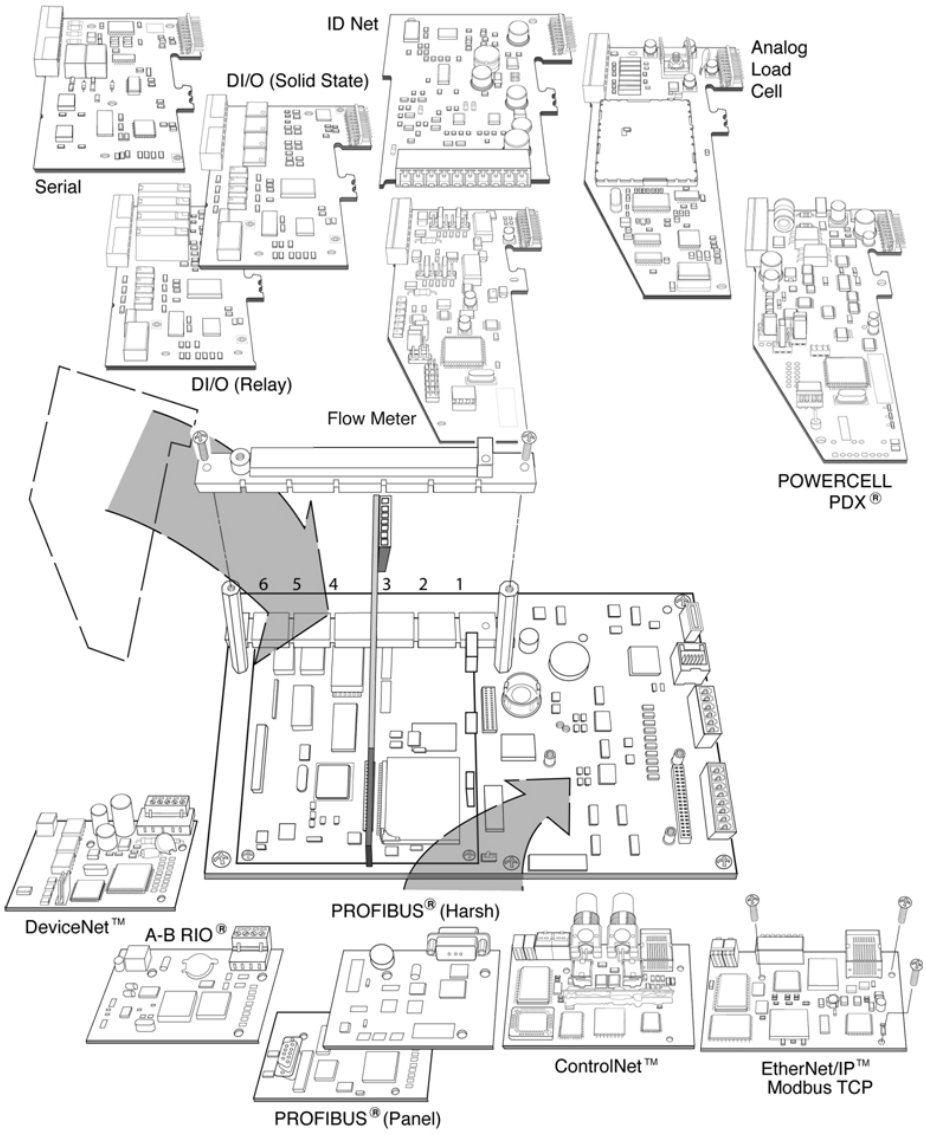


Figure A-38: IND780 Q.IMPACT Options Locations

Analog Load Cell

Figure A-39: Analog Load Cell Option Board

Jumper Settings

One jumper (W1) on the IND780 Q.IMPACT analog scale option board permits the gain of the analog section to be set to either 2 mV/V or 3 mV/V. The factory default is 3 mV/V, which normally will work well for both 2 mV/V and 3 mV/V load cells. If 2 mV/V load cells are used, the jumper can be changed to the 2 mV/V position. Figure A-40 shows the jumper's location and settings on the board.

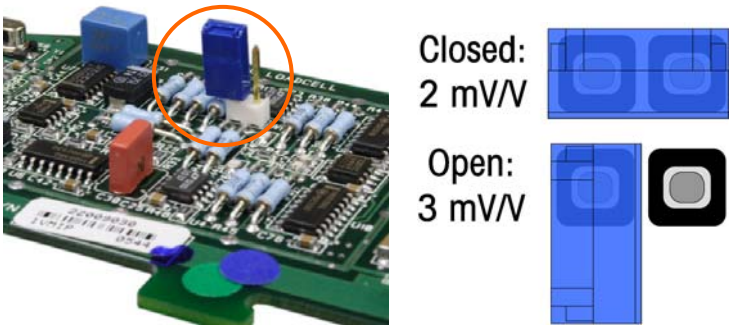


Figure A-40: Analog Load Cell Board Millivolt Jumper Location and Settings

The 2 mV/3 mV jumper settings are described in Table A-6.

Table A-6: Millivolt Jumper Description

Jumper	On	Off	Description
W1	X		When the jumper is closed, the connected scale's load cell setting is 2 mV/V.
		X	When the jumper is open, the connected scale's load cell setting is 3 mV/V

Connections

WARNING!

TO AVOID DAMAGE TO THE PCB OR LOAD CELL, REMOVE POWER FROM THE IND780 Q.IMPACT TERMINAL AND WAIT AT LEAST 30 SECONDS BEFORE CONNECTING OR DISCONNECTING ANY HARNESS.

When using the IND780 Q.IMPACT with one or more analog load cells, load cell connections are made to the connector located on the Analog Load Cell option board. The 7-position connector is visible at top right in Figure A-39, with the board's 2-position discrete output connection next to it. Note that for clarity the board's socket is shown with two (unwired) connectors plugged into it.

- When installing Analog Load Cell boards, to prevent electromagnetic interference twist the connector wires before attaching the connector to the board.

Analog Load Cell boards may be placed in any of slots 1 through 4, for a total of four scales. The IND780 Q.IMPACT can power as many as 16 load cells.

The IND780 Q.IMPACT terminal is designed to power up to eight 350-ohm load cells (or a minimum resistance of approximately 43 ohms) per card. To confirm that the load cell load for this installation is within limits, the total scale resistance (TSR) must be calculated. To calculate TSR:

$$TSR = \frac{\text{Load Cell Input Resistance (ohms)}}{\text{Number of Load Cells}}$$

Ensure that the TSR of the load cell network to be connected to the IND780 Q.IMPACT has a resistance greater than 43 ohms before connecting the load cells. If the resistance is less than 43 ohms, the IND780 Q.IMPACT will not operate properly.

In addition, the maximum cable distance must be reviewed. Table A-7 provides recommended maximum cable lengths based on TSR and cable gauge.

Table A-7: Recommended Maximum Cable Lengths

TSR (Ohms)	24 Gauge (meters/feet)	20 Gauge (meters/feet)	16 Gauge (meters/feet)
350	243/800	610/2000	1219/4000
87 (4-350 Ω cells)	60/200	182/600	304/1000
43 (8-350 Ω cells)	30/100	91/300	152/500

Figure A-41 shows wiring definitions for the analog load cell connector. Note that when using four-wire load cells, jumpers must be placed between the +Excitation and +Sense terminals and between the Excitation and Sense terminals.

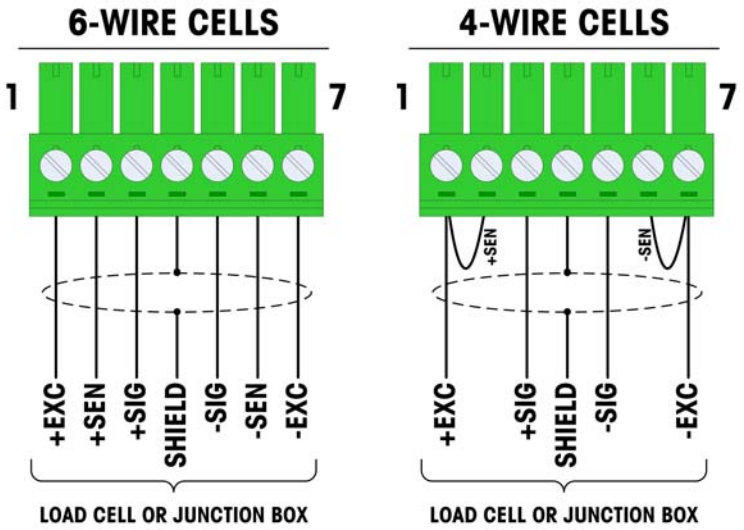


Figure A-41: Load Cell Connections

Note for the standard four-wire cable: If an increase in load results in a decrease in weight display, reverse the signal wires (+SIG and □SIG).

Figure A-42 shows wiring definitions for the analog load cell discrete output connector.

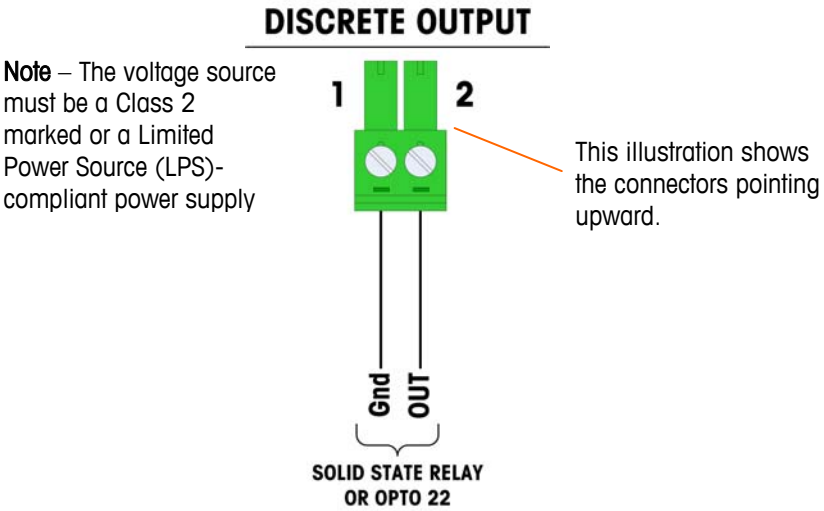


Figure A-42: Analog Load Cell Discrete Output Connector

The TTL-compatible open collector output is reserved for use only with the scale's material transfer target functionality. It provides the signal for the feed output associated with the active target for that scale. It is not necessary to configure this output. The output is a current-sinking component which can handle from 5 to 30 volt DC signals at a maximum of 35 mA current. A solid-state relay or OPTO 22 is typically connected to buffer the IND780 Q.IMPACT terminal outputs to a 120 or 220 volt AC signal.

FCE (Final Control Element) Wiring using Analog Load Cell Board

Figure A-43 illustrates the method of connecting a valve (Final Control Element/FCE) using the Analog Load Cell card and IND780 Q.iMPACT COM2 port. Note that it is up to the user to provide adequate circuit protection (circuit breakers or fusing) in accordance with any applicable Electrical Codes for their installation.

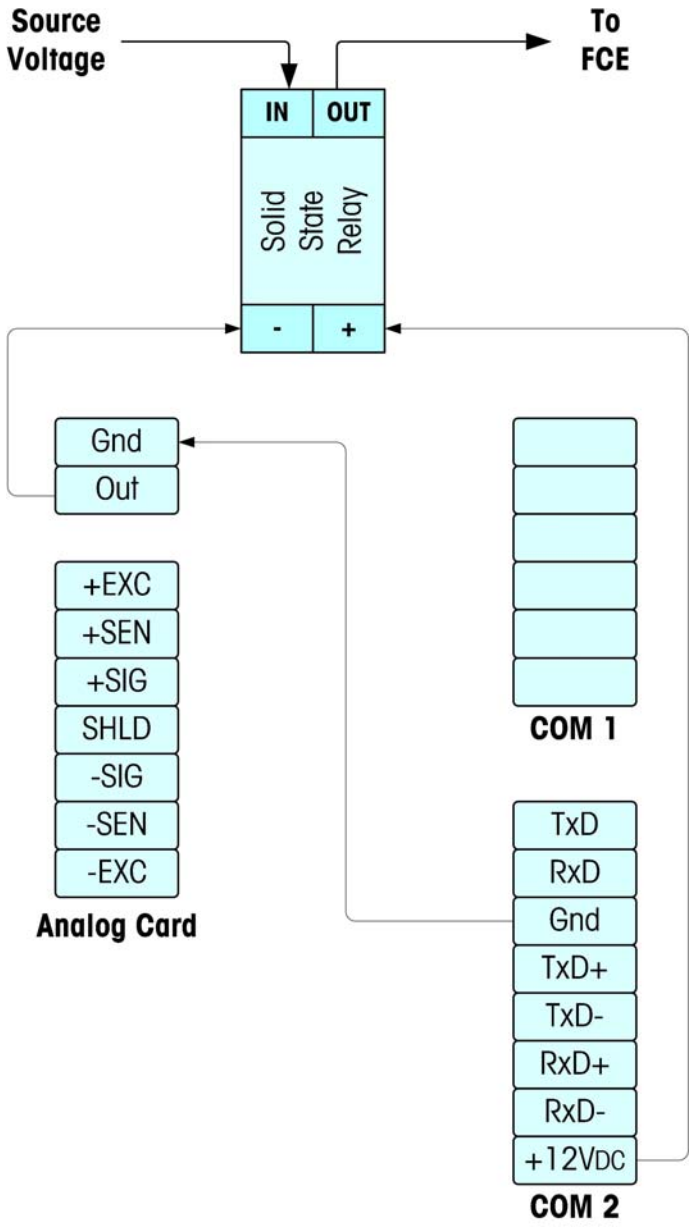


Figure A-43: FCE Wiring using Analog Load Cell Card and COM2 Port

LED Interpretation

Figure A-44 indicates the location of LED on the Analog Load Cell board.

Figure A-44: Analog Load Cell LED

Table A-8: Analog Load Cell LED

LED	Color	Function
USB	Amber	Slow blink (~1 Hz) indicates no USB communication with Main PCB Fast blink (~4 Hz) indicates USB communication with Main PCB is operating properly

POWERCELL PDX

Jumper Settings

The POWERCELL PDX® board has several jumpers. The W6 jumper is used to set in the POWERCELL PDX network's terminating resistor on the IND780 Q.IMPACT. Figure A-45 shows the jumpers' locations and settings. Table A-9 describes the purpose of each setting.

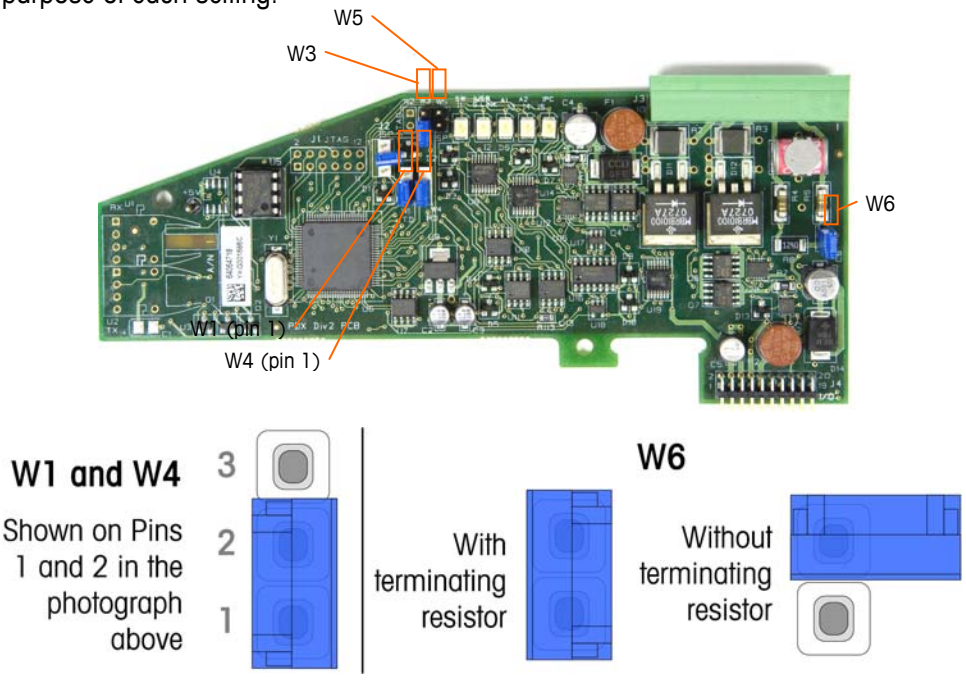


Figure A-45: POWERCELL PDX Board Jumper Locations and Settings

Table A-9: POWERCELL PDX Board Jumper Description

Jumper	On	Off	Description
W3		X	Always set to off in normal operation (factory use).
W5		X	Always set to off in normal operation (factory use).
W6	X		Set this jumper on to install a POWERCELL PDX network terminating resistor. Should be on in normal operation.
		X	Remove this jumper if a network terminating resistor is not to be installed in the terminal.
	Pins		
W1	1, 2		Jumper pins 1 and 2 in normal operation. (reserved)
W4	1, 2		Jumper pins 1 and 2 in normal operation. (reserved)

Connections

⚠ WARNING!

TO AVOID DAMAGE TO THE PCB OR LOAD CELL, REMOVE POWER FROM THE IND780 Q.IMPACT TERMINAL AND WAIT AT LEAST 30 SECONDS BEFORE CONNECTING OR DISCONNECTING ANY HARNESS.

⚠ WARNING!

THE POWERCELL PDX SCALE INTERFACE BOARD #64064718 (KIT NUMBER 64067252) MUST NOT BE USED IN AN IND780 Q.IMPACT TERMINAL INSTALLED IN AN AREA CLASSIFIED AS DIVISION 2 OR ZONE 2/22. FAILURE TO COMPLY WITH THIS WARNING COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE.

The POWERCELL PDX option board should be placed in slot 1 or slot 2 on the main board. This option is used with METTLER TOLEDO POWERCELL® PDX® load cells used in large tank and vehicle weighing applications. Figure A-46 shows a POWERCELL PDX option board. Only one POWERCELL PDX option board can be installed in the terminal, to support up to four scales.

Figure A-46: POWERCELL PDX Option Board

Figure A-47 shows the terminal strip connections for this board.

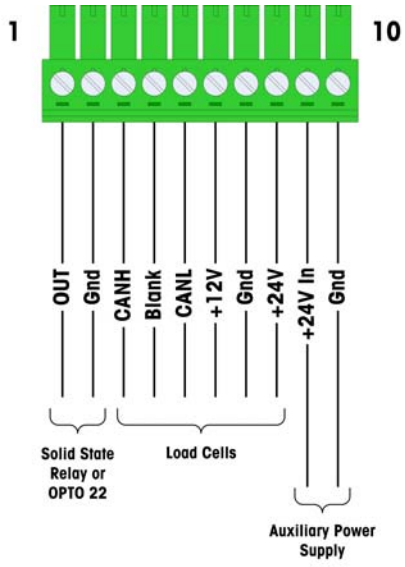


Figure A-47: POWERCELL PDX Option Board Connections

The TTL-compatible open collector output is reserved for use only with the scale's material transfer target functionality. It provides the signal for the feed output associated with the active target for that scale. It is not necessary to configure this output. The outputs are current-sinking components which can handle from 5 to 30 volt DC signals at a maximum of 35 mA current. A solid-state relay or OPTO 22 is typically connected to buffer the IND780 terminal outputs to a 120 or 220 volt AC signal.

Depending on the number of load cells and the cabling configuration, the IND780 Q.IMPACT terminal uses either its internal 12 VDC supply (via pins 6 and 7) or an external 24 VDC supply (via pins 7 and 8) to power the load cells. Refer to Table A-10 for the recommended maximum cable lengths and the number of load cells supported by the IND780 Q.IMPACT POWERCELL PDX option board when using its internal 12 VDC supply.

Table A-10: Recommended Maximum Cable Lengths (for +12 VDC)

Total Cell-Cell Cable (meters/feet)	Home Run Cable (meters/feet)	Number of PDX Cells
60/197	300/984	≤ 8
80/262	250/820	≤ 10
85/278	200/656	≤ 12
100/328	100/328	≤ 12
100/328	85/278	≤ 14
140/459	50/164	≤ 14

When the terminal is used with cable lengths exceeding those given above or with more than 14 POWERCELL PDX cells, it is recommended to install the optional external 24 VDC power supply (P/N 0917-0240). With the external supply, it is possible to use up to 24 load cells per terminal, a maximum home run cable

length of 300 m (984 ft) and a total of 200 m (656 ft) of cell-to-cell cable. The external power supply is connected to pins 9 and 10 on the PDX board.

Home Run Cable Grounding and Shielding

Ground and shield terminations are a critical part of the system's immunity to noise and electrical surges. To prepare for the terminations on the home run cable:

1. Cut and remove an appropriate length of the outer braid shield and the insulation sheath, ensuring that there is sufficient length to provide strain relief for the connection of the wires to the option board.
2. Trim the inner braid shield and the foil, leaving about 20 mm (0.8 inches) exposed.
3. When installing an IND780 Q.IMPACT harsh enclosure terminal:
    a. Install the cable gland assembly, metal clamp and the brass sleeve onto the home run cable while sliding back the outer braid shield (Figure A-48). The inner drain wire should go into the enclosure through the cable gland, while the outer drain wire remains on the outside.
    b. Fold and spread out the inner braid shield and foil over the metal ring before pressing the grommet into the body of the cable gland, as shown in Figure A-48. Tighten the cable gland's nut with the brass sleeve onto the body of the gland.

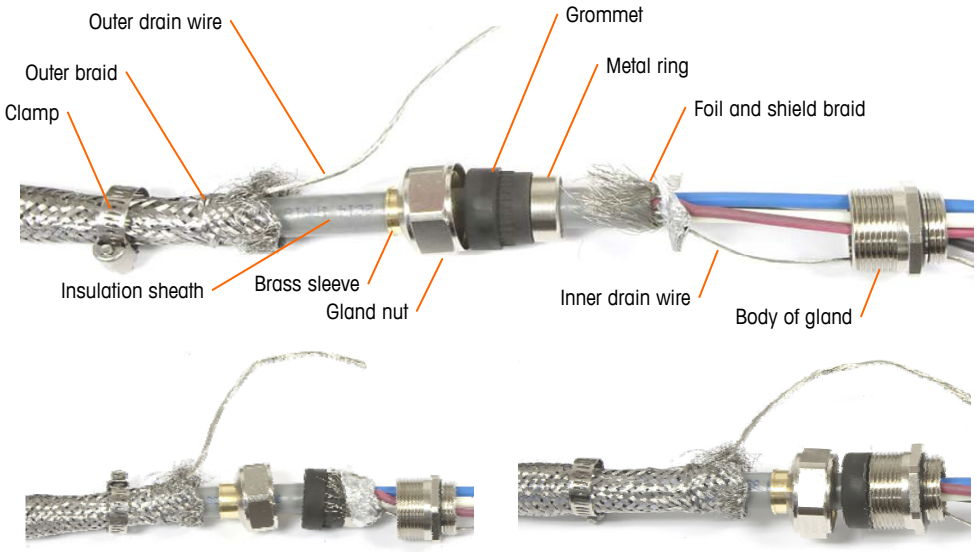


Figure A-48: PDX Home Run Cable and Gland Assembly

    c. Pull the outer braid forward to cover the brass sleeve and wrap one end of a flat braided ground cable over it before securing everything down using the metal clamp (Figure A-49). Route the home run cable's outer drain wire along with the flat braided cable through a ground lug attached to the rear of the harsh enclosure. The other end of the flat braided cable is terminated at the ground rod.

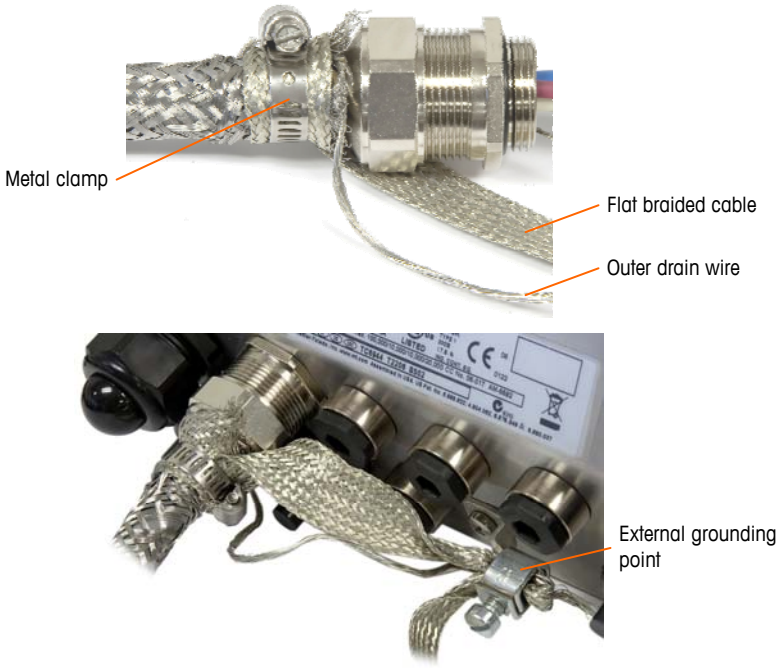


Figure A-49: PDX Home Run Outer Braid Termination, Harsh Enclosure

4. To terminate the home run cable's outer and inner braid shield for an IND780 Q.IMPACT panel mount terminal, when using a cable gland with the external panel housing, follow the procedure described in step 3, above. Alternatively, when using a conduit hub entry:

   a. Slide back the outer braid and fold the trimmed inner braid and foil shield back evenly over the edge of the cable insulation sheath, as shown in Figure A-50.

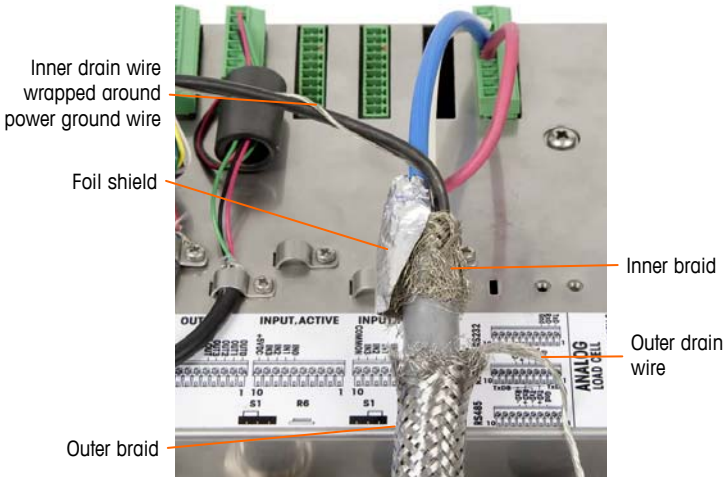


Figure A-50: PDX Home Run Cable, Panel Mount Enclosure

   b. Slide forward the outer braid to cover over the inner braid and foil. Pull the outer drain wire back over the outer braid and trim it to approximately 25 mm (1 inch). Place the flat braided ground cable around the home run cable and the drain wire before finally securing everything to the back

cover of the IND780 Q.IMPACT using the large strain relief cable clamp provided with the unit (Figure A-51).

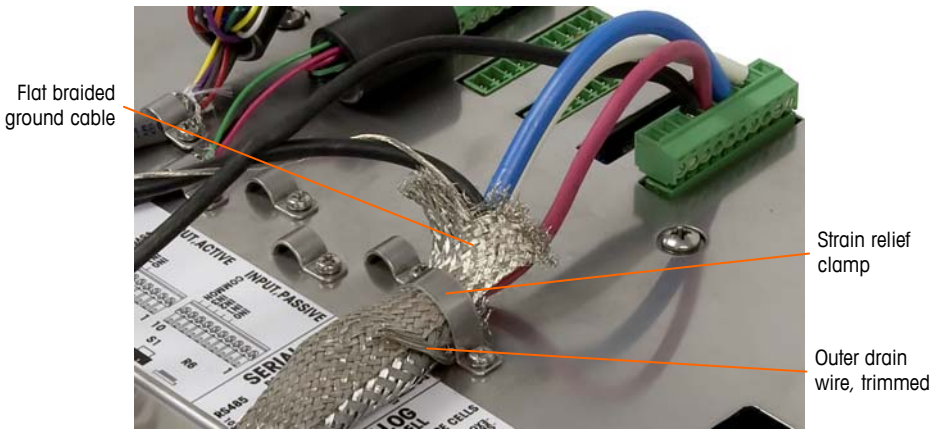


Figure A-51: PDX Home Run Outer Braid Termination, Panel

5. For an IND780 Q.IMPACT harsh enclosure, to make the power ground connection on pin 7 of the option board terminal strip:

   a. First, a separate short length of the power ground wire with a ring terminal on one end must be prepared in advance. Attach this separate wire with the ring terminal end to the ground stud located inside the terminal's enclosure using a hex nut. Connect the other end to pin 7 on the terminal strip.

   b. Next, twist the home run cable's inner drain wire together with the core power ground wire and make a connection to the same ground stud using another ring terminal as shown in Figure A-52.

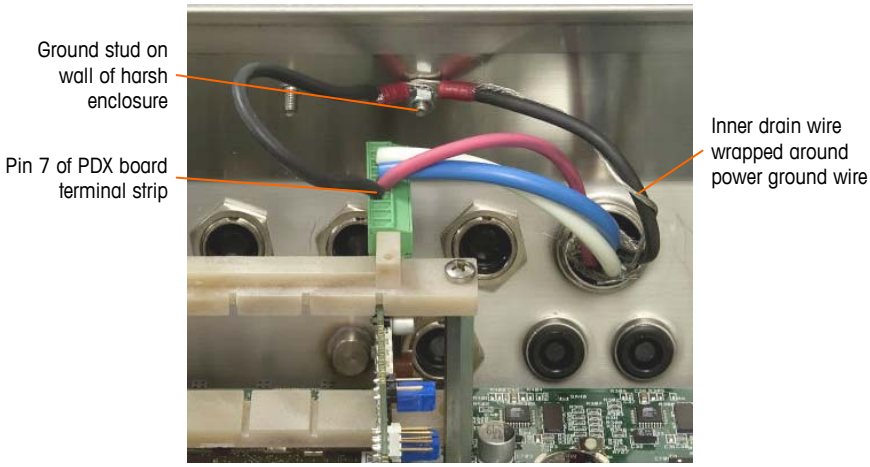


Figure A-52: PDX Home Run Power Ground Connection, Harsh

6. For an **IND780 Q.IMPACT panel mount enclosure**, make the terminations described in step 5 to the external ground stud indicated in Figure A-53.

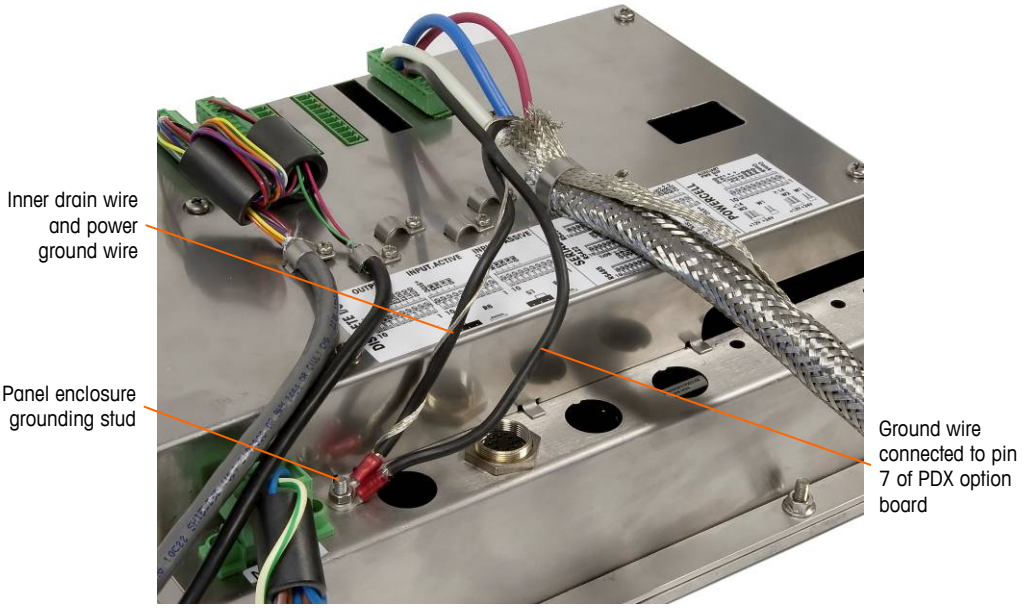


Figure A-53: Completed PDX Home Run Power Ground Connection, Panel Mount Enclosure

Open Collector Output

The PDX option board provides a single TTL-compatible open collector output (pin 1 and pin 2), with current sinking components that can handle from 5 to 30 VDC signals at a maximum of 35 mA current. A solid state relay or OPTO 22 is typically connected to buffer the output to a 120 or 220 VAC signal. The voltage source must be a Class 2 marked or a Limited Power Source (LPS)-compliant power supply.

This output is reserved for use with the scale's material transfer target functionality. It provides the feed output signal associated with the active target for a PDX scale assigned as scale 1.

LED Interpretation

Figure A-54 indicates the locations of LEDs on the POWERCELL PDX board. Table A-11 describes the function of the LEDs.

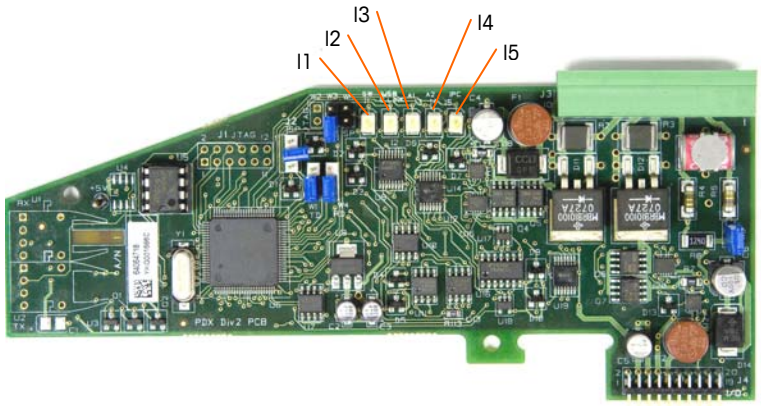


Figure A-54: POWERCELL PDX Board LEDs

Table A-11: POWERCELL PDX Board LEDs Indications

LED	Color	Function
I1: SW	Amber	ON – the board's discrete output is turned on OFF – the board's discrete output is turned off
I2: USB	Amber	ON – the USB connection to the main board is active OFF – the USB connection to the main board is inactive
I3: A1 I4: A2	Amber	I3 solid ON, I4 OFF – indicates that the CAN communication to the load cells is active I3 and/ or I4 blinking – indicates that the CAN communication to the load cells is interrupted
I5: IPC	Amber	Slow blink (~1 Hz) indicates that the board's processor is not working correctly Fast blink (~ 3 Hz) indicates that the board's processor is working correctly

Flow Meter Interface

The Flow Meter Option Board (Figure A-55) is a two-channel isolated counter/flow meter board available for use with the IND780 Q.iMPACT terminal. The board provides a flow meter totalizer target comparison to directly control on-board discrete outputs.

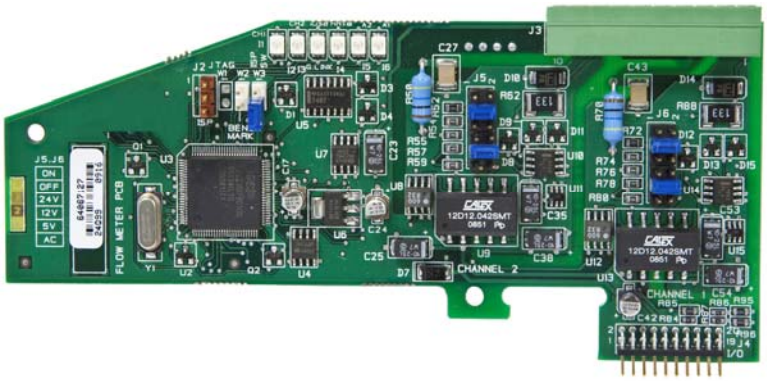


Figure A-55: Flow Meter Interface Board

For additional details about the flow meter interface, refer to Appendix D.

Interface Wiring

The Phoenix Contact 10-pin connector pin outs are as follows:

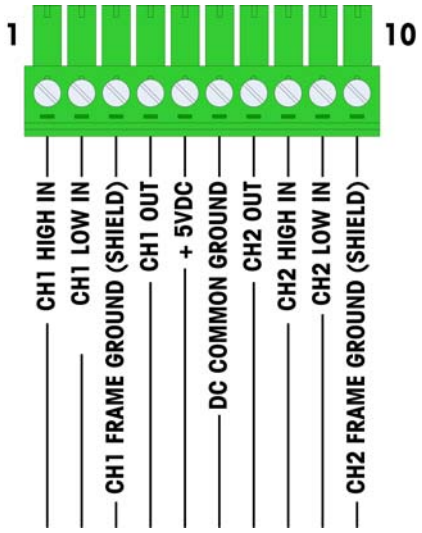


Figure A-56: Flow Meter Connector

Pins 3 and 10 (the frame grounds for Channels 1 and 2) provide floating grounds, and are the return lines for pins 1 and 8 (the high inputs for Channels 1 and 2). This maintains the isolation of the input circuitry from the rest of the board electronics.

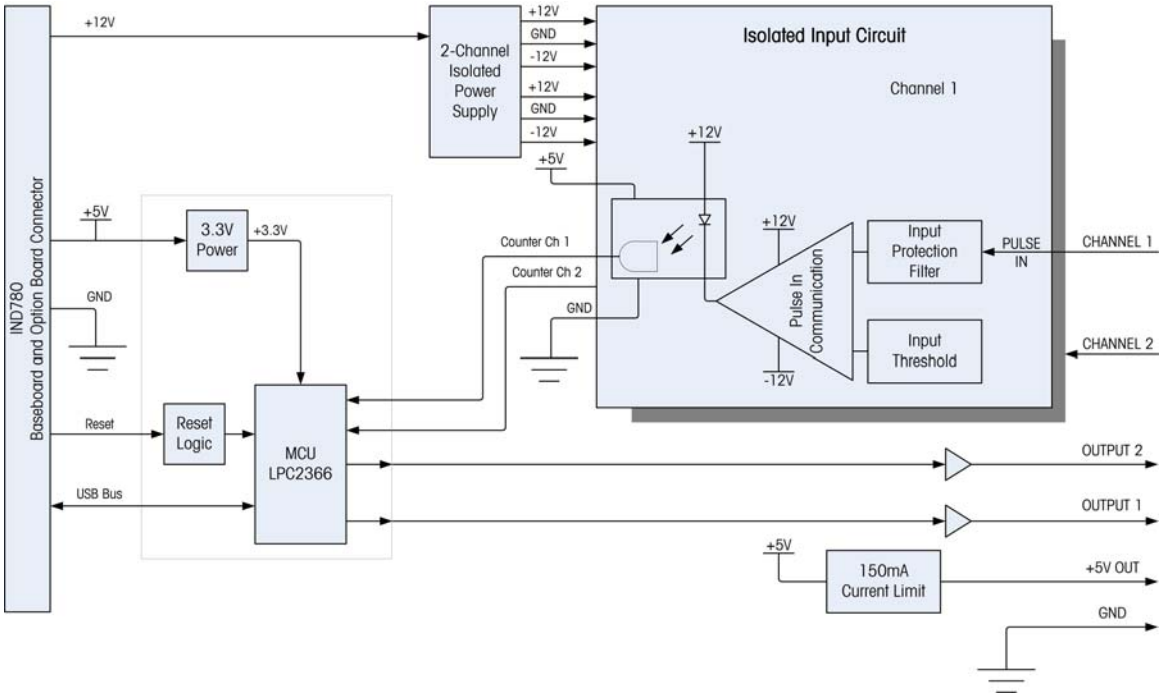


Figure A-57: Block Diagram, Channel 1 Shown

Jumper Settings

The flow meter board has four sets of hardware jumpers, indicated in Figure A-58.

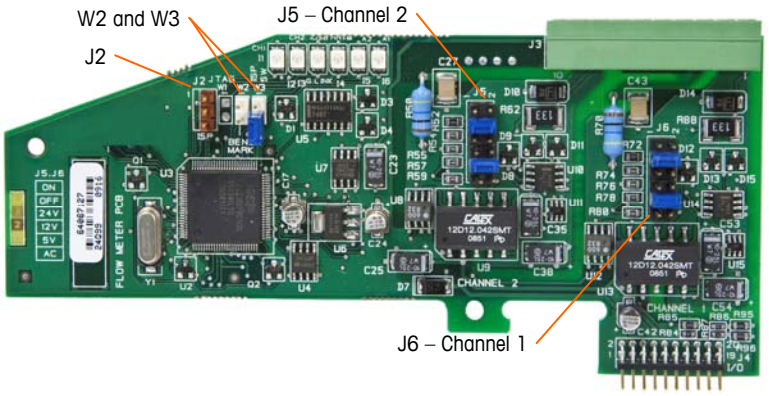
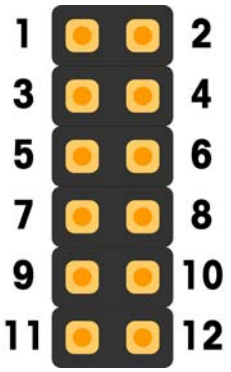


Figure A-58: Flow Meter Interface Board Jumper Locations

J5/J6 – Filter Enable

Each of the two input channels indicated in Figure A-58 has a set of six jumper settings, which function as shown in Table A-12. Jumper locations 1-2 (enable) and 3-4 (disable) control the 15kHz low-pass analog filter, which is used to filter noise on the input.

Table A-12: Settings for Jumpers J5 (Channel 2) and J6 (Channel 1)



Function	Jumper Location	
Analog Low-Pass Filter on	1	2
Analog Low-Pass Filter off	3	4
24V Range	5	6
12V Range	7	8
5V Range	9	10
AC Range	11	12

The analog filter should be enabled in the following cases:

- For flow meter frequencies below 15 kHz
- For all AC applications, regardless of frequency

J5/J6 – Input Switching Threshold

For each channel, this jumper has four possible positions (5/6, 7/8, 9/10, 11/12), which set the comparison voltage level for the input comparator. Voltage levels are:

- 0.0 VAC – use the AC jumper selection
- 2.3 VDC – use the 5 VDC jumper selection
- 6.0 VDC – use the 12 VDC jumper selection
- 8.0 VDC – use the 24 VDC jumper selection

Please consult the documentation for the specific flow meter you intend to use.

Wiring a Flow Meter

An attached flow meter can be either isolated with respect to the Q.i output voltage, or it can be non-isolated and share a common output voltage. The circuits in Figure A-59 and Figure A-60 illustrate these two methods of connecting a flow meter's pulse outputs to a Q.i flow meter interface board.

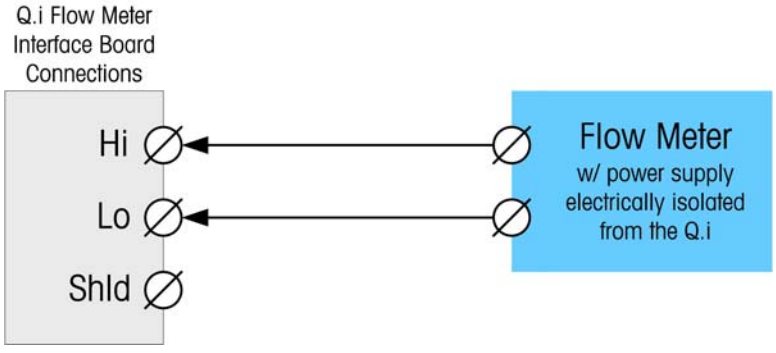


Figure A-59: Isolated Flow Meter Connections

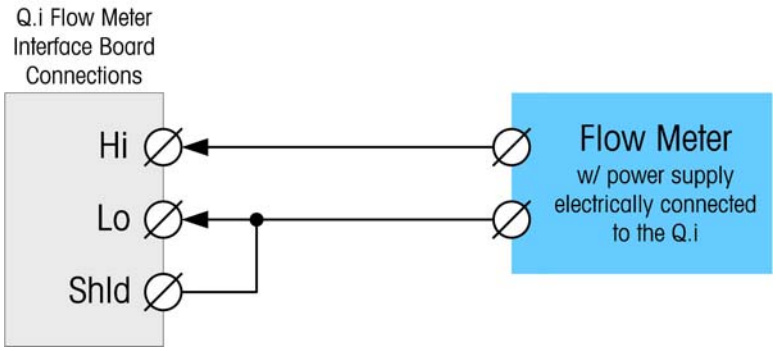


Figure A-60: Non-Isolated Flow Meter Connections

Discrete I/O (Input/Output)

Mode Selector Switch

A switch on the Discrete I/O board selects whether the inputs will be active or passive. An explanation of these two modes and sample wiring diagrams were provided earlier in this chapter. Ensure that the switch is set properly before wiring to the inputs. The location of the switch (S1) is shown in the drawing and photograph in Figure A-61. In both cases, the switch in the illustration is set to active.

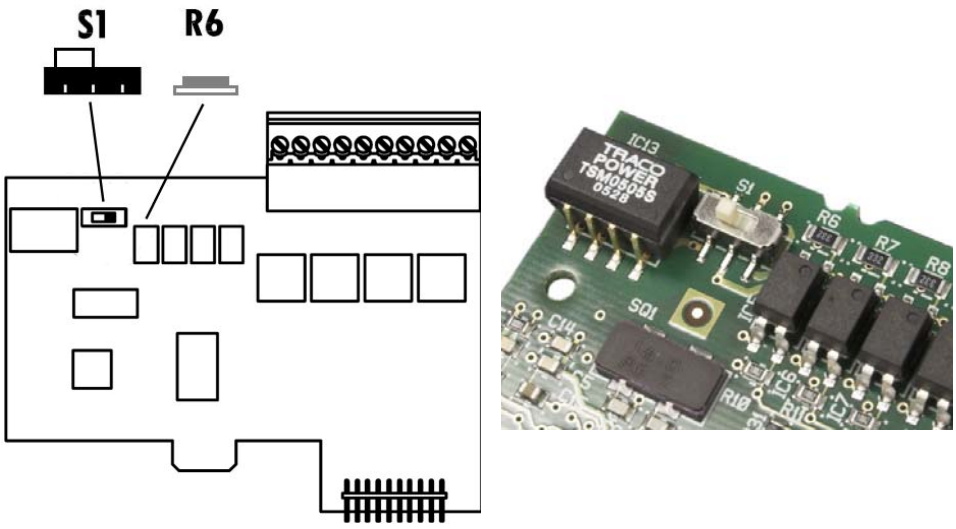


Figure A-61: Discrete I/O Board Mode Selector Switch Location

Connections

The relay output version of the Discrete I/O option provides four isolated inputs and four dry-contact, normally open relay outputs. The inputs can be selected as either active or passive based on the position of the slide switch on the board.

Figure A-62 and shows a Discrete I/O board in its Solid State Relay configuration, and Figure A-63 the Relay version.

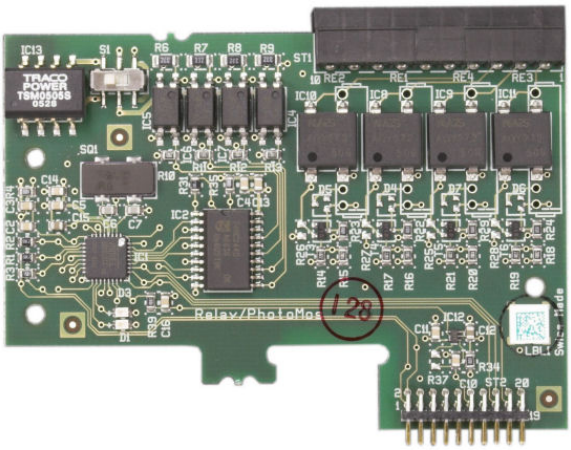


Figure A-62: Discrete I/O Board, Solid State Relay

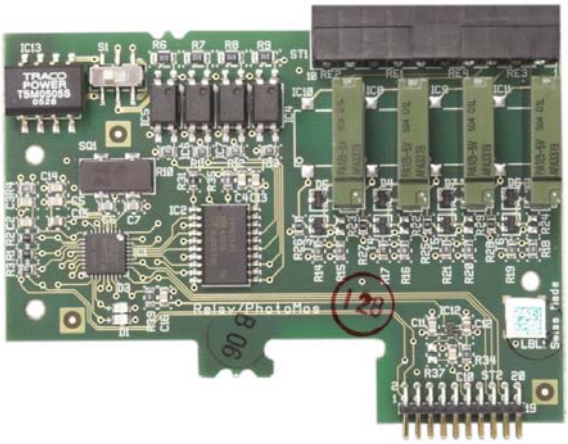


Figure A-63: Discrete I/O Board, Relay

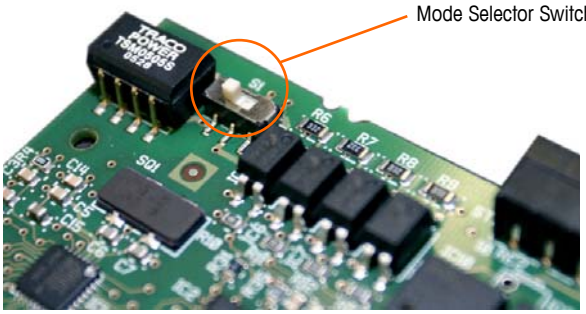


Figure A-64: Discrete I/O Mode Selector Switch, Active Position

Active Input

Selecting the inputs as active enables connection of switches or other simple devices to trigger an input. No voltage is supplied by the external simple device. An example of how to wire to the active inputs is shown in Figure A-65. Note that pin 10, the +5VDC connection, can carry no more than 200 mA current.

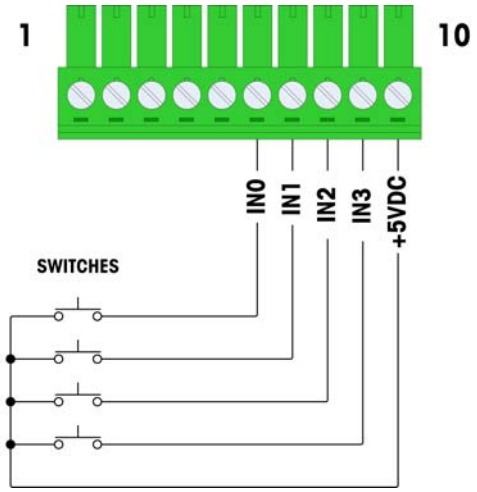
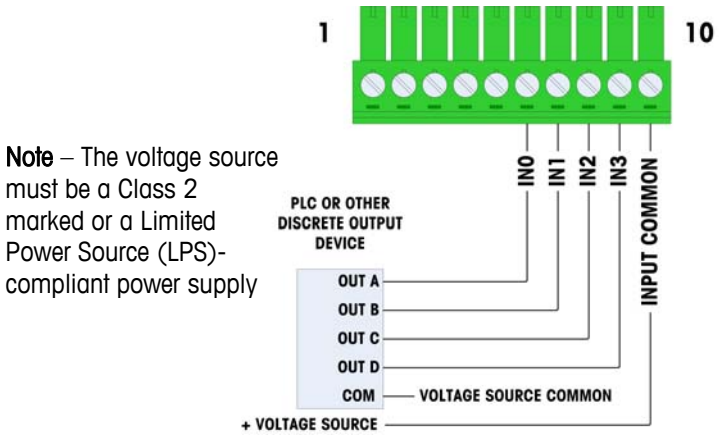


Figure A-65: Example of Active Input from Switches

Passive Input

Selecting the inputs as passive enables other devices such as PLCs to provide the trigger voltage (typically 24 VDC, 5-30 VDC) to turn the IND780 Q.IMPACT inputs "on". An example of wiring to the passive inputs is shown in Figure A-66. The voltage polarity may be reversed. Furthermore, inputs can be programmed in SETUP to accept either a + True or – True polarity level as "ON".



Note – The voltage source must be a Class 2 marked or a Limited Power Source (LPS)-compliant power supply

Figure A-66: Example of Passive Input from Discrete Output Device

Relay Outputs

The relay and solid state relay outputs can switch up to 30 VAC or 30 VDC voltages at 1A maximum. The relay outputs are not polarity-sensitive since they are dry contact outputs. An example of wiring to the outputs is given in Figure A-67.

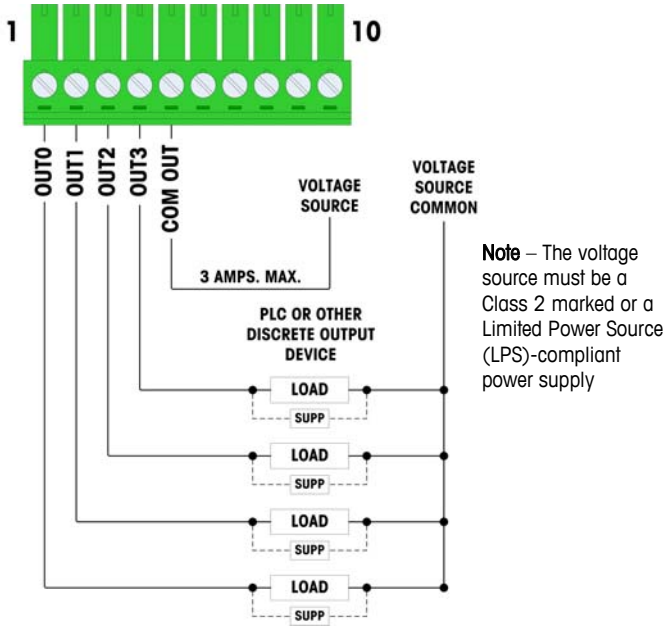


Figure A-67: Relay Outputs

IDNet

Connections

WARNING!

TO AVOID DAMAGE TO THE PCB OR LOAD CELL, REMOVE POWER FROM THE IND780 Q.IMPACT TERMINAL AND WAIT AT LEAST 30 SECONDS BEFORE CONNECTING OR DISCONNECTING ANY HARNESS.

For IDNet base load cells, the IND780 Q.IMPACT terminal supplies 12 VDC for the new T-Brick type, and 30 VDC for the legacy PIK-Brick type. When using an IDNet card in the IND780 Q.IMPACT terminal, the cable connection from the base is made to a connector on the rear of the housing. IDNet cards are supplied with a length of cable and a connector that mates to the connector on the IND780 Q.IMPACT terminal. The board is shown in Figure A-68.

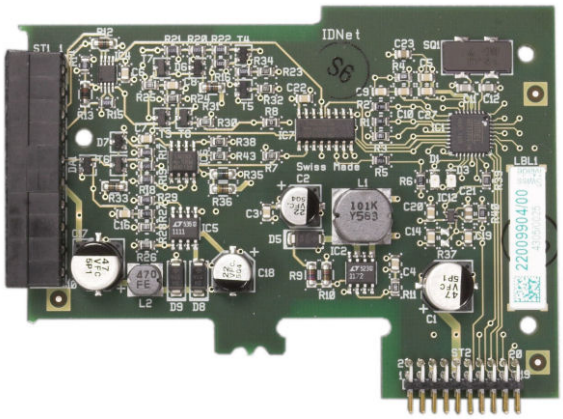


Figure A-68: IDNet Option Board

Figure A-69 shows the IDNet harness. One end attaches to the option board, and the threaded body of the connector mounts in one of the keyed holes in the back of the Panel or Harsh Enclosure, with its nut on the outside of the enclosure. Route the harness wire away from any Analog Loadcell Boards to protect the IND780 Q.IMPACT from external influences. Refer to Figure A-21 and Table A-1 for the Harsh enclosure mounting position.

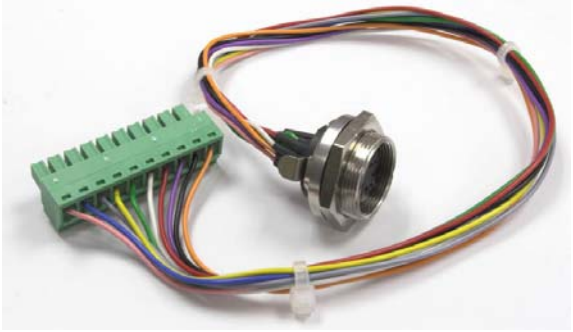


Figure A-69: IDNet Harness

The IDNet cable is required to connect between the option board and the enclosure case. The cable is configured as shown in Figure A-70.

IDNet Cable 64062067			
P1	**P2**	**Color**	**Remarks**
P1-A	P2-8	Green	TxD+/RxD+
P1-B	P2-9	Blue	+30V
P1-C	P2-8	Gray	+12V
P1-D	P1-A	Green	Jumper
P1-E	P2-4	Red	RxD1+
P1-F	P2-5	White	RsD-
P1-G	N.C.		
P1-H	P2-20	Pink	Gnd
P1-J	P2-7	Yellow	TxD-
P1-K	P2-3	Violet	TxD1-
P1-L	P2-2	Black	TxD1+
P1-M	P2-1	Orange	RxD1-

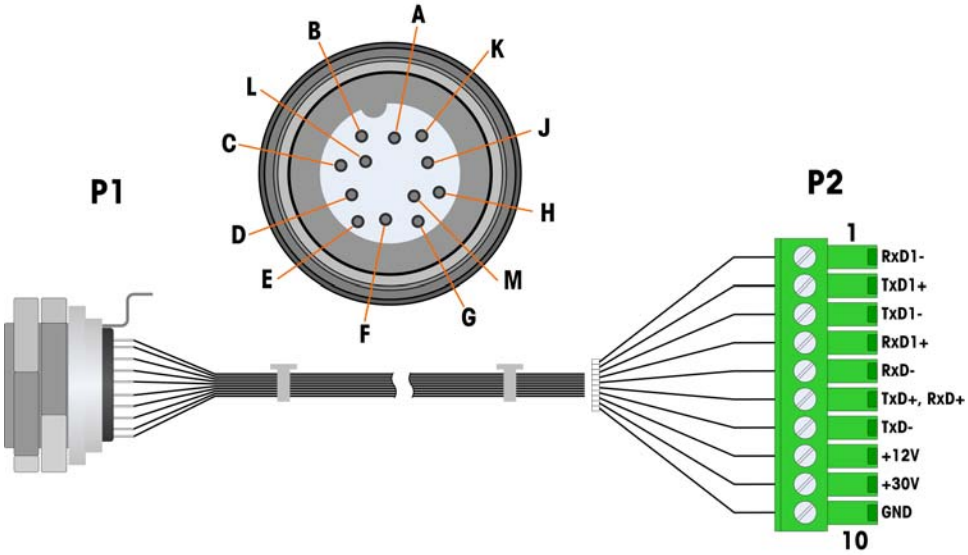


Figure A-70: IDNet Cable for IDNet Option Board

Serial Option Board

Connections

The Serial option board provides an extra COM port. The card can be placed in slots 2 to 6 on the main PCB. The board is shown in Figure A-71, and connector pin assignments in Figure A-72.

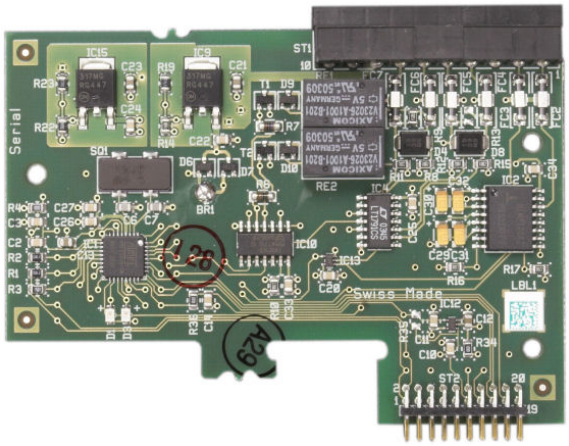


Figure A-71: Serial Option Board

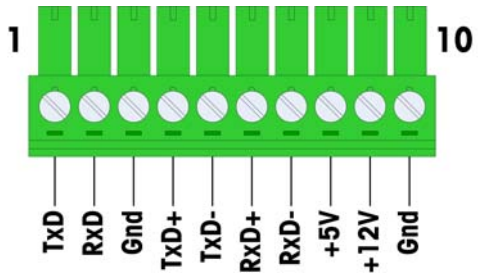


Figure A-72: Serial Option Board Connector

Port connector assignments for this board are shown in Figure A-73, and termination for RS232, RS422 and RS485 in Table A-13.

Table A-13: Serial Option Board Pin Connections

Pin	Signal	Function	Notes
1	TxD	RS-232 Transmit data	
2	RxD	RS-232 Receive data	
3	GND	RS-232 Signal ground	
4	TxD+	RS-422/485 Transmit +	Jumper to RxD+ for RS-485
5	TxD-	RS-422/485 Transmit -	Jumper to RxD- for RS-485
6	RxD+	RS-422/485 Receive +	Jumper to TxD+ for RS-485
7	RxD-	RS-422/485 Receive -	Jumper to TxD- for RS-485
8	+5V	+5V out, 0.5 A max.	
9	+12V	+12V out, 0.5 A max.	
10	GND	Ground	

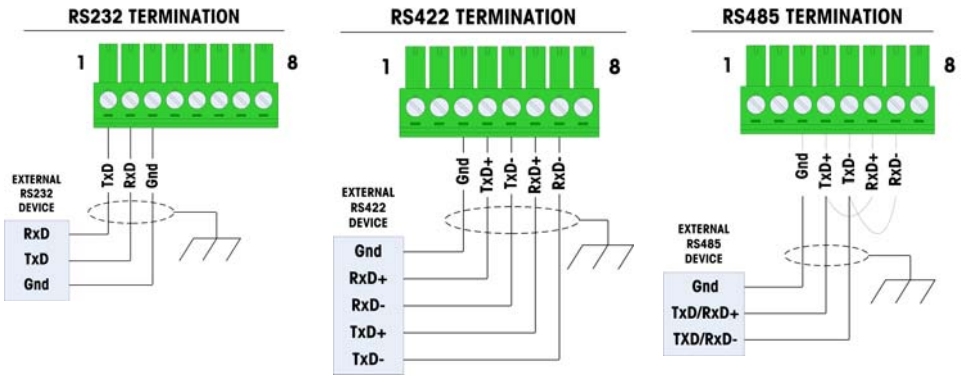


Figure A-73: Connector Terminations for Serial Option Board

RS-485 Transmission Line Termination

The RS-485 network should include a terminating resistor, installed between the two lines at or on the last node. The terminating resistor should match the characteristic impedance of the transmission line, approximately 120 ohms. This terminating resistor is required when connecting ARM100 modules to the port.

PLC Interface Modules

DeviceNet Connections

The DeviceNet option board (Figure A-74) is connected to the network by a DeviceNet-specific twisted pair cable.

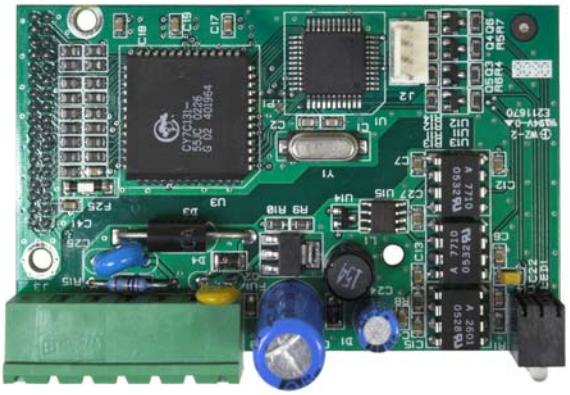
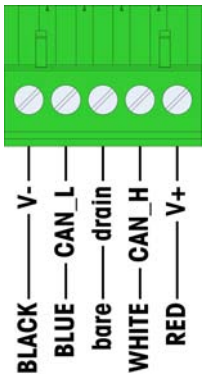


Figure A-74: DeviceNet Option Board

Figure A-75 indicates the pin numbering of the DeviceNet Option Board connector., Wire colors and functions are detailed in Figure A-76.

Figure A-75: DeviceNet Option Board Connector Pin Numbering



NOTES:
1. CONNECTION WITH 2 TWISTED PAIR SHIELDED CABLE BELDEN 3082A OR 2083A OR EQUIVALENT.
2. REFER TO O.D.V.A. DEVICENET DOCUMENTATION FOR OTHER CONSIDERATIONS.
3. WIRE SIZE: 14 AWG (2.088 mm2) MAXIMUM
   22 AWG (0.322 mm2) MINIMUM.

Figure A-76: DeviceNet Connector Wiring

Consult http://www.odva.org/ for additional DeviceNet wiring information.

PROFIBUS Connections (Harsh Enclosure)

The PROFIBUS connection to the harsh enclosure is made using a straight nine pin connector inside the IND780 Q.IMPACT enclosure. Follow the instructions included with the connector to terminate the wires. Figure A-77 shows the PROFIBUS module for use in the Harsh Enclosure, with its connector at upper right.

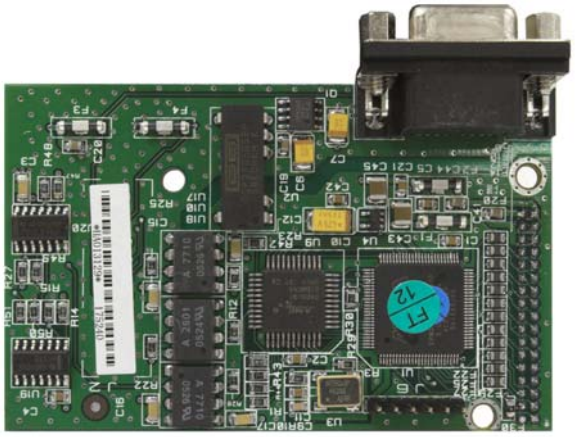


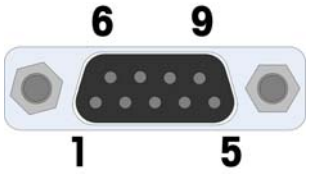
Figure A-77: PROFIBUS PLC Module for Harsh Enclosure

Follow the wiring instructions included with the connector to terminate the wires.

PROFIBUS Connections
(Panel Mount Enclosure)

The PROFIBUS connection to the Panel Mount enclosure is made using a straight nine-pin connector. The connector will extend through the cutout in the back panel of the terminal. This connector (or an equivalent) is a standard METTLER TOLEDO part # 64054361. The connector is not supplied by METTLER TOLEDO as part of the option.

Attach the nine-pin mating plug to the connector. Pin assignments are shown in Figure A-78. Follow the wiring instructions included with the connector to terminate the wires.



PROFIBUS CONNECTOR WIRING	
PIN	**SIGNAL**
1	None
2	None
3	RxD/TxD +
4	RTS
5	Gnd BUS
6	+5V BUS
7	None
8	RxD/TxD -
9	None

Figure A-78: PROFIBUS 9-Pin Connector Assignments

Figure A-79 shows the PROFIBUS board used in panel mount installations, with the appropriate connector circled.

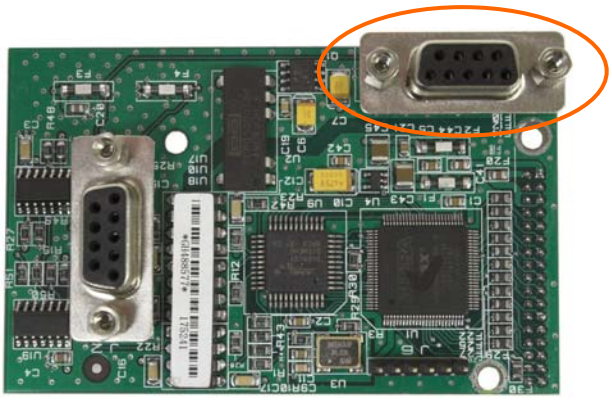


Figure A-79: PROFIBUS PLC Module for Panel Mount Enclosure

Figure A-80 shows (from left to right) the module installed in the panel mount enclosure, with the connector attached, and the rear panel in place.

Figure A-80: PROFIBUS PLC Module Connector for Panel Mount Enclosure

ControlNet Interface

The ControlNet PLC Module (Figure A-81, Figure A-82) connects to the ControlNet network via one or two coaxial cables (Figure A-84). Channel B is redundant with Channel A, and is not used unless ControlNet detects no signal on Channel A. Note that the module's address is set in software, and the MAC ID switches indicated in Figure A-82 are not used.

Figure A-81: ControlNet PLC Module

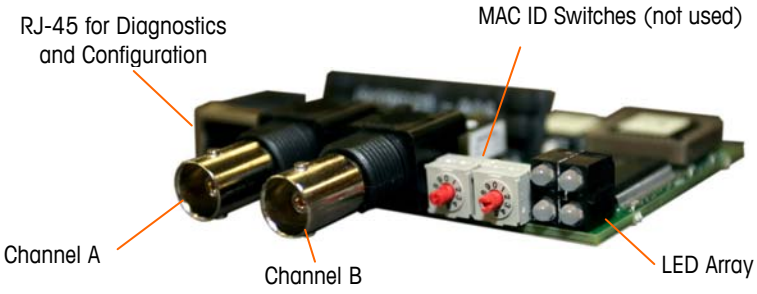


Figure A-82: ControlNet PLC Module Connections and Components

Do **not** plug an Ethernet cable into the RJ-45 connector shown at left in Figure A-82. Damage to the IND780 Q.IMPACT may result.

Figure A-83 shows the array of status indicator LEDs on the ControlNet card (see also Figure A-82).

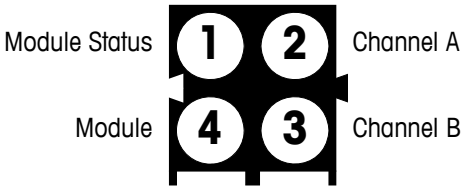


Figure A-83: ControlNet Status Indicator LEDs

Figure A-84 shows an example of a ControlNet cable, and a close-up view of the connector. Note that the connector may be straight or right-angled, as seen here. This cable is not supplied by Mettler Toledo.

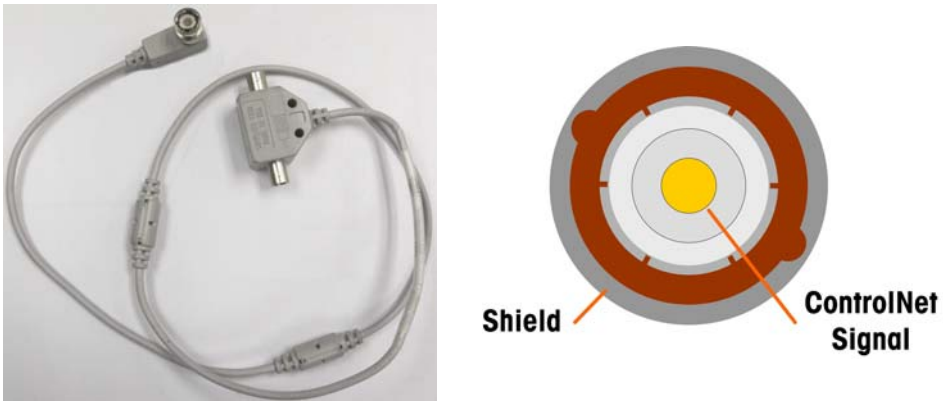


Figure A-84: ControlNet Cable and Connector

Ethernet / IP and Modbus TCP Interface

The Ethernet / IP Module (Figure A-85, Figure A-86) connects to the network via a standard Ethernet patch cable. The module's address is set in software, and the DIP switches indicated in Figure A-86 are not used and must all be set to OFF.

Note: For use in a Modbus TCP network, the module must be version 1.32 or higher.

Figure A-85: Ethernet / IP PLC Module

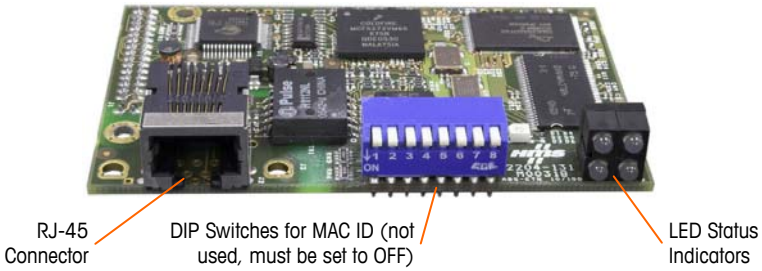


Figure A-86: Ethernet / IP PLC Module Components

Figure A-87 shows the array of status indicator LEDs on the Ethernet / IP card (see also Figure A-86).

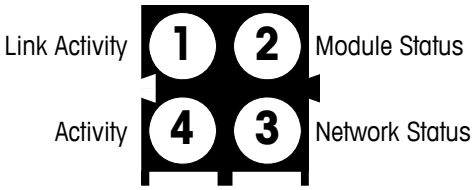


Figure A-87: Ethernet / IP Status Indicator LEDs

Rockwell (Allen Bradley) RIO Connections

Connections to the Remote IO option are made using a three-pin terminal connector on the RIO option. The connection should be wired as shown in Figure A-88.

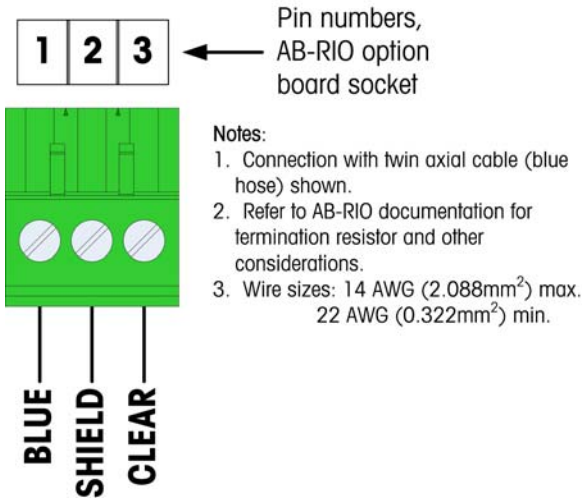


Figure A-88: RIO Connection Wiring

The part number for the Remote IO cable is Belden 9463. It is sometimes referred to as "Blue Hose" cable.

Figure A-89 shows the RIO PLC interface module, with its connector at upper right.

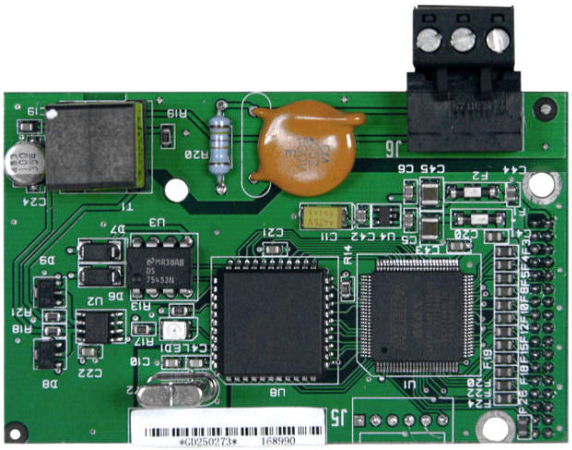


Figure A-89: Allen Bradley RIO PLC Interface Module

Sealing the Enclosure

When the IND780 Q.IMPACT terminal is used in a metrologically "approved" application, it must be protected from tampering by use of seals. An optional sealing kit is available from METTLER TOLEDO that contains all the required hardware (Part number 64056538). Note that when the terminal is sealed non-metrological components cannot be serviced without breaking the seal.

Figure A-90 and Figure A-91 show the components of the sealing kit and how to use them, respectively.

Figure A-90: Components of the Sealing Kit: Wire and Seal (left) and Screw (right)

Figure A-91: Use of the Sealing Kit:
Wire Through Screw (left), Wire Through Seal (center), Seal Closed (right)

Panel Enclosure Sealing

The Panel Mount enclosure must be sealed internally and externally. Follow these steps:

1. Ensure that the appropriate approval region has been selected in setup under Scale > Type > Approval and that the Metrology security switch S1 is in the "on" position.
2. Install the Security Cover to prevent access to S1, the Metrology Security Switch indicated in Figure A-92, Main PCB Switches.

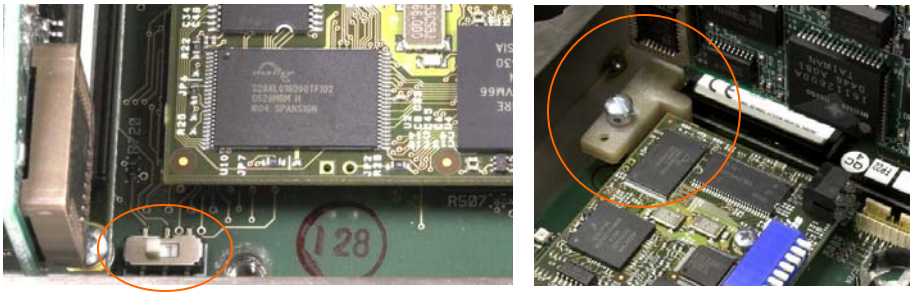


Figure A-92: Metrology Security Switch (left) and Cover Installed (right)

3. To protect the load cell interconnecting cable/s (attached to option boards), a security seal must be placed over the connectors to ensure that they are not removed or disconnected. The seal also prevents access to the wire retaining screws indicated in Figure A-93. Figure A-94 shows a seal in place.

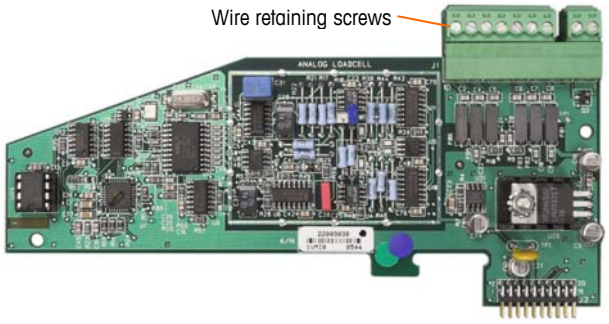


Figure A-93: Unprotected Option Board Connection

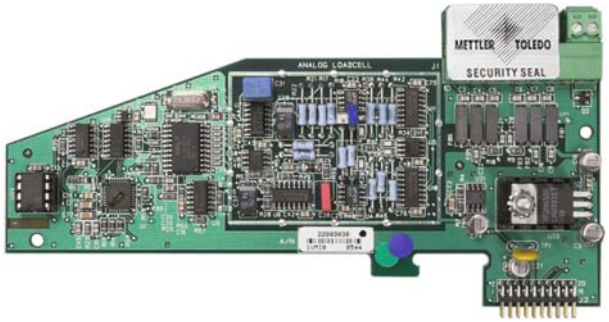


Figure A-94: Security Seal Installed

4. Finally, the back panel of the enclosure is sealed. Three sealing screws are indicated in Figure A-95 – two secure the panel in place on its stand-offs and one secures one end of the upper card guide.

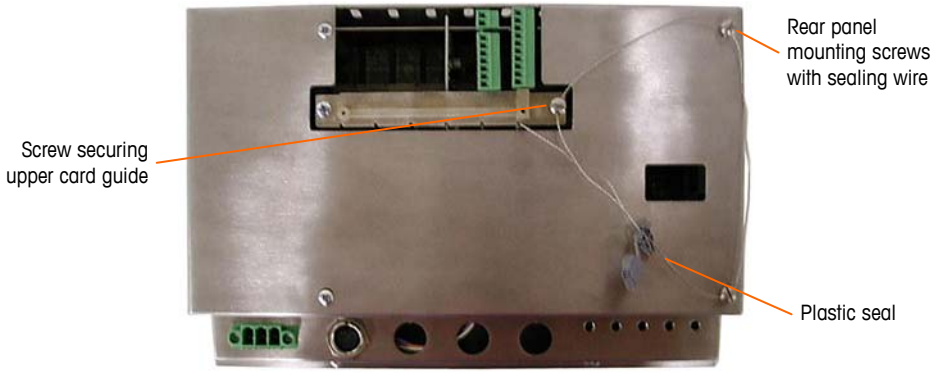


Figure A-95: 3-Point Sealing, Panel Enclosure Rear Cover

5. With the screws installed, thread the sealing wire through each of them, then thread its ends through the plastic seal.
6. Remove most of the slack from the wire, and snap the seal shut.

Harsh Enclosure Sealing

For external sealing of the harsh enclosure, refer to Figure A-90 and Figure A-96 and follow these steps:

1. Ensure that the appropriate approval region has been selected in setup under Scale, Type, Approval and that the Metrology security switch SW1-1 is in the "on" position.
2. With the front panel installed on the enclosure and snapped into place, thread the free end of the wire seal through either the left or right hole in the IND780 Q.iMPACT terminal front panel, and through the hole in the retaining clip.
3. Thread the end of the wire cable through the hole in the plastic seal (as shown in Figure A-96), remove any remaining slack in the wire, and snap the seal shut.

Figure A-96: Harsh Enclosure Seal Threaded and Ready to be Closed – Standard Orientation (left) and with Panel Reversed (right)

4. Trim off any excess wire.

Appendix B

Default Settings

The following tables list the factory default settings for the IND780 Q.iMPACT terminal setup parameters. For standard IND780 default settings, refer to Appendix B of the IND780 Technical Manual.

Table B-1: Setup Defaults

Setup Feature	Default Value	As configured
Control I/O Module – Scale Control		
Description	Default	
Fast Feed Type [If Type ≠ Hand Add]	None	
Fine Feed FCE Source	Scale Board	
GIW/LIW Selector Out [If Type = Scale and Fine Feed FCE Source = Scale Board]	None	
Control I/O Module – Flow Meter		
Description	Default	
Fast Feed Type [If Type ≠ Hand Add]	None	
Enable Manual Weigh [If Type = Flow Meter]	None	
Equipment Channel Module		
Minimum Add	0	
Description	Default	
Dump Trip Point [Only if Equipment Type = Scale Unit]	3&	
Equipment Channel Module – Flow Rate Thresholds		
Zero	5 divisions / sec	
Minimum PAC [Only if Equipment Type = Scale Unit] or Flow Meter	1.5 times Zero Threshold	
Abort Drain at Zero Flow	Disabled	
Unstable Device	2 times Zero Threshold	

Setup Feature	Default Value	As configured
Equipment Channel Module – Process Times		
Feed Override Time	0 sec	
Min. Slow Step Time	30 sec	
Stable Device Wait Time [Only if Equipment Type = Scale Unit or Flow Meter]	3 sec	
OLP Feed Alone Time [Only if Equipment Type = Scale Unit]	8 sec	
OLP Time Tolerance	8 sec	
Material Path – Selected Material Path		
Description	Default	
Material Path – Source Measuring Device		
Max. Flow Rate Alarm	0 / sec	
Feed Algorithm	Spill only GIW	
Material Path – Process Times		
Slow Step Timer Factor	2	
Minimum Open Time	2 sec	
Drain Time	5 sec	
Material Path – Average Flow Rate Limits		
Low	0 / sec	
High	3% of scale capacity / sec	
Material Path – Average Spill Limits		
Low	0	
High	3% of scale capacity	
Material Path – Jog		
Auto Jog Mode	Disabled	
Material Path – Other Parameters		
Algorithm Correction	30%	
Flow Rate Sample Period	2 sec	
Reset PAC Variables	No	

Appendix C

Q.i Tables

Q.i Table and Record Overview

The IND780 Q.i uses the IND780 Standard Database Tables to define, set up and run the Q.i material transfer control system. Either the Q.i configuration tool or the IND780 Q.iMPACT terminal interface can be used to set up these tables. The IND780 Q.iMPACT exchanges these tables with a PC Shared Data Server or via FTP communications. These tables are:

Table #	Table Name	Function	Record Instance # and Record Types
A4	Equipment Channel Module Table	Defines the physical configuration of the equipment.	SCALE_UNIT STORAGE_SCALE FLOW_METER DYNAMIC_WEIGHING PLC_BRIDGE_SLOT
A5	Control I/O Module Table	Defines the discrete I/O associated with equipment.	SCALE_CONTROL FLOW_METER OPERATOR_ACTION
A6	Material Path Table	Defines how the material flows in the system.	Q.I_SETUP Q.I_RUNTIME MATPATH_HEADER

Equipment Channel Module Table

Equipment Table Header Record

The EQUIP_HEADER record in the Equipment Table has the version number and the creation date for the Equipment Table and the Control Module Table. The Batch Tables Tool must change the version number and creation date whenever it changes any entries in the Equipment Module Table or the Control Module Table.

Equipment Table Field	Standard Table Field	Field Format	Comment
Equipment Header Record ID	GUID	GUID	SQL creates unique global ID.
Equipment Name	KEY	16 UC	EQUIP_HEADER
Equipment Description	Description	40 UC	
Record Type	Data1	16 UC	EQUIP_HEADER

Equipment Table Field	Standard Table Field	Field Format	Comment
Version Number & Validation/Status	Data2	16 UC	Format "X Y" where X = Version Number 1-999999 Y = Validation/Status 1=Released, 2=Testing, 3=Development
Author	Data16	40 UC	
Creation Date & Time	Data17	40 UC	YYYY/MM/DD HH:MM:SS

Equipment Table Scale Unit Records

The SCALE_UNIT records in the Equipment Table define the Control I/O Modules associated with a Scale Unit. The Scale Unit is capable of transferring material and performing auxiliary material transfer operations.

Equipment Table Field	Standard Table Field	Field Format	Comment
Scale Unit Record ID	GUID	GUID	SQL creates unique global ID.
Equipment Name	KEY	16 UC	1 - 198
Equipment Description	Description	40 UC	
Record Type	Data1	16 UC	SCALE_UNIT
Node Number	Data2	16 UC	Cluster Node Number 1-20
Scale Number	Data3	16 UC	Scale 1 – 5
Automatic Weigh-In Scale Control Module Name	Data4	16 UC	*Pointer into the Control Module Table
Transport Header Control Module Name for Weigh-In Scale	Data5	16 UC	*Pointer into the Control Module Table When the Weigh-In Scale has multiple material sources, the Transport Header Control Module selects which material to feed.
Automatic Weigh-Out Scale Control Module Name	Data6	16 UC	*Pointer into the Control Module Table
Transport Header Control Module Name for Weigh-Out	Data7	16 UC	*Pointer into the Control Module Table
Auxiliary Control Module Name 1	Data8	16 UC	*Pointer into the Control Module Table
Auxiliary Control Module Name 2	Data9	16 UC	*Pointer into the Control Module Table
Auxiliary Control Module Name 3	Data10	16 UC	*Pointer into the Control Module Table
Auxiliary Control Module	Data11	16 UC	*Pointer into the Control

Equipment Table Field	Standard Table Field	Field Format	Comment
Name 4			Module Table
Manual Weigh-In Operator Action Control Module Name	Data12	40 UC	*Pointer into the Control Module Table
Manual Weigh-Out Operator Action Control Module Name	Data13	40 UC	*Pointer into the Control Module Table
Auxiliary 1 Operator Action Control Module Name	Data14	40 UC	*Pointer into the Control Module Table
Auxiliary 2 Operator Action Control Module Name	Data15	40 UC	*Pointer into the Control Module Table
Auxiliary 3 Operator Action Control Module Name	Data16	40 UC	*Pointer into the Control Module Table
Auxiliary 4 Operator Action Control Module Name	Data17	40 UC	*Pointer into the Control Module Table

Equipment Table Storage Tank Records

The STORAGE_TANK records in the Equipment Table define a tank that can enter new material into a batch system or can store output material that the batch system produces. The STORAGE_TANK does not have a scale associated with it to transfer or weigh material.

This record has statistics on the amount of material currently stored in a storage tank, but the "Current Weight" statistics require the operator to enter accurately the amount of material placed into an Input Storage Tank or removed from an Output Storage Tank.

Equipment Table Field	Standard Table Field	Field Format	Comment
Storage Tank Record ID	GUID	GUID	SQL creates unique global ID.
Equipment Name	KEY	16 UC	1 - 198
Equipment Description	Description	40 UC	
Record Type	Data1	16 UC	STORAGE_TANK
Node Number	Data2	16 UC	Cluster Node Number 1-20
Storage Type	Data3	16 UC	1 = Input Storage, 2 = Output Storage
Level-Indicator Control Module Name	Data4	16 UC	*Pointer into the Control Module Table The Level-Indicator Control Module indicates when the STORAGE_TANK is full or empty. It also has a gate/valve control.
Reserved	Data17	40 UC	

Equipment Table Flow Meter Records

The Flow Meter records in the Equipment Table define the Control I/O Modules associated with a flow meter.

Equipment Table Field	Standard Table Field	Field Format	Comment
Flow Meter Record ID	GUID	GUID	SQL creates unique global ID.
Equipment Name	KEY	16 UC	1 - 198
Equipment Description	Description	40 UC	
Record Type	Data1	16 UC	FLOW_METER
Node Number	Data2	16 UC	Cluster Node Number 1-20
Flow Meter Number	Data3	16 UC	Flow Meter 1 – 12
Flow Meter Control Module Name	Data4	16 UC	Pointer into the Control Module Table
Flow Meter Transport Header Control Module Name	Data5	16 UC	Pointer into the Control Module Table When the Flow Meter has multiple material sources, the Transport Header Control Module selects which material to feed.
Manual Flow Meter Operator Action Control Module Name	Data6	16 UC	Pointer into the Control Module Table
Equipment Statistics			
Total # Phases	Data16	16 UC	Total # of phases associated with this Equipment module
Total Weight and Units	Data17	16 UC	Total amount of weight distributed by this Equipment module, e.g., 1000 kg

Equipment Table Q.i Dynamic Weighing Records

The Q.i Phase Logic uses the DYNAMIC_WEIGHING Records in the Equipment Table to help control the material transfers in the Scale Units and flow meters for more accurate feeds. Scale Units require all data fields in this record. The Data fields marked "*Flow Meter also" are applicable to flow meters as well as scales.

Equipment Table Field	Standard Table Field	Field Format	Comment
Dynamic Weighing Record ID	GUID	GUID	SQL creates unique global ID.
Equipment Name	KEY	16 UC	1 - 198
Equipment Description	Description	40 UC	

Equipment Table Field	Standard Table Field	Field Format	Comment
Record Type	Data1	16 UC	DYNAMIC_WEIGHING * Flow Meter also
Stable Scale Time	Data2	16 UC	This is the number of seconds to wait for a stable scale reading before returning an "Unstable Scale" failure status. Range is 5-10 seconds. * Flow Meter also
Feed Override Time	Data3	16 UC	This time is in seconds. Q.i sets a status indicating that the Material Transfer is within the feed override time. Any external logic (such as Slow Stem Timer or an operator changing modes) must not remove the permissive on the enabling logic that is controlling the Final Control Element (FCE) during this time. It prevents something other than the Fast-Cut-Off from closing the FCE, which might cause the Q.i to develop erroneous data for subsequent update of its constants. Default = 20 seconds * Flow Meter also
Minimum Slow Step Time	Data4	16 UC	The Q.i algorithm computes a "step slow" value. If the computed value is less than the minimum specified here, Q.i uses the minimum instead. Typical range is 30-60 seconds. * Flow Meter also
Overlap Feed Alone Time	Data5	16 UC	An overlapped feed must feed alone this time before cutoff, in seconds. Typically, it is 10-20 seconds.
Overlap Time Tolerance	Data6	16 UC	Additional time in seconds allowed for an overlapping feed to complete.

Equipment Table Field	Standard Table Field	Field Format	Comment
Zero Flow Threshold	Data7	16 UC	Flow rate below which the system assumes zero flow. Typically, it is sized 0.001%-0.01% of Max Scale Capacity/second. In a "dump to empty", the Q.i uses this value to determine when a "dump to empty" is complete. After this point, Q.i keeps the FCE energized until the "drain time" expires. When this value < 0, Q.i task uses absolute Value for drain timer and aborts Drain Timer at zero flow. * Flow Meter also
Unstable Device Flow Threshold	Data8	16 UC	Flow rate above which Q.i generates a "Noisy Scale" condition when waiting for a stable scale reading. Typically, it is 0.005%-0.05% of Max Scale Capacity per second, but it Must be larger than Minimum Flow. * Flow Meter also
Minimum Add	Data9	16 UC	The smallest amount of material the system will attempt to add. Typically, it is 0.01%-1% of Max Scale Capacity. * Flow Meter also
Maximum Unit Size in Weight and Units	Data10	40 UC	This is the capacity size of a Scale Unit, e.g., 1000 kg
Dump Trip Point	Data11	40 UC	Q.i considers Dump To Empty complete below this level. Typically, it is 0.001%-0.01% of Max Unit Size, but it must be less than smallest batch size for the Unit.
Min Q.i Flow Rate Threshold	Data12	40 UC	Q.i starts to apply the predictive algorithm when measured flow exceeds this value. Typically, it is 0.1% of Max Unit Size, but it must be larger than Minimum Flow. Q.i sets the target = SP – Spill until the flow rate reaches this value. * Flow Meter also

Equipment Table Field	Standard Table Field	Field Format	Comment
Current Zero	Data13	40 UC	Q.i calculates this value after a "Dump to Empty" operation; it sets the value to the actual scale weight when it algorithmically detects the zero. This helps track a "heel" buildup in the vessel.

Equipment Table PLC Bridge Slot Records

The IND780 uses the PLC_BRIDGE_SLOT Records in the Equipment Table to setup the configuration of how the Equipment Channel Modules accept commands and report their status to a host PLC or DCS. A Bridge terminal in a cluster has a PLC/DCS adapter located within the terminal, and it provides multiple "slots" through which the PLC/DCS can access to multiple equipment channel modules. The equipment channel modules can be located locally within the Bridge terminal or in a remote terminal. The number of slots that the Bridge terminal supports depends on the PLC/DCS and the type of PLC/DCS message configuration.

Equipment Table Field	Standard Table Field	Field Format	Comment
PLC Bridge Slot Record ID	GUID	GUID	SQL creates unique global ID.
Equipment Name	KEY	16 UC	1 - 198
Equipment Description	Description	40 UC	
Record Type	Data1	16 UC	PLC_BRIDGE_SLOT
Node Number of PLC Bridge Terminal	Data2	16 UC	Cluster Node Number 1-20 This equipment module communicates to a PLC through this Bridge terminal.
Slot Number in PLC Bridge	Data3	16 UC	This equipment module uses this slot in the Bridge terminal.

Control I/O Table

Control I/O Module Table Scale Control Records

The Scale Control I/O Module Records in the Control Module Table define the Discrete I/O control parameters for a Scale Batching Unit or Scale Storage Tank.

When a Scale supports both Weigh-In and Weigh-Out, there can be a separate Scale Control Module for each, which a Scale Unit Record in the Equipment Table must identify. For Analog Scale and other new scales, there is a single Discrete Output on the Scale Option Board. The Data4 default value selects the Discrete Output on the Scale Option Board as the FCE, and Data11 defines a Discrete Output for switching the FCE between weigh-in and weigh-out operations. Both Scale Control Modules must define the common FCE and the switching control when sharing them.

The fields marked "information only" are also in the Equipment Table but provide helpful information to a user who is browsing these records.

Control I/O Module Table Field	Standard Table Field	Field Format	Comment
Scale Control Module (CM) Record ID	GUID	GUID	SQL creates unique global ID.
CM Name	KEY	16 UC	1 -297
CM Description	Description	40 UC	
Record Type	Data1	16 UC	SCALE_CONTROL
Node Number	Data2	16 UC	Cluster Node Number 1 – 20 (information only; CM elements reside in same terminal as Equipment Module)
Scale Number	Data3	16 UC	Scale Number 1– 5; 0 = None (information only)

Control I/O Module Table Field	Standard Table Field	Field Format	Comment
Final Control Element (FCE) for Fine Feed	Data4	16 UC	Discrete Output Shared Data name turns on and off feed control. For an Analog Scale, a default value of "SCLBRD" in this field selects the Discrete Output FCE located on the corresponding Analog Scale Board. The Analog Scale Board does the target weight comparisons at 91.5 hertz for setting this Discrete Output FCE. This Discrete Output is an "open collector" where external hardware logic must supply the voltage. If you specify any other Discrete Output FCE, the target weight comparison occurs at a much slower rate of 20 hertz. In order to use this FCE for both weigh-in and weigh-out operations, you must also specify the Discrete Output name in Data11. The "SCLBRD" value selects the Discrete Output on the other new scale bases.
Feedback Switch	Data5	16 UC	Discrete Input Shared Data name provides Feedback to indicate when the valve is open.
Permissive Interlock	Data6	16 UC	Discrete Input Shared Data name enables external logic to enable or disable the feed.
Alarm	Data7	16 UC	Discrete Output Shared Data name turns on an alarm.
Fast-Feed Target Control Element	Data8	16 UC	Discrete Output Shared Data name turns on and off two-speed fast feed control.
Gate/Pump/Valve Control	Data9	16 UC	Discrete Output Shared Data name controls gate/pump/valve separately from the FCE, if needed.

Control I/O Module Table Field	Standard Table Field	Field Format	Comment
Concurrent or Independent Fast Feed Control	Data10	16 UC	"None", "Concurrent", or "Independent" Fast Feed Control
Weigh-In/Weigh-Out Selector (only valid when Data4 is set to default = SCLBRD)	Data11	16 UC	Discrete Output Shared Data name allows dynamic switching of the default FCE in Data4 so that it can work in either a weigh-in or weigh-out operation. A value of 1 in the Discrete Output selects a Weigh-In operation; a value of 0 selects a Weigh-Out operation. External hardware logic must "AND" the Scale Option Board Discrete Output and this Data11 Discrete Output to provide the FCE control for either the weigh-in or the weigh-out operation.

Control I/O Module Table Flow Meter Control Records

The Flow Meter Control I/O Module Records in the Control Module Table define the Discrete IO control parameters for a flow meter.

The fields marked "information only" are also in the Equipment Table but provide helpful information to a user who is browsing these records.

Control I/O Module Table Field	Standard Table Field	Field Format	Comment
Flow Meter Control Module (CM) Record ID	GUID	GUID	SQL creates unique global ID.
CM Name	KEY	16 UC	1 - 297
CM Description	Description	40 UC	
Record Type	Data1	16 UC	FLOW_METER
Node Number	Data2	16 UC	Cluster Node Number 1 – 20 (information only; CM elements reside in same terminal as Equipment Module)
Flow Meter Number	Data3	16 UC	Flow Meter Number 1– 12 (information only)

Control I/O Module Table Field	Standard Table Field	Field Format	Comment
----	Data4	16 UC	The Final Control Element (FCE) is part of the IND780 Flow Meter interface.
Feedback Switch	Data5	16 UC	Discrete Input Shared Data name provides Feedback to indicate when the valve is open.
Permissive Interlock	Data6	16 UC	Discrete Input Shared Data name enables external logic to enable or disable the feed.
Alarm	Data7	16 UC	Discrete Output Shared Data name turns on an alarm.
Gate/Pump/Valve Control	Data8	16 UC	Discrete Output Shared Data name controls gate/pump/valve separately from the FCE, if needed.
Manual Weighing Control	Data9	16 UC	Input Discrete IO allows operator manually to enable FCE in order to enable manual control of the flow meter operation.
Fast-Feed Target Control Element	Data10	16 UC	Discrete Output Shared Data name turns on and off two-speed fast feed control.
Concurrent or Independent Fast Feed Control	Data11	16 UC	"Concurrent" or "Independent" Fast Feed Control

Material Path Table

Material Path Table Header Record

The MATPATH_HEADER record in the Material-Path Table has the version number and the creation date for the Material-Path Table.

Material-Path Table Field	Standard Table Field	Field Format	Comment
Material-Path Header Record ID	GUID	GUID	SQL creates unique global ID.
Material-Path Name	KEY	16 UC	MATPATH_HEADER
Material-Path Description	Description	40 UC	
Record Type	Data1	16 UC	MATPATH_HEADER

Material-Path Table Field	Standard Table Field	Field Format	Comment
Version Number & Validation/Status	Data2	16 UC	Format "X Y" where X = Version Number 1- 999999 Y = Validation/Status 1=Released, 2=Testing, 3=Development
Author	Data16	40 UC	
Creation Date & Time	Data17	40 UC	YYYY/MM/DD HH:MM:SS

Material Path Table Q.i Setup Records

The Q.I_SETUP records in the Material Path Table have the setup data needed to run the Q.I material transfer PAC algorithms.

Material Path Table Field	Standard Table Field	Field Format	Comment
Material-Path Record ID	GUID	GUID	SQL creates unique global ID.
Material-Path Name	KEY	16 UC	1 - 999
Material-Path Description	Description	40 UC	
Record Type	Data1	16 UC	Q.I_SETUP
Q.i Feed Algorithm	Data2	16 UC	Q.i Spill Only, Gain In Weight = 0 Q.i Spill Only, Loss In Weight = 1 Q.i K1 algorithm, Gain In Weight = 2 Q.i K1 algorithm, Loss In Weight = 3 Q.i K2 algorithm, Gain In Weight = 4 Q.i K2 algorithm, Loss In Weight = 5 Q.i Dump to Empty = 6

Material Path Table Field	Standard Table Field	Field Format	Comment
Destination Equipment Name in Equipment Table	Data3	16 UC	*Pointer into the Equipment Table = 1-198 1. The material goes to the Destination Equipment that is a Scale Unit. 2. At beginning of the feed, the Q.i finds the weight in the Destination Scale Unit to determine if this Material Feed will cause an overflow in the destination channel. At the end of the feedings, the Q.i determines if the loss in weight in the source channel matches the gain in weight in the destination unit. 3. If the Destination Equipment is not a Scale Unit, Q.i disables Unit Verification and Batch Count Checking. 4. There may be multiple concurrent feeds into the destination channel. Destination Channel = "OUT_OF_CLUSTER" indicates that the Destination is outside of this cluster.
Equipment Name for material flow control	Data4	16 UC	*Pointer into the Equipment Table = 1 - 198 Equipment that physically controls feeding material this material. It could be a scale or a flow meter.
Rate Time Units and Path Number in Transport Header	Data5	16 UC	This field contains two fields separated by one or more spaces. The first field is the rate time units in weight units per time units, e.g., kg/sec. The second field is the Path Number in the Transport Header that the Equipment Module uses to select the flow path for the material, if required.
Slow Step Timer Factor	Data6	16 UC	The Slow Step Timer is Factor*(target / average flow). The factor is normally set as 1.5, but is adjustable on a material basis. If SST Factor< 0, Q.i uses absolute value for SST Factor, but generates alarm only when SST expires.

Material Path Table Field	Standard Table Field	Field Format	Comment
Minimum Open Time	Data7	16 UC	Q.i does not apply the spill compensation for this time in seconds immediately following control device opening. If = 0, there is no minimum time. A feed must be active this minimum time in seconds before Q.i considers it "successful" and updates its Q.i feed parameters. This check guarantees that the flow rate is valid before Q.i updates the Q.i parameters for a Material Path.
Drain Time	Data8	16 UC	This is the time in seconds that the system will wait for material to drain into a vessel after feed is complete and before testing for material delivery tolerance.
Average Flow Rate Low Limit	Data9	16 UC	This is the lower alarm limit for the Average Flow Rate "A". It is typically set at 50% of the flow rate, in weight or volume units/second. Value may be negative.
Average Flow Rate High Limit	Data10	16 UC	This is the upper alarm limit for the Average Flow Rate "A". It is typically set at 150% of the Flow Rate, in weight or volume units/second.
Average Spill Low Limit	Data11	16 UC	This is the lower alarm limit for the Average Spill "AA". It is typically set at 50% of the average spill, in weight or volume units. Value may be negative.
Average Spill High Limit	Data12	40 UC	This is the upper alarm limit for the Average Spill "AA". It is typically set at 150% of the average spill, in weight or volume units.
Algorithm Update Parameter	Data13	40 UC	Q.i uses this value in calculation of Average Flow Rate "A", Average Spill "AA", and Cutoff Constants "B", "BB", and "C". It controls how quickly the system responds to a change in operating conditions. Range is 0.0–1.0. You use Smaller values (0.1–0.3) for systems that have run consistently batch after batch, while you should use larger values (0.6-0.8) for systems whose material transfer flow characteristics change frequently. Default value is 0.2.

Material Path Table Field	Standard Table Field	Field Format	Comment
Flow Rate Filter Sample Period	Data14	40 UC	This value determines specifies the time, from 1 to 60 seconds, over which the IND780 calculates the rate. For lower values, Q.i responds more quickly to changes in rate. For larger values, the rate value changes more smoothly.
Max Flow Rate Alarm Value	Data15	40 UC	Flow rates above this value generate an alarm and terminate the feed. Value = 0 turns off alarm checking.
Slow Feed Time	Data16	40 UC	In a two-speed feed system, this is the amount of time needed for the slow feed. A value is 0 disables the two-speed feed and the entire feed proceeds at the slow feed.
Auto-Jog Time Parameters	Data17	40 UC	Field 1: Mode 0=disabled, 1=Jog to Tolerance, 2=Jog To Target Field 2 : Jog On Time in milliseconds Field 3: Jog Off Time in milliseconds (three fields, separated by one or more blank spaces)

Material Path Table Q.i Runtime Records

The Q.I_RUNTIME record contains the data that the Q.i PAC algorithm dynamically maintains at the end of a material transfer to adjust the spill values for the next Q.i feed using this material path. The IND780 Q.iMPACT writes this record when a material transfer feed is completed using this material path.

Material Path Table Field	Standard Table Field	Field Format	Comment
Material-Path Record ID	GUID	GUID	SQL creates unique global ID.
Material-Path Name	KEY	16 UC	1 - 999
Material-Path Description	Description	40 UC	
Record Type	Data1	16 UC	Q.I_RUNTIME
Average Flow Rate "A"	Data2	16 UC	Calculated/ Initialized in Setup. Average Flow Rate "A", in weight or volume units / second.
Average Spill "AA"	Data3	16 UC	Calculated/ Initialized in Setup. Average Spill "AA", in weight or volume units.
Cutoff Constant K1	Data4	16 UC	Calculated. First-order cutoff parameter used in spill calculation.

Material Path Table Field	Standard Table Field	Field Format	Comment
Cutoff Constant K2	Data5	16 UC	Calculated. Second-order cutoff parameter used in spill calculation.
Flow at Last Cutoff "Q"	Data6	16 UC	Calculated. Material flow rate at the cutoff of the last feed cycle, in weight or volume units / second.
Spill at Last Cutoff	Data7	16 UC	Calculated. Material spill following the last feed cycle, in weight or volume units.
Cutoff Constant B	Data8	16 UC	Calculated. Q.i uses "B" in K2 model. It is the "Average Flow Squared".
Cutoff Constant BB	Data9	16 UC	Calculated. Q.i uses "BB" in K2 model. It is the "Average Flow * Spill".
Cutoff Constant C	Data10	16 UC	Calculated. Q.i uses "C" in K2 model. It is the "Average Flow Cubed".
Cutoff Constant A_hat	Data11	16 UC	Calculated. Q.i uses in K2 model.
Cutoff Constant AA_hat	Data12	16 UC	Calculated. Q.i uses in K2 model.
Consecutive Good Feed Counter	Data13	16 UC	Calculated. Counts consecutive good feeds.
Total Good Feed Counter	Data14	40 UC	Calculated. Counts total good feeds.
Total Bad Feed Counter	Data15	40 UC	Calculated. Counts the total bad feeds. Feeds aborted early in the Material Transfer cycle are not counted as bad feeds.

Material Path Table Field	Standard Table Field	Field Format	Comment
Diagnostic Status Bits Last Material Transfer Status	Data 16	40 UC	Calculated. Q.i sets feed diagnostic status word at completion of the feed. The Q.i Processing Phase updates these bits internally during a Material Transfer. However, the Q.i Phase only updates the table record at the completion of the phase with the last setting of these status bits. Characters 1-10 are a 32-bit decimal number. Each of the 32 bits means: 0 OK to process requested feed 1 Minimum Open Time passed OK 2 Primary Feed Delayed Until Secondary Completes 3 Predictive algorithm started OK 4 Predictive algorithm completed OK 5 Feed Complete & Waiting for Stable Scale 6 Over Tolerance 7 Under Tolerance 8 Flow Rate within limits 9 Flow rate within 50% of range 10 Flow rate within 75% of range 11 Spill within limits 12 Spill within 50% of range 13 Spill within 75% of range 14 Primary Feed Alone 15 Awaiting Start Stability 16 Dump Trip Point Passed 17 K1 / K2 Limit Violation 18 Checking Fast Flow Rate Alarm 19 Hand Add Complete Detected 20 Feed Aborted Awaiting Drain 21 Power Failure During Feed 22 Configuration Reset During Feed 23 Look Back Time Too Small 24 ETC Error on Last Primary Feed 25 Substitute Spill Only Feed 26 – 31 Reserved Calculated. Characters 12-14 are the Last Material Transfer Status is set at completion of feed.
Fast Feed Flow Rate	Data17	40 UC	Calculated. Average Fast Feed Flow Rate

Material Path Table Material Inventory Records

Material-Path Table Field	Standard Table Field	Field Format	Comment
Material-Path Record ID	GUID	GUID	SQL creates unique global ID.
Material-Path Name	KEY	16 UC	1 - 999
Material-Path Description	Description	40 UC	
Record Type	Data1	16 UC	MAT_SOURCE
Material Name	Data2	16 UC	Name of this Material
Source Equipment Name in Equipment Table	Data3	16 UC	Type is specified in Data6. *Pointer into the Equipment Table = 1 - 198 "HAND_ADD" indicates that the operator manually adds this material. "OUT_OF_CLUSTER" indicates that material comes from outside the IND780 Batch cluster.
Perform Potency Adjustment in Recipe for this Source Material	Data4	16 UC	1=Yes, 0=No
Material Potency %	Data5	16 UC	100% is the nominal potency value. The operator must enter the potency value when he adds new material to the system.
Material Storage Type	Data6	16 UC	Equipment module is specified in Data3. 1 = SCALE_UNIT 2 = STORAGE_SCALE 3 = STORAGE_TANK 4 = HAND_ADD 5 = OUT_OF_CLUSTER

Material Source Record

The MAT_SOURCE records in the Material-Path Table define the material and the source equipment and for transferring the material. There can be multiple MAT_SOURCE records for the same material if the material resides in multiple equipments.

The IND780 Batch updates the statistics in this record at the completion of the material transfer phase that transfers equipment along this path.

Material-Path Table Field	Standard Table Field	Field Format	Comment
Material-Path Record ID	GUID	GUID	SQL creates unique global ID.
Material-Path Name	KEY	16 UC	1 - 999
Material-Path Description	Description	40 UC	
Record Type	Data1	16 UC	MAT_INVENTORY
Material Name	Data2	16 UC	Name of this Material
Source Equipment Name in Equipment Table	Data3	16 UC	Type is specified in Data6. *Pointer into the Equipment Table = 1 - 198 "HAND_ADD" indicates that the operator manually adds this material. "OUT_OF_CLUSTER" indicates that material comes from outside the IND780 Batch cluster.
Perform Potency Adjustment in Recipe for this Source Material	Data4	16 UC	1=Yes, 0=No
Material Potency %	Data5	16 UC	100% is the nominal potency value. The operator must enter the potency value when he adds new material to the system.
Material Storage Type	Data6	16 UC	Equipment module is specified in Data3. 1 = SCALE_UNIT 2 = STORAGE_SCALE 3 = STORAGE_TANK 4 = HAND_ADD 5 = OUT_OF_CLUSTER
Material Path Statistics			
Cumulative Material Transfer Phases	Data7	16 UC	Cumulative number of material transfer phases using this material

Material-Path Table Field	Standard Table Field	Field Format	Comment
Cumulative Material fed in this Material	Data13	40 UC	Cumulative Weight and Units , e.g., 1000 kg
Material Expiration Date	Data17	40 UC	Material Expiration Date if applicable YYYY/MM/DD HH:MM:SS

Batch System Setup (bx)

The IND780 Batch stores the BX block in Flash memory. It contains global setup parameters for the Batch System.

Access "Supervisor" default level is customizable by individual field.

Class Code bx

ControlNet Class Code 83 hex

Instances 1

Attributes

Some Q.i Parameters				
bx0100	Composite bx block	Struct	na	Composite of entire block
bx0101	Reserved	US	na	
bx0102	Reserved	US	na	
bx0103	Reserved	US	na	
bx0104	Reserved	US	na	
bx0105	Q.i PAC XREF Status	By	na	PAC Database XREF Status 0= Needs to be built, 1= Built
bx0106	PAC Global Data Base	6S	na	"GLOBL" indicates that Web pages update Data Base globally. "LOCAL" indicates that web pages update data bases locally
bx0107	PAC Weight Entry Method	By	na	0 = Absolute Weight, 1 = % of Capacity
bx0108	Q.i 365 Bridge Enable	By	na	1=Enable

bx0109	Q.I Trace Level	By	rt	0 = Minimum Trace to Ethernet LPRINT (default). This is the normal operation version. It contains only the feed history records and the command/status trace. 1 = Moderate Trace to Ethernet LPRINT 2 = Detailed Trace to Ethernet LPRINT 10 = Minimum Trace to Ethernet LPRINT and Compact Flash File 11= Moderate Trace to Ethernet LPRINT and Compact Flash File (debug only) 12 = Detailed Trace to Ethernet LPRINT and Compact Flash File (debug only) 255 = Timings information trace to Ethernet LPRINT (debug only) 254 = PLC trace data to Ethernet LPRINT (debug only) 245 = Timings information trace to Ethernet LPRINT and Compact Flash File (debug only) 244 = PLC trace data to Ethernet LPRINT and Compact Flash File (debug only)
System Configuration Parameters				
bx0110	Batch Configuration	By	na	0 = No Batch 1 = IND780 Batch Configuration 2 = Classic Q.i PLC Configuration supporting the Classic Q.i Message Interface. 3 = Enhanced Q.I PLC Configuration supporting the Enhanced Q.i PLC Message Interface See Method Description Below
bx0111	Master Terminal Node	By	na	Node number of Master terminal It has the master version of the Batch Database. In an IND780 Batch System, it does the batch and recipe processing.
bx0112	Reserved	By	na	
bx0113	Reserved	By	na	
Table Date and Version Numbers				
bx0140	Equipment Table Date/Time	AL2	na	Date/Time of last external change to Equipment Table
bx0141	Equipment Table Version Number	S11	na	Equipment Table Version Number. The remote terminals, in particular, use this value to determine if they need to download a new version of the table from the master terminal.
bx0142	Control Module Table Date/Time	AL2	na	Date/Time of last external change to Control ModuleTable
bx0143	Control Module Version Number	S11	na	Control Module Table Version Number The remote terminals, in particular, use this value to determine if they need to download a new version of the table from the master terminal.
bx0144	Material Path Table Date/Time	AL2	na	Date/Time of last external change to Material Path Table

bx0145	Material-Path Table Version Num	S11	na	Material-Path Version Number. The remote terminals, in particular, use this value to determine if they need to download a new version of the table from the master terminal.
bx0146	Last Master SD Update Time	AL2	na	At Master Terminal, the Last Update Time for common SD fields that IND780 Batch keeps synchronized between the Master and Remote terminals.
bx0147	Last Remote SD Synch Time	AL2	na	At Remote Terminal, the last time that the Remote Terminal synchronized its common SD fields with the Master Terminal
bx0148	Reserved	AL2	na	
bx0149	Reserved	AL2	na	
Miscellaneous Parameters				
bx0164	Enable K1_K2 Limits	By	na	1 = Yes
bx0165	Disable Q.I Look-Back Time	By	na	1 = Disable
bx0166	Dump-to-Empty Comparison Factor	D	na	Q.i Phase uses this parameter to determine if the Dump-to-Empty weight is too small compared to the last Dump-to-Empty weight for this Material Path. If it is too small, the Q.i Phase cannot overlap this feed. The value can be between 0.0 and 1.0. The default is .75.
bx0167	Reserved	UL	na	
bx0168	Reserved	S17	na	
bx0169	Reserved	By	na	
bx0170	Q.I K1 Limit	D	na	Maximum Value for K1 Limits
bx0171	Q.I K2 Limit	D	na	Maximum Value for K2 Limits
bx0172	Reserved	D	na	
bx0173	Reserved	D	na	
bx0174	Reserved	UL	na	
bx0175	Out from PLC Assembly Length	UL	na	User can set this value when pl0130 = 3
bx0176	Out from PLC Assembly Instance #	By	na	User can set this value when pl0130 = 3
bx0177	Reserved	By	na	

Method

You must have an I-Button to enable the Batch and/or Q.i configurations capabilities in the IND780.

Q.i Phase Commands (cq)

A PLC Controller in a Bridge Terminal or the Equipment Phase Marshaling Task in the Master Terminal may send a Shared Data Request Message to the IND780 Q.iMPACT to give a specific command to a specific equipment channel or Scale Unit.

To send the message, the PLC Ladder program in the PLC Controller executes a MESSAGE instruction to "Set All Attributes" in "ACM00" Object. A PLC Q.i Phase Marshaling Task in the Bridge terminal formats the PLC host command as Equipment Phase command and sends the PLC host command to the EP Shared Data field for the specific Q.i Equipment Phase Task.

The PLC Q.i Phase Marshaling Task directs the command to a specific Terminal and Process Identifier. When Q.i Process receives a command to begin moving material, the Q.i Equipment Phase Task uses the Material-Path Index field to find the appropriate Material-Path Table entry and the Equipment Table entry. The command includes the target amount of material and the required tolerances. The Q.i Equipment Phase Task retrieves the feed parameters from the Material-Path and Equipment Tables.

The Q.i Process initiates and controls the Material Transfer associated with the command. The Q.i Process operates once a second to update the Q.i cutoff values based on the current the scale or flow meter status information. The Q.i Process interacts with the Scale and Flow Meter tasks to get the current status and to set cutoff values.

The IND780 Batch stores the CQ block in dynamic HEAP memory.

Access	"Operator" default level is customizable by individual field.
Class Code	cq
ControlNet Class Code	84 hex
Instances	There are 16 instances of the Q.i Command block, one for each possible scale.

Q.i Process Command Shared Data

cq--00	Composite CQ block		Struct	na
cq--01	Equipment Channel Number	By	na	Equipment Channel Number for Command
cq--02	Message Sequence Number	By	na	Message Sequence Number of Command
cq--03	Material Path Index	US	na	Material Path Index
cq--04	Integer Command Number	By	rt	"Command" Number 0 = None 1 = Start Material Transfer 2 = Start Material Transfer with Gross Weight Target. Valid only for scale devices. 3 = Start Hand Add 4 = Acknowledge Material Transfer or Hand Add Complete

				5 = Abort Material Transfer 6 = Reset Slow Step Timer 7 = Start Control Override Mode 8 = Turn on FCE in Control Override Mode. The target weight contains the number of ticks to keep the FCE on. 9 = Turn off FCE in Control Override Mode 10 = Restart Auto Mode 11 = Complete Feed in Control Override Mode 12 = Master Reset – Instrument Channel 13 = Report Last Status 14 = Master Reset – Cluster 15 = Validate Aggregate Secondary Feeds 16 = Reset Estimated Time To Complete Error 17 = Toggle Fast Feed in Control Override Mode. If the positive tolerance = 0.0, then set fast feed =off. If the positive tolerance = 1.0, turn the fast feed = on. The target weight contains the number of seconds to keep the fast feed on. 18 = Abort Drain Timer 19 = Store Material Transfer Command (enhanced mode) 20 = Clear Material Transfer Commands (enhanced mode) 21 = Not Used 22 = Start Stored Material Transfer Commands (enhanced mode) 23 = Store Gross Weight Material Transfer Command (enhanced mode) 31 = Reset ControlNet Cluster.
cq--05	Overlapping Feed Group	By	na	Identifies which Primary and Secondary Feed requests belong to a group of feeds that make up an overlapping feed. A value = 0 indicates that this is not an overlapping feed.
cq--06	Number of Overlapping Feeds	US	na	Number of Secondary Overlapping Feeds that are simultaneously going into a Unit. This field is only meaningful in a Primary Overlapped Feed command for a scale instrument. The Material-Path must have a Gain-In-Weight feed. The PAC turns on the FCE when it determines there will be enough time after the overlap completes to run the PAC algorithm with the scale.
cq--07	Target Weight	F	na	Target Feed Weight
cq--08	Positive Tolerance	F	na	Positive Feed Tolerance
cq--09	Negative Tolerance	F	na	Negative Feed Tolerance
cq--10	Batch ID/ Display Message	ABy40	rt	Batch ID from Host Controller that is used for Data Collection Messages. If there is a "~" in the field, the data following the "~" is used as a Display Message for the Q.iMPACT display.

cq--11	Bit Commands	UL	rt	The bit commands have the same number values as the Integer Commands shown above, except they are single bits instead of integers.

Q.i Process Command Status Shared Data

es0105	Command Status	By	na	"Command Status" Qi sets this immediately after processing a command. 0. SUCCESS – Start Gain In Weight Material Transfer Command Complete 1. SUCCESS – Start Loss In Weight Material Transfer Command Complete 2. SUCCESS – Start Flow Meter Material Transfer Complete 3. SUCCESS – Start Manual Control Material Transfer Complete 4. SUCCESS – Hand Add Command Complete 5. SUCCESS – Command Complete 6. Command Not Complete – Request status again after a short delay 7. ERROR – Communications Error 8. ERROR – Invalid Channel Number 9 ERROR – Invalid Command 10. ERROR – Invalid Material-Path Table Index Number 11. ERROR – Invalid Algorithm in Material-Path Table Entry 12. ERROR – Invalid Feed Type in Material-Path Table Entry 13. ERROR – Invalid Unit Table Index Number in Material-Path Table Entry 14. ERROR – Invalid Gain In Weight Feed and Dump to Empty Algorithm Combination in Material-Path Table Entry 15. ERROR – Source / Destination Mismatch in Material-Path Table Entry 16. ERROR – Other Invalid Data in Material-Path Table Entry 17. ERROR – Invalid Loss In Weight Feed in Material-Path Table Entry and Overlapping Feed Command 18. ERROR – Invalid Data in Measuring Device Table Entry 19. ERROR – Invalid Mode for Command, e.g. Controller is requesting start a new material transfer before last feed is complete or before the controller has acknowledged that the material transfer is complete. 20. ERROR – Requested add amount too small 21. ERROR – Requested add amount would bring unit over capacity 22. ERROR – Unit Currently over Capacity 23. ERROR – Unit Currently under Zero 24. ERROR – Instrument Malfunction

				25. ERROR – Target Weight is Less Than Spill 26. ERROR – Response Timeout 27. ERROR – Too many overlapping feeds 28. WARNING – Delayed start to feed due to overlapping feed 29. WARNING – Abort ignored since time to complete was less than feed override time. 30. ERROR - Invalid overlap group number. 31. WARNING –Waiting For All Secondary Requests. 32. WARNING – Waiting For Measuring Device Stability. 33. ERROR – Not Enough Material. 34. ERROR – Device Not Calibrated Properly. 255 Command In Progress
The following fields typically are only applicable in the "Acknowledge Material Transfer Complete" Command Response. However, when a Start Material Transfer command fails immediately, these fields will contain values indicating a Material Transfer failure.				
es0107	Last Material Transfer Status	US	nz	Last Material Transfer Status Q.i sets this at completion of feed.
				0 Successful Material Transfer – K1, K2 parameters updated 1 Successful Material Transfer – Spill Only 2 Successful Material Transfer – Dump to Empty 3 Successful Hand Add 4 Material Transfer Complete – K1, K2 parameters NOT updated 5 Material Transfer Complete – Parameters Reset 6 Material Transfer Complete with Manual Operation 7 Failed – Unstable Measuring Device 8 Failed – Overlapping Feed Error Corrupted Flow 9 Failed – Erratic Flow Error 10 Failed – Low Flow Error 11 Failed – High Flow Rate Alarm Error 12 Failed – Communication Error 13 Failed – Instrument Error 14 Failed – Unit Capacity Error 15 Failed – Predictive Algorithm Error 16 Failed – Material Transfer with Manual Operation 17 Failed – Amount of material transferred did not match in source and destination 18 Failed – Controller Aborted Material Transfer 19 Failed – Controller Reset Channel 20 Failed – Controller Reset Unit 21 Failed – Controller Reset Cluster 22 Failed – Slow Step Timer Timeout 23 Failed – Secondary Requests Timeout 24 Failed – Power Failure During Feed 25 Failed – Command Failed, Transfer Not Started 26 Material Transfer In Progress

Q.i Process Data

The Qi Phase Logic runs the PAC Processes once a second. When it runs, the Phase Process sets its current status in the Process Table Shared Data, as necessary. In case of critical events, such as, the completion of a material movement operation or an error, the Qi updates the status immediately.

The IND780 Batch stores the HQ block in BRAM memory.

Access "Administrator" default level is customizable by individual field.

Class Code hq

ControlNet Class Code __hex

Instances 13 – an instance of the PAC Process Table Object exists for each of 13 Q.i processes.

Attributes

hq--00	Composite HQ block	Struct	na	Composite of entire block
hq--01	Current Material Path Index	US	na	Current Material Path Number
hq--02	Current Command Number	By	na	Current Command Being Processed
hq--03	Current Overlap Group	By	na	Current Overlap Group
hq--04	Current # Overlapping Feeds	By	na	Current # Overlapping Feeds
hq--05	Current Target Weight	D	na	Current Target Feed Weight
hq--06	Current Positive Tolerance	D	na	Current Positive Feed Tolerance
hq--07	Current Negative Tolerance	D	na	Current Negative Feed Tolerance
hq--08	Batch ID message	40S	na	Batch ID message that IND780 Batch writes to the Batch History file
hq--09	Feed Time	UL	na	Feed time in seconds
				Qi PAC sets the current value once a second during feed and sets total time at completion of feed.
hq--10	Weight Units	S3	na	Descriptor for weight units "lb", "kg", "g", or "t"
hq--11	Diagnostic Status	UL	na	PAC sets feed diagnostic status word during feed cycle. At completion of feed, the limits values reflect status of feed. Refer to Qi_RUNTIME records in the Material Transfer Table for bit meaning assignments.
hq--12	Feed Start Time	AL2	na	Windows CE time representation

hq--13	Unit Weight at Start	D	na	
hq--14	Unit Weight at Completion	D	na	
hq--15	Reserved	D	na	
hq--16	Reserved	UL	na	
hq--17	Reserved	US	na	

Bridge Interface to Q.i365 Application

The IND780 Q.i provides a bridge to interface to the PC Q.i365 Application that was developed for the JagX Q.i. The bridge supports these features of the Q.i365 application:

Feature	Description
Password protection	Security rights for users and user groups
Capturing material transfer data for each executed transfer	Store data, print data, export data
Chart view as an analysis tool for viewing stored data	Selecting/editing variables to view in chart. Exporting a chart ane printing a chart.
Tabular view as an analysis tool for viewing stored data	Selecting/editing variables to view in a table. Exporting a table and printing a table.
Material path configurations	Uploading from a Q.i terminal. Exporting configuration data and printing configuration data.
Error log	View material path alarms and warnings
Statistical Process Control (SPC) functions	Error Statistics Error Chart Feed Flow and Spill Chart Histogram
History log	Shows 100 most recent status messages

Q.i Procedure to Apply Database Updates

The Q.i System uses these Batch Database Tables for configuring setup values for the Q.i System:

- Equipment Module Table
- Control Module Table
- Material Path Table

These tables reside in the Master Terminal of the Q.i System cluster. The user can edit the tables using the Control Panel in the Master Terminal or can edit them with

the PC Q.i Configuration Tool. The user must edit the tables in the Master Terminal to have the updates automatically applied to all terminals in the cluster.

After updating the tables with new values, the following procedure reads the new values from the tables, distributes the tables to all terminals in the Q.i cluster, and applies the new values to the Q.i terminals.

1. After changing the values in any of these tables, the table editing tool writes a new version number in the header record of the changed table. The new version number enables the Q.i System to recognize that there are changes in the table.
2. If the changes are in the Control Module Table or in the Equipment Module Table with the exception of the DYNAMIC_WEIGHING record, the table editing tool writes the trigger xg0101=1 in the Master Terminal. This trigger resets any running Material Transfers and applies the new database tables. The Master Terminal alerts the remote terminals to also reset any running Material Transfers and apply the database changes.
3. If the setup changes were in the DYNAMIC_WEIGHING record of the Equipment Module table, then the table editing tool writes the trigger xg0106=1. This trigger will apply the changes in all terminals without resetting the Material Transfers that are running.
4. If the changes are to the Material Path table, the table editing tool does not set any triggers in the Q.i System. The Q.i System automatically reads the appropriate record from the Material Path table at the start of a Material Transfer.

A Q.i terminal automatically reads and applies any database changes at power-up.

Miscellaneous Enhancements for IND780 Batch

Time Synchronization

The IND780 clusters use the "industry-standard" Internet Group Management Protocol (IGMP) that is a core part of the TCP/IP protocol. IGMP enables the IND780 to setup a cluster of terminals and to detect when a cluster node has gone offline. Each IND780 listens for other IND780's in the cluster to multicast regularly their heartbeat messages.

Periodically, the Master Terminal in the cluster can also send a time synchronization data in the multicast message to synchronize the time in all terminals in the cluster.

IND780 Device Simulation Mode (sm)

The IND780 Batch provides a simulation mode for scales and flow meters where a PC program can simulate the scale and flow meter inputs to the IND780.

The PC uses the Shared Data Server on the IND780 to send the scale and flow meter simulation data to the IND780, and to retrieve the state of the FCE and other control elements from the IND780.

The IND780 Batch stores the SM block in dynamic HEAP memory.

Access	"Administrator" default level is customizable by individual field.
Class Code:	sm
ControlNet Class Code	9B hex
Instances	There are 16 instances of the SM block. The first 4 instances are for scale simulations. The last 12 instances are for flow meter simulations.

Attributes

sm--00	Composite sm block	Struct	na	Composite of entire block
sm--01	Input to IND780 Block	ABy100	rt	
sm--02	Output from IND780 Block	ABy100	rt	
sm--03	GIW FCE control element	By	rt	Scale Gain In Weight 1 = feed on; 0 = feed off
sm--04	GIW Fast Feed control element	By	rt	Scale Gain in Weight 1 = fast feed on; 0 = fast feed off
sm--05	LIW FCE control element	By	rt	Scale Loss In Weight 1 =feed on; 0 = feed off
sm--06	LIW Fast Feed control element	By	rt	Scale Loss In Weight 1 =Fast feed on; 0 = Fast feed off
sm--07	Target Weight	D	rt	Target Weight - optional parameter that the terminal can use to adjust the size of feeding curve.
sm--08	Dribble Weight	D	rt	Dribble Weight - optional parameter that the terminal can use to adjust the size of the feeding curve
sm--09	Reserved	D	rt	
sm--10	Reserved	D	rt	
sm--11	Cycle complete	By	rt	1 = Cycle complete
sm--12	Reserved	By	rt	

Method description

The PC simulation program uses the following data structures to communicate flow meter data with the IND780 in sm--01 and sm--02.

```
// Read
typedef struct {
        unsigned char limit[3];
        unsigned char preset[3];
        unsigned char accumulatedFlow[3];
```

```
        unsigned char rate[2];
        unsigned char Mfactor[2];
        unsigned char Kfactor[2];
        unsigned char Rfactor[2];
        unsigned char rateLimit[2];
        unsigned char configuration[2]; // bit 0 - Count Direction, 0 = Up, 1 = Down
                                        // bit 1 - Not used
                                        // bit 2 - Count Enable, 0 = Disabled, 1 = Enabled
                                        // bit 3 - Rate Mode, 0 = Instantaneous, 1 = 1Hz. averaging
                                        // bit 4 - Output Polarity, 0 = Normal on, 1 = Normal off
                                        // bit 5 - Output Enable, 0 = Disabled, 1 = Enabled
                                        // bit 6 - Output Force, 0 = Off, 1 = On
                                        // bit 7 - Stop On Limit, 0 = Disabled, 1 = Enabled
                                        // bit 8 - Counter Preset, 0 = Disabled, 1 = Enabled
                                        // bit 9 - Save Configuration, 0 = Disabled, 1 = Enabled
                                        // bit 10 - Load Configuration, 0 = Disabled, 1 = Enabled
                                        // bit 11 - Enable Digital Filter, 0 = Disabled, 1 = Enabled
                                        // bit 12 - Rate Register M Scaling, 0 = Disabled, 1 = Enabled
                                        // bit 13 - Reset Rollover Flag, 0 = No rollover, 1 = Counter rolled
                                        // over
                                        // bit 14 - Not used
                                        // bit 15 - Not used
            unsigned char status[2];    // bit 0 - Limit Flag, 0 = Limit not reached, 1 = Limit reached
                                        // bit 1 - Max Rate Flag, 0 = Max rate not exceeded, 1 = Max rate
                                        // exceeded
                                        // bit 2 - Zero Rate Flag, 0 = Rate not equal to zero, 1 = Rate equal to
                                        // zero
                                        // bit 3 - Counter Rollover Flag, 0 = Not rolled over, 1 = Count has
                                        // rolled over
                                        // bit 4 - Input State, 0 = Input low, 1 = Input high
                                        // bit 5 - Output State, 0 = Output off, 1 = Output on
                                        // bit 6 - EEPROM Error, 0 = EEPROM OK, 1 = EEPROM error
                                        // bit 7 - RAM Error, 0 = RAM OK, 1 = RAM error
                                        // bit 8 - ROM Error, 0 = ROM OK, 1 = ROM error
                                        // bit 9 - CPU Error, 0 = CPU OK, 1 = CPU error
                                        // bit 10 - Configuration Error, 0 = No error, 1 = Bad configuration
                                        // bit 11 - FPGA Fault, 0 = No fault, 1 = Fault
                                        // bit 12 - Counter Direction, 0 = Normal, 1 = Inverted
                                        // bit 13 - Not used
                                        // bit 14 - Not used
                                        // bit 15 - Not used
    } RP1_FlowMeter;
// Write
typedef struct {
    unsigned char limit[3];
    unsigned char preset[3];
    unsigned char accumulatedFlow[3];
    unsigned char rate[2];
    unsigned char Mfactor[2];
    unsigned char Kfactor[2];
    unsigned char Rfactor[2];
    unsigned char rateLimit[2];
    unsigned char configuration[2]; // see RP1_FlowMeter
} RP2_FlowMeter;
```

Extrapolate Cutoffs for IDNET Bases

The A-to-D weight update rate of the IDNET bases is slow compared to the Analog Bases – approximately 20 hertz versus 91.5 hertz. The IND780 currently cannot perform very accurate cutoffs with the IDNET bases because it only performs the cutoffs after the A-to-D update occurs.

Implement an extrapolation algorithm that predicts the time between A-to-D updates that the cutoff will occur based on the calculated rate. Then, turn-off the feed at the extrapolated time.

Concurrent, Recurring Feeds

Start multiple concurrent feeds with a single host command, after the feed parameters for the multiple feeds have been pre-setup. This feature is useful for drum-filling or bottle-filling applications where the host can set up feed parameters one time and then issue a single start command to start for multiple concurrent feeds, on a recurring basis.

The host can issue the start command to execute the same feeds on a recurring basis without having to reload the feed parameters. This works particularly well with the enhanced Q.i PLC interface where the PLC can set a single bit to start each feed in one output assembly from the PLC to the IND780.

Appendix D

Flow Meter Interface

Overview

The Flow Meter Option Board is a two-channel isolated counter/flow meter board available for use with the Q.iMPACT option in the IND780 terminal. The board provides a flow meter totalizer target comparison to directly control on-board discrete outputs.

The board can count the input pulses up to 50 kHz on each of two isolated input channels simultaneously, as well as measuring the frequency of the input signal. Four-jumper selectable switching threshold for each input channel are available as well as a jumper selectable 15 kHz analog filter. The required peak input levels for the AC mode are 50mV to 50Vrms. The required peak input level for the DC mode are 2.5 volts to 42 volts at 1 Amp. The state of the input counter levels is also available to the processor, so that any channel can be used as a discrete input.

The control outputs are 7407 open-collector drivers. Each control O/P is capable of sinking 40 mA. The Max off state O/P voltage is 30V. This enables the control O/P to drive interposing relays such as those by Opto-22.

Each flow meter board in an IND780 has its own unique address, assigned automatically by the IND780. Each flow meter board has two isolated input channels. Each IND780 can accommodate up to six flow meter boards, for a total of 12 isolated input channels per terminal.

Setup and calibration of the flow meter channels is done using the PC based Q.i Configuration Tool or the front panel of the IND780. Please refer to the **Users Guide**, chapter 3, **Configuration** for detailed instructions.

Features

- Two individually isolated input channels
- Jumper selectable 15 kHz analog RC filter for each input
- Four jumper selectable input switching thresholds (0.0V, 2.3V, 6.0V, 8.0V)
- Input frequency: AC 50 kHz Max or DC
- Maximum count value: 4,294,967,295
- Channel update time of 5 msec/channel maximum
- Frequency output mode
- Two open-collector output switches

- Current limited 5V output power
- Input to backplane isolation of 750VDC
- Input channel to channel isolation of 750VDC
- Easy calibration using actual throughput or calculated settings
- Power supply: The digital circuitry runs off the system's +5V supply; the isolated input circuitry is powered by the system's 12V supply.

Terminal Blocks

The field connection on the Flow Meter Option Board consists of a single Phoenix Contact 10 pin socket connection block. It receives a single Phoenix Contact 10-pin plug connection block. Figure D-1 shows the Flow Meter Option Board with the location of pin number 1 indicated (adjacent to the corner of the board).

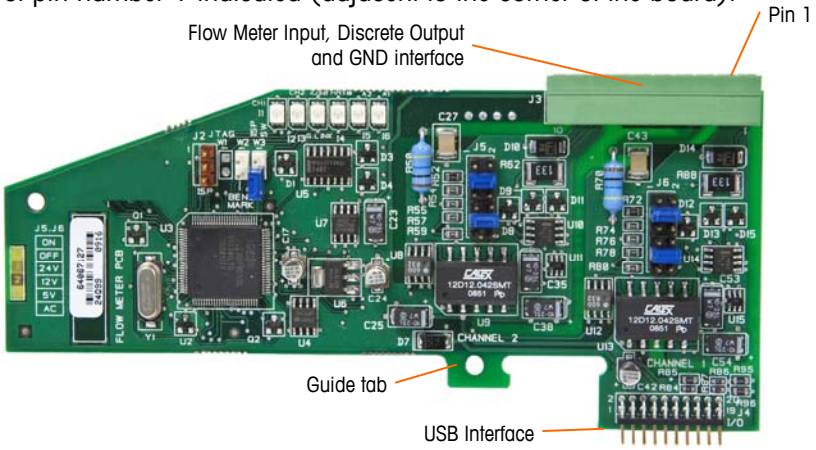


Figure D-1: Flow Meter

The Phoenix Contact 10-pin connector pin outs are as follows:

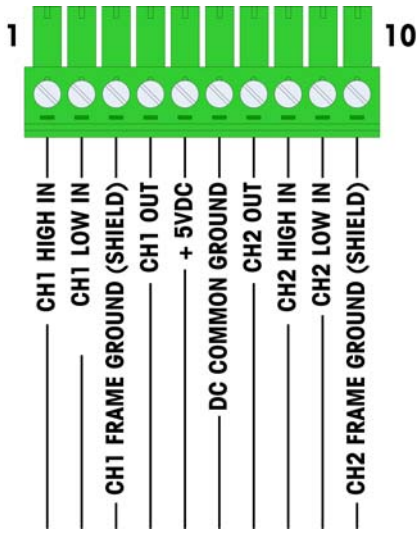


Figure D-2: Flow Meter Connector

Pins 3 and 10 (the frame grounds for Channels 1 and 2) provide floating grounds, and are the return lines for pins 1 and 8 (the high inputs for Channels 1 and 2).

This maintains the isolation of the input circuitry from the rest of the board electronics.

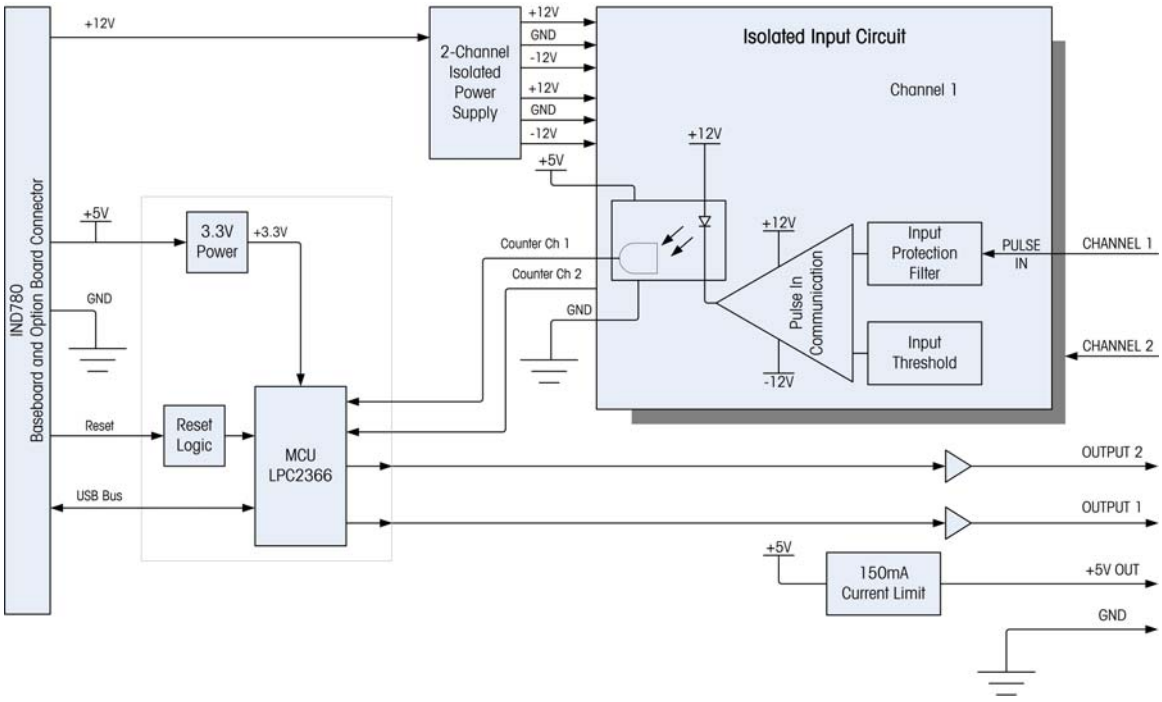


Figure D-3: Block Diagram, Channel 1 Shown

Board Components

The flow meter board consists of digital circuitry, two isolated analog input circuits, and two open-collector outputs with a 150mA, 5V power source.

Digital Circuitry

The digital circuitry consists of a micro-controller, EEPROM and glue logic. The micro-controller counts input pulses and measures flow rate for each isolated input circuit. It also does limit comparisons on the inputs and sets the outputs based on the results. The EEPROM is used to store configuration data that should not be lost at power-down. A USB version 1.0 communication links the Flow Meter Option Board to the IND780 main controller board.

Isolated Analog Input Circuits

Each isolated input circuit consists of a comparator, an optocoupler, one set of hardware jumpers and discrete resistors, capacitors, diodes, and a transient voltage suppressor. The comparator is used to compare the input voltage to the switching voltage. Each input section has a hardware jumper to select one of the four available input switching voltages. A second hardware jumper is provided to enable or disable a 15 kHz analog filter on each input. The optocoupler isolates the output of the comparator from the counter input of the microcontroller. The transient voltage suppressor provides ESD protection for each input. The diodes provide over-voltage protection of each input.

Open Collector Outputs

The output circuitry contains two non-isolated open collector 7407 drivers that can be used to drive the input to an Opto 22 output module. The board also provides a 150 mA, 5V power source that can be used to provide power to an Opto 22 output module.

Note: The IND780 Flow Meter Option Board may **only** be used with flow meter outputs that do not exceed Class 2 limits according to The National Electric Code.

The open collector outputs are TTL compatible and current-sinking, and can handle signals from 5 to 30 VDC at a maximum of 35 mA.

Hardware Jumper Settings

The flow meter board has four sets of hardware jumpers, indicated in Figure D-4.

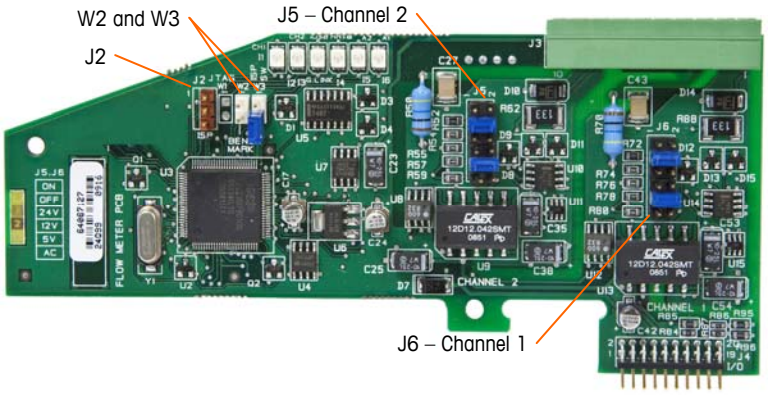
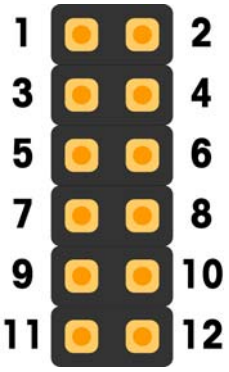


Figure D-4: Flow Meter Interface Board Jumper Locations

J5/J6 – Filter Enable

Each of the two input channels indicated in Figure D-4 has a set of six jumper settings, which function as shown in Table D-1. Jumper locations 1-2 (enable) and 3-4 (disable) control the 15kHz low-pass analog filter, which is used to filter noise on the input.

Table D-1: Settings for Jumpers J5 (Channel 2) and J6 (Channel 1)



Function	Jumper Location	
Analog Low-Pass Filter on	1	2
Analog Low-Pass Filter off	3	4
24V Range	5	6
12V Range	7	8
5V Range	9	10
AC Range	11	12

The analog filter should be enabled in the following cases:

- For flow meter frequencies below 15 kHz
- For all AC applications, regardless of frequency

J5/J6 – Input Switching Threshold

For each channel, this jumper has four possible positions (5/6, 7/8, 9/10, 11/12), which set the comparison voltage level for the input comparator. Voltage levels are:

- 0.0 VAC – use the AC jumper selection
- 2.3 VDC – use the 5 BDC jumper selection
- 6.0 VDC – use the 12 VDC jumper selection
- 8.0 VDC – use the 24 VDC jumper selection

Please consult the documentation for the specific flow meter you intend to use.

Microprocessor setup and programming

Jumpers J2 and W2 are for factory use only, during board manufacturing, setup and programming. The operating position is open and no jumper is supplied.

Jumper W3 is a single on/off jumper used only by the factory during board manufacturing, setup and programming. The operating position is open.

Wiring a Flow Meter

An attached flow meter can be either isolated with respect to the Q.i output voltage, or it can be non-isolated and share a common output voltage. The circuits in Figure D-5 and Figure D-6 illustrate these two methods of connecting a flow meter's pulse outputs to a Q.i flow meter interface board.

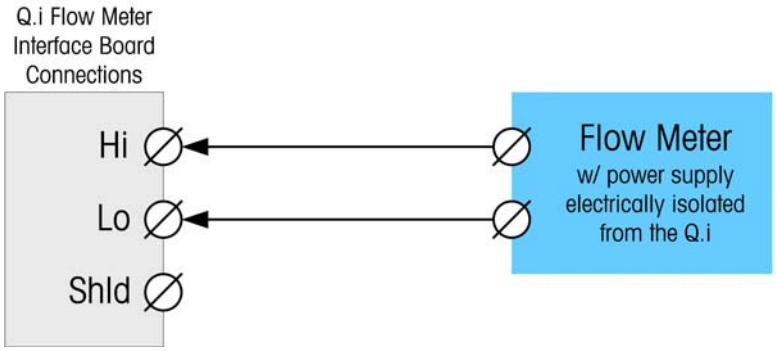


Figure D-5: Isolated Flow Meter Connections

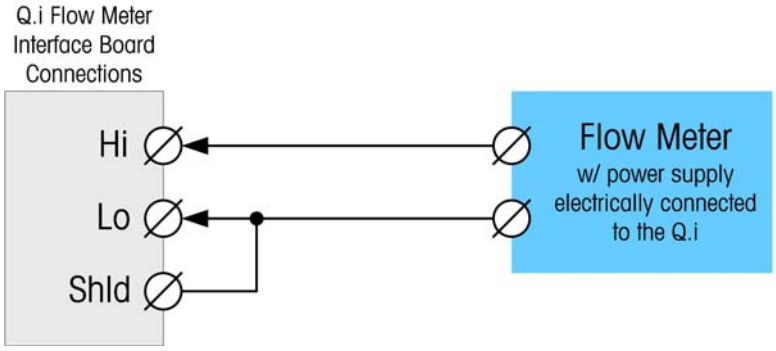


Figure D-6: Non-Isolated Flow Meter Connections

Electrical Specifications

Specification	Description			
Configuration	2 channels of differential flow meter inputs (uni-directional) or 1 channel of differential flow meter inputs (bi-directional); 2 open collector output switches			
Input Modes	AC or one of the 3 levels of DC inputs			
Voltage Range	AC (rms)	DC (5V)	DC (12V)	DC (24V)
VIL*	-50mV	+1.4V	+3.0V	+4.0V
VIH*	+50mV	+3.4V	+9.0V	+12.0V
Vmax	+/-50V	+/-50V	+/-50V	+/-50V
Maximum Input Voltage	42 VDC peak			
Maximum Input Current	1 A			
Minimum Input Impedance	11 KΩ			
Input Specifications				
Maximum Input Frequency	50 KHz			
Min. Input Frequency for Rate Measurement	1 Hz			

Duty Cycle	Input Level	Frequency Max.	Duty Cycle	Max Duty Cycle	Min Pulse Width
	5 VDC	50 kHz	35	55	7 µsec
	12 VDC	50 kHz	40	60	8 µsec
	24 VDC	50 kHz	40	60	8 µsec
	AC	50 kHz	40	50	8 µsec

Minimum Input Low Time	8 µsec (input filter off); 16 µsec (input filter on)
Minimum Input High Time	8 µsec (input filter off); 16 µsec (input filter on)
Channel Update Time	
Accumulated Flow Data	≤5 msec per channel maximum
Rate Data	
Instantaneous	Larger of (2/FREQ) or channel update time.
Average	2 seconds

Specification	Description
Accuracy	
1 Hz Averaging Mode	+/- 1 Hz
Instantaneous mode Analog Filter	+/- 1% @ 50KHz 15kHz software selectable for each channel
Maximum Count Value	4,294,967,295
Maximum Rate Value	65,535
Fault detection	Configuration error.
Isolation	
Input Channel to Backplane	750 VDC Continuous
Input Channel to Input Channel	750 VDC Continuous
Discrete Output	
Target latency time (turn off time)	200 μsec maximum
Preset to output on time	20 msec maximum
Power-up state	Off
Output Type	Open collector, TTL-compatible, current-sinking, negative true
Maximum Output Current Sink 35 mA Output Voltage 5-30 VDC	
Power Requirements	
Internal Supply +5V (no Output current)	230mA maximum
Internal Supply +5V (with 150mA Output current)	440mA maximum
Internal Supply +12V	150mA maximum
Aux Power Supply	
Output Power	5V @ 150 mA, current limited

Appendix E

Communications

Typical Q.iMPACT PLC Configuration

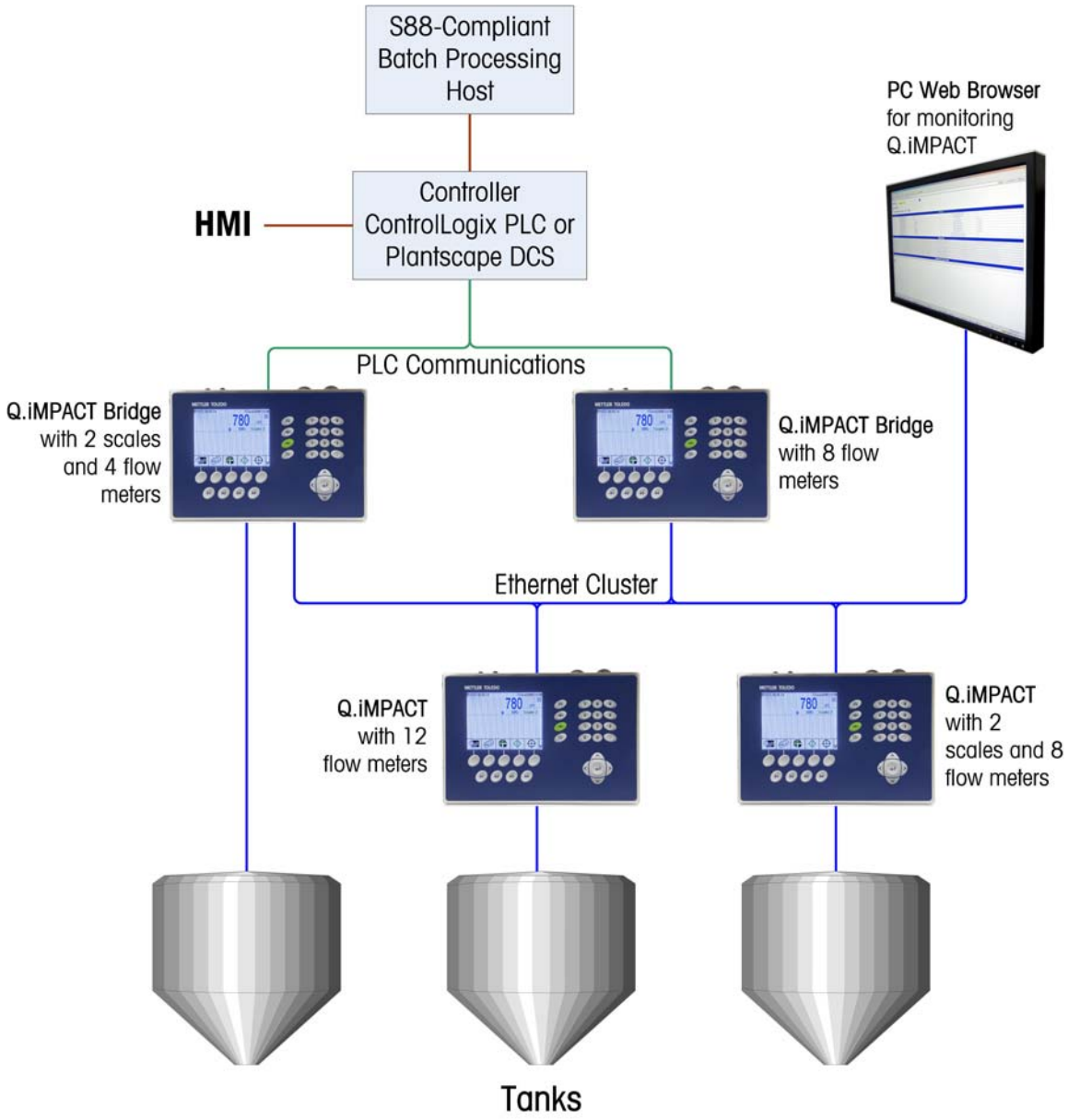


Figure E-1: Example of Q.iMPACT PLC Configuration

PLC/DCS Communications

The IND780 Q.iMPACT terminal is a material transfer control system. A Host PLC or DCS System does the Batch and Recipe Processing. Q.i 780 can initiate the material transfer to run in the IND780 terminal cluster.

- The user must statically configure the PLC cyclic message slots in the Bridge terminals to communicate with specific IND780 Equipment Phases.
- The PLC message slots buffer the dynamic data, commands, and statuses for the specific Equipment Phase Modules.
- Bridge terminals use these PLC cyclic message slots to exchange the phase data with the PLC.
- A Q.i 780 cluster can have up to 20 nodes (terminals) and 198 Equipment Channel Modules that run the Equipment Phase Logic.

Bridge Terminal for PLC/DCS Communications

A Bridge Terminal in the cluster has a PLC/DCS interface board that communicates to the Host PLC or DCS.

- An IND780 Q.i System must have one or more Bridge Terminals in a cluster.
- All the Bridge terminals in a Q.i Cluster support either the Enhanced Q.i Messaging or the Classic Q.i Messaging.
- In the Classic Q.i Messaging, a Bridge Terminal can provide the PLC interface for 24 Equipment Modules using both cyclic and explicit PLC Messaging.
- In the Enhanced Q.i Messaging, the Bridge Terminal supports 12 Equipment Modules using only cyclic messages.
- Host communications are either ControlNet or Ethernet/IP or Profibus

Classic Host Controller Communications

The goal of the IND780 Classic Q.i messaging is to provide the same host message interface as the JagXtreme Q.i cluster for the Classic Q.i command, response, and assembly messages.

Note: If the PLC/DCS uses messages other than these specific Classic Q.i PLC messages, the IND780 will not be compatible with the PLC/DCS.

Mixing a JagX Q.i cluster with a IND780 Q.i cluster

There are physical limitations and logical differences when adding an IND780 Classic Q.i terminal to an existing JagXtreme Q.i installation.

- You cannot mix IND780 terminals and JagXtreme terminals in the same cluster. Each type of terminal must reside in its own homogeneous cluster.
- However, you can have separate IND780 and JagXtreme clusters attached to the same Host PLC or DCS
- The hardware connections are different for the IND780 and the JagXtreme terminals.
- Setup menus and Configuration procedures are different between JagXtreme Q.i and IND780 Q.i terminals.
- Web Pages are different between JagXtreme Q.i and IND780 Q.i terminals.

Host Communications

The PLC/DCS Equipment Phase Marshaling Task runs in the Bridge Terminal to exchange the phase commands and responses from the PLC/DCS with the Equipment Phase Logic in the local or the remote terminals.

- In the Classic Q.i Messaging, the PLC uses Explicit Messages to send commands to the Equipment Channel Modules.
- In the Enhanced Q.i Messaging, the PLC/DCS uses Cyclic Output-from-PLC/DCS assembly messages to send the commands.
- PLC/DCS Phase Marshaling logic provides special interface logic to access and interpret the PLC/DCS commands.
- Equipment Phase Logic tasks must write their status every second to the Bridge Terminal.
- The Bridge Terminal sends the status data to the PLC/DCS using Cyclic Input-to-PLC/DCS message assemblies.

Web pages

Web Pages allow a user to monitor remotely the status of the Q.i Cluster using a standard PC Web Browser. They do not allow you to configure the IND780 Q.i.

Classic Q.i PLC/DCS Message Interface

A PLC/DCS Host Controller communicates with the Q.iMPACT through ControlNet, Ethernet IP, Profibus DP, or TCP/IP/Ethernet communications.

The IND780 Q.iMPACT can support either the Classic Q.i PLC/DCS Message Interface or an Enhanced Q.i PLC/DCS Message Interface. The user can select which interface the IND780 Q.iMPACT will use in System Setup.

Classic Q.i Explicit Commands and Responses

The Host Controller sends commands to the Q.iMPACT cluster through Q.iMPACT Bridge terminals using two Class 3 Explicit Shared Data Messages. The Controller sends the command with one message. Then it requests the Q.iMPACT to send the response to the command in the second message. The format of all command and response messages is the same for all flow meter and scale instrument channels. To send the message, the PLC/DCS Ladder program executes a MESSAGE instruction to "Set All Attributes" in "cq--00" Object.

A sample program named _10AIM_SWL_V_1_@_1_1.ncd for Allen-Bradley ControlLogix processors may be used as a reference for how to communicate to an IND780 Q.iMPACT in "Classic" PLC communications mode. It can be downloaded from the ftp support site. Note that the IND780 terminal must also be set to Classic communications mode.

The Controller may activate one, many, or all instrument channels to run concurrently. It monitors the activity of multiple channels simultaneously through cyclic messages. However, it can only send one command message at a time to one channel through one Q.iMPACT Bridge terminal. To communicate with multiple channels through a bridge, it must send the commands sequentially one a time. The Host Controller may direct command/response message pairs to any channel through any bridge terminal. However, the Host Controller should balance the use of the bridge terminals. It should send messages destined for a channel in one bridge terminal to that bridge terminal. This will provide for faster responses.

The Host Controller addresses each command to an instrument channel. The Q.iMPACT channel processes the command immediately. After sending a command to an instrument channel, the Host Controller must ask for the response to that command. For most commands, the Q.iMPACT channel has the response to the command available within 250 milliseconds. In the case that the response is not ready when the Host Controller requests it, the Q.iMPACT channel will reply with a "Command not Complete" status. This will most likely happen on commands to instruments located in remote Q.iMPACT terminals. The Host Controller must only ask for the response again after a short, e.g., 50 milliseconds, delay, and then it will receive the actual command status.

The first four fields of each command uniquely identify each command and its matching response. These fields are:

- Instrument Channel number
- Sequence number
- Material Path index
- Command

By comparing these fields in the command and response messages, the Host Controller can strictly match the request and response.

For each new command, the Host Controller must generate a new sequence number. The Q.iMPACT channel uses the sequence numbers to help isolate and correct communication errors. If a Q.iMPACT channel sees a command message where the first four fields are identical to the previous command, it assumes that this new message is the communications' retry message for a previous command. It simply ignores the command and restores the previous status.

When the Host Controller needs to send commands to multiple instrument channels at once, the Host Controller must send the commands and request the responses for each instrument channel in strictly ordered pairs. That is, it must send the command to instrument channel #1 and then ask for the response to instrument channel #1. Then, it can send the command to instrument channel #2 and then get the response for instrument channel #2.

If the Host Controller does not maintain this strict request/response pairing, it may get the response matched to the wrong command. In order to prevent this from happening, the Host Controller should always compare the first five bytes of the request and response messages. They should always be identical for a matching request and response. If they are not identical, there is a coding or communication error.

The "Master Reset - Cluster" command is an exception. The Q.iMPACT Message Router sends a "Master Reset – Channel" command to all instrument channels in the cluster. The Master Reset commands put the Q.iMPACT instrument channels back to their initialized state.

Classic Q.i PLC/DCS Explicit Command Message Format

Offset	Data Descriptor	Data Type
0	Channel Number (1 – 198)	Byte
1	Message Sequence Number. The controller must generate a new sequence number for each new command.	Byte
2	Material Path Index (1 - 999)	Integer
4	Command	Byte
The following fields are applicable only the "Start Material Transfer Cycle" Command		
5	"Group Number" for Start Material Transfer Command. This field identifies which Primary and Secondary feed requests belong to the group of feeds that make up an overlapping feed. A value = 0 indicates that this NOT an overlapped feed request.	Byte

Offset	Data Descriptor	Data Type
6	"Number of Overlapping Secondary Feeds" that are being fed into a Unit simultaneously with THIS Primary Feed. This field is only meaningful in a Primary Feed using scale instrument for the Vessel. The Material-Path must indicate this Gain-In-Weight feed. The PAC turns on the FCE for the Primary Feed when it determines there will be enough time after the overlap completes to run the PAC algorithm with the scale.	Byte
7	Reserved	Byte
8	Target Weight. For "Start Material Transfer" or "Start Hand Add" commands, this field *must* contain the target weight for the feed. For "Turn On FCE In Control Override Mode", this field *must* contain the number of seconds to keep the FCE on. The value "-9999" is a 32-year timeout. All other negative values are a 0-second timeout. For "Reset Slow Step Timer", this field *may* contain the number of seconds to set the slow step timer. If this field is 0, the Q.iMPACT resets the slow step timer to its original value for the feed.	IEEE Float 32
12	Tolerance + Value "-9999" disables tolerance check. In the Toggle Fast Feed in the Control Override Mode, a value of 0.0 turns off the Fast Feed. A value of 1.0 turns on the Fast Feed.	IEEE Float 32
16	Tolerance – Value "-9999" disables tolerance check.	IEEE Float 32
20	"Material Transfer ID" is an identifier field that is sent from the Material Transfer Controller. The Q.iMPACT reports this field as part of the data collection record. If there is a "~" in the field, the Q.iMPACT displays the data following the "~".	40 Character
	End of Message. Length = 60.	

Command Values

1 Start Material Transfer.

2 Start Material Transfer with Gross Weight Target. This command is only valid for a scale device.

3 Start Hand Add.

4 Acknowledge Material Transfer or Hand Add Complete

5 Abort Material Transfer

6 Reset Slow Step Timer

7 Start Control Override Mode

8 Turn on FCE in Control Override Mode

9 Turn off FCE in Control Override Mode

10 Restart Auto Mode

11 Complete Feed in Control Override Mode

12 Master Reset – Instrument channel

13 Report Last Status

14 Master Reset – Cluster

15 Validate Aggregate Secondary Feeds

16 Reset Estimated Time to Complete Error

17 Toggle Fast Feed in Control Override Mode

18 Abort Drain Timer

31 Reset all ControlNet Cards in Cluster

Classic Q.i PLC/DCS Explicit Response Message Format

Offset	Data Descriptor	Data Type
0	Channel Number from Command	Byte
1	Message Sequence Number from Command	Byte
2	Material Path Index from Command	Integer
4	Command Number from Command	Byte
5	Command Status. See Listing below.	Byte
The following fields typically are only applicable in the "Acknowledge Material Transfer Complete" Command Response. However, when a Start Material Transfer command fails immediately, these fields will contain values indicating a Material Transfer failure.		
6	Material Transfer Status See Listing below.	Byte
7	Reserved	Reserved
8	Material Transfer Status Qualifiers 0 Over Tolerance 1 Under Tolerance 2 Power Failure during feed 3-15 Reserved	16 Binary
10	Reserved	Integer
12	Delivered Weight	IEEE Float 32
16	Deviation Error from Target Weight	IEEE Float 32
	End of Message. Length = 20	

Command Status Values

0 SUCCESS – Start Gain-In-Weight Material Transfer Command Complete

1 SUCCESS – Start Loss-In-Weight Material Transfer Complete.

2 SUCCESS – Start Flow Meter Material Transfer Complete.

3 SUCCESS – Start Validate Aggregate Feed Complete.

4 SUCCESS – Start Hand Add Command Complete.

5 SUCCESS – Command Complete

6 Command Not Complete – Request status again after a short delay

7 ERROR – Communications Error

8 ERROR – Invalid Instrument Channel Number

9 ERROR – Invalid Command

10 ERROR – Invalid Material-Path Table Index Number

11 ERROR – Invalid Algorithm in Material-Path Table Entry

12 ERROR – Invalid Feed Type in Material-Path Table Entry

13 ERROR – Invalid Measuring Device Channel Table Index in Material Path Table Entry

14 ERROR – Invalid Gain In Weight Feed and Dump to Empty Algorithm Combination in Material Path Table

15 ERROR – Invalid Destination in Material Path Table Entry.

16 ERROR – Other invalid data in Material Path Table Entry

17 ERROR – Overlap Feed Request Error, including invalid Loss In Weight Feed in Material Path Entry and Overlapping Feed Command.

18 ERROR – Invalid data In Measuring Device Channel Table Entry

19 ERROR – Invalid Mode for Command, e.g., Controller is requesting to start a new material transfer before the last feed is complete or before the controller has acknowledged that the last material transfer is complete.

20 ERROR – Requested add amount too small

21 ERROR – Requested add amount would bring Scale Device over capacity

22 ERROR – Scale Device Currently over Capacity

23 ERROR – Scale Device Currently under Zero

24 ERROR – Instrument Malfunction

25 ERROR – Target Weight is less than Spill

26 ERROR – Response Timeout

27 ERROR – Too many overlapping feeds

28 WARNING – Delayed start to feed due to overlapping feed.

29 WARNING – Abort ignored since Time to Complete was less than Feed Override Time

30 ERROR – Invalid overlap group number

31 WARNING – Waiting for All Secondary Requests.

32 WARNING – Waiting for Measuring Device Stability.

33 ERROR – Not Enough Material.

34 ERROR – Device not configured or calibrated properly.

98 ERROR – Abort Unstable Scale.

99 ERROR – No Overlap Commands Being Processed.

Material Transfer Status Values

0 Successful Material Transfer – K1, K2 parameters updated

1 Successful Material Transfer – Spill Only

2 Successful Material Transfer- Dump to Empty

3 Successful Hand Add

4 Material Transfer Complete - Parameters NOT updated

5 Material Transfer Complete – Parameters reset.

6 Material Transfer Complete with Manual Operation

7 Failed – Unstable Scale

8 Failed – Overlapping Feed Error Corrupted Flow

9 Failed – Erratic Flow Error

10 Failed - Low Flow Error

11 Failed - High Flow Rate Alarm Error

12 Failed – Communication Error

13 Failed – Instrument Error

14 Failed – Scale Device Capacity Error

15 Failed – Predictive Algorithm Error

16 Failed – Material Transfer with Manual Operation

17 Failed – Amount of material transferred did not match in source and destination.

18 Failed – Controller Aborted Material Transfer

19 Failed – Controller Reset Channel

20 Failed – Reserved

21 Failed – Controller Reset Cluster

22 Failed – Slow Step Timer Timeout

23 Failed – Secondary Requests Timeout

24 Failed – Power Failure During Feed

25 Failed – Start Material Transfer Command Failed Immediately – Transfer Did Not Start

26 Status Only – Material Transfer Is In Progress.

27 Failed – Transfer Start Failed Due to Unstable Device

IND780 Q.i to PLC/DCS Classic Q.i Cyclic Input Assembly

The Q.iMPACT sends the real-time process data to the Host Controller through the Q.iMPACT->Controller Cyclic Input Assembly message. Each Q.iMPACT channel, representing either a weigh scale or flow meter, has a Q.iMPACT->Controller Input Assembly data block that is 20 bytes long. The format of the block is the same for all channels. The Q.iMPACT packs multiple instrument channels into one large Cyclic Input-to-Controller Assembly message. 24 instrument channels can fit

snuggly into one 496-byte Class 1 message, with 16 bytes reserved for future growth.

An "Instrument Channel" is the logical representation of a physical measurement device, either a scale or flow meter. There are up to 198 instrument channels in a Q.iMPACT cluster, numbered from 1 to 198. A Controller issues commands to a physical device using its instrument channel number. You assign the instrument channel numbers during system configuration.

Data from each instrument channel fits into an "Assembly Slot" within the Cyclic Input messages. Cyclic input data from each instrument channel, or the size of each assembly slot, is 20 bytes long. The format of the data block is the same for all instrument channels. There are 24 assembly slots in one 496-byte Cyclic Input-to-Controller Assembly message with 16 bytes reserved for future growth.

Within a cluster, "Q.iMPACT Bridge" terminals contain a PLC/DCS interface board that communicates to a Controller. Each bridge terminal has an Assembly message structure for up to 24 instrument channels. It also contains a message router that sends command messages to remote Q.iMPACT terminals.

There is a fixed assignment of "instrument channels" to "assembly slots" within each bridge terminal. That is, each instrument channel has a fixed assembly slot within the Cyclic Message Assembly of a bridge terminal. Q.iMPACT assigns instrument channels to assembly slots sequentially within the bridge terminal, during system configuration. The instrument channels may be local to the bridge terminal or they may be in remote Q.iMPACT terminals. For most efficient operation of the cluster, you should configure as many instrument channels as possible to the local Assembly structure. A Host Controller application must know the assembly slot for each instrument channel in order to get the real-time data for each device.

There must be a separate Q.iMPACT ControlNet Interface Card for every 24 instruments in the Q.iMPACT Cluster. For example, to support a cluster with 96 instruments, you would need four ControlNet Interface cards in the cluster in four separate Q.iMPACT terminals. A Q.iMPACT cluster can contain up to 198 instruments.

The Instrument Channel Configuration Block has the assignment of instrument channels to the Q.iMPACT Bridge terminal containing the PLC interface. The following table shows the arrangement of instrument data within the larger assembly message for multiple instrument channels.

Reserved	Data Bytes 1-2 2-Byte Checksum for Assembly	Data Bytes 3-4 2-Byte One's Complement of Checksum		Data Byte 16
Assembly Slot 1	Data Byte 17	Data Byte 18		Data Byte 36
Assembly Slot 2	Data Byte 37	Data Byte 38		Data Byte 56
Assembly Slot 3	Data Byte 57	Data Byte 58		Data Byte 76
Assembly Slot 4	Data Byte 77	Data Byte 78		Data Byte 96
Assembly Slot 5	Data Byte 97	Data Byte 98		Data Byte 116

Assembly Slot 6	Data Byte 117	Data Byte 118		Data Byte 136
Assembly Slot 7	Data Byte 137	Data Byte 138		Data Byte 156
Assembly Slot 8	Data Byte 157	Data Byte 158		Data Byte 176
Assembly Slot 9	Data Byte 177	Data Byte 178		Data Byte 196
Assembly Slot 10	Data Byte 197	Data Byte 198		Data Byte 216
Assembly Slot 11	Data Byte 217	Data Byte 218		Data Byte 236
Assembly Slot 12	Data Byte 237	Data Byte 238		Data Byte 256
Assembly Slot 13	Data Byte 257	Data Byte 258		Data Byte 276
Assembly Slot 14	Data Byte 277	Data Byte 278		Data Byte 296
Assembly Slot 15	Data Byte 297	Data Byte 298		Data Byte 316
Assembly Slot 16	Data Byte 317	Data Byte 318		Data Byte 336
Assembly Slot 17	Data Byte 337	Data Byte 338		Data Byte 356
Assembly Slot 18	Data Byte 357	Data Byte 358		Data Byte 376
Assembly Slot 19	Data Byte 377	Data Byte 378		Data Byte 396
Assembly Slot 20	Data Byte 397	Data Byte 398		Data Byte 416
Assembly Slot 21	Data Byte 417	Data Byte 418		Data Byte 436
Assembly Slot 22	Data Byte 437	Data Byte 438		Data Byte 456
Assembly Slot 23	Data Byte 457	Data Byte 458		Data Byte 476
Assembly Slot 24	Data Byte 477	Data Byte 478	.....	Data Byte 496

The Q.iMPACT normally updates data for the Cyclic Input-to-Controller Assembly once a second. In case of critical events, such as, the completion of a material movement operation or an error, the Q.iMPACT updates the status immediately. The Host Controller sets the rate at which it cyclically reads the Assembly.

Classic Q.i Input Assembly Equipment Channel Format

The Cyclic Input-to-Controller Assembly data for each equipment channel is 20 bytes long. The Q.i Process Table below shows the format of the assembly data for each channel.

Offset	Data Descriptor	Data Type	Internal Update Rate
0	Channel Number (1-198)	Byte	Set once a second
1	Status 1 0 "PAC Data Integrity Bit" alternates polarity every 5 seconds. 1 Instrument Data Integrity OK 2 Scale Over Capacity 3 Scale Under Zero 4 Scale Motion 5 Material Transfer Cycle Active 6 Final Control Element Output 0 = Off , 1 = On 7 Waiting for Controller to Acknowledge Last Material Transfer/Hand Add complete	8 Binary	Set once a second. Set Critical Events immediately.
2	Status 2 0 Feed Type 1 Feed Type. 0=Gain In Weight, 1= Loss In Weight, 2= Flow Meter, 3 = Hand Add 2 Manual-Not Auto-Mode 3 Gross Weight Feed 4 Feed Override Active – external logic inhibited from removing feed permissive 5 Feed Failed 6 Communication Error 7 Device Stability Warning 8 Very Unstable Device 9 Too High or Too Low Flow at cutoff 10 Three Times Average Flow at cutoff 11 Fast Feed Rate Alarm 12 Wait for All Overlap Requests 13 Waiting to Start Primary Overlapped Feed 14 Primary Overlapped Feed In Progress 15 Secondary Overlapped Feed In Progress	16 Binary	Set once a second during Material Transfers. Set Critical Events immediately.

Offset	Data Descriptor	Data Type	Internal Update Rate
4	Feed Weight. Q.i resets this field to zero at the beginning of a feed. During most feeds, this field contains the Net Accumulated Weight for the single feed. During Primary Overlapped feeds, this field contains the combined weight of all feeds. At completion of the feed, it contains the Delivered Weight for this feed.	IEEE Float 32	Set once a Second during Material Transfer Cycle.
8	Gross Weight. For scales, this field is the gross weight. For flow meters, this field is the same as Feed Weight.	IEEE Float 32	Set once a Second for Scales.
12	Rate of Change of Weight	IEEE Float 32	Set once a second during Material Transfers for Flow Meters, and once a second for Scales.
16	Time until Slow Step Timer Expires in Seconds. 0 = Alarm.	Integer	Set once a second during Material Transfers
18	Estimated Time to Complete in Seconds	Integer	Set once a second during Material Transfers
	End of Message. Length = 20.		

Enhanced Q.i PLC/DCS Message Interface

Enhancement 1

The IND780 Enhanced Q.i PLC Message Interface uses polled, cyclic messages to send Q.i command and response messages.

For Allen-Bradley ControlLogix processors, a sample program named "EnhancedAIM.acd" may be used as a reference for how to communicate to an IND780 Q.iMPACT in enhanced PLC communications mode. The program can be downloaded from the ftp support site. Note that the IND780 terminal must also be set to Enhanced mode communications.

Our field experience has shown that the one-shot, explicit, event messages for sending command and response information to the Q.i are unreliable in the long-term, because eventually the PLC/DCS communications will drop a message. As a result, there needs to be a large amount of code in the PLC/DCS to monitor the status of the messages and to implement retries when the command message does not get through. Using the cyclic messaging, when a message gets lost, the PLC/DCS automatically polls for another message a few milliseconds later. By relying on the repetitive nature of cyclic data, we can be confident that our

command and response messages will soon get through without special retry logic in the PLC/DCS.

The Enhanced Q.i PLC Message Interface expands the information in the Cyclic Input data blocks and uses one Cyclic Output data block.

- The 436-byte Cyclic Input block to the PLC contains both the Process Data and the Command Response data for multiple equipment channels. The Process Data is identical to the Classic Q.i PLC Cyclic Input Block and contains the Q.i process data. The Command Response data for the individual channels is similar to the Q.i Classic Command Response data but has compacted data.
- The Cyclic Input Data is 36 bytes long for each equipment channel so one PLC Interface can support up to 12 equipment channels.
- The 436-byte Cyclic Output from PLC data block is similar in structure to the Classic Q.i Command Data.

Enhancement 2

The IND780 Enhanced Q.i PLC/DC Message Interface can use bit-based commands. These bit-based commands can be easier for the PLC/DCS to process than integer-based commands because PLC/DCS ladder programs are often bit-based. It may be easier for a PLC ladder program to turn bits ON or OFF to initiate or to stop a process.

Enhancement 3

The IND780 Classic and Enhanced Q.i PLC/DCS Message Interface makes the "Acknowledge Material Transfer" command optional. When the Q.i receives a "Start Material Transfer" command for a channel that is waiting for "Acknowledge Material Transfer" command, the Q.i automatically begins processing the new "Start Material Transfer" command.

Enhancement 4

The IND780 Enhanced Q.i PLC/DCS Message provides an ability to store a command for each Equipment module and start all stored commands simultaneously with a single command.

IND780 to PLC/DCS Enhanced Q.i Cyclic Input Data

The IND780 Enhanced Q.i PLC/DCS Message Interface uses more cyclic input-to-PLC/DCS data per equipment channel than the Classic Q.i PLC/DCS Message Interface. The Enhanced Q.i PLC/DCS Message Interface contains both Q.i Process Data and the Q.i Command Response Data.

The IND780 Enhanced Q.i PLC/DCS Cyclic Input Data requires 36 bytes for each equipment channel, so one PLC/DCS Interface can support up to 12 equipment

channels. The following table shows the layout of the data for the 12 equipment channels within the Cyclic Input Assembly.

Reserved	Data Bytes 1-2 2-Byte Checksum for Assembly	Data Bytes 3-4 2-Byte One's Complement of Checksum	
Assembly Slot 1	Data Byte 5	Data Byte 6	Data Byte 40
Assembly Slot 2	Data Byte 41	Data Byte 42	Data Byte 76
Assembly Slot 3	Data Byte 77	Data Byte 78	Data Byte 112
Assembly Slot 4	Data Byte 113	Data Byte 114	Data Byte 148
Assembly Slot 5	Data Byte 149	Data Byte 150	Data Byte 184
Assembly Slot 6	Data Byte 185	Data Byte 186	Data Byte 220
Assembly Slot 7	Data Byte 221	Data Byte 222	Data Byte 256
Assembly Slot 8	Data Byte 257	Data Byte 258	Data Byte 259
Assembly Slot 9	Data Byte 293	Data Byte 294	Data Byte 328
Assembly Slot 10	Data Byte 329	Data Byte 330	Data Byte 364
Assembly Slot 11	Data Byte 365	Data Byte 366	Data Byte 400
Assembly Slot 12	Data Byte 401	Data Byte 402	Data Byte 436

The following table shows the layout of the Enhanced Q.i Cyclic Input Data for each equipment channel.

Offset	Data Description	Data Type	Update Rate
0	Equipment Channel Number (1-198)	Byte	Set permanently at power-up or after channel reconfiguration
1	Status 1 0 "PAC Data Integrity Bit" alternates polarity every 5 seconds. 1 Instrument Data Integrity OK 2 Scale Over Capacity 3 Scale Under Zero 4 Scale Motion 5 Material Transfer Cycle Active 6 Final Control Element Output 0 = Off , 1 = On 7 Waiting for Controller to Acknowledge Last Material Transfer/Hand Add complete	8 Binary	Set Once a Second. Critical Events are set immediately.

Offset	Data Description	Data Type	Update Rate
2	Status 2 0 Feed Type – Bits 0 & 1 1 Feed Type 0=Gain In Weight, 1= Loss In Weight, 2= Flow Meter, 3 = Hand Add 2 Manual-Not Auto-Mode 3 Gross Weight Feed 4 Feed Override Active – external logic inhibited from removing feed permissive 5 Feed Failed 6 Communication Error 7 Device Stability Warning 8 Very Unstable Device 9 Too High or Too Low Flow at cutoff 10 Three Times Average Flow at cutoff 11 Fast Feed Rate Alarm 12 Wait for All Overlap Requests 13 Waiting to Start Primary Overlapped Feed 14 Primary Overlapped Feed In Progress 15 Secondary Overlapped Feed In Progress	16 Binary	Set once a second during Material Transfers. Critical Events are set immediately.
4	Feed Weight. This field is reset to zero at the beginning of a feed. During most feeds, this field contains the Net Accumulated Weight for the single feed. During Primary Overlapped feeds, this field contains the combined weight of all feeds. At completion of the feed, it contains the Delivered Weight for this feed.	IEEE Float 32	Set once a second during Material Transfer Cycle. And set at Completion of Feed.
8	Gross Weight. For scales, this field is the gross weight. For flow meters, this field is the same as Feed Weight.	IEEE Float 32	Set once a second for Scales.
12	Rate of Change of Weight	IEEE Float 32	Set once a second during Material Transfers for Flow Meters, and once a second for Scales.
16	Time until Slow Step Timer Expires in Seconds. 0 = Alarm.	Integer 16	Set once a second during Material Transfers.
18	Estimated Time to Complete in Seconds	Integer 16	Set once a second during Material Transfers.

Offset	Data Description	Data Type	Update Rate
The Enhanced Q.i PLC Interface contains the following fields as part of the Input Assembly. They are Command Response Fields.			
20	Status 3 0 Fast Feed Active 1 Stability/Drain Time Active 2 Auto-Jog Active	Byte	Set once a second during Material Transfers
21	Sequence Number from Command. Each new command must contain the next rotating sequence number to identify it as a new command. After setting a new command for an equipment channel, the PLC must monitor this field to determine that Q.i has received the command.	Byte	Set upon receipt of command.
22	Material Path from Command	Integer 16	Set upon receipt of command
24	Command Number from Command After setting a new command for an equipment channel, the PLC must monitor this field to determine that Q.i has received the command.	Byte	Set upon receipt of command.
25	Command Status See Listing in Classic Q.i Interface.	Byte	Set at completion of Initial Command Processing.
26	Material Transfer Status See Listing in Classic Q.i Interface.	Byte	Set at Completion of Feed or when a Material Transfer Command fails in the Initial Command Processing.
27	Material Transfer Status Qualifiers 0 Over Tolerance 1 Under Tolerance 2 Power Failure during feed 3-7 Reserved	Byte	Set at Completion of Feed.
28	Deviation Error from Target Weight	IEEE Float 32	Set at Completion of Feed.
32	Reserved	32	Reserved
	End of Message. Length = 36.		

PLC/DCS to IND780 Enhanced Q.i Cyclic Output Data

The Enhanced Q.i PLC/DCS Interface uses the Cyclic Output data to send commands to the Q.i equipment channels. There can be up to 12 command blocks, one each for 12 different equipment channels. These "output from PLC/DCS" command blocks correspond to the "input to PLC/DCS" blocks containing the status and process data described in the previous section.

The PLC/DCS needs to setup all of the command data fields in a block when it is sending a command. After setting all the other fields, the PLC/DCS must transition the Integer Command from a Zero to a Non-Zero value to alert the Q.i that a new command is ready for processing.

After setting the command data and the command trigger, the PLC/DCS program needs to look at the Cyclic Input data for the equipment channel to verify that the destination equipment channel has received the command. Specifically, the PLC/DCS needs to verify that the Command and Sequence Number in the Cyclic Input Assembly Command Response for the destination equipment channel match the Command and Sequence Number in the Cyclic Output Command. The equipment channel sets these fields to indicate that it has received the command.

The PLC/DCS program must not set a new command until it has verified that the destination equipment channel in a block has received the current command.

The format of the Enhanced Q.i Cyclic Command data is nearly the same as the Classic Q.i Explicit Command data, with these two exceptions:

- There is an additional field for setting bit commands. Using the "Bit Command" field, a PLC/DCS can set a bit to initiate a command instead of setting an integer number in the "Integer Command". The bit number to activate the command is same as the integer command number. To activate a command using a bit, the PLC/DCS must transition the entire Bit Command field from a Zero to a Non-Zero value. The Q.i treats more than one bit is set as an illegal command. The general flow of the bit command processing is the same as the Integer Command processing described above.
- Due to the space limitations in the Cyclic Input Data, there is no Display Message field in each command block.

The following table shows the layout of the command blocks within the "output from PLC/DCS" assembly data.

Reserved	Byte 1	Byte 4		
Assembly Slot 1	Data Byte 5	Data Byte 6	.....	Data Byte 40
Assembly Slot 2	Data Byte 41	Data Byte 42		Data Byte 76
Assembly Slot 3	Data Byte 77	Data Byte 78		Data Byte 112
Assembly Slot 4	Data Byte 113	Data Byte 114		Data Byte 148
Assembly Slot 5	Data Byte 149	Data Byte 150		Data Byte 184
Assembly Slot 6	Data Byte 185	Data Byte 186		Data Byte 220

Assembly Slot 7	Data Byte 221	Data Byte 222		Data Byte 256
Assembly Slot 8	Data Byte 257	Data Byte 258		Data Byte 259
Assembly Slot 9	Data Byte 293	Data Byte 294		Data Byte 328
Assembly Slot 10	Data Byte 329	Data Byte 330		Data Byte 364
Assembly Slot 11	Data Byte 365	Data Byte 366		Data Byte 400
Assembly Slot 12	Data Byte 401	Data Byte 402		Data Byte 436

The following table shows the layout of the command data fields within each command block.

Offset	Data Descriptor	Data Type
0	Equipment Channel Number (1 – 198)	Byte
1	Message Sequence Number. The controller must generate a new sequence number for each new command. The legal sequence number values are 0-7.	Byte
2	Material Path Index (1 - 999)	Integer 16
4	Integer Command 1 Start Material Transfer. 2 Start Material Transfer with Gross Weight Target. This command is only valid for a scale device. 3 Start Hand Add. 4 Acknowledge Material Transfer or Hand Add Complete 5 Abort Material Transfer 6 Reset Slow Step Timer 7 Start Control Override Mode 8 Turn on FCE in Control Override Mode 9 Turn off FCE in Operator Override Mode 10 Restart Auto Mode 11 Complete Feed in Control Override Mode 12 Master Reset – Instrument channel 13 Report Last Status 14 Master Reset – Cluster 15 Validate Aggregate Secondary Feeds 16 Reset Estimated Time to Complete 17 Toggle Fast Feed in Override Mode 18 Abort Drain Timer 19 Store Feed Material Transfer Command for later execution 20 Clear Stored Material Transfer Commands 21 Not used 22 Start Stored Material Commands for cluster 31 Reset all PLC Cards in Cluster	Byte

Offset	Data Descriptor	Data Type
The following fields are applicable only the "Start Material Transfer Cycle" Command		
5	"Group Number" for Start Material Transfer Command. This field identifies which Primary and Secondary feed requests belong to the group of feeds that make up an overlapping feed. A value = 0 indicates that this NOT an overlapped feed request.	Byte
6	"Number of Overlapping Secondary Feeds" that are being fed into a Unit simultaneously with THIS Primary Feed. This field is only meaningful in a Primary Feed using scale instrument for the Vessel. The Material-Path must indicate this Gain-In-Weight feed. The PAC turns on the FCE for the Primary Feed when it determines there will be enough time after the overlap completes to run the PAC algorithm with the scale.	Byte
7	Reserved	Byte
8	Target Weight. For "Start Material Transfer" or "Start Hand Add" commands, this field *must* contain the target weight for the feed. For "Turn On FCE In Control Override Mode", this field *must* contain the number of seconds to keep the FCE on". The value "-9999" is a 32-year timeout. All other negative values are a 0-second timeout. For "Reset Slow Step Timer", this field *may* contain the number of seconds to set the slow step timer. If this field is 0, the Q.iMPACT resets the slow step timer to its original value for the feed.	IEEE Float 32
12	Tolerance + Value "-9999" disables tolerance check.	IEEE Float 32
16	Tolerance – Value "-9999" disables tolerance check.	IEEE Float 32
20	Bit Command Please refer to the Integer Command field above for the individual bit command numbers. For example, setting Bit 1 initiates a "Start Material Transfer".	32-bit Integer
24	Descriptive Text	12 Bytes
	End of Message. Length = 36.	

Q.i Shared Data

PLC Setup (pl)

pl0130	Q.i ControlNet Cyclic Assembly	By	na	Instance Number selection for Cyclic IO Assemblies ControlNet PLCs: 0 = Use HMS default instance numbers for **Q.i** ControlNet PLCs where 100 = Cyclic Assembly Input to PLC (T-O) and 150 = Cyclic Assembly Output from PLC (O-T). Classic T-O assembly length is 496 bytes and classic O-T assembly length is 4 bytes. 1 = Use IND780 Q.i Retro instance numbers for **Q.i** ControlNet PLCs where 10 is Cyclic Assembly Input to PLC (T-O) and 255 = Cyclic Assembly Output from PLC (O-T). Classic T-O assembly length is 496 bytes and classic O-T assembly length is 4 bytes. 2 = Use IND780 Q.i Retro instance numbers for **Q.i** Honeywell ControlNet PLC where 10 is Cyclic Assembly Input to PLC (T-O) and 2 = Cyclic Assembly Output from PLC (O-T). Classic T-O assembly length is 496 bytes and classic O-T assembly length is 22 bytes. 3 = Use IND780 Q.i Retro instance numbers for **Q.i** Honeywell ControlNet PLC where 10 is Cyclic Assembly Input to PLC (T-O), and Cyclic Assembly Output from PLC (O-T) comes from Shared Data field bx0176. Classic T-O assembly length is 496 bytes and classic O-T assembly length comes from Shared Data field bx0175.

System Process Data (xt)

xt0102	Number of Q.i K1/K2 Licenses	By	rt	Number of Q.i K1/K2 licenses in cluster. The Q.i Master gathers the individual licenses from the nodes in the cluster and writes the sum of the licenses here.

ControlNet Explicit Shared Data Messaging

The ControlNet Information Protocol (CIP) is the ControlNet logical message layer protocol. It operates over either the ControlNet or the Ethernet physical layer. The IND780 supports two types of CIP application-level messaging: Class 1 is Cyclic Assembly Messaging, and Class 3 is Explicit Shared Data Messaging. Previous sections describe the cyclic assembly messages.

ControlLogix ControlNet and Ethernet/IP PLC's use the MSG command to access IND780 Explicit Shared Data Messaging. The MSG command uses Class ID, Instance ID, and Attribute ID to identify uniquely each Shared Data field. The following section shows the Class ID codes that identify the Shared Data blocks. The Instance ID is the instance of the Shared Data block. The Attribute ID is the attribute number for each individual field in the within the block. The attribute

numbers appear in the definition of each Shared Data block, earlier in this document.

The IND780 supports the Get_Attribute_Single, Set_Attribute_Single, and Get_Attribute_All CIP Service Codes. The "attribute_single" commands access a single Shared Data field. The Get_Attribute_All reads an entire block of Shared Data, up to the message size limitations.

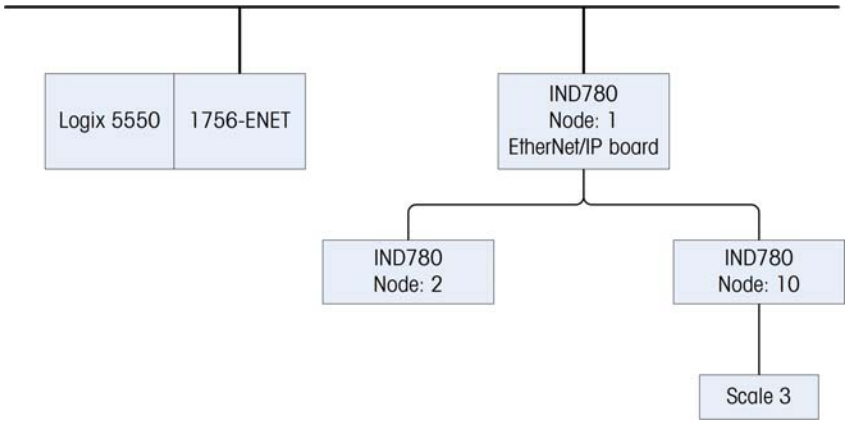
For example, the MSG command uses the following parameters to read the displayed net weight field for Scale 3, which is wt0302.

MSG Instruction CIP Message Parameters for Local Node	
Parameter	**Value**
Service Code	0x0E (Get_Attribute_Single)
Class ID	0x68 (Scale Weight Object)
Instance ID - low-byte	0x03 (Scale 3)
Instance ID - high-byte	0x00 (Local Node)
Attribute ID	0x02 (Displayed Net Weight)

To enable a PLC to access Shared Data in a remote node in a cluster, the IND780 splits the Instance ID into two separate fields. The Instance ID is a two-byte field. The high-byte is the remote node number and the low-byte is the Instance ID. When the high-byte is zero, the IND780 directs the request to its local node.

For example, the MSG command uses the following parameters to read the displayed net weight field for Scale 3 in node 10.

MSG Instruction CIP Message Parameters for Remote Nodes	
Parameter	**Value**
Service Code	0x0E (Get_Attribute_Single)
Class ID	0x68 (Scale Weight Object)
Instance ID - low-byte	0x03 (Scale 3)
Instance ID - high-byte	0x0A (Node 10)
Attribute ID	0x02 (Displayed Net Weight)



ControlNet Class Codes

A ControlNet PLC accesses IND780 Shared Data blocks using the following class codes:

Block	Class Code	Description
WT	0x68	Dynamic scale weight
AL	0x6C	Application dynamic character array fields
AJ	0x6D	Application dynamic floating point fields
AI	0x6E	Application dynamic integer fields
WX	0x75	Scale statuses
WC	0x76	Scale commands
DI	0x78	Discrete IO status
SC	0x92	Target commands
ST	0x93	Target statuses
XD	0x65	System state
AK	0x6B	Application dynamic string fields
WS	0x66	Scale process data
CS	0x67	Scale setup data
CT	0xB7	Scale tare setup
SP	0x69	Target process data
XS	0x6A	System setup
NS	0x6F	Network node status
AC	0x70	Application dynamic commands
PW	0x71	Power cell network dynamic data
CE	0x72	Scale calibration data
CX	0x73	Cell shift adjust data
CC	0x74	Cell calibration data
RE	0x77	Remote discrete input edges
AS	0x79	Application dynamic statuses
PI	0x7A	Input from PLC assembly template
PO	0x7B	Output from PLC assembly template
XT	0x7C	System process data
AP	0x7D	Application integer process data
AF	0x7E	Application floating point process data
AR	0x78	Application string process data
NC	0x80	Cluster node IP addresses

Block	Class Code	Description
NC	0x81	IND780 batch node enable
M1	0x82	IND780 batch equipment channel configuration
BX	0x83	IND780 batch global settings
CQ	0x84	IND780 Q.i command
MZ	0x85	IND780 Q.i command status
PD	0x86	Ind780 Q.i to plc assembly data
EP	0x87	IND780 Q.i equipment phase commands
ES	0x88	IND780 Q.i equipment phase status
ED	0x89	IND780 Q.i process table
U0	0x8A	IND780 Q.i equipment module
__	0x8B	Reserved for IND780 Q.i
Q0	0x8C	IND780 Q.i material path table
__	0x8D	Reserved for IND780 Q.i
FW	0x8E	Dynamic flow meter weight
FS	0x8F	Flow meter setup
__	0x90	Reserved for IND780 Q.i
HS	0x91	Q.i classic history data
CP	0x94	Custom print commands and status
RI	0x95	Remote discrete IO status
XC	0x96	System feature controls
AT	0x97	Application start/stop triggers
IW	0x98	IW block for IND560 dynamic
M2	0x99	IND780 Batch equipment channel configuration
QC	0x9a	QC block - miscellaneous system commands
SM	0x9B	SM block - scale simulation
AW	0x9C	Application message block
PY	0x9D	POWERCELL PDX dynamic counts data
0	0x9E	Reserved
0	0x9F	Reserved
0	0xA0	Reserved
0	0xA1	Reserved
0	0xA2	Reserved
0	0xA3	Reserved
0	0xA4	Reserved
0	0xA5	Reserved

Block	Class Code	Description
0	0xA6	Reserved
0	0xA7	Reserved
0	0xA8	Reserved
0	0xA9	Reserved
0	0xAB	Reserved
0	0xAC	Reserved
0	0xAD	Reserved
0	0xAE	Reserved
0	0xAF	Reserved
0	0xB2	Reserved
0	0xB3	Reserved
0	0xB4	Reserved
0	0xB5	Reserved
0	0xB6	Reserved

PROFIBUS Interface Board

Introduction

The following information is for persons responsible for setting up and commissioning a Q.iMPACT-based system. Skills required are IND780 Q.iMPACT setup knowledge, PLC programming, and PROFIBUS experience. For further in depth information on Profibus, contact Siemens.

Topics covered:

- IND780 Q.iMPACT PROFIBUS interface board
- Setting up and adding a Q.iMPACT terminal to a PROFIBUS network
- Siemens S7 program examples
- Q.iMPACT terminal supported commands
- Technical information
- Q.i GSD file details

After installing the PROFIBUS card and setting the node address (refer to Chapter 3, Configuration, of the **IND780 Technical Manual**), set the IND780 terminal to Classic communications mode.

Overview

The Controller communicates to the Q.iMPACT through a "Bridge" using PROFIBUS communications. A Bridge terminal is an IND780 Q.iMPACT that contains a PROFIBUS interface card. The Bridge, may support run-time messaging for up to 10 instrument channels located in either the local or remote terminals. IND780 Q.iMPACTs communicate with each other through a separate TCP/IP/Ethernet link.

The PROFIBUS interface card enables the Bridge to communicate to a PROFIBUS L2-DP master according to DIN 19 245. It consists of a PCB and software that resides in the terminal to implement the data exchange.

240 bytes of data are transmitted from the terminal to the Host Controller. This block of data contains the status of up to 10 instruments (Scales or Flowmeters) and other system information. This data block is cyclic in nature and is continuously retrieved by the Host Controller. We shall refer to this is the **INPUT DATA**.

72 bytes of data are transmitted from the Host Controller to the IND780 Q.iMPACT terminal. This data block is used to "Control" the Q.i. Ie to send Start Feed or Abort Feed commands as well as to read and write to variables (most often referred to as shared data variables) within the terminal. We shall refer to this is the **OUTPUT DATA**.

The maximum number of instrument channels is limited to 168 based on the optimum configuration of PROFIBUS interface cards and flow meter interface cards only. This optimum configuration is comprised of 18 Bridge terminals with two flow meter cards each (8 instrument channels total) and 2 standard terminals with three flow meter cards each (12 instrument channels total). For a scale only system, the maximum number of instrument channels is limited to 80. This configuration is comprised of 8 Bridge terminals with two dual scale cards each (4 instrument channels total) and 12 standard terminals with two dual scale cards each (4 instrument channels total).

The address of the Q.iMPACT is software-configurable within the terminal.

Baud rates from 9.6k to 12MB are supported. The PROFIBUS board will autodetect the configured baud rate.

Material Transfer status is normally updated twice a second per instrument channel. This status is then made available to the Controller from the Bridge terminal. Instrument channels that are remote to their assigned Bridge terminal also send their Material Transfer statuses to this Bridge terminal at a rate of twice a second per instrument channel. This means that even though the actual data from the terminal may be reaching the Controller every 20 mS the actual data will only be changing every 500mS. As a result you should not use this data for high speed control external to the Q.iMPACT. The Q.iMPACT should always be in direct control of a Feed

The Q.i.GSD file is supplied with the Q.i on the CD and must be installed prior to commissioning the Q.i PROFIBUS network.

The PROFIBUS interface card installed in an IND780 terminal supports three types of data exchange: Shared data reads / writes, PAC command / response pairs, and Cyclic Messaging for Multiple PAC Instrument Channels.

For further technical information on the PROFIBUS interface please refer to:

Command Sequence Overview

There is no dedicated "Start bit" to trigger the Q.i. Ie there is no bit that when turned ON will cause the Q.i to evaluate the Data in its Input Buffer and act on it, such as Start a Feed. The Q.i relies on detecting that there has been a data "change". Whenever the Input Buffer has changed ie there is new data the Q.i sees this as an implied "trigger" or "Start bit". In order to separate the Commands **a NULL command MUST BE SENT**.

In other words, once you have loaded the Command Data into the Output Buffer, it is normally left there for about 100 to 200 mS. This will allow enough time for the data to reach and be evaluated by the Q.i. **You must then place NULLS (zeroes) into the Output Buffer BEFORE sending the next Command**

Upon Startup of the PLC or Controller by default NULLS should be placed into the Output Buffer

Data Input to Controller

This Input data block is 240 bytes in length and is structured as follows:

Bytes 0 > 1	Checksum [1]	Integer	
Bytes 2 > 3	Inverted Checksum [2]	Integer	
Bytes 4… 15	Reserved		
Bytes 16… 35	Instrument 1 [3]	10 words	(Assembly slot 1)
Bytes 36… 55	Instrument 2	10 words	(Assembly slot 2)
Bytes 56… 75	Instrument 3	10 words	(Assembly slot 3)
Bytes 76… 95	Instrument 4	10 words	(Assembly slot 4)
Bytes 96… 115	Instrument 5	10 words	(Assembly slot 5)
Bytes 116… 135	Instrument 6	10 words	(Assembly slot 6)
Bytes 136… 155	Instrument 7	10 words	(Assembly slot 7)
Bytes 156… 175	Instrument 8	10 words	(Assembly slot 8)
Bytes 176… 195	Instrument 9	10 words	(Assembly slot 9)
Bytes 196… 215	Instrument 10	10 words	(Assembly slot 10)
Bytes 216 > 217	Shared Data Status [4]	1 word	
Bytes 218 … 239	Shared Data Read Value [5]	11 words	

1. This is the integer (word) sum of words starting with the word composed of Data Byte 16 and ending with the word composed of Data Byte 215. The carry is discarded during the summing process.
2. This is the bit inverse of the Checksum
3. This is all the input data for one Instrument. NOTE: the assembly slot is the "key" to which Channels data is contained in these words. The Assembly slot number can be seen on the Channel setup page of the Q.i. Refer to **Input Assembly**, below for breakdown of this data
4. The status of data writes to the Q.i is provided here

   00 – Null Status

   01 – Command Completed Successfully

   02 – Invalid Shared Data Name (Shared Data Writes only)

   03 – Invalid Shared Data Command

   04 – Cannot Write Because This Is A Legal-For-Trade Field (Shared Data Writes only)

   05 – Cannot Access Remote terminal
5. The Shared Data read command returns the data here. Refer to **Read Response**, below for details.

Input Assembly for one Instrument

The following block of data exists for each of the 10 Assembly Slots (Instruments) in the Data Block Input to the Controller. The following table describes the content of just one of the 10 word data blocks.

Offset	"Data Descriptor Label"	Short Name	Type	Comment
0	Channel Number	Channel	Byte	
1	Status 1		8 bit Binary	
	0 "PAC Data Integrity Bit"	DataIntegrity		Alternates polarity every 5 seconds.
	1 "Instrument Data Integrity OK "	DataOK		
	2 "Scale Over Capacity"	OverCapacity		
	3 "Scale Under Zero"	UnderZero		
	4 "Scale Motion"	ScaleMotion		
	5 "Material Transfer Cycle Active"	CycleActive		0 = Off , 1 = On
	6 "Final Control Element Output"	FCE_Output		
	7 "Waiting for Controller to Acknowledge Last Material Transfer/Hand Add complete"	AwaitingACK		Q.i will not accept a new Start Feed command until the Ack (4) command has been sent

Offset	"Data Descriptor Label"	Short Name	Type	Comment
2	Status 2 0 "Feed Type", 0=Gain In Weight 1 "Feed Type", 1= Loss In Weight, 2= Flow Meter, 3 = Hand Add 2 "Manual-Not Auto-Mode" 3 "Gross Weight Feed" 4 "Feed Override Active" 5 "Feed Failed" 6 "Communication Error" 7 "Device Stability Warning" 8 "Very Unstable Device" 9 "Too High or Too Low Flow" at cutoff 10 "Three Times Average Flow" at cutoff 11 "Fast Feed Rate Alarm" 12 "Wait for All Overlap Requests" 13 "Waiting to Start Primary" Overlapped Feed 14 "Primary Overlapped Feed" In Progress 15 "Secondary Overlapped Feed" In Progress	FeedType ManualMode GrossWeight FeedOverride FeedFailed CommError WgtUnstable VeryUnstable ErraticFlow 3TimesFlow RateAlarm WaitOvlpReq DelayPrimary PrimOverlap SecOverlap	16 bit Binary	The two bits represent a number between 0 and 3 Q.i will Ignore Commands to Stop a Feed
4	"Feed Weight". This field is reset to zero at the beginning of a feed. During most feeds, this field contains the Net Accumulated Weight for the single feed. During Primary Overlapped feeds, this field contains the combined weight of all feeds. At completion of the feed, it contains the Delivered Weight for this feed.	FeedWeight	Float 32 (4 bytes)	This value will remain until the next Start Feed command
8	"Gross Weight". For scales, this field the gross weight. For flow meters, this field is the same as Feed Weight.	GrossWeight	Float 32 (4 bytes)	This value is always active and can be used by the HMI for weight display purposes
12	"Rate of Change of Weight"	Flow Rate	Float 32 (4 bytes)	This value is always active and can be used by the HMI for Flow Rate display purposes
16	"Time until Slow Step Timer Expires" in Seconds. 0 = Alarm.	SlowStepTimr	Integer (Word)	
18	"Estimated Time to Complete" in Seconds	TimeToFinish	Integer	

Offset	"Data Descriptor Label"	Short Name	Type	Comment
	Message Length = 20 bytes			

Read Response (Item 5)

This area has a dual function:

Function A It contains the response to a Command sent to the Q.i. The Q.i responds to each Command received with a response "number" (SEE Command Response list below). The Controller should always evaluate this response number in order to determine whether the command sent was successful. In some case the Q.i will reject a command as being invalid. I.e. the Feed Target may be to large for the scale and overflow the scale. In this case the Q.i would respond with a code of "21"

Some of the Command Data is "echoed" back in the response data. This makes it possible to match the correct Command and response data by ensuring that the Channel, Sequence number and Material Path match those of the Command.

The structure and content of this response is detailed in the table below. The structure and content of Command responses are listed below that.

Function B Whenever the Controller sends a Shared data Read command to the Q.i the value of the Shared Data is placed in this area. The data is left justified and in ASCII format

Offset	"Data Descriptor Label"	Short Name	Type
0	"Channel Number" as in PAC command	Channel	Byte
1	"Message Sequence Number" as in PAC command	SequenceNum	Byte
2	"Material-Path Index" as in PAC command	MaterialPath	Integer
4	"Command" Number as in PAC command	Command	Byte
5	"Command Status" See Listing below.	ComandStatus	Byte
The following fields typically are only applicable in the "Acknowledge Material Transfer Complete" Command Response. However, when a Start Material Transfer command fails immediately, these fields will contain values indicating a Material Transfer failure.			
6	"Material Transfer Status" See Listing below.	MxferStatus	Byte
7	"Reserved"	Reserved	Reserved
8	"Material Transfer Status Qualifiers" 3 "Over Tolerance" 4 "Under Tolerance" 5 "Power Failure" during feed 3-15 Reserved	MxferStatQ	16 Binary
10	"Reserved"	Reserved	Integer

Offset	"Data Descriptor Label"	Short Name	Type
12	"Delivered Weight"	FeedWeight	Float 32
16	"Deviation Error from Target Weight"	TargetError	Float 32
	Message Length = 20		

Command Status Values

0 SUCCESS – Start Gain-In-Weight Material Transfer Command Complete
1 SUCCESS – Start Loss-In-Weight Material Transfer Complete.
2 SUCCESS – Start Flow Meter Material Transfer Complete.
3 SUCCESS – Start Validate Aggregate Feed Complete.
4 SUCCESS – Start Hand Add Command Complete.
5 SUCCESS – Command Complete
6 Command Not Complete – Request status again after a short delay
7 ERROR – Communications Error
8 ERROR – Invalid Instrument Channel Number
9 ERROR – Invalid Command
10 ERROR – Invalid Material-Path Table Index Number
11 ERROR – Invalid Algorithm in Material-Path Table Entry
12 ERROR – Invalid Feed Type in Material-Path Table Entry
13 ERROR – Invalid Measuring Device Channel Table Index in Material-Path Table Entry
14 ERROR – Invalid Gain In Weight Feed and Dump to Empty Algorithm Combination in Material-Path Table
15 ERROR – Invalid Destination in Material-Path Table Entry.
16 ERROR – Other invalid data in Material-Path Table Entry
17 ERROR – Overlap Feed Request Error, including invalid Loss In Weight Feed in Material-Path Entry and Overlapping Feed Command.
18 ERROR – Invalid data In Measuring Device Channel Table Entry
19 ERROR – Invalid Mode for Command, e.g., Controller is requesting to start a new material transfer before the last feed is complete or before the controller has acknowledged that the last material transfer is complete.
20 ERROR – Requested add amount too small
21 ERROR – Requested add amount would bring Scale Device over capacity
22 ERROR – Scale Device Currently over Capacity
23 ERROR – Scale Device Currently under Zero
24 ERROR – Instrument Malfunction
25 ERROR – Target Weight is less than Spill
26 ERROR – Response Timeout
27 ERROR – Too many overlapping feeds
28 WARNING – Delayed start to feed due to overlapping feed.
29 WARNING – Abort ignored since Time to Complete was less than Feed Override Time
30 ERROR – Invalid overlap group number
31 WARNING – Waiting for All Secondary Requests.
32 WARNING – Waiting for Measuring Device Stability.
33 ERROR – Not Enough Material.
34 ERROR – Device not configured or calibrated properly.
35 SUCCESS – Secondary Feed Start command queued.

36 ERROR – License Violation.
95 ERROR – Scale Capacity Problem.
96 ERROR – Scale Instrument Problem.
97 ERROR – Scale Loss-In-Wt Busy.
98 ERROR – Abort Unstable Scale.
99 ERROR – Not Overlap Commands being processed.

Material Transfer Status Values:

0 Successful Material Transfer – K1, K2 parameters updated
1 Successful Material Transfer – Spill Only
2 Successful Material Transfer- Dump to Empty
3 Successful Hand Add
4 Material Transfer Complete - Parameters NOT updated
5 Material Transfer Complete – Parameters reset.
6 Material Transfer Complete with Manual Operation
7 Failed – Unstable Scale
8 Failed – Overlapping Feed Error Corrupted Flow
9 Failed – Erratic Flow Error
10 Failed - Low Flow Error
11 Failed - High Flow Rate Alarm Error
12 Failed – Communication Error
13 Failed – Instrument Error
14 Failed – Scale Device Capacity Error
15 Failed – Predictive Algorithm Error
16 Failed – Material Transfer with Manual Operation
17 Failed – Amount of material transferred did not match in source and destination.
18 Failed – Controller Aborted Material Transfer
19 Failed – Controller Reset Channel
20 Failed – Reserved
21 Failed – Controller Reset Cluster
22 Failed – Slow Step Timer Timeout
23 Failed – Secondary Requests Timeout
24 Failed – Power Failure During Feed
25 Failed – Start Material Transfer Command Failed Immediately – Transfer Did Not Start
26 Status Only – Material Transfer Is In Progress.

Data output to Controller

The Data Output Block is 72 bytes in length. By changing the content of a few of the values we are able to perform functions such send a Command to the IND780 Q.iMPACT or write data to a shared data variable or read data from a shared data variable.

There is only one of these data blocks per bridge Q.i (A bridge Q.i is a Q.i with a communication board installed and functioning. I.e. it is communicating directly with a PLC or DCS).

Data Output Structure

Function	Address	Type	Comment
Reserved	Byte 0	Byte	
Commmand Type	Byte 1	Byte	0 – Null Command 1 – Read Shared Data 2 – Write Shared Data 10 – PAC Command [0x0A] [1] 20 – PAC Command Status [0x14][2]
Reserved	Byte 2	Byte	
Terminal Node	Byte 3	ASCII	Ranges from '1' to 'k'. This corresponds with numbers 1 to 20. This is the terminal ID or number, and is an ASCII character. Ie a '5' would be a 0x35 or 53 decimal.
Variable name (Shared data variable)	Bytes 4…9	6 ASCII chars	When using command type 1 or 2 the Shared Data variable must be specified here. The variable name is preceded with an '/'. Ie '/ws102' In decimal the bytes would contain the following values: 92,119,115,49,48,50.
reserved	Byte 10 & 11	2 bytes	
Write Value [3]	Byte 12 … 71	60 bytes	This is either the data that you want written to a Shared Data Variable OR it is the PAC Command data, see below for the 60 byte structure of this Command Data
	Total length	72 bytes	

1. No remote node or variable name is required. The shared data write value contains the **Controller -> Q.iMPACT Command Assembly for Single Instrument Channel.**
2. No remote node, variable name, or shared data write value is required (any data in these fields will be ignored).
3. If writing to a variable (Command type 2), then the data written will be here. If sending a PAC Command such as Start Feed or Abort Feed then these 60 bytes contain the details of this command, such as Target, Channel and Material Path. Refer to **PAC Command Structure**, below.

PAC Command Structure

Offset	"Data Descriptor Label"	Name	Data Type
0	"Channel Number" (1 – 160)	Channel	Byte
1	"Message Sequence Number". The controller should generate a new sequence number for each new command.	SequenceNum	Byte
2	"Material-Path Index" (1- 1000)	MaterialPath	Integer, 16 bits

Offset	"Data Descriptor Label"	Name	Data Type
4	1 Start Material Transfer. 2 Start Material Transfer with Gross Weight Target. This command is only valid for a scale device. 3 Start Hand Add. 4 Acknowledge Material Transfer or Hand Add Complete 5 Abort Material Transfer 6 Reset Slow Step Timer 7 Start Manual Mode 8 Turn on FCE in Manual Mode 9 Turn off FCE in Manual Mode 10 Restart Auto Mode 11 Complete Feed in Manual Mode 12 Master Reset – Instrument channel 13 Report Last Status 14 Master Reset – Cluster 15 Validate Aggregate Secondary Feeds 16 Reset ETC Error from Last Pri. Feed 20 Queue Start Material Transfer * 21 Queue Start Mat'l Transfer, Gross Wt * 22 Start Queued Material Transfers * 23 Reset Queued Material Transfers * 25 Turn on Fast FCE in Manual Mode * 26 Turn off Fast FCE in Manual Mode * 30 Reset Local PROFIBUS Card 31 Reset all PROFIBUS Cards in Cluster	Command Number * Q.i Lite version only	Byte
The following fields are only applicable to the "Start Material Transfer Cycle" Command			
5	"Group Number" for Start Material Transfer Command. This field identifies which Primary and Secondary feed requests belong to the group of feeds that make up an overlapping feed. A value = 0 indicates that this NOT an overlapped feed request.	GroupNumber (**not** Q.iLite)	Byte
6	"Number of Overlapping Secondary Feeds" that are being fed into a Unit simultaneously with THIS Primary Feed. This field is only meaningful in a Primary Feed using scale instrument for the Vessel. The Material-Path must indicate this Gain-In-Weight feed. The APC turns on the FCE for the Primary Feed when it determines there will be enough time after the overlap completes to run the APC algorithm with the scale.	OverlapNum (**not** Q.iLite)	Byte
7	"Reserved"	Reserved	Byte
8	For "Start Material Transfer" or "Start Hand Add" commands, this field *must* contain the target weight for the feed. For "Turn On FCE In Manual Mode", this field *must* contain the number of seconds to keep the FCE on". The value "-9999" is a 32-year timeout. All other negative values are a 0-second timeout. For "Reset Slow Step Timer", this field *may* contain the number of seconds to set the slow step timer. If this field is 0, the Q.iMPACT resets the slow step timer to its original value for the feed.	TargetWeight	Float, 32 bits

Offset	"Data Descriptor Label"	Name	Data Type
12	"Tolerance +" Value "-9999" disables tolerance check.	PosTolerance	Float, 32 bits
16	"Tolerance –"Value "-9999" disables tolerance check.	NegTolerance	Float, 32 bits
20	"Material Transfer ID" is an identifier field that is sent from the Material Transfer Controller. The Q.iMPACT reports this field as part of the data collection record. If there is a "~" in the field, the Q.iMPACT displays the data following the "~".	MatTranID	40 Character
	Message Length = 60 bytes		

To **issue a PAC Command**, the Controller must load the Shared Data Command with a 10 and the Shared Data Write Value with the PAC Command Assembly. The terminal Node and Variable Name fields can be left blank. The Controller must examine the Shared Data Status after the PAC Command to determine if the operation has completed successfully. The Controller must then send a Null command to complete the sequence. This is needed in order to reset the status back to "null status" so that the Controller does not use the status of the previous command.

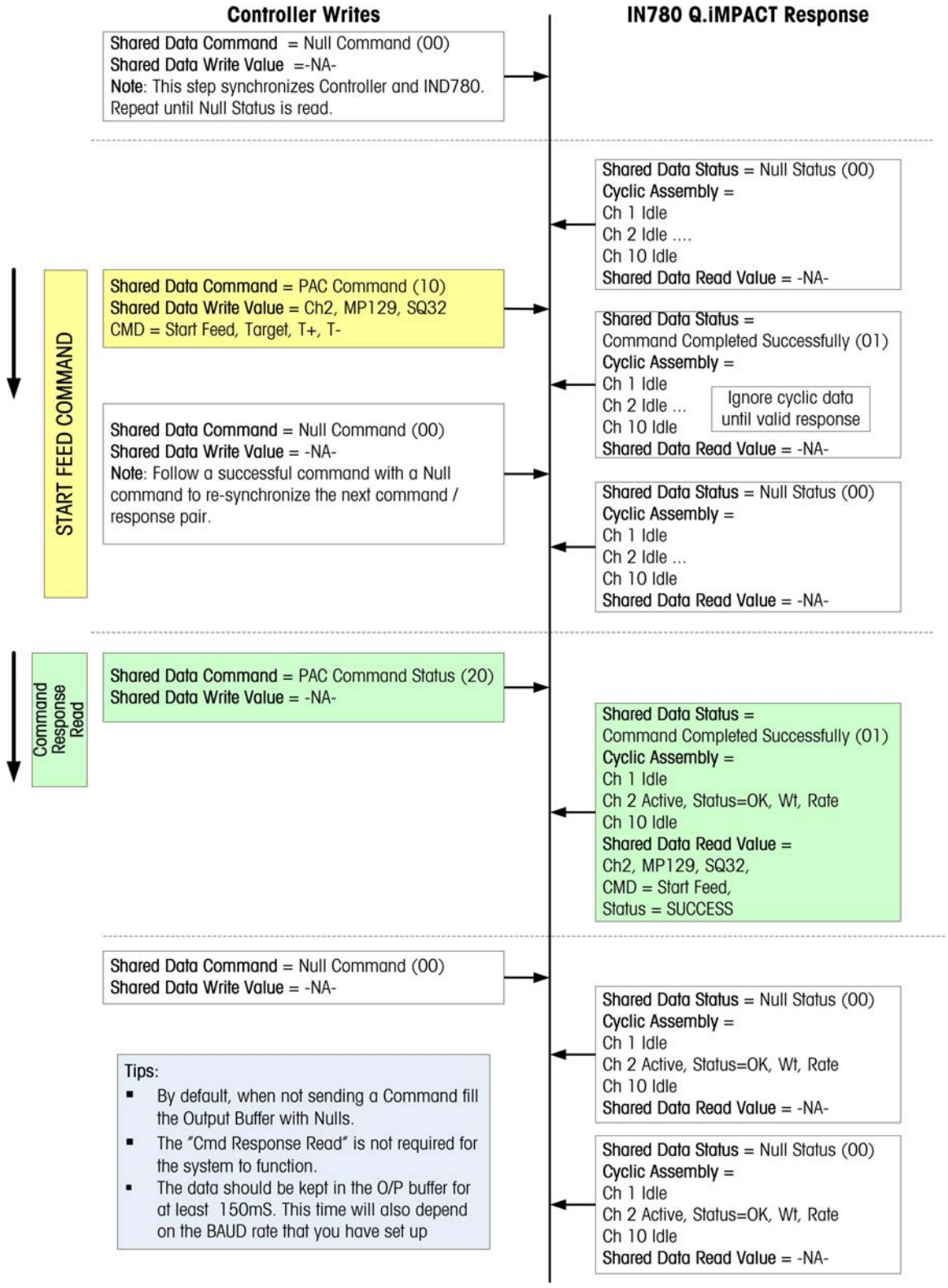
To **get a PAC Command Response**, the Controller must load the Shared Data Command with a 20. The Shared Data Write Value, the terminal Node, and the Variable Name fields can be left blank (any data in these fields will be ignored). The Controller must examine the Shared Data Status after issuing the PAC Command Response command to determine if the operation has completed successfully. If successful, the Shared Data Read Value contains the Q.iMPACT -> Controller Response Assembly. The Controller must then send a Null command to complete the sequence.

Controller Response (Assembly)

Offset	"Data Descriptor Label"	Short Name	Data Type
0	"Channel Number" as in PAC command	Channel	Byte
1	"Message Sequence Number" as in PAC command	SequenceNum	Byte
2	"Material-Path Index" as in PAC command	MaterialPath	Integer, 16bits
4	"Command" Number as in PAC command	Command	Byte
5	"Command Status" See Listing below.	ComandStatus	Byte
The following fields typically are only applicable in the "Acknowledge Material Transfer Complete" Command Response. However, when a Start Material Transfer command fails immediately, these fields will contain values indicating a Material Transfer failure.			
6	"Material Transfer Status" See Listing below.	MxferStatus	Byte
7	"Reserved"	Reserved	Reserved byte

Offset	"Data Descriptor Label"	Short Name	Data Type
8	"Material Transfer Status Qualifiers" 0 "Over Tolerance" 1 "Under Tolerance" 2 "Power Failure" during feed 3-15 Reserved	MxferStatQ	16 Binary
10	"Reserved"	Reserved	Integer
12	"Delivered Weight"	FeedWeight	Float 32
16	"Deviation Error from Target Weight"	TargetError	Float 32
	Message Length = 20 bytes		

Typical Controller-to-IND780 Q.iMPACT Sequence for Sending a Command



Practical Examples – S7 PLC

The next section will show you how to interface to a Siemens S7 PLC. It is assumed that you are familiar with programming a Siemens S7 PLC and configuring a PROFIBUS DP network.

In our examples:

- A Siemens S7-314C-2DP is used
- The Q.i Output Buffer (240 bytes) is mapped to the S7 PIB data area from address 256
- The Q.i Input Buffer (72 bytes) is mapped to the S7 PQB data area from address 256
- The PQB[256] is mapped into DB10….
- The PQB[72] is mapped from DB1…
- The IND780 Q.iMPACT terminal is set to Classic communications mode

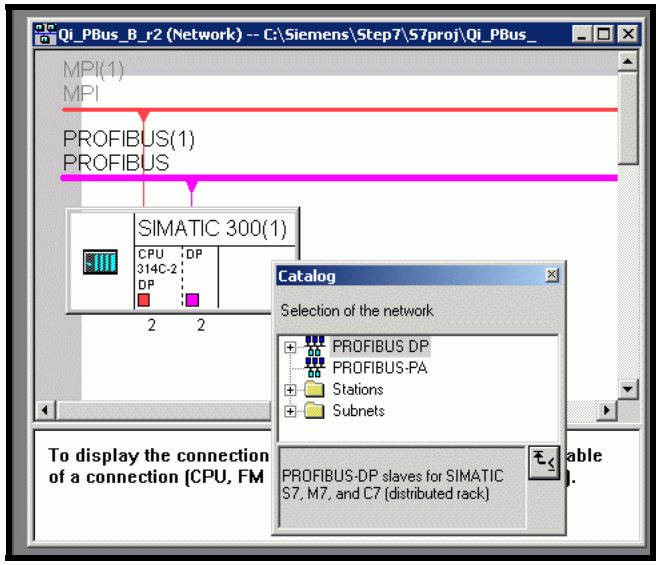
The code examples shown below have been simplified for clarity, and although they will work. A functioning system should add to and expand this functionality. The actual PLC code shown below is included on your CD. Or it can be downloaded from the Q.i website.

Adding a Q.i Terminal to a PROFIBUS network

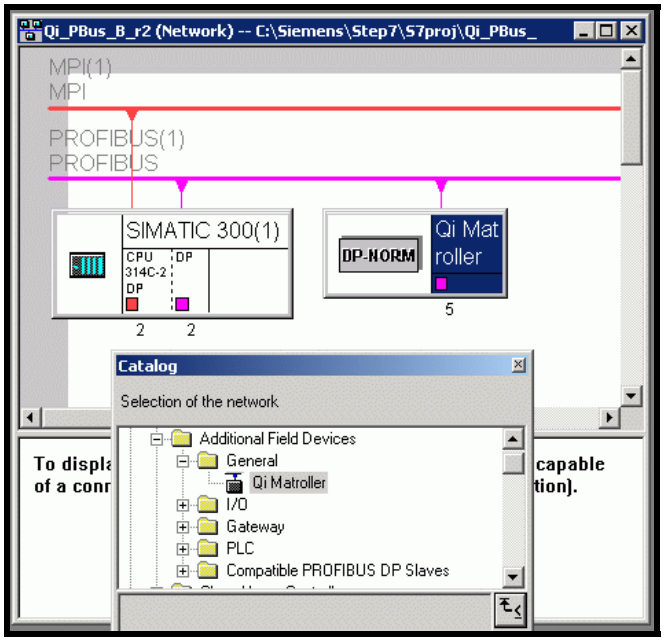
- **Note:** Before adding the terminal, the Q.i.GSD file (supplied on your IND780 Q.iMPACT documentation CD) must be installed.

1. Add the IND780 Q.i terminal to the Network:

   a. The PROFIBUS catalog is opened for viewing.



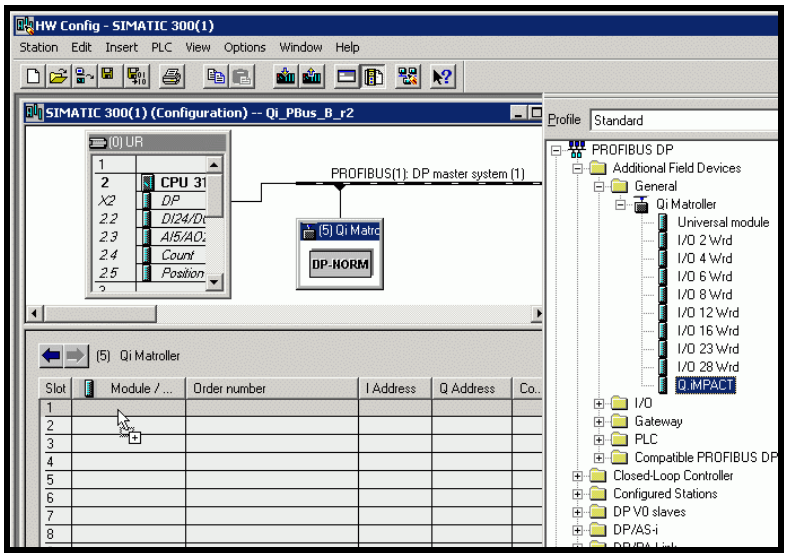
   b. The IND780 Q.i terminal is then dragged onto the Profibus Network



2. Next, configure the hardware by defining the I/O address locations:

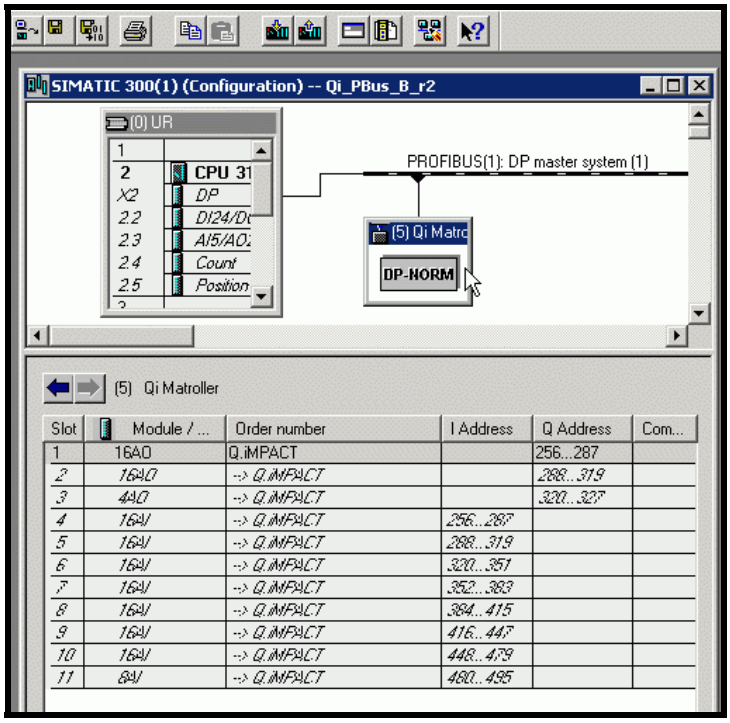
a. Select the Q.iMPACT from the list of I/O options. (All the other options refer to the base terminal and cannot be used by the IND780 Q.iMPACT).

b. The Q.iMPACT address options are then dragged into slot 1 as shown.



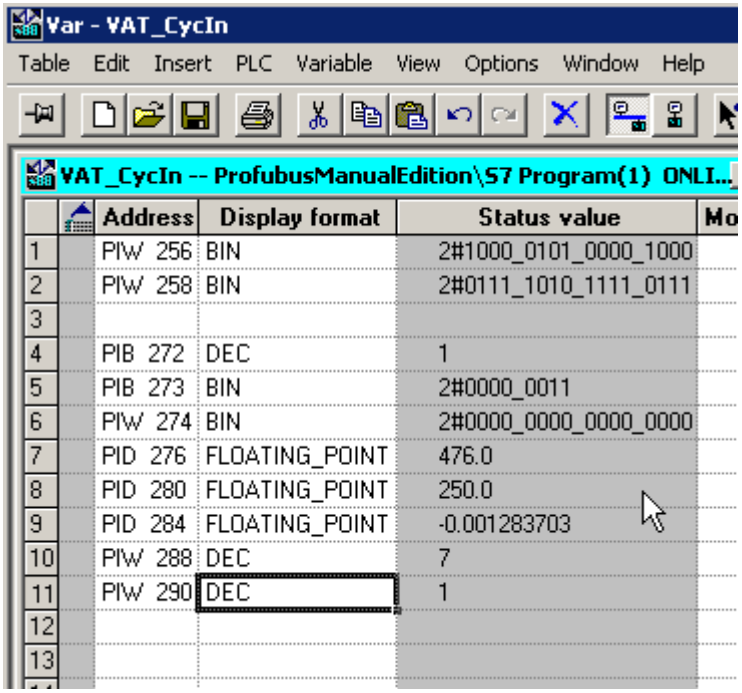
This shows the address mapping after adding the I/O mapping. In this example the Peripheral addressing starts at 256 for both Inputs and Outputs. The starting address's can be changed to suit your needs.

Note the 72 bytes of Output buffer size and the 240 bytes of Input buffer size.



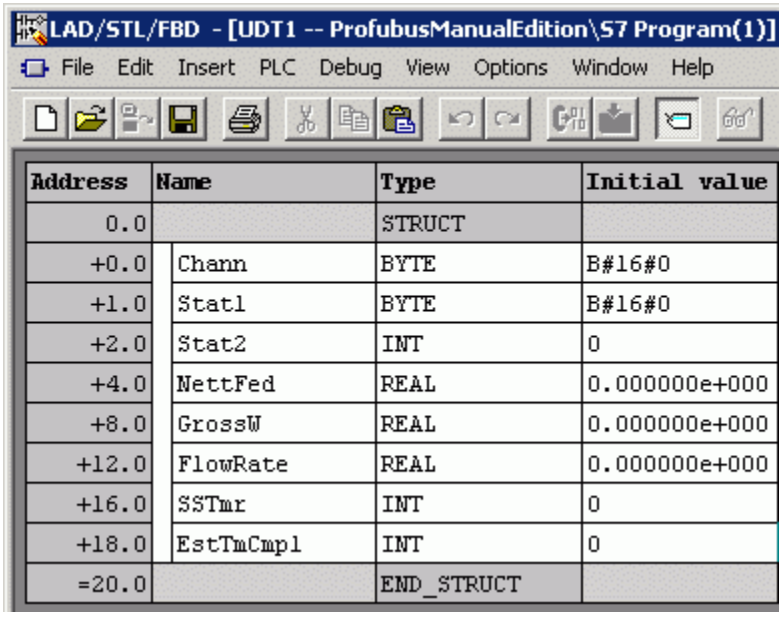
The Input Data

This is a view of the Input Buffer that the data from the terminal is copied into by the ProfiBus network. The correct display format has been chosen for each variable. PIW 256 and PIW 258 are the Checksum and Checksum inverted. The inverted bits can clearly be seen. The gap between PIW 258 and PIB 272 are the unused "reserved" system bytes for future use. The actual Channel (Instrument) data starts at PIB 272. The format from this point on is based on the table above called " Input Assembly …" Each Channel uses 10 words. This data should be copied into a Data Block area for use by your program.



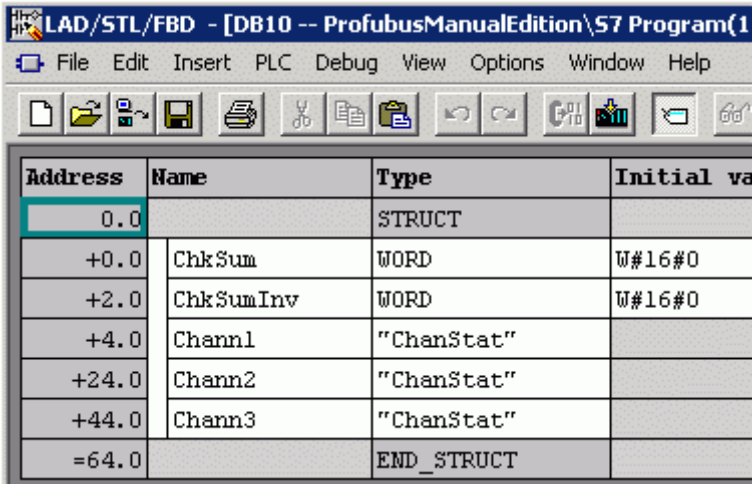
	Address	Display format	Status value	Mo
1	PIW 256	BIN	2#1000_0101_0000_1000	
2	PIW 258	BIN	2#0111_1010_1111_0111	
3				
4	PIB 272	DEC	1	
5	PIB 273	BIN	2#0000_0011	
6	PIW 274	BIN	2#0000_0000_0000_0000	
7	PID 276	FLOATING_POINT	476.0	
8	PID 280	FLOATING_POINT	250.0	
9	PID 284	FLOATING_POINT	-0.001283703	
10	PIW 288	DEC	7	
11	PIW 290	DEC	1	
12				
13				

Channel Specific UDT – below is an example of a channel specific UDT formatted to display the channel input data in the correct format.



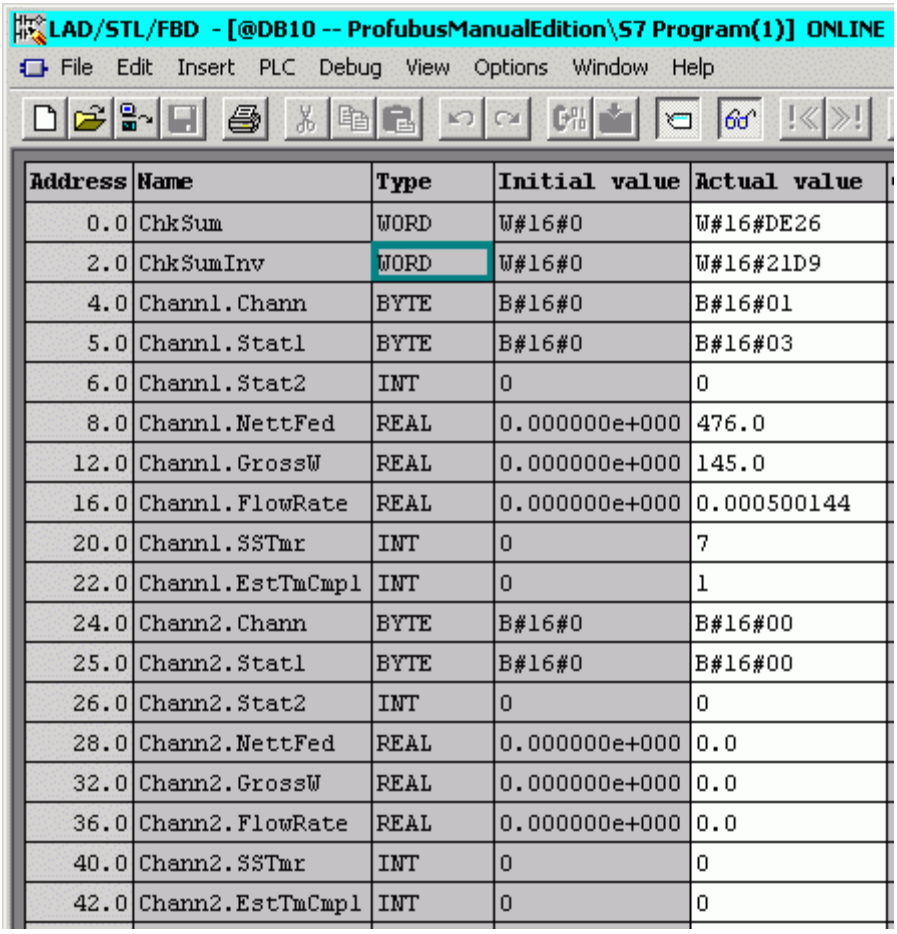
Address	Name	Type	Initial value
0.0		STRUCT	
+0.0	Chann	BYTE	B#16#0
+1.0	Statl	BYTE	B#16#0
+2.0	Stat2	INT	0
+4.0	NettFed	REAL	0.000000e+000
+8.0	GrossW	REAL	0.000000e+000
+12.0	FlowRate	REAL	0.000000e+000
+16.0	SSTmr	INT	0
+18.0	EstTmCmpl	INT	0
=20.0		END_STRUCT	

This is a view of DB10 Structured to accept the data from the PIW area. The UDT shown above has the symbolic name of "ChanStat". In the example below space for the display of 3 channels only has been created. This is shown in the "Declaration view"



Address	Name	Type	Initial va
0.0		STRUCT	
+0.0	ChkSum	WORD	W#16#0
+2.0	ChkSumInv	WORD	W#16#0
+4.0	Channl	"ChanStat"	
+24.0	Chann2	"ChanStat"	
+44.0	Chann3	"ChanStat"	
=64.0		END_STRUCT	

Here is the same DB shown in "Data View". Data from a configured channel is shown. The Gross weight for the channels is in address 12.0 and has a value of 145.0



Address	Name	Type	Initial value	Actual value
0.0	ChkSum	WORD	W#16#0	W#16#DE26
2.0	ChkSumInv	WORD	W#16#0	W#16#21D9
4.0	Channl.Chann	BYTE	B#16#0	B#16#01
5.0	Channl.Statl	BYTE	B#16#0	B#16#03
6.0	Channl.Stat2	INT	0	0
8.0	Channl.NettFed	REAL	0.000000e+000	476.0
12.0	Channl.GrossW	REAL	0.000000e+000	145.0
16.0	Channl.FlowRate	REAL	0.000000e+000	0.000500144
20.0	Channl.SSTmr	INT	0	7
22.0	Channl.EstTmCmpl	INT	0	1
24.0	Chann2.Chann	BYTE	B#16#0	B#16#00
25.0	Chann2.Statl	BYTE	B#16#0	B#16#00
26.0	Chann2.Stat2	INT	0	0
28.0	Chann2.NettFed	REAL	0.000000e+000	0.0
32.0	Chann2.GrossW	REAL	0.000000e+000	0.0
36.0	Chann2.FlowRate	REAL	0.000000e+000	0.0
40.0	Chann2.SSTmr	INT	0	0
42.0	Chann2.EstTmCmpl	INT	0	0

This is an example of code to copy the data from the PIW area into DB10. In this case we have not copied the PIB 260 to PIB271 data into the DB10 as this area is currently unused by the Q.i and contains no useful data at this point in time.

```
// Checksum data
      L     PIW  256
      T     DB10.DBW    0               // Checksum
      L     PIW  258
      T     DB10.DBW    2               // Inverted Checksum

// Assembly Slot1 (Scale A in this example)
      L     PIW  272
      T     DB10.DBW    4
      L     PIW  274
      T     DB10.DBW    6
      L     PIW  276
      T     DB10.DBW    8
      L     PIW  278
      T     DB10.DBW   10
      L     PIW  280
      T     DB10.DBW   12
      L     PIW  282
      T     DB10.DBW   14
      L     PIW  284
      T     DB10.DBW   16
      L     PIW  286
      T     DB10.DBW   18
      L     PIW  288
      T     DB10.DBW   20
      L     PIW  290
      T     DB10.DBW   22
```

The Output Data

The Output data is used to Write and Read to (Shared) Variables in the Q.i terminal as well as to send Commands such as "Start a Feed" and "Abort a Feed".

In our examples below the S7's output buffer starts from PQB256 and is 72 bytes in length. By changing the value of certain variables we can perform the various functions. It is important to remember that the Output Buffer must be filled with zeroes between placing data in the output buffer. These zeroes (nulls) are required so that the Q.i can separate and recognize a new command.

As there is no actual "Start bit". The terminal assumes that new or fresh data at its input buffer is an implied start. It will then evaluate any new data in its input buffer and act on it, if it is valid.

Here is an example of a UDT (called "Output") structured for the Output Buffer. Note: there is a nested UDT called "CommStruct" within this UDT which is 60 bytes long. This UDT is based on the Data Output Buffer which is described elsewhere in this chapter.

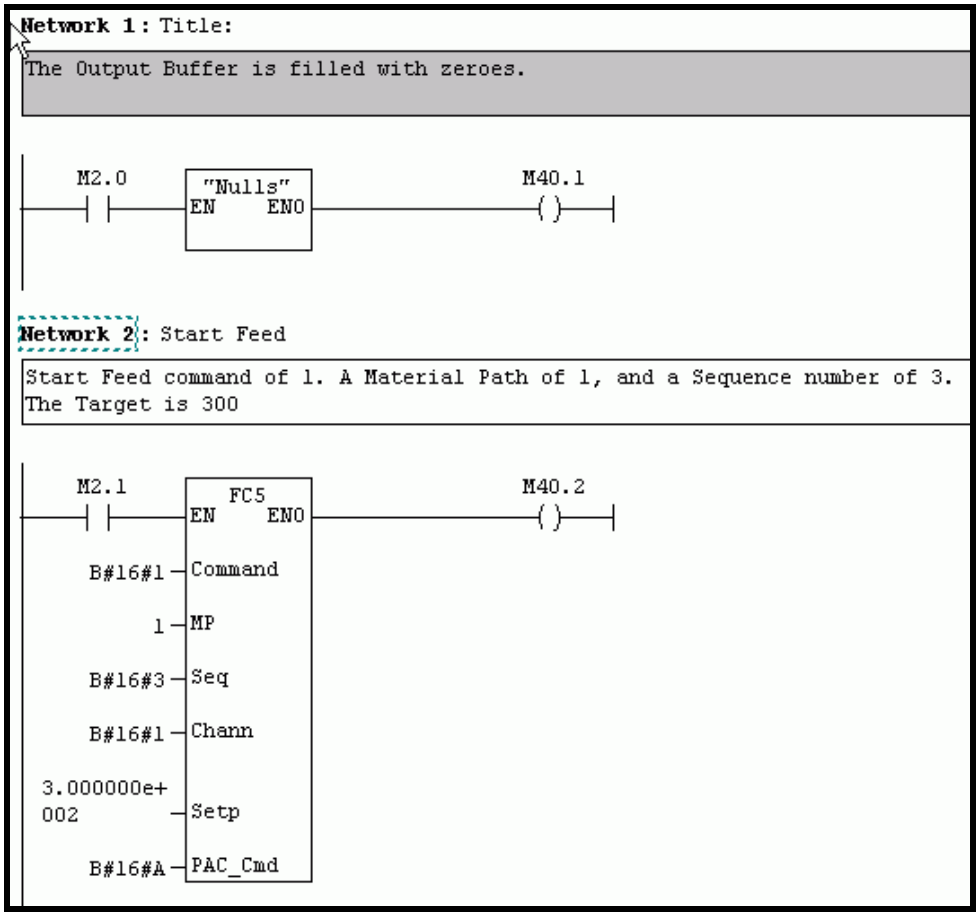
Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Res1	BYTE	B#16#0	
+1.0	CmdType	BYTE	B#16#0	
+2.0	Res2	BYTE	B#16#0	
+3.0	Node	CHAR	' '	
+4.0	VarName	ARRAY[1..6]		
*1.0		CHAR		
+10.0	Res3	WORD	W#16#0	
+12.0	IntCmd	"CommStruct"		
=72.0		END_STRUCT		

This is the structure of the nested UDT "CommStruct" embedded in the UDT above.

Address	Name	Type	Initial value	Co
0.0		STRUCT		
+0.0	Chann	BYTE	B#16#0	
+1.0	Seq	BYTE	B#16#0	
+2.0	MatPath	INT	0	
+4.0	Command	BYTE	B#16#0	
+5.0	Grp	BYTE	B#16#0	
+6.0	GrpQty	BYTE	B#16#0	
+7.0	Res	BYTE	B#16#0	
+8.0	Target	REAL	0.000000e+000	
+12.0	TolP	REAL	0.000000e+000	
+16.0	TolN	REAL	0.000000e+000	
+20.0	MatId	ARRAY[1..40]		
*1.0		CHAR		
=60.0		END_STRUCT		

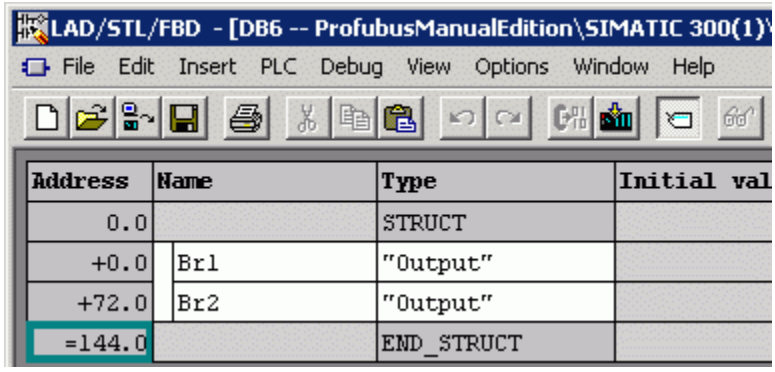
Here we are passing Start Feed data to FC5. In this example we are passing the minimum amount of data. A more complete set of parameters would include Tolerance values and Material ID etc.

The "Nulls" Function places zeroes into the Output Buffer



DB6 has had two instances of the output UDT added. They have been called BR1 and BR2. Br1 will most probably be communicating with "Bridge1". In the example code on the next page you can see BR1 being used.

"BR1"



This is the FC5 code. The parameters passed to FC5 are then copied into the correct locations of the "Output" UDT. NOTE: these examples are intended to assist you to get started. A fully programmed system should pass more parameters. There are a number of parameters which have been embedded in the code for clarification and display purposes. Parameters such as the Node address and Tolerances would normally also be variables that are passed to the FC.

In the example below "Op_Cmd" is the symbol for DB6. BR1 is one instance of the "Output" UDT

FC5

Address	Declaration	Name	Type	Initial value	Comment
0.0	in	Command	BYTE		
2.0	in	MP	INT		
4.0	in	Seq	BYTE		
5.0	in	Chann	BYTE		
6.0	in	Setp	REAL		
10.0	in	PAC_Cmd	BYTE		
	out				

FC5 : Start Feed Parameters

Comment:

Network 1: Title:

Passed parameters are copied to their correct locations in the "Output" UDT Output

```
      L     #Command                    // Command
      T     "Op_Cmd".Brl.IntCmd.Command
      L     #MP                         // Material Path
      T     "Op_Cmd".Brl.IntCmd.MatPath
      L     #Seq                        // Sequence number
      T     "Op_Cmd".Brl.IntCmd.Seq
      L     #Chann                      // Channel number of Material Path
      T     "Op_Cmd".Brl.IntCmd.Chann
      L     #Setp                       // Target
      T     "Op_Cmd".Brl.IntCmd.Target
      L     #PAC_Cmd                    // Type of Command data
      T     "Op_Cmd".Brl.CmdType
```

Network 2 : Title:

This is the Matroller Node Address (49 = "1")
Cyrrently Embedded in the code, should be passed by the calling Function

```
      L     49
      T     "Op_Cmd".Brl.Node
```

Copying the Output Buffer (DB6) to the Peripheral Output Area

The following is a portion of the code that copies DB6 to the PQB area. From the PQB area it gets copied into the Q.i Input Buffer by the PROFIBUS DP network. The complete code is on the CD supplied with the IND780 Q.iMPACT.

- Note the swapping of the some of the bytes in this area.

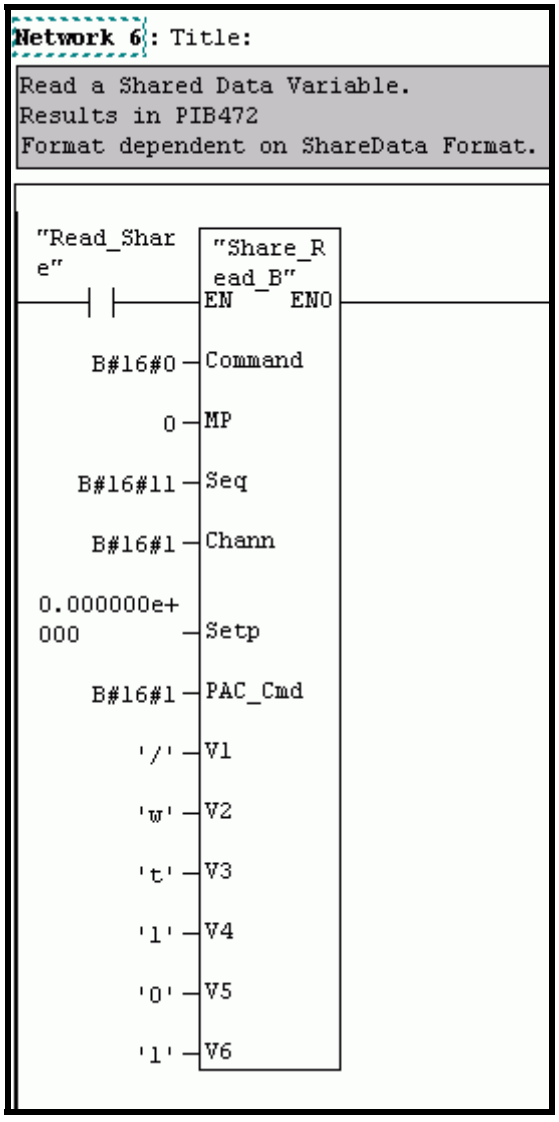
```
L     "Op_Cmd".Brl.VarName[4]
T     PQB  263
L     "Op_Cmd".Brl.VarName[5]
T     PQB  264
L     "Op_Cmd".Brl.VarName[6]
T     PQB  265
L     DB6.DBB   10
T     PQB  266
L     DB6.DBB   11
T     PQB  267
L     "Op_Cmd".Brl.IntCmd.Chann
T     PQB  269                    // byte swap with Seq
L     "Op_Cmd".Brl.IntCmd.Seq
T     PQB  268                    // byte swap with Chann
L     DB6.DBB   14
T     PQB  270
L     DB6.DBB   15
T     PQB  271
L     "Op_Cmd".Brl.IntCmd.Command
T     PQB  273                    // byte swap "B"
L     "Op_Cmd".Brl.IntCmd.Grp
T     PQB  272                    // byte swap "B"
L     "Op_Cmd".Brl.IntCmd.GrpQty
T     PQB  275                    // byte swap "C"
L     "Op_Cmd".Brl.IntCmd.Res
T     PQB  274                    // byte swap "C"
L     DB6.DBB   20
T     PQB  276
L     DB6.DBB   21
T     PQB  277
```

Commissioning and debugging

Refer to the IND780 Technical Manual.

Reading a Shared Data Variable

In this example, we are using a different Function (FC7). In order to read a Shared data variable the PAC_Cmd is now 1. And the Shared Data name is 'wt101', which is the gross weight of Scale A. The value is returned in bytes 218 to 239 of the cyclic data input. The Share data name is always preceded by a '/'.



This is the view of the Cyclic Input Buffer after the above mentioned Function has been called. The Gross weight is 591 and can be seen in DBB215 …DBB217. The format of the returned data will change depending on the Share data. The Share Data document will specify the format of the returned Share Data variable.

@VT_IP -- ProfubusManualEdition\SIMATIC 300(1)\CPU 314C-2 DP\S7 Prog...

	Address	Symbol	Display format	Status value	Mo
1	DB10.DBW 0	"IP_Buff".ChkSum	DEC	11682	
2	DB10.DBW 2	"IP_Buff".ChkSumInv	DEC	-11683	
3	DB10.DBB 4	"IP_Buff".Chann1.Chann	DEC	1	
4	DB10.DBB 5	"IP_Buff".Chann1.Stat1	HEX	B#16#02	
5	DB10.DBW 6	"IP_Buff".Chann1.Stat2	HEX	W#16#0000	
6	DB10.DBD 8	"IP_Buff".Chann1.NettFed	FLOATING_POINT	325.0	
7	DB10.DBD 12	"IP_Buff".Chann1.GrossW	FLOATING_POINT	591.0	
8	DB10.DBD 16	"IP_Buff".Chann1.FlowRate	FLOATING_POINT	-0.001500432	
9					
10	DB10.DBB 204		HEX	B#16#00	
11	DB10.DBB 205		HEX	B#16#01	
12	DB10.DBB 206		CHARACTER	''	
13	DB10.DBB 207		CHARACTER	''	
14	DB10.DBB 208		CHARACTER	''	
15	DB10.DBB 209		CHARACTER	''	
16	DB10.DBB 210		CHARACTER	''	
17	DB10.DBB 211		CHARACTER	''	
18	DB10.DBB 212		CHARACTER	''	
19	DB10.DBB 213		CHARACTER	''	
20	DB10.DBB 214		CHARACTER	''	
21	DB10.DBB 215		CHARACTER	'5'	
22	DB10.DBB 216		CHARACTER	'9'	
23	DB10.DBB 217		CHARACTER	'1'	
24	DB10.DBB 218		CHARACTER	B#16#00	
25	DB10.DBB 219		CHARACTER	B#16#00	
26	DB10.DBB 220		CHARACTER	B#16#00	
27	DB10.DBB 221		CHARACTER	B#16#00	
28	DB10.DBB 222		CHARACTER	B#16#00	
29	DB10.DBB 223		CHARACTER	B#16#00	
30	DB10.DBB 224		CHARACTER	B#16#00	
31	DB10.DBB 225		CHARACTER	B#16#00	
32	DB10.DBB 226		CHARACTER	B#16#00	
33	DB10.DBB 227		CHARACTER	B#16#00	

Command 1- Start Material Transfer

This command will result in the Q.i transferring an exact amount based on the Target embedded within the command. If the Target was 35 kg for example, 35 kg will be added into the scale regardless of what the weight was prior to the command being issued. (Note: the final result must still be within the scale capacity)

Command 2 - Start Material Transfer with Gross

This command will result in the Q.i transferring material to a target amount. For example if there already was 10kg in the scale and Command 2 was sent with a Target of 50kg only 40 kg will be added. This command can only be used with a scale

Command 3 - Start Hand Add

This is a Pseudo material. It is treated as a normal material except that the Q.i does not control the addition of the material. This would be done manually by an operator. Once the additions have been made the Q.i must be informed of this fact either by activating one of the Q.i's digital inputs. The Q.i will calculate the net amount transferred and any errors. A normal report is created identical to a normal material transfer.

Command 4 – Acknowledge Material Transfer

Whenever a Material Transfer has been successfully started by the Q.i, the cycle must be completed by sending a Command 4 when the bit "Waiting for Controller to Ack Last Material Transfer" (bit7) goes high. The Q.i will not accept another command once it is expecting Command 4. This even applies for Aborts and Power failures occurring during a Material Transfer. The one exception is a Channel or Cluster Reset action issued from a Web Page. The Reset action clears all registers.

Command 5 – Abort Material Transfer

This Command will cause the Q.i FCE (Final Control element) to turn OFF and the Q.i to report net amount Transferred up until the Abort Command was sent. A Command 4 must still be sent in order to complete the Cycle.

SPECIAL NOTE: If the Q.i is within the Feed Override period the Abort Command will not be accepted and the Q.i will complete the Transfer

Command 6 – Reset Slow Step Timer

The Slow Step Timer will be reset to either the value embedded within the command OR if a zero was sent as the target it will be reset to its default value entered in the Material Path Setup Page

Command 7 – Start Manual Mode

This will cause the Q.i to go from Auto to Manual mode. If this occurs during a Material Transfer the FCE will turn OFF. Various options are now available such as:

1. Add material by Manually controlling FCE O/P using Commands 8 and 9.
2. Add material by hand.
3. Return to Auto mode with Command 10

Option 1 once you are finished adding manually are you are not using option 3 route, the command 11 (complete Feed in Manual) must now be used. The Q.i will now add up how much was added in Auto mode together with how much was added in Manual mode and use this total amount in the Transfer Report. The "Waiting for Controller to Ack Last Material Transfer" (bit7) will then turn ON. The Command 4 must now be issued in order to complete the cycle

Option 2 once you are finished adding by hand and are not using option 3 route, the command 11 (complete Feed in Manual) must now be used. The Q.i will now add up how much was added in Auto mode together with how much was added in Manual mode and use this total amount in the Transfer Report. The "Waiting for Controller to Ack Last Material Transfer" (bit7) will then turn ON. The Command 4 must now be issued in order to complete the cycle

Option 3 returning to Auto will cause the Q.i to carry on where it left off. The FCE will turn ON and the Transfer will complete

Command 8 – Turn ON FCE in Manual

This command will turn ON the Q.i FCE only when the Q.i has been switched to manual mode. If a value is entered in the target such as 5 then the FCE will turn on for 5 seconds. If 0 is entered it will stay ON indefinitely.

Command 9 – Turn OFF FCE in Manual

This command will turn OFF the Q.i FCE only when the Q.i has been switched to manual mode.

Command 10 – Restart Auto Mode

If during a Mat Transfer the Q.i has been put in the Manual Mode this command will return it to Auto mode. NOTE: If a Transfer has not completed it will automatically continue with the Mat. Transfer

Command 11 – Complete Feed in Manual Mode

If during a Mat Transfer the Q.i has been switched to Manual mode and additional material has been added. This command is used to signal that the Transfer is

complete a Mat Transfer report is generated and the cycle must be completed with an Ack (Cmd 4) when prompted.

NOTE: The report will add up total added during Auto mode as well as manually.

Command 12 – Master Reset Instrument Channel

This command will completely reset a channel no matter what it is doing at the time. No further commands are required to be sent to the Q.i. It is now ready for the next Material Transfer i.e. Command 1 or 2

NOTE: this action can also be initiated from the Web Pages

Command 13 – Report last status

It is possible to retrieve the results of a Material Transfer again at a later time with this command. Obviously it will report the last material transfer

Command 14 – Master Reset Instrument Channel

This command will completely all channels no matter what the Quip's are doing at the time. No further commands are required to be sent to the Quip's. They are now ready for the next Material Transfer i.e. Command 1 or 2

NOTE: this action can also be initiated from the Web Pages

Command 15 – Validate aggregate Secondary Feeds

This command is used to crosscheck the accuracy of Flow meters with a Scale. The Flow meters would need to feed into the scale, which is doing the validating.

Usage:

Send Command 15 specifying a group number (x) and number of secondary feeds (y). The channel must be a valid scale.

If (y) was 2 then two more Start Material Transfers must be sent. One to each Flow meter, embedded in this command would be a group number, which must be identical to (x). The group number associates/links the three channels. Once the two Flow meters have completed their Transfer the Q.i checks their total net amounts against the scales changed weight. A Valid Material Transfer report for this scale is then generated. This scale will set its "Waiting for Controller to Ack Last Material Transfer" bit as if it had actually performed a Transfer even though it did not actually control one. The scale would then have to be Ack'd and the resulting report can be read.

Command 20 – Queue Material Transfer Start

Command 21 – Queue Material Transfer Start with Gross Weight Target

Command 22 – Start All Queued Material Feeds

Command 23 – Reset All Queued Material Feeds

The Q.i Lite has been enhanced to permit queuing of multiple material-transfer-start commands. A single command starts all of the queued material-transfer-start requests nearly simultaneously

When a command 20 or 21 is received, the channel number, material-path, target weight, and tolerances are validated. This data is then stored in the command queue assigned to the process. There can be up to twelve processes per Q.i Lite. When a command 22 is received, the data in the command queue is processed just like a regular start material transfer command. A command 20 is processed like a command 1 (Start Material Transfer) and a command 21 is processed like a command 2 (Start Material Transfer with Gross Weight Target). When this group of feeds have completed, another command 22 will start the feeds again. A command 20 or 21 with the same channel and material-path as one already queued can be sent during idle times if the target weight or tolerances need to be updated. A command 23 will erase all command queues.

Note: Sending a command 22 with no commands queued will result in an Invalid-Command command status (9).

The Reset Channel (command 12) or Reset Cluster (command 14) does not affect the command queues. Only command 23 will erase the command queues.

Warning: Queued commands are NOT power-fail protected.

The Material Transfer Check web page contains the necessary controls to queue and start multiple feeds.

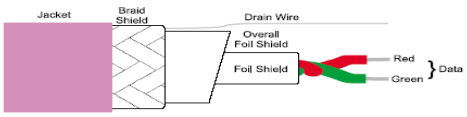
Command 30 – Reset the Cluster

WARNING: USE THIS COMMAND WITH CAUTION!

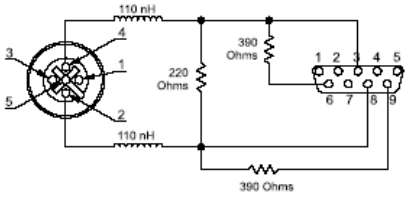
This command will completely reset the entire Cluster. Any Material feeds in progress will stop and all pending Material Acknowledges will be reset. All channels will be in a rest state ready to accept new material transfer commands

PROFIBUS-DP Cable Specifications

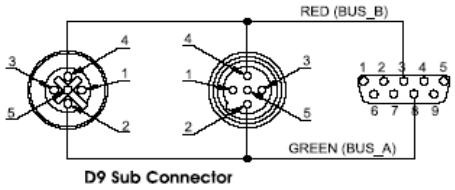
Baud Rate (k baud)	9.6	19.2	93.75	187.5	500	1500	12000
Maximum Cable Length	1200 m	1200 m	1200 m	1000 m	400 m	200 m	100 m



Schematic for RKSW D9S/T 455-1M

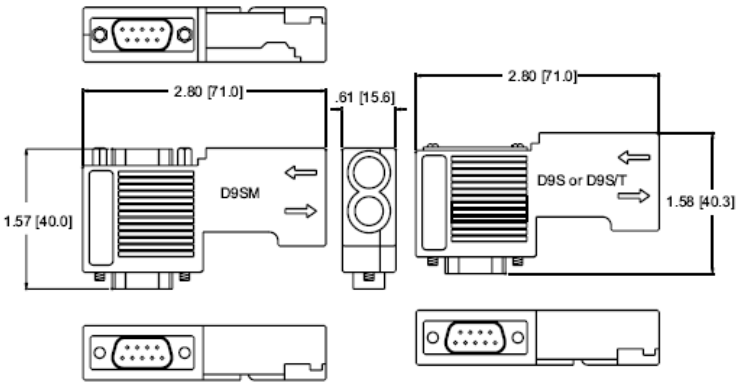


Schematic for RSSW D9S RKSW 455-1M-1M



D9 Sub Connector

PROFIBUS-DP D9 Sub Connector



Pinouts

1 - N/C
2 - N/C
3 - Red (Bus_B)
4 - N/C
5 - N/C
6 - N/C
7 - N/C
8 - Green (Bus_A)
9 - N/C

D9SM-*

D9S or D9S/T-*

Cluster Configurations for 20 Terminals

The following table shows the possible configurations of PROFIBUS, scale, and flow meter interface cards for 20 terminals (except where noted) in a cluster. The "Number of Bridges" is the number of Bridge terminals.

In the board configuration column of Table E-1, F = Flow Meter PCB (4 channels each), S = Scale PCB (2 channels each) and P = PROFIBUS PCB.

Table E-1: Cluster Configurations for 20 Terminals

# of Scale Channels	# of Flow Meter Channels	# of Bridges	Board Configuration per Terminal
0	168	18	18*(2F+P) + 2*(3F)
2	168	17	17*(2F+P) + 2*(3F) + 1*(2F+S)
4	164	17	17*(2F+P) + 2*(3F) + 1*(F+2S)
6	160	17	16*(2F+P) + 2*(3F) + 1*(2F+S) + 1*(2S+P)
8	156	17	16*(2F+P) + 2*(3F) + 1*(F+2S) + 1*(2S+P)
10	152	17	15*(2F+P) + 2*(3F) + 1*(2F+S) + 1*(2S) + 1*(2S+P)
12	148	17	15*(2F+P) + 2*(3F) + 1*(F+2S) + 1*(2S) + 1*(2S+P)
14	144	16	14*(2F+P) + 2*(3F) + 1*(F+2S) + 2*(2S+P) + 1*(F+S+P)
16	144	16	14*(2F+P) + 2*(3F) + 1*(F+2S) + 2*(2S+P) + 1*(F+2S)
18	140	16	14*(2F+P) + 1*(3F) + 1*(2F+S) + 2*(2S+P) + 2*(F+2S)
20	136	16	14*(2F+P) + 1*(3F) + 3*(F+2S) + 2*(2S+P)
22	132	16	13*(2F+P) + 1*(3F) + 1*(2F+S) + 2*(F+2S) + 3*(2S+P)
24	128	16	13*(2F+P) + 1*(3F) + 3*(F+2S) + 3*(2S+P)
26	124	16	12*(2F+P) + 1*(3F) + 1*(2F+S) + 2*(F+2S) + 4*(2S+P)
28	120	16	12*(2F+P) + 1*(3F) + 3*(F+2S) + 4*(2S+P)
30	120	15	11*(2F+P) + 1*(3F) + 1*(2F+S) + 3*(F+2S) + 4*(2S+P)
32	116	15	11*(2F+P) + 1*(3F) + 4*(F+2S) + 4*(2S+P)
34	112	15	10*(2F+P) + 1*(3F) + 1*(2F+S) + 3*(F+2S) + 5*(2S+P)
36	108	15	10*(2F+P) + 1*(3F) + 4*(F+2S) + 5*(2S+P)
38	104	15	9*(2F+P) + 1*(3F) + 1*(2F+S) + 3*(F+2S) + 6*(2S+P)
40	100	15	9*(2F+P) + 1*(3F) + 4*(F+2S) + 6*(2S+P)
42	96	15	8*(2F+P) + 1*(3F) + 1*(2F+S) + 3*(F+2S) + 7*(2S+P)
44	96	14	7*(2F+P) + 2*(3F) + 4*(F+2S) + 7*(2S+P)
46	92	14	7*(2F+P) + 1*(3F) + 1*(2F+S) + 4*(F+2S) + 7*(2S+P)
48	88	14	7*(2F+P) + 1*(3F) + 5*(F+2S) + 7*(2S+P)
50	84	14	6*(2F+P) + 1*(3F) + 1*(2F+S) + 4*(F+2S) + 8*(2S+P)
52	80	14	6*(2F+P) + 1*(3F) + 5*(F+2S) + 8*(2S+P)
54	76	14	5*(2F+P) + 1*(3F) + 1*(2F+S) + 4*(F+2S) + 9*(2S+P)
56	72	14	5*(2F+P) + 1*(3F) + 5*(F+2S) + 9*(2S+P)
58	72	13	4*(2F+P) + 1*(3F) + 1*(2F+S) + 5*(F+2S) + 9*(2S+P)

# of Scale Channels	# of Flow Meter Channels	# of Bridges	Board Configuration per Terminal
60	68	13	4*(2F+P) + 1*(3F) + 6*(F+2S) + 9*(2S+P)
62	64	13	3*(2F+P) + 1*(3F) + 1*(2F+S) + 5*(F+2S) + 10*(2S+P)
64	60	13	3*(2F+P) + 1*(3F) + 6*(F+2S) + 10*(2S+P)
66	56	13	2*(2F+P) + 1*(3F) + 1*(2F+S) + 5*(F+2S) + 11*(2S+P)
68	52	13	2*(2F+P) + 1*(3F) + 6*(F+2S) + 11*(2S+P)
70	48	13	1*(2F+P) + 1*(3F) + 1*(2F+S) + 5*(F+2S) + 12*(2S+P)
72	48	12	2*(3F) + 6*(F+2S) + 12*(2S+P)
74	36	11	1*(2F+S) + 7*(F+2S) + 11*(2S+P) [19 terminals]
76	24	10	1*(3F) + 3*(F+2S) + 6*(2S) + 10*(2S+P)
78	12	9	1*(2F+S) + 1*(F+2S) + 9*(2S) + 9*(2S+P)
80	0	8	12*(2S) + 8*(2S+P)

PROFIBUS GSD file content

```
;==================
;GSD file for
;Product : Jaguar Industrial Terminal
;Manufacturer: Mettler Toledo
;Status : Part Number: Revision: M.2
;==================
#Profibus_DP
Vendor_Name = "Mettler Toledo , Inc. "
Model_Name = "IND780 Q.iMPACT "
Revision = "VM.2      "
Ident_number = 0x6713
Protocol_Ident = 0
Station_Type = 0
FMS_supp = 0
Hardware_Release = "V 1.0  "
Software_Release = "M.2"
9.6_supp = 1
19.2_supp = 1
93.75_supp = 1
187.5_supp = 1
500_supp = 1
1.5M_supp = 1
3M_supp = 1
6M_supp = 1
12M_supp = 1
MaxTsdr_9.6 = 60
MaxTsdr_19.2 = 60
MaxTsdr_93.75 = 60
MaxTsdr_187.5 = 60
MaxTsdr_500 = 100
MaxTsdr_1.5M = 150
MaxTsdr_3M = 250
MaxTsdr_6M = 450
```

```
MaxTsdr_12M = 800
Redundancy = 0
Repeater_Ctrl_Sig = 0
24V_Pins = 0
Freeze_Mode_supp = 0
Sync_Mode_supp = 0
Auto_Baud_supp = 1
Set_Slave_Add_supp = 0
User_Prm_Data_Len = 0x01
User_Prm_Data = 0
Min_Slave_Intervall = 0x0001
Modular_Station = 1
Max_Module = 0x01
Max_Input_Len = 0xF0
Max_Output_Len = 0x48
Max_Data_Len = 0x0138
Module= "I/O 2 Wrd" 0x61,0x51
EndModule
Module= "I/O 4 Wrd" 0x63,0x53
EndModule
Module= "I/O 6 Wrd" 0x65,0x55
EndModule
Module= "I/O 8 Wrd" 0x67,0x57
EndModule
Module= "I/O 12 Wrd" 0x6b,0x5b
EndModule
Module= "I/O 16 Wrd" 0x6f,0x5f
EndModule
Module= "I/O 23 Wrd" 0x6f,0x66,0x5f,0x56
EndModule
Module= "I/O 28 Wrd" 0x6f,0x6b,0x5f,0x5b
EndModule
Module= "Q.iMPACT"
0x6f,0x6f,0x63,0x5f,0x5f,0x5f,0x5f,0x5f,0x5f,0x5f,0x5f,0x57
EndModule
```

Appendix F

Glossary of Terms

Term	Definition
Absolute Target	**Target** mode which treats the target value from the Controller to the Q.iMPACT terminal as the vessel weight required at feed cutoff (e.g., fill the vessel to 1800 KG).
Absolute Tolerance Checks	The Q.iMPACT terminal uses the absolute feed tolerance to check the feed error (in weight units) directly against these tolerance numbers, also in weight units.
Additive Target	Target mode which treats the target value from the Controller to the Q.iMPACT terminal as the total amount of material to be moved into the vessel (e.g., add 800 KG of material to the vessel).
AIM	An AIM (Application Interface Module), also known as a Function Block or Communications Driver, is a piece of software included in a batching, blending or filling Controller (typically a PLC or DCS) to ease the integration of a Q.iMPACT terminal with its **host Controller**. This is usually a bi-directional interface that operates between each piece of equipment.
Algorithm Correction	This correction determines the degree of change when recalculating the selected control algorithm's new operating parameters. This correction applies to **Spill Only**, **K1** and **K2** algorithms and is entered as a percent from 0-100. An adjustment of 10% would mean that a 10% change would be applied when new parameters are calculated based on the Material Feed just completed on a particular material. A more aggressive entry of 90% would mean that there would be a 90% change applied when the new parameters are calculated based on the Material Feed just completed on a particular material. The controller uses this value in calculating **Average Flow Rate** and **Average Spill** to control how quickly the system responds to a change in operating conditions. The range is usually 10% to 30% in material transfer processes that change slowly and infrequently. Values from 60% to 90% should be used for processes that change quickly or frequently. Qi uses this value in calculation of Average Flow Rate "A", Average Spill "AA", and Cutoff Constants "B", "BB", and "C". Range is 0.0–1.0. Smaller values (0.1–0.3) are used for systems that have run consistently batch after batch, while larger values (0.6-0.8) should be used for systems whose material transfer flow characteristics change frequently. Default value is 0.2.

Term	Definition
Assembly Slot	An assembly slot is the physical location in the Q.iMPACT terminal for a printed circuit board. Inside the IND780 Q.iMPACT terminal, assembly slot one is the slot near the physical center of the terminal. Slot six is closest to the incoming AC power/power supply. An assembly slot is similar to a Channel; however the **numbering** starts from one again with each Q.iMPACT terminal.
Average Flow Rate	The average feed flow rate at cutoff, in weight units per second.
Average Flow Rate Limits, High	This is the upper limit for the **Average Flow Rate**. No Control Algorithm updates will occur if the Flow rate at cutoff exceeds this value. This is the upper alarm limit for the Average Flow Rate "A". It is typically set at 150% of the Flow Rate, in weight or volume units per second.
Average Flow Rate Limits, Low	This is the lower limit for the **Average Flow Rate**. No Control Algorithm updates will occur if the Flow rate at cutoff is less than this value. This is the lower alarm limit for the Average Flow Rate "A". It is typically set at 50% of the flow rate, in weight or volume units/second. The value may be negative.
Average Spill	The average **spill** in weight at cutoff. Derived from the average of the "Actual Spill" as calculated by the system after every feed. This field can also be used initially to set new seed values for the process.
Average Spill Limits, High	This is the upper alarm limit for the **Average Spill**. No Control Algorithm updates will occur if the actual Spill value exceeds this value. This is the upper alarm limit for the Average Spill "AA". It is typically set at 150% of the average spill, in weight or volume units.
Average Spill Limits, Low	This is the lower alarm limit for the **Average Spill**. No Control Algorithm updates will occur if the actual Spill value exceeds this value. This is the lower alarm limit for the Average Spill "AA". It is typically set at 50% of the average spill, in weight or volume units. Value may be negative.
Board	A printed circuit board.
Bridge	A Bridge is a communications interface board installed in a Q.iMPACT terminal; used to communication with a **Controller**. There must be one or more **Bridge** terminals in a **Cluster**. All the Bridge terminals in a Cluster support either the **Enhanced Communication** Mode or the **Classic Communication Mode**.
Bridge Terminal Number	The terminal node number of the Q.iMPACT terminal that contains the PCB Communications board that communicates with the host DCS or PLC system
Bridge Slot Number	The number assigned to the assembly data packet that contains input data for an Equipment Channel Module. There are a maximum of 24 **assembly slot** numbers for the **Classic Communications Mode** using Ethernet IP and ControlNet and a maximum of 12 assemble slot numbers for the **Enhanced Communications Mode** using Ethernet IP and ControlNet. PROFIBUS DP uses Enhanced mode only with a maximum of 10 assembly slot numbers.

Term	Definition
Calculated Target	The Q.iMPACT terminal calculates a **Target** at the start of the feed based on the starting weight in the vessel and the requested amount for the feed. The Target is the weight at which the IND780 Q.i stops the feed.
Channel	An instrument (scale or flow meter) connected to a Q.iMPACT terminal. A maximum of 200 channels may exist in a single cluster. There can be a maximum of four scales or 12 flow meters in each Q.iMPACT terminal or any combination that does not exceed 12 channels.
Card	A printed circuit board
Classic Communication Mode	This is a form of communication between the **host controller** (PLC or DCS) and the Q.iMPACT terminal. This form of communication uses Explicit Shared Data messages over ControlNet or Ethernet IP communications protocol. The IND780 Q.iMPACT terminal allows the user to select the **Classic Communications Mode** or **Enhanced Communications Mode** during system setup.
Cluster	Group of between 2-20 Q.iMPACT terminals that all connect to the same Local Area Network (LAN). Typically consists of one **Master** terminal and multiple **Remote** terminals.
Controller	A device that minimizes the difference between a desired value (often called the **target**) and a measured value (often called the process variable) by manipulation of an output; an instrument, device or mechanism that controls the batching process. Typically, this could be a PLC, DCS, a hybrid of the two or soft PLC.
ControlNet	Proprietary fieldbus developed by Allen-Bradley
Control I/O Module	Control I/O Modules are the most basic element of the physical model. A Control I/O Module is typically a collection of sensors, actuators, other Control I/O Modules and associated process equipment that operate as a single entity from the point of view of control. A Control I/O Module contains the following: • Automatic and manual modes • Simulation mode • Permissive Interlocks • Alarms • Typically one or more Discrete I/O
Cyclic data	Data blocks received by the **Host controller** at regular intervals. No code is required by the user in order to receive the data. However the Cyclic data must be setup when configuring the ControlNet network.
Digital Rate Filter	When a vessel is executing a function that induces noise into the reading of the weight, such as an agitator, it is necessary to remove the noise by using the digital rate filter. While it is desirable to leave this filter on in these cases, some processes require dynamic control of the filtering. The IND780 Q.iMPACT terminal provides for both a low pass filter and a notch filter.

Term	Definition
Drain Timer	This is the time, in seconds, which the system will wait at the end of the feed (after feed cutoff) for the material to completely drain into or from a vessel before testing the scale stability and material feed tolerances.
Drain Time	The time required for all material left in the feed line between the final control element and the receiving vessel to move into the vessel. After this time, no additional change in vessel weight should be detected. This is the time in seconds that the system will wait for material to drain into a vessel after feed is complete and before testing for material delivery tolerance.
Dump to Empty	When transferring the contents of one vessel into another, generally the entire amount of material in the source vessel is transferred, within reasonable limits. The discharge valve on the vessel is closed when the vessel's net weight is less than or equal to zero. This function allows the system to perform all required reasonability tests so that the Controller does not have to. • Any loss in weight configuration when a completely empty tank or vessel is desired.
Dump Trip Point	The level at which the drain timer starts in a **Dump-to-Empty** operation. After expiration of the drain timer, the Q.iMPACT terminal shuts off the Dump-to-Empty operation when it detects zero flow.
Dynamic Slow Step Monitoring	This function monitors the progress of the material feed and alarms when the material has been feeding for 150% of the expected feed time as calculated from the material target and the average flow rate. The material feed will be halted if the slow step timer times out.
Enhanced Communications Mode	Uses only cyclic messaging to communicate between the **Host Controller** and the Q.iMPACT terminal.
Estimated time to complete	Approximation of how long a feed is going to take to complete.
Ethernet	Widely used local area network environment
Equipment Channel Module	An Equipment Channel Module is a functional group of physical devices that can carry out specific minor processing activities. • An Equipment Channel Module is a scale or flow meter together with its Control I/O Module(s) • It may contain other Equipment Channel Modules or Control I/O Modules • It may contain decision-based logic • Different **Units** can share Equipment Channel Modules • A larger grouping may include an Equipment Channel Module either permanently or temporarily

Term	Definition
Equipment Phase	An Equipment Phase is the smallest element of procedural control that can accomplish process-oriented tasks. An Equipment Phase performs unique, basic, and generally independent process-oriented tasks. Often, the phase level links a procedure to physical equipment control. Here are some rules about using Equipment Phases: • An Equipment Phase can operate on more than one Unit, but not at the same time • More than one Equipment Phase can act on physical entities, such as **Units**, **Equipment Channel Module**s, and Control I/O Modules • An Equipment Phase may require one or more other phases to also be running to perform its task
Feed	Material moving at a steady state from one location to another.
Fast Feed Output	This refers to the physical output connection that is used for the faster feed in a **2-speed feed**ing system. This output is not used in a single speed feeding system.
Feed Output	This refers to the physical output connection that is used for the slower feed in a **2-speed feed**ing system or the only feed output in a single speed feeding system.
Feed Override Time	The time in seconds before the completion of a material transfer when the feed algorithm prohibits any Commands from disrupting the feed e.g. an "Abort" command during the "Feed Override Time" will be ignored.
Feed, Fast	Fast Feed is the second slowest feed rate of a multiple speed feeder. Feed starts when the delivered material weight exceeds the **Target** – Fast Feed Value and stops when the delivered material weight exceeds the Target –Feed Value
Feed, Fine	The value entered for the amount of material that will be fed in the slower rate of feed in a **2-speed feed**ing system. This value and the **spill** value are subtracted from the target to determine the point that the fast feed output turns off.
Feed Finish	Success/Fail Status after completion of operation
Feed Start	The equipment and system are in ready state and the transfer of material starts
Feed Stop	The instrument will interrupt the transfer at right time
Fieldbus (generic term)	Fieldbus is a method of connecting field instrumentation using a communications network that links the field instruments to each other, rather than connecting each field instrument individually to the Controller. Fieldbus uses digital communication protocols; which allows information to be communicated between the control system and the field instrument in addition to the process signal. Instrumentation connected to a fieldbus network is always of the smart instrumentation type.

Term	Definition
Final Control Element, FCE	The valve, slide gate, or other actuated process device in a delivery system, which is used to stop flow of the material into the receiving vessel during a feed operation. The Final Control Element is located as close to the receiving vessel as possible to minimize Pre-act. Sometimes abbreviated FCE.
Flow Meter	An instrument which measures the flow rate of material passing through it, converting the flow into pulses or a digital signal which is read by the flow meter card (or PCB) in the Q.iMPACT terminal. A flow meter consists of a metering device (type depending on application) and a transmitter. The Q.iMPACT terminal receives a calibrated signal from the Flow Meter transmitter and does not perform any Flow Meter calibration internally.
Flow Meter Feed	A material feed based on material being measured by means of a flow meter.
Flow Rate Filter Sample Period	Sets the period of time in seconds (from 1 to 60) over which the flow rate is calculated. Smaller values allow the Controller to respond more quickly to changes in rate, while larger values permit the rate to change more smoothly. In most cases, lower values give better cutoff results. This value determines specifies the time, from 1 to 60 seconds, over which the IND780 calculates the rate. For lower values, Qi responds more quickly to changes in rate. For larger values, the rate value changes more smoothly.
Flow Rate Thresholds, Minimum PAC	The flow rate above which the Q.iMPACT process begins to apply the predictive algorithms. Below this flow rate a fixed spill value is used.
Function Block Module	This software module exists within the Controller and is the bi-directional communications interface to the Q.iMPACT terminal. Can also be referred to as a Communications Driver.
Gain-In-Weight System (GIW)	A feed system that adds material to a vessel by detecting the gain in weight on the receiving vessel.
Group Feeds	In some case such as automatic, multi head filling equipment it would be beneficial if all feeds in the bank could start simultaneously. The group feed function caters to this need, and negates the "slew effect". I.e., it ensures that each feed in a bank of (e.g.) 12 filling heads starts simultaneously, rather than slightly later than the one before it in the bank.
Hand Add	This describes a process whereby the addition of material is controlled entirely by an Operator, either by manually controlling a valve or by placing the materials in by hand. Where possible the weighing equipment will monitor the change in weight. The completion of the addition is signaled manually by the operator either by activating an input or by interaction with the weighing equipment's program.
Histogram	Statistical control charting technique used to visualize the distribution of a set of process data samples, such as feed error, as a plot of frequency of occurrence versus deviation from mean.
Host Control System or Host Controller	Supervising control system; controls and monitors the Q.iMPACT terminal.

Term	Definition
Hub	Connection point for equipment on an **Ethernet** network. All traffic arriving on one port in the hub is sent out of all other ports.
Instrument	In the Q.iMPACT terminal context, a scale, load cell system or flow meter that measures the movement of material between the **Unit**s.
K1 Algorithm	A patented **Predictive Adaptive Control (PAC)** feed algorithm that predicts the cutoff point for a feed based on the ratio of the average **Spill** of the material (the amount of material, by weight, which flows into the vessel from the time the cutoff command is given and the time flow completely stops) to the average material flow rate (in weight units/sec). The K1 algorithm is used to calculate the Spill value dynamically during a feed. Select K1 for the following circumstances: • A gain in weight or loss in weigh process which has a linear relationship between the Flow rate and the Spill value would use a K1 algorithm. • Materials which typically have a reasonable and repeatable flow rate (a rate in units per seconds between 0.05% and 1.0% of maximum vessel size). • Used with horizontal feeds that do not have any initial downward velocity, with slower flow rates or vertical feeds which have minimal initial downward velocity.
K2 Algorithm	A patented **Predictive Adaptive Control (PAC)** feed algorithm that predicts the cutoff point for a feed based on a non-linear combination of the average **Spill** of the material (the amount of material, by weight, which flows into the vessel from the time the cutoff command is given and the time flow completely stops), the average material flow rate (in weight units/sec), and other calculated variables. The K2 algorithm is used to calculate the Spill value dynamically during a feed. Select K2 for the following circumstances: • For materials which are flowing by gravity under the source tank's head pressure into the receiving vessel. • A process which has a non-linear relationship between the Flow rate and the Spill value. • Typically used where the initial downward velocity is significant – fast feeds, downwards into the vessel with large deceleration forces. • Slight increase in Spill as the flow rate increases.
K1 & K2 Limits	Specifies the maximum and minimum allowable values for the **K1** and **K2** factors. Prevents runaway calculations due to process upsets.
LAN	Local Area Network
Load Cell	An instrument which measures the live load of the added material and dead weight of the vessel in units of weight; the weight is transmitted digitally from the weigh scale interface to the **Controller**.

Term	Definition
Loss-In-Weight Feeders/ Loss-In-Weight System (LIW)	A feed system that adds material to a vessel by detecting the loss of weight of the source vessel.
Low and High Flow Alarm Management	**Spill** is heavily dependent on flow rate. A material feed could fail if the flow rate is too high or too low. Therefore, it is beneficial to have a corresponding alarm management function for material feeds if a flow rate is below or beyond its normal operating range.
Material Movement Calculation and Reporting	At the conclusion of a feed, the Q.iMPACT software calculates the amount of material moved, the feed error, the flow rate at cutoff, and the actual spill. These calculated values are made available for reporting functions back to the PLC/DCS.
Material Error Detection and Intervention	When the Q.iMPACT terminal moves materials into or out of a vessel, it verifies that the amount transferred is within the specified tolerances. Q.iMPACT will check the feed error against a tolerance weight values and inform the system if the feed error is outside of the tolerance amount. Q.iMPACT supports positive and negative tolerances specified in the material.
Material Feed Problem Diagnostics	When the Q.iMPACT terminal detects problems before, during, and after the execution of a feed, it reports the errors to the PLC/DCS in the form of diagnostic messages. The Q.iMPACT Web Pages also displays the errors.
Material Feed Types	There are three types of material feeds: 1. **Gain-In-weight (GIW)** feed 2. **Loss-In-Weight (LIW)** feed 3. **Flow Meter** feed Function of GIW feeder is a scale or load cell based feed system that adds material to a vessel by detecting the gain of weight of the destination vessel. LIW is a scale or load cell based feed system that adds material to a vessel by detecting the loss of weight from the source vessel. Flow Meter feeder is a feed system that adds material to a vessel by monitoring the volumetric addition of material through the Flow Meter instrument.
Matroller	Material Transfer Controller (Matroller) is a term that was used to identify the JAGXTREME-based Q.iMPACT terminal (Q.i Matroller or Q.iMPACT Matroller). This term is no longer used with the IND780 Q.iMPACT terminal.
Material Path	Identifies the unique combination of a material, a **channel** (measurement device) and a **final control element (FCE)** (e.g. valve, screw feeder, etc.). This represents a material flow path along which the material moves.
Maximum Flow Rate Alarm Value	Flow rates above this value generate an alarm and terminate the feed. Setting the value to 0 turns alarm checking OFF.

Term	Definition
Minimum Open Time	The time in seconds at the start of a feed, in which the controller does not apply a **K1** or **K2** algorithm, normally due to an unstable flow rate which renders these algorithms ineffective. Qi does not apply the spill compensation for this time in seconds immediately following control device opening. If = 0, there is no minimum time. A feed must be active this minimum time in seconds before Qi considers it "successful" and updates its Qi feed parameters. This check guarantees that the flow rate is valid before Qi updates the Qi parameters for a **Material Path**.
Minimum Material Addition	A minimum **target** value can be set per instrument; any Start Feed commands which have a target value below this value will be ignored.
Minimum Slow Step Time	The algorithm uses this value when its computed **slow step time** value is less than this minimum value. The Slow Step Time is the timeout value for a material transfer
Noisy Scale	If the rate of change in weight from one scale reading to the next (usually .05 seconds) is greater than the configured "zero" flow rate, the scale is flagged as "noisy". If the scale is noisy but within an acceptable limit, Q.iMPACT notifies the PLC/DCS, but the Q.iMPACT terminal continues its current function. If the scale is too noisy, Q.iMPACT terminates the current function.
Overlapping Feeds	In order to reduce batch cycle time, the overlapping feed technique can be used. This technique allows delivery of a material to the destination tank using the tank's load cells while an intermediate material is being added to the destination tank from a pre-weigh vessel.
Overlap Feed Alone Time	During an **Overlapping Feed** operation involving a primary and one or more secondary feeds, the primary must be the last material feeding. The minimum length of time that the primary must feed for is the **Overlap Feed Alone** Time
Overlap Feed Alone Tolerance	Sets the additional time tolerance in seconds allowed for a primary **Overlapping Feed** to complete. You may use it to compensate for potential time variations that may occur in completing secondary fees. In practice it is added to the "Overlap Feed Alone Time" by the control algorithms when doing the pre-feed calculations.
Percentage of Target Tolerance Checks	Percentage of feed **target** tolerance checks test the feed error (in weight units) against the calculated percentage of the feed target, as indicated by the configured tolerance. The PLC/DCS specifies the tolerances to the Q.iMPACT terminal in weight values.
Pre-act	Term, no longer used, for **Spill**.
Predictive Adaptive Control (PAC)	A set of patented control algorithms that are used to maintain tight feed cutoffs (+/- 0.05% of vessel full-scale weight) through the measurement of vessel weight and flow rate. The algorithms are able to Adapt to normal variations in the process and Predict the proper cutoff point based on these measurements. Please refer to **K1** and **K2** for additional information
Post-Feed	Operator and Phase are informed of the Completion and take whatever actions are necessary.

Term	Definition
Pre-Feed	Actions necessary to perform a feed.
Q.i	Q.i is the acronym for Quantum Impact. Together, Quality Increases, Quicker Ingredients and Quantifiable Improvement = Quantum Impact.
Q.iMPACT Master	One Q.iMPACT terminal within a **cluster** must be assigned as the Master. The Master performs certain Cluster housekeeping functions.
Q.iMPACT Remote	Between one and nineteen Q.iMPACT terminals within a **cluster** can be designated as Remote terminals. The Remote terminals communicate with the **Master** terminal within a single cluster.
Q.iMPACT Slave	The JAGXTREME-based Q.iMPACT version of a **Remote**. This term is no longer used.
Reasonable checks	Some conditions should be checked before a material feed. Applicable conditions may pertain to and affect operators, equipment, processes, product, etc. For example, if a material feed is requested and the amount of the feed called for is less than what can reasonably be added, the material feed should be suspended and the operator informed that associated conditions are not met.
Reasonable Request	If the PLC or DCS requests a material transfer that is less than what can reasonably be added, the Q.iMPACT terminal does not attempt the transfer and reports a status to the PLC or DCS.
Router	Connection point for equipment on an **Ethernet** network that, like a **hub** or **switch**, directs digital traffic, but is programmable with an interface that configures how traffic will be treated.
Scale, Load Cell System or Flow Meter Capacity	The name assigned to the measuring device's maximum capacity.
Seed Value	Arbitrary initial term representing a best estimate of appropriate value, from which **PAC** algorithm begins its calculations.
Shared Data	Variables found within a Q.iMPACT terminal.
Shared Data Block	A group of related **shared data** variables found within a Q.iMPACT terminal.
Slow Feed Time	In a **two-speed feed** system, this is the amount of time needed for the slow feed. A value is 0 disables the two-speed feed and the entire feed proceeds at the slow feed.
Slow Step Timer	A timer is calculated and started at the beginning of every feed. It is designed to monitor the progress of the Material Feed dynamically. When the material has been feeding for much more time (such as 150%) than the expected feed time as calculated from the material set-point and the average flow rate, the feed is considered to have "Timed Out". In other words, should this value reach zero before the feed is complete, the feed is considered to have "Timed Out". The system will then either generate an Alarm or it may Abort the feed depending on configuration.

Term	Definition
Slow Step Timer Factor	This is the **Slow Step Timer** calculation factor. Slow Step Timer = Factor * (target/average flow). A factor of 1.5 would imply that the material feed can take up to 50% longer than expected before an alarm or abort is generated. The Slow Step Timer is Factor*(target / average flow). The factor is normally set as 1.5, but is adjustable on a material basis. If SST Factor< 0, Qi uses absolute value for SST Factor, but generates alarm only when SST expires.
Spill	The amount of material that will be added (on a weigh-in) or removed (on a weigh-out) from the scale or load cell system after the **final feed** (FCE) is turned off. In a weigh-in process, this is the material that will continue to be recorded after the FCE element was deactivated. There are four major components of spill: • Instrument reading lag • Material in **suspension** • Material that will flow through the restricting device after the closure command • Kinetic energy stored in the material which is released as it impacts the vessel This value is subtracted from the target value (or added in the case of a weigh-out) to determine when the feed output (FCE) turns off.
Spill Only	A feed algorithm that predicts the cutoff point for a feed based only on the average **Spill** of the material (the amount of material which flows into the vessel from the time the cutoff command is given and the time flow completely stops). A Spill Only feed is one where the Spill value has been pre-determined prior to the start of the feed and does not change during the feed (The dynamic Flow Rate is not monitored). The Spill value could be identical to the previous feed or a modified version of the previous feed. Select Spill Only for the following circumstances: • Gain in weight or loss in weight applications where the feeds are short (≤ 6 seconds) • Materials which typically have very low flow rates (a rate in units per seconds less than 0.05% of maximum vessel size) • Materials which have a widely varying (erratic) flow rate • The flow rate is not proportional to the final Spill value
Stable Measuring Device Wait Time	If at the start or end of a feed, the instruments is deemed to be "Unstable" or "In Motion", the **Controller** will wait for the instrument to become "Stable" for this length of time.
Stable Scale	When using the weight reading of a vessel scale, it is necessary to know if the scale is stable when the reading is acquired. The stable scale function provides information as to the reliability of the scale reading: Scale Reading OK, Scale Reading Questionable but OK, and Scale Reading Not OK.

Term	Definition
Suspension	The material committed to flow from the end of a restricting device into (on a weigh-in) or out of (on a weigh-out) a scale or load cell system. May also be called In Flight, Free Fall, Overshoot, etc.
Switch	Connection point for equipment on an **Ethernet** network, more capable than a **hub** but less complex than a **switch**. A router is able to recognize the addresses of devices connected to it, and route traffic accordingly, so that most network traffic goes only where it is directed, rather than to every port.
Target	The target is the weight value that is the end goal of the material transfer process. If a container should be filled with 10 kg of material, the target value is 10 kg. Also known as the "Target"
Target Cutoff Control	Based on the target provided to the Q.iMPACT terminal from the controller, the appropriate cutoff point is calculated at which the feed is stopped via the Final Control Element in order to provide the system with precisely the requested amount of material(s). This provides accurate, high-speed cutoff control for batching, blending and filling systems.
Tolerance	The weight range above and below the **target** value that will be acceptable as an "in tolerance" target comparison. The tolerance can either be entered as a weight deviation from the target or a percentage deviation from the target, depending upon the setup parameters.
Two Speed Feed	Two speed feed can be advantageous in circumstance where the limitations of the **target** comparator speed do not meet the feed speed (feed time or filling rate) and control accuracy (Upper and lower control limits) of the system do not meet the manufacturers requirements. In cases like this it may be advantageous to marry the PAC functionality with 2-speed feed control to allow the more difficult performance requirements to be met compared with using more complex and costly control techniques.
Unit Feed Comparison and Alarming	The Q.iMPACT terminal monitors the amounts of material requested to be transferred from all sources (one source for a single feed, multiple sources for an overlapping preweigh feed or simultaneous flow meter feeds), and compares this number to the actual amount transferred into the vessel at the conclusion of all feeds. If the two amounts differ by more than the configured tolerance, the PLC/DCS is notified.
Unit Cycle Count Management and Alarming	In high-speed batching, a pre-weigh vessel which has just dumped may proceed to refill for the next batch. If the current batch sequence were to be halted for any reason, the batch aborted, or the sequence returned to a previous step, there is the possibility that material in a vessel from the previous batch or material for the next batch may be dumped into the receiving vessel, thereby invalidating the batch. In order to prohibit this condition, each vessel maintains a cycle counter, which indicates which batch is contained in the vessel. When a dump from one vessel to another is requested, the cycle counters are compared to insure that each vessel is "on the same batch".

Term	Definition
Unit	A Unit conducts one or more major process activities, such as crystallize, react, mix or make a solution. A unit is usually a major piece of processing equipment where batching occurs. You can think of the unit as follows: • The vessel itself • The vessel and the attached instrumentation, such as a scale or temperature transmitter • The vessel and other associated equipment, such as scales, valves, flow meters, agitators, or recirculation pumps • Any combination of the above
Unstable Flow Rate Threshold	This sets the flow rate above which the Q.i process generates a **Noisy Scale** condition while waiting for a stable scale reading.
Update Constants	At the conclusion of a feed, the Q.iMPACT terminal updates the cutoff constants based on the performance of the current feed. If the updated cutoff constants meet the required reasonability tests (average flow and average spill compared with high limit and low limit values), then the values are written back to the material database so that they can be used the next time the material is fed.
Vessel Empty Management	A common problem when emptying a vessel is that the dump process may end prematurely. While the dump appears to be finished, there is still too much material left in the vessel. This function makes certain that a reasonable amount of material has been transferred out of the vessel before a detected "zero" flow is allowed to indicate a completed dump condition.
Vessel Overflow	Just before a material is transferred to a vessel, the vessel's capacity is checked. If an attempt to add a material will cause an overflow condition, the transfer is aborted and the operator is informed of the overflow situation.
Weigh In	The material transfer process where the container that will hold the material is placed on or is part of a scale/load cell system, and material is weighed into the container. Aka, **Gain-in-Weight**, GIW, Ingredient Addition, Filling, etc.
Weigh Out	The material transfer process where the container that will hold the material is placed on or is part of a scale/load cell system, and material is weighed from / out of the container. Aka, **Loss-in-Weight**, LIW, Dosing, Dispensing, etc.
Weigh Scales (Gain-In-Weight Feeders)	A feed system that adds material to a vessel by detecting the **gain of weight** of the destination vessel.
Workstation	The system component used to configure the view settings in a **Cluster** and from which to log and analyze data from the cluster. Typically a Personal Computer (or PC) with the Q.iMPACT PC Configuration tool loaded for configuration and Q.i365 loaded for data analysis.
X-Bar and R-Bar charts	Statistical control charting techniques used to visualize the behavior of a set of process data samples, such as feed target and error.

Term	Definition
Zero Flow Rate Threshold	The flow rate below which the system assumes the instrument is in a "Zero Flow" State.
Zero Shift Management	As the process runs, the zero point (empty point) of the vessel will drift due to material buildup, temperature variations at the sensing devices, etc. As the system is used, this drift is tracked and automatically compensated for. If too much drift is detected, the operator is alerted to take corrective action.

METTLER TOLEDO
1900 Polaris Parkway
Columbus, Ohio 43240

64068643