

Electronic Marshalling in Smart Instrumentation



Digitizing Instrumentation Input / Output

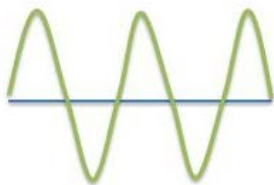
Electronic Marshalling in Smart Instrumentation Topics

- Analog vs. Digital Instrumentation and Wiring Methods
- Conventional and Bus Wiring Methods
- Digital Bus Networks and Electronic Marshalling
- Emerson DeltaV CHARacterization Module (CHARM)
- Schneider Electric's Foxboro Intelligent Marshalling
- Honeywell Experion Universal Process I/O
- ABB Ability™ System 800xA Select I/O
- Siemens SIMATIC PCS 7 Electronic Marshalling
- Yokagawa Centum VP N-IO Electronic Marshalling
- Documenting Electronic Marshalling in Smart Instrumentation
- Summery of Electronic Marshalling in Smart Instrumentation



Analog vs. Digital Instrumentation and Wiring Methods

- **Analog Instrumentation** using electromechanical technology has been the mainstay of Control System automation for many years
- Characteristics of Analog Instrumentation:
 - An analog instrument uses voltage, current, power or energy for measurement
 - The analog instrument uses a pointer or dial for indicating the measured quantity
 - 4-20mA or millivolt signals must be carried on a pair of wires all the way to the controller or Indicator
 - Because of the low level of voltage and current it is subject to interference requiring the signal wiring to be twisted and shielded for noise suppression



**Analog
Signal**



Analog vs. Digital Instrumentation and Wiring Methods

- **Digital Instrumentation** Hardware has several advantages over Analog Instrumentation Hardware:
 - **Accuracy** - The digital measurement is read to several significant digits
 - **Reliability** - More reliable due to inherent noise immunity and less moving parts
 - **Economy** - Due to the integration of millions of digital logic elements on a single miniature chip forming low cost integrated circuit (ICs)
 - **Programmability** - Digital devices are completely compatible with computer systems
 - **Speed** - Logic elements can produce an output in less than 10 nanoseconds
 - **Flexibility** - Digital hardware is inherently flexible in implementation and compatible with any transmission network or wiring method

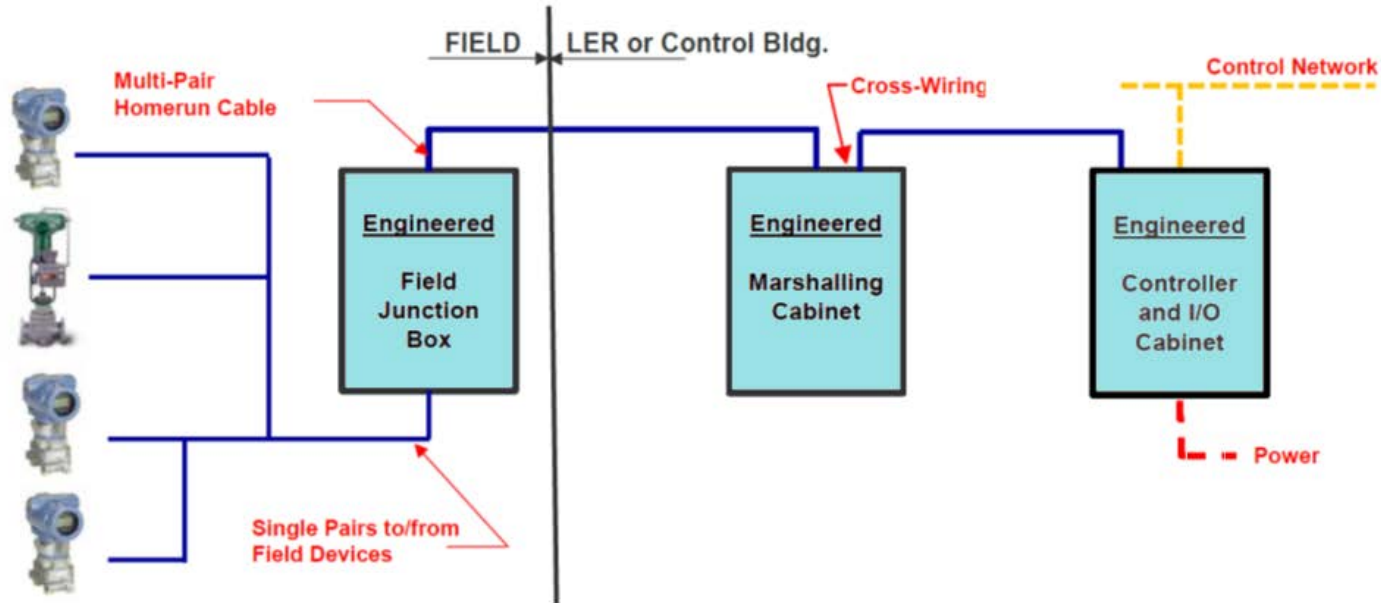
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Digital
Signal



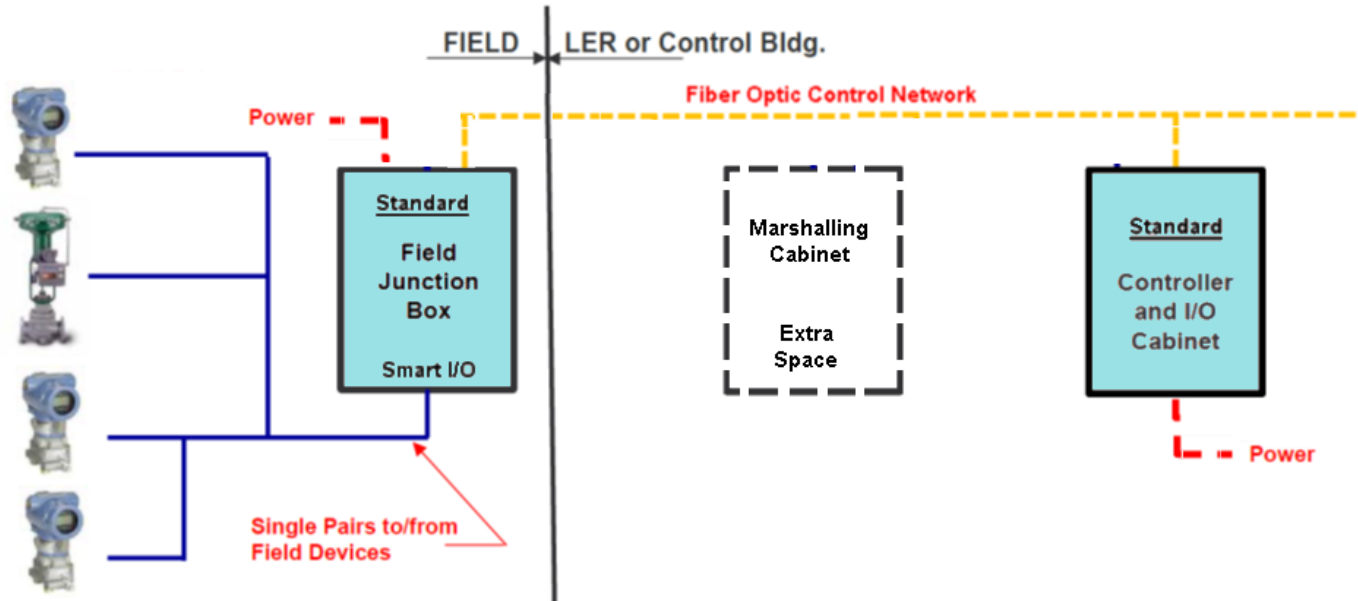
Analog vs. Digital Instrumentation and Wiring Methods

- Analog Instrumentation** Wiring Methods require custom engineered junction boxes, marshalling Panels and I/O cabinets with large multi-pair homerun cables and cross wiring to specific DCS I/O addresses



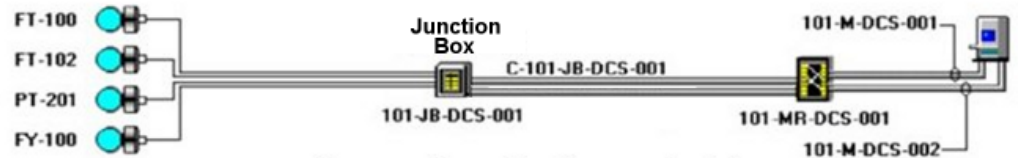
Analog vs. Digital Instrumentation and Wiring Methods

- **Digital Instrumentation** allow the use of Standardized Field Junction Boxes with Electronic Marshalling, Smart Field I/O and Addressable Controllers that eliminates marshalling and most of the wiring

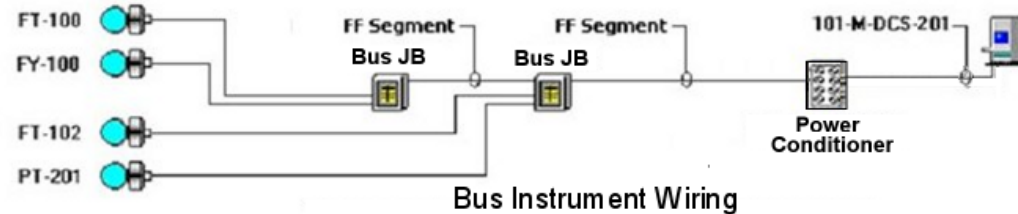


Conventional and Bus Wiring Methods

- Conventional Analog Wiring:
 - Field Device Wiring
 - Junction Box Wiring
 - Homerun Cable
 - Marshaling Cabinets
 - I/O Cabinets
- Digital Bus Instrument Wiring:
 - Field Device Spurs
 - Bus Junction Boxes
 - Segment Cable
 - Power Conditioner
 - I/O Cabinets



Conventional Instrument Wiring



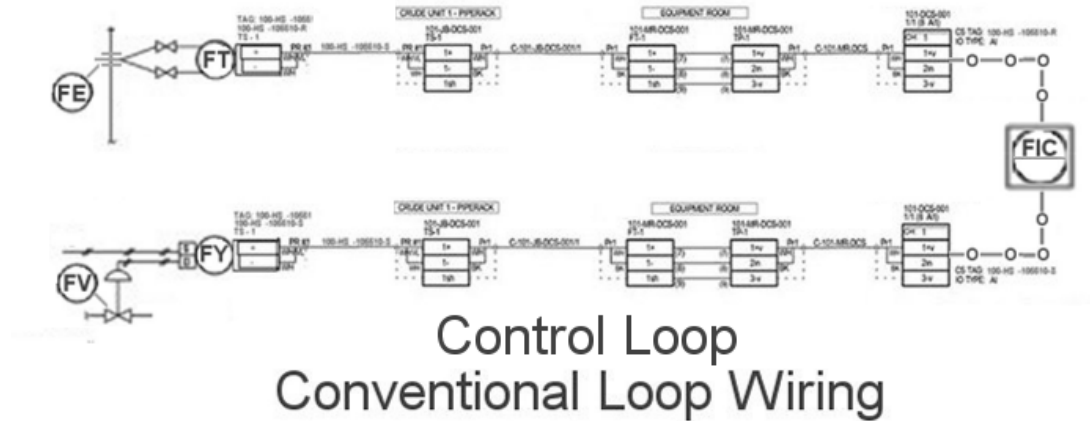
Bus Instrument Wiring

- Conventional Instrument Wiring Requires a Wired Signal from the Field to the DCS for each Device or Instrument
- Digital Bus Wiring uses Single Pair wiring for all Spurs and Segments carrying multiple signals to the DCS

Conventional and Bus Wiring Methods

- A Conventional Control Loop Wiring Method:

- Field Element (FE)
 - Transmitter (FT)
 - AI Signal Wiring
 - DCS Controller (FIC)
 - AO Signal Wiring
 - I/P Converter (FY)
 - Control Valve (FV)
- The Control Loop has Both Input and Output signals
 - Conventional Wiring can carry both Analog and Digital Loops

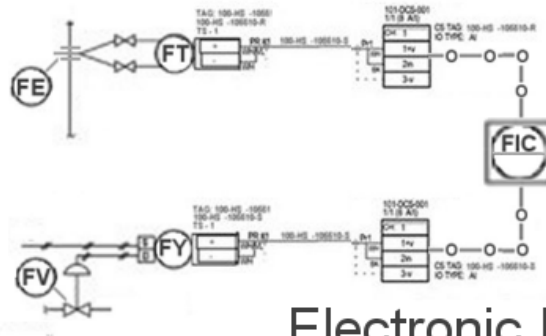


- The Wiring Matrix will depend on the Location of the DCS I/O and the configuration of the Marshalling Panel
- Marshalling jumpers the field signal to the proper DCS I/O

Conventional and Bus Wiring Methods

Bus Wiring Method that lead to Electronic Marshalling

- A Remote I/O Control Loop Wiring:
 - Field Element (FE)
 - Transmitter (FT)
 - AI Signal Wiring
 - DCS Controller (FIC)
 - AO Signal Wiring
 - I/P Converter (FY)
 - Control Valve (FV)
- The Control Loop has Both Input and Output signals



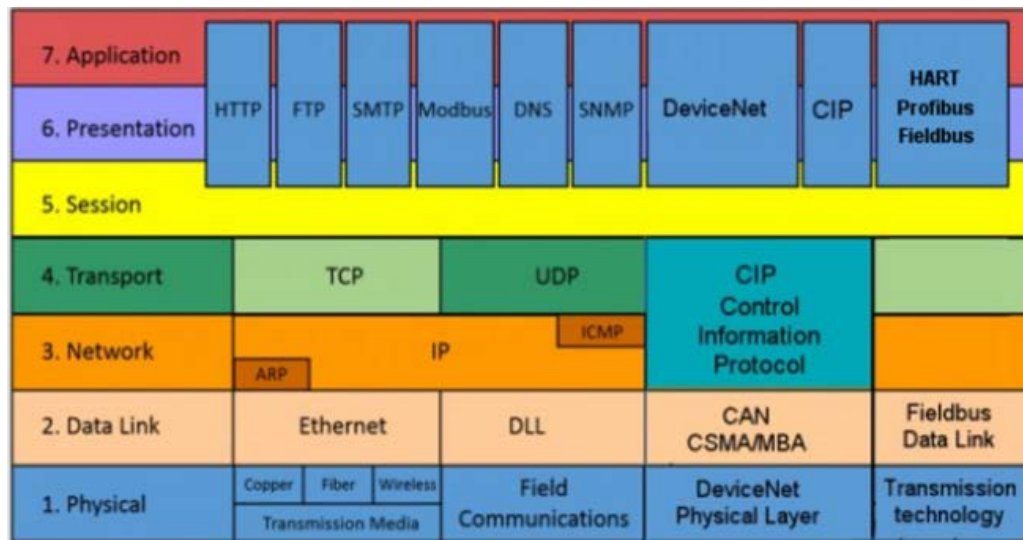
Electronic Marshalling
Conventional Loop Wiring

- By putting the Electronic Marshalling I/O cabinet in the Field you can eliminate the Junction Box and the Marshalling Panel
- This wiring method is referred to as Remote I/O

Digital Bus Networks and Electronic Marshalling

Digital Network Signal Protocols:

- Digital Network Physical Layer Protocols:
 - HTTP – FTP – SMTP
 - Modbus – DNS
 - Device Net – CIP
 - **HART – Profibus – Fieldbus**
- 255 byte Data Link Layer:
 - Ethernet – TCP/IP
 - Data Link Layer (DLL)
 - CAN – CSMA/MBA
 - **Fieldbus Data Link**
- Most Electronic Marshalling use the **Transmission Technology** Physical Layer Protocol

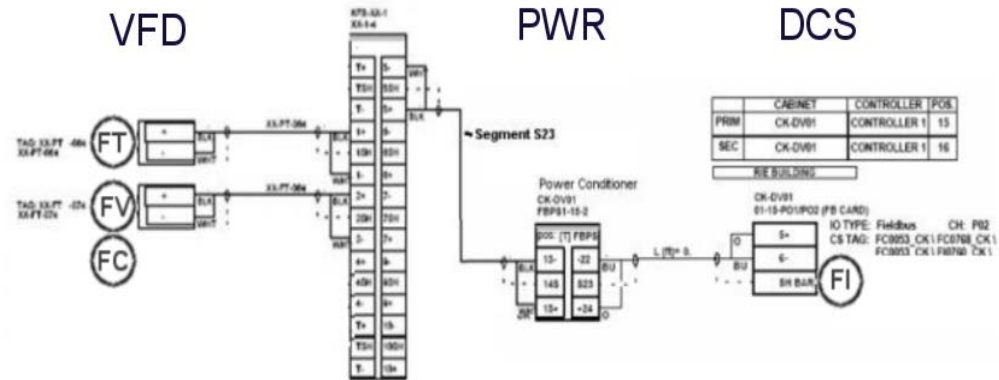


- Digital Signals can be assembled into data packets distributed to on any Control Network by selecting the correct Network Physical Layer Protocol

Digital Bus Networks and Electronic Marshalling

Digital Bus Network Components:

- Virtual Field Devices (VFD):
 - Transmitter (FT)
 - Control Valve (FV)
 - Controller (FC)
- Loop Power for is provided from the Segment Power Conditioner (PWR)
- The DCS Controller acts as a programmer and Indicator (FI) or Controller
- Note the Controller (FC) is in the Field



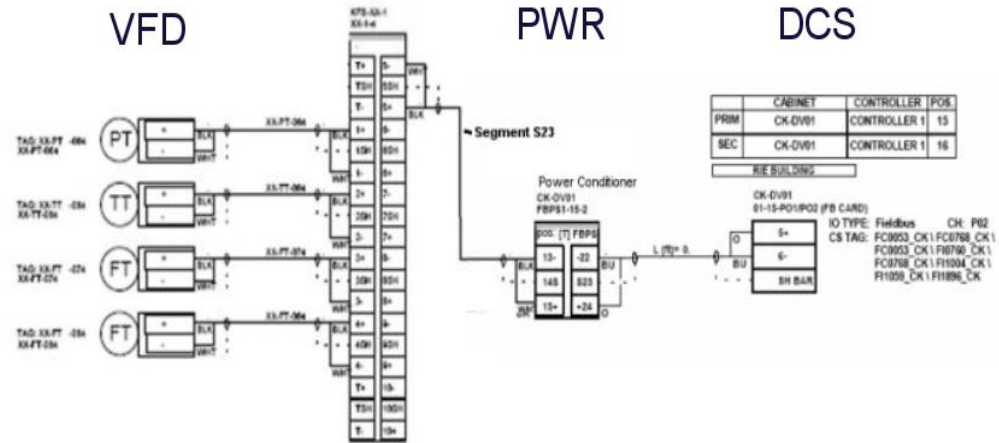
DIGITAL BUS LOOP WIRING

- In a Bus Loop – The Elements are all Programmed as Virtual Devices so the only things carried on the Bus Network are the signals between device nodes

Digital Bus Networks and Electronic Marshalling

Digital Bus Network Segments:

- Each Segment can carry Multiple Loops
- All devices in a loop must be on the same Segment
- Number of devices on a Segment is limited by the manufactures recommended Protocol Parameters
- Control may reside in the Field or in the DCS



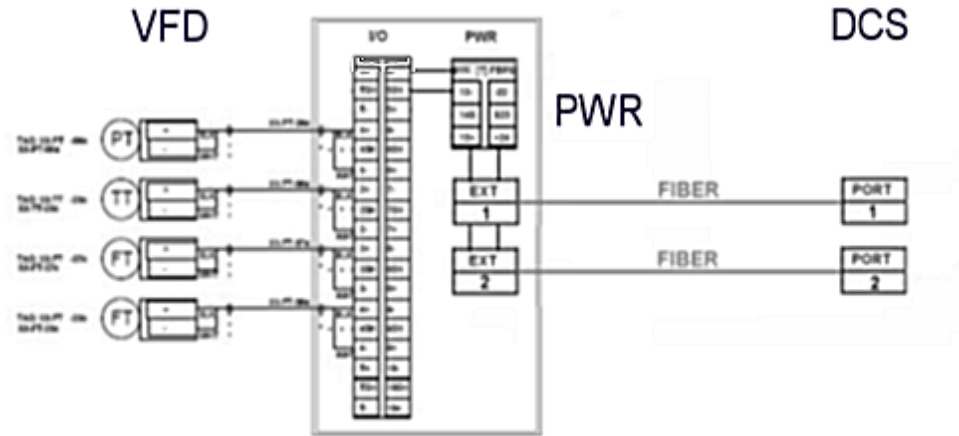
DIGITAL SEGMENT WIRING

- A Digital Bus Network can be configured for Electronic Marshaling by moving the Power Conditioner to the field and using Fiber Optic or Ethernet cables to connect to the DCS

Electronic Marshalling Wiring Methods

Electronic Marshaling Digital Bus Networks:

- Electronic Marshaling Cabinets (EMC) are made by several DCS manufactures using different Bus protocols but they all wire as Remote I/O cabinets
- In this configuration the Field Devices can be wired directly to the I/O constituting a Remote I/O for Field I/O cabinet
- This completely eliminates physical Marshalling Cabinets and Homerun Cables



ELECTRONIC MARSHALLING CABINET

- A Digital Bus Network can be configured as an Electronic Marshalling Cabinet by moving the Power Conditioner to the field and using Fiber Optic or Ethernet cables to connect to the DCS

Emerson DeltaV CHARacterization Module (CHARM)

CHARM I/O Card (CIOC) Configuration:

- Each Field Panel has a redundant CIOC Carrier ; I/O Cards with redundant Ethernet Communications Module and 24VDC Power Supply
- CHARM Base Plate; DIN rail-mounted with power, bus connectors, and Supports 12 CHARMs per Base Plate
- CHARM Terminal Block - removable terminal block providing connections to field wiring and physical latch for CHARM
- CHARMs - Characterization Module for each field signal - Provides basic analog to digital conversion and signal isolation to the redundant communication bus
- DIN rail mount for all CIOC components
- CIOC is Configurable for:
 - Basic Process Control Systems (BPCS)
 - Safety Instrumented Systems (SIS)
 - Intrinsically Safe (IS) Systems



Emerson DeltaV CHARacterization Module (CHARM)

- CIOC Can be located in an RIE building or Mounted in a CHARM Field Enclosure
- Instrument Wiring to CIOC can be Direct or by Junction Boxes and Homerun Cables

Charm Field Enclosures Equipped as Follows:

- Power distribution and isolation components for primary and secondary 24V DC Power to CHARM I/O Cards.
- AC power feeds with redundant AC/DC 24V DC bulk power supplies.
- Grounding bars for CG (Chassis Ground) and DC Reference Ground
- Wire Ducts and Name Plates
- CIOC Carriers, Base Plates and Terminals.



Standardized Field I/O Enclosures

Schneider Electric Foxboro Universal Fieldbus Module (FBM)

Foxboro Universal Fieldbus Module (FBM) 247

- Software configured I/O points from anywhere in the world
- Plan overall I/O count during FEED stage and assign IOAs during installation
- Easily accommodate late binding project changes
- Decrease inventory overhead with a common base that spans 24 V – 240 V
- Agency approval package allowing worldwide use



Foxboro Universal Fieldbus Module

Phoenix Contact's VIP-ER Optimized for the FBM 247

- A single input/output accessory (IOA) for each channel
- Terminals for discrete wiring or cable connection
- Power bus terminals with redundancy
- Each channel has four connections (A, B, C, D) and multiple shield options



Phoenix Contact I/O Signal Conditioners

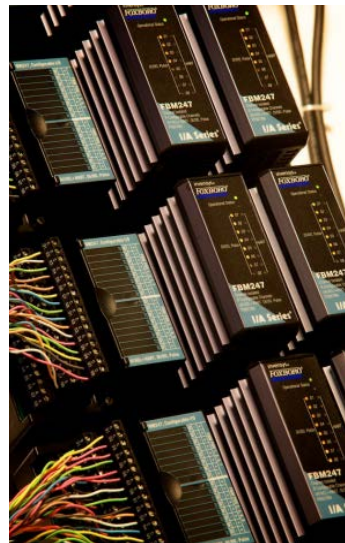
Schneider Electric Foxboro Universal Fieldbus Module (FBM)

The Foxboro Universal I/O Intelligent Field Marshalling Cabinet

- Available with Fieldbus or VIP Wiring assemblies

Preconfigured with Foxboro Universal Fieldbus Modules and Phoenix Contact VIP-ER with Input / Output Accessories

- Elimination of marshalling infrastructure
- Increased I/O density per cabinet
- Reduced field and maintenance labor costs
- Decreased inventory and cost of spares
- Less engineering work and less documentation to maintain
- Faster implementation and start-up:
- Cabinets to field before final design
- Easy to implement last minute design changes
- Less chances of error after factory acceptance testing



Standardized Field I/O Enclosures

Honeywell Experion Universal Process I/O

Universal Process I/O provides all the benefits of the Series C I/O family and introduces the following new features:

- 32 Universal Channels per module
- Each channel individually configurable as AI, AO, DI or DO
- HART 7 support for AI and AO
- True soft configuration with no additional hardware needed to switch I/O configuration
- Full optional I/O redundancy
- Local and remote deployment capability
- Cabinet & DIN RAIL mounting options
- Extended temperature range (-40 to +70 Deg C)



Universal Process I/O Module

Honeywell Experion Universal Process I/O

Universal I/O Cabinets, enabled by Universal Channel Technology allow the cabinets to be standardized, since any field signal can be connected to any I/O channel.

- Allows for prepackaged solutions for faster project execution
- Adapts to I/O changes late in the design, mitigating schedule risks
- Supports remote location deployment thereby reducing cables and cabinets
- Offers a DIN RAIL mount option
- Reduces the spares needed on site and makes maintenance easy
- Allows for process and safety I/O to be located in same cabinet, saving on infrastructure costs



Standardized Field I/O Enclosures

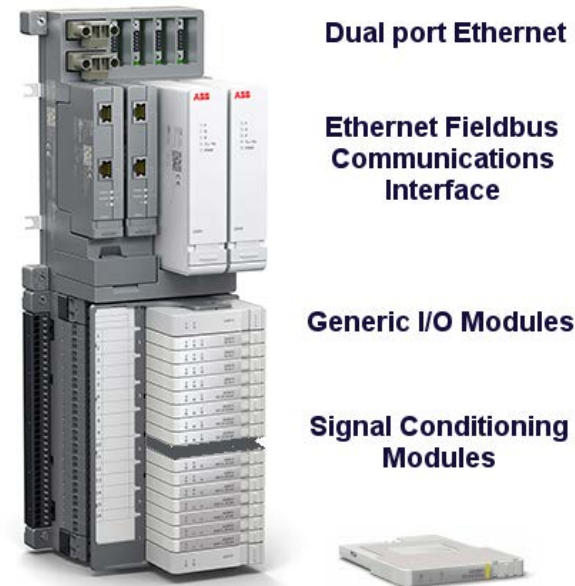
ABB Ability™ System 800xA Select I/O

ABB Ability System 800xA Select I/O Signal Module Termination Unit (MTU)

- Hosts the Generic I/O Module(s) (GIOs) and up to 16 Signal Conditioning Modules (SCMs)
- 12 Select I/O MTUs can be connected to one Ethernet FCI Termination Unit
- 16 field terminal blocks for each SCM
- 2 power terminal blocks (PTBs) for powering digital outputs
- An optional grounding bar for landing shields / spares

Signal Conditioning Modules (SCMs):

- Individually condition and provide power to a connected field device
- Different SCMs are available for various process and safety field device types



Select I/O Module

ABB Ability™ System 800xA Select I/O

ABB Ability System 800xA Select I/O Field cabinet that includes the following components:

- Ethernet Field Communications Interface (FCI)
- Select I/O Module Termination Unit (MTU) populated with Generic I/O modules (GIOs) and Signal Conditioning modules (SCMs)
- One set of 'system' power supplies is needed for the entire Select I/O cluster
- Optionally, a set of 'external field' power supplies will be added for power hungry digital outputs
- 16 field terminal blocks for each SCM
- 2 power terminal blocks (PTBs) for powering digital outputs
- An optional grounding bar for landing shields / spares



Standardized Field I/O Enclosures

Siemens SIMATIC PCS 7 Electronic Marshalling

SIMATIC Compact Field Unit (CFU)

- Complete elimination of individual marshalling cabinets
- Plug-and-produce simplicity
- More flexibility through consistent decentralization
- Seamless integration with SIMATIC PCS 7



SIMATIC ET 200SP HA

- Communication standard using PROFINET
- Redundancy at the PROFINET interface (S2 or R1)
- Terminal block with integrated I/O redundancy
- Station expansion possible during operation
- Compact modules with permanent wiring
- Identical terminal block for all 24 V standard signals
- Compact size with up to a maximum of 56 I/O modules per station
- High channel density of up to 32 channels
- System integrated power bus Seamless integration in SIMATIC PCS 7



Standardized Field I/O Enclosures

Yokagawa Centum VP N-IO (Network-IO) Electronic Marshalling

Smart Configurable I/O Module

- 16 Channels N-IO
- Signal: AI / AO / DI / DO
- Software Configurable
- HART 7 Support
- Extended Temp.: -40°C to 70°C

Signal Conditioner (Adaptors)

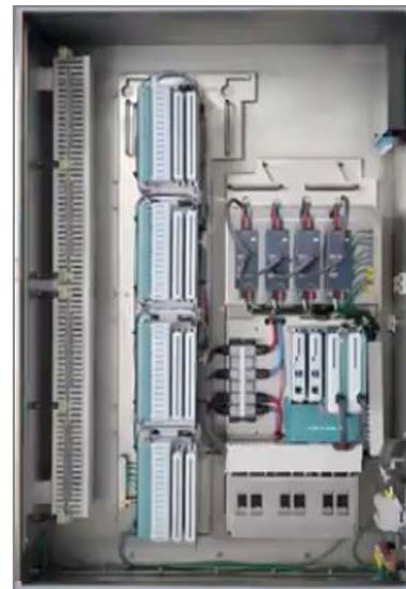
- Default type is through type adaptor
- Single channel integrity
- Pulse, Voltage DI, Relay DO, AI/AO

Standard Pre-engineered Enclosure for N-IO

- Eliminate marshaling cabinets
- Reduced Footprint with remote I/O
- Standardized Field Panel Design



Configurable I/O Module
With Signal Conditioners




Standardized Field N-IO Enclosures

Documenting Electronic Marshalling in Smart Instrumentation

The first step is to download or build the DCS Interfaces into the SI reference explorer


- Honeywell, DeltaV and Yokagawa can be downloaded through Intergraph Smart Support
- Foxboro DCS Interface is available from Smart Instrumentation Administration Module
- To build a DCS Interface you can use any of the others interfaces and modify the hierarchy

DCS Interfaces

 Yokogawa CS 3000


17 April 2014

For more information on Interfaces and Complementary Software [Click here](#).

 Honeywell

16 April 2014

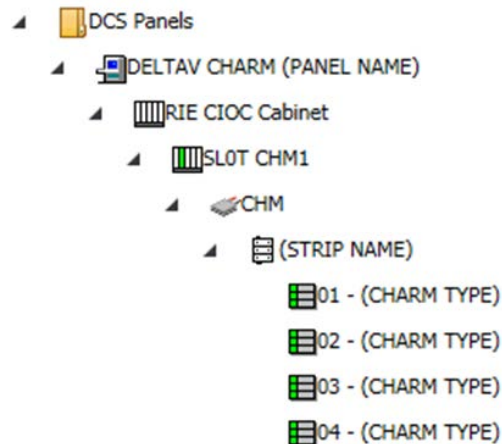
For more information, [click here](#).

 DeltaV Interface

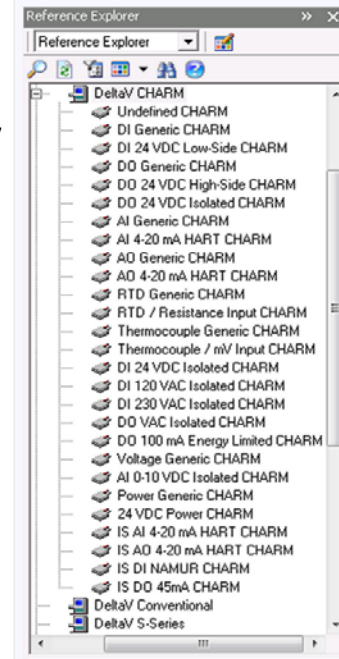
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For more information on Interfaces and Complementary Software [Click here](#).

Download DCS Interfaces



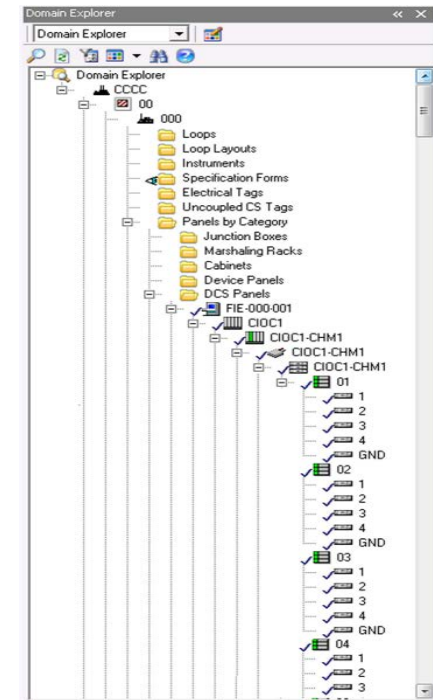
Build a DCS Interface



Documenting Electronic Marshalling in Smart Instrumentation

DCS Interface Hierarchy in the Reference Explorer

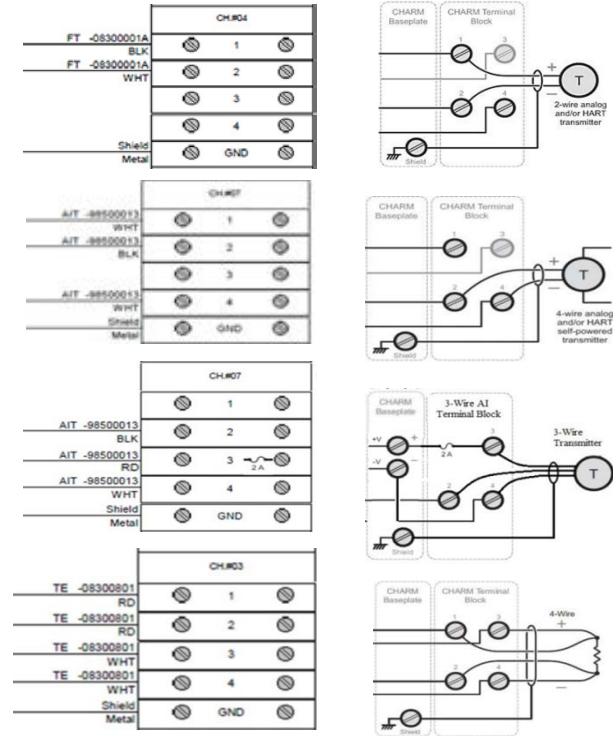
- **Panel (Field Cabinet)**
 - Rack
 - Slot
 - **Terminal Strip (Branch)**
 - CHARM or Conditioning Module
 - **Channel (I/O Address)**
 - Terminals
- The **Panel** is the Field Junction Box or I/O Cabinet Name
- The **Terminal Strip** is the Carrier for the Signal Conditioners – This will allow the wiring reports to show all the I/O channels in a cabinet
- The **Channel** carries all of the required DCS addressing data fields – Only the label in the channel number will show in the Wiring Reports



Documenting Electronic Marshalling in Smart Instrumentation

Wiring the channels will require different terminal arrangements for each different type for Field Device I/O

- Loop powered 2 wire AI, AO, DI and DO will use a pass thru signal conditioner as most use Bus Protocols
- Field Powered 2 and 3 wire AI and DI may have different terminal arrangements than Loop Powered devices
- Loop powered 3 and 4 wire Field Devices will have different wiring connection patterns depending on the DCS manufacture
- RTD 3 and 4 wire Field Devices will have different wiring connection patterns depending on the DCS manufacture



Documenting Electronic Marshalling in Smart Instrumentation

Wiring reports are greatly simplified as the only connections are between the Filed Device and the Field Panel I/O channels

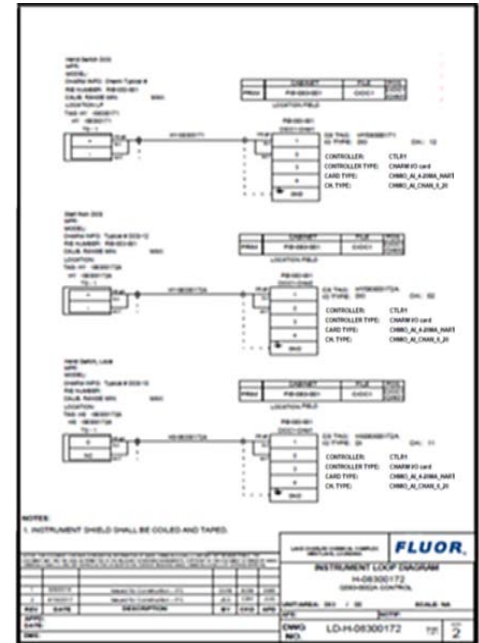
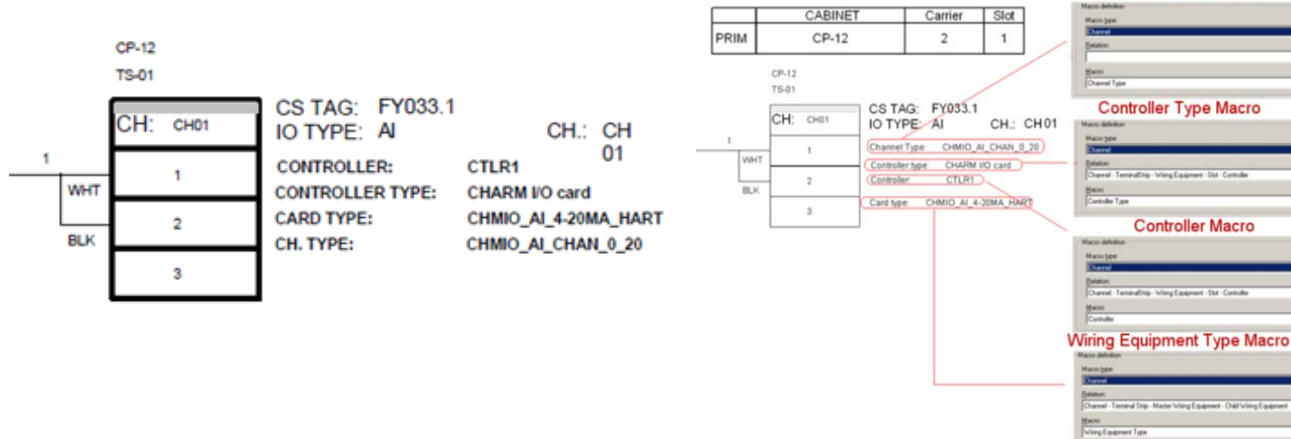
- The “Panel – Strip with Adjacent Connections “ will show the Device Panel and DCS Field I/O Panel connections but is limited on the amount of DCS addressing data shown
- The “Panel – Strip with Adjacent Connections (Enhanced Report...” will show the Device Panel and DCS Field I/O Panel connections allows additional channel data to be displayed if needed to show Electronic Marshalling configuration data by adding macros to the Channel Symbol

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Documenting Electronic Marshalling in Smart Instrumentation

Electronic Marshalling Loop Diagrams are greatly simplified because there are only two connection points in most devices

- Macros can be added to the channel symbol to show additional properties
- In some cases loop diagrams may be eliminated altogether



Electronic Marshalling in Smart Instrumentation Summery

Pros of Electronic Marshalling:

- Elimination of Multi Pair Homerun Cables and custom Marshalling Panels
- Elimination of custom Field Junction Boxes and DCS I/O cabinets
- Minimizing the number of connection points (points of failure) in the wiring matrix
- Supported by most DCS manufactures and certified for PCS, SIS and F&G control systems
- Lends itself well to modular construction and flexible DCS and PLC configuration

Cons of Electronic Marshalling

- Requires 120 Volt UPS wiring at each Remote I/O cabinet
- Requires all signals to be digital and will not carry analog signal component
- Some instrument systems require direct wiring to the CPU and cannot use Electronic Marshalling

Electronic Marshalling in Smart Instrumentation Summery

- Electronic Marshalling requires Digital Instrumentation and Wiring Methods to support the Bus Networks and data protocols required to networking the signals
- Digital Bus Networks used for Electronic Marshalling are normally an extension of Fieldbus or Profibus that simply moved the Power Conditioners and Communications Interface into a field I/O cabinet
- Emerson DeltaV, Foxboro, Honeywell, ABB, Siemens and Yokagawa all support some type of Electronic Marshalling
- The Smart Instrumentation wiring module is capable of documenting the Electronic Marshalling and Bus Networks

Electronic Marshalling has become the standard emerging technology for Control Systems and Instrument Systems wiring matrixes

“Troubleshooting a wiring problem is a soul-killing experience.”
~ Casey Neistat

Questions?

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