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Westinghouse &
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Technical Data
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IMPACC WIRING SPECIFICATION BASE RULES

VERSION 1.1

TD17513

EATON

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Introduction

IMPACC (Integrated Monitoring Protection and Control Communications) was developed specifically for power distribution and industrial applications. It centers around the Industrial Communications (INCOM) chip which employs frequency shift key (FSK) technology and has the following benefits:

- Devices are easily "daisy chained" with inexpensive shielded twisted pair cable:
- Noise immunity and signal integrity verification ensure reliable data transfer.
- Up to 1,000 devices are supported on a Main Network;
- Up to 99 devices are supported in a Subnetwork;
- Up to 1,000 devices may be monitored and controlled from a single location running Series III software;
- Distances of up to 10,000 feet are supported without repeaters;
- Polarity is not an issue when connecting wiring to devices;
- Wiring may be run as close to power wiring as NEC (or CSA) and local safety codes permit. Attention should be paid to NEC Articles 725, and 800 (NEC 1993) and CEC section 60 in particular rule 60-306 (CEC 1990);
- Wiring may be run in control and communication cable trays and conduit in accordance with NEC (or CSA) and local safety codes. Attention should be paid to NEC Articles 725, and 800 (NEC 1993) and CEC section 60 in particular rule 60-306 (CEC 1990).

System Configurations

The architecture for an IMPACC System allows all of the following:

- Devices wired in a "daisy chained" fashion;
- Devices wired in a "simple tap" fashion;
- Devices organized as a "complex tap";
- Devices in a subnetwork under a "submaster".

Definitions

Master - The Master is the only device on a Main Network which issues command signals. All other devices on a Main Network respond to commands from the Master addressed to them (see Figs.4 and 7). A Master must be utilized in conjunction with a higher level system or host that determines which command messages and information requests the Master should send over the Main Network.

A Master may be any of the following:

- A Computer Operated Network Interface card (CONI) which must be used in conjuction with an IBM-compatible personal computer running a software package that collects information from the IMPACC System. Among some of the software packages available are: Cutler-Hammer's Series III or Series III with Enhanced Graphics; Iconics' Genesis; and Intellution's FIX DMACS.

- A Master INCOM Network Translator (MINT) which acts as a gateway between an IMPACC System and any host capable of RS232 communications (or RS485 when used with a RS232 to RS485 interface converter) . The host may be a Personal Computer (PC), Programmable Logic Controller (PLC), Building Management System (BMS), or Distributed Control System (DCS / SCADA). A software driver is required in the host that enables communications with the MINT. If the required driver does not presently exist, one will need to be developed based off information provided in the IMPACC Communications Protocol Manual (IMPCOM - TD

17384). Contact the Advanced Products Support Center (APSC) on 1-800-809-APSC for a current listing of available IMPACC Connectivity options.

- An NL-583 module which is used in conjunction with a Westinghouse PLC PC503 or PC55 processor or with any PC2000 processor using an NL-599 remote I/O subsystem. Pre-programmed software function blocks furnished with the NL-583 module eliminate the need to develop a driver that translates between the PLC and the IMPACC System.
- A Mod Bus Gateway and Ethernet Bridge which acts as a gateway between an IMPACC System and any host using a Mod Bus or Ethernet protocol and that is capable of RS 232 communications (or RS485 when used with a RS232 to RS485 interface converter). The modules transform information from the INCOM protocol into the appropriate protocol for the host system. They are loaded with software and programmed at the factory and then sent to the customer for device configuration.

Submaster - The Submaster is the only device on a subnetwork which issues command signals. All other devices on a Subnetwork respond to commands from the Submaster addressed to them. The Submaster appears as a single device to the Main Network above and responds, on the Main Network, to commands addressed to it by the Master (see Figs.4 and 7).

Submasters and the devices supported on their subnetworks are as follows:

Submaster	Supported Subnetwork Devices
Assemblies Electronic Monitor II (AEMII)	Digitrip RMS 700/800 PONI connected to: IQ Data, IQ Generator, IQ Data Plus II, or IQ Data Plus II HV.
Central Monitoring Unit (CMU)	Advantage Control Module (ACM) connected to: Advantage Starter/Contactor. WPONI connected to: Advantage Starter/Contactor/Overload. PONI connected to: IQ 500.
Central Energy Display (CED)	IQ Energy Sentinel Addressable Relay II (for sync. pulse only) PONI connected to: IQ Data Plus II, IQ Data Plus II HV
Breaker Interface Module (BIM)	Digitrip RMS 810/910 OPTIM Trip Unit IQ Energy Sentinel

Main Run - A Main Run is a length of cable greater than 200 feet on which the Master or Submaster resides. The Master or Submaster may be connected to a Main Run in a Simple Tap or Daisy Chained fashion and may be located at either end of the Main Run or somewhere in between (see Figs. 1 and 2).

EOLTR - An End of Line Termination Resistor is used to eliminate reflections and to provide a load into which the INCOM transceiver can drive its signal.

Node - An IMPACC compatible device such as a Digitrip 810, IQ Analyzer with PONI, Advantage with WPONI, or IQ Energy Sentinel.

Daisy Chain - A cable layout where all nodes appear as parallel loads across a single run of shielded twisted pair. (see Fig. 1).

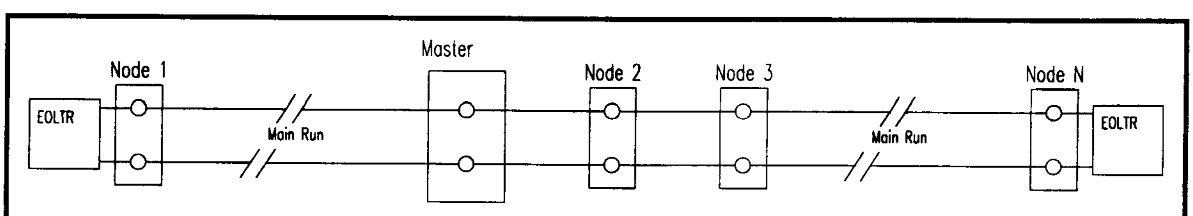

Figure 1

Simple Tap - A Short Run of cable which physically "Ts" off of a Main Run and has one node at the end. The Short Run of cable can be a maximum of 200 feet. No EOLTRs are used within a Simple Tap (see Fig. 2).

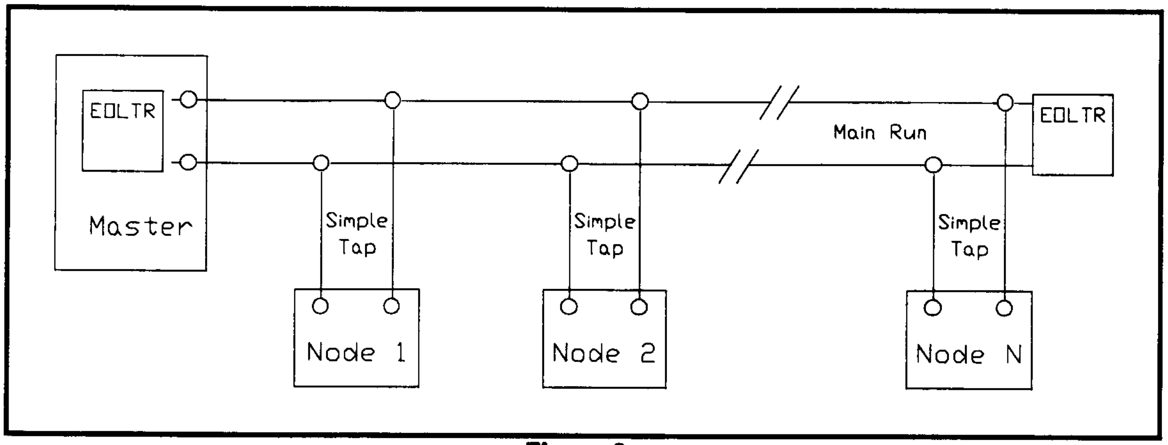

Figure 2

Complex Tap - A Short Run of cable which physically "Ts" off of a Main Run and may have "sub Ts". The total length of cable in the Complex Tap must not exceed 200 feet. The total number of IMPACC devices must be equal to or less than 64. Three levels of subtaps are allowed with a restriction of 4 feet on the third level. No EOLTRs are used within a Complex Tap (see Fig. 3).

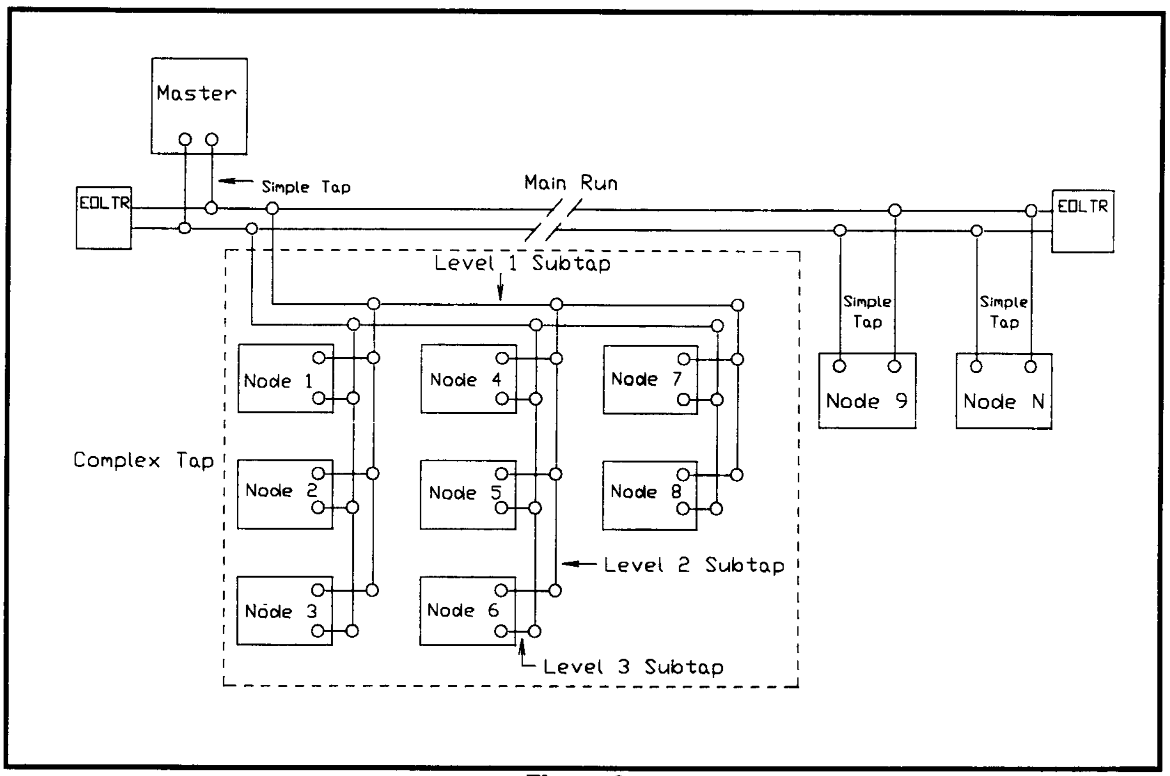

Figure 3

Main Network - A Main Network consists of the Main Run connected to the Master as well as all the cabling in Simple Taps and Complex Taps connected to that Main Run (see Fig. 4).

Subnetwork - A Subnetwork consists of the Main Run connected to the Submaster as well as all the cabling in Simple Taps and Complex Taps connected to that Main Run (see Fig. 4).

Note: Daisy Chained devices, Simple Taps and Complex Taps may appear, not only in Main Networks, but also in Subnetworks (see Fig. 4).

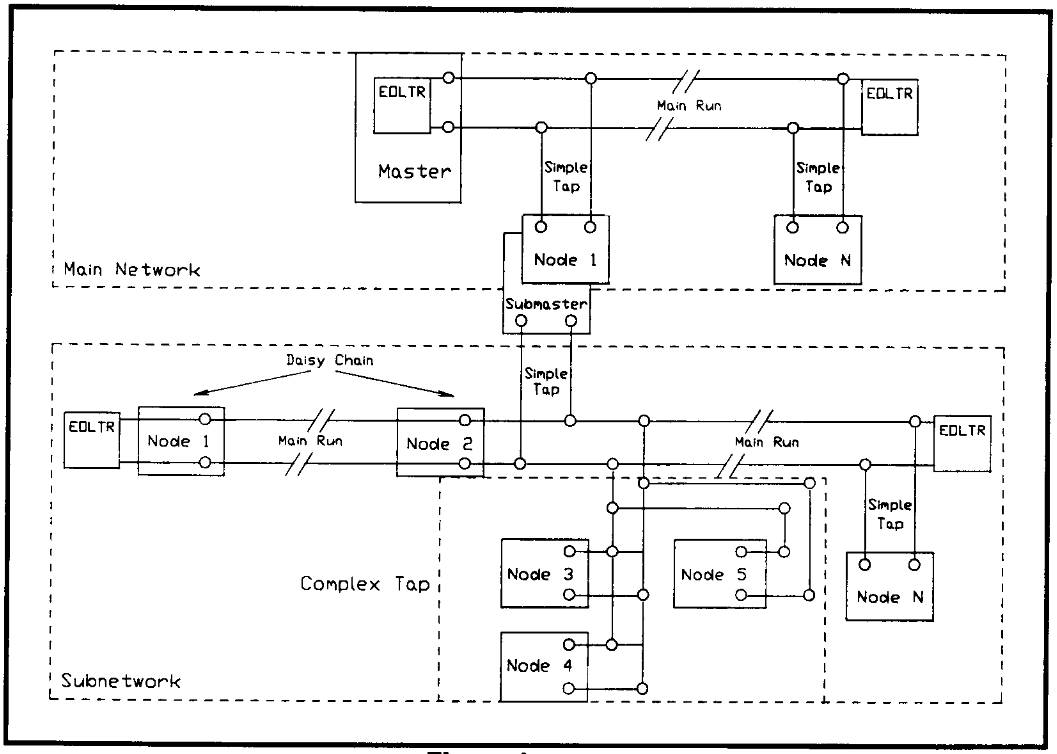

Figure 4

Additional Cable Architectures

Cable Star and Cable Branch architectures are permitted (see Figs. 5 and 6):

Cable Star - A Cable Star configuration is created when the Master or Submaster is connected to more than one Main Run (see Fig. 5).

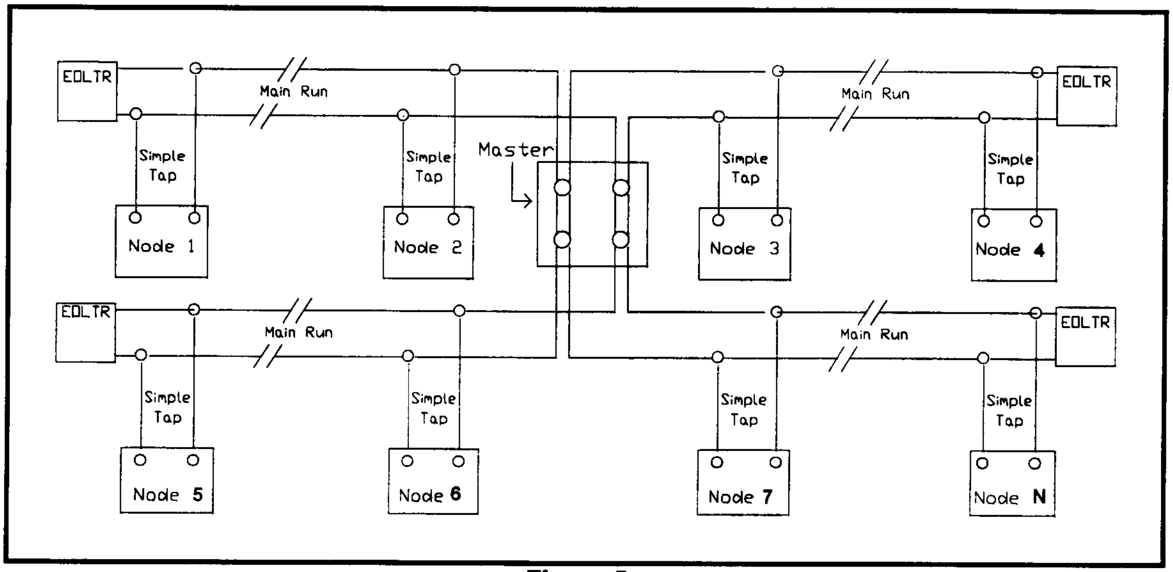

Figure 5

Cable Branch - A Main Run splitting into one or more Main Runs (see Fig. 6).

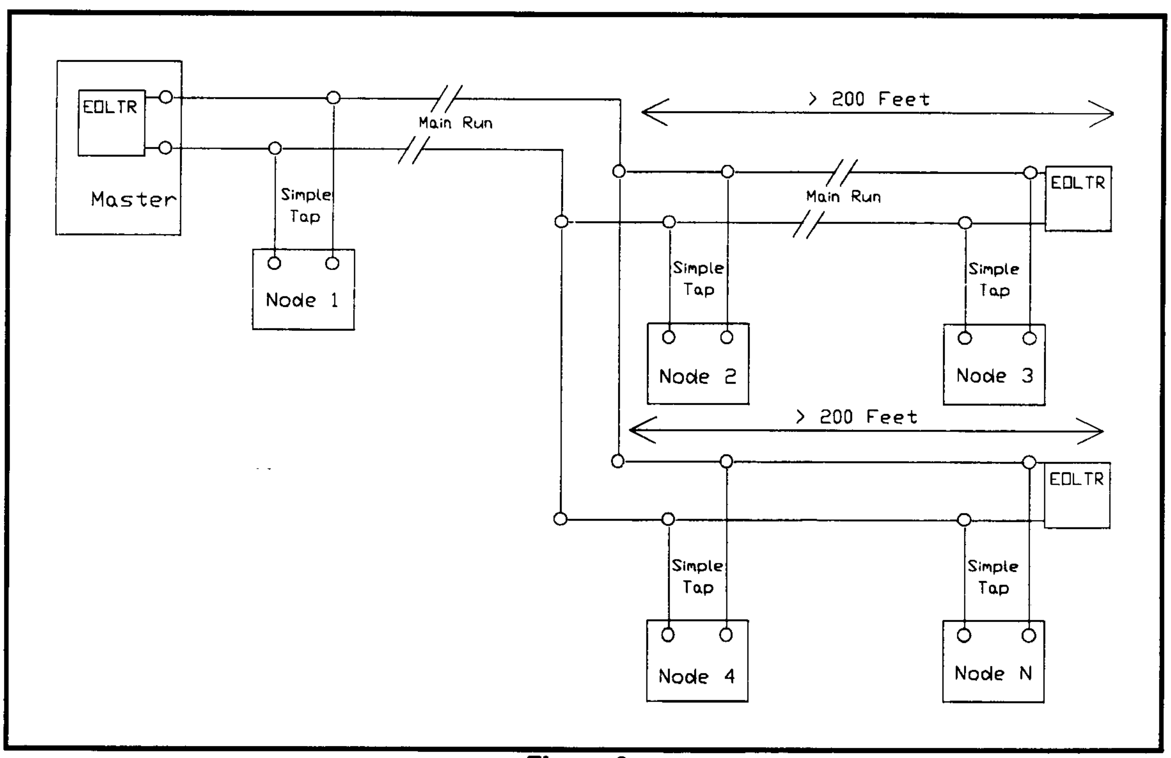

Figure 6

Wiring Specifications

IMPACC (Integrated Monitoring Protection and Control Communications) was specifically designed with the intention of delivering a comprehensive and powerful energy management solution for use in electrical distribution environments while ensuring affordability, flexibility, simplicity and noise immunity. An IMPACC System installed per the following rules will allow the user to fully realize all of the above advantages. Failure to follow these rules could result in sub-optimal system performance. These base rules are expected to have been followed as a starting point before troubleshooting is performed on a system.

These base rules apply for systems utilizing the Cutler-Hammer IPONI communication module on the main network. Use of non-INCOM based PONIs follow the rules of the communication physical layer for which they were designed (i.e. RS 232 PONI is point to point, 50 feet). Use of the Buffered PONI results in different system capacities. Please contact APSC for system's capacity information with this product.

***Rule 1:* Cable Selection**

Approved cable types:

- Any of the cables in the Belden 9463 family;
- Quabbin 6205
- Commscope 9022
- IMPCABLE - a 600 V rated cable custom designed for IMPACC - Style # 2A95705G01

***Rule 2:* Cable Intermixing**

Any of the various application cables within the Belden 9463 family of cables may be intermixed without compromising communication performance.

Since industrial or commercial installations often require a wide range of cable application choices, preference should be given for wiring with Belden 9463. The Belden 9463 family of cables contains choices for armored, high temperature, direct burial, or plenum applications among others. For guidance in selecting the appropriate application cable from the Belden 9463 family of cables, or for technical information on IMPCABLE or Belden 9463 cables, contact Belden's Technical Support Desk by calling 1-800-235-3361 and selecting option 3.

Often, one may choose to wire all Main Runs with Belden 9463 and wire Complex Taps or Subnetworks within distribution gear with IMPCABLE where a 600 Volt rated cable may be required.

***Rule 3:* System Topology, Size, and Capacity**

Topology

- Bus -or Single star
- Maximum of long lines from star: 5
- Line termination:
  - None for tap
  - 100 ohms at end of long line
- Maximum cable length between ends of longest lines: 10,000 feet

Attenuation

- Total system capacity: 25 dB
- Attenuation per device: 0.01 dB
- Attenuation for approved wire types:

Cable type	Attenuation/1000 feet
IMPCABLE	1.6 dB
Beldon 9463 family	2.0 dB

- Attenuation at star:

Number of long lines	Attenuation
3	3.5 dB
4	6 dB
5	8 dB

Definition

- Daisy chain: point to point wiring between devices or clusters of devices
- Star: Single point with a number of long lines emanating from it
- Long line: >200 foot wire run
- Simple Tap: <200 foot connection to cluster of devices

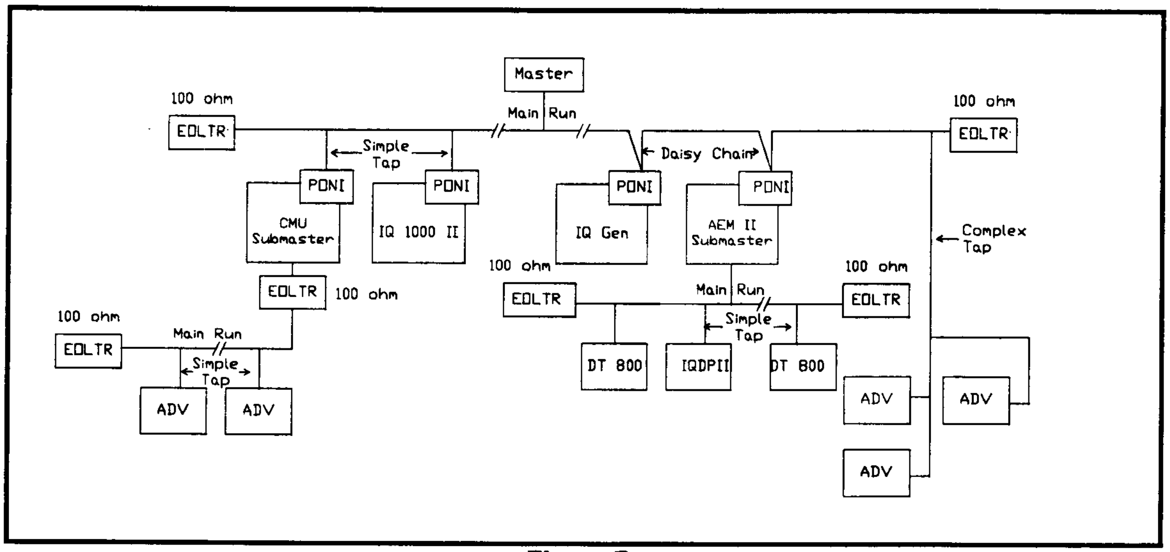

Figure 7

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***Rule 4:* Cable Splicing**

The mechanics of cable splicing and appropriate equipment are covered in Appendix A . The prime goal is to create a secure electrical connection while minimizing exposure to electrical transients. Ferrules are used to dress cable ends in order to avoid problems associated with frayed and loose wires. Beside facilitating cable installation, subsequent data line troubleshooting and downtime are minimized. Most IMPACC devices have built-in two pole terminal blocks which can be used for splicing. Additionally, terminal blocks should be utilized when splicing elsewhere in the gear or facility to ensure a secure electrical connection. All devices, End Of Line Termination Resistors, Simple Taps and Complex Taps should be placed in a parallel across the cable.

***Rule 5:* Cable Shielding**

The cable shielding and outer jacket should not be stripped back beyond 1 1/2 inches. Three pole terminal blocks are used at tap points to ensure a continuous metallic shield ground path. To ensure a secure electrical connection when daisy chaining IMPACC devices that have built-in two pole terminal blocks, mechanically crimp sleeves onto the two shield path drain wires (See Figure 9). The cable shield ground path for a Main Network and Subnetwork must not be joined together. Each should have a separate connection to earth ground reference.

***Rule 6:* Cable Grounding**

The shield ground path of a Main Network (and each Subnetwork) should be broken up into separate isolated segments in such a way that a single, solid earth ground is available within 3000 feet of any point along a Main Network (or Subnetwork). Isolation is accomplished by <u>*not*</u> tying together the drain wires of neighbouring segments at the appropriate splicing junction.
The unused drain wire end may be taped back upon the cable to prevent accidental grounding.
A solid earth ground is accomplished by connecting the shield ground path's drain wire to a #14 AWG or larger multi-stranded wire that has an impedance path of 1 ohm or less to a known earth ground. **Note**: The building electrical ground may not be effective since it may travel through many connections and considerable distances before reaching earth ground. In such cases a new ground path will be required since the effectiveness of this shield earth ground connection will affect the integrity of data transferred over the cable (see Figs. 8 and 9).

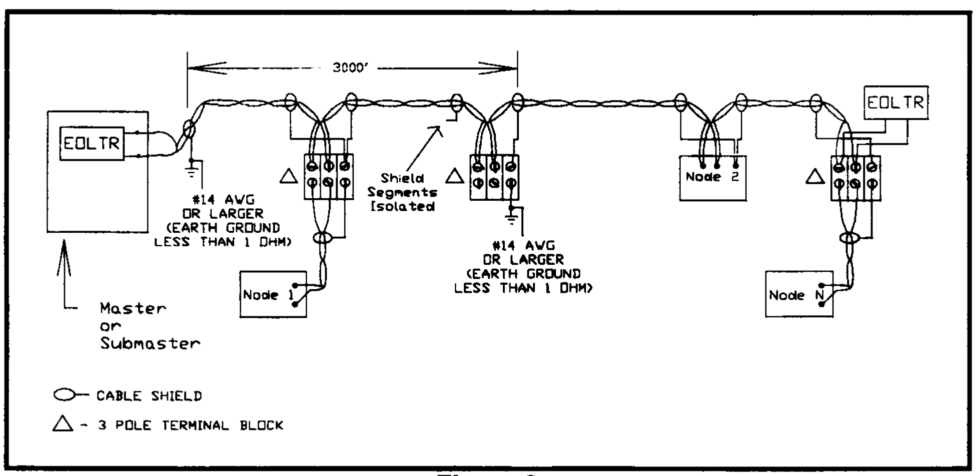

Figure 8

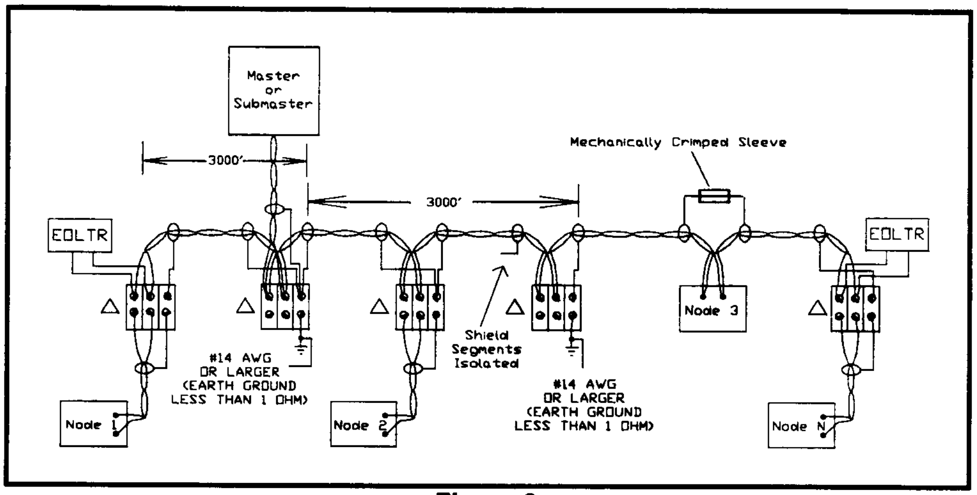

Figure 9

Rule 7: Cable Termination

The Main Runs of the Main Network and each Subnetwork require a pair of End Of Line Termination Resistors (EOLTRs) (see Fig. 9). The EOLTRs maintain signal strength and minimize reflections. The EOLTRs should be 1/2 watt 100 ohm carbon or metal film resistors. Wire wound resistors are not acceptable. The EOLTRs should be placed at the two most distant points along the Main Runs of a Main Network or Subnetwork (see Figs. 1 and 4). EOLTRs should be placed in parallel across the splicing junction servicing the Complex Tap rather than at the far end within the Complex Tap (see Fig. 7). Taps off of the Main Runs do not require end of line termination.

Rule 8: Device Address

In order to avoid the possibility of devices in a Main Network having the same addresses as those in Subnetworks, set Main Network device addresses at 100 or higher excluding addresses 901 to 908. Note, Addressable Relay IIs on a CED Subnetwork must have addresses 901 to 908. Choose addresses less than 100 for Subnetwork devices, except for Addressable Relay IIs on a CED Subnetwork. Devices in separate Subnetworks may have the same address settings.

Cable Architecture Example

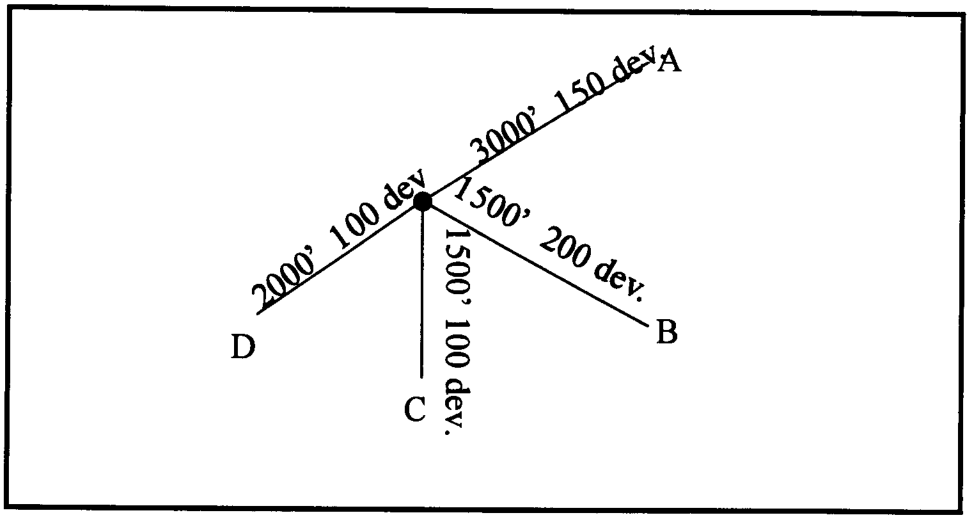

Figure 10

TOPOLOGY: Single star with four long lines

PROCEDURE:

- Compute "allowed attenuation" for star system

Total system capacity	25 dB
Deduct for star	- 6 dB
Net capacity	19 dB

- Calculate attenuation of each long line:

Line	Length	Devices	Attenuation
A	3,000	150	(2dB*3)+1.5=7.5 dB
B	1,500	200	(2dB*1.5)+2=5.0 dB
C	1,500	100	(2dB*1.5)+1=4.0 dB
D	2,000	100	(2dB*2)+1 =5.0 dB

- Add two largest attenuations: A+D=12.5 dB

- Compare to allowed attentuation: 12.5 dB<19 dB, therefore the network is OK

Appendix A - Cable Splicing Techniques

Although cable terminating tools, techniques and accessory devices may seem to be of subsidiary importance to the bigger picture of network architecture, this topic is critical for successful network implementation. Network performance may be compromised by a loose or frayed wire requiring considerable effort to locate. In addition to reducing potential system downtime for the customer, proper cable end preparation results in faster and higher quality system startup and troubleshooting.

TOOLS

The tools for network termination fall into several categories of cable sheath and shield removal, wire insulation removal and wire end dressing. The Belden 9463 cable consists of one twisted pair of insulated wire covered by two layers of shielding and an outer PVC jacket (see Fig. 11). The first shield is an aluminized mylar shield followed by a 57% tinned copper braid. In between the two shields lies a #20 AWG drain wire for shield splicing and termination. When terminating, no more than 1 1/2 inches of the cable the outer jacket and shield layers must be removed in the process of baring the drain wire and the twisted pair. Care must be taken not to nick the drain wire since any break will effect the shield coverage from there on.

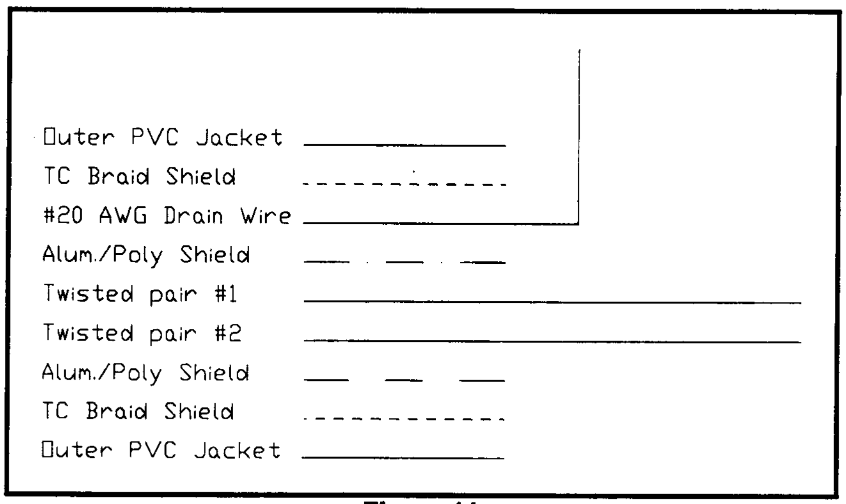

Figure 11

OUTER JACKET

Ideal is a company that can supply many wire terminating tools. For hand removal of the outer jacket the Ideal "Coaxial Cable Stripper" Cat # 45-165 works best. It has a several sets of replaceable blades which can make the circular cut around the cable and then split the cable length wise for removal. The blade can be set to cut the TC braid however it is not recommended since the drain wire is often nicked as well. An alternative hand tool for the circular cut is the ideal "Cyclops Stripper" Cat # 45-514. An automated approach for jacket removal can be achieved with Schleuniger wire processing equipment. The Schleuniger HC207 is a programmable semi-portable device which is adept at removing the outer jacket, braid and twisted pair ends. The tool quickly creates a precise cut depth and length.

SHIELD REMOVAL

The TC braid can be removed by combing out the braid and then cutting it off the base of the PVC jacket. The combing process can be handled with a thin screwdriver inserted between the braid and the inner shield. The tip of the screwdriver is driven through the braid and then pulled up through the braid in effect combing it out. It may require several passes to accomplish. The inner Aluminum Polyester Foil shield has a seam which can be unfolded and with the help of a sharp nick at the PVC base can be easily pealed off.

TWISTED PAIR

The twisted pair can be stripped with a wide variety of hand or automated devices. The key goal is to form a clean and uniform length of insulation strip. Uneven lengths or nicked wires lead to bad connections and mismatch with ferrule devices discussed later. The Schleuniger tool is ideal for stripping the ends of the twisted pair wires. The Ideal "Auto Stripmaster" also provides an accurate strip length.

FERRULES

The use of ferrules to dress wire ends eliminates frayed wires, strengthens connection points, and joins daisy chained wires easily. Phoenix Contact has a series of ferrules for single and double wires per terminal block jaw. As an additional benefit, ferrules for daisy chained applications will maintain network continuity even when the terminal block jaw is loose. For all applications, initial and rework wiring is made quicker and cleaner. A longer version of the ferrule works well with the Addressable Relay II.

CABLE TOOL AND ACCESSORY VENDORS

Ideal
Sycamore, Illinois 60178
(800)435-0705

Schleuniger
150 Dow St.
Manchester, New Hampshire 03101
(603)668-8117

Phoenix Contact
Harrisburg, Pennsylvania 17111-0100
(717)944-1300

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