



INSTALLATION & MAINTENANCE

R/LINK ATCS RADIO CODE LINE SYSTEM

OCTOBER 2009 (REVISED AUGUST 2014)

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The equipment covered in this manual has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the 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/her own expense.

DOCUMENT HISTORY

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A.1	Aug 2014		Convert to Siemens branding

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NOTES, CAUTIONS, AND WARNINGS

Throughout this manual, notes, cautions, and warnings are frequently used to direct the reader's attention to specific information. Use of the three terms is defined as follows:

NOTE

Generally used to highlight certain information relating to the topic under discussion.

CAUTION

APPEARS IN UPPERCASE TYPE AND REFERS TO PROPER PROCEDURES OR PRACTICES WHICH IF NOT STRICTLY OBSERVED, WILL RESULT IN DAMAGE TO EQUIPMENT. CAUTIONS TAKE PRECEDENCE OVER NOTES AND ALL OTHER INFORMATION, EXCEPT WARNINGS.

WARNING

HIGHLIGHTED IN BOLD, UPPERCASE TYPE AND APPLIES TO SAFE AND RELIABLE OPERATION OF SAFETRAN EQUIPMENT. WARNINGS ALWAYS TAKE PRECEDENCE OVER NOTES, CAUTIONS, AND ALL OTHER INFORMATION.

If there are any questions, contact Siemens Application Engineering.

ELECTROSTATIC DISCHARGE (ESD) PRECAUTIONS

Static electricity can damage electronic circuitry, particularly low voltage components such as the integrated circuits commonly used throughout the electronics industry. Therefore, procedures have been adopted industry-wide which make it possible to avoid the sometimes invisible damage caused by electrostatic discharge (ESD) during the handling, shipping, and storage of electronic modules and components. Safetran has instituted these practices at its manufacturing facility and encourages its customers to adopt them as well to lessen the likelihood of equipment damage in the field due to ESD. Some of the basic protective practices include the following:

- Ground yourself before touching card cages, modules, or components.
- Remove power from card cages before removing or installing modules.
- Remove circuit boards (modules) from card cages by the ejector lever only.
- Handle circuit boards by the edges only.
- Never physically touch the circuit board contact fingers or allow these fingers to come in contact with an insulator (e.g., plastic, rubber, etc.).
- When not in use, place circuit boards in approved static-shielding bags, contact fingers first. Remove circuit boards from static-shielding bags by grasping the ejector lever or the edge of the board only. Each bag should include a caution label on the outside indicating static-sensitive contents.
- Cover workbench surfaces used for repair of electronic equipment with static dissipative workbench matting.
- Use integrated circuit extraction/insertion tools designed to remove and install electrostatic-sensitive integrated circuit devices such as PROM's (OK Industries, Inc., Model EX-2 Extractor and Model MOS-40 Inserter (or equivalent) are highly recommended).
- Utilize only anti-static cushioning material in equipment shipping and storage containers.

For information concerning ESD material applications, please contact the Safetran Electronic Division Technical Support Staff in Rancho Cucamonga, California. ESD Awareness Classes and additional ESD product information are also available through the Technical Support Staff.

GLOSSARY

- AAR: Association of American Railroads - An organization that establishes uniformity and standardization among different railroad systems.
- AEI: Automatic Equipment Identification - Equipment installed at sites along the track to read and report train consist information.
- ARES: Advanced Railroad Electronics System - Created by Rockwell International as an alternative to AAR ATCS.
- ATCS: Advanced Train Control System - A set of specifications compiled by the AAR for controlling aspects of train operation.
- BCP: Base Communications Package - Defined by the ATCS specifications as the transmitter/receiver base station and associated processors to handle communications between mobile and central office equipment.
- BER: Bit Error Rate - Expresses the quality of a communications in the number of errors per bits sent.
- CC: Cluster Controller – An ATCS ground network node responsible for the control of a group of base communications packages (BCPs).
- Code Line: A non-vital line circuit, the principle purpose of which is to carry control and/or indication codes, such as for the supervisory control system portion of CTC.
- Control System (traffic): A block signal system under which train movements are authorized by block signals whose indications supersede the superiority of trains for both opposing and following movements on the same track (Standard Code).
- CRC: Cyclic Redundancy Check - The CRC on a data packet is normally calculated and appended to the data so that the receiver can verify that no data was lost or corrupted during transit.
- CSMA/CA: Carrier-Sense-Multiple-Access/Collision Avoidance - A scheme for allowing multiple transmitters sharing a single medium to cooperatively timeshare with a minimum of overlap and interference.
- CTC: Centralized Traffic Control – A system of controlling train movement on a track by utilizing track blocks and wayside block signals.
- dB: Abbreviation for decibel. The standard unit for expressing transmission gain or loss and relative power levels. Decibels indicate the log ratio of power output to power input.

GLOSSARY Continued

- DCE: Data Communications Equipment - Any device (printer, terminal, etc.) that merely transports (establishes, maintains, and terminates a session) but does not originate or consume data.
- DTE: Data Terminal Equipment - Any device (computer, terminal, etc.) that originates or consumes data over a transmission facility (can act as data source, data sink, or both).
- Echelon[®]: The company that created the LonTalk[™] LAN used by an R/LINK system to communicate between I/O modules and radio at a location. The term is often used to refer to the twisted pair network.
- EEPROM: Electrically Erasable Programmable Read-Only Memory – A storage device whose contents can be erased and reprogrammed electrically without removing the device from its circuit.
- EIA: Electronics Industries Association - A standards organization in the U.S. specializing in the electrical and functional characteristics of interface equipment.
- ERP: Effective Radiated Power - The product of the antenna power (transmitter power less transmission-line loss) times either the antenna power gain or the antenna field gain squared.
- ESD: Electro-Static Discharge – The sudden release of energy caused by two materials containing different static charges coming in close contact. This equalizing of different charges can be damaging to solid state devices due to the high voltages (of short duration) possible during the discharge.
- HDLC: High-level Data Link Control - A serial protocol for exchanging synchronous information. Polled HDLC is the normal protocol used for ATCS base stations (BCPs).
- I/O: Refers to the input/output interface of a device or module.
- KINDIS: K Indicator Disable – An R/Link I/O module output power source for driving relays (a relay has a reference designator of “K”). Using KINDIS instead of signal battery power to drive relays provides a software method for I/O circuit fault checking.
- LAN: Local Area Network - A limited network where the data transfer medium is generally wires or cable. In R/LINK systems, refers to an individual twisted pair Echelon[®] network of a code line system connecting I/O modules to a radio at a wayside location.

GLOSSARY Continued

- LAN Segment: In this manual, refers to that portion of an Echelon[®] network that is inclusive of nodes connected together to form a subnet only (number of nodes in a segment restricted by LAN limitations), and separated from the rest of the network by routers, bus repeaters, or other types of transmission media such as radio link.
- LCP: Local Control Panel – Provides indication and control for the WCP/CPU and allows for switching from remote to local control of I/O circuits for testing.
- LED: Light Emitting Diode – A solid state indicator.
- MCP: Mobile Communications Package – A Motorola Spectra radio and associated interface panel used by mobile ATCS compatible equipment to communicate to the central office.
- NMS: Network Management System - A collection of computer programs for managing, monitoring, and troubleshooting an ATCS network.
- Non-vital circuit: A circuit the function of which does not affect the safety of train operation.
- Null-Modem: A cable or adapter that connects two DTE devices directly (eliminates the requirement for modems) by emulating the physical connections of a DCE (the Transmit output of each DTE is connected to the Receive input of the other DTE).
- PC: Protocol Converter – Provides front end processing to convert various protocols to ATCS-compatible packets.
- R/LINK: A non-vital code line system of one or more R/LINK modules configured for specific applications and communicating by twisted pair LAN to a radio for sending/receiving control and indication codes to/from a central office.
- RS232: EIA interface standard between DTE and DCE, employing serial binary data interchange.
- RSSI: Received Signal Strength Indication - A numerical value indicating the relative/absolute strength of received carrier.
- RTU: Remote Terminal Unit - Also known as Field Code Unit or Code Unit. Used to perform non-vital I/O under control of a central office unit.

GLOSSARY Concluded

- Signal Aspect: The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train; the appearance of a cab signal conveying an indication as viewed by an observer in the cab.
- Spread Spectrum: A method of using either frequency hopping or direct-sequence modulation to spread a radio's RF energy over the complete bandwidth of the radio.
- SSR: Spread Spectrum Radio - In this manual, refers to Safetran's S³/Link radio that uses direct-sequence modulated broadband transmissions for security and noise immunity.
- WCP: Wayside Communications Package - The radio and associated processor used by mobile ATCS compatible equipment to communicate to the central office.
- WCC/FPD: Wayside Communications Controller/Field Protocol Device - Provides packet switching and protocol conversion from a central office to a group of base communications packages (BCPs).
- WCP/CPU: Wayside Communications Package/Central Processor Unit – The processor module (P/N 53105) associated with the MCS2000 radio in a WCP.

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SECTION I

INTRODUCTION

1.0 GENERAL

This manual describes the operation, installation, and diagnostics of the R/Link Non-vital Radio Code Line System. Since the system is periodically upgraded with additional features, prospective users are encouraged to contact Safetran Systems Corporation for the latest technical information.

1.1 APPLICABLE DOCUMENTS

1. ATCS Specification 200 - ATCS Protocols (March 1993)
2. ATCS Specification 200 - Communications Architecture (March 1993)
3. ATCS Specification 250 - ATCS Message Formats (March 1993)
4. ATCS Specification 700 - CPC Specification (March 1993)
5. ATCS Specification 157 - CPC Operation (March 1993)
6. R/Link ATCS Radio Code Line System Application Logic Generation Guide (Safetran Document Number COM-00-94-06)
7. Packet Switch (53401) For ATCS Radio Code Line Systems, Installation & Operation (Safetran Document Number COM-00-96-03)
8. Wayside Communications Package (WCP), 53411, Installation (Safetran Document Number COM-00-98-01)

1.2 R/LINK MODULE DESCRIPTION

The 53100 Series R/Link I/O modules are ideally suited for code line replacement and new installations that use ATCS RF communications. Each I/O module provides a number of inputs and outputs, and multiple modules can be combined to form installations of virtually any size.

Refer to figure 1-1 for an illustration of a typical 53100 series R/Link I/O module. Figure 1-2 illustrates the front panels of the three types of R/Link I/O modules.

The 53100 Series R/Link I/O modules operate in conjunction with ATCS radio equipment such as Motorola MCP or Safetran Spread-Spectrum radios to directly control signal interlockings. Safetran's Wayside Communications Package (WCP) is used in an Advanced Train Control System (ATCS) data network to provide the interface between the Base Control Package (BCP) and downstream field equipment and delivers ATCS messages to and receives messages from field equipment via an RF link. Application messages are sent and received from nonvital code units, wayside inspection devices, and RS232/422 communication devices via the serial port. Local I/O or ancillary functions are provided to the optional Echelon[®] LAN.

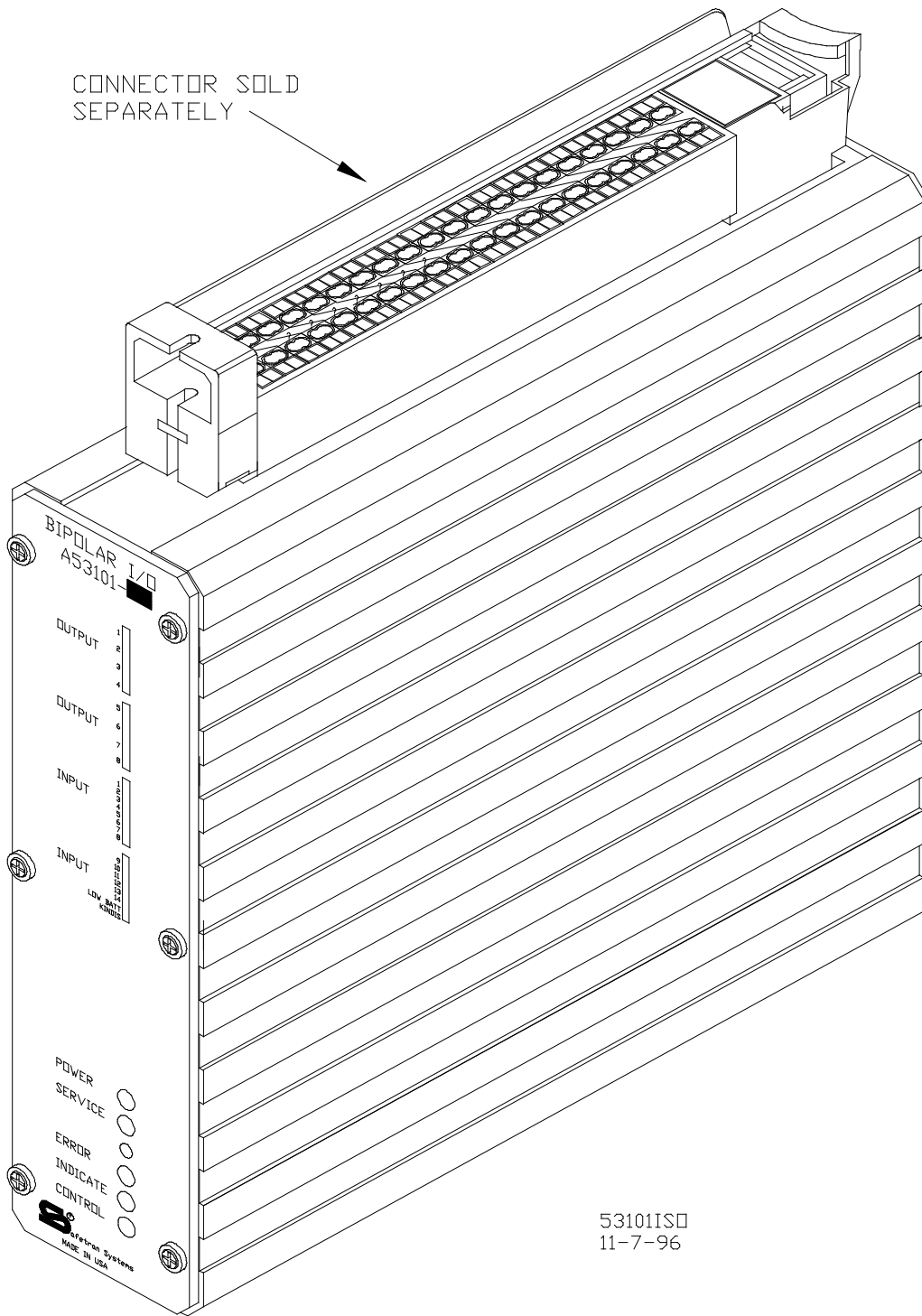
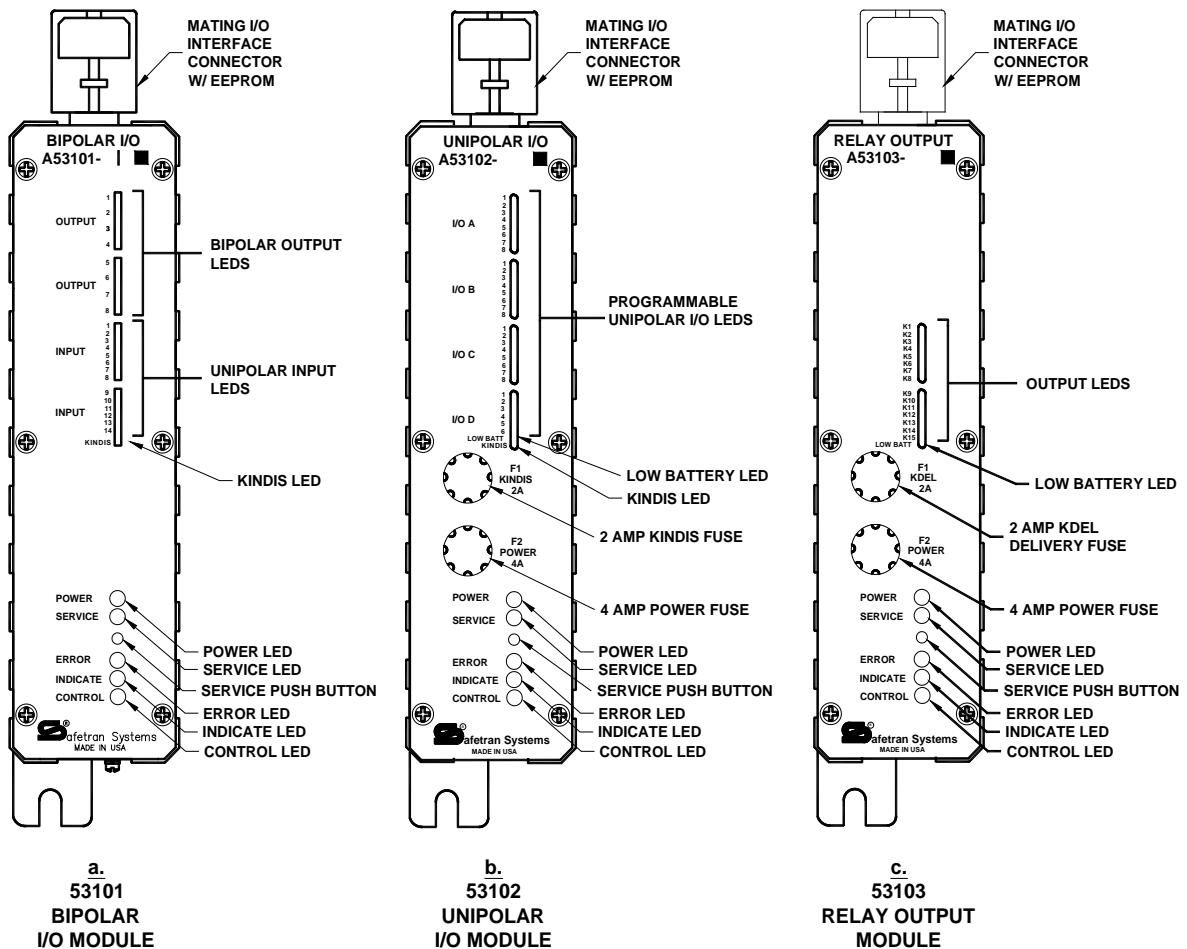


Figure 1-1
Typical 53100 Series Module (shown with mating I/O connector)



IOMODULE.DWG
04-20-99

Figure 1-2
R/Link I/O Module Front Panels

1.2.1 Bipolar I/O Module, 53101

The 53101 I/O module is ideally suited to replacing US&S DC code line systems. It provides 8 bipolar outputs, and 14 unipolar inputs, which are sufficient for most end-of-siding applications. The 53101 Bipolar I/O module can drive a maximum of 8 magnetic stick (KP) relays and read a maximum of 14 indications. The 53101 combines with other modules in the A53100 family to form complete CTC communications and control systems.

Each 53101 module is controlled by an onboard Echelon® Neuron® (c) processor. Output controls are received via the LonTalk™ LAN and delivered to the bipolar outputs either continuously or pulsed (configurable). Opto-isolated read-back circuits verify the delivery of each output.

Inputs are sensed (at a rate that is configurable) and generate an indication message whenever a change of state occurs. An optional indication hold-off time is provided to allow the interlocking

circuits to become stable before the change-of-state message is generated. The module provides an indication KINDIS battery output that can be fed back into the input circuits to sense relay contact states. Using this KINDIS voltage allows the unit to diagnose the input circuits. The KINDIS LED indicates whether the KINDIS output is enabled or disabled.

I/O state LED indicators are provided on the front panel for each I/O circuit to facilitate troubleshooting and maintenance.

The following system status LED indicators are provided:

POWER (Green)	Lighted steady during power-on operation
SERVICE (Red)	Lighted when SERVICE push button is pressed
ERROR (Red)	Following detection of an error, the number of flashes between pauses represents the error code. If an error is subsequently cleared, the ERROR indicator is extinguished.
INDICATE (Red)	Flashes to indicate detection of change of state input or a request for recall
CONTROL (Red)	Flashes to indicate delivery of control data
LOW BATTERY (Yellow)	Lights if input power drops below the operating threshold

NOTE

The ERROR, INDICATE, and CONTROL indicator LEDs each flash once during system restart.

I/O termination points are accessible from the top of the unit where they interface to the module via a WAGO style 221 removable plug connector. The module fits onto a standard signaling relay rack and can optionally be wall mounted.

Configuration data for the module is maintained externally using an EEPROM embedded in the WAGO I/O connector; thus allowing maintenance replacement of the module without the need for reconfiguration.

The module operates directly off the signal battery, and 2000V rms isolation is provided by the transformer-coupled LonTalk™ interface.

1.2.1.1 53101 Specifications

Bipolar Outputs:	8
Output Voltage:	+ or - Supply Voltage
Output Current:	250mA continuous
Unipolar Inputs:	14
Minimum Input Voltage:	8V DC
Maximum Input Voltage:	Supply Voltage
Indication Battery Outputs:	1 (KINDIS)
Supply Voltage:	9V DC through 16 V DC
Supply Power:	< 100mA all outputs off, all inputs open
LonTalk™ I/F:	1.2 Mbit/s
LonTalk™ Isolation:	2000V rms
I/O connector:	Wago style 221

1.2.1.2 53101 Interface Connector Pinouts

Table 1-1
53101 Interface Connector Pinouts

Pin #	Mnemonic	Function	Pin #	Mnemonic	Function
1	IOA-0A	Output 1 +	21	IOA-0B	Output 1 -
2	IOA-1A	Output 2 +	22	IOA-1B	Output 2 -
3	IOA-2A	Output 3 +	23	IOA-2B	Output 3 -
4	IOA-3A	Output 4 +	24	IOA-3B	Output 4 -
5	IOA-4A	Output 5 +	25	IOA-4B	Output 5 -
6	IOA-5A	Output 6 +	26	IOA-5B	Output 6 -
7	IOA-6A	Output 7 +	27	IOA-6B	Output 7 -
8	IOA-7A	Output 8 +	28	IOA-7B	Output 8 -
9	IB-00	Input 1	29	IB-01	Input 2
10	IB-02	Input 3	30	IB-03	Input 4
11	IB-04	Input 5	31	IB-05	Input 6
12	IB-06	Input 7	32	IB-07	Input 8

Table 1-1 Concluded

Pin #	Mnemonic	Function	Pin #	Mnemonic	Function
13	IB-08	Input 9	33	IB-09	Input 10
14	IB-10	Input 11	34	IB-11	Input 12
15	IB-12	Input 13	35	IB-13	Input 14
16	TWP1	LonTalk™	36	KINDIS	Indication battery
17	TWP2	LonTalk™	37	*CS	EEPROM chip select
18	TX	EEPROM TX	38	SCL	EEPROM serial clock
19	RX	EEPROM RX	39	+5V	EEPROM +5V
20	IOV -	Supply Battery -	40	IOV +	Supply Battery +

1.2.1.3 53101 Configuration Options

Output Delivery Time:	50ms, 100ms, 200ms, 500ms, 1s, 2s, Continuous
Input Holdoff Time:	None, 50ms, 100ms, 200ms, 500ms, 1s, 2s
Kindis Input Control:	On / Off
Location ID:	ATCS Hierarchical (Type 7)
LonTalk™ Node ID:	0 through 256

1.2.1.4 53101 Mechanical Specifications

Weight:	2.2 lb (1 kg)
Depth:	9.5 in (24.1 cm)
Height:	9 in (22.9 cm)
Width:	2.5 in (6.4 cm)
Mounting:	Relay Rack or Wall Mount

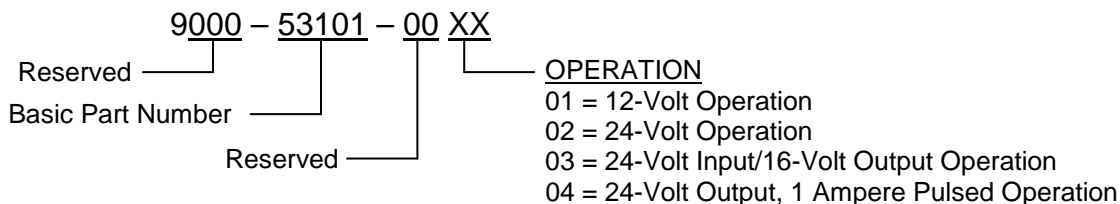
1.2.1.5 53101 Ordering Information

To order, specify the basic part number (53101) plus the applicable prefix and suffix as shown in the configuration chart below.

NOTE

Bipolar I/O Module, part number 53101-XX, does not include mating I/O connector assembly part number 53002 (ordered separately).

Bipolar I/O Module Configuration



For mating I/O connector assembly (with embedded serial EEPROM), order part number 9000-53002-0001.

1.2.2 Unipolar I/O Module, 53102

The 53102 Unipolar I/O module is designed to deliver controls and read interlocking status as part of a CTC control system. The I/O ports (a maximum of 30) can be configured as inputs or outputs (in groups of 8). The 53102 combines with other modules in the A53100 family to form complete CTC communications and control systems.

Each module is controlled by an onboard Echelon[®] Neuron[®] (c) processor. Output controls are received via the LonTalk[™] LAN and delivered to the outputs either continuously or pulsed (configurable). Opto-isolated read-back circuits verify the delivery of each output.

Inputs are sensed at a configurable rate and generate an indication message via LonTalk[™] whenever a change of state occurs. An optional indication hold-off time allows the interlocking circuits to become stable before the change-of-state message is generated. The module provides an indication battery output that can be fed back into the input circuits to sense relay contact states. Using this KINDIS voltage allows the unit to diagnose the input circuits.

Additional LonTalk[™] messages supported include rechecks, diagnostics, configuration control, and error status updates.

I/O state LED indicators are provided on the front panel for each I/O circuit to facilitate troubleshooting and maintenance.

The following system status LED indicators are provided:

POWER (Green)	Lighted steady during power-on operation
SERVICE (Red)	Lighted when SERVICE push button is pressed
ERROR (Red)	Following detection of an error, the number of flashes between pauses represents the error code. If an error is subsequently cleared, the ERROR indicator is extinguished.

INDICATE (Red)	Flashes to indicate detection of change-of-state input or a request for recall
CONTROL (Red)	Flashes to indicate delivery of control data
LOW BATTERY (Yellow)	Lights if input power drops below the operating threshold

NOTE

The ERROR, INDICATE, and CONTROL indicator LEDs each flash once during system restart.

I/O termination points are accessible from the top of the unit where they interface to the module via a WAGO style 221 removable plug connector. The module fits onto a standard signaling relay rack and can optionally be wall mounted.

Configuration data for the module is maintained externally using an EEPROM embedded in the WAGO I/O connector; thus allowing maintenance replacement of the module without the need for reconfiguration.

The module operates directly off the signal battery, and 2000V rms isolation is provided by the transformer-coupled LonTalk™ interface.

1.2.2.1 53102 Specifications

Unipolar Outputs:	Up to 30 in groups of 8
Output Voltage:	Open Collector
Output Current:	125mA continuous / 350mA pulsed
Unipolar Inputs:	Up to 30 in groups of 8
Minimum Input Voltage:	8V DC
Maximum Input Voltage:	Supply Voltage
Indication Battery Outputs:	1
Supply Voltage:	9V DC through 30 V DC (Nominal 12V or 24V)
Supply Power:	< 100mA all outputs off, all inputs open
LonTalk™ I/F:	1.2 Mbit/s
LonTalk™ Isolation:	2000V rms
I/O connector:	Wago style 221

1.2.2.2 53102 Interface Connector Pinouts

Table 1-2
53102 Interface Connector Pinouts

Pin #	Mnemonic	Function	Pin #	Mnemonic	Function
1	IO-1	Input / Output 1	21	IO-2	Input / Output 2
2	IO-3	Input / Output 3	22	IO-4	Input / Output 4
3	IO-5	Input / Output 5	23	IO-6	Input / Output 6
4	IO-7	Input / Output 7	24	IO-8	Input / Output 8
5	IO-9	Input / Output 9	25	IO-10	Input / Output 10
6	IO-11	Input / Output 11	26	IO-12	Input / Output 12
7	IO-13	Input / Output 13	27	IO-14	Input / Output 14
8	IO-15	Input / Output 15	28	IO-16	Input / Output 16
9	IO-17	Input / Output 17	29	IO-18	Input / Output 18
10	IO-19	Input / Output 19	30	IO-20	Input / Output 20
11	IO-21	Input / Output 21	31	IO-22	Input / Output 22
12	IO-23	Input / Output 23	32	IO-24	Input / Output 24
13	IO-25	Input / Output 25	33	IO-26	Input / Output 26
14	IO-27	Input / Output 27	34	IO-28	Input / Output 28
15	IO-29	Input / Output 29	35	IO-30	Input / Output 30
16	TWP1	LonTalk™	36	KINDIS	Indication battery
17	TWP2	LonTalk™	37	*CS	EEPROM chip select
18	TX	EEPROM TX	38	SCL	EEPROM serial clock
19	RX	EEPROM RX	39	+5V	EEPROM +5V
20	IOV -	Supply Battery -	40	IOV +	Supply Battery +

1.2.2.3 53102 Configuration Options

Output Delivery Time:	50ms, 100ms, 200ms, 500ms, 1s, 2s, Continuous
Input Holdoff Time:	None, 50ms, 100ms, 200ms, 500ms, 1s, 2s
Kindis Input Control:	On / Off
Location ID:	ATCS Hierarchical
LonTalk™ Node ID:	0 through 256

1.2.2.4 53102 Mechanical Specifications

Weight:	2.2 lb (1 kg)
Depth:	9.5 in (24.1 cm)
Height:	9 in (22.9 cm)
Width:	2.5 in (6.4 cm)
Mounting:	Relay Rack or Wall Mount

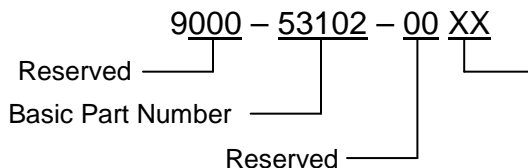
1.2.2.5 53102 Ordering Information

To order, specify the basic part number (53102) plus the applicable prefix and suffix as shown in the configuration chart below.

NOTE

Unipolar I/O Module, part number 53102-XX, does not include mating I/O connector assembly part number 53002 (ordered separately).

Unipolar I/O Module Configuration



OPERATION

- 01 = 12-volt operation, 10-ohm inputs, no outputs
- 02 = 24-volt operation, diode inputs, no outputs
- 03 = 12-volt operation, no inputs, diode outputs
- 04 = 24-volt operation, 10-ohm inputs, no outputs
- 05 = 12-volt operation, diode inputs, no outputs
- 06 = 24-volt operation, no inputs, diode outputs
- 07 = 12-volt operation, 10-ohm inputs, diode outputs
- 08 = 12-volt operation, diode inputs, diode outputs
- 09 = 12-volt operation, no inputs, 10-ohm outputs
- 10 = 24-volt operation, 10-ohm inputs, diode outputs
- 11 = 24-volt operation, diode inputs, diode outputs
- 12 = 24-volt operation, no inputs, 10-ohm outputs

NOTE

Contact Safetran Technical Support for the proper configuration for your application.

For mating I/O connector assembly (with embedded serial EEPROM), order part number 9000-53002-0001.

1.2.3 Relay Output Module, 53103

The Safetran 53103 Relay Output module is designed to deliver controls as part of a CTC control system. Each module contains 15 controllable non-vital relays; and the contact options can be jumpered for a mixture of Form-C and Form-A outputs. The 53103 combines with other modules in the 53100 family to form complete CTC communications and control systems.

Each module is controlled by an onboard Echelon[®] Neuron[®] (c) processor. Output controls are received via the LonTalk[™] LAN, and delivered to the outputs either continuously or pulsed (configurable). Select-Check-Execute capability is provided through readback of the relay contact positions.

The 53103 is available with either latched or unlatched relays. Latched relays stay in the last state set position, and are unaffected by equipment restarts or power failure. They are typically used to drive vital signal control relays.

An extruded aluminum case, roughly the size of a style ST-1 signaling relay, encloses each module and fits onto a standard relay rack. This allows equipment to be handled without electrostatic discharge (ESD) damage.

Relay contact positions are sensed at a configurable rate, and generate an indication message via LonTalk[™] whenever a change of state occurs. The module provides an execute delivery output to indicate that all contacts are in their called-for state. Additional LonTalk[™] messages supported include rechecks, diagnostics, configuration control, and error status updates.

Output state LED indicators for each relay output circuit are provided on the front panel to facilitate troubleshooting and maintenance.

The following system status LED indicators are provided:

POWER (Green)	Lighted steady during power-on operation
SERVICE (Red)	Lighted when SERVICE push button is pressed
ERROR (Red)	Following detection of an error, the number of flashes between pauses represents the error code. If an error is subsequently cleared, the ERROR indicator is extinguished.
INDICATE (Red)	Flashes to indicate detection of change of state input or a request for recall.
CONTROL (Red)	Flashes to indicate delivery of control data
LOW BATTERY (Yellow)	Lights if input power drops below the operating threshold

NOTE

The ERROR, INDICATE, and CONTROL indicator LEDs each flash once during system restart.

I/O termination points are accessible from the top of the unit where they interface to the module via a WAGO style 221 removable plug connector. The module fits onto a standard signaling relay rack and can optionally be wall mounted.

Configuration data for the module is maintained externally using an EEPROM embedded in the mating I/O connector, thus allowing maintenance replacement of the module without the need for reconfiguration.

The module operates directly off the signal battery, and 2000 volts rms isolation is provided by the transformer-coupled LonTalk™ interface.

1.2.3.1 53103 Specifications

Form-A Outputs:	Up to 15 (See paragraph C.4)
Form-C Outputs:	Up to 10 (See paragraph C.4)
Output Voltage:	Voltage free contacts
Output Current:	1A continuous
Control Delivery Outputs:	1
Supply Voltage:	9V DC through 30 V DC (Nominal 12V or 24V)
Supply Power:	< 100mA all outputs off, all inputs open
LonTalk™ I/F:	1.2 Mbit/s
LonTalk™ Isolation:	2000V rms
I/O connector:	Wago style 221

1.2.3.2 53103 Configuration Options

Output Delivery Time:	50ms, 100ms, 200ms, 500ms, 1s, 2s, Continuous
Input Holdoff Time:	None, 50ms, 100ms, 200ms, 500ms, 1s, 2s
Kindis Input Control:	On / Off
Location ID:	ATCS Hierarchical
LonTalk™ Node ID:	0 through 256

1.2.3.3 53103 Output Contact Options (Internal Jumper Selectable)

Table 1-3
53103 Output Contact Options

Option #	Form A Contacts	Form C Contacts
1	15	0
2	12	2
3	9	4
4	6	6
5	3	8
6	0	10

1.2.3.4 53103 Interface Connector Pinouts

Table 1-4
53103 Interface Connector Pinouts

Pin #	Mnemonic	Function	Pin #	Mnemonic	Function
1	K1-F	1 Front	21	K1-H	1 Heel
2	K2-F	2 Front	22	K2-H	2 Heel
3	K3-F	3 Front	23	K3-H	3 Heel
4	K4-F	4 Front	24	K4-H	4 Heel
5	K5-F	5 Front	25	K5-H	5 Heel
6	K6-F	6 Front	26	K6-H	6 Heel
7	K7-F	7 Front	27	K7-H	7 Heel
8	K8-F	8 Front	28	K8-H	8 Heel
9	K9-F	9 Front	29	K9-H	9 Heel
10	K10-F	10 Front	30	K10-H	10 Heel
11	K11-F/K10-B	11 Front / 10 Back	31	K11-H/K9-B	11 Heel / 9 Back
12	K12-F/K8-B	12 Front / 8 Back	32	K12-H/K7-B	12 Heel / 7 Back
13	K13-F/K6-B	13 Front / 6 Back	33	K13-H/K5-B	13 Heel / 5 Back
14	K14-F/K4-B	14 Front / 4 Back	34	K14-H/K3-B	14 Heel / 3 Back
15	K15-F/K2-B	15 Front / 2 Back	35	K15-H/K1-B	15 Heel / 1 Back
16	TWP1	LonTalk™	36	KDEL	Control Delivery
17	TWP2	LonTalk™	37	*CS	EEPROM chip select
18	TX	EEPROM TX	38	SCL	EEPROM serial clock
19	RX	EEPROM RX	39	+5V	EEPROM +5V
20	IOV -	Supply Battery -	40	IOV +	Supply Battery +

1.2.3.5 53103 Mechanical Specifications

Weight:	2.2 lb (1 kg)
Depth:	9.5 in (24.1 cm)
Height:	9 in (22.9 cm)
Width:	2.5 in (6.4 cm)
Mounting:	Relay Rack or Wall Mount

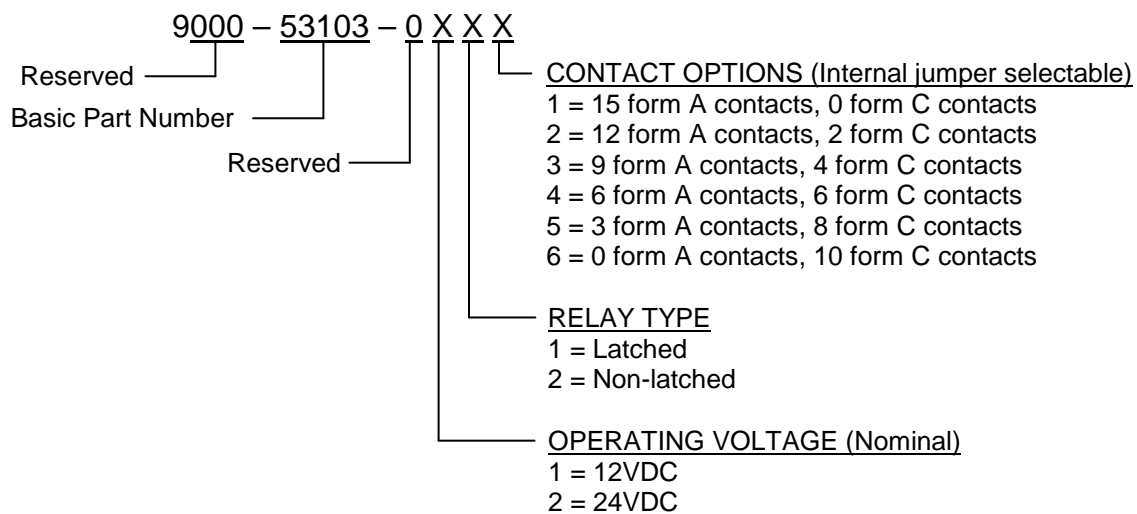
1.2.3.6 53103 Ordering Information

To order, specify the basic part number (53103) plus the applicable prefix and suffix as shown in the configuration chart below.

NOTE

Relay Output Module, part number 53103-XXX, does not include mating I/O connector assembly part number 53002 (ordered separately).

Relay Output Module Configuration



NOTE

Contact Safetran Technical Support for the proper configuration for your application.

For mating I/O connector assembly (with embedded serial EEPROM), order part number 9000-53002-0001.

1.2.4 Wayside Communications Package (WCP), 53411

The components of the Wayside Communications package (WCP) include the 53105 WCP/CPU II module (shown in figure 1-3), the 53412 MCS 2000 Radio (shown in figure 1-4), optional 53106 DC/DC Converter (shown in figure 1-5) and optional 50636 Local Control Panel (a typical site specific version is shown in figure 1-6).

Refer to Appendix C for information on Safetran’s Wayside Communications Package (WCP) and refer to Appendix D for information on configuring the Motorola Spectra MCP radio.

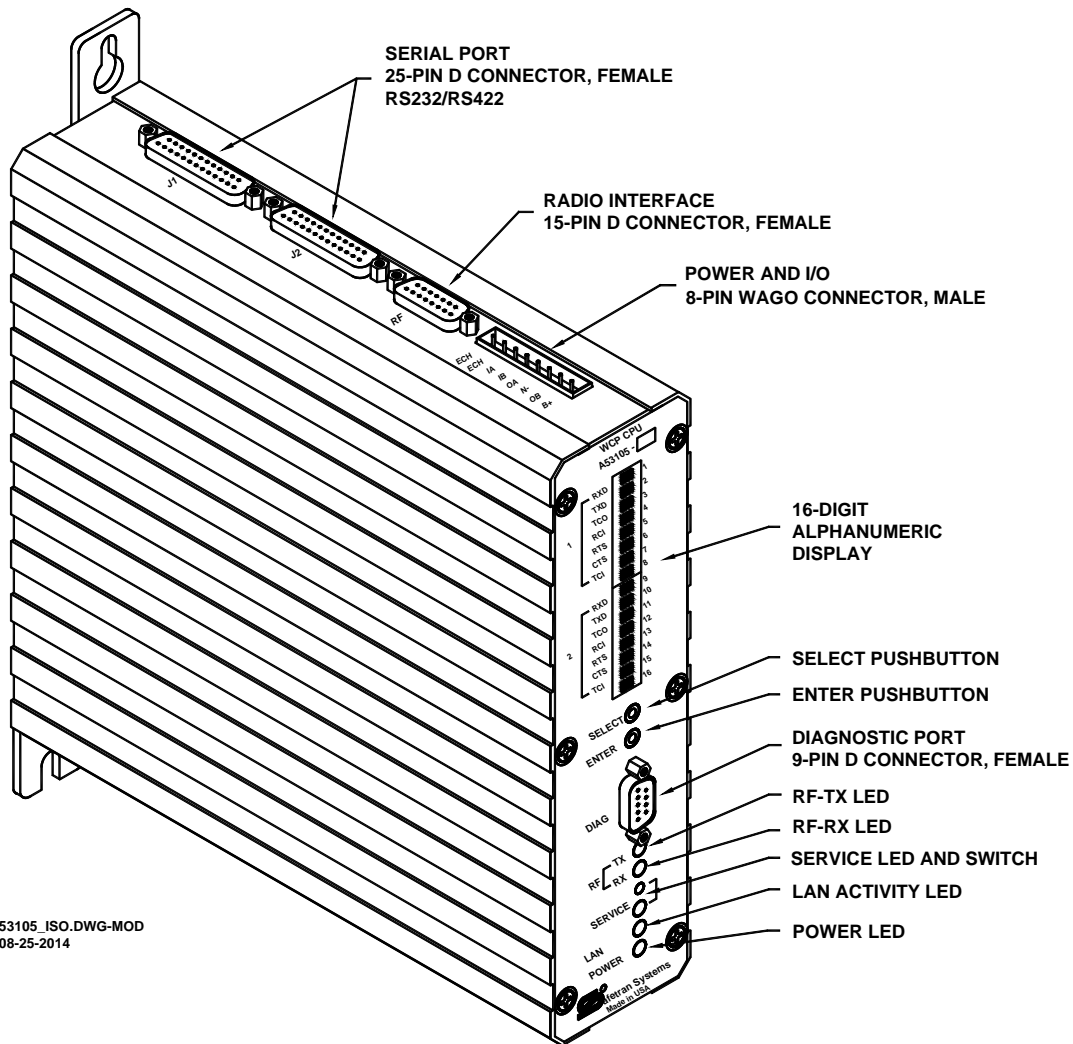


Figure 1-3
WCP/CPU II Module, 53105

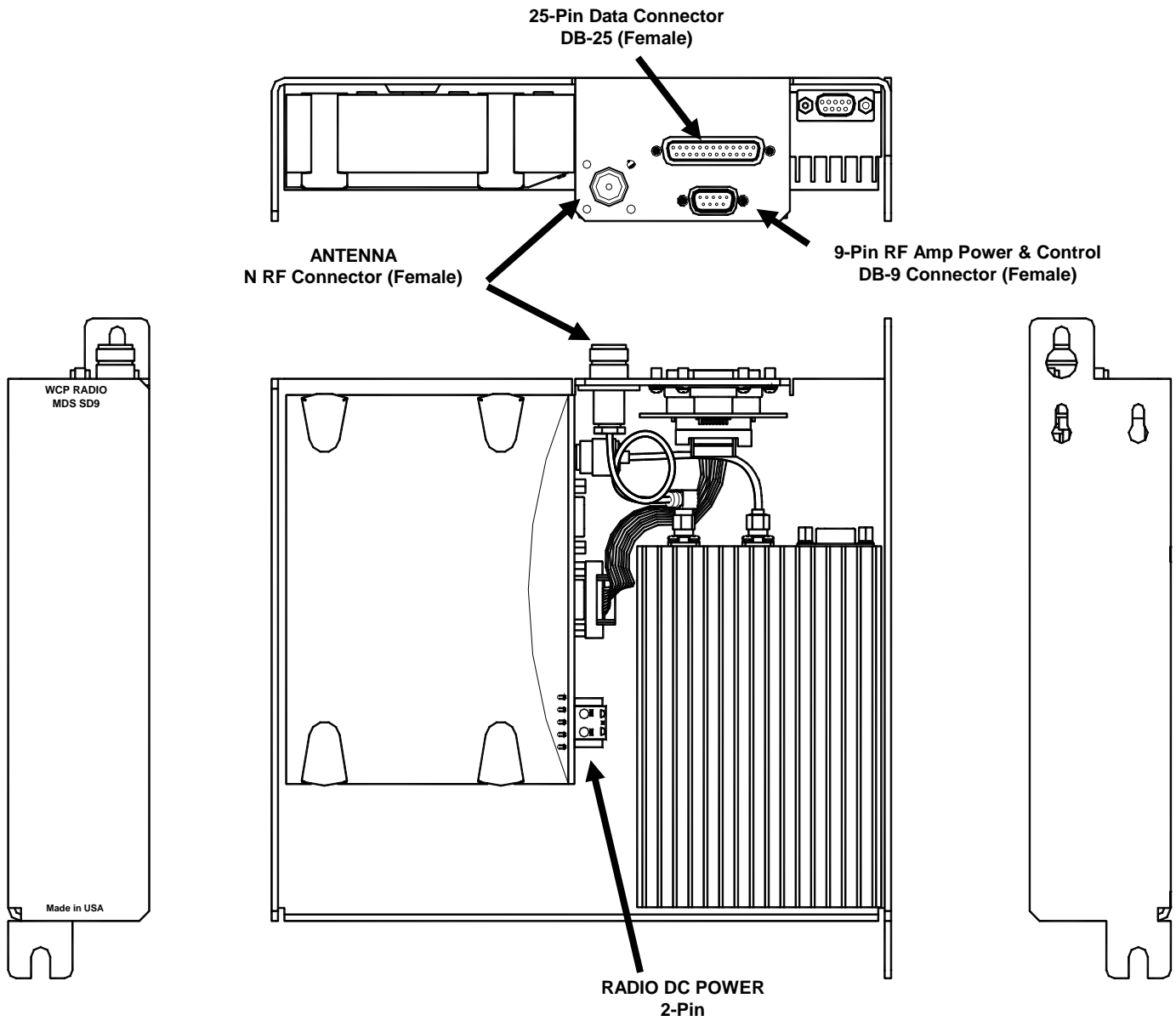


Figure 1-4
WCP Radio, 53412

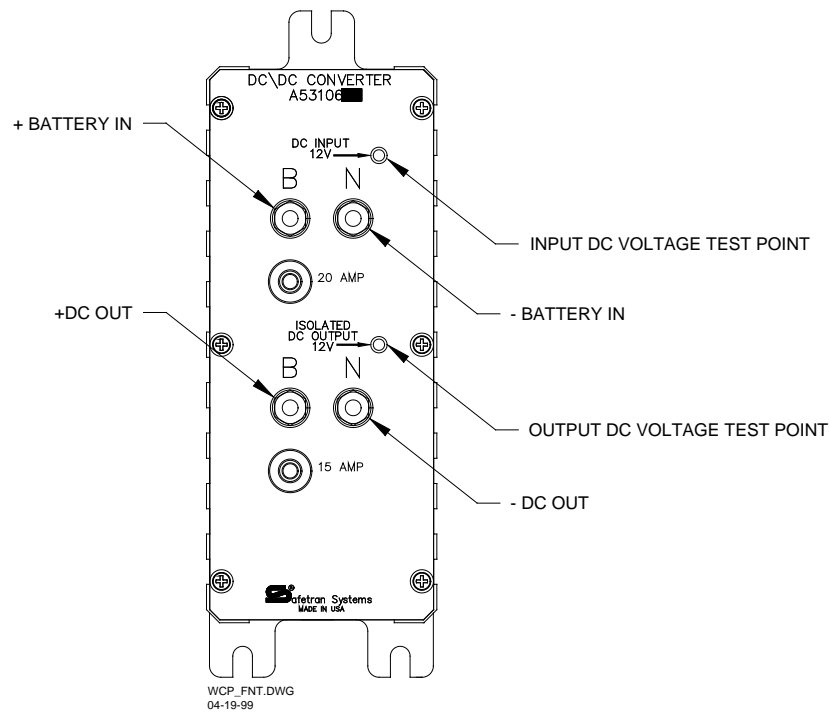
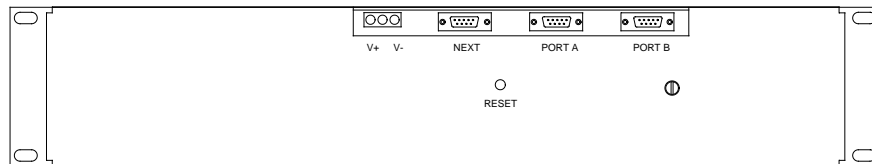
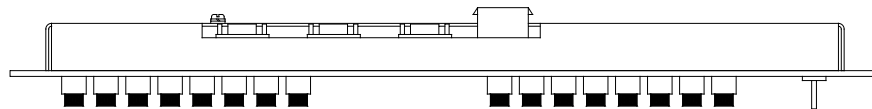


Figure 1-5
DC/DC Converter, 53106, Front View

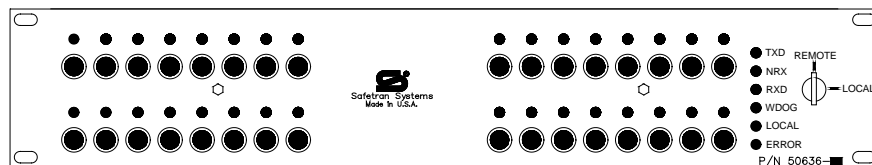
BACK PANEL



TOP VIEW



FRONT PANEL



LCP.DWG
04-22-99

Figure 1-6
Typical Local Control Panel, 50636

1.3 TYPICAL R/LINK INSTALLATION

A typical R/Link Radio Code Line wayside installation is shown in figure 1-7. Each 53100 Series module is a different node on the LAN and can be distributed as required throughout the interlocking. The system supports the usual indication, recall, and control traffic as well as diagnostic, event recording, and other secondary functions. The 53105 WCP/CPU can provide non-vital logic, protocol conversion, and serve as an interface to an RF transceiver in an ATCS network.

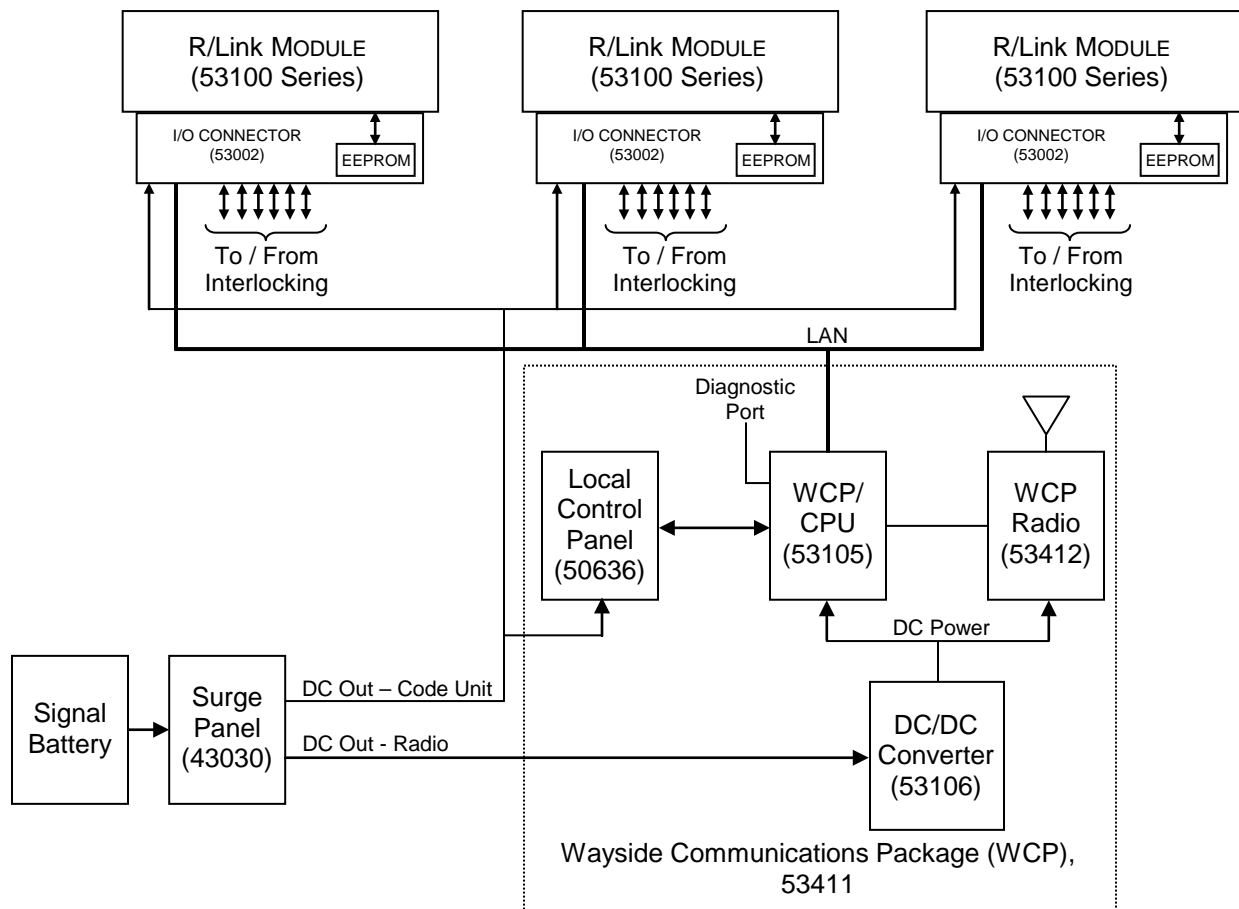


Figure 1-7
Typical R/Link Wayside Installation

Different types of I/O modules are provided to accommodate various interface requirements. The 53101 Bipolar I/O Module can drive a maximum of 8 magnetic stick (KP) relays and read 14 indications. The 53102 Unipolar I/O Module accommodates 30 controls or indications while the 53103 Relay I/O Module contains up to 15 voltage-free contacts for use as required. One module is normally sufficient for an end-of-siding application but, if required, multiple modules can be cascaded up to a maximum of 95.

NOTE

Eight modules may be cascaded without restriction, however, certain LAN restrictions apply if this number is exceeded. Contact Safetran Technical Support for LAN specifications and methods of extending the network.

Site-specific configuration data for each I/O module is held in serial EEPROM's mounted in the removable I/O plug connectors so that the configuration data remains when a module is removed. This facilitates maintenance since no special tools or software are required to reconfigure a module when it is replaced.

Modules are provided with extensive LED indications for controls, indications, errors, battery voltage, etc. to aid in troubleshooting an installation.

The WCP/CPU (53105) performs the main processing in the installation and consolidates individual module control and indication messages for the entire location (group manager function).

Optional application logic processing is available to apply nonvital application equations and timers to the controls and indications. This data is prepared on a standard PC using either ladder diagrams or Boolean equations as required.

An optional local control panel (LCP) interfaces with the radio to provide local control and indication facilities. Each panel provides 32 indications and 32 controls and multiple panels can be cascaded for larger installations. Safetran provides a custom layout panel for use with the LCP.

Safetran strongly recommends installation of surge suppression equipment such as the R/Link Surge Suppression Panel, (43030), or equivalent.

1.4 ATCS ADDRESSING

The Advanced Train Control System (ATCS) standardizes the message formats and addressing scheme used by all railroads for train control applications. The system operates by sending and receiving standard datagrams (using a standard addressing scheme) between the various ATCS-compatible signaling and operating equipment. Addresses are provided for wayside equipment, central office equipment, on-board equipment, base stations, maintenance equipment, rail cars, as well as all other types of equipment normally found in a railroad environment. These messages convey operating instructions and status information such as track-and-time permits, code line controls and indications, hot box data, etc.

Work Order (W/O), CTC, NMS, and other office equipment communicate with the on-board and wayside equipment via base stations (BCPs). Each BCP is controlled by a cluster controller, (CC), protocol converter (PC) or a wayside communications controller/field protocol device

(WCC/FPD). Field radios are a mixture of WCPs and spread-spectrum radios. All communication is accomplished using ATCS datagrams or packets.

It is important to note that the ATCS system is not a polling system (i.e., the RF channel is normally quiescent until either a field location or the office initiates a transmission). Therefore, message collisions will occasionally occur when multiple field units attempt to simultaneously transmit indication messages via a common base station. In such a case, the message sender does not receive the RF acknowledge frame and will repeat the message as appropriate.

A complete description of the ATCS system and an illustration of a typical ATCS network is presented in Appendix A.

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SECTION II

SYSTEM OPERATION

2.0 GENERAL

System operation consists of the handling of control, indication, and recall (recheck) messages. Operation is either straight through (no local processing) or mapped by the application logic equations. In addition, provisions are made for initialization, configuration, event recording, and troubleshooting.

2.1 ROUTE LEARNING

The R/Link system is a “route learning” system. Therefore, information concerning field location configuration data, including which field units are active, base stations used, etc., is not required. The R/Link system is controlled by the Wayside Communications Controller / Field Protocol Device (WCC/FPD), which dynamically “learns” system topology. The following rules enable the “learning” process:

- Each R/Link system field code unit is programmed to send an indication message to the office WCC/FPD at least once per minute, or when an input change occurs.
- Within the first minute of operation, the WCC/FPD receives one or more indication messages from each active R/Link field unit. As each message is received, the WCC/FPD records in a table that the location is an R/Link, the identification of the base station (BCP) through which the message was received, and the signal strength of the received message.
- If a field location is detected by more than one base station, the WCC/FPD notes the signal strengths for all copies of the message and selects the BCP with the strongest signal for subsequent outbound transmissions to that field location.
- Following a 1-minute delay, the WCC/FPD is fully operational and will begin routing controls and recalls for R/Link locations to the appropriate base stations via the ATCS network.
- The WCC/FPD tracks up to three base stations per field location and will switch to a weaker station if the main path becomes nonoperational.
- The WCC/FPD maintains a 150-second timer for each field location and answers only polls from the CTC system for field locations with active timers. The timer is updated when an indication message is received from the field (once per minute or more).

2.2 ATCS GROUND CONTACT PROCEDURE

The ATCS specifications require that before data can be transmitted between the office and field, a ground contact procedure must be executed to synchronize the send and receive packet numbers at both the office and field. This is necessary so that the units can correctly acknowledge and retry data packets as required. The R/Link system fully supports the ground contact procedure but is configured so that in the event of a failure, the units will remain operational (Active Failure Mode).

When an MCP is initially powered up or reset, a number of copies of the Ground Contact Request message are sent. If no Ground Contact Reset reply is received, the request is repeated up to six times and then reverts to the Active Failure Mode.

2.3 SITE GROUP MANAGER

Each R/Link field location contains a “group or site manager” that manages the control and indication traffic for that location. For R/Link implementation, the group manager is located within the WCP/CPU and is assigned a dedicated ATCS Type 7 address. The group manager performs the functions discussed in the following paragraphs.

2.3.1 Control Processing

Control messages from the central office are addressed to the group manager and contain complete controls for the site or location. If site-specific application data is installed, the controls are placed in the control input area and processed through the application logic to determine the new state of any outputs to the interlocking. If no application data is available, the controls are copied directly to the interlocking output area.

The R/Link system is implemented with a number of distributed I/O modules and each module processes only a portion of the controls. Therefore, interlocking output messages must be separated and distributed to the various I/O modules. The group manager accomplishes this distribution process by broadcasting output data to all I/O modules. Configuration data held by each module then indicates the words and bits to be extracted from the overall control message for that module’s specific use. The advantage of this scheme is that configuration data is not required to be maintained in the radio to reflect actual I/O mapping.

2.3.2 Indication Processing

A reverse condition occurs for indication messages. Each I/O module operates independently and may detect a change in an input state at any time. When this occurs, a module indication message is sent to the group manager via the radio where it is consolidated with the last known indications from all other modules.

When site-specific application data is installed, the input data is first processed through the logic to update the office indications, otherwise, it is forwarded directly to the CTC office via the ATCS RF network.

2.3.3 Dispatcher Recall Processing

Dispatcher recalls sent to the group manager are broadcast to the I/O modules. When all I/O modules have replied with the current indications, an indication is returned to the recall message source. If none or only some of the modules reply, no message is returned in response to a dispatcher recall.

2.3.4 Periodic Recall Processing

The group manager is responsible for periodically issuing an unsolicited indication message. This is accomplished by broadcasting a recall message to all I/O modules once each minute.

2.3.5 Local Control Panel Processing

The R/Link system supports connection of a local control panel via a separate serial port on the radio. The push-button indications are detected by a local processor (located on the panel), and transferred to a special input area which can be readily accessed by the application logic.

Output LEDs on the panel are controlled through site-specific application logic. Separate flashing and steady outputs are provided for each LED. (Refer to the R/Link Application Logic Generation Guide for details.)

2.3.6 MCP Interface Panel, 47585

NOTE

The MCP Interface Panel is for use with the Motorola Spectra MCP radio and is not required with the new WCP. The functions performed by the MCP Interface Panel are built into Safetran's WCP.

The MCP Interface Panel contains the Echelon[®] LonTalk[™] Interface Module (23516) which translates message packets from the MCP radio into packets suitable for transmission onto the Echelon[®] twisted pair network and vice-versa. The protocol between the interface module and MCP radio is polled, with the LonTalk[™] interface module functioning as the master. Status of the communication channel is indicated by the RX and TX LEDs located on the Interface Panel.

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SECTION III

INSTALLATION

3.0 GENERAL

General installation of R/Link I/O modules is described in the paragraphs that follow. For detailed installation information for the Wayside Communications Package and optional equipment, refer to Appendix C.

3.1 MECHANICAL

The components of an R/Link system can be either wall-mounted or mounted on a standard GRS Style B relay rack (refer to figures 3-1 and 3-2 for typical rack installation diagrams). Appendix C, figure C-9 and Appendix D, figures D-1 and D-2 illustrate field rack installation radio options.

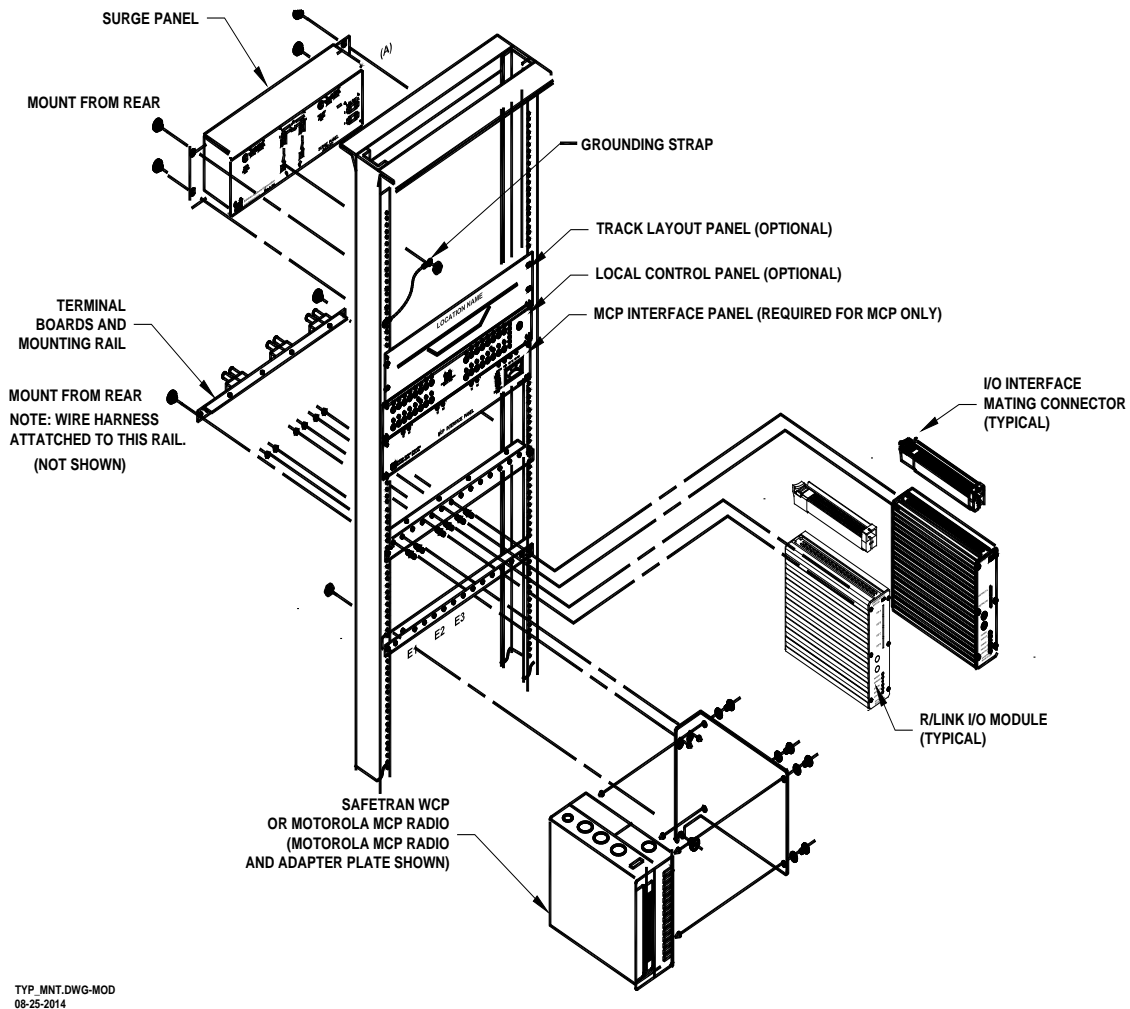


Figure 3-1
Typical Rack Mounting

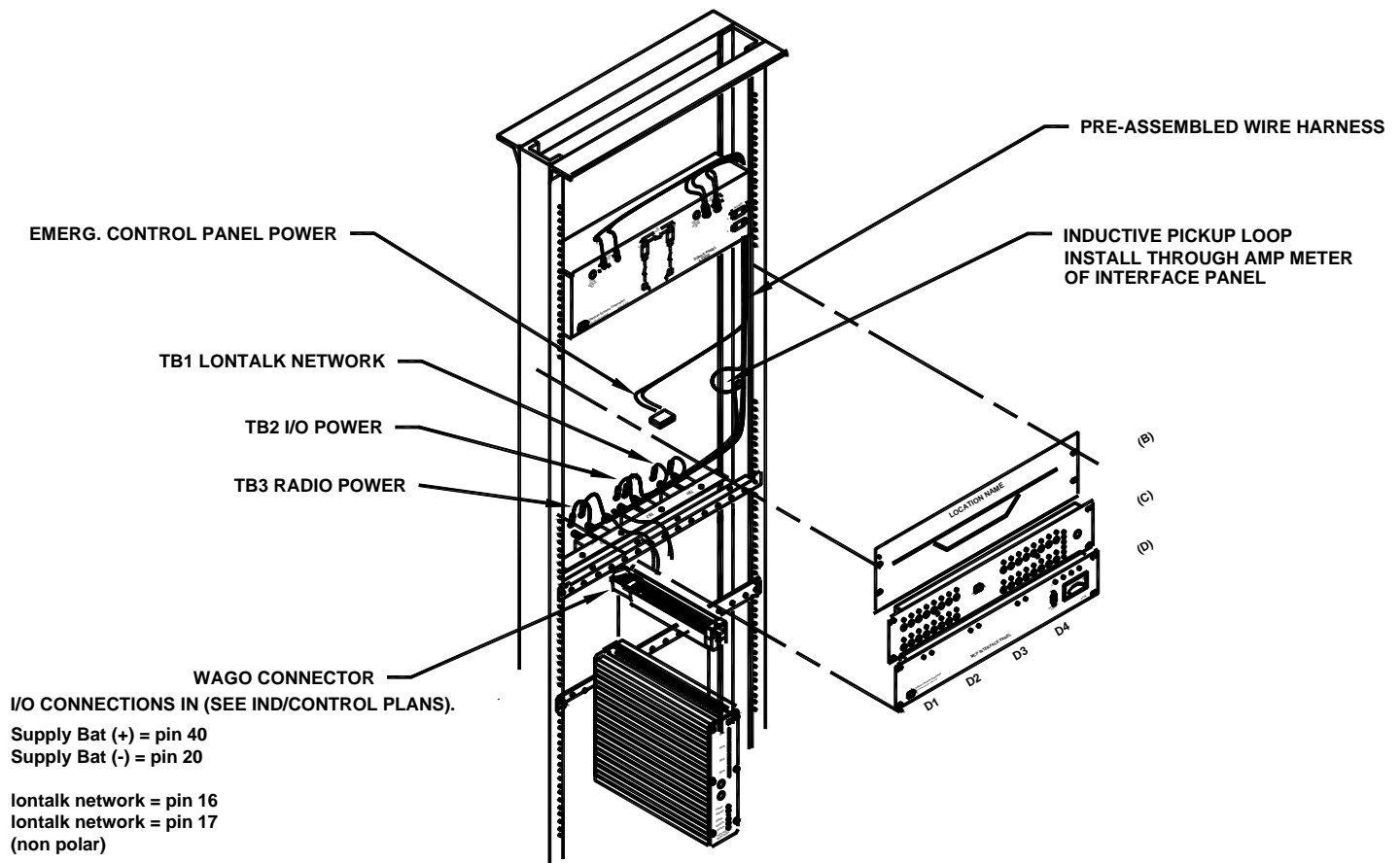


Figure 3-2
Typical Rack Wiring Harness

The modules are secured at the top by a teardrop arrangement and at the bottom with a retaining bolt. All wiring connections for the I/O modules are accomplished from the top of the modules via dual cage clamps (order mating connector assembly 9000-53002-0001. Maximum wire size is number 16AWG; 18AWG is recommended (for cage clamps, use only stranded wire).

NOTE

Adequate clearance must be provided above each I/O module to allow the mating connector to be inserted and removed. The connector must be pivoted upward approximately 45 degrees at the rear of the module before it can be removed.

A similar mounting arrangement is provided for the radio. Safetran's Spread-Spectrum radio has the same physical dimensions as the I/O modules and mounts in the same manner. The Motorola radio is equipped with a special bracket to permit mounting in a relay rack. Alternatively, the Motorola radio can be mounted on a standard 19-inch equipment rack or shelf. All interconnections to the WCP/CPU and radio are accomplished at the top of the modules. The Diagnostic port of the WCP/CPU is accessible from the front panel.

The local control interface and surge panels are designed for mounting in a 19-inch equipment rack. Brackets are also available which allow the units to be wall- or relay rack-mounted.

3.2 POWER

Power for the radio, I/O modules, and optional Local Control Panel (LCP) is normally supplied from the signal battery, either 12 or 24 volts. Safetran recommends that a surge panel such as the R/LINK Surge Suppression Panel, Part No. 43030, or equivalent be used to provide surge and lightning protection to the radio and I/O modules. The surge panel is equipped with separate surge suppressors and equalizers for the radio and the remainder of the code equipment and also provides combination circuit breakers/on-off switches for each path. Separate power runs are required from the surge panel to each I/O module.

The WCP requires a DC/DC converter such as the Safetran 53106, or a separate battery system from the signal battery (refer to Appendix C for WCP installation and wiring).

If a Motorola MCP radio is used, the transmit current (11 to 16 amperes) may require use of number 10 AWG or larger wire to ensure that significant voltage drop does not occur when the transmitter is keyed. If necessary, the MCP radio can be powered through a separate battery/charger combination. Power for the interface panel is supplied by the radio via the panel diagnostic port.

3.3 INDICATION WIRING

The 53100 Series modules are positive sensing (i.e., an indication is considered active if a voltage is present at the indication input). This voltage may be provided by the signal battery or, alternatively, the KINDIS voltage provided by each module as an output. Using the KINDIS voltage has the advantage that the unit can perform periodic self-tests and diagnostics on the input circuits by momentarily removing the KINDIS voltage.

3.4 CONTROL WIRING

Control wiring is determined by the type of I/O interfacing used. Refer to the individual module descriptions in Section I for controls.

3.5 ECHELON[®] LAN WIRING

The 53100 series modules are interconnected with each other and with the WCP/CPU as nodes on an 18AWG to 20AWG twisted-pair cable. This cable carries data at 1.25 Mbps (million bits per-second) between the various nodes. The following LAN wiring recommendations apply:

- Maximum length allowed for total cable run = 430 feet (130m). In general, the length should be kept as short as possible. The recommended maximum length = 53 feet (16m).
- Modules should be directly daisy-chained (bus topology) with no loops (i.e., no multiple paths to nodes). Each module connector permits two cables to be connected in this manner.
- No more than 8 nodes in any 16 meter (53 feet) length of transmission cable. No more than 16 nodes total per network segment. Contact Safetran Technical Support for larger networks.
- Do not attach surge protection to the LAN connections, and do not run LAN cable outside of protective enclosure.
- Termination is not required for short LAN cable runs (less than 53 feet). Contact Safetran Technical Support for networks requiring longer runs.
- Echelon[®] wiring is not polarity sensitive.
- Belden 8461 twisted pair, or equivalent is recommended; shielded cable is not required.

3.6 EEPROM DEVICES

The mating connector for the 53100 Series I/O module (connector part number 53002) must be ordered separately, as it is not shipped with the R/Link I/O module (see Ordering Information). The mating connector is an assembly that is shipped from the factory with an embedded serial EEPROM wired to the appropriate connector pins. Normally, it is not necessary to rewire or modify this device.

3.7 RADIO INSTALLATION

For installation of the Wayside Communications Package (WCP), refer to Appendix C.

For installation and configuration of the Motorola MCP radio, refer to Appendix D.

3.8 INSTALLATION DRAWINGS

For installation drawings, refer to Section VI.

SECTION IV

TROUBLESHOOTING

4.0 GENERAL

Extensive error and status indications have been provided to aid in maintaining and troubleshooting the R/LINK equipment. Two levels of information are available, depending on whether a lap-top computer is available.

4.1 WCP TROUBLESHOOTING

NOTE

The following troubleshooting procedures are required only for Safetran's WCP system (a newer system). For troubleshooting Motorola's MCP radio (an older system), refer to paragraph 4.2.

Extensive error and status indications have been provided to aid in maintaining and troubleshooting the WCP. Two information levels are available, depending on whether a laptop computer is available.

4.1.1 Code System Application

Initial troubleshooting involves determining the most likely location of the fault. On a code line with a number of field and base stations, it is relatively simple to locate the common denominator if more than one location is not responding. This could be a shared base station, shared wire line, or leased circuit between base stations and the office, or the office equipment. If the fault is isolated to a specific location, the following information may be helpful.

4.1.1.1 RF Link

ATCS code systems transmit period messages (about once every minute) from the field to the office. By detecting and following the flow of this traffic, the fault can quickly be localized.

RF traffic can be monitored on a laptop, or by the LED display. The TX LED lights each time the BCP transmits, while the RX LED lights each time a valid ATCS header is received.

Using the laptop, the MONE 2 \$300 command monitors the data messages observed on the RF link. The MOND command halts data monitoring. The SL command reports the current radio status and frequency (channel).

Data messages are reported as IN (inbound) or OUT (outbound). Inbound messages are always directed to the office while outbound messages are always directed to a field unit. By using the

ATCS datagram structure provided, the messages can be decoded to determine their labels, destinations, and source addresses.

NOTE

In the destination and source address fields, a zero (0) is always represented by the character A (e.g., 50 is written as 5A).

Normal traffic on this link consists of indication, control, and recheck messages which are approximately 26 bytes in length. The RF acknowledge messages are considerably shorter at approximately 12 bytes each. Activity is present only when controls, indications, or rechecks are being sent (no polling).

4.1.1.2 ATCS RF Message Reception

Messages received from the ATCS RF network are demodulated by the Mobile Radio and a corresponding RX Audio signal is fed to the Wayside Communications Module. This signal, together with a Receive Signal Strength Indication (RSSI) signal, are processed by the Wayside Communications Module and applied in the ATCS Message format to the LAN or in various Applications Message formats (protocols) to units connected to the serial port. The ATCS Message destination is determined by the ATCS Address (see Appendix A for a description of the ATCS address scheme).

The RSSI signal is a relative indication of antenna system operational status. The signal level may be displayed on the WCP/CPU module alphanumeric display as described in section 4 of the WCP/CPU II Installation & Operation manual, COM-00-97-10. Changes in the antenna system operational status may be determined by comparing the current displayed value with previous values. Table 4-1 lists the relationship between the RSSI voltage values and the received RF level.

4.1.1.3 RSSI Scale and Base Fields

RSSI scaling and base values are set to match the system WCP Radio module number. The scaling and base values are set into the WCP/CPU II via the Main Editor Screen (see section 4 of the WCP/CPU II Installation & Operation manual, COM-00-97-10). The scaling and base value settings for each WCP Radio module are shown in table 4-2.

Table 4-1
MCS2000 Mobile Radio RSSI Typical Output Voltages By Model Number

Model Number	M01WJLP4PW4AN (A version)				M01WJLP4PW4B N (B version)		M01WJLP4PW4C N (C version)	
	FUF1632B		FUF1632C		FUF1182A		FUF1693B	
Tanapa Number	RF Level (db)	RSSI Voltage	RF Level (db)	RSSI Voltage	RF Level (db)	RSSI Voltage	RF Level (db)	RSSI Voltage
	-117	1.576	-117	0.686	-127	0.633	-117	1.211
	-107	1.788	-107	0.925	-117	0.971	-107	2.070
	-97	1.881	-97	1.054	-107	1.531	-97	2.620
	-87	1.918	-87	1.183	-97	1.984	-87	3.214
	-77	1.980	-77	1.406	-87	2.514	-77	3.879
	-67	2.089	-67	1.791	-77	3.059	-67	4.455
	-57	2.248	-57	2.335	-67	3.559	-57	5.129
	-47	2.424	-47	2.947	-57	4.116	-47	5.871
	-37	2.541	-37	3.453	-47	4.912	-37	6.539
	-27	2.587	-27	3.722	-37	5.649	-27	7.045
	-17	2.682	-17	4.610	-27	6.294	-17	7.273
	-7	2.669	-7	5.330	-17	6.757	-7	7.536
	0	2.670	3	5.309	-7	7.014	0	7.433
					3	6.909		
					13	6.907		
					17	6.096		

Table 4-2
RSSI Scale and Base Field Values

M01WJLP4PW4AN (A version)		M01WJLP4PW4BN (B version)		M01WJLP4PW4CN (C version)	
Scale	Base	Scale	Base	Scale	Base
4/5	-147	9/25	-137	9/25	-137

4.1.1.4 Code System Troubleshooting

1. Verify that the location transmits at least once each minute by observing the RF TX LED indicator on the BCM front panel, or by monitoring port \$300 on the DIAGNOSTIC PORT. If the LED lights, proceed to step 4.
2. Verify that the office equipment acknowledges the transmission. The RF RX LED normally flashes in response to each transmission. If the RX LED does not flash, or if the radio rejects

the response, the transmission is repeated five times with a delay between transmissions of approximately 6 seconds. If the RF RX response is seen each time with no retries, the problem is not associated with the indication messages. Proceed to step 7.

3. If the radio transmits at least once each minute but there is no response from the office, check the following:
 - a. Antenna connections and reflected power
 - b. Verify radio self-test alarms using the AL command. If necessary, reset the radio to repeat the self-tests using the TEST command.
 - c. Radio power supply voltage - Verify that the voltage level does not drop during transmissions.
 - d. Radio output power - Verify peak transmit current (± 8 Amperes) or use an RF wattmeter.
 - e. Radio frequency - Check code plug location \$F2 or use the SL command to verify the current channel.
 - f. Data inverted - Check code plug location \$180. Attempt to write one of the following values: \$45, \$55, \$65 or \$75 (see appendix C).
 - g. Verify ATCS message format using the MONE 2 \$300 command. Ensure the correct site address and code line number are used and that an indication message is being sent periodically to the proper office address.

If all above items are normal, the base station location must be monitored to determine if the problem is at the base site or along the line to the office equipment.

4. No transmissions from the field
 - a. Verify that the PWR LED on the BCM front panel is lighted.
 - b. Verify that all self-tests are passed.
 - c. Attempt a manual key-up by using the front-panel switches, or by placing the radio in service mode and using the PTT command.
 - d. Verify that the BCM has acquired its client ID's by using the CL command. Most BCM's are configured such that their ID is supplied by the attached code system.
 - e. Check the ground contact status (SL command). Normally, after a reset, the BCM attempts to establish ground contact with the office. If this fails, the BCM reverts to passive mode. If the ground contact status is neither active or passive, verify the contents of code plug location \$3e for the correct option.

4.2 MCP TROUBLESHOOTING

NOTE

The following troubleshooting procedures are required for Motorola MCP radios (an earlier system), only. Many of these functions have been incorporated as part of Safetran's WCP radio (a later system). Refer to paragraph 4.1 for troubleshooting Safetran's WCP system.

Four LEDs are provided on the MCP Interface Panel to indicate the operational status of the MCP radio and include:

- A yellow STATUS indicator which is normally lighted steady but switches to flashing or is extinguished if the MCP detects an internal error
- A green RF-TX indicator which lights when the radio is transmitting. The LED should flash at least once each minute, or when a change of state in the indications occurs. Initially, following a power-up, the radio attempts to contact the CPC to perform the Ground Contact Procedure. This involves sending and receiving up to four messages in rapid succession and should not be confused with normal control and indication traffic.
- A red RF-RX indicator which lights each time the radio squelch setting is exceeded (i.e., carrier is detected). This normally occurs when a recheck or control is sent by the office or an indication message is acknowledged by the office.

NOTE

The CPC/CC will not transmit to a site without first acknowledging the site so that the appropriate base station can be used.

- A red PWR indicator which indicates power is available at the MCP Interface Panel. The internal DC/DC converter of the radio supplies power to the panel so that the LED actually reflects the status of the radio power supply. If the PWR indicator is not lighted, verify that the power connector to the MCP radio is connected securely.

In addition, the MCP Interface Panel is equipped with either a voltage meter or a current meter. If a current meter is provided, the meter should normally indicate approximately 1.5 amperes and up to 11 amperes when the radio is transmitting. If a voltage meter is provided, the meter should indicate a steady 12-13 volts even while the radio is transmitting, indicating sufficient power is available.

4.3 MCP RADIO TEST PORT

If available, a laptop computer can be connected to the nine-pin DIAGNOSTIC PORT connector on the MCP Interface Panel. Run the IL.BAT command from the Safetran directory and use the Install (F5) and Online (F7) commands to access the radio. Alternatively, communications software such as PROCOMM set for 9600, n, 8, and 2 can be used.

Enter the TEST command and observe that the radio executes and reports on all self tests. For a complete listing of the commands available on the MCP radio, refer to the applicable Motorola documents.

4.3.1 MCP RF Link

- The MONE 2 \$300 command monitors the data messages observed on the RF link.
- The MOND command halts the data monitoring.
- The COS command reports each time the radio breaks the squelch (carrier detect).
- The SL command reports the current radio status and frequency (channel).

Data messages are reported as IN (inbound) or OUT (outbound). Inbound messages are always directed to the office while outbound messages are always directed to a field unit. By using the ATCS datagram structure provided, the messages can be decoded to determine their labels, destinations, and source addresses.

NOTE

In the destination and source address fields, a zero (0) is always represented by the character A (e.g., 50 is written as 5A).

Normal traffic on this link consists of indication, control, and recheck messages, which are approximately 26 bytes in length. The RF acknowledge messages are considerably shorter at approximately 12 bytes each. Activity is present only when controls, indications, or rechecks are being sent (no polling).

4.3.2 I/O Module Communications

The I/O module communications link can be monitored either by the client port LEDs on the MCP Interface Panel or from the DIAGNOSTIC PORT as described above.

The MCP radio is connected to the I/O modules via an Echelon® LonTalk™ Interface Module (A23516) located on the MCP Interface Panel. When the system is operating properly, the MCP Interface Panel rapidly polls the MCP radio and the client port TX and RX LEDs on the interface panel are normally both blinking. The RX LED flashes for inbound data (toward the MCP) while the TX LED flashes for outbound data (away from the MCP).

The MONE 1 \$100 command monitors the data messages observed on the I/O module link. The MOND command halts data monitoring. Inbound (IN) messages are toward the MCP while outbound (OUT) messages away from the MCP and toward the I/O modules.

NOTE

The monitoring software may not record all activity due to the rapid nature of the polling.

4.3.3 I/O Module Errors

The I/O modules are equipped with the following LEDs to aid in troubleshooting and diagnostics:

- POWER LED to indicate the presence of power
- SERVICE LED to indicate the on-board processor is faulty. Normally extinguished except when the SERVICE push button is pressed
- CONTROL LED to indicate successful receipt of a control
- INDICATION LED to indicate a change of state on the inputs was detected or that a recall was executed
- Separate LEDs for each input and output circuit
- An LED to indicate low-battery condition
- An LED to indicate status of the KINDIS output

The ERROR LED flashes when an error condition exists. Count the number of flashes between each pause to determine the error code number. Refer to Table 4-3.

**Table 4-3
I/O Module Errors**

Error Number	Error Name	Description
1	EEPROM READ	Processor could not read external EEPROM in connector on startup
2	EEPROM WRITE	Processor could not write external EEPROM in connector
3	INPUT	Active input did not follow KINDIS voltage (KINDIS option only)
4	OUTPUT	Output read-back did not match output
5	CARD TYPE	I/O module does not match configured type per EEPROM
6	CONFIG	Invalid configuration data in EEPROM

NOTE

Additional information regarding the above errors may be obtained by connecting a laptop computer to the MCP DIAGNOSTIC PORT and selecting the Read Config option from the Safetran IL.EXE program.

4.4 TROUBLESHOOTING TIPS

Initial troubleshooting involves determining the likely location of the fault. On a code line with a number of field and base stations, it is relatively simple to locate the common denominator if more than one location is not responding. This could be a shared base station, shared wire line, or leased circuit between base stations, and the office, or the office equipment itself. If the fault is traced to a specific location, perform the following steps.

1. Check that the location transmits at least once a minute by verifying the status of the “RF TX” LED on the diagnostic panel, or monitoring port \$300 from the diagnostic port. If not, go to step 4.
2. Check that the office equipment is acknowledging the transmission. The “RF RX” LED should flash in response to each transmission. If not, or if the radio is rejecting the response, the transmission will be repeated five times, with about a 6 second delay in between. If the “RF RX” response is seen each time with no retries, then the problem is not with the indication messages. Go to step 7.
3. The radio is transmitting once a minute or less, with no response from the office. Check the following:
 - Antenna connections
 - Verify radio self-test alarms using the “AL” command. Reset the radio if necessary to repeat the self tests.
 - Radio power supply voltage - specifically that no voltage dip occurs during transmission
 - Radio output power - verify peak txmit current (+\ - 15 amps), or use RF Watt meter
 - Radio frequency - check code plug location \$F2 or use “SL” command to verify current channel
 - Data inverted - check code plug location \$180. Try to write one of the following values: \$41, \$51, or \$61
 - Verify ATCS message format using the “MONE 2 \$300” command. Check that the correct site address and code line number are being used, and that a indication message is indeed being sent periodically to the correct office address.

If the above items check out, then the base station location needs to be monitored to determine if the problem is at the base site or further towards the office. Perform the following:

4. No transmissions from the field.

- Verify that power LEDs on the diagnostic panel and I/O modules are on.
- Verify that the TX and RX client port LEDs for the LonTalk™ twisted pair link on the diagnostic panel are flashing rapidly. If only one, or none of them is flashing, then the communications link between the radio and interface panel is not working, and you should go to step 5.
- Verify that the I/O modules are rechecked once a minute by observing the “Indicate” LEDs on the various I/O modules; if not, go to step 6.
- Verify that no ERROR LEDs are flashing on any I/O modules, which could indicate a hardware problem.
- Verify that the RF-RX LED is not lighted steady. The MCP radio is half-duplex. Reset the equipment and verify that the location reconfigures properly. Check the site address with the “CL” command on the MCP on-line terminal screen. There should be two fields: one “LOCL” for the MCP radio itself, and one on the appropriate client port. If these fields are absent, then the radio was not able to read the I/O module configuration data held in EEPROM. In this case, proceed to step 6.
- Verify the I/O module configuration data using the read-back command provided on the Interlogic program.
- Verify I/O module operation using the “WINK” command provided on the Interlogic program. If configuration data can not be read from a module, or the Wink command fails, examine the twisted pair LAN wiring, and try re-installing the I/O modules.

5. Communications failure between the radio and the MCP interface panel. This failure is characterized by the RX and TX LEDs for the client port flashing slowly (each 1/2 second) or at a random rate. This link operation consists of the interface panel periodically polling the radio. If the interface panel client port “RX” LED does not periodically flash with power applied, then the interface panel is faulty and should be replaced. If it is, perform the following tests:

- Reset radio and observe self-test message results
- Check the code plug configuration
- Replace radio
- Replace the interface panel
- Check cabling for opens or shorts

If the RX LED is flashing slowly (every 1/2 second) and the TX LED is extinguished, or flashing at a rate that is slower than the RX LED, connect a laptop computer to the diagnostic port of the radio and verify the following conditions:

- EXECUTIVE software has been uploaded to the radio
- EXECUTIVE software is running. This can be verified by the “SL” command to show the status of the radio. If the “SL” command is not operational, perform MCP EXECUTIVE upload.

- Correct code plug has been uploaded. Uploading of code plug is normally performed only on a newly installed radio.
6. Communications failure on the twisted pair LonTalk™ LAN.
- Monitor data flow using the “MONE 2 \$10x” command (x = client port number). Verify that both inbound and outbound traffic is present at least once a minute.
 - Verify cabling for shorts or opens
 - Remove modules one by one to determine if fault clears
 - Replace interface panel
 - Replace radio
7. Location on-line, but no response to control messages
- If site-application data is installed, verify that all I/O modules are indicating in properly. Controls will not be enabled after a restart until all indications have been received.
 - Verify power to I/O modules
 - Communicate with the I/O modules using the “Read Configuration” or “Wink” commands to ensure proper operation.
 - Manually force an output by toggling an output bit in the Interlogic bit map fields.

SECTION V

DRAWINGS

5.0 GENERAL

This section contains the following drawings:

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
5-1	Typical R-Link Field Rack Equipment List Drawing	5-7
5-2	Typical R-Link Field Rack Bit Assignment Drawing	5-9
5-3	Typical R-Link Field Rack Drawing	5-11
5-4	Typical R-Link Field Rack ECP / Track Layout Drawing	5-13
5-5	Typical R-Link Field Rack 53102 – Unipolar I/O Wiring Drawing	5-15
5-6	Typical R-Link Field Rack 53103 – Relay Output I/O Wiring Drawing	5-17
5-7	Typical R-Link Field Rack Wiring / Flow Drawing.....	5-19
5-8	Typical R-Link Field Rack Cables Drawing (2 sheets)	5-21
5-9	Rack Installation Canadian Pacific Rail R-Link Mechanical drawing (2 sheets).....	5-23

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Figure 5-1
Typical R-Link Field Rack Equipment List Drawing

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REVISIONS				
REV	DESCRIPTION	DATE	DFTG APPVL	ENGR APPVL

ITEM NO.	QTY. REQ'D.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	EDP NO.	MATERIAL	DATA: SPEC, REF DES, SIZE, NOTES, VENDORS
20						
19						
18						
17						
16						
15	3	Z805-00390-0002	2 POS. TERM. BLK	Z805-00390-0002	----	AAR TERM BLOCK
14	2	53002-01	CONNECTOR/PROM	9000-53002-0001	----	WAGO
13	1	47693-01	RS232 SERIAL CBLE	9000-47693-0001	----	----
12	1	47692-02	ECHLN NETWORK CBLE	9000-47692-0002	----	----
11	2	47681-02	CLIENT PORT CABLE	9000-47681-0002	----	----
10	1	47682-02	SERV PORT CABLE	9000-47682-0002	----	----
9	1	4635-3703	7' EQUIP RACK	Z925-00114-0000	----	CHATSWORTH PROD INC
8	1	43030-01	RLINK SURGE PANEL	9000-43030-0001	----	----
7	3	Z610-38563-0001	MCP MOUNTING RAILS	Z610-38563-0001	----	----
6	1	MD38566-01	SILKSCREENED PANEL	Z610-38566-0001	----	----
5	1	50636-01	EMERGENCY CONT PNL	9000-50636-0001	----	REV 1
4	1	47585-A640	INTFACE PANEL	9000-47585-A640	----	REV 1
3	1	47695-01	MCP MOUNTING BRKT	9000-47695-0001	----	----
2	1	53103-0111	RLY OUTPUT MODULE	9000-53103-0111	----	REV 1
1	1	53102-01	UNIPOLAR MODULE	9000-53102-0001	----	REV 1

LIST OF MATERIAL


APPLICATION		UNLESS OTHERWISE SPECIFIED	SIGNATURES	DATE	 Safetran Systems Corporation ELECTRONIC DIVISION
NEXT ASSY	USED ON				
	S/O 18042	TOLERANCES ON:	CHECK		TYPICAL FIELD RACK RLINK EQUIPMENT LIST
		DECIMALS .X ± -	DESIGN C.TRUJILLO	5/20/94	
		DECIMALS .XX ± .03	PROJECT		
		DECIMALS .XXX ± .010	RELEASE		
		ANGLES ± -	Safetran Systems Corporation ELECTRONIC DIVISION 10655 7TH STREET CUCAMONGA, CA 91730		SIZE C
		FRACTIONS ± -			
		MATERIAL:			SCALE NONE
					SHEET 1 OF 9

Figure 5-2
Typical R-Link Field Rack Bit Assignment Drawing

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TYPICAL LOCATION 01

WORD	BIT ASSIGNMENTS FROM OFFICE TO FIELD								
	1	2	3	4	5	6	7	8	
1	C	1NWZ	1RWZ	--	--	STOP	1LGZ	1RGZ	1RCOZ
	I	1NWK	1RWK	1LK	1TK	1LGK	1RGK	--	--
2	C	XOZ ON	SMZ	ECZ	--	--	--	--	--
	I	SMK	POK	AUX	--	--	--	--	1RAK
3	C	1LA TBZ ON	1LA TBZ OFF	1LC TBZ ON	1LC TBZ OFF	1R TBZ ON	1R TBZ OFF	1W TBZ ON	1W TBZ OFF
	I	1LA TBK ON	1LA TBK OFF	1LC TBK ON	1LC TBK OFF	1R TBK ON	1R TBK OFF	1WBK ON	1WBK OFF
4	C	--	--	1	0	0	0	0	0
	I	CHK PASS	CHK FAIL	1	0	0	0	0	0
5	C	---	---	---	---	---	---	---	---
	I	---	---	---	---	---	---	---	---
6	C	---	---	---	---	---	---	---	---
	I	---	---	---	---	---	---	---	---
7	C	---	---	---	---	---	---	---	---
	I	---	---	---	---	---	---	---	---
8	C	---	---	---	---	---	---	---	---
	I	---	---	---	---	---	---	---	---

C = CONTROLS I = INDICATIONS

FIRMWARE SPECIFICATIONS			
MCP RADIO	23516	53101	53103
9V031-A01A 5/9/94	9V025-A01A 5/9/94	9V026-A01A 5/9/94	9V028-A01A 5/9/94


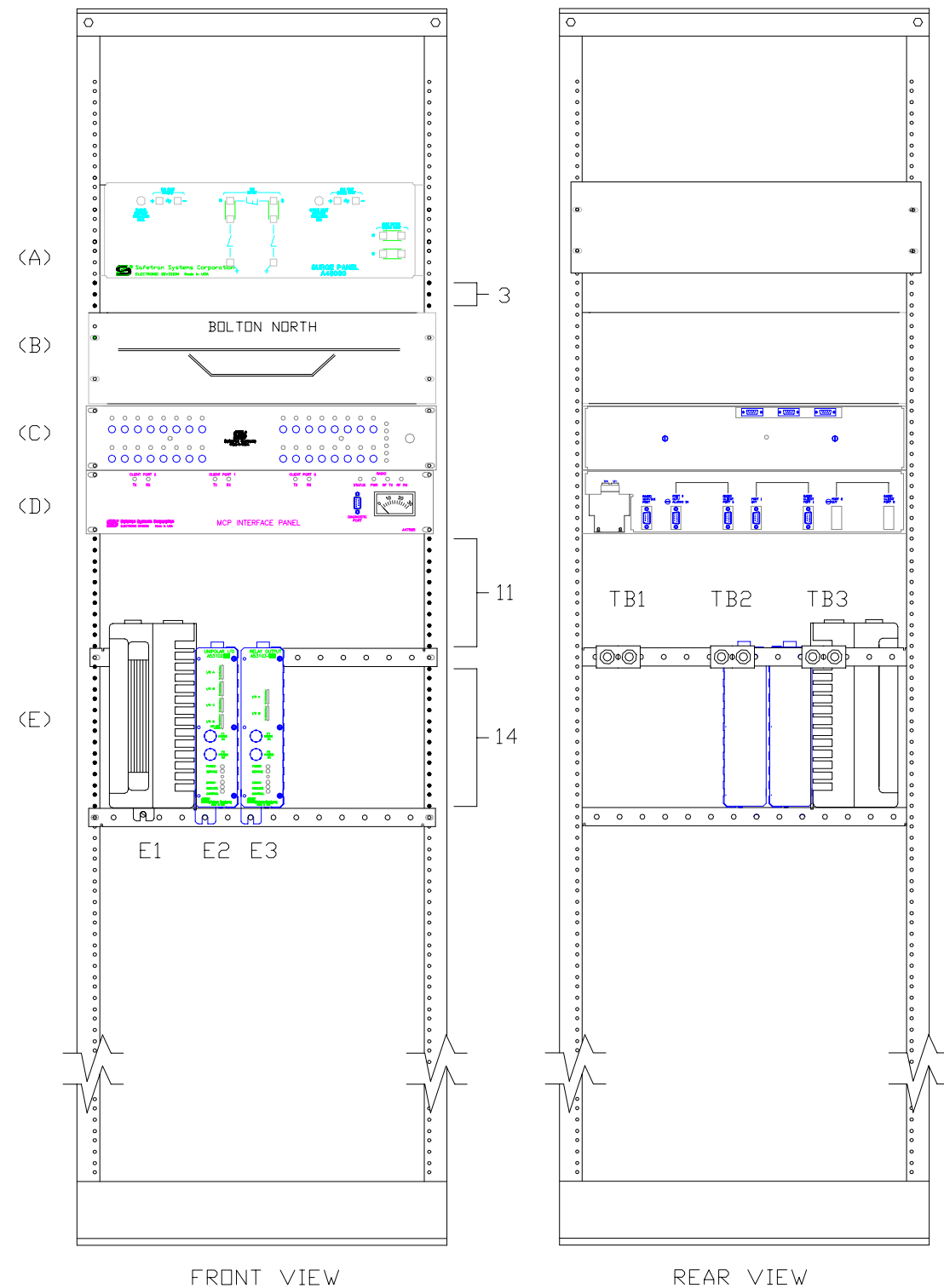
 Safetran Systems Corporation ELECTRONIC DIVISION	
TYPICAL FIELD RACK RLINK BIT ASSIGNMENT	
SIZE C	S / □
SCALE NONE	SHEET 2 OF 9

Figure 5-3
Typical R-Link Field Rack Drawing

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RACK CABLE INTERCONNECTION CHART			
ROW "E1" MCP(SERV PORT)	TO/FROM	ROW "D" INTFACE PNL(SERV PORT)	SERV PORT CABLE A47682
ROW "E1" MCP(CLIENT PORT 0)	TO/FROM	ROW "D" INTFACE PNL(CLIENT PORT 0)	CLIENT PORT CABLE A47681
ROW "E1" MCP(CLIENT PORT 1)	TO/FROM	ROW "D" INTFACE PNL(CLIENT PORT 1)	CLIENT PORT CABLE A47681
ROW "D" INTFACE PNL(PORT 0 OUT)	TO/FROM	ROW "E2" UNIPOLAR MODULE(PINS 16, 17)	NETWORK CABLE A47692
ROW "D" INTFACE PNL(PORT 1 OUT)	TO/FROM	ROW "C" EMERGENCY CONTROL PANEL	RS232 A52120
ROW "E" NETWORK WIRING (PINS 16, 17)	TO/FROM	ROW "E" NETWORK WIRING (PINS 16, 17)	TWISTED PAIR SHIELDED CABLING

S Safetran Systems Corporation
ELECTRONIC DIVISION

TYPICAL
FIELD RACK
RLINK
RACK

SIZE
C

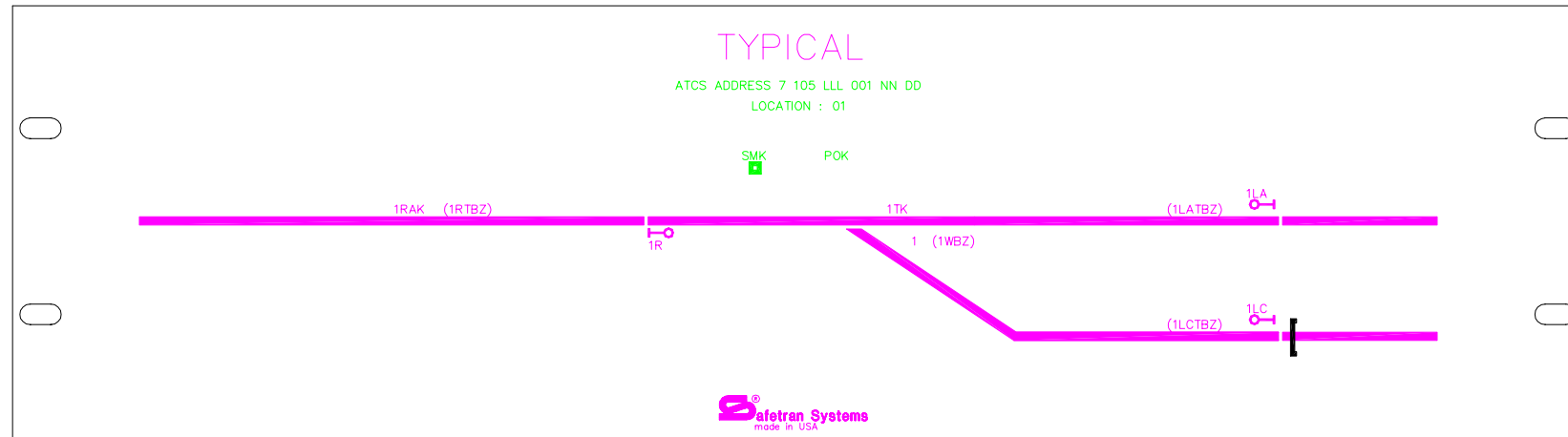
SCALE NONE

SHEET 3 OF 9

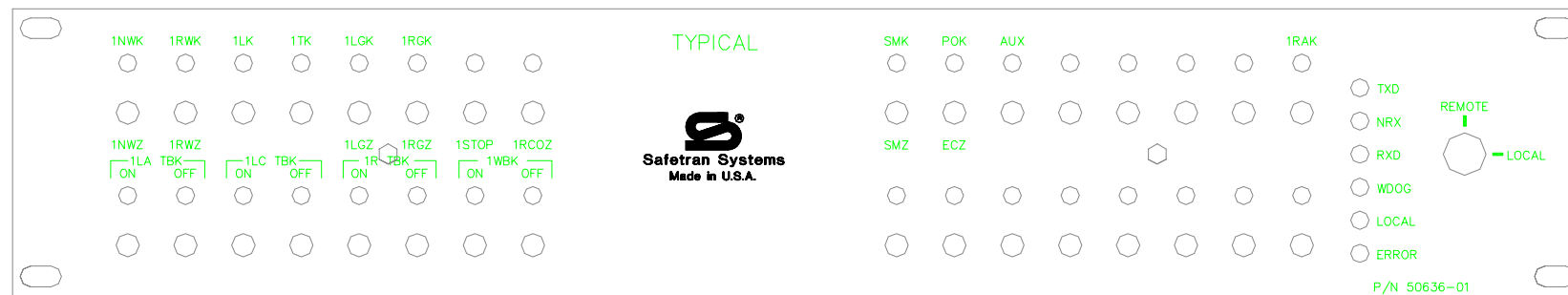
Figure 5-4
Typical R-Link Field Rack ECP / Track Layout drawing

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-01
 (B) SILK SCREENED PANEL



(C) SILK SCREENED EMERGENCY CONTROL PANEL

Safetran Systems Corporation ELECTRONIC DIVISION	
TYPICAL FIELD RACK RLINK ECP/TRACK LAYOUT	
SIZE C	S/O
SCALE NONE	SHEET 4 OF 9

Figure 5-5
Typical R-Link Field Rack 53102 – Unipolar I/O Wiring Drawing

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INDICATIONS

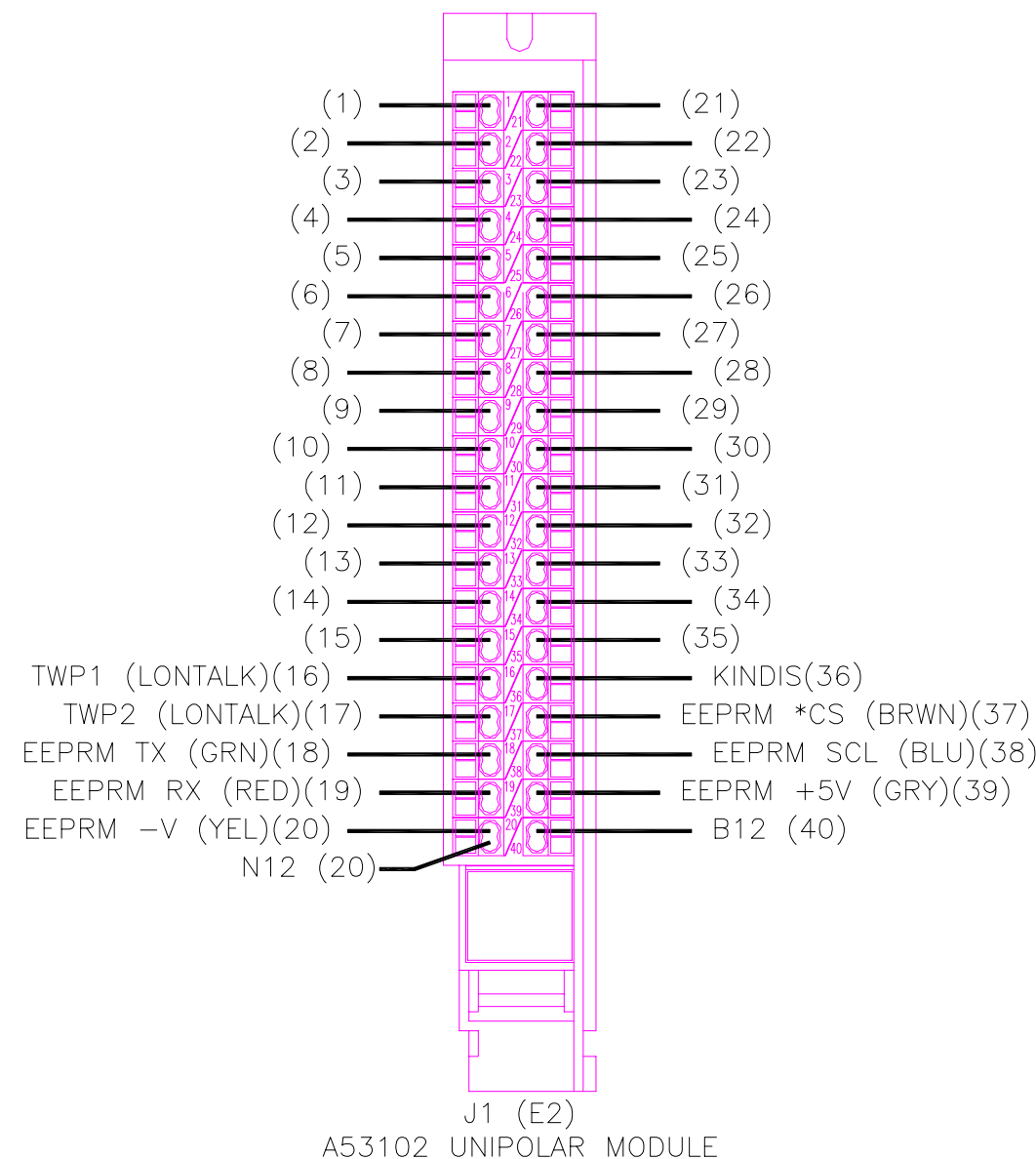
J1-1	1NWK	(CP_WIRNG)
J1-21	1RWK	(CP_WIRNG)
J1-2	1LK	(CP_WIRNG)
J1-22	1TK	(CP_WIRNG)
J1-3	1LGK	(CP_WIRNG)
J1-23	1RGK	(CP_WIRNG)
J1-4	N/U	(CP_WIRNG)
J1-24	N/U	(CP_WIRNG)
J1-5	SMK	(CP_WIRNG)
J1-25	PDK	(CP_WIRNG)
J1-6	AUX	(CP_WIRNG)
J1-26	N/U	(CP_WIRNG)
J1-7	N/U	(CP_WIRNG)
J1-27	N/U	(CP_WIRNG)
J1-8	N/U	(CP_WIRNG)
J1-28	1RAK	(CP_WIRNG)

J1-9	N/U	(CP_WIRNG)
J1-29	N/U	(CP_WIRNG)
J1-10	N/U	(CP_WIRNG)
J1-30	N/U	(CP_WIRNG)
J1-11	N/U	(CP_WIRNG)
J1-31	N/U	(CP_WIRNG)
J1-12	N/U	(CP_WIRNG)
J1-32	N/U	(CP_WIRNG)

CONTROLS

J1-13	SMZ	(CP_WIRNG)
J1-33	ECZ	(CP_WIRNG)
J1-14	N/U	(CP_WIRNG)
J1-34	N/U	(CP_WIRNG)
J1-15	N/U	(CP_WIRNG)
J1-35	N/U	(CP_WIRNG)

● = 53102 CONNECTOR (WAGO)




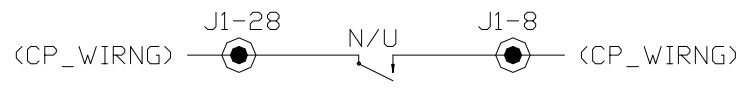
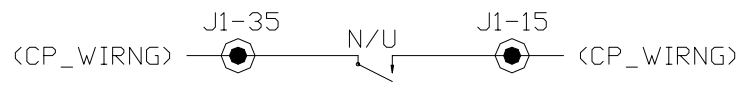
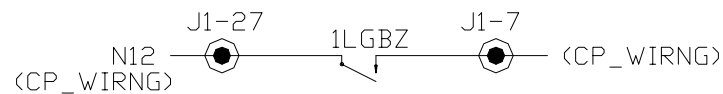
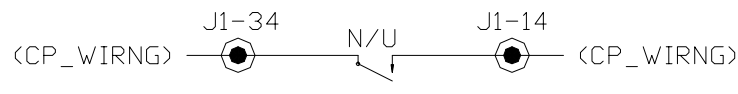
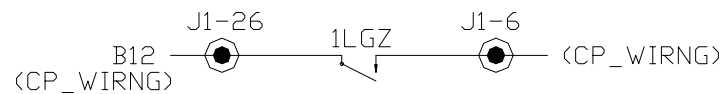
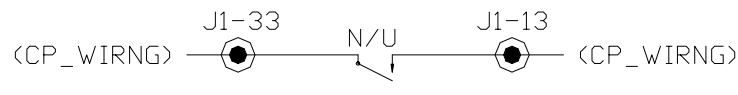
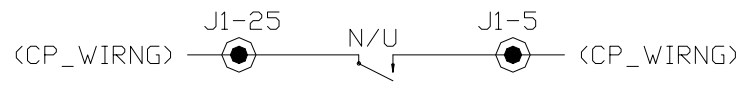
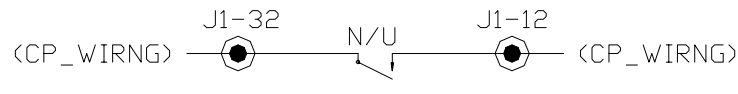
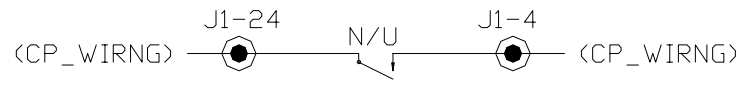
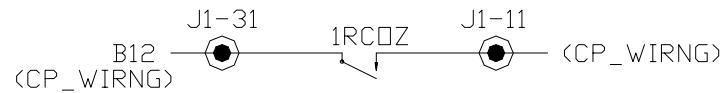
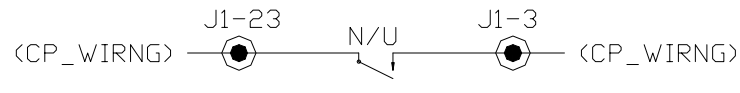
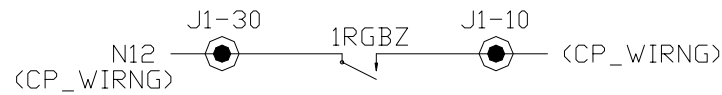
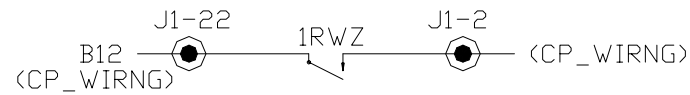
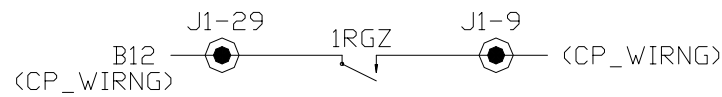
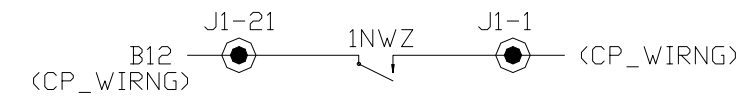
 Safetran Systems Corporation ELECTRONIC DIVISION	
TYPICAL RLINK FIELD RACK 53102 - UNIPOLAR I/O WIRING	
SIZE C	S/O
SCALE NONE	SHEET 5 OF 9

Figure 5-6
Typical R-Link Field Rack 53103 – Relay Output I/O Wiring Drawing

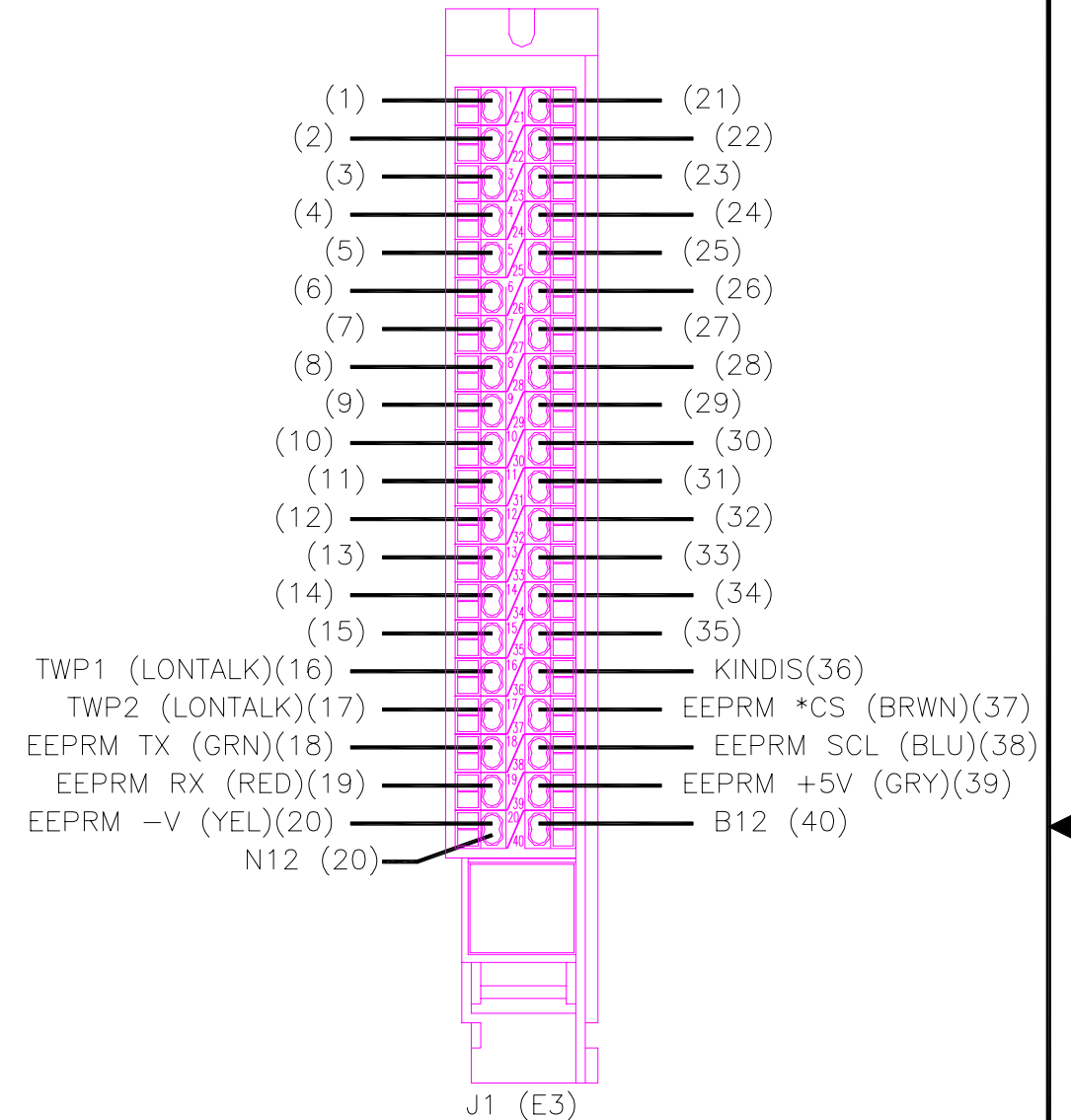
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CONTROLS (A53103)



● = 53102 CONNECTOR (WAGO)



J1 (E3)
A53103 RELAY OUTPUT MODULE


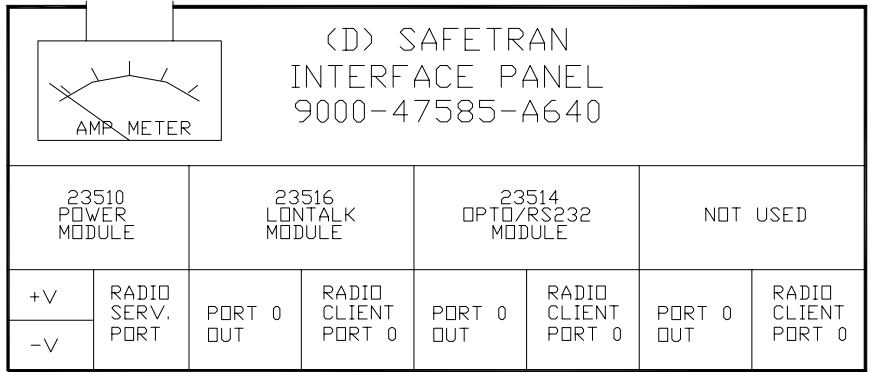
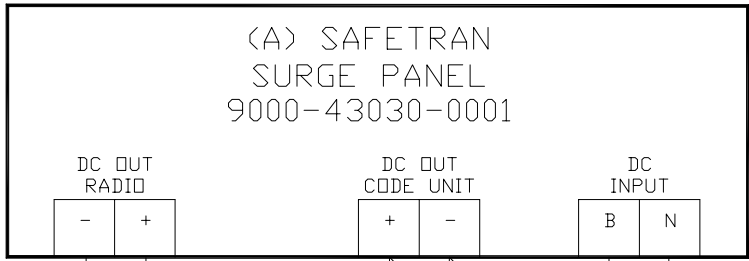
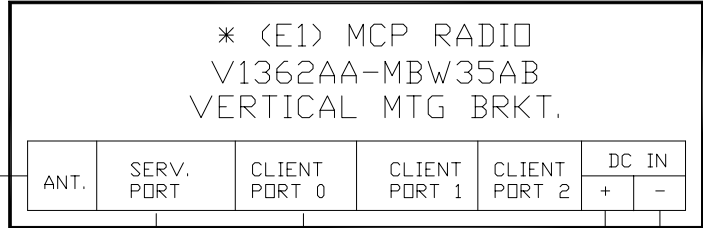
 Safetran Systems Corporation ELECTRONIC DIVISION	
TYPICAL RLINK FIELD RACK 53103 RELAY OUTPUT I/O WIRING	
SIZE C	S / O
SCALE NONE	SHEET 6 OF 9

Figure 5-7
Typical R-Link Field Rack Wiring / Flow Drawing

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* YAGI ANTENNA



TO VITAL CKTS (16 AWG)

TO VITAL CKTS (16 AWG)

* = CUSTOMER SUPPLIED
(XX) = RACK LOCATION

Safetran Systems Corporation
ELECTRONIC DIVISION

TYPICAL FIELD RACK RLINK WIRING/FLOW

SIZE C

SCALE NONE

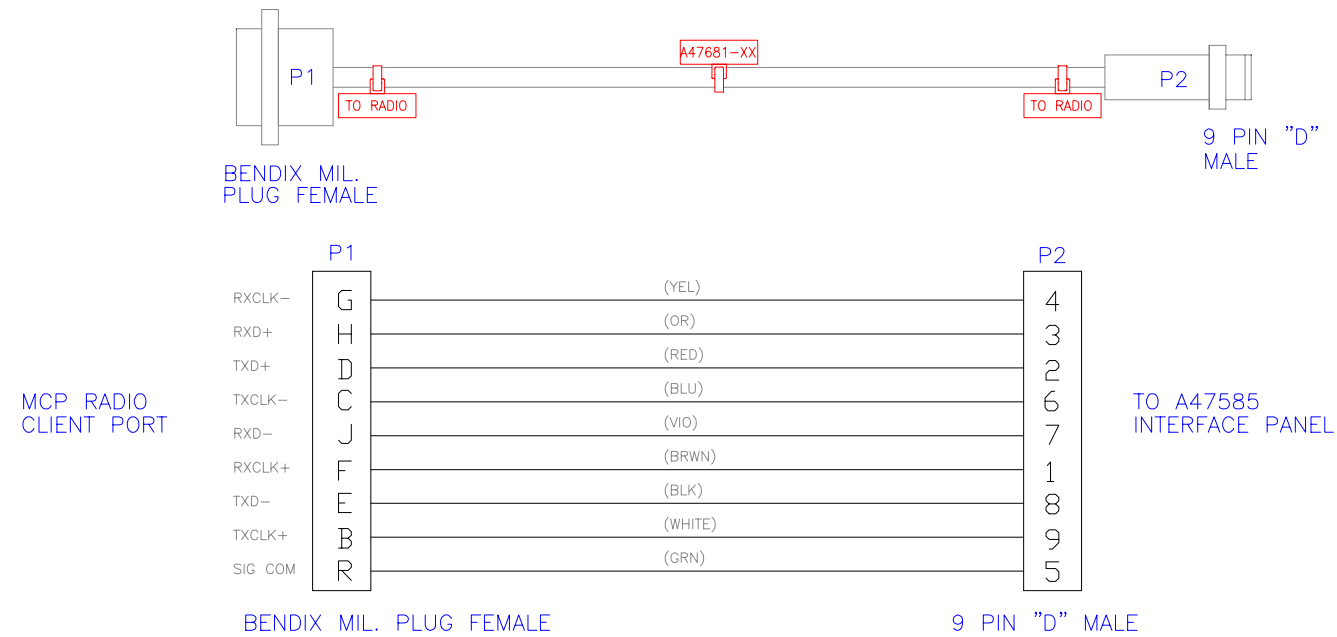
SHEET 7 OF 9

Figure 5-8
Typical R-Link Field Rack Cables Drawing

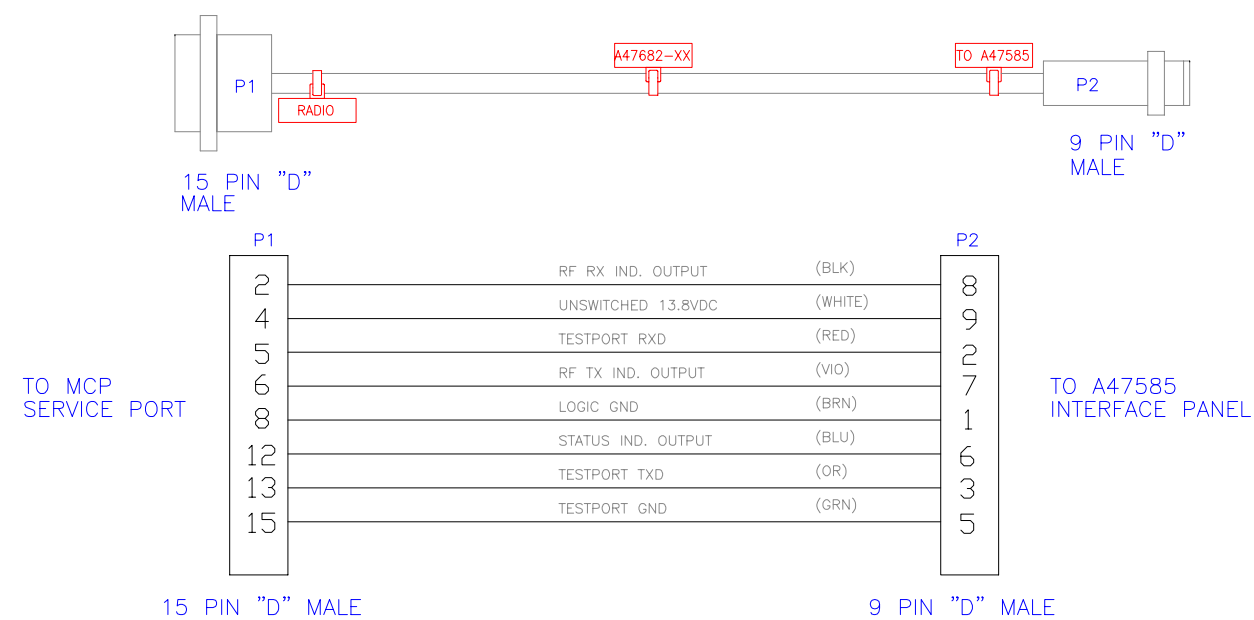
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CLIENT PORT CABLE A47681



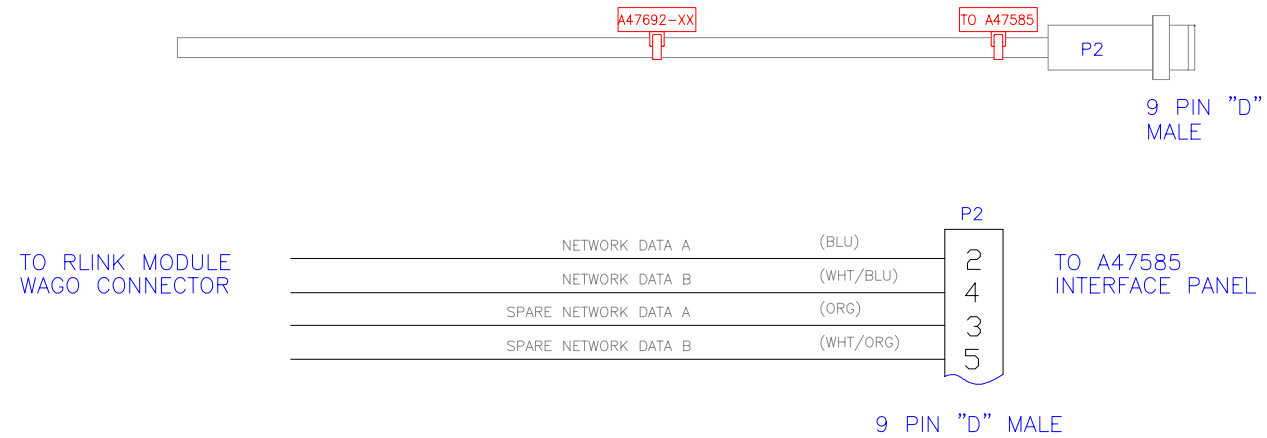
SERVICE PORT CABLE A47682



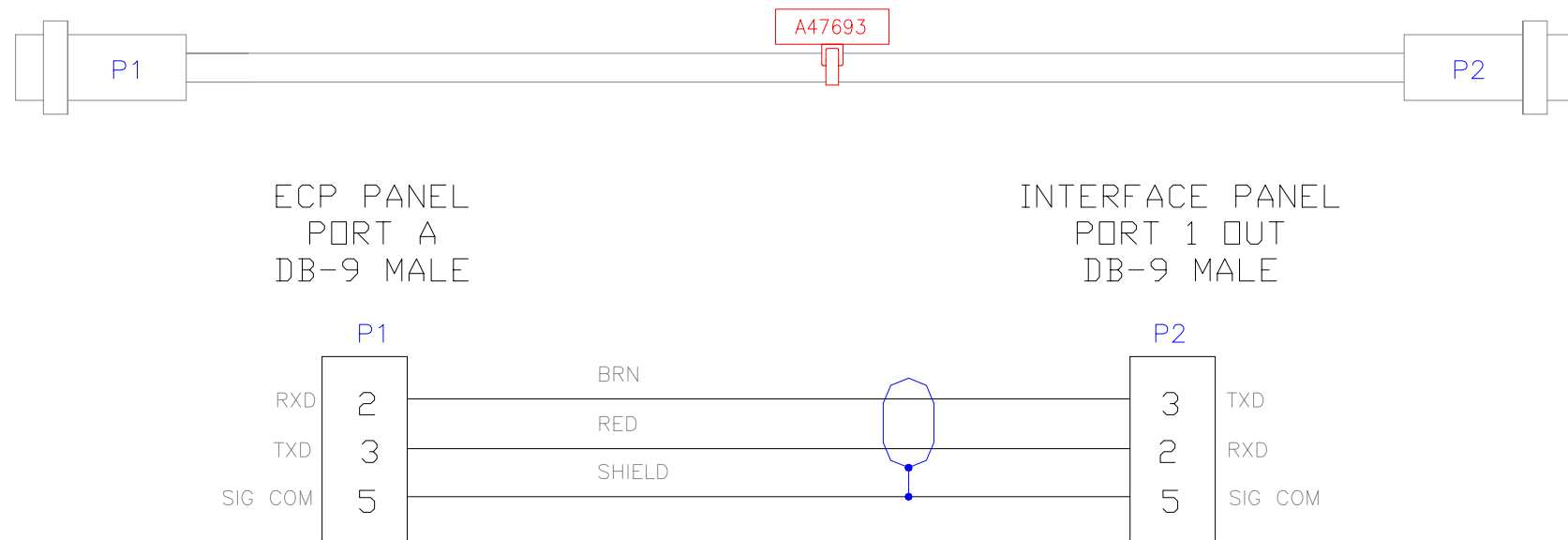
 Safetran Systems Corporation ELECTRONIC DIVISION	
TYPICAL FIELD RACK RLINK CABLES	
SIZE C	S / O
SCALE NONE	SHEET 8 OF 9

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MCP RADIO SERV PORT CABLE A47692



ECP PANEL SEREIAL CABLE A47682



S Safetran Systems Corporation
ELECTRONIC DIVISION

TYPICAL
FIELD RACK
RLINK
CABLES

SIZE
C

S/O

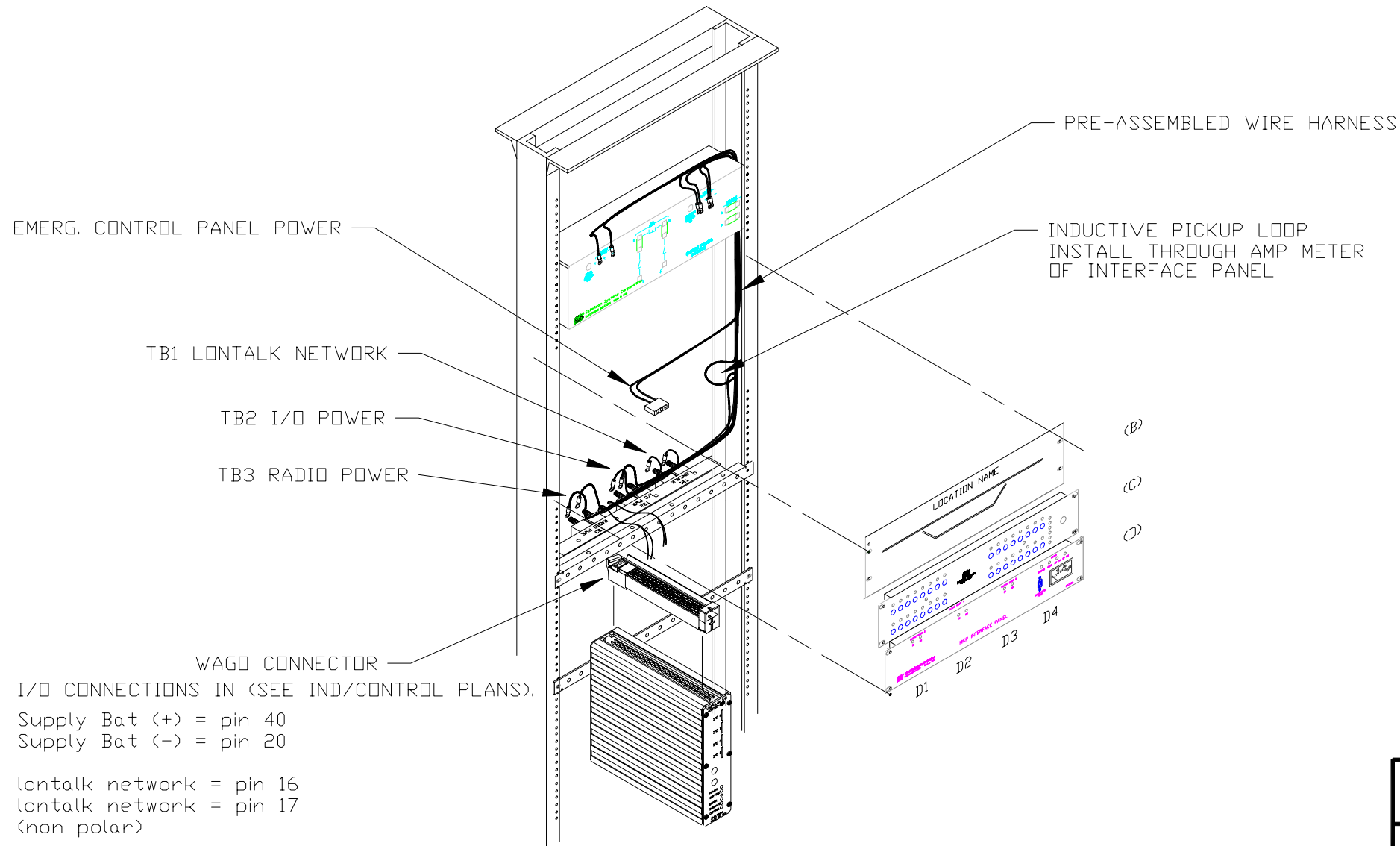
SCALE NONE

SHEET 9 OF 9

Figure 5-9
Rack Installation Canadian Pacific Rail R-Link Mechanical Drawing

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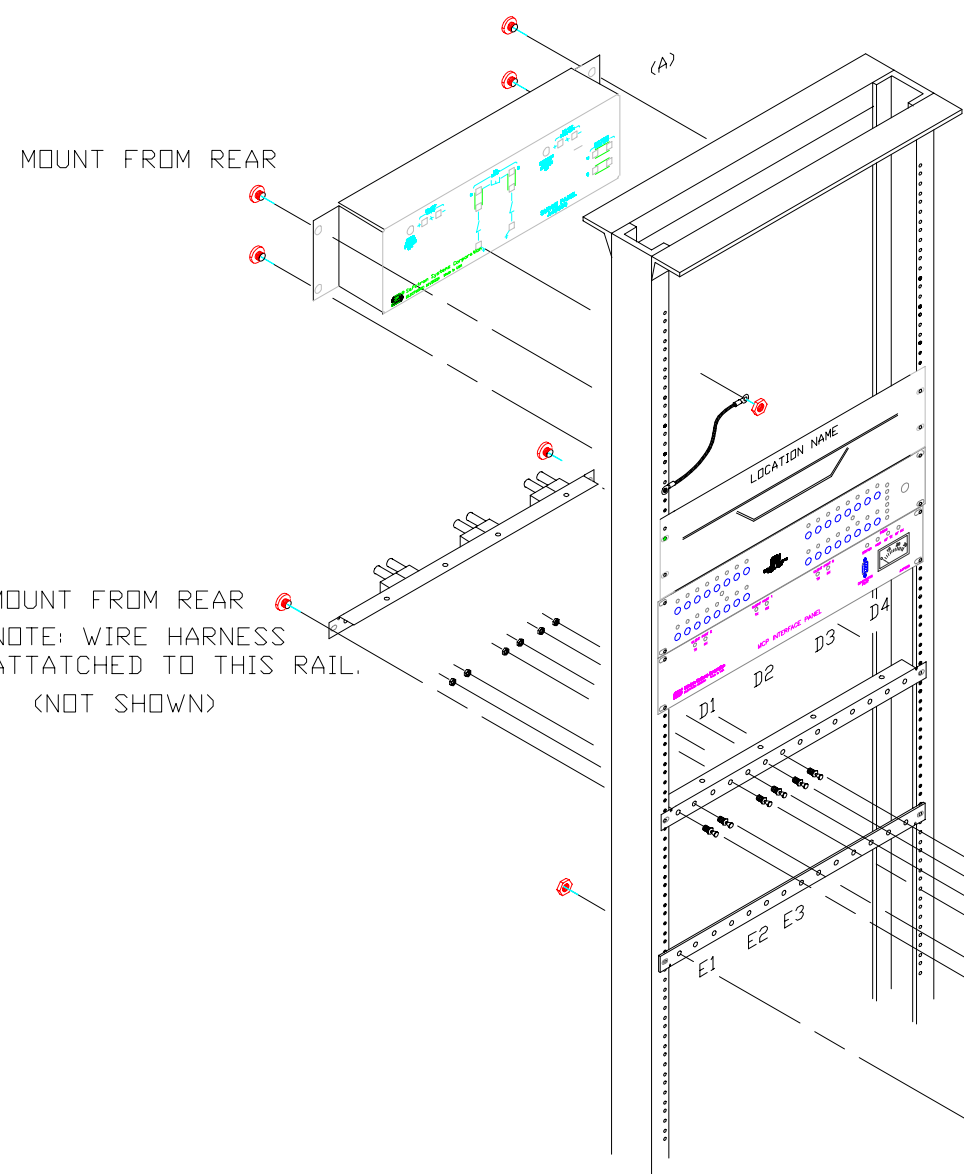
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Front View

 Safetran Systems Corporation ELECTRONIC DIVISION	
RACK INSTALLATION CANADIAN PACIFIC RAIL RLINK MECHANICAL	
SIZE C	S018042
SCALE NONE	SHEET 1 OF 2

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(B) NOTE: PANEL (B) TRACK LAYOUT TO BE DELIVERED AFTER ARTWORK APPROVAL BY CUSTOMER.


(C)

(D)

(E)

CONNECTOR PRE-WIRED BY CUSTOMER

MCP RADIO PROVIDED BY CUSTOMER.

 Safetran Systems Corporation ELECTRONIC DIVISION	
RACK INSTALLATION CANADIAN PACIFIC RAIL RLINK MECHANICAL	
SIZE C	S018042
SCALE NONE	SHEET 2 OF 2

APPENDIX A

ADVANCED TRAIN CONTROL SYSTEM

A.1 OVERVIEW

The Advanced Train Control System (ATCS) standardizes the message formats and addressing scheme used by all railroads for train control applications. The system operates by sending and receiving standard datagrams (using a standard addressing scheme) between the various ATCS compatible signaling and operating equipment. Addresses are provided for wayside equipment, central office equipment, on-board equipment, base stations, maintenance equipment, railcars, and anything else found in a railroad environment. These messages convey operating instructions and status information such as track-and-time permits, codeline controls and indications, hot-box data, etc. A typical ATCS network is shown in figure A-1.

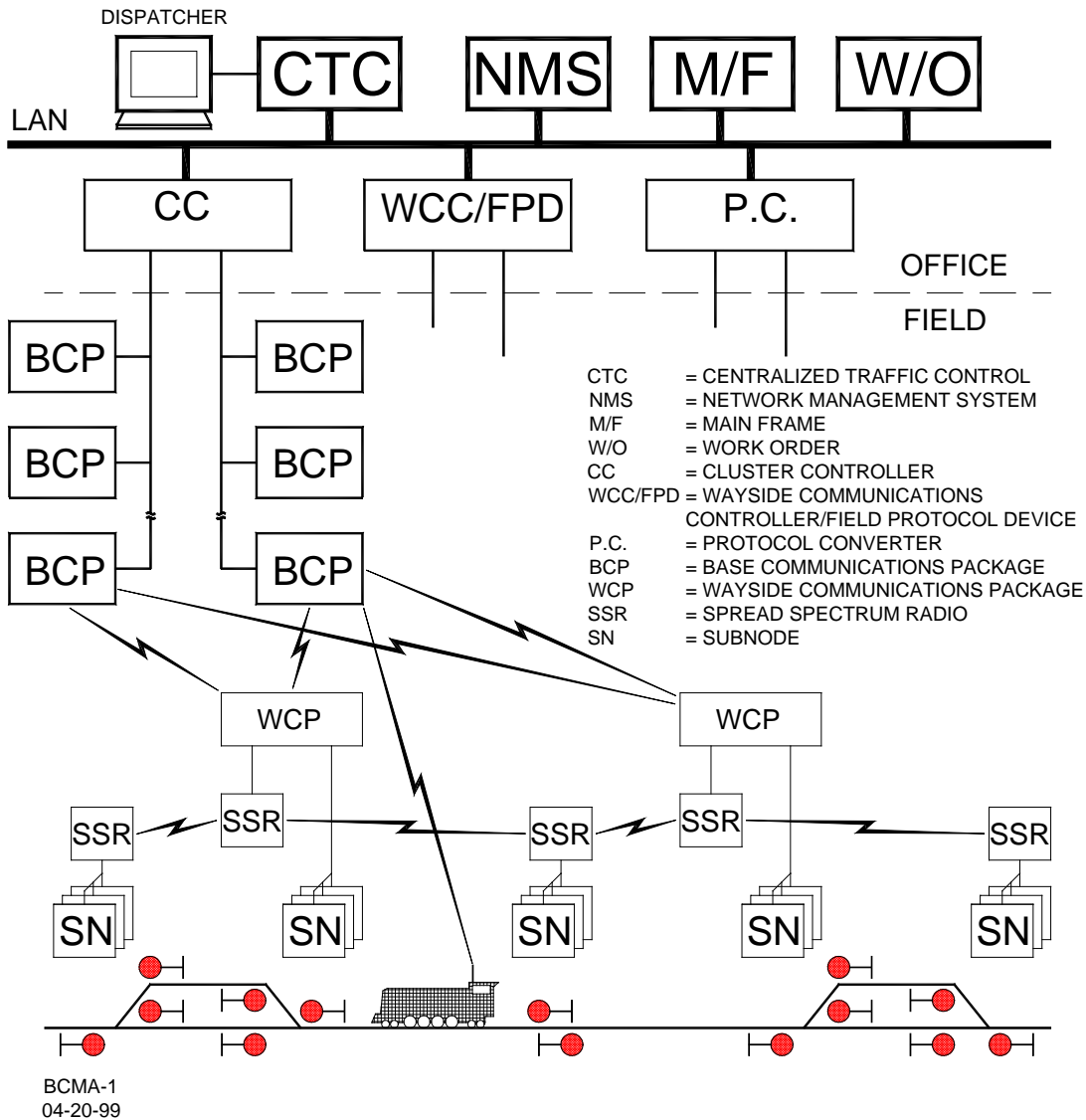


Figure A-1
Typical ATCS Network

Centralized Train Control (CTC) office equipment communicates with the onboard and wayside equipment via Base Communication Packages (BCPs), controlled by Cluster Controllers (CCs), Protocol Converters (PCs), or Wayside Communications Controller/Field Protocol devices (WCC/FPDs). Network Management System (NMS) office equipment monitors the dynamic performance of the network. Field radios are a mixture of Wayside Communication Packages (WCPs) and Spread-Spectrum Radios (SSRs). All communications use ATCS datagrams or packets.

Each ATCS datagram carries with it a destination address (i.e., the address of the equipment it is destined for), and a source address (i.e., the equipment that generated it). These addresses are constructed with slight differences for the various uses. For example, on-board equipment will have a Type 1 (locomotive) address while wayside equipment will have a Type 7 (wayside) address. A number of the various types of addresses used are described in the following paragraphs. For further information concerning ATCS addressing, refer to the following specifications:

ATCS Specification 200 (March 1993) - ATCS Protocols
 ATCS Specification 200 (March 1993) - Communications Architecture
 ATCS Specification 250 (March 1993) - ATCS Message Formats
 ATCS Specification 700 (March 1993) - CPC Specification
 ATCS Specification 157 (March 1993) - CPC Operation
 R/Link ATCS Radio Code Line System Application Logic Generation Guide (Safetran
 Document No. C-00-94-06)

A.1.1 Locomotive Addresses (Type 1)

Each locomotive address consists of twelve digits in the following format: **1.RRR.VVVVVV.DD**,

where:

1 = Locomotive address type
 RRR = Railroad number (see Appendix B)
 VVVVVV = Locomotive number
 DD = Device on board locomotive (e.g., Engineers display)

A.1.2 Office Equipment Addresses (Type 2)

These addresses are allocated to all office equipment, specifically to all mainframe applications, CTC systems, diagnostic, and maintenance equipment. Each office equipment address consists of ten digits in the following format: **2.RRR.NN.DDDD**

where:

2 = Office equipment address type
 RRR = Railroad number (see Appendix B)
 NN = Unit in the office (e.g., CTC computer, 53401 Packet Switch, etc.)
 DDDD = Application in the office (e.g., maintenance alarm monitoring)

A.1.3 Base Station Address (Type 3)

Base station addresses are allocated to each base station to permit the office maintenance equipment to communicate with the base and interrogate it for current status plus other relevant statistics. Each address consists of 10 digits in the following format: **3.RRR.NN.DDDD**

where:

3	=	Wire line address type
RRR	=	Railroad number (see Appendix B)
NN	=	Node number (railroad defined)
DDDD	=	Base device number (railroad defined)

The ATCS specification recommends that the BCP node number be the same as the node number of the CC (47620) to which it is connected. The device number is user defined, and can be set to any convenient value.

A.1.4 Wayside Equipment (Type 5)

The type 5 wayside address was used on earlier ATCS systems and is the default addressing scheme for Advanced Railroad Electronic System (ARES) wayside equipment. Although the ARES network differs slightly from the ATCS specification, for purposes of this discussion, the two can be considered identical systems.

Each address consists of ten digits in the following format: **5.RRR.NN.LL.GG**

where:

5	=	Wayside address type
RRR	=	Railroad number (see Appendix B)
NN	=	Node or routing region number
LL	=	Code-line number
GG	=	Group or location number

This addressing scheme does not have the ability to address multiple devices at each location. The node number typically follows the node number of the CC controlling the base stations for the location.

A.1.5 Wayside Equipment (Type 7)

This is the default ATCS wayside addressing scheme. Wayside addresses are allocated to each equipment item at a field location, such as signaling equipment, AEI readers, and hazard detectors. The addresses are hierarchical (i.e., all equipment items at a specific site share the common root address).

Each address consists of 14 digits in the following format: **7.RRR.LLL.GGG.SS.DD**

where:

- 7 = Wayside address type
- RRR = Railroad number (see Appendix B)
- LLL = Code-line or region number
- GGG = Group or location number
- SS = Equipment or subnode at location
- DD = Device controlled by this equipment

The LLL fields are normally assigned by each railroad according to internal conventions, and may represent a region, district, code line, or other area designation that shows it is part of the railroad.

The GGG field must be coordinated between the CTC equipment and field equipment configuration.

For the SS field, two subnode numbers are always pre-assigned at each location. The wayside-to-office communications device is defined as number 01, and number 02 is reserved for the wayside-to-wayside communications system. Any additional equipment (e.g., the R/Link™ I/O modules), will therefore have subnode numbers starting with 03. Subnode number 99 is reserved as a broadcast address to all equipment at a location.

Device numbers (DD field) are allocated in sequence beginning at 01. Each piece of field equipment has at least one internal device, but it may have more depending on the equipment. Examples of full ATCS addresses for a wayside code system would be as follows:

For CP Rail, code line 8, control point 1: 7.105.008.001.03.02.

For the WCP radio at the same location : 7.105.008.001.01.01.

A.1.6 Other Address Types

Other address types are defined in ATCS for future applications. Please refer to the appropriate ATCS specifications for full details.

A.2 ATCS MESSAGE FORMATS

The major fields in an ATCS message are shown in figure A-2.



Figure A-2
Major Fields Of An ATCS Message

A.2.1 Destination Field

The **Destination** field is the address of the recipient equipment. For example, if this is an indication message coming from a wayside code unit, the destination address will be the CTC dispatching equipment (2.RRR.NN.DDDD).

A.2.2 Source Field

The **Source** field is the sender’s address (e.g., 7.RRR.LLL.GGG.SS.DD).

A.2.3 Message Number Field

The message number (**M#**) field is allocated by the sender in a sequential fashion so that the recipient can detect duplicate, missing, or out of order messages.

A.2.4 Label Field

The **Label** field describes the type of data carried by the message. Many different labels have been defined in ATCS Specification 250. Additional labels are defined by suppliers to perform custom functions.

A.2.4.1 Information Datagrams

Only three ATCS **Information** datagram labels are used for code line operation in the R/Link system: controls, indications, and recalls. All R/Link traffic is sent as priority 2 (channels 4 and 5) traffic. Refer to table A-1 for ATCS information labels.

**Table A-1
ATCS Messages**

Message	ATCS Label	Hex Label
Controls:	9.0.1	\$1201
Indications	9.2.11	\$128b
Recalls	9.1.8	\$1248

Control Message Format:

Control messages are sent from the office to the field as a result of dispatcher or automatic route-setting action. Refer to table A-2 for control messages.

**Table A-2
Control Messages**

Field Name	Bytes	Typical Value
ATCS Header	1 thru 22	See spec.
ATCS Label	23 and 24	\$1201 (9.0.1)
ATCS Version	25	3
Number of Controls	26	1
Bits In Last Control	27	8
First Control	28	
Second Control	29	
Etc.	30 ...	

Indication Message Format:

Indication messages are sent from the field either (a) when a change of state occurs, or (b) once per minute. Message layout is shown in table A-3.

**Table A-3
Indication Messages**

Field Name	Bytes	Typical Value
ATCS Header	1 thru 22	See Spec.
ATCS Label	23 and 24	\$128b (9.2.11)
ATCS Version	25	3
Number of Indication Bytes	26	1
Bits In Last Indication Byte	27	8
First Indication Byte	28	
Second Indication Byte	29	
Etc.	30...	

Recall Message Format:

Recall messages are sent by the dispatcher as listed in table A-4.

**Table A-4
Recall Messages**

Field Name	Bytes	Typical Value
ATCS Header	1 thru 22	See spec.
ATCS Label	23 and 24	\$1248 (9.1.8)
ATCS Version	25	3

A.2.4.2 RF Acknowledge Format

In addition to information datagrams, brief RF acknowledge messages are used between the cluster controller (CC) or central protocol converter (CPC) and MCP/WCP radios to acknowledge successful transmission of data packets. Indication messages are sent by the field locations when there is a change of state, as well as at least once per minute. Control and recall messages are sent by the office as required.

A.2.5 Data Field

The **Data** field carries the particular data required for the type of message defined by the **Label** field.

A.2.6 Other ATCS Messages

Periodically, different messages may be observed on the R/Link system due to traffic from foreign railroads, the network management system, etc. These messages are described in detail in ATCS Specification 250.

A.3 ATCS TRANSMISSION MODES

The ATCS specification describes five transmission modes that can be used for data transfer. The R/Link system currently uses Modes 0 and 1 only. Control and indication messages are sent as Mode 1 which, when a message is properly received, requires the receiver to send a short RF acknowledge message to the sender. Unacknowledged messages are repeated by the sender up to the configured number of times.

Recall messages are sent as Mode 0. Unlike Mode 1, the messages are not acknowledged by the receiver. To increase the success rate of messages over the RF link, three consecutive copies of the message are sent.

A.4 ATCS RADIO NETWORK – LAYER 1

The ATCS radio network consists of pairs of UHF channels. These channels are as follows:

<u>Channel Number</u>	<u>Base to Mobile Frequency</u>	<u>Mobile to Base Frequency</u>
1	935.8875	896.8875
2	935.9375	896.9375
3	935.9875	896.9875
4	936.8875	897.8875
5	936.9375	897.9375
6	936.9875	897.9875

NOTE

Transmission on the channels is baseline FSK. The deviation of the carrier to a higher frequency is interpreted as a logical 0 and to a lower frequency as a logical 1. The bit rate is 4800 bits per second. Nominal channel separation is 12.5kHz.

APPENDIX B

ATCS SPECIFICATION 250 RAILROAD CODE LIST

The following chart lists the codes assigned to all carriers in accordance with ATCS Specification No. 250 and includes the railway carrier name along with the alphabetical and numerical codes assigned to each. In the event a discrepancy exists between the information in the following list and the current AAR specification, the AAR specification shall prevail.

ATCS SPECIFICATION 250 RAILROAD CODE LIST

ID	Company Name	RR Mark	ATCS
001	Aberdeen And Rockfish Railroad Company	AR	009
002	Akron & Barberton Belt Railroad Company	ABB	002
003	Alabama & Florida Railway Co	AF(LR)	917
004	Alameda Belt Line	ABL	014
005	Alameda Corridor Transportation Authority	ACTA	015
006	Alaska Hydro-Train	AHT	039
007	Alaska Railroad Corporation	ARR	005
008	Alexander Railroad Company	ARC	049
009	Algiers Winslow And Western Railway Company	AWW	004
010	Algoma Central Railroad Inc	AC	008
011	Allegheny & Eastern Railroad Inc	ALY	532
012	Alley Railroad Company		664
013	Almanor Railroad Company	AL	046
014	Alton & Southern Railway Company	ALS	032
015	Amador Central Railraod Company	AMC	019
016	Andalusia & Concecuh Railroad Company	ACRC	173
017	Angelina & Neches River Railroad Company	ANR	035
018	Anthracite Railway Inc	ATRW	176
019	Apache Railway Company	APA	011
020	Apalachicola Northern Railroad Company	AN	012
021	Appanoose County Community Railroad Inc	APNC	226
022	Arcade And Attica Railroad Corporation	ARA	013
023	Arkansas And Missouri Railroad Co	AM	906
024	Arkansas Louisiana & Mississippi (Missouri) Railro	ALM	016
025	ARTC		047
026	Ashley, Drew & Northern Railway Company	AND	020
027	Ashtabula Carson & Jefferson Railroad	ACJR	235
028	Atchison, Topeka And Santa Fe Railway Company Ats	ATSF	022
029	Atcs Shared Network	ATCS	340
030	Atcs Testing & Field Evaluation	ATCR	050
031	Atcs Testing & Field Evaluation	ATCT	620
032	Atlantic & Western Railway, L P	ATW	025
033	Austin Railroad	AUNW	924
034	Austin, Todd And Ladd Railroad Company	ATLT	514
035	Baltimore And Annapolis Railroad Company	BLA	053
036	Bangor & Aroostook Railroad Company	BAR	056
037	Bath And Hammondsport Railroad Company	BH	079
038	Batten Kill Railroad Inc	BKRR	086
039	Bauxite & Northern Railway Company	BXN	084
040	Bay Colony Railroad Corporation	BCLR	082
041	Bayside Railway Co		021
042	BC HYDRO RAIL	BCE	072
043	BC RAIL LTD	BCOL	997
044	Beaufort And Morehead Railroad Company	BMH	068
045	Beech Mountain Railroad Company	BEEM	060
046	Belfast And Moosehead Lake Railroad Company	BML	087
047	Belt Railway Company Of Chicago	BRC	083
048	Belton Railroad Company	BRR	207
049	Berlin Mills Railway	BMS	073
050	Bessemer And Lake Erie Railroad Company	BLE	061

ID	CompanyName	RR Mark	ATCS
051	Birmingham Southern Rr Co	BS	065
052	Black River & Western Corporation	BRW	066
053	Bloomer Line, The	BLOL	223
054	Blue Mountain And Reading Railroad	BMRG	256
055	Border Pacific Railroad Co	BOP	225
056	Boston And Maine Corporation	BM	069
057	Brandon Corporation	BRAN	081
058	Brandywine Valley Railroad Company	BVRY	067
059	Broken Hill Proprietary Co.		042
060	Brownsville And Rio Grande International Rr	BRG	170
061	Buffalo Southern Railroad Inc	BSOR	085
062	Burlington Junction Railway	BJRY	383
063	Burlington Northern (Manitoba) Ltd	BNML	457
064	Burlington Northern Railroad Company	BN	076
065	Burlington Northern Santa Fe	BNSF	777
066	C&J Railroad Investment Company	CJRR	565
067	Cadillac And Lake City Railway Co	CLK	093
068	Cadiz Railroad Company	CAD	092
069	Cairo Terminal	CTML	162
070	California Western	CWR	100
071	CALTRAIN	CALTRAIN	708
072	Camas Prairie Railnet Inc	CSP	952
073	Cambria And Indiana Railroad Company	CI	101
074	Canada And Gulf Terminal Railway Company, The	CGT	116
075	Canadian National Railways	CN	103
076	Caney Fork And Western Rr	CFWR	187
077	Canton Railroad Company	CTN	097
078	Cape Fear Railways Inc	CF	099
079	Carolina Rail Services Inc	CRIJ	988
080	Carrollton Railroad	CARR	113
081	Carthage Knightstown & Shirley Railroad	CKSI	396
082	Cedar Rapids & Iowa City Railway Company	CIC	111
083	Cedar Valley	CVAR	313
084	Central California Traction Company	CCT	112
085	Central Indiana & Western Railroad Co Inc	CEIW	949
086	Central Michigan Railway Co	CMGN	472
087	Central Montana Rail Inc	CM	374
088	Central New York Railroad Corporation	CNYK	151
089	Central Vermont Railway	CV	120
090	Central Western Railway Corp	CWRL	527
091	Charles City Rail Lines	CCRY	967
092	Chattahoochee Industrial Railroad	CIRR	222
093	Chattahoochee Valley	CHV	124
094	Chelatchie Praire Railraod	CCPR	155
095	Chesapeake And Ohio Railway Company	CO	125
096	Chesapeake Western	CHW	179
097	Chestnut Ridge Railway Company	CHR	117
098	Chicago And Northwestern	CNW	131
099	Chicago And West Pullman	CWP	172
100	Chicago And Western Indiana	CWI	132

ATCS SPECIFICATION 250 RAILROAD CODE LIST

ID	CompanyName	RR Mark	ATCS
101	Chicago Central & Pacific Railroad Co	CC	569
102	Chicago Heights Terminal Transfer Railroad Company	CHTT	139
103	Chicago Illinois Midland	CIM	130
104	Chicago Short Line Railway Company	CSL	147
105	Chicago Southshore & South Bend Railroad	CSS	168
106	Cimarron Valley Railroad, L C	CVR	378
107	City Of Columbia	CT	090
108	City Of Prineville Railway	COP	166
109	Claremont Concord Railroad Corporation	CCRR	188
110	Clarendon And Pittsford Railroad Company, The	CLP	169
111	Cliffaide Railroad Company	CLIF	181
112	Colonels Island Railroad Co	CISD	164
113	Colorado & Wyoming Rwy Co	CW	158
114	Colorado Springs & Eastern	CSE	319
115	Columbia & Cowlitz Railway Company	CLC	163
116	Columbia & Silver Creek Railroad Company	CLSL	165
117	Columbus And Greenville Railway	CAGY	177
118	Conemaugh & Black Lick Railroad Company	CBL	215
119	Connecticut Central	CCCL	416
120	Connecticut Department of Transportation	CDOT	007
121	Consolidated Rail Corporation	CR	190
122	Cooperstown And Charlotte Valley Rwy	CACV	114
123	Copper Basin Railway Inc	CBRY	909
124	Corinth And Counce	CCR	201
125	Corman	RJCR	970
126	Cotton Belt (St. Louis Southwestern Rwy Company)	SSW	694
127	CP RAIL SYSTEM	CP	105
128	Crab Orchard & Egyptian Railroad	COER	089
129	CSXT	CSXT	171
130	Curtin Milburn	CMER	180
131	Cuyahoga Valley Railway Company, The	CUVA	186
132	D & I Railroad Company	DAIR	211
133	Dakota Minnesota & Eastern Railroad Corp	DME	912
134	Dakota Rail Inc	DAKR	221
135	Dakota Southern Railway Company	DSRC	526
136	Dansville And Mount Morris Railroad Company, The	DMM	220
137	Dardanelle & Russellville Railroad Company,	DR	191
138	Davenport Rock Island And North Western Railway Co	DRI	192
139	Delaware & Hudson Railway Company Inc	DH	195
140	Delaware Coast Line Rr Co	DCLR	214
141	Delta Valley & Southern Railway Company	DVS	193
142	Denver Union Terminal Ry Co.	DUT	288
143	Dequeen And Eastern Railroad Company,	DQE	200
144	Des Moines Union	DMU	202
145	Detroit And Mackinac	DM	204
146	Dominion And Atlantic	DA	209
147	Doniphan Kensett & Searcy Railway	DKS	210
148	DRGW	DRGW	197
149	Duluth & Northeastern Railroad Company,	DNE	212
150	Duluth Missabe And Iron Range Railway Company	DMIR	213

ID	CompanyName	RR Mark	ATCS
151	Duluth Winnipeg And Pacific Railway Company	DWP	216
152	Dunn-Erwin Railway Corporation	DER	219
153	East Camden & Highland Rr Co	EACH	242
154	East Cooper And Berkeley Railroad Company	ECBR	229
155	East Erie Commercial Railroad	EEC	040
156	East Jersey Railroad And Terminal Company	EJR	245
157	East St. Louis Junction Rr	ESLJ	233
158	East Tennessee Railway, L P	ETRY	257
159	Eastern Shore Railroad Inc	ESHR	251
160	Edgmoor & Manetta	EM	232
161	El Dorado And Wesson Railway Company	EDW	247
162	Elgin Joliet & Eastern Railway Company	EJE	238
163	EsCANABA And Lake Superior Railroad Company	ELS	241
164	Esquimalt And Nanaimo	EN	246
165	Essex Terminal Railway Company The	ETL	228
166	Eureka Southern	EUKA	368
167	Everett Railroad	EV	231
168	Falls Creek	FCRK	267
169	Farmrail Corporation	FMRC	280
170	FCA - Ferrovía Centro - Atlantica SA	??	029
171	Ferdinand & Huntingburg	FRDN	273
172	Ferrocarril De Chihuahua Al Pacifico,	CHP	284
173	Ferrocarriles Nacionales De Mexico	NDM	266
174	Ferrocarriles Nacionales De Mexico	SBC	283
175	Ferrocarriles Nacionales De Mexico -	FCP	738
176	Ferrocarriles Unidos Del Sureste, S.A.	SE	281
177	Florida Central Railroad Co	FCEN	986
178	Florida East Coast Railway Company	FEC	263
179	Florida Midland Railroad Co Inc	FMID	507
180	Fonda, Johnstown And Gloversville	FJG	264
181	Fordyce And Princeton Railroad Co	FP	265
182	Fore River	CRY	908
183	Fort Smith And Van Buren	FSVB	279
184	Fort Worth & Western Railroad	FWWR	277
185	Galveston Railroad L P	GVSR	567
186	Galveston Warves	GWF	303
187	Galveston, Houston And Henderson	GHH	293
188	Garden City Western Railway Company, The	GCW	287
189	Genesee And Wyoming Railroad Company	GNWR	320
190	Georgetown Railroad Company	GRR	302
191	Gettysburg Railway	GBRY	294
192	Gloster Southern Railroad Company	GLSR	916
193	GO TRANSIT	GOT	954
194	Goderich - Exeter Railway Company	??	027
195	Golden Triangle Railroad	GTRA	295
196	Grafton And Upton Railroad Company	GU	323
197	Grainbelt Corporation	GNBC	443
198	Grand River	GRNR	322
199	Grand Trunk Western Railroad Incorporated	GTW	308
200	Graysonia, Nashville And Western	GNA	307

ATCS SPECIFICATION 250 RAILROAD CODE LIST

ID	CompanyName	RR Mark	ATCS
201	Great River Railroad	GTR	271
202	Great Southwestern	GSWR	305
203	Great Western Railway Company, The	GWR	311
204	Green Bay And Western	GBW	312
205	Green Hills Rural Development	GHRD	980
206	Green Mountain Railroad Corporation	GMRC	314
207	Gulf And Mississippi	GMSR	392
208	Hammersley Iron (Australia)		041
209	Hampton & Branchville Railroad Company	HB	330
210	Hartford And Slocomb Railroad Company	HS	366
211	Hartwell Railway Company	HRT	334
212	Helena Southwestern Railroad Company	HSW	331
213	High Point Thomasville & Denton Railroad Company	HPTD	366
214	Hillsboro And North Eastern Railway	HLNE	338
215	Hillsdale County Railway Company, Inc.	HCRC	326
216	Hillside (Australia)		018
217	Hollis & Eastern R R Co	HE	328
218	Houston Belt & Terminal Railway Company	HBT	342
219	Huntsville & Madison County Railroad Authority	HMCR	391
220	Huron And Eastern Railway Company Inc	HESR	890
221	Hutchinson And Northern Railway Company, The	HN	332
222	Illinois Central Railroad Company	IC	360
223	Indian Creek Railroad Company	ICRK	380
224	Indiana & Ohio Rail Corp.	INOH	344
225	Indiana Hi-Rail Corporation	IHRC	352
226	Indiana Rail Road Corporation	INRD	780
227	Indianapolis Union Railway	IU	363
228	Indonesia (Indonesian State Railways)		093
229	International Bridge And Terminal Company, The	IBT	358
230	Interstate Railroad Company	SOU	381
231	Iowa Interstate Railroad Ltd	IAIS	316
232	Iowa Northern Railroad	IANR	341
233	Iowa Southern Railroad Company	ISR	272
234	Iowa Traction Railroad Company	IATR	994
235	ITS - Highway Advanced Transportation Controller		051
236	ITS - Non-ATCS Railroad		052
237	Jefferson Warrior Railroad Co Inc	JEFW	254
238	Kankakee Beaverville And Southern Railroad Company	KBSR	399
239	Kansas And Missouri Railway	KM	414
240	Kansas City Southern Railway Company	KCS	400
241	Kansas City Terminal Railway Company	KCT	401
242	Kentucky And Tennessee Railway	KT	405
243	Keokuk Junction Railway	KJRY	365
244	Kiamichi Railroad Company Llc	KRR	424
245	Knox & Kane Railroad Company	KKRR	376
246	Kwt Railway Inc	KWT	996
247	Kyle Railroad Company	KYLE	377
248	Lake Erie & Northern	LEN	421
249	Lake Erie, Franklin & Clarion Railroad Company	LEF	423
250	Lake Superior & Ishpeming Railroad Company	LSI	425

ID	CompanyName	RR Mark	ATCS
251	Lake Terminal Railroad Company, The	LT	404
252	Lamoille Valley Railroad Company	LVRC	452
253	Lancaster And Chester Railway Company	LC	426
254	Landisville Railroad Inc (Formerly Amherst Industr	AMHR	071
255	Laurinburg And Southern Railroad Company	LRS	427
256	Levin-Richmond Terminal Corporation	PRT	606
257	Lewis & Clark Railway Co	LINC	355
258	Little Rock & Western Railway, L P	LRWN	485
259	Little Rock Port Railroad	LRPA	435
260	Livonia, Avon & Lakeville Railroad Corporation	LAL	398
261	Logansport & Eel River Short-Line Co Inc	LER	304
262	Long Island Railroad Company	LIRR	436
263	Longview, Portland & Northern Railway Company	LPN	450
264	Los Angeles Junction Railway Company	LAJ	428
265	Louisiana & Arkansas Railway Company	LA	441
266	Louisiana & Delta Railroad Inc	LDRR	972
267	Louisiana And North West Railroad Company, The	LNW	442
268	Louisville And Wadley Railway Company	LW	451
269	Louisville New Albany & Corydon Railroad	LNAL	446
270	Lowville And Beaver River Railroad Company, The	LBR	447
271	Ludington & Northern Railway	LUN	430
272	Madison Railroad (A Div Of City Of Madison Port Au	CMPA	144
273	Magma Arizona Railroad Company	MAA	463
274	Mahoning Valley Railway Company, The	MVRY	504
275	Maine Central Railroad Company	MEC	456
276	Manufacturers Junction Railway Company	MJ	459
277	Manufacturers Railway Company	MRS	460
278	Marinette, Tomahawk & Western Railroad	MTW	520
279	Maryland And Delaware Railroad Company	MDDE	454
280	Maryland And Pennsylvania Railroad Company	MPA	463
281	Maryland Midland Railway Inc	MMID	495
282	Maryland Rail Commuter	MARC	003
283	Massachusetts Bay Transportation Authority	MBTA	006
284	Massachusetts Central Railroad Corporation	MCER	461
285	Massena Terminal Railroad Company, The	MSTR	471
286	Mccloud Railway Company	MCR	466
287	Mckeesport Connecting Railroad Company	MKC	583
288	Meridian & Bigbee Railroad Company	MBRR	462
289	Metra		892
290	Mexican Pacific Railroad Company, Inc.	MDP	285
291	Mg Rail Inc	MGRI	388
292	Michigan-Wisconsin Transportation Company	MWTT	512
293	Mid Atlantic Railroad Co., Inc.	MRR	877
294	Middletown & Hummelstown Railroad Company	MIDH	479
295	Middletown & New Jersey Railway Company Inc	MNRR	475
296	Midland Terminal Co, The	MDLR	385
297	Midlouisiana Rail Corporation	MDR	919
298	Midsouth Corporation	MSRC	905
299	Milwaukee Road	MILW	140
300	Minnesota Commercial Railway Co	MNNR	973

ATCS SPECIFICATION 250 RAILROAD CODE LIST

ID	CompanyName	RR Mark	ATCS
301	Minnesota Dakota & Western Railway Company	MDW	610
302	Mississippi & Skuna Valley Railroad Company	MSV	503
303	Mississippi Delta Railroad	MSDR	786
304	Mississippi Export Railroad Company	MSE	506
305	Mississippian Railway Cooperative Inc	MSRW	502
306	Missouri Pacific Railroad Company	MP	494
307	Missouri-Kansas-Texas Railroad Co.	MKT	490
308	Mobile & Gulf Railroad Company	MG	483
309	Modesto And Empire Traction Company	MET	524
310	Monongahela Connecting Rr Co.	MCRR	498
311	Monongahela Railway Company	MGA	497
312	Montana Rail Link Inc	MRL	671
313	Morristown & Erie Railway Inc	ME	511
314	Moscow, Camden & San Augustine Railroad	MCSA	548
315	MRS Logistics of South America	??	028
316	Muncie And Western Railroad Company	MWR	464
317	N D C Railroad Company	NDCR	902
318	N J Transit Rail Operations (Commuter Carrier)	NJTR	574
319	Napa Valley Railroad Co	NVRR	402
320	Nash County Railroad Corp	NCYR	776
321	Nashville And Eastern Railroad Corp	NERR	934
322	National Railroad Passenger Corporation	AMTRAK	891
323	National Railways Of Mexico (Ferrocarriles Naciona	NDM	286
324	New Hampshire Northcoast Corp	NHN	787
325	New Hope & Ivyland Rail Road	NHRR	585
326	New York & Lake Erie Railroad	NYLE	545
327	New York Cross Harbor Railroad Terminal Corp	NYCH	573
328	New York Susquehanna And Western Railway Corp	NYSW	546
329	Nicolet Badger Northern Railroad Inc	NBNR	476
330	Nittany & Bald Eagle Railroad Co	NBER	249
331	Norfolk & Portsmouth Belt Line Railroad Company	NPB	549
332	Norfolk And Western Railway Company	NW	550
333	Norfolk Southern	NS	555
334	North Carolina & Virginia Railroad Co Inc	NCVA	531
335	North Shore Railroad Co	NSHR	248
336	North Stratford Railroad Corporation	NSCR	570
337	Northwestern Oklahoma Railroad Company	NOKL	591
338	Northwestern Pacific Railroad Company	NWP	559
339	Oakland Terminal Railroad Company	OTR	586
340	Octoraro Railway, Inc.	OCTR	587
341	Ogden Union Railway And Depot Company, The	OURD	956
342	Ohi-Rail Corporation	OHIC	579
343	Oil Creek & Titusville Lines	OCTL	948
344	Okanagan Valley Railway Company	OKAN	945
345	Oklahoma Central Railroad Co	OCR	270
346	Oklahoma, Kansas And Texas Railroad	OKKT	593
347	Old Augusta Railroad Company	OAR	578
348	Omaha Lincoln And Beatrice Railway Company	OLB	598
349	Ontario Central Railroad Corporation	ONCT	589
350	Ontario Midland Railroad Corporation	OMID	588

ID	CompanyName	RR Mark	ATCS
351	Ontario Northland Railway (Ontario Northland Trans	ONT	754
352	Oregon & Northwestern Railroad Co.	ONW	596
353	Oregon Pacific & Eastern Railway Company	OPE	597
354	Oregon, California & Eastern Railway	OCE	603
355	Ottertail Valley Railroad Co Inc	OTVR	983
356	Ottumwa Terminal Railroad Co	OTT	276
357	Paducah & Illinois Railroad Company	PI	614
358	Paducah & Louisville Railroad	PAL	907
359	Panther Valley Railroad Corporation	PVAL	575
360	Patapsco & Back Rivers Railroad Company	PBR	609
361	Pearl River Valley Railroad Company	PRV	636
362	Pecos Valley Southern Railway Company, The	PVS	644
363	Pee Dee River Railroad Corp	PDRR	010
364	Peninsula Terminal Company	PT	643
365	Peoria And Pekin Union Railway Company	PPU	645
366	Philadelphia Belt Line Railroad Company, The	PBL	608
367	Philadelphia Bethlehem And New England Railroad Co	PBNE	659
368	Pickens Railway Company	PICK	624
369	Pioneer And Fayette Railroad Company	PF	630
370	Pioneer Valley Railroad Company	PVRR	611
371	Pittsburg & Shawmut Railroad Inc	PSR	627
372	Pittsburgh Chartiers & Youghiogheny Railway Compan	PCY	629
373	Pittsburgh, Allegheny & Mckees Rocks Rr Co	PAM	607
374	Plymouth Short Line Ltd	PSLL	566
375	Pocono Northeast Railway, Inc.	PNER	618
376	Point Comfort & Northern Railway Company	PCN	651
377	Port Bienville Railroad	PBVR	677
378	Port Of Tillamook Bay Railroad	POTB	637
379	Port Royal Railroad	PRYL	393
380	Portland Terminal Company	PTM	619
381	Portland Traction Company	PRTD	632
382	Prescott And Northwestern Railroad Company	PNW	634
383	Providence And Worcester Railroad Company	PW	631
384	Quebec Central Railway Company	QC	658
385	Queensland Rail (Australia)		036
386	Quincy Railroad Company	QRR	656
387	Rac (Railway Association Of Canada)		033
388	Rarus Railway Company	RARW	516
389	Red River Valley & Western Railroad Co	RRVW	321
390	Renfe (National Railways Of Spain)		119
391	River Terminal Railway Company, The	RT	665
392	Robe (Australia)		044
393	Roberval And Saguenay Railway Company, The	RS	669
394	Rochester & Southern Railroad Inc	RSR	941
395	Rockdale Sandow & Southern Railroad Company	RSS	675
396	Rocky Mountain Railcar And Railroad Inc	RMRR	915
397	Roscoe Snyder & Pacific Railway Company	RSP	673
398	Sabine River & Northern Railroad Company	SRN	678
399	Saint Lawrence Railroad	SLAW	705
400	Saint Marys Railroad Company	SM	682

ID	CompanyName	RR Mark	ATCS
401	Salt Lake Garfield And Western Railway Company	SLGW	690
402	San Diego & Imperial Valley Railroad Co Inc	SDIY	315
403	San Luis Central Railroad Company	SLC	696
404	San Manuel Arizona Railroad Company	SMA	794
405	Sand Springs Railway Company	SS	707
406	Sandersville Railroad Company	SAN	691
407	Santa Maria Valley Railroad Company	SMV	741
408	Savannah State Docks Railroad Company	SSDK	679
409	Sequatchie Valley Railroad Inc	SQVR	910
410	Shore Fast Line Railroad Company Sflr 2	SFLR	255
411	Sierra Railroad Company	SERA	716
412	Singapore (Singapore)		076
413	Sisseton Southern Railway Co	SSOR	440
414	Somerset Railroad Corporation	SOM	772
415	SOO Line Rail Company	SOO	030
416	South Branch Valley Rail Road	SBVR	732
417	South Brooklyn Railway Company	SBK	718
418	South Buffalo Railway Company	SB	719
419	South Carolina Central Railroad Co Inc	SCRF	582
420	South Central Tennessee Railroad Corporation	SCTR	672
421	Southeast Kansas Railroad Company	SEKR	944
422	Southeastern Penn Transp Authority	SEPTA	024
423	Southern Indiana Railway Inc	SIND	720
424	Southern New Jersey Light Rail Transit	??	026
425	Southern Pacific Transportation Company	SP	721
426	Southern Railway Company	SOU	724
427	Southern San Luis Valley Railroad Company	SSLV	706
428	St Maries River Railroad Company	STMA	698
429	STA		048
430	Staten Island Railway Corporation	SIRY	389
431	Steelton & Highspire Railroad Company	SH	799
432	Stewartstown Railroad Co	STRT	729
433	Stockton Terminal And Eastern Railroad	STE	739
434	Strasburg Railroad Company	SRC	686
435	Strouds Creek And Muddlety Railroad	SCM	687
436	Sunset Railway Company	SUN	734
437	Tacoma Muncpal Belt Line Railway	TMBL	759
438	Tasrail		119
439	Tennessee Railway Company	SCM	767
440	Tennessee, Alabama And Georgia Railway	SOU	755
441	Tencken Railroad Company Inc	TKEN	745
442	Terminal Railroad Association Of St Louis	TRRA	757
443	Terminal Railway Alabama State Docks	TASD	758
444	Texas & Northern	TN	795
445	Texas Central Railroad Company	TEXC	750
446	Texas City Terminal Railway Company	TCT	761
447	Texas Mexican Railway Company, The	TM	762
448	Texas North Western Railway Company	TXNW	747
449	Texas South-Eastern Railroad Company	TSE	765
450	Texas, Oklahoma & Eastern Railroad Company	TOE	764

ID	CompanyName	RR Mark	ATCS
451	Thailand (Thai State Railways)		102
452	Tippecanoe Railroad Company	TIPP	753
453	Tonawanda Island Railroad Inc	TIRL	743
454	Towanda And Monroeton Shippers Lifeline, Inc.	TMSS	752
455	Transkentucky Transportation Railroad Co Inc	TTIS	773
456	Tranz Rail (Tasmania)		057
457	Trintity Railway Express		751
458	Trona Railway Company	TRC	779
459	TTCI Test Unit 1	TTCI	884
460	TTCI Test Unit 2	TTCI	885
461	TTCI Test Unit 3	TTCI	886
462	TTCI Test Unit 4	TTCI	887
463	TTCI Test Unit 5	TTCI	888
464	TTCI Test Unit 6	TTCI	889
465	Tucson, Cornelia & Gila Bend Railroad Company	TCG	783
466	Tulsa-Sapulpa Union Railway Company L L C	TSU	709
467	Turtle Creek Industrial Railroad Inc	TCKR	744
468	Tuscola And Saginaw Bay Railway Company Inc	TSBY	770
469	Union Pacific Railroad Company	UP	802
470	Union Railroad Company	URR	803
471	Union Railroad Of Oregon	UO	800
472	United South Eastern Railways Company	SE	281
473	Unity Railways Company	UNI	806
474	Upper Merion And Plymouth Railroad Company	UMP	808
475	Utah Railway Company	UTAH	811
476	Valdosta Southern Railroad	VSO	816
477	Vandalla Railroad Company	VRRC	781
478	Ventura County Railway Company	VCY	821
479	Vermont Railway Inc	VTR	817
480	Via Rail Canada Inc	VIA	818
481	Victrack (Australia)		017
482	Virginia Railway Express	VRE	023
483	Visalla Electric Railroad Company	VE	824
484	Walking Horse & Eastern Railroad Co Inc	WHOE	390
485	Warren & Saline River Railroad Company	WSR	832
486	Washington Central Railroad Company, Inc. Wcrc	WCRC	943
487	Washington County Railroad Corporation	WACR	812
488	Washington Terminal	WATC	849
489	Waterloo Railway Company	WLO	835
490	Wctu Railway Company	WCTR	844
491	Weatherford Mineral Wells & Northwestern	WMWN	837
492	West Jersey Short Line, Inc.	WJSL	387
493	West Shore Railroad Corp	WTSE	882
494	West Tennessee Railroad Corp	WTNN	258
495	West Virginia Northern Railroad	WVN	866
496	Western Railroad Company	WRRC	838
497	Westrail (Australia)		038
498	White Pass & Yukon	WPY	845
499	Willamette Valley Railway Company, Inc	WVR	863
500	Wilmington Terminal Railroad Inc	WTRY	981

ATCS SPECIFICATION 250 RAILROAD CODE LIST

ID	CompanyName	RR Mark	ATCS
501	Winchester And Western Railroad Company	WW	850
502	Winifrede Railroad Company	WNFR	852
503	Winston-Salem Southbound Railway Company (Csx Tran	WSS	854
504	Wisconsin & Calumet Railroad	WICT	382
505	Wisconsin & Southern Railroad Company	WSOR	879
506	Wisconsin Central Limited	WC	260
507	Yancey Railroad Company	YAN	876
508	Youngstown & Austintown Railroad Co	YARR	372
509	Youngstown & Southern Railway Company	YS	875
510	Yreka Western Railroad Company	YW	873
511	UK ATCS Testing and Field Evaluations	????	974
512	Network Rail - London North Eastern - UK	????	975
513	Network Rail - London North Western - UK	????	976
514	Network Rail - Scotland - UK	????	977
515	Network Rail - South East - UK	????	978
516	Network Rail - Western - UK	????	979

APPENDIX C

WAYSIDE COMMUNICATIONS PACKAGE (WCP)

NOTE

Appendix C is for R/Link systems using the Safetran WCP radio system only. For systems using the Motorola Spectra MCP radio, refer to Appendix D.

C.0 GENERAL

In the Wayside Communications Package, the WCP/CPU module (53105) acts as main system processor (controller for the radio and consolidates individual R/Link I/O module control), and acts as host to establish communications between the nodes on the LAN.

C.1 INSTALLATION OVERVIEW

The main components of the Wayside Communications Package (WCP) (53411) can be either wall-mounted or mounted on a standard GRS Style B relay rack as shown in Figure C-1. These components include the 53105 WCP/CPU module, 53412 WCP radio and the optional 53106 DC/DC Converter module. The modules are secured at the top by a teardrop arrangement and at the bottom by a retaining bolt.

The Motorola MCS 2000 radio is equipped with a bracket to permit mounting in a relay rack.

Refer to Section I, paragraph 1.2.4 for illustrations of the WCP/CPU module, 53412 MCS 2000 radio, and the optional 53106 DC/DC Converter.

C.2 POWER

Power for the WCP/CPU, MCS 2000 radio, and DC/DC Converter are discussed in the paragraphs that follow.

C.2.1 WCP CPU, 53105

The WCP/CPU has an internal isolated DC/DC converter that can accept a 9VDC to 36VDC input range.

NOTE

It is recommended that the WCP/CPU module be connected to the same power source as the MCS2000 radio; see Figure C-3.

C.2.2 MCS 2000 Radio, 53412

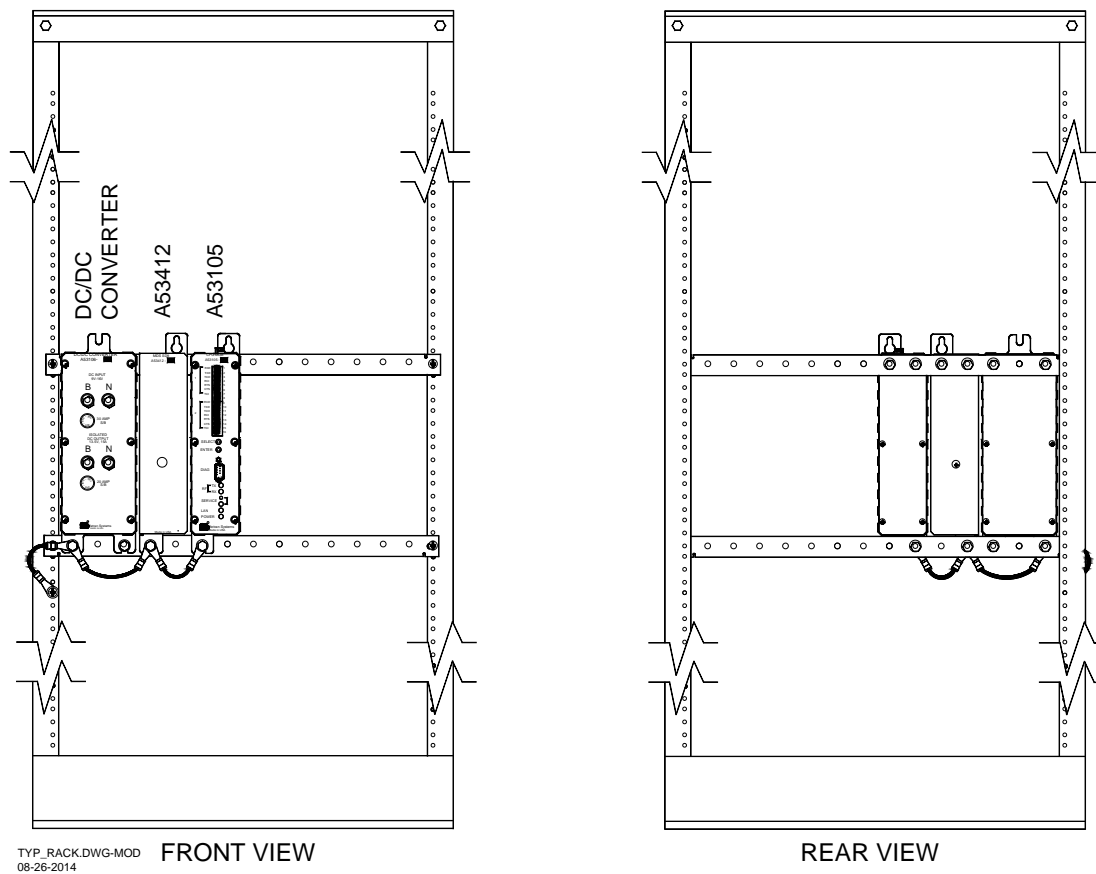
The MCS 2000 radio requires an external DC/DC converter such as the Safetran 53106 (refer to paragraph C.2.3), or a separate battery system from the signal battery.

NOTE

The MCS 2000 transmit current (up to 12 Amps) requires use of number 10 AWG or larger wire to ensure that significant voltage drop does not occur when the transmitter is keyed.

C.2.3 DC/DC Converter, 53106

This unit is designed to supply a constant output voltage to the MCS 2000 radio with an input voltage range selected as follows. For an input voltage range of 9VDC to 16VDC, use a 9000-53106-01, for an input voltage range of 20VDC to 26VDC, use a 9000-53106-02.



**Figure C-1
Typical WCP Field Rack Installation**

NOTE

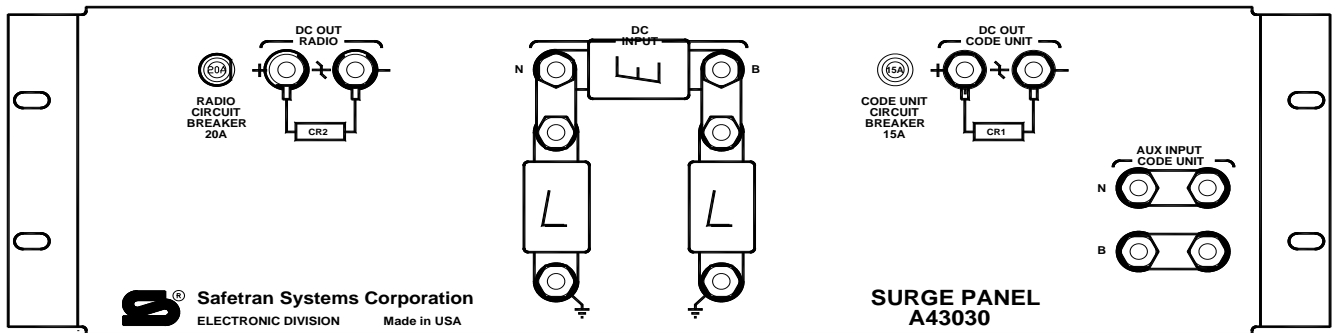
At low input voltages, instantaneous current through the power wiring can exceed 25A, and it is therefore extremely important to ensure tight connections and adequate wire gauge (minimum #10 AWG).

CAUTION

DO NOT INSTALL PRIMARY SURGE PROTECTION, OTHER THAN ARRESTORS AND EQUALIZERS, ON THE INPUT TO THE DC/DC CONVERTER AS THE ADDED INDUCTANCE MAY CAUSE THE UNIT TO WORK ERRATICALLY AT LOW INPUT VOLTAGES.

C.2.4 Grounding And Surge Protection

Safetran recommends that a surge panel such as R/Link™ Surge Suppression Panel, 43030, or equivalent, be used to provide surge and lightning protection to the modules (see Figure C-2). The panel is equipped with separate surge suppressors and equalizers for the radio and the remainder of the code equipment and also provides combination circuit breakers/on-off switches for each of the two paths. Generic grounding and surge protection recommendations are provided in Appendix E.



WCP5-3-MOD
08-26-2014

**Figure C-2
Surge Panel**

C.3 EQUIPMENT INTERCONNECT CABLING

The equipment cabling for a basic WCP installation is shown in Figure C-3. All necessary information is provided on the diagram and in Table C-1. The item numbers listed in the left column of Table C-1 correspond to the cable/connector numbers (e.g. #4) appearing on Figure C-3.

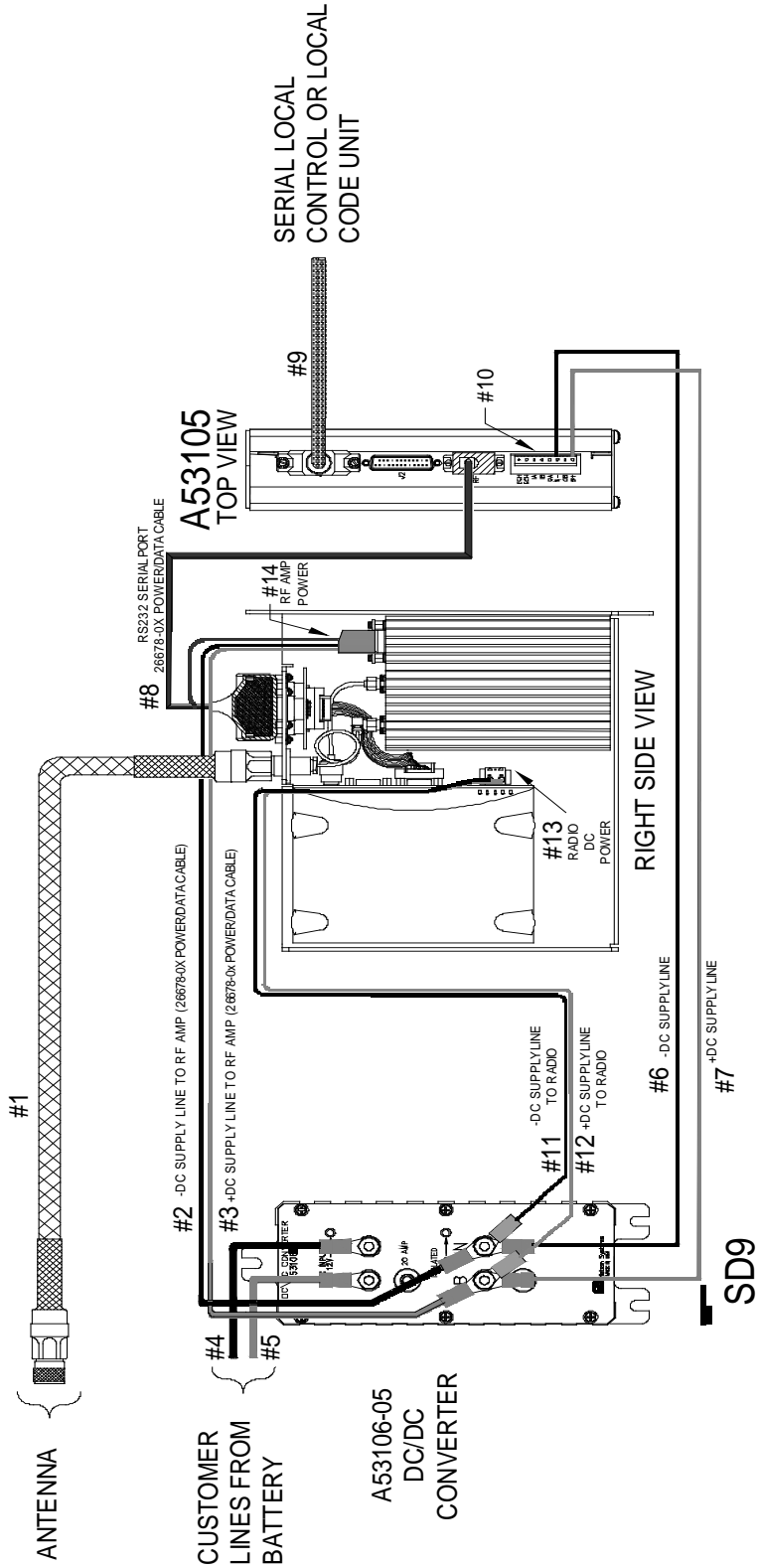


Figure C-3
Wayside Communication Package Typical Interconnect Diagram

Table C-1
WCP CPU Interconnect Cable Description

Item	Part Number	Type	Where Used	Cable Termination/Description
1	See radio manual	RF cable	MCS2000 (RF connector) to antenna	Male N to male N
2	Z706-02006-0000	Power cable	53106 (Isolated DC Output) to MCS2000 (2-pin power conn.)	Dual-lead, DC-power cable with 20A in-line fuse and 2-pin polarized radio power connector
3	Customer supplied	Lead 1, twisted pair power cable	Battery (+) to 53106 (DC Input – B)	Red 10/12AWG (positive lead) insulated ring lug; other end to battery positive terminal
4	Customer supplied	Lead 2, twisted pair power cable	Battery (-) to 53106 (DC Input – N)	Black 10/12AWG (negative lead) insulated ring lug; other end to battery negative terminal
5	Customer supplied	Lead 1, twisted pair power cable	53106 (Isolated DC Output – B) to 53105 (Wago 8-pin – B+)	10/12 AWG insulated ring lug to red stripped and tinned lead (positive)
6	Customer supplied	Lead 2, twisted pair power cable	53106 (Isolated DC Output – N) to 53105 (Wago 8-pin – N-)	10/12 AWG insulated ring lug to black stripped and tinned lead (negative)
7	9000-26558-000X ^[1]	RF data cable	53105 (RF control conn.) to MCS2000 (Accessory conn.)	Male 15-pin D (P1) to female 25-pin D (P2)
8	26560 ^[2]	Signal cable	53105 (J1 serial port) to 50636 (Port A)	See Figure C-4 ^[2]
9	Z715-09038-0008	8-pin Wago [®] Connector	53105 (Power/LAN connections)	Connector screw-down terminals
10	Belden 8461 or equiv. ^[3]	Twisted pair LAN cable	53105 to LAN	Stripped and tinned leads both ends (polarity is arbitrary)

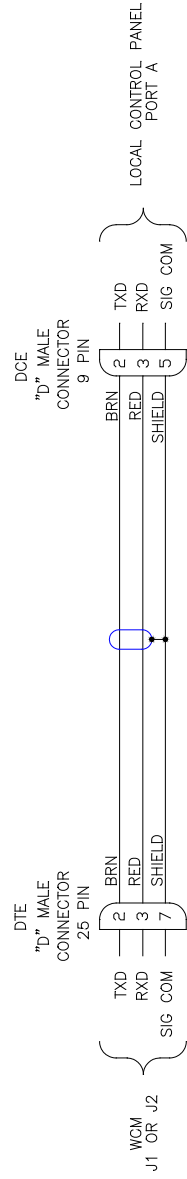
[1] Cable three feet long = 9000-26558-0001; cable six feet long = 9000-26558-0002.

[2] For other options, refer to figures C-5 through C-7.

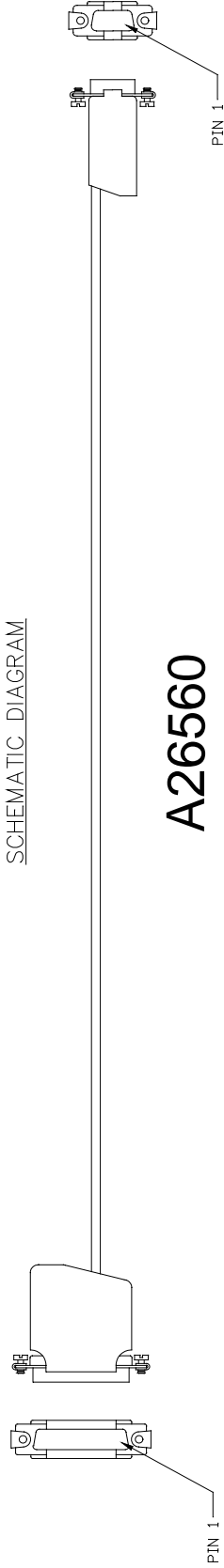
[3] Refer to paragraph C.4 for equivalent Echelon[®] LAN cable specifications.

C.4 ECHELON[®] LAN CABLE SPECIFICATIONS

- Level 4 (NEMA) stranded, 18 AWG twisted pair (shield is optional)
- DC Resistance: 18.0 ohms per 1000 feet (304.8 meters) @ 68° F (20° C) (per conductor)
- DC Resistance Unbalance: 5% maximum
- Impedance: 100 ohms ± 15% (1.0 to 20.0 Mhz)
- Attenuation: 5.5 dB/1000 feet (304.8 meters) @ 68° F (20° C) maximum (1.0 Mhz)
- Pair Mutual capacitance: 17 pF/foot (30.48 centimeters) maximum
- Pair-to-ground capacitance unbalance: 1 pF/foot (30.48 centimeters) maximum



SCHEMATIC DIAGRAM



WCP-4.3
08-10-98

Figure C-4
Safetran Cable Assembly
WCP/CPU to Local Control Panel

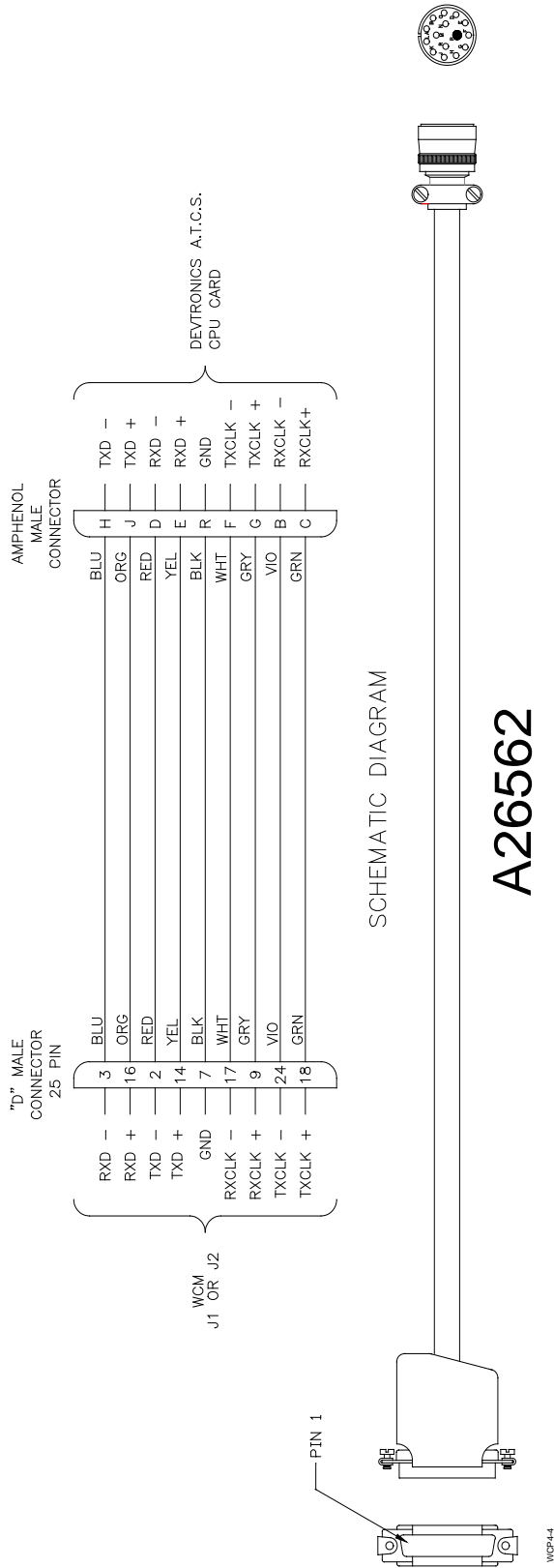


Figure C-5
Safetran Cable Assembly
WCP/CPU to Devtronics ATCS CPU Card

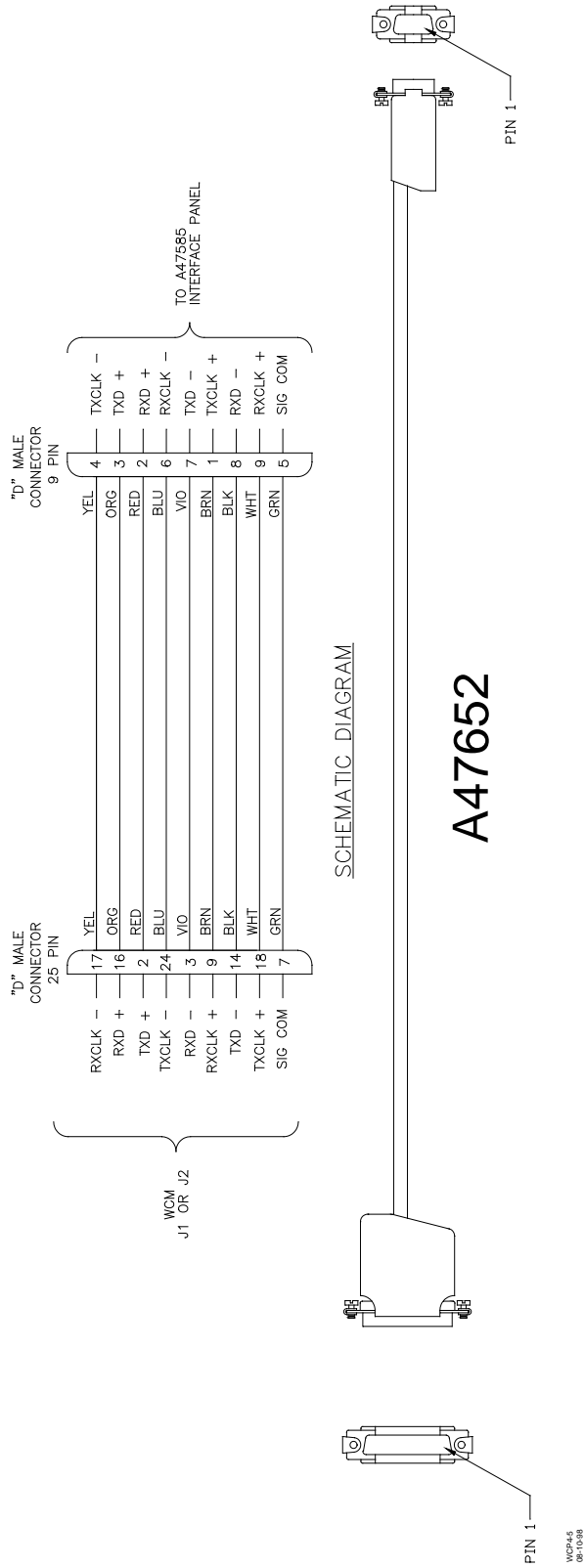


Figure C-6
Safetran Cable Assembly
WCP/CPU to MCP Interface Panel
(Serial interface to interface module)

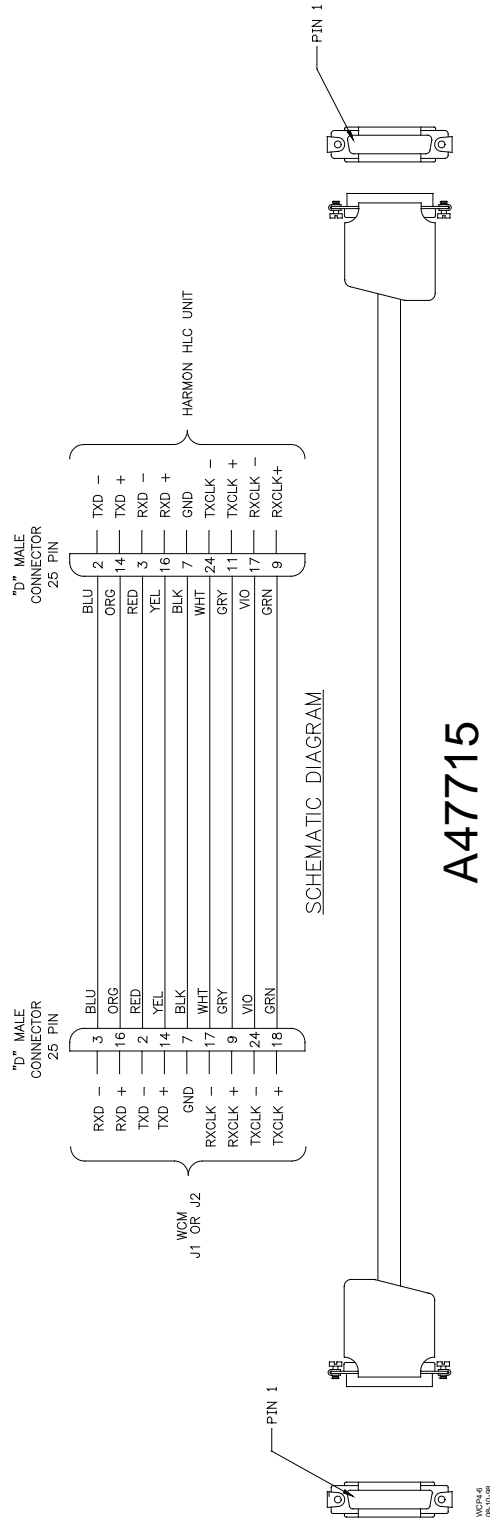


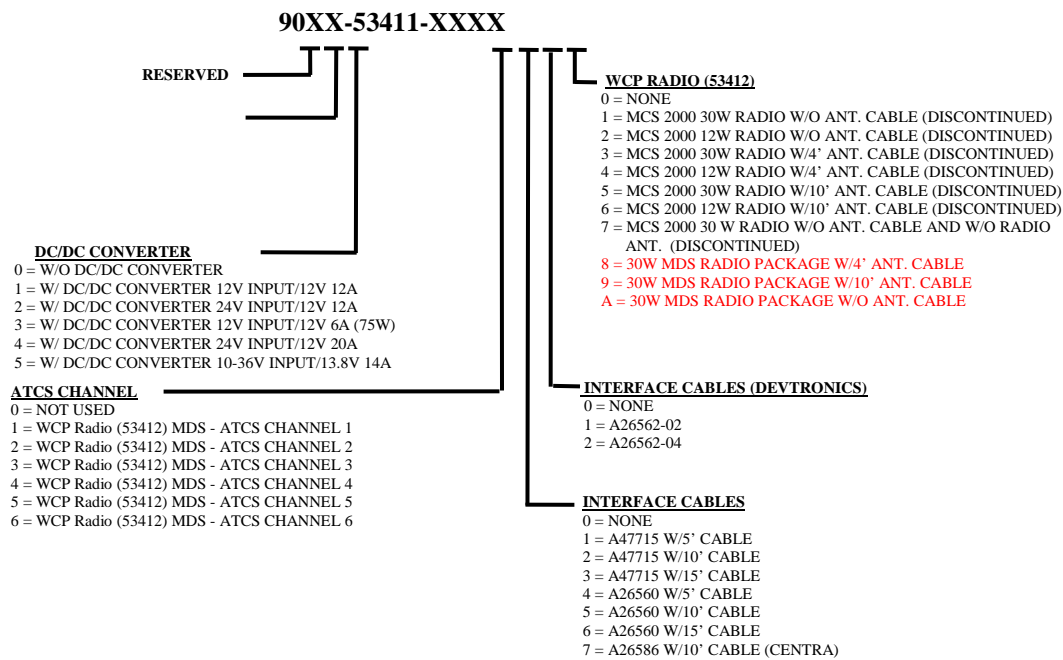
Figure C-7
Safetran Cable assembly
WCP/CPU to Harmon HLC Unit

C.5 WCP OPTIONS OVERVIEW

This section lists the options available for WCP installations. For further information, contact Safetran Technical Support.

C.6 WCP ORDERING INFORMATION

The basic configuration options available for the WCP are provided in the WCP basic configuration chart below. To order, specify the basic WCP part number (53411) plus the applicable prefix and suffix numbers.



NOTE

Contact Siemens Technical Support for the proper configuration for your application.

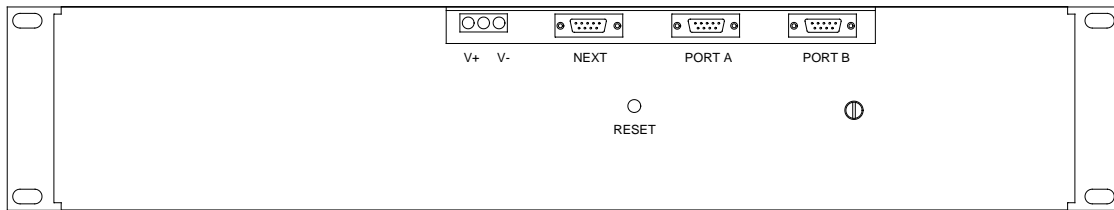
C.7 WCP INSTALLATION OPTIONS

The installation options available for the WCP are listed in Table C-2.

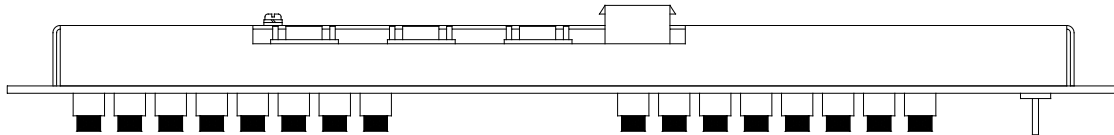
**Table C-2
Installation Options**

Part Number	Order Number	Description
43030	9000-43030-0001	Surge Panel - 36V @ 20A (see figure C-2)
50636	9000-50636-0023	Local Control Panel (see figure C-8)

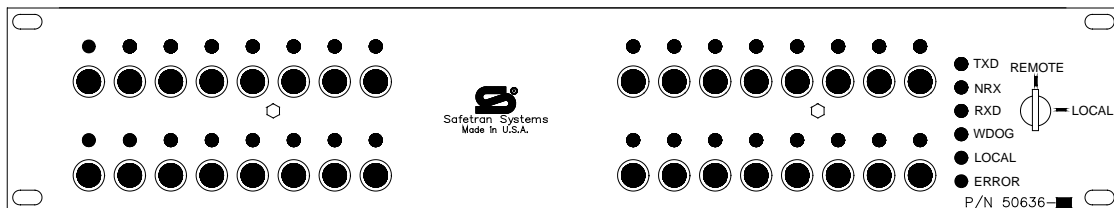
BACK PANEL



TOP VIEW



FRONT PANEL



LCP.DWG
04-22-99

**Figure C-8
Local Control Panel**

A typical rack-mount options configuration is shown in figure C-9. The equipment cabling for a typical installation employing a surge panel and a local control panel is shown in figure C-10. All necessary information is provided on the diagram and in table C-3. The item numbers listed in the left column of table C-3 correspond to the cable/connector numbers (e.g., #3) appearing in figure C-10.

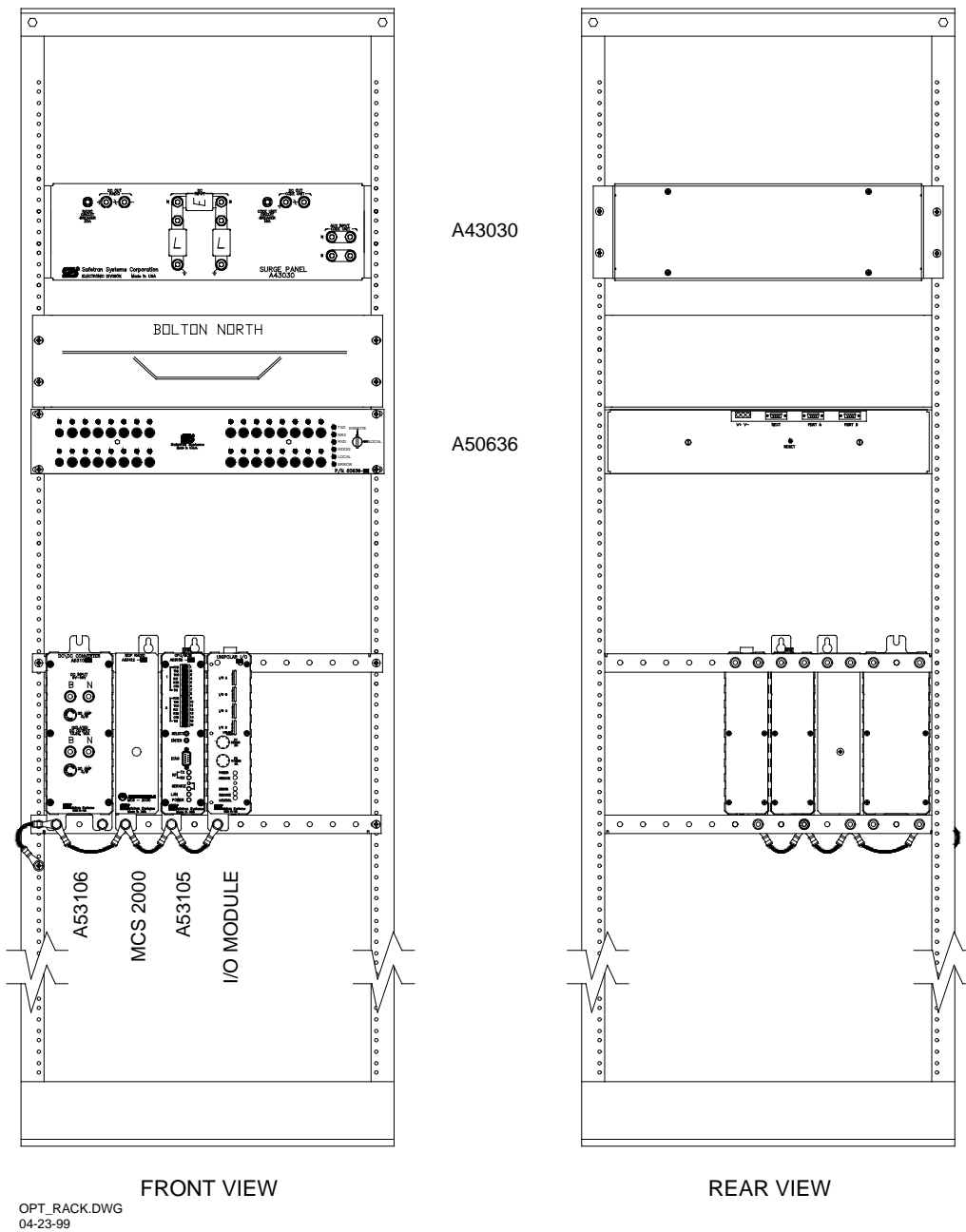
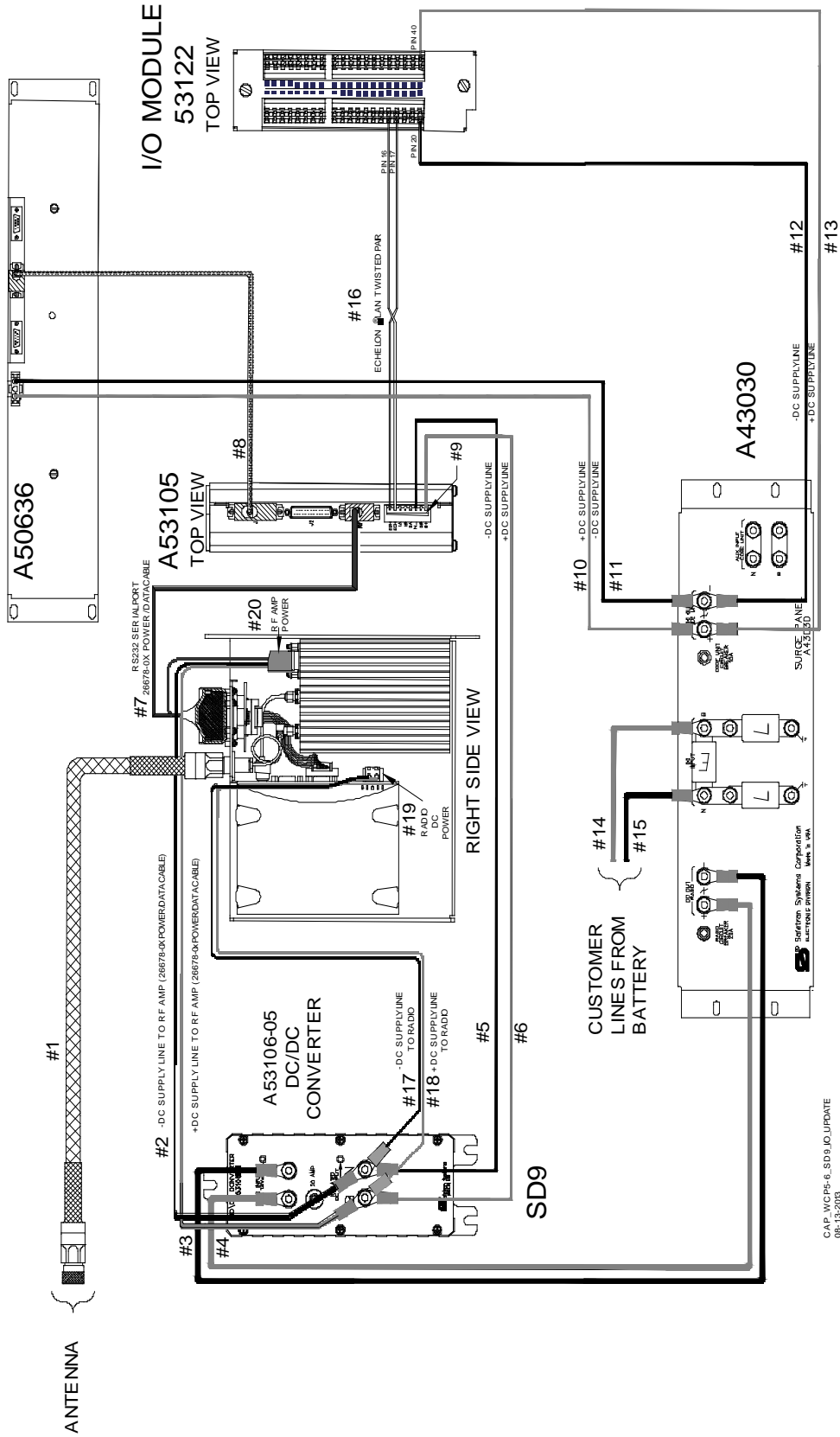


Figure C-9
WCP Field Rack Installation Options



CAP: WCP-6-SD9_ID_UPDATE
08-13-2015

Figure C-10
WCP Options Interconnection Diagram

**Table C-3
WCP Cable Options**

Item	Part Number	Type	Where Used	Cable Termination/Description
1	See radio manual	RF cable	MCS2000 (RF Connector) to antenna	Male N to male N
2	Z706-02006-0000	Power cable	53106 (Isolated DC Output) to MCS2000 (2-pin power connector)	Dual-lead, DC-power cable with 20A in-line fuse and 2-pin polarized radio power connector
3	Customer supplied	Lead 1, twisted pair power cable	43030 (DC Out-Radio +) to 53106 (DC Input-B)	Red 10/12 AWG (positive lead); insulated ring lugs on both ends
4	Customer supplied	Lead 2, twisted pair power cable	43030 (DC Out-Radio -) to 53106 (DC Input-N)	Black 10/12 AWG (negative lead); insulated ring lugs on both ends
5	Customer supplied	Lead 1, twisted pair power cable	53106 (Isolated DC Output-B) to 53105 (Wago 8-pin B+)	Red 10/12 AWG insulated ring lug to red stripped and tinned lead (positive)
6	Customer supplied	Lead 2, twisted pair power cable	53106 (Isolated DC Output-N) to 53105 (Wago 8-pin N-)	Black 10/12 AWG insulated ring lug to black stripped and tinned lead (negative)
7	9000-26558-000X ^[1]	RF data cable	53105 (RF control connector) to MCS2000 (Accessory connector)	Male 15-pin D (P1) to female 25-pin D (P2)
8	26560 ^[2]	Signal cable	53105 (J1 serial port) to 50636 (Port A)	See figure C-3 ^[2]
9	Z715-09038-0008	8-pin Wago [®] connector	53105 (Power/LAN connections)	Connector screw-down terminals
10	Customer supplied	Lead 1, twisted pair power cable	43030 (DC Out - Code Unit +) to 50636 (V+)	Red 10/12 AWG (positive lead); insulated ring lug to Molex pin (item #18)
11	Customer supplied	Lead 2, twisted pair power cable	43030 (DC Out - Code Unit -) to 50636 (V-)	Black 10/12 AWG (negative lead); insulated ring lug to Molex pin (item # 18)
12	Customer supplied	Lead 1, twisted pair power cable	43030 (DC Out - Code Unit +) to I/O module (pin 40)	Red 10/12 AWG; insulated ring lug to stripped and tinned lead (positive)

Table C-3 Concluded

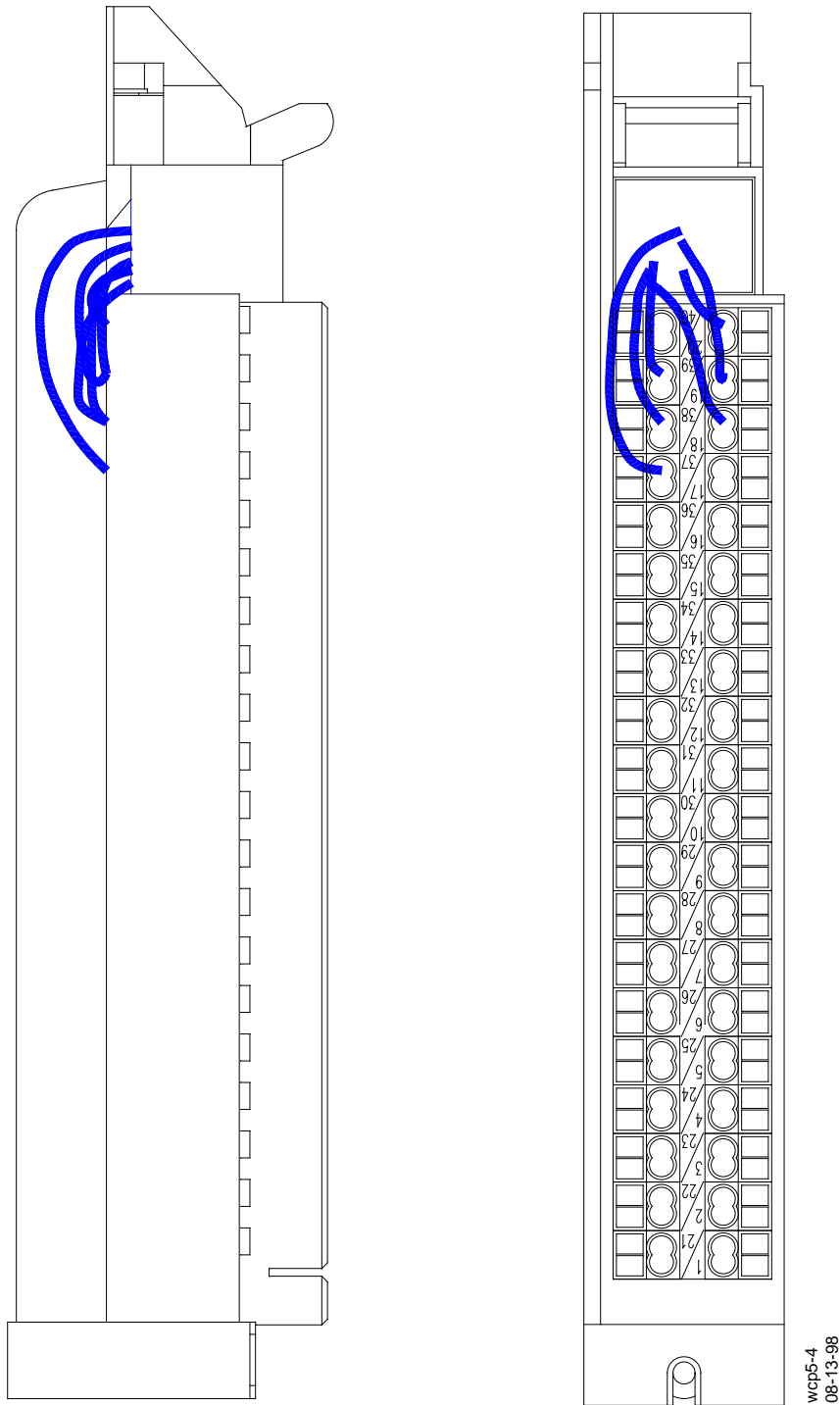
Item	Part Number	Type	Where Used	Cable Termination/Description
13	Customer supplied	Lead 2, twisted pair power cable	43030 (DC Out - Code Unit -) to I/O module (pin 20)	Black 10/12 AWG; insulated ring lug to stripped and tinned lead (negative)
14	Customer supplied	Lead 1, twisted pair power cable	Battery (+) to 43030 (DC Input - B)	Red 10/12 AWG insulated ring lug; other end to battery positive terminal
15	Customer supplied	Lead 2, twisted pair power cable	Battery (-) to 43030 (DC Input - N)	Black 10/12 AWG insulated ring lug; other end to battery negative terminal
16	Belden 8461 or equiv. ^[3]	Twisted pair LAN cable	LAN connection from 53105 to I/O modules	Stripped and tinned leads both ends (polarity is arbitrary)
17	Z715-03432-0006	Connector	50636 (LCP power connection)	Molex [®] 3-pin connector for LCP power connection
18	Z715-03432-0007	Contact	50636 (V+ and V-)	Pin contact for item #17
19	9000-53002-0001 ^[4]	40-pin Wago [®] Connector	53100 series I/O module	Dual cage clamps (see figure C-11)

[1] Cable three feet long = 9000-26558-0001; cable six feet long = 9000-26558-0002.

[2] For other options, refer to figure C-4 through C-6.

[3] Refer to paragraph C.4 for equivalent Echelon[®] LAN cable specifications.

[4] One connector required for each I/O module used in system.



wcp5-4
08-13-98

Figure C-11
I/O Module Interface Connector Assembly, 53002

C.8 CONFIGURATION OPTIONS MATERIALS LIST

The configuration options available for the WCP as shown in figures C-9 and C-10 are listed in table C-4.

**Table C-4
Configuration Options**

Description	Quantity Included	Order Number
Local Control Panel	1 ea.	9000-50636-0023
Surge panel, 36V 20A	1 ea.	9000-43030-0001
Molex [®] 3-pin connector for LCP	1 ea.	Z715-03432-0006
Molex [®] pins for 350760-4 connector	2 ea.	Z715-03432-0007
Wago [®] EEPROM 40-pin connector assembly	1 ea.	9000-53002-0001

C.9 PERIPHERAL EQUIPMENT

C.9.1 SSR Battery Protector

The SSR battery protectors are listed in Table C-5.

**Table C-5
SSR Battery Protector**

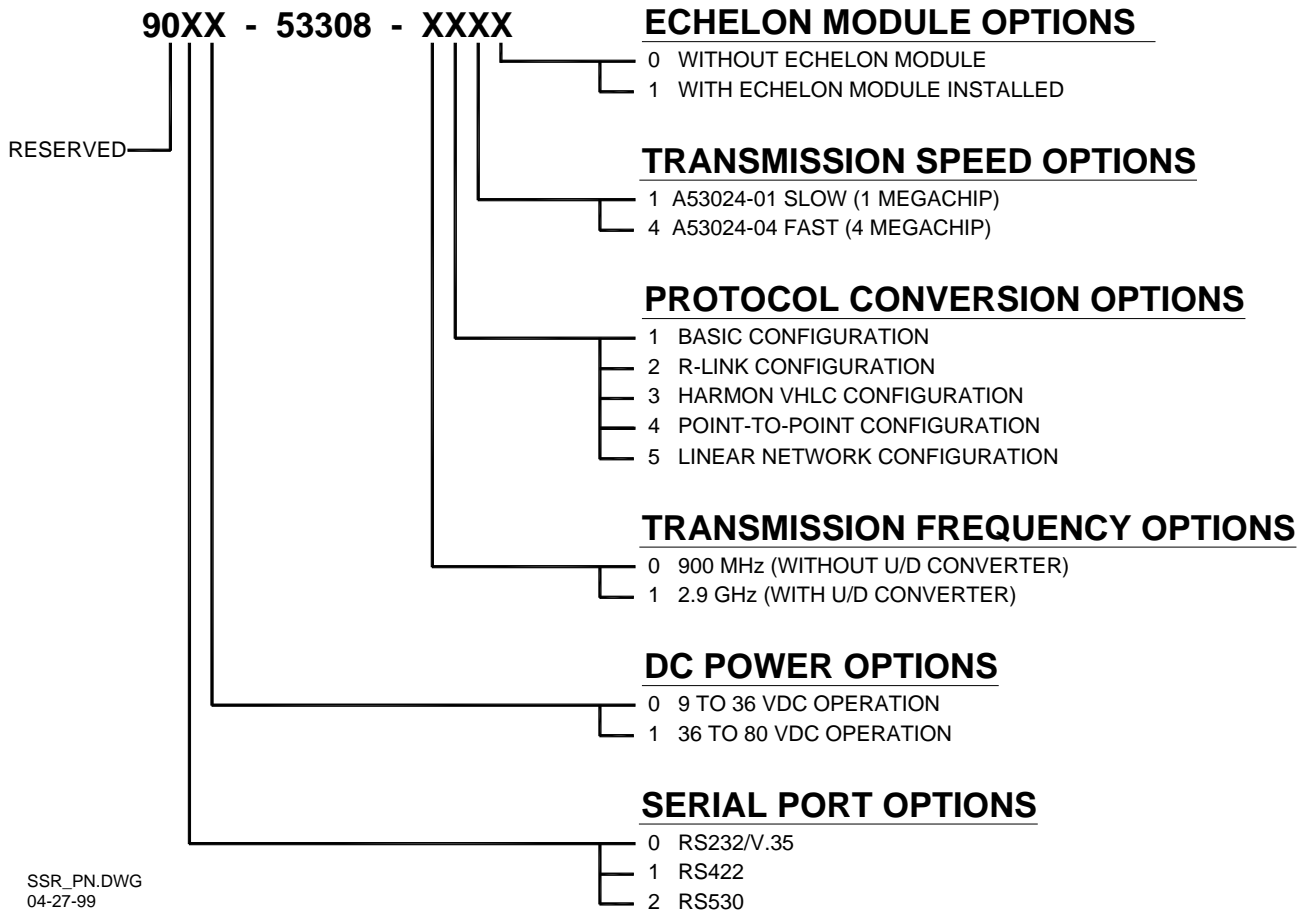
Description	Quantity Included	Order Number
SS Radio Battery Protector - <u>32V@10A</u>	1 ea.	Z803-00074-0000
SS Radio Battery Protector - <u>32V@5A</u>	1 ea.	Z803-00118-0000

C.9.2 I/O Module Ordering Information

For I/O modules available for use with the WCP, refer to Section I.

C.9.3 Spread Spectrum Radio Ordering Information

The various Spread Spectrum Radio (SSR) configuration options available are provided in the configuration chart below. To order, specify the basic SSR part number (53308) plus the applicable prefix and suffix numbers as shown in the configuration chart below.

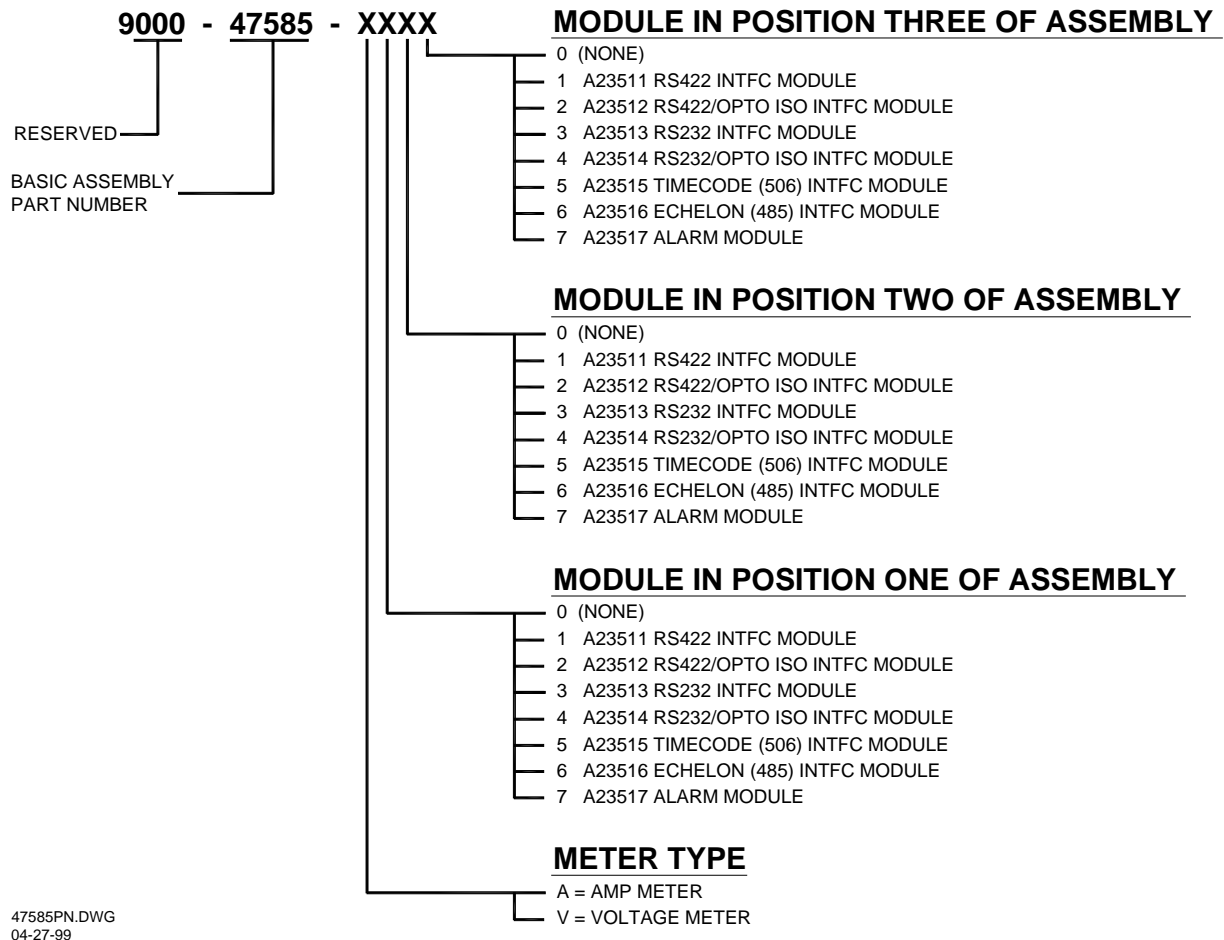


NOTE

Contact Siemens Technical Support for the proper configuration for your application.

C.9.4 MCP Interface Panel Ordering Information

The various MCP Interface Panel configuration options available for use with the R/Link system are provided in the configuration chart below. To order, specify the basic MCP Interface Panel part number (47585) plus the applicable prefix and suffix numbers.

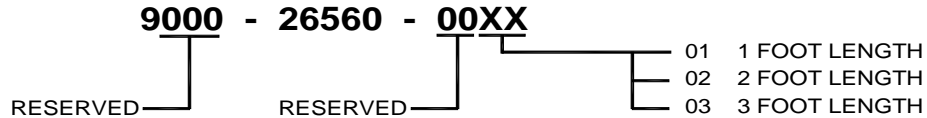


The MCP Interface Panel can be populated with up to three interface modules and either an ammeter or a voltmeter. Although the panel is generally used with the Motorola MCP radio to provide needed interface conversion (such as serial interface or Echelon[®] interface to the radio), it may also be used on rare occasions with the WCP (for example, to use the panel's interface modules to provide opto isolation). Figure C-6 illustrates a cable that can be used for connecting the WCP/CPU's RS232/RS422 serial port to an interface module in the MCP Interface Panel.

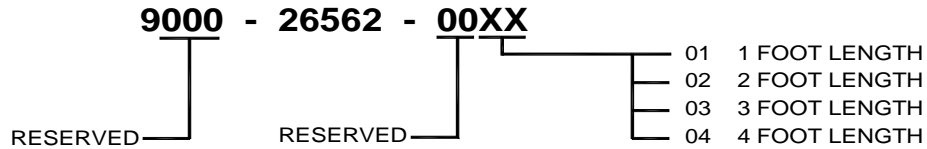
C.9.5 Interconnection Cable Ordering Information

The peripheral interconnection cables used with the WCP are provided in the configuration chart below. To order, specify the basic cable part number plus the applicable prefix and suffix numbers.

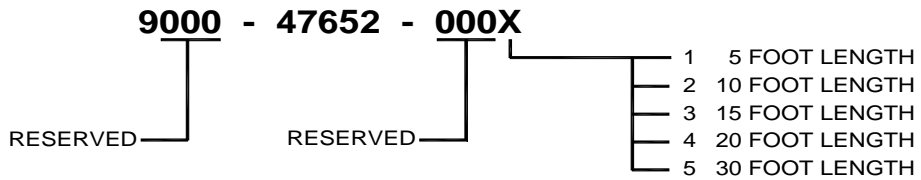
WCP TO LOCAL CONTROL PANEL



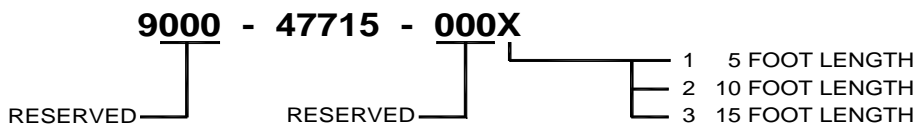
WCP TO DEVTRONICS A.T.C.S. CABLE



WCP TO MCP INTERFACE PANEL CABLE



WCP TO HARMON LOGIC CONTROLLER



wcp1-5
07-28-98

APPENDIX D

CONFIGURATION OF MOTOROLA SPECTRA MCP

NOTE

Appendix D is for R/Link systems using the Motorola Spectra MCP radio only. For configuration of I/O modules for use with the Safetran WCP system, refer to Appendix C or the WCP (53411) Installation manual (COM-00-98-01).

D.0 INSTALLATION OVERVIEW

The R/Link I/O modules are secured at the top by a teardrop arrangement and at the bottom by a retaining bolt. When the 53100 Series modules have been correctly installed and wired, power should be applied before proceeding with configuration.

The Motorola Spectra MCP radio requires a bracket to permit mounting in a relay rack (refer to Section III, figure 3-1).

The MCP Interface Panel converts the RS422 output from the radio to the various electrical levels required for the I/O modules, ECP panel, hot box equipment, etc. In addition, LEDs are provided to indicate data transmit and receive, power status, radio keyed, squelch, and status. A DB-9 connector supplies the interface to a PC or laptop computer which can be connected for diagnostics and system monitoring.

D.1 MCP RADIO POWER

Safetran strongly recommends installation of surge suppression equipment such as the R/Link Surge Suppression Panel, Part No. A43030, or equivalent. If necessary, the MCP radio can be powered through a separate battery/charger combination. Power for the MCP Interface Panel is supplied by the radio via the panel diagnostic port. Separate power runs are required from the surge panel to each I/O module.

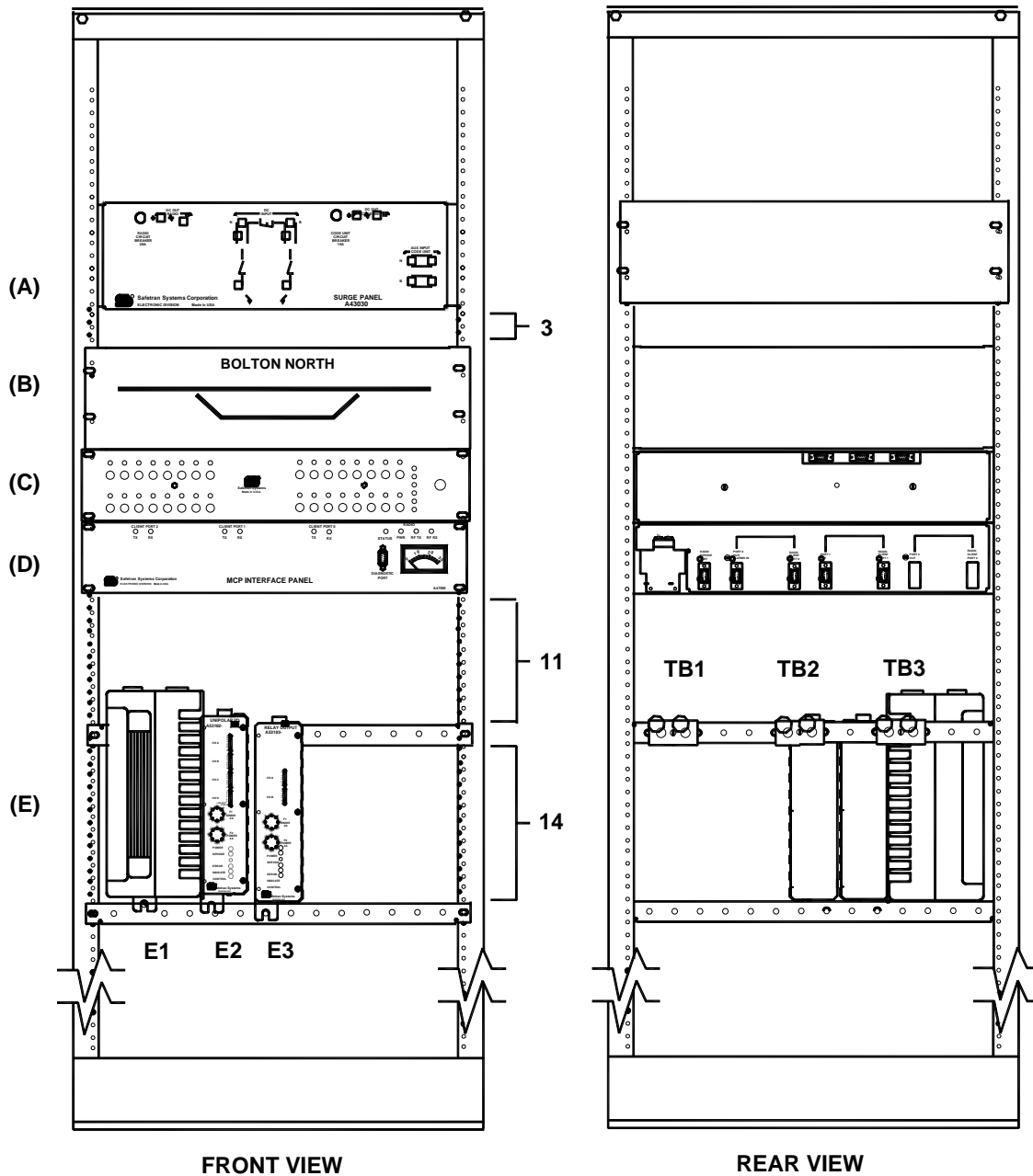
NOTE

The MCP radio transmit current (11 to 16 Amps) requires use of number 10 AWG or larger wire to ensure that significant voltage drop does not occur when the transmitter is keyed.

D.2 MCP INSTALLATION

Refer to figure D-1 for a typical MCP rack installation and figure D-2 for interconnections.

CONFIGURATION OF MOTOROLA SPECTRA MCP



RACK CABLE INTERCONNECTION CHART			
ROW "E1" MCP(SERV PORT)	TO/FROM	ROW "D" INTFACE PNL(SERV PORT)	SERV PORT CABLE A47682
ROW "E1" MCP(CLIENT PORT 0)	TO/FROM	ROW "D" INTFACE PNL(CLIENT PORT 0)	CLIENT PORT CABLE A47681
ROW "E1" MCP(CLIENT PORT 1)	TO/FROM	ROW "D" INTFACE PNL(CLIENT PORT 1)	CLIENT PORT CABLE A47681
ROW "D" INTFACE PNL(PORT 0 OUT)	TO/FROM	ROW "E2" UNIPOLAR MODULE(PINS 16, 17)	NETWORK CABLE A47692
ROW "D" INTFACE PNL(PORT 1 OUT)	TO/FROM	ROW "C" EMERGNCY CONTROL PANEL	RS232 A52120
ROW "E" NETWORK WIRING (PINS 16, 17)	TO/FROM	ROW "E" NETWORK WIRING (PINS 16, 17)	TWISTED PAIR SHIELDED CABLING

MCP_RACK.DWG - MODIFIED
09-25-2014

Figure D-1
Typical MCP Rack Installation

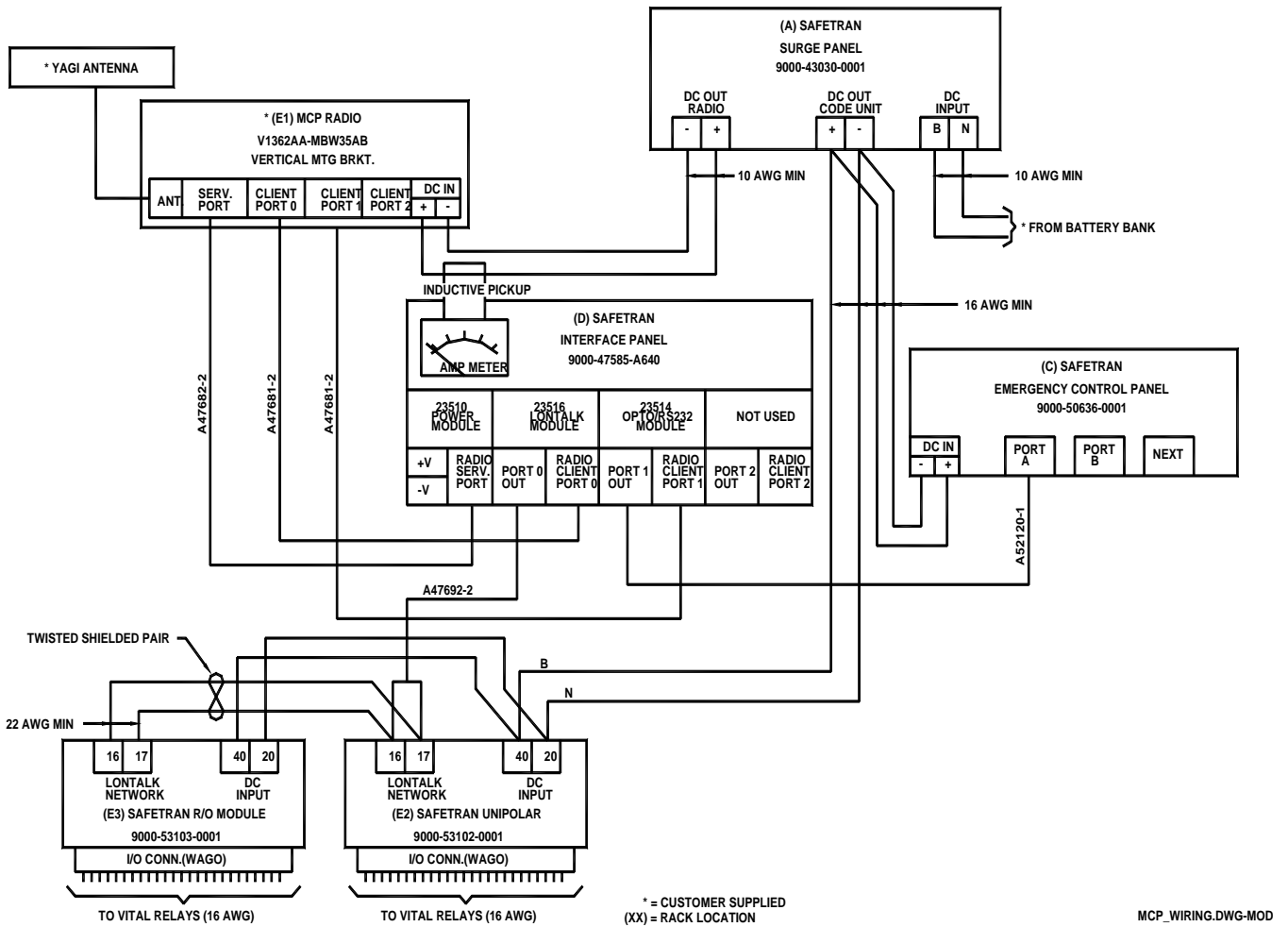


Figure D-2
Typical MCP Rack Interconnections

D.3 I/O MODULE CONFIGURATION

Configuration is performed module by module using a laptop PC running MS-DOS with Safetran’s Interlogic program. After applying power to the modules, perform the following steps:

1. Connect the laptop PC to the system using the DB-9 connector on the MCP Interface Panel, Spread-Spectrum radio, or, alternatively, directly to the MCP radio DB-15 port.
2. From the **Safetran** directory, run batch file **RLINK.BAT**. The system responds by installing the serial, event log, and redirector drivers, running the **IL.EXE** program, and displaying the Main Menu.
3. Press the **INSTALLATION** key (F5). The program displays the configuration and installation data for the first module at the site. If this is not correct, select **EDIT** (F1), and edit the data. When complete, press F8 to save the data and return to the Installation Menu.
4. Press the **INSTALL MODULE** (F4) key. The program prompts for a **SERVICE** push button to be pressed. Each module is equipped with a **SERVICE** push button to enable the module to be uniquely identified.

5. Locate and press the SERVICE push button on the front panel of the I/O module being installed. The configuration data will be automatically downloaded and the I/O module will reset itself. Verify that the ERROR, INDICATE, and CONTROL LEDs flash simultaneously during rebooting.
6. If more than one I/O module is required, press the NEXT (F2) key and repeat the edit and installation procedure above for all remaining modules.
7. If the Install procedure fails, press the ESC key to terminate the program. Examine all wiring and repeat the above procedure.

Two commands are provided that can be used to verify the wiring for the node number currently displayed on the Configuration screen. The READ CONFIG command (F5) reads and displays the current configuration. Similarly, the WINK command (F6) instructs a module to simultaneously flash the associated control and indication LEDs so that the module can be readily identified.

D.4 EDITING THE CONFIGURATION FIELDS

Two types of fields are displayed. “User Selection” fields require the space bar to be pressed to toggle between the different possibilities. “User Entered” fields require entry of a user-defined number. “Fixed Fields” display data that cannot be altered by the user.

D.4.1 Module Type

The module type selects the type of I/O module that will be installed. Three types are currently supported and include bipolar (53101), unipolar (53102), and relay (53103). Depending on the type of module selected, various other fields are displayed. Place the cursor over the field and press the space bar to select the type.

D.4.2 Railroad Identification

Each railroad has been assigned a unique three-digit identification number by the AAR. For example, typical numbers are 721 (Southern Pacific), 022 (Santa Fe), etc. Refer to Appendix D for a complete listing. The field is common to all modules at a location and once entered or modified is automatically applied to all modules.

NOTE

The railroad identification number must match the identification number of the office equipment. Place the cursor in the field and enter the applicable number.

D.4.3 Region/Line Identification

Each railroad is divided into small regions, divisions, or code lines, as appropriate. The number entered for this parameter is arbitrary and may be set to any convenient value. Safetran

recommends that the code line identification for this section be used. The field is common to all modules at the location and, once entered or modified, is automatically applied to all modules.

NOTE

The line identification must match the line identification of the central equipment. Place the cursor in the field and enter the number.

D.4.4 Location Identification

The location identification is also referred to as the site, or group, identification. Each location must have a unique number in the range 0 through 999. This field is common to all modules at the location and, once entered or modified, is automatically applied to all modules.

NOTE

Location numbers 1 through 127 only are supported by current office equipment. Place the cursor in the field and enter the number.

D.4.5 Node Identification

The node identification is unique to each module. Each equipment item at a site is assigned a specific node number beginning with 1 for the primary radio (MCP), 2 for the secondary or backup radio, and thereafter on a sequential numbering basis. Therefore, the first I/O module is always node 3, followed by the second as node 4, etc. This field cannot be edited and the numbers are assigned by the configuration system.

D.4.6 Site Database Revision

This field displays the current revision of the site database and is automatically updated when the application logic is compiled. It is installed in each I/O module connector to allow the system to verify that the correct version of the site-specific database is present at system startup.

D.4.7 Control Offset

Each control message from the office contains a number of eight-bit control words. This field indicates the first control word number assigned to the module counting from zero. Therefore, if a module is configured for four output words and the field is set to 2, control words 2, 3, 4, and 5 (the third, fourth, fifth, and sixth words) will be delivered as outputs by the module. Note that the configuration program automatically adjusts the field based on the number of control words used by the previous modules. It is always zero (0) for the first module..

D.4.8 Indication Offset

The indication offset is similar to the control word offset but indicates the word position for the module in the full indication message sent to the office equipment. Therefore, a value of 2 for a

module with one indication word indicates that the module is responsible for the third indication word sent to the office from the site. Note that the configuration program automatically adjusts this field based on the number of control words used by the previous modules. It is always 0 for the first module.

D.4.9 Control Delivery Time

The control delivery time determines the length of time that the control outputs will remain active (hot). The range is from 100 milliseconds to constant (latched). Use the space bar to select the applicable entry.

D.4.10 Indication Delivery Time

The indication delivery time determines the length of time the I/O module will wait before recognizing a change in inputs as a valid indication. This is useful if there are significant relay settling times involved. Use the space bar to select the appropriate entry.

D.4.11 KINDIS

The KINDIS output on the I/O modules is available and should be used as an indication battery. This allows the I/O module to perform additional diagnostics on the input circuits. When used, KINDIS must be enabled. If regular signal battery is used, KINDIS should be disabled. Use the space bar to select ON or OFF.

D.4.12 Control Read-Back

When enabled, the control read-back field instructs the I/O module to append the read-back state of the associated outputs to indications. This allows the site-specific application logic to perform closed-loop verification of system operation.

D.4.13 Number of Input/Output Words

Currently, only the unipolar module (A53102) can be configured with variable I/O. Each of the four words can be selected as either input or output. (Note that only six bits in the last word are available for I/O.) As the input and output selections are changed, the configuration program automatically adjusts the control and indication offsets of subsequent I/O modules as required.

D.5 MCP CONFIGURATION

The MCP radio requires special code plug configuration to operate with the R/LINK modules. It may also be necessary to upgrade the executive firmware if the software version is earlier than 3.30. Safetran's Interlogic, or any general purpose communications software, can be used to make the changes discussed in the paragraphs that follow.

To run the Interlogic program from the Safetran directory enter RLINK. This will execute the RLINK.BAT routine, load the serial drivers, and start the IL.EXE program. Select INSTALL (F5) and ONLINE MODE (F7). Verify that the MCP is connected by pressing the ENTER key several times and observing the MCP prompt (*).

D.5.1 MCP Code Plug Configuration

Locate the client port that is connected to the R/LINK via the MCP Interface Panel. This is normally client port 0. Refer to the MCP code plug configuration in this document and set the following fields:

- Port Configuration (location \$10A for client port 0) to asynchronous operation (\$08).
- Port Mode (location \$10B for client port 0) to LonTalk™ Mode (\$09).
- General Timer (location \$112 through \$115 for port 0) to \$00,\$00,\$0F,\$00.

To display current values, use the DCP command. To update the values, place the radio in service mode, (SERV command), use the PCP Location Value command (e.g., to change location \$10A to \$8, enter PCP \$10A \$8). When complete, use the FPROG command to save the changes.

To assist the user, the Interlogic program has upload (restore a code plug from a user-defined file) and download (copy a code plug to a user-defined file) utilities available. From the Interlogic ONLINE TERMINAL, select UPLOAD CODEPLUG (F3).

If a local control panel is installed, it will be connected via a separate client port. The correct values in the code plug for this port are:

- Port Configuration - Async Operation (\$08).
- Port Mode - SCS128 (\$08)
- General Timer - \$00, \$00, \$0F, \$00

NOTE

Unless the MCP radio was previously configured for R/LINK operation, the radio may lock up when the code plug changes above are performed. Reset the radio and then, from the Online Term menu option, enter an ! character as soon as the self-test messages begin appearing to abort the boot process. The code plug can now be changed as described above.

D.5.2 MCP Executive Upload

The MCP firmware must be revision level 3.40 or higher to operate properly with R/LINK. The VER command can be used to display the current version of the MCP software.

Safetran distributes MCP software as a filename FLROMHEX.xxx where xxx indicates the version (e.g., FLROMHEX.330 will be revision 3.30). To load a new version into the MCP, perform the following steps:

1. Use the Online Term option (F7) on the Interlogic program to enter the MCP Terminal Mode.
2. Enter the TEST command to reset the MCP.
3. Simultaneously press and hold the CNTRL and K keys until the radio responds with the ABRT - LOAD prompt.
4. Upload the FLROMHEX.xxx program in ASCII format. If the Interlogic program is being used, press the UPLOAD EXEC key (F4) from the Online menu.

The process requires approximately nine minutes. When complete, the radio will respond with a 1 prompt followed by the normal start-up self tests.

D.6 CODE PLUG PARAMETERS

Code plug parameters for Safetran's WCM Firmware, Version XCM4.05P, are listed in table D-1. For additional information regarding subsequent revisions to the firmware, contact Safetran Customer Service.

It is recommended that users only modify these parameters using the supplied utility program. However, if the parameters are manipulated directly, care should be taken that the wrong locations are not inadvertently modified.

NOTE

Time values are expressed in 10-millisecond increments. For example, 15 seconds would be expressed as 1500.

Many values are bit-mapped. Bit 0 is defined as the value 01, bit 1 as 02, bit 3 as 04, etc. Actual value to be programmed is the sum of all required bits (e.g., if bits 1, 2, and 4 are set, the value is $(2+4+16) = \$16$ (22 decimal)).

All values are in decimal, except where specifically indicated with the hexadecimal prefix (\$).

**Table D-1
WCM Code Plug Parameters**

Location	Description	Default Value
\$01	Manufacturer equipment code	\$01
\$02	ATCS equipment code	\$01
\$02 thru \$09	ATCS address of FPD. The values are interpreted as 16 nibbles with the last nibble specifying the address length. Zero is coded as \$A. Example: 7A.22.51.6A.28.A1.A1.0E This is used to set the FPD address when the attached equipment cannot provide the address via an XID process.	Null
\$0A thru \$11	ATCS address to which health and malfunction report messages should be sent. Example: 2A.22.A1.AA.AA.00.00.0A	Null
\$12	Local processing options bit map Bit 0 - Enable site code line application logic Bit 1 - Enable duplicate reject suppress facility Bit 2 - Enable site simulation Bit 3 - Enable site ladder logic Bit 6 - Enable AMCI Alert messages	Null
\$13	Maximum number of ground contact attempts per radio channel	6
\$14 thru \$17	Time between ground contact attempts	6000
\$18 thru \$1B	Layer 4 duplicate elimination timer value	1500 (15 sec.)
\$1C thru \$1F	Ground contact expiration timer value	Reserved
\$20 thru \$27	ATCS address for cluster controller time requests	Null
\$28	Out-of-coverage radio channel. If this value is \$FF, no channel change is performed when entering out-of-coverage mode.	1
\$29 thru \$2A	Not used	Null
\$2B	Alarm enable bits Bit 0 - External alarm 5 Bit 1 - Port 0 contact failure Bit 2 - Port 1 contact failure Bit 3 - Port 2 contact failure Bit 4 - Port 0 hardware failure Bit 5 - Port 1 hardware failure Bit 6 - Port 2 hardware failure Bit 7 - Not used	Null

Table D-1 Continued

Location	Description	Default Value
\$2C	Alarm enable bits Bit 0 - Mobile channel usage (COS too long) Bit 1 - Out of coverage (lost contact) Bit 2 - A/D failure Bit 3 - External alarm 0 Bit 4 - External alarm 1 Bit 5 - External alarm 2 Bit 6 - External alarm 3 Bit 7 - External alarm 4	Null
\$2D	Alarm enable bits Bit 0 - Radio failure Bit 1 - Radio bus failure Bit 2 - Radio power amplifier Bit 3 - Radio AC power failure Bit 4 - Code plug CRC failure Bit 5 - Carrier without data Bit 6 - Rf modulator failure Bit 7 - Ground contact failure	Null
\$2E thru \$3C	Not used	Null
\$3D	This parameter specifies the number of ground network messages that must be received within the period configured (see 'Regain contact window') for contact to be regained (\$44 thru \$47).	1
\$3E	Ground contact options Bit 0 - Enable ground contact procedure Bit 1 - Restrict channel cycle to default only Bit 2 - Enable passive contact if active contact fails Bit 3 - Send ground contact status to clients Bit 4 - Send ground contact status on mode change Bit 5 - Use time message exchange (Version 1 Spec.) Bit 6 - Always use code plug address for GC attempt	\$15
\$3F	Not used	Null
\$40 thru \$43	Rf poll expiration timer	1770 (60 sec.)
\$44 thru \$47	Time within which ground contact messages are to be received (see \$3D)	1770 (60 sec.)
\$48 thru \$4B	Not used	Null

Table D-1 Continued

Location	Description	Default Value
\$4C thru \$4F	Channel 2 rf retry interval	400 (4 sec.)
\$50 thru \$53	Channel 4 rf retry interval	490
\$54 thru \$57	Channel 6 rf retry interval	760
\$58 thru \$5B	Channel 8 rf retry interval	1080
\$5C thru \$5F	Channel 10 rf retry interval	1450
\$60 thru \$63	Channel 12 rf retry interval	2000
\$64 thru \$67	Channel 14 rf retry interval	2900
\$68 thru \$6B	Channel 16 rf retry interval	3900
\$6C thru \$6F	Retry quantum time	91
\$70 thru \$73	Retry slope	30
\$74 thru \$77	Flow recovery time before starting recovery	500 (5 sec.)
\$78 thru \$7B	Flow recovery time limit	1000 (10 sec.)
\$7C thru \$7F	Beacon timer	\$FFFFFFFF
\$80 thru \$83	Cluster controller reset timer	1000 (10 sec.)
\$84 thru \$85	Number of fast beacons	5
\$86 thru \$87	Maximum number of beacon retries	6
\$88 thru \$8F	ATCS address to which beacons are to be sent. The values are interpreted as 16 nibbles with the last nibble specifying the address length. Zero is coded as \$A. Unused bytes can be set to 0 (null). Example: 2A.22.51.6A.28.00.00.0A	Null
\$90	Network layer options Bit 0 - Enable NAK packets to ground network Bit 1 - Enable service signals to ground network Bit 2 - Enable emergency messages by channel group Bit 3 - Enable lost contact when out of coverage Bit 4 - Suppress layer 3 duplicate elimination Bit 5 - Ignores COS test before transmit when set	Null
\$91	Broadcast Bit 0 - Enable wayside broadcast on zero device address	Null
\$92	Wireline Bit 0 - Inhibits rf transmission of wayside wire line addresses	1
\$93	Emergency turnaround Bit 0 - No turnaround Bit 1 - Turnaround on trunk failure Bit 2 - Always turnaround emergencies	1

Table D-1 Continued

Location	Description	Default Value
\$94 thru \$97	Network address change time. If the BCM receives a local network address that is different from that of a client's current address (i.e. the BCM network address is redefined), this parameter determines the period before the BCM is reset.	1500 (15 sec.)
\$98 thru \$A3	Not used	0
\$A4 thru \$A5	Number of null rf frames after each transmission. When set to \$FFFF, BCP is keyed continuously.	0
\$A6 thru \$A7	Maximum number of bits per non-emergency message. When set to \$FFFF, no limit applies.	4800
\$A8 thru \$A9	Maximum number of bits per emergency message	14400
\$AA thru \$AD	Not used	0
\$AE thru \$B1	Minimum value for channel retry random access timer (channel idle)	130
\$B2 thru \$B5	Maximum value for channel retry random access timer (channel idle)	130
\$B6 thru \$B9	Minimum value for channel retry random access timer (channel receiving sync bits)	1
\$BA thru \$BD	Maximum value for channel retry random access timer (channel receiving sync bits)	80
\$BE thru \$C1	Minimum value for channel retry random access timer (channel receiving busy bits)	1
\$C2 thru \$C5	Maximum value for channel retry random access timer (channel receiving busy bits)	200
\$C6 thru \$C9	Minimum value for channel retry random access timer (busy bit status not yet defined - less than 3 received)	1
\$CA thru \$CD	Maximum value for channel retry random access timer (busy bit status not yet defined)	80
\$CE thru \$D1	Maximum time before carrier-without-data alarm	\$FFFFFFFF
\$D2 thru \$D5	Mobile channel usage timer	\$FFFFFFFF
\$D6 thru \$D9	Out-of-coverage timer since last rf message	6000
\$DA thru \$DD	Minimum channel idle time	75
\$DE thru \$E1	Maximum channel idle time	150
\$E2	Rf link options Bit 0 - Enable null rf link address for ground contact messages	1
\$E3 thru \$E5	Not used	0
\$E6 thru \$E9	Radio key-up time	4
\$EA thru \$ED	Radio dekey time	1

Table D-1 Continued

Location	Description	Default Value
\$EE	Radio type 0 = None 1 = MCS 2000 2 = MSF 3 = MTR 2000	1
\$EF	Radio usage	5
\$F0	Minimum radio channel. Set to desired channel for single-channel operation or to lowest channel used in scanning.	1
\$F1	Maximum radio channel. Set to desired channel for single-channel operation or to highest channel used in scanning.	6
\$F2	Default (single-channel operation) or first (scanned operation) radio channel.	
\$F3 - \$F7	Remainder of radio channel scan sequence. These parameters (including \$F2) determine the scan sequence of the ground contact process. Location \$F2 is the channel on which the unit begins scanning. The channels in the list must be in the range of valid channels. If the complete list is not used, unused channels must be set to \$FF.	1,2,3,4,5,6
\$F8	SSI enable. Negative value relating to BASE RSSI (dB). Normally set to -125 (\$7D)	0
\$F9	Minimum SSI	0
\$FA	SSI scaling multiplier.	0
\$FB	SSI scaling divisor.	0
\$FC	SSI simulation	0
\$FD - \$FE	Not used	
\$FF	RF transmit power. Reserved for future application. 0 = Low 1 = High 2 = Auto	
\$100 - \$103	Port 0 contact failure timer	6000
\$104 - \$105	Port 0 link (polling) address. Undefined when set to \$FFFF Start of polling range for certain emulations (WCP)	\$FFFF
\$106 thru \$107	Port 0 group link address	\$FFFF

Table D-1 Continued

Location	Description	Default Value
\$108	Port 0 options Bit 0 - Inhibit XID exchange Bit 1 - Enable emergency bit in message Bit 2 - Enable time stamp Bit 3 - Enable ADM mode failure Bit 4 - Reset BCM on port contact alarm	0
\$109	Port 0 usage 5 - Ground equipment 6 - OBC equipment 18 - WIU equipment \$FF - Not used	18
\$10A	Port 0 configuration Bit 0 - RTS/CTS handling required Bit 1 - RS232 / RS422 selection Bit 2 - RTS always asserted Bit 3 - Async port configuration Bit 4 - External modem equipped Bit 5 - Idle character enable Bit 6 - Locomotive ID unit equipped Bit 7 - External TXCLOCK port option	0
\$10B	Port 0 mode 1 - HDLC ADM Mode 2 - HDLC ABM Mode 3 - HDLC Polled Mode 4 - HDLC UI Mode 6 - Null HDLC Mode 7 - Genisys Mode (Office) 8 - SCS-128 Local Control Panel (ECP) 9 - Not used \$A - MCS-1 Mode \$B - ASYNC port packetizer mode \$C - Spread-Spectrum Radio Protocol \$D - Not Used \$E - SCS128 Emulation \$F - Genisys mode (Field) \$10 - CN2000 A \$11 - CN2000 B	1
\$10C	Port 0 baud rate. Value = baud rate/300, e.g. 9600 baud = \$20	32
\$10D	Port 0 number of poll response information frames per poll	5
\$10E	Maximum poll address	0
\$10F	Alternate task number (special application)	\$FF

Table D-1 Continued

Location	Description	Default Value
\$110 thru \$111	Other link address	\$FFFF
\$112 thru \$115	General purpose timer value. Used for either locomotive ID unit receive time-out or code line protocol poll timer. Recommended values: Port mode: Genisys, SCS-128, MCS-1 = \$000000A0 Lontalk [®] Mode = \$000000F0	
\$116 thru \$119	Port 1 contact failure timer	6000
\$11A thru \$11B	Port 0 baud rate. Value = baud rate/300, e.g. 9600 baud = \$20 Start of polling range for certain emulations (WCP)	\$FFFF
\$11C thru \$11D	Port 1 group link address	\$FFFF
\$11E	Port 1 options Bit 0 - Inhibit XID exchange Bit 1 - Enable emergency bit in message Bit 2 - Enable time stamp Bit 3 - Enable ADM mode failure Bit 4 - Reset BCM on port contact alarm	0
\$11F	Port 1 usage 5 - Ground equipment 6 - OBC equipment 18 - WIU equipment \$FF - Not used	18
\$120	Port 1 configuration Bit 0 - RTS/CTS handling required Bit 1 - RS232 / RS422 selection Bit 2 - RTS always asserted Bit 3 - Async port configuration Bit 4 - External modem equipped Bit 5 - Idle character enable Bit 6 - Locomotive ID unit equipped Bit 7 - External TXCLOCK port option	0

Table D-1 Continued

Location	Description	Default Value
\$121	Port 1 mode 1 - HDLC ADM Mode 2 - HDLC ABM Mode 3 - HDLC Polled Mode 4 - HDLC UI Mode 6 - Null HDLC Mode 7 - Genisys Mode (Office) 8 - SCS-128 Local Control Panel 9 - Not used \$A - MCS-1 Mode \$B - ASYNC port packetizer mode \$C - Spread-Spectrum Radio Protocol \$D - Not used \$E - SCS128 Emulation \$F - Genisys mode (Field) \$10 - CN 2000 A \$11 - CN 2000 B	1
\$122	Port 1 baud rate. Value = baud rate/300, e.g. 9600 baud = \$20	32
\$123	Port 1 number of poll response information frames per poll	5
\$124	Maximum Poll Address	0
\$125	Alternate task number (special application)	\$FF
\$126 thru \$127	Other link address	\$FFFF
\$128 thru \$12B	General purpose timer value. Used for either locomotive ID unit receive time-out or code line protocol poll timer	\$FFFFFFFF
\$12C thru \$135	Not Used	
\$136	Lontalk (tm) configuration flag: 0 = not used; 1 = used	
\$137	DC configuration : 0 = None 1 = US&S 506 2 = US&S 514 3 = J Code 4 = K Code 5 = Alarm	
\$138 - \$13D	Not used	
\$13E thru \$141	General purpose timer value. Used for either locomotive ID unit receive time-out or code line protocol poll timer	\$FFFFFFFF

Table D-1 Continued

Location	Description	Default Value
\$142 thru \$143	Internal entity link address	1
\$144 thru \$145	Link address for ground network	\$23
\$146 thru \$147	Link address for emergency transmission	\$25
\$148 thru \$149	Link address for transmission to rf user	\$27
\$14A thru \$14B	HDLC broadcast address	\$00FF
\$14C thru \$14D	HDLC control messages	\$00FF
\$14E thru \$155	Not used	\$0000
\$156 thru \$157	Rf idle frame address	\$0000
\$158 thru \$159	Rf link layer address for frames to locomotives	\$0001
\$15A thru \$15B	Rf link layer address for frames to non-locomotives	\$0004
\$15C thru \$15D	Rf link layer address for frames to wire line-connected waysides	\$0003
\$15E thru \$15F	Rf link layer address for frames to rf-connected wayside	\$0005
\$160 thru \$161	Rf link layer address for frames to ground network	\$0023
\$162 thru \$163	Rf link layer address for emergency frames to ground network	\$0025
\$164 thru \$165	Rf link layer address for frames to other rf users	\$0027
\$166 thru \$167	Rf link layer address for broadcast frames	\$00FF
\$168 thru \$174	Reserved for channel frequency configuration	
\$175	Not used	0
\$176	Asic - not used	
\$177	Asic configuration value	
\$178 thru \$17D	Asic frame sync pattern	\$90E0 \$2254 \$00F6

Table D-1 Continued

Location	Description	Default Value
\$17E	Transmitter configuration digital loopback Bit 0 - Invert busy bit status Bit 1 - Hardware busy bit input Bit 2 - Enable analog loopback Bit 3 - Enable digital loopback Bit 4 - Invert transmit data Bit 5 - Invert receive data Bit 6 - Bit sync enable Bit 7 - N/A (always 0)	\$4A
\$17F	Transmitter configuration analog loopback Bit 0 - Invert busy bit status Bit 1 - Hardware busy bit input Bit 2 - Enable analog loopback Bit 3 - Enable digital loopback Bit 4 - Invert transmit data Bit 5 - Invert receive data Bit 6 - Bit sync enable Bit 7 - N/A (always 0)	\$41
\$180	Transmitter configuration open loopback Bit 0 - Invert busy bit status Bit 1 - Hardware busy bit input Bit 2 - Enable analog loopback Bit 3 - Enable digital loopback Bit 4 - Invert transmit data Bit 5 - Invert receive data Bit 6 - Bit sync enable Bit 7 - N/A (always 0)	\$51
\$181 thru \$183	Not used	0
\$184 thru \$18D	Hardware initialization values (factory only)	
\$18E thru \$191	Alert initial delay time	FFFFFFFF
\$192 thru \$195	Alert response delay time	FFFFFFFF
\$196 thru \$197	Alert report rate	FFFF
\$198 thru \$199	Not used	FFFF
\$19A thru \$19D	Alert retry time	FFFFFFFF

Table D-1 Continued

Location	Description	Default Value
\$19E thru \$1A1	Alert delivery delay time	\$FFFFFFFF
\$1A2 thru \$1A9	Alert report address	0,0,0,0,0,0,0,0
\$1AA thru \$1AD	Not used	0
\$1B0	Enable version field. This parameter determines if the version field is included in datagrams.	1
\$1B1	This parameter determines the format of the health and malfunction/self-test report messages. The 89 spec. (0), 90 spec. (1) and latest spec. (3) versions are supported.	3
\$1B2	This parameter determines the format of the communications statistics message. Versions 1 and 3 are supported.	3
\$1BE thru \$1BF	CRC of unprotected portion of code plug	\$DEAD
\$1C0 thru \$1C5	Encrypted password for protected portion of code plug	MCP
\$1C6 thru \$1D4	Serial number as 15 ASCII bytes	
\$1D5 thru \$1D7	Maintenance date. Format: 3 unsigned bytes, DD/MM/YY	
\$1D8 thru \$1D9	Procuring railroad. Format: Unsigned integer. This parameter is used for the procuring railroad number for the Version 3 Health Report.	
\$1DA thru \$1DB	Not used	0
\$1DC thru \$1DD	ATCS hardware revision number. Format: Unsigned integer. This parameter is used for the ATCS hardware revision in the Version 3 Health Report.	
\$1DE thru \$1DF	ATCS software revision number. Format: Unsigned integer This parameter is used for the ATCS software revision in the Version 3 Health Report.	
\$1E0 thru \$1E1	Power-up count. Format: Unsigned integer. This parameter is used for recording the number of power-ups the unit has performed.	0
\$1E2 thru \$1E3	Rf modulator failure count. Format: Unsigned integer. This parameter is used for recording the number of modulator self- test failures.	0

Table D-1 Concluded

Location	Description	Default Value
\$1E4 thru \$1E5	Radio failure count. Format: Unsigned integer. This parameter is used for recording the number of radio self-test failures.	0
\$1E6 thru \$1E7	A/D converter failure count. Format: Unsigned integer. This parameter is used for recording the number of A/D self-test failures.	0
\$1E8 thru \$1E9	Client port 0 failure count. Format: Unsigned integer. This parameter is used for recording the number of client port self- test failures.	0
\$1EA thru \$1EB	Client port 1 failure count. Format: Unsigned integer. This parameter is used for recording the number of client port self- test failures.	0
\$1EC thru \$1ED	Client port 2 failure count. Format: Unsigned integer. This parameter is used for recording the number of client port self- test failures.	0
\$1EE thru \$1F5	Manufacturer hardware revision number. Format: 8 bytes, ASCII. This parameter is used for the manufacturer hardware revision in the Version 3 Health Report.	
\$1F6 thru \$1FD	Not used	0
\$1FE thru \$1FF	Restricted code plug CRC for restricted code plug area. Format: Unsigned integer.	\$DEAD

D.7 TRANSMITTER CONFIGURATION CODEPLUG PARAMETER DESCRIPTIONS

These paragraphs detail the bit state combinations that may be assigned to the transmitter configuration code-plug, position \$180, for the following systems:

- Safetran A53410 Base Communications Package (MTR2000)
- Safetran A53411 Wayside Communications Package (MCS2000)
- Motorola Spectra Mobile Communications Package

Within an ATCS network, the transmitter configuration codeplug parameters of the associated communications packages (refer to Appendix A for a typical ATCS network) must be compatible to ensure proper communications.

The compatible inversion states for the Safetran BCP, the Safetran WCP and/or the Motorola MCP are summarized in table D-2. The corresponding codeplug values for each inversion state are also included.

**Table D-2
System Configuration Compatibility Summary**

Safetran BCP		Safetran WCP		Motorola MCP	
MTR2000 Inversion	MTR2000 Loc. \$180 Codeplug Value	MCS2000 Inversion	MCS2000 Loc. \$180 Codeplug Value	Spectra MCP Inversion	Spectra MCP Loc. \$180 Codeplug Value
Rx = No Tx = No	41	TX = Yes Rx = Yes	71	TX = Yes Rx = Yes	71
Rx = Yes Tx = Yes	71	TX = No Rx = No	41	TX = No Rx = No	41
Rx = No Tx = Yes	51	TX = Yes Rx = No	51	TX = Yes Rx = No	
Rx = Yes Tx = No	61	TX = No Rx = Yes	61	TX = No Rx = Yes	61

D.7.1 Codeplug Position \$180 Transmit/Receive Configuration

The bit assignment for position \$180 is as follows:

Bit Position	Function Assignment	Hexadecimal Position Assignment
0	Invert Busy Bit Status	16 ⁰
1	Hardware Busy Bit Input	
2	Enable Analog Loopback	
3	Enable Digital Loopback	
4	Invert Transmit Data	16 ¹
5	Invert Receive Data	
6	Bit Sync Enable	
7	No Function Assignment (always 0)	

NOTE

*Bit state values assign options to single bits, where:
1 = Yes , 0 = No.*

The bit states for position \$180 are as follows:

\$51 (default) TX= YES RX = NO

Bit Position	Function Assignment	Bit State	Hexadecimal Value
0	Invert Busy Bit Status	1	1
1	Hardware Busy Bit Input	0	
2	Enable Analog Loopback	0	
3	Enable Digital Loopback	0	
4	Invert Transmit Data	1	50
5	Invert Receive Data	0	
6	Bit Sync Enable	1	
7	Bit 7	0	

\$41 TX= NO RX = NO

Bit Position	Function Assignment	Bit State	Hexadecimal Value
0	Invert Busy Bit Status	1	1
1	Hardware Busy Bit Input	0	
2	Enable Analog Loopback	0	
3	Enable Digital Loopback	0	
4	Invert Transmit Data	0	40
5	Invert Receive Data	0	
6	Bit Sync Enable	1	
7	Bit 7	0	

\$61 TX= NO RX = YES

Bit Position	Function Assignment	Bit State	Hexadecimal Value
0	Invert Busy Bit Status	1	1
1	Hardware Busy Bit Input	0	
2	Enable Analog Loopback	0	
3	Enable Digital Loopback	0	
4	Invert Transmit Data	0	60
5	Invert Receive Data	1	
6	Bit Sync Enable	1	
7	Bit 7	0	

\$71 TX= YES RX = YES

Bit Position	Function Assignment	Bit State	Hexadecimal Value
0	Invert Busy Bit Status	1	1
1	Hardware Busy Bit Input	0	
2	Enable Analog Loopback	0	
3	Enable Digital Loopback	0	
4	Invert Transmit Data	1	70
5	Invert Receive Data	1	
6	Bit Sync Enable	1	
7	Bit 7	0	

D.8 PHD2000 BCP TRANSMITTER CONFIGURATION CODEPLUG PARAMETER DESCRIPTIONS

The Motorola PHD2000 BCP codeplug is slightly different from the Safetran WCP codeplug. The PHD2000 BCP codeplug utilizes a separate address location for setting the inversion bits of its transmitter and receiver. In addition to setting the proper inversion bits it is necessary to change the settings of the Transmitter Configuration Analog Loopback and Digital Loopback Tests. Failure to set these parameters correctly will cause the Modulator self test to fail.

Within an ATCS network, the transmitter configuration codeplug parameters of the associated communications packages communications (refer to Appendix A for a typical ATCS network) must be compatible to ensure proper communications. The compatible inversion states for the PHD2000 BCP, the Safetran WCP and/or the Motorola MCP are summarized in table D-3. The corresponding codeplug values for each inversion state are also included.

**Table D-3
Motorola PHD2000 BCP Codeplug Configuration Summary**

Motorola PHD2000 BCP		Safetran WCP		Motorola MCP	
MSF5000 Inversion	MSF5000 Loc. \$178 (TX) Loc. \$183 (RX) Codeplug Values	MCS2000 Inversion	MCS2000 Loc. \$180 Codeplug Value	Spectra MCP Inversion	Spectra MCP Loc. \$180 Codeplug Value
Rx = No Tx = No	\$178 = 05 \$181 = 13 \$182 = 0B \$183 = 03	TX = Yes Rx = Yes	71	TX = Yes Rx = Yes	71
Rx = Yes Tx = Yes	\$178 = 0D \$181 = 15 \$182 = 0D \$183 = 07	TX = No Rx = No	41	TX = No Rx = No	41
Rx = No Tx = Yes	\$178 = 05 \$181 = 13 \$182 = 0B \$183 = 07	TX = Yes Rx = No	51	TX = Yes Rx = No	51
Rx = Yes Tx = No	\$178 = 0D \$181 = 15 \$182 = 0D \$183 = 03	TX = No Rx = Yes	61	TX = No Rx = Yes	61

D.8.1 Codeplug Position \$178 Receiver Configuration

The bit assignments for position \$178 are as follows:

Bit Position	Function Assignment	Hexadecimal Position Assignment
0	Number of frame sync mismatches	16 ⁰
1	Number of frame sync mismatches	
2	Number of frame sync mismatches	
3	Invert RX data	

NOTE

*Bit state values assign options to single bits, where:
1 = Yes, 0 = No.*

The bit states for position \$178 are as follows:

\$05 RX = NO

Bit Position	Function Assignment	Bit State	Hexadecimal Value
0	Number of frame sync mismatches	1	5
1	Number of frame sync mismatches	0	
2	Number of frame sync mismatches	1	
3	Invert RX data	0	

\$0D RX = YES

Bit Position	Function Assignment	Bit State	Hexadecimal Value
0	Number of frame sync mismatches	1	D
1	Number of frame sync mismatches	0	
2	Number of frame sync mismatches	1	
3	Invert RX data	1	

D.8.2 Codeplug Position \$181 Transmitter Configuration Digital Loopback

The bit assignments for position \$181 are as follows:

Bit Position	Function Assignment	Hexadecimal Position Assignment
0	Invert Busy Bit	16 ⁰
1	Hardware Busy Bi	
2	Invert Transmitted Data	
3	Enable Analog Loopback	
4	Enable Digital Loopback	16 ¹
5	No Function Assignment (always 0)	
6	No Function Assignment (always 0)	
7	No Function Assignment (always 0)	

\$0B INVERT TX= NO

Bit Position	Function Assignment	Bit State	Hexadecimal Bit Value
0	Invert Busy Bit	1	B
1	Hardware Busy Bit	1	
2	Invert Transmitted Data	0	
3	Enable Analog Loopback	1	

\$0D INVERT TX = YES

Bit Position	Function Assignment	Bit State	Hexadecimal Bit Value
0	Invert Busy Bit	1	D
1	Hardware Busy Bit	0	
2	Invert Transmitted Data	1	
3	Enable Analog Loopback	1	

D.8.4 Codeplug Position \$183 Transmitter Configuration Normal (OPEN)

The bit assignments for position \$183 are as follows:

Bit Position	Function Assignment	Hexadecimal Position Assignment
0	Invert Busy Bit	16 ⁰
1	Hardware Busy Bit	
2	Invert Transmitted Data	
3	Enable Analog Loopback	

NOTE

*Bit state values assign options to single bits, where:
1= Yes , 0 = No.*

The bit states for position \$183 are as follows:

\$0B TX= NO

Bit Position	Function Assignment	Bit State	Hexadecimal Bit Value
0	Invert Busy Bit	1	3
1	Hardware Busy Bit	1	
2	Invert Transmitted Data	0	
3	Enable Analog Loopback	0	

\$0D TX = YES

Bit Position	Function Assignment	Bit State	Hexadecimal Bit Value
0	Invert Busy Bit	1	7
1	Hardware Busy Bit	1	
2	Invert Transmitted Data	1	
3	Enable Analog Loopback	0	

APPENDIX E

SURGE PROTECTION & GENERIC GROUNDING PROCEDURES

E.0 GENERAL

With all R/Link radio applications care should be taken to prevent ground differentials between the grounding points that can cause equipment damage. The following paragraphs provide general recommendations for surge protection and grounding.

E.1 SURGE PROTECTION

Electrical surges experienced by railroad electrical equipment basically consist of natural or man-made sources. Two natural phenomenon: the movement of charged clouds over installations and direct lightning strikes to, or near, those installations, generally account for the natural sources. Man-made surges, although usually lower in strength than the natural variety, are more numerous, and because of the lower power involved compared to lightning-induced surges, are the easiest to protect against. Basically, two methods are used for combating surges: shielding and surge suppression. Many surge protection techniques use a combination of the two methods.

E.1.1 Shielding

Shielding is a means of protecting lines and circuits by encasing them or placing them next to metal conductors connected to ground to redirect stray energy to earth ground (providing the proper path to ground for stray energy is covered in paragraph E.3, *Generic Grounding Procedures*). Although surges will not be completely eliminated by shielding, the magnitude of the surges will be greatly reduced. For example, a grounded wire strung above a signal wire in a pole line system greatly reduces surges in the signal wire, but does not eliminate the possibility of induced surges altogether.

E.1.2 Surge Suppression

Suppression-type protectors, usually called arresters, work by clamping surges to acceptable levels. Generally, there are two classes of arresters: Primary and Secondary. External primary arresters take the first step towards protecting electrical equipment by reducing the surge down to the two to three thousand volt range. For some equipment, this is sufficient protection. However, for equipment containing semiconductor technology, a secondary level of surge protection is required. The secondary protection is provided by arresters internal to the equipment that protect down to the range of twenty to five hundred volts.

E.1.3 Cables And Wiring

Cabling should be installed in a manner that minimizes inductive coupling that might otherwise allow surge energy to bypass the protective and isolating elements in the system. The input/output conductors entering the building should follow a path as short as possible to the air gap surge protectors. These conductors should not be within three inches of other conductors, including the signal wires from the surge protectors to the relay racks. The signal wires from the

surge protectors to the relay rack should be dressed together and separated from power and other signal wires by at least three inches. The signal wires between the relay isolation and the Safetran equipment should be dressed together and separated from power or other signal wires by at least three inches. Where physical separation is not possible, the wires should be run at right angles to each other.

E.2 SURGE PANELS

Surge protection should be provided on battery/charger systems to prevent the system from rising to dangerous voltages with reference to building ground. The protectors should be installed in series with a circuit breaker so that if they fail in the shorted mode, the circuit breaker will open to isolate the system from ground.

The proper primary surge protection can be provided by the use of Safetran surge panels that have the correct configuration of arresters and equalizers for the specific applications.

NOTE

For information on surge protection products, contact Siemens Industry, Inc. Rail Automation, Engineering, Rancho Cucamonga, CA.

E.3 GENERIC GROUNDING PROCEDURES

All R/LINK equipment and enclosures should be properly grounded to prevent ground differentials between the grounding points that can cause equipment damage. The following paragraphs present recommendations for grounding equipment and enclosures.

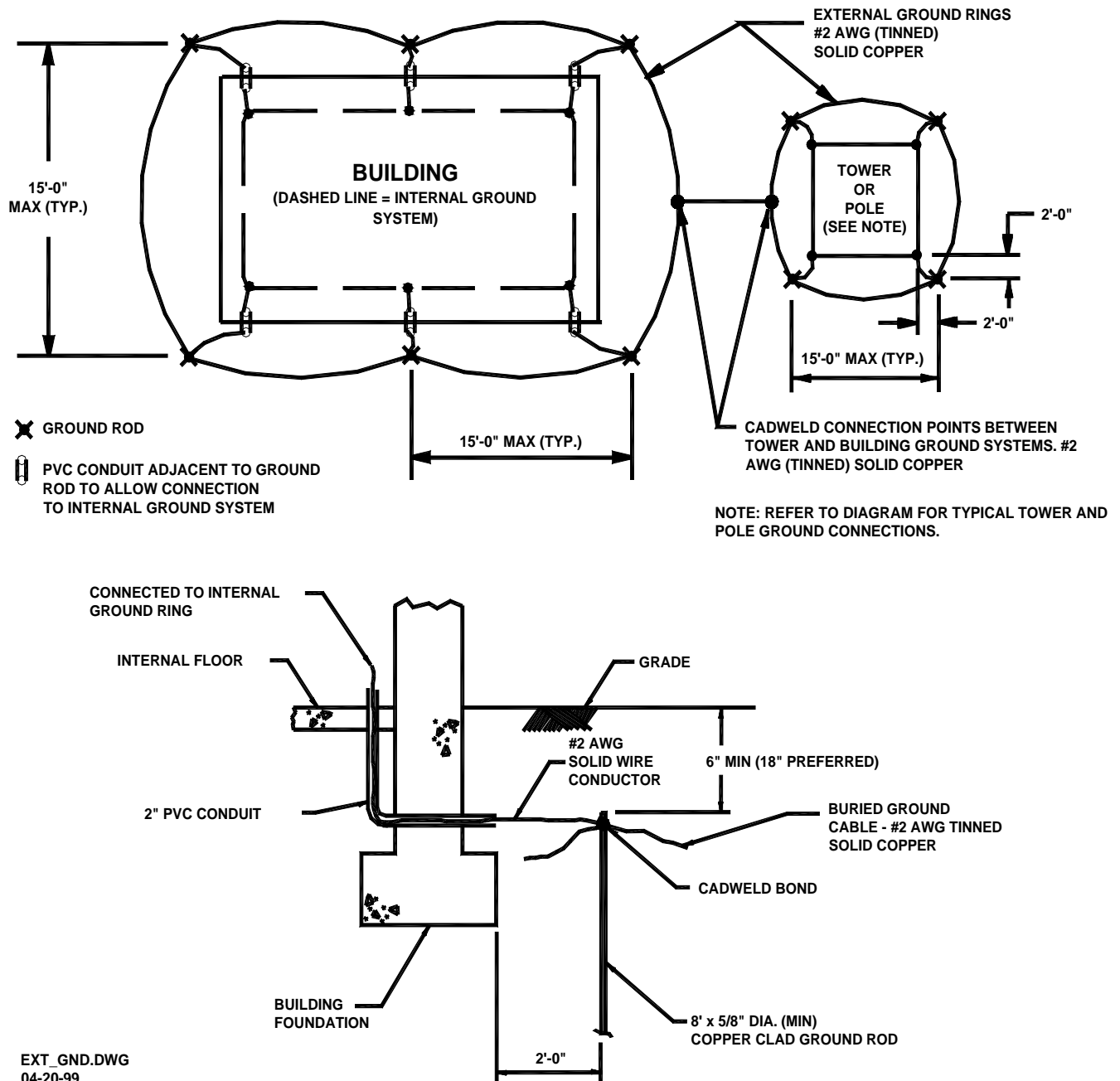
E.3.1 External Building Ground

Grounding electrodes should be a minimum of 8 feet in length and located approximately 2 feet away from each corner of the building with the top of each element at least 6 inches below grade (18 inches preferred). Spacing between electrodes should not exceed 15 feet. The ground elements should be bonded together with a ring of #2 AWG solid copper wire. All below-grade connections shall be Cadwelded (or equivalent exothermic weld). Refer to figure E-1 for typical external ground connections.

The following items should be connected to the ground ring using a #2 AWG solid copper conductor:

- All hydro ground elements within 6 feet of the ground ring
- All metal objects within 50 feet of the building (e.g., fuel storage tanks, metal fences, guy wires, and other significant metal objects)
- Air gap surge protectors on the common ground side of the arresters (as direct as possible through the floor)

- A conductor from each ground electrode to the closest corner of the building, passed up through the floor and up the inside wall to connect with an internal ground ring located 6 inches from the inside ceiling (sides of buildings wider than 15 feet also use conductors from ground electrodes placed between the corners at maximum 15 foot intervals - see figure E-1).



**Figure E-1
Typical External Ground Connections**

E.3.2 Internal Building Ground

The internal ground ring (refer to figure E-2) should be #2 AWG copper, and may be stranded or solid. Ground conductors should be short and as direct as possible, avoiding sharp bends. Ground ring and conductors should not be allowed to touch equipment, cable trays, structural members and metal walls except at the grounding point. The following items should be connected to the internal ground ring using a minimum #6 AWG stranded copper conductor (#2 is preferred):

- All relay racks (mounted modules should make a solid chassis ground connection)
- Standalone equipment (if modules or radios are not rack mounted, they should be separately grounded).
- AC panels
- Battery system surge protectors
- Building metal door frames and doors
- Cable trays, structural members and metal walls

NOTE

Bonding conductor connections to the interior ground ring should be made using split brass bolts or parallel brass connectors (see figure E-4).

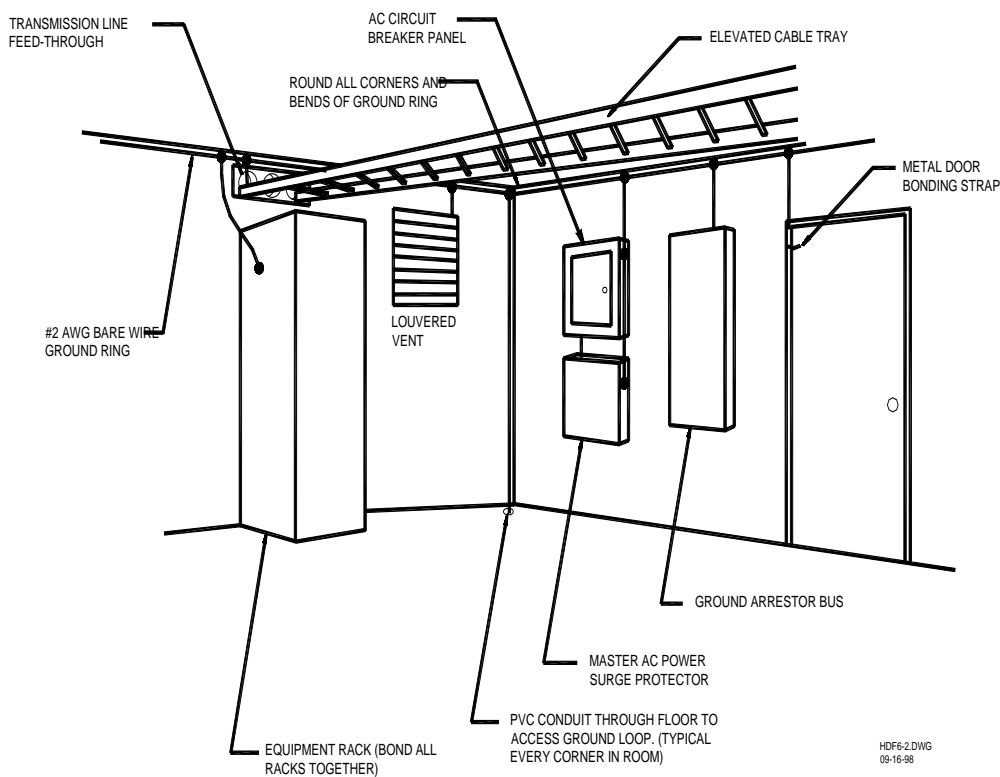


Figure E-2
Typical Internal Ground Connections

E.3.3 Antenna Ground

A good RF ground will determine the quality of a radio antenna system. Poor grounds result in antennas not operating efficiently. RF energy is dissipated in the ground resistance and it is possible to lose between 50 and 90 percent of the RF power in heating the ground losses under the antenna instead of propagating into the air. Ground resistances can vary from very low values of 5 ohms or less to more than 100 ohms. The following factors will affect the specific ground resistance:

- Conductivity of the soil
- Composition of the soil
- Water content of the soil

Note that the ideal ground depth depends on the level of the local water table; it is rarely at ground level and can be several feet below grade.

E.3.3.1 Antenna Ground – Roof-Mount Yagi

A roof-mounted Yagi antenna should have the pipe mast grounded to the outside grounding ring with a minimum #2 AWG solid copper conductor. The Heliac cable ground kit should be connected within 1 foot of the cable entry to the building and connected to the copper conductor. A lightning surge protector is not required if the Yagi antenna is less than 10 feet above the building roof. The inside terminating connector on the antenna Heliac should be bonded to the internal ground ring.

E.3.3.2 Antenna Ground – Towers and Poles

As with all elevated metal objects, antennas will attract lightning strikes. An adequate and effective antenna ground is required for proper radiation and to minimize electrical noise and interference. On tower and pole-equipped sites, the antenna should be well grounded by means of a #2 AWG solid copper conductor connection from the tower or pole grounding element(s) to the tower/pole ground ring (see figure E-3). The tower ground system should have 5 ohms or less earth resistance and should be connected to the building ground system (see figure E-1). The transmission line should be brought off the tower or pole with the sharpest bend permitted by the manufacturer's specifications to act as a spot impedance to the extremely high strike current. The antenna cable should be grounded to the tower/pole-grounding conductor prior to the bend on its way to the building (for antenna installation, refer to the radio manual).

The messenger wire for the cable should be bonded to the tower/pole ground and the external building ground ring. The antenna cable should be grounded outside the building, within 1 foot of the building entry, to the external building ground ring via a #2 AWG solid conductor. A lightning arrester should be installed on the Heliac cable within 1 foot of the building entrance, and bonded to the internal ground ring.

Surge arrestors or a lightning protector should be installed at the point where the antenna cable enters the building or instrument case. The lightning protector should be properly grounded at the single-point chassis ground. Connectors must be weatherproofed to prevent corrosion to enable efficient grounding and a drip loop is recommended at the instrument case or bungalow.

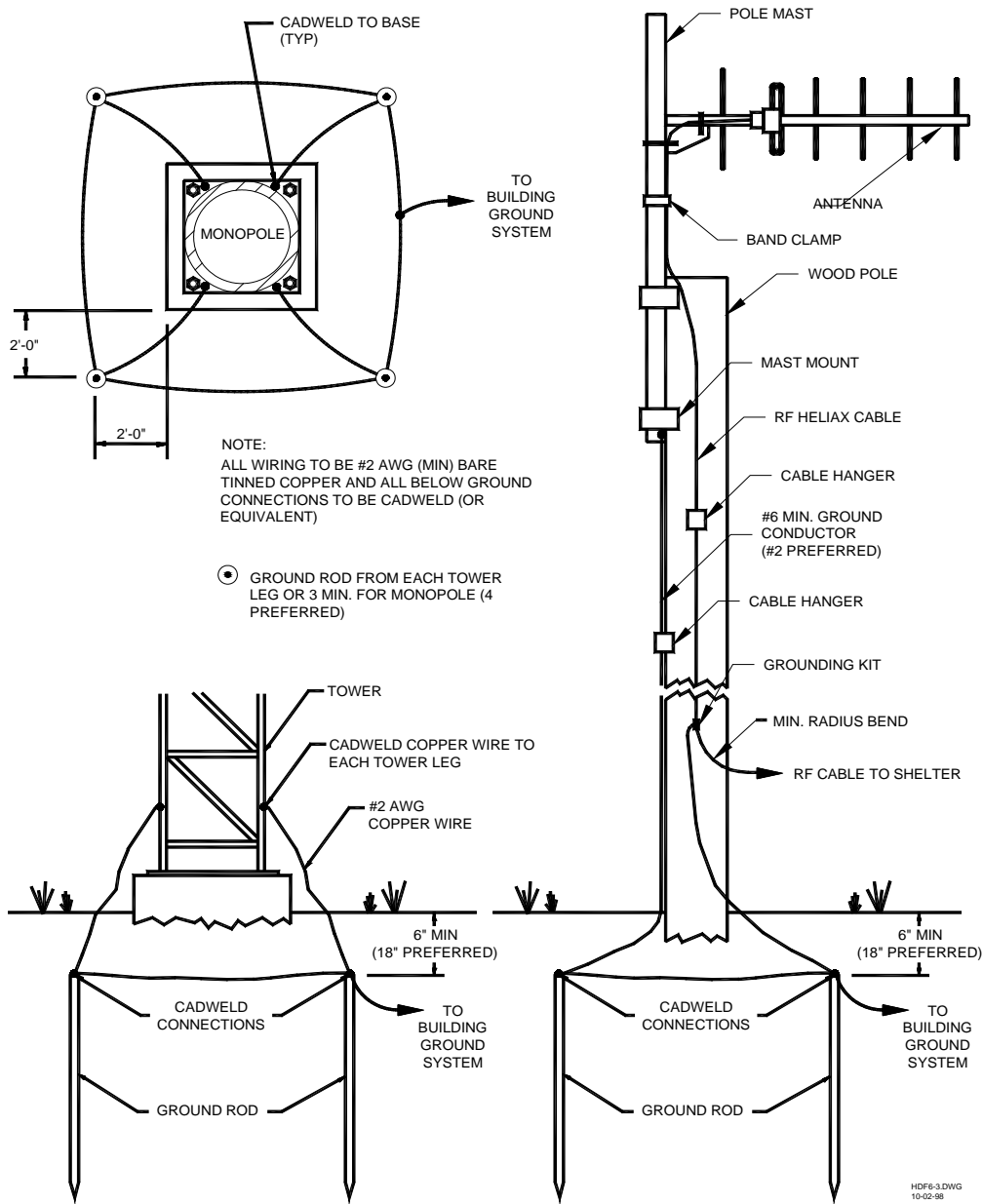
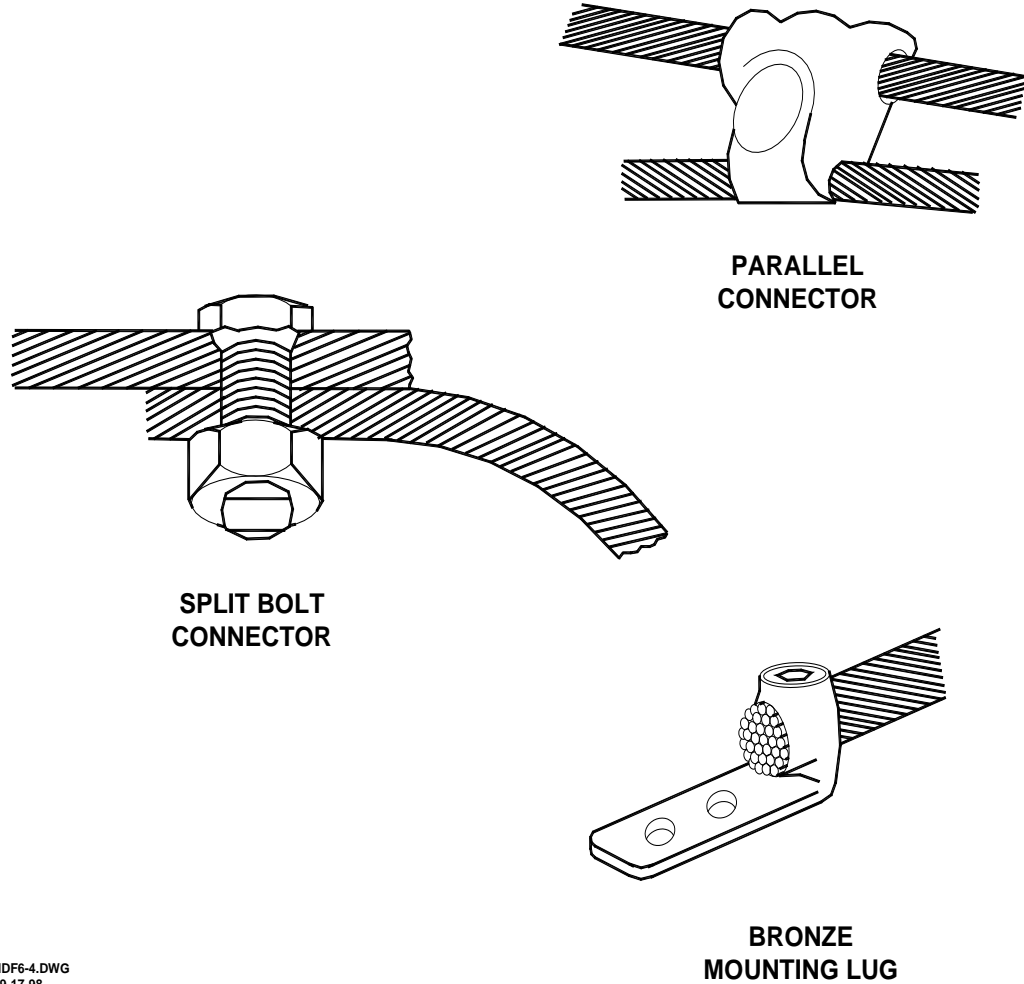


Figure E-3
Typical Tower and Pole Ground Connections



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Figure E-4
Typical Connections for Grounding and Bonding

E.3.4 AC Power Ground

AC power grounding should adhere to the standards set forth by the applicable local or regional electrical code. When bonding AC panels to the internal ground ring, the connection should be made to the outside surface of the panel (refer to figure E-4 for an illustration of a bronze mounting lug). Hydro ground electrodes should be bonded to the building ground electrodes only if they are within 6 feet of each other. A surge protector should be installed on the main electrical panel (refer to figure E-2) for any ungrounded electrical feed in or out of the building, and the connection to all air gap suppressors removed.

E.3.5 Communications Ground

All power and telephone company grounds should be made common to the communications ground. A surge arrester such as a Polyphaser™ should be installed at the point where the cable enters the building or instrument case.

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