Installation and Operation

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NOTICE

SpeedNet ME radio instruction sheets can be downloaded at **sandc.com/en/support/product-literature/**. Software can be downloaded at **sandc.com/en/support/sc-customer-portal/**. If requiring assistance, please call the S&C Global Support and Monitoring Center at 1-888-762-1100.

Qualified Persons

⚠ WARNING

Only qualified persons who are knowledgeable in the installation, operation, and maintenance of overhead and underground electric distribution equipment, along with all associated hazards, may install, operate, and maintain the equipment covered by this publication. A qualified person is someone who is trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from nonlive parts of electrical equipment
- The skills and techniques necessary to determine the proper approach distances corresponding to the voltages to which the qualified person will be exposed
- The proper use of special precautionary techniques, personal protective equipment, insulated and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment

These instructions are intended ONLY for such qualified persons. They are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

Read this Instruction Sheet

NOTICE

Thoroughly and carefully read this instruction sheet and all materials included in the product's instruction handbook before installing or operating the SpeedNet ME Mesh End-Point Radio. Familiarize yourself with the Safety Information on page 3. The latest version of this publication is available online in PDF format at **sandc.com/en/support/product-literature/**.

Retain this Instruction Sheet

This instruction sheet should be available for reference wherever a SpeedNet ME radio is to be used. Retain this instruction sheet in a location where you can easily retrieve and refer to it.

Proper Application

⚠ WARNING

The equipment in this publication is only intended for a specific application. The application must be within the ratings furnished for the equipment. Ratings for the SpeedNet ME radio are listed in the ratings table in Specification Bulletin 1074-31.

Warranty

The standard warranty contained in S&C's standard conditions of sale, as set forth in Price Sheet 150, applies to SpeedNet ME radios.

Warranty of the SpeedNet ME radio is contingent upon the installation, configuration, and use of the SpeedNet ME radio and software in accordance with S&C's applicable instruction sheets. This warranty does not apply to major components not of S&C manufacture, such as batteries, and other communication devices. However, S&C will assign to immediate purchaser or end user all manufacturers' warranties that apply to such major components.

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels and tags attached to your SpeedNet ME Mesh End-Point Radio. Familiarize yourself with these types of messages and the importance of these various signal words:

⚠ DANGER

"DANGER" identifies the most serious and immediate hazards that will likely result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ WARNING

"WARNING" identifies hazards or unsafe practices that can result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ CAUTION

"CAUTION" identifies hazards or unsafe practices that can result in minor personal injury if instructions, including recommended precautions, are not followed.

NOTICE

"NOTICE" identifies important procedures or requirements that can result in product or property damage if instructions are not followed.

Following Safety Instructions

If you do not understand any portion of this instruction sheet and need assistance, contact your nearest S&C Sales Office or S&C Authorized Distributor. Their telephone numbers are listed on S&C's website **sandc.com**, or call the S&C Global Support and Monitoring Center at 1-888-762-1100.

NOTICE

Read this instruction sheet thoroughly and carefully before installing a SpeedNet ME Mesh End-Point Radio.

Replacement Instructions and Labels

If additional copies of this instruction sheet are needed, contact your nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

It is important that any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting your nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

Before Starting

Choose a location where the SpeedNet ME radio can be securely mounted.

NOTICE

For remote antenna installations, where the antenna is not mounted directly on the control enclosure, S&C recommends installing lightning protection to avoid damaging the SpeedNet ME radio.

Network Design

SpeedNet ME radios serve as a communication end point for SCADA devices. They can connect to a SpeedNet ME radio mesh network. They can be installed in a variety of network configurations. Plan your network in advance, and develop a logical IP addressing scheme for your particular application. Depending on your network type, several factors may influence your design:

- Point-to-point vs. end-point within a mesh
- Stand-alone network connection

When network topology has been determined, the SpeedNet ME radios can be configured appropriately.

IP Basics

SpeedNet ME radios use Internet Protocol (IP) version 4, and all references to IP addresses in these installation instructions refer to IPv4 addresses. An IP address is the unique identifier for a node (host connection) on an IP network. The IP address is a 32-bit binary number, usually shown as four decimal values separated by decimal points. Each value represents 8 bits in the range 0 to 255 (known as octets), and this is called "dotted decimal" notation.

For example: 172.26.220.200 can be viewed in binary form:

172 .26 .220 .200

10 1 0 11 00.000 11 0 1 0.11 0 11100.11 00 1 000

Every IP address consists of two parts that identify the network and the node. The address class and subnet mask determine which part belongs to the network address and which part belongs to the node address.

There are five address classes. The IP address class can be determined by examining the first four bits of the IP address:

- Class A addresses begin with 0xxx, or 1 to 126 decimal.
- Class B addresses begin with 10xx, or 128 to 191 decimal.
- Class C addresses begin with 110x, or 192 to 223 decimal.
- Class D addresses begin with 1110, or 224 to 239 decimal.
- Class E addresses begin with 1111, or 240 to 254 decimal.

Addresses beginning with 01111111, or 127 decimal, are reserved for loop-back and internal testing on a local machine. This can be tested by pinging 127.0.0.1, which points to the local machine. Class D addresses are reserved for multicasting, and Class E addresses are reserved for future use and should not be used for a host address.

This is how the class determines, by default, which part of the IP address belongs to the network (N) and which part belongs to the node (n).

- Class A–NNNNNNNN.nnnnnnnn.nnnnnnnn.nnnnnnnn
- Class B–NNNNNNNN.NNNNNNNN.nnnnnnnn.nnnnnnnn
- Class C–NNNNNNNN.NNNNNNNN.NNNNNNNN.nnnnnnnn

In the example, 172.26.220.200 is a Class B address, so by default the network part of the address (known as the network address) is defined by the first two octets (172.26. x.x), and the node part is defined by the last two octets (x.x.220.200).

To specify the network address in an IP address, the node section is entered as zeros. In the example, 172.26.0.0 specifies the network address for 172.26.220.200. When the node section is set to all "1"s, it specifies a broadcast sent to all nodes on the network and is indicated as 172.26.255.255, which is the broadcast address for the example. Note that this is true for all classes, regardless of the length of the node section.

Subnet Masking

Applying a subnet mask to an IP address allows the network and node parts of the address to be identified. The network bits are represented by the "1"s in the mask, and the node bits are represented by the "0"s. Performing a bitwise logical **And** operation between the IP address and the subnet mask results in the Network Address or Number. The Network Address is also called the subnet.

For example, using the test IP address and the default Class B subnet mask, we get:

10101100.00011010.11110000.11001000 172.26.240.200
Class B IP address

11111111.11111111.00000000.00000000 255.255.000.000
Default Class B subnet mask

10101100.00011010.00000000.00000000 172.26.000.000
network address

Default subnet masks:

- Class A–255.0.0.0–
  11111111.00000000.00000000.00000000
- Class B–255.255.0.0–
  11111111.11111111.00000000.00000000
- Class C–255.255.255.0–
  11111111.11111111.11111111.00000000

Private Subnets

Three IP network addresses are reserved for private networks. The addresses are 10.0.0.0, Subnet Mask 255.0.0.0; 172.16.0.0, Subnet Mask 255.240.0.0; and 192.168.0.0, Subnet Mask 255.255.0.0. These addresses are also notated 10.0.0.0/8, 172.16.0.0/12, and 192.168.0.0/16. They can be used by anyone setting up internal IP networks, such as a lab or home LAN behind a NAT or proxy server or a router. It is always safe to use these because routers on the Internet by default will never forward packets coming from these addresses.

Subnetting an IP network can be done for a variety of reasons, including organization, use of different physical media (such as Ethernet, FDDI, WAN, etc.), preservation of address space, and security. The most common reason is to control network traffic. In a traditional unswitched Ethernet network, all nodes on a segment see all the packets transmitted by all the other nodes on that segment. Performance can be adversely affected under heavy traffic loads, because of collisions, and the resulting retransmissions. A router is used to connect IP networks to minimize the amount of traffic each segment must receive.

MAC Address

In networking, the Media Access Control (MAC) address is a unique identifier programmed into each network device. This number acts like a name for the device, and all SpeedNet ME radios have unique MAC addresses. Some devices have user-configurable MAC addresses, but the SpeedNet ME radio MAC address is configured at the factory and cannot be changed. Most protocols use MAC addresses that are globally unique, but not all protocols use MAC addresses or require they be unique.

Unlike IP addresses, MAC addresses do not have node and network sections, and a receiving node cannot determine any network information from the MAC address. The length of a MAC address is six bytes, and an IP address is four bytes long. Therefore, the MAC address cannot be represented using an IP address. So, an IP address must be mapped to its corresponding MAC address. Address Resolution Protocol (ARP) is used to locate a specific MAC address. ARP broadcasts an ARP request packet, which contains the source MAC address, the source IP address, and the destination IP address. Each node in the local network receives this packet. A node that has the specified destination IP address returns an ARP reply packet containing its MAC address to the originating host.

On broadcast networks, such as Ethernet, the MAC address allows each node to be uniquely identified and allows frames to be marked for specific nodes. It thus forms the basis of most of the layer 2 networking upon which higher OSI layer protocols are built to produce complex functioning networks. See Table 1 on page 7.

Table 1. OSI Model

	Data Unit	Layer	Function
Host IED (Intelligent Electronic Device) Layers	Data	Application	Network process to application. IntelliRupter® Fault Interrupter/ IntelliTeam® Automatic Restoration System
		Presentation	Data representation and encryption
		Session	Interhost communication
	Segments	Transport	End-to-end connections and reliability (UDP/TCP)
Media SpeedNet Layers	Packets	Network	Path determination and logical addressing (IP)
	Frames	Data Link	Physical addressing (MAC and LLC)
	Bits	Physical	Media, wireless, fiber-optics, and wire

Network Example

S&C strongly recommends use of private IP addresses when configuring a SpeedNet ME radio network. The following example of a SpeedNet ME radio network uses several private IP subnets from the 192.168.0.0 block of private addresses.

The SpeedNet ME radio network, depicted in Figure 1, contains three Ethernet segments. The first segment uses the 192.168.200.0 Class C subnet, encompassing a range of addresses from 192.168.200.1 to 192.168.200.254. The second segment uses the 192.168.201.0 Class C subnet, encompassing a range of addresses from 192.168.201.1 to 192.168.201.254. The third segment uses the 192.168.202.0 Class C subnet, encompassing a range of addresses from 192.168.202.1 to 192.168.202.254. All three radios share the 192.168.203.0 Class C subnet for their wireless interfaces. It is over this common subnet that traffic is routed between Ethernet segments.

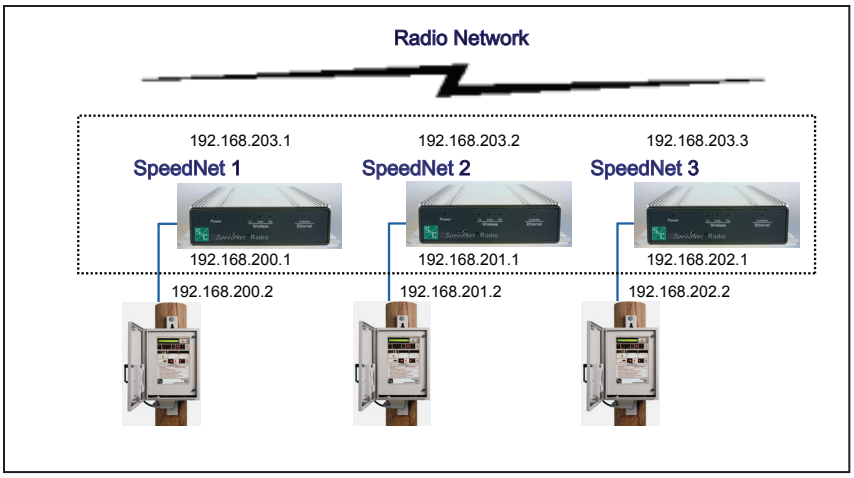


Figure 1. Multi-network using SpeedNet ME radios.

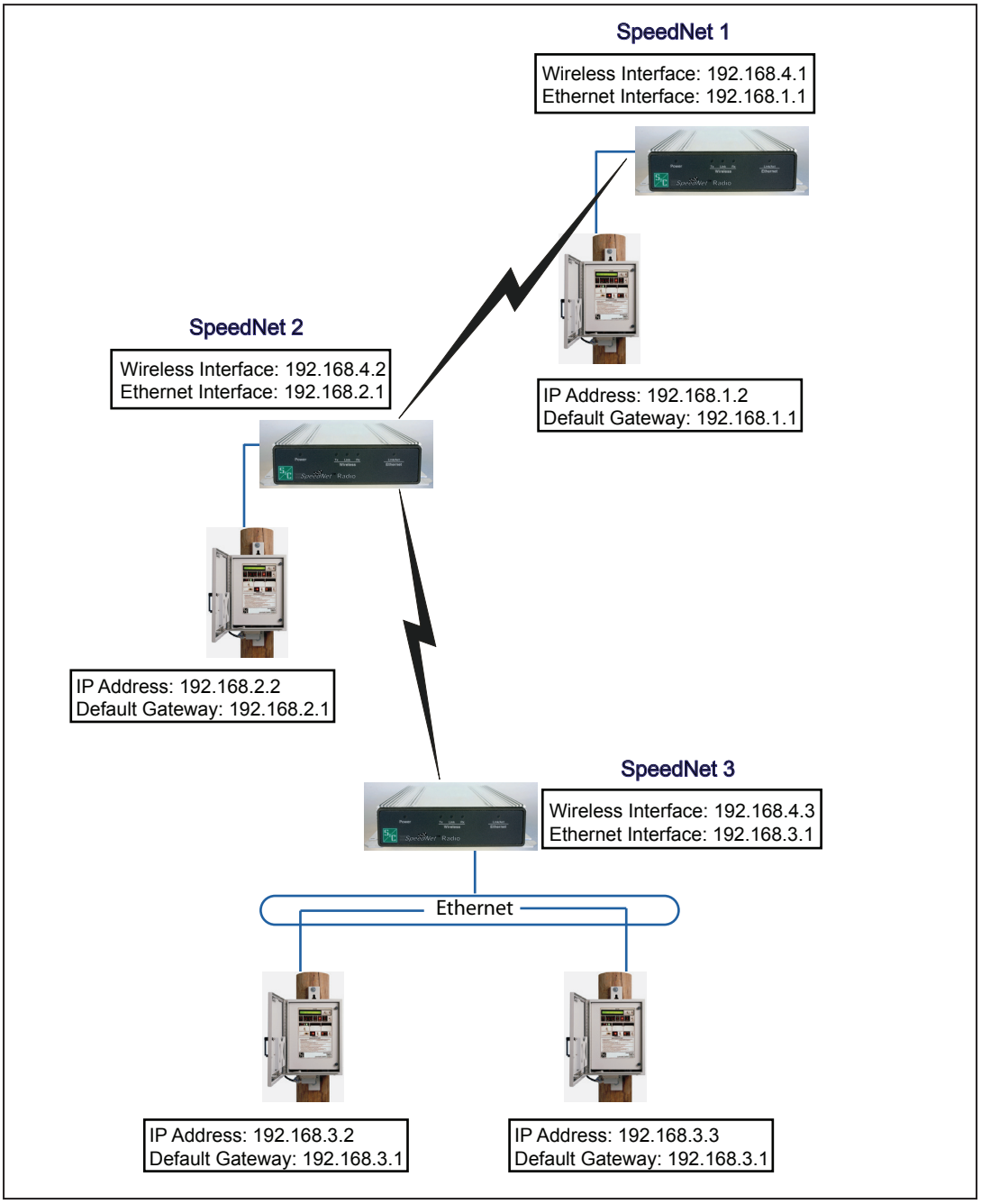


Figure 2. Wireless network using SpeedNet ME radios with AODV.

When the individual data networks are established, the IP addressing scheme should be planned. In Figure 1 on page 7. each SpeedNet ME radio host ID is "1" and each automatic switch control host ID is "2." Following a numbering scheme such as this will make it easier to keep track of which IP addresses are used for each device.

The SCADA network in this example uses the 192.168.203.0 subnet. This subnet is different than the subnets used for the Ethernet segments. The wireless interface of the SpeedNet ME radio from Subnet 1 is assigned an address of 192.168.203.1. The wireless interface of the SpeedNet ME radio from Subnet 2 is assigned an address of 192.168.203.2. The wireless interface of the SpeedNet ME radio from Subnet 3 is assigned an address of 192.168.203.3.

It would be helpful to draw a diagram as a planning aid and reference guide when designing the SCADA network.

Routing Options

The SpeedNet ME Mesh End-Point Radio is an end-node radio and does not participate in building the mesh network. It does however, connect to a SpeedNet Radio mesh network capable of providing secure, long-range communication with high message rates. SpeedNet ME radios provide a point-to-point wireless connection between two or more separate Ethernet subnets. Data are then routed between the Ethernet subnets. Route information can be entered manually, or it can be processed automatically by Ad hoc On-demand Distance Vector (AODV). See Figure 2 on page 8 for an example of a wireless network using SpeedNet ME radios with AODV. AODV routing is a routing protocol for mobile ad hoc networks and other wireless ad hoc networks. SpeedNet ME radios use a proprietary AODV routing system that works dynamically to maintain message routing. It generates fewer transmissions and conserves network capacity. In the case of SpeedNet ME radios, AODV will be limited to discovering and establishing the best possible point-to-point link. SpeedNet ME radios will not serve as message relays for other nodes in the network.

Using Static Routes

The routing mode to use (static routes vs. AODV) will be determined by the present configuration of the network with respect to roting mode (whether it is using static routes or AODV). The radios do not support a mixture of static routes and AODV routing. See Figure 3.

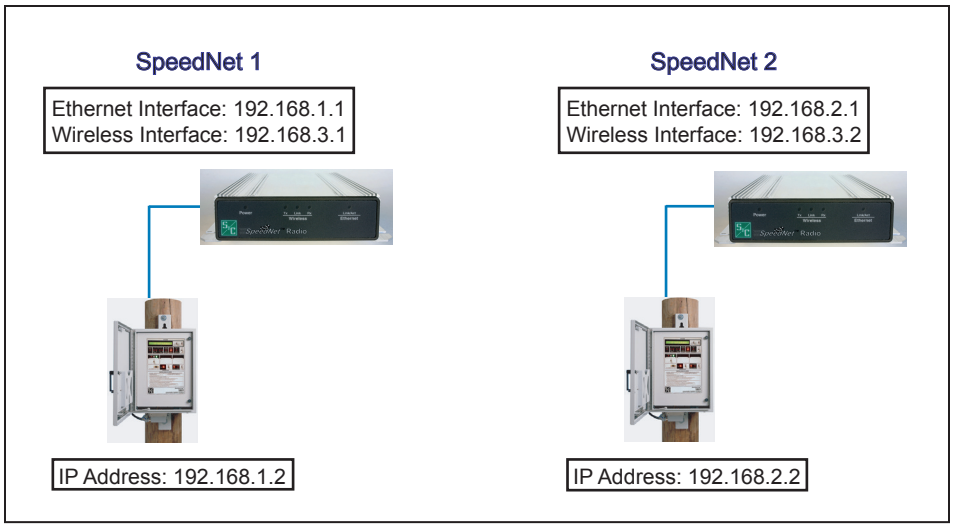


Figure 3. Wireless network using SpeedNet ME radios with static routes.

To route traffic between subnets, several things must happen. First, all hosts on a given subnet must use the attached SpeedNet ME radio as their default gateway. As an alternative, manual routes can be entered in each host's routing table. Hosts from Subnet 1 will list 192.168.1.1 as their default gateway. If AODV is disabled and static routing is used, it is necessary to add static routes in each SpeedNet ME radio. The SpeedNet ME radio from Subnet 1 must have a static route to Subnet 2, using the SpeedNet ME radio from Subnet 2 as the gateway. The route should be set up like this:

192.168.2.0	255.255.255.0	192.168.3.2
Network	Netmask	Gateway

All hosts from Subnet 2 should use 192.168.2.1 as their default gateway. As an alternative, manual routes can be entered in each host's routing table. The SpeedNet ME radio from Subnet 2 must have a static route to Subnet 1, using the SpeedNet ME radio from Subnet 1 as the gateway. This route should be set up like this:

192.168.1.0	255.255.255.0	192.168.3.1
Network	Netmask	Gateway

NOTICE

It is important to understand there are actually three subnets in this example: Subnet 1, Subnet 2, and the radio network.

It is also important that all radio wireless IP addresses should be on the same subnet, while all radio Ethernet IP addresses should be on different, non-overlapping subnets. Otherwise, the radios will not be able to communicate with each other.

FCC Warning

This device must be professionally installed. It is the responsibility of the installer to ensure that proper antenna and cable combinations are used in order to remain within FCC Part 15 limits.

The SpeedNet ME radio is specifically designed to close the longest possible links. This goal is accomplished in part by delivering the highest permissible RF output power to the antenna per the FCC Part 15 Rules. In August 1996, the FCC adopted RF exposure guidelines that established safety levels for various categories of wireless transceivers. Those limits are consistent with safety standards previously published by the National Council on Radiation Protection (NCRP) Report 86, §17.4.1, §17.4.1.1, §17.4.2, and §17.4.3 as well as the American National Standards Institute (ANSI) in §4.1 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 30 GHz," ANSI/IEEE C95.1-1992.

The SpeedNet ME radio complies with these FCC exposure guidelines when the following precautions are obeyed:

- One of the exact antennas recommended in this instruction sheet is installed.
- The cable run for the selected antenna exceeds the minimum length quoted in this instruction sheet.
- All persons maintain a minimum separation of 12 inches (30.48 cm) from the SpeedNet ME radio antenna

Disconnect the ac/dc input power source from the SpeedNet ME radio whenever repositioning the antenna. You are responsible for taking the necessary steps to ensure these guidelines are communicated to all persons that may come near the SpeedNet ME radio antenna.

Antenna Requirements

SpeedNet ME radios have been designed to operate with the antennas listed below, having a maximum gain of 3 dBd (5.15 dBi) or 10 dBd (12.15 dBi) respectively and an impedance of 50 ohms:

- Omni-directional fiberglass antenna: Antenex FG9023 or equivalent, 3 dBd (5.15 dBi)
- Uni-directional Yagi antenna: Kathrein TY-900 or equivalent, 10 dBd (12.15 dBi)

To reduce potential radio interference to other users, the antenna type and its gain should be chosen so the equivalent isotropically radiated power (EIRP) is not more than permitted for successful communication.

Antenna/Cable Requirements

Antennas for SpeedNet ME radios must be installed by a qualified radio technician to comply with FCC Part 15 radiated power limits. Only antennas supplied by S&C Electric Company may be used with the SpeedNet ME radio.

The FCC mandates that Effective Isotropic Radiated Power (EIRP) may not exceed +36 dBm. This is equivalent to a radio running at full output power (1 watt +30 dBm) with a +6 dBi antenna. The antenna cable must have sufficient loss to bring the EIRP below +36 dBm if a higher-gain antenna is used. For example, using a +8 dBi antenna with a radio transmitting at full power would result in an EIRP of +38 dBm. In this situation, the antenna cable must provide at least 2 dB loss to bring the EIRP into compliance. SpeedNet ME radios have configurable transmit power that can be selected using the SpeedNet ME radio client tool or by using the IntelliTeam® CNMS Communication Network Management System. Settings of +30 dBm (default), +25 dBm, and +10 dBm are available. Any confirmed decrease in output power should be considered when calculating ERIP.

Tables 2 and 3, and Tables 4 and 5 on page 12 show the amount of loss incurred with several common antenna cables.

Table 2. Antenna Cable Loss

Cable Type	Loss per 100 Feet of Cable
LMR-400	3.9 dB
-600	2.5 dB
LMR-900	1.7 dB

Table 3. Antenna Cable Loss Examples with LMR-400 Cable①

Antenna Gain	Length/Loss	ERP
+8.2 dBi	60 feet (18 m)/2.3 dB loss	+36.0 dBm
+10.2 dBi	110 feet (34 m)/4.3 dB loss	+36.0 dBm
+12.1 dBi	160 feet (49 m)/6.2 dB loss	+36.0 dBm

① Assuming 1-watt output power from the SpeedNet ME radio.

Table 4. Antenna/Cable Loss Examples with LMR-600 Cable①

Antenna Gain	Length/Loss	ERP
+8.2 dBi	90 feet (27 m)/2.3 dB loss	+36.0 dBm
+10.2 dBi	170 feet (52 m)/4.3 dB loss	+36.0 dBm
+12.1 dBi	245 feet (75 m)/6.1 dB loss	+36.0 dBm

①Assuming 1-watt output power from the SpeedNet ME radio.

Table 5. Antenna Cable Loss Examples with LMR-900 Cable①

Antenna Gain	Length/Loss	ERP
+8.2 dBi	135 feet (41 m)/2.3 dB loss	+35.9 dBm
+10.2 dBi	250 feet (76 m)/4.3 dB loss	+36.0 dBm
+12.1 dBi	310 feet (94 m)/5.3 dB loss	+35.9 dBm

①Assuming 1-watt output power from the SpeedNet ME radio.

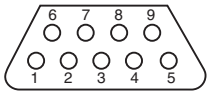
If using a different type of cable, verify cable loss prior to installation. See Table 6.

Table 6. Attenuation Chart

	Nominal Attenuation Frequency in MHz dB/100 feet								
Cable Type	10 MHz	30 MHz	50 MHz	150 MHz	220 MHz	450 MHz	900 MHz	1.2 GHz	2.4 GHz
100 Series	2.3	3.9	5.1	8.9	10.9	15.8	22.8	26.7	38.9
195 Series	1.1	2.0	2.5	4.4	5.4	7.8	11.1	12.9	18.6
240 Series	0.8	1.3	1.7	3.0	3.7	5.3	7.6	8.8	12.7
400 Series	0.4	0.7	0.9	1.5	1.9	2.7	3.9	4.5	6.6
600 Series	0.2	0.4	0.5	1.0	1.2	1.7	2.5	2.9	4.3
LMR-400-UF	0.5	0.8	1.1	1.8	2.2	3.3	4.7	5.5	7.9
RG142/U									
RG213/U	0.6	1.2	1.5	2.8	x	5.2	7.3	x	x
RG214/U	0.6	0.9	1.3	2.3	x	4.5	7.3	x	x
RG223/U	1.2	2.0	2.8	5.0	x	9.8	13.4	x	x
RG316/U									
RG393/U									
RG58A/U	1.5	2.6	3.3	6.8	x	12.6	21.0	x	x
RG8/U (CXP1318FX)	0.5	0.8	1.1	1.8	2.2	3.3	4.7	5.5	7.9
RG8X-Mini	1.0	2.0	2.3	4.7	x	8.6	13.0	x	x

Interface Pinouts

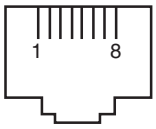
The RS-232 Interface of the SpeedNet ME radio is configured as Data Communications Equipment (DCE). See Figure 4.



Pin	Function	Description
1	NC	No connection
2	TXD	RS-232 transmit
3	RXD	RS-232 receive
4	NC	No connection
5	GND	Signal ground
6	NC	No connection
7	CTS	Clear to send
8	RTS	Request to send
9	NC	No connection

Figure 4. SpeedNet ME radio RS-232 interface pinout.

The SpeedNet ME radio Ethernet interface uses an RJ-45 connector with the pinout shown in Figure 5. The Ethernet port is on the rear panel of the SpeedNet ME radio. It is auto-sensing for assignment of transmit and receive lines (no crossover cables required) and auto-negotiates for a 10-Mbps or 100-Mbps data rate as required by the connected device.



Pin	Function	Description
1	TXD+	Transmit
2	TXD-	Transmit
3	RXD+	Receive
4	NC	No connection
5	NC	No connection
6	RXD-	Receive
7	NC	No connection
8	NC	No connection

Figure 5. SpeedNet ME radio Ethernet RJ-45 interface pinout.

Cable Installation

Complete the following steps when connecting cables:

STEP 1. Connect the antenna to the SpeedNet ME radio.

STEP 2. Connect the Ethernet cable to the SpeedNet ME radio and PC used for configuration.

STEP 3. Connect the power supply to the SpeedNet ME radio.

Regulatory and Compliance Statements:

This document contains statements required for compliance with the rules and policies of various national and international regulatory agencies.

United States of America – FCC (Federal Communication Commission)

This device complies with part 15 of the FCC rules and regulations regarding unlicensed transmissions. Operation is subject to the following two conditions: (1) This device may not cause harmful interference and (2) this device must accept any interference.

The changes or modifications not expressly approved by the S&C Electric Company could void the user's authority to operate the equipment.

Note: This equipment 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 own expense.

Canada – ISED (Innovation, Science & Economic Development Canada)

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme aux normes Industry Canada exemptes de licence RSS standard(s). Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable.

The changes or modifications not expressly approved by the S&C Electric Company could void the user's authority to operate the equipment.

CAN ICES-3 (A)/NMB-3(A)

Australia/New Zealand (ACMA)

The above-mentioned product complies with the requirements of the relevant ACMA Standards made under the Radiocommunications Act 1992 and the Telecommunications Act 1997. These standards are referenced in notices made under section 182 of the Radiocommunications Act and 407 of the Telecommunications Act.

Brazil (ANATEL):

Atendimento à Regulamentação Anatel

Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados.

Para maiores informações, consulte o site da ANATEL, www.gov.br/anatel/pt-br.