

Meter Engineers
Handbook
for Cellular
Communication

DIGI 



Introduction

When Digi began serving the utility industry, Dire Straits “Money for Nothing” topped the Billboard charts, the first cell phone was hitting the market (weight: 1.3lbs, talk time: 1hr) and Ronald Reagan was president.

We’ve come a long way since 1985, but the qualities that we started with—dedicated engineering, responsive tech support and an industry-leading warranty—are the same qualities that allow us to continue serving the largest investor owned utilities as well as the smallest rural electric cooperatives.

On the following pages we provide information on connecting common C&I meters with Digi TransPort® 3G and 4G LTE cellular routers, as well as information on installation, cabling and antennas.

Special thanks are due to Digi customers in meter shops across the world. Thank you for sharing what you’ve learned as you have used Digi product in the field.

We’ve enjoyed writing this guide and we hope you’ll find it useful. If you notice anything outdated or think of something to add, please send us an email.

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1

Cellular Communications for Commercial and Industrial Metering

Flexible and secure cellular routers connect remote C&I meters with a utility’s meter data management system for accurate billing and planning.

The utilities business is challenged from every angle to be increasingly productive and profitable. The very nature of managing remote equipment in many locations can be difficult and expensive, and maximizing uptime while reducing costs is often a requirement. Meter shops face a growing set of demands: more accurate and timely billing, increased support for dispute resolution, measurement of power quality and reactive power, and support for measuring the cost of power delivery. To meet these demands, metering professionals need a cellular router that:

- Supports multiple Ethernet and serial devices
- Can be preconfigured for easy installation by field technicians
- Is certified on Sprint, Verizon, AT&T, Rogers and Telus
- Offers the high security features required by NERC/CIP

Digi TransPort® routers fit the bill. They are secure (dynamic routing, VPN and firewall support), carrier-agile (supporting Sprint, Verizon and AT&T on one platform) and flexible (with Ethernet, RS232/485, GPS, USB and analog/digital IO). Learn more at www.digi.com/transport.

Digi’s Solutions for the Utility Industry

Problem	Solution
“Under the glass” cellular-enabled meters can’t be moved to improve reception.	Digi TransPort routers offer several mounting and antenna options.
Meter shops must support a mix of new and legacy equipment with diverse protocols and physical interfaces.	Digi TransPort cellular routers have Ethernet and serial ports, proven compatibility with common MDM systems and support for DNP and Modbus.
No way to confirm proper communication between a meter and router.	Digi TransPort routers can be pre-configured to double check communication and green light the installation.
Complicated installations require training and documentation.	Pre-assembled, weatherproof Utility Communication Hub simplifies installation.
Expensive and complicated to support a piecemeal solution with products from many vendors.	Digi offers a single source for all warranty and support concerning the Utility Communication Hub.

2

Initial Setup and Configuration for Digi TransPort® WR21, WR41 and WR44

2.1 Common Digi TransPort Setup Procedures for all Meter Types

PRE-CONFIGURATION OF DIGI TRANSPORT

Required equipment for this configuration:

- Digi TransPort WR21, WR41 or WR44
- Computer or laptop
- Ethernet cable
- SIM and data plan purchased from a carrier (Verizon, ATT, etc.)

CONNECTING TO THE CARRIER

- Insert the SIM into SIM 1 slot on the front of the Digi TransPort and screw on both WWAN antennas.
- Connect the Ethernet cable to port 0 of the Digi TransPort (some models only have one Ethernet port).
- Connect the Ethernet cable to the laptop.
- Power on the Digi TransPort.
- Open a browser on the laptop; i.e., Internet Explorer, Firefox, Chrome, etc.
- In the URL window type **192.168.1.1**. The default configuration of the Digi TransPort has the DHCP turned on so the laptop will be given an IP address automatically. The built in WebUI of the router should now be displayed (see section 1.2 for common problems if you aren't able to connect).
- When the login screen comes up, type in the username and password. The default username and password is **username** and **password** (all lower case). After login you will go immediately to the **Home** screen.
- On the menus to the left, just below the **Home** option, you will see the **Wizards** option. Click on **Wizards** and then choose the **Carrier Switching Wizard**. Follow the directions in the **Wizard** and pick whichever carrier you've chosen.
 - If you are using **Verizon** there is nothing else to do. It might take 10-15 minutes but the Digi TransPort will self register and populate its APN.
 - If you are using **AT&T** (and some others) then an APN must be manually entered here: **Configuration-Network>Interfaces>Mobile**. Click on the button to **Use custom APN instead of built-in APN** and enter the APN (Check with your carrier as to what APN your particular SIM uses, some common ones for AT&T are **broadband**, **INTERNET** and **i2gold**). It may take 10-15 minutes for the Digi TransPort to register.

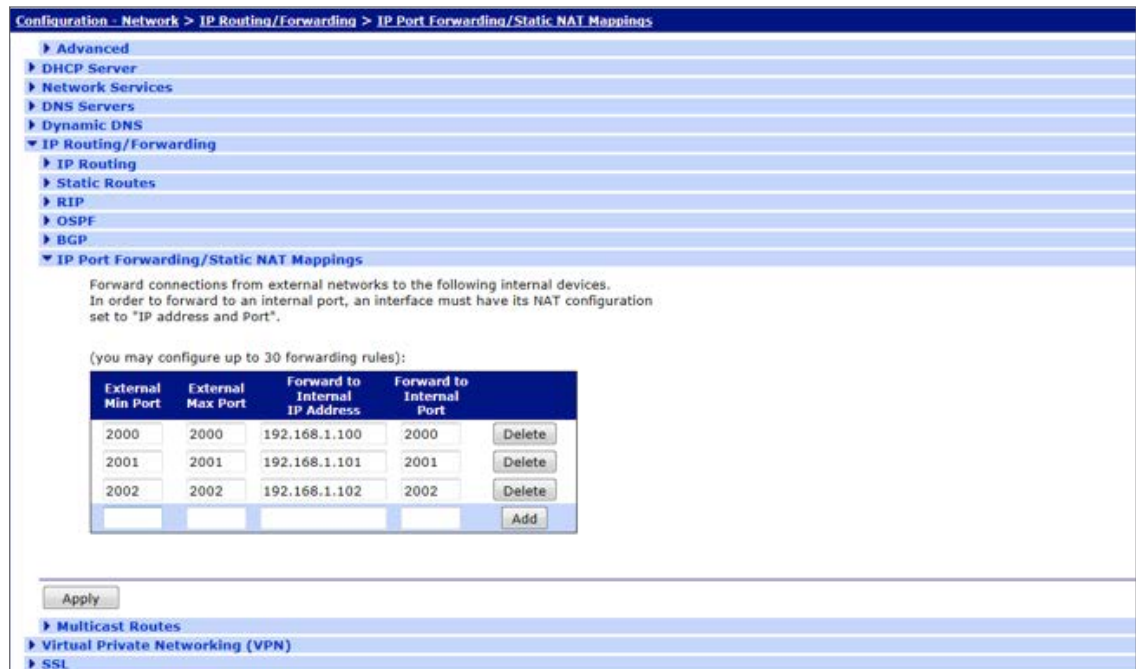
3 Connecting the Digi Transport to Common Electric Meters

3.1 Common Problems when Connecting to a Digi TransPort via the Ethernet Cable

- Turn off the Wi-Fi on the laptop before connecting the Ethernet cable to the Digi TransPort. The Wi-Fi DHCP could also be using the 192.168.1.X network.
- You may need to release your old IP address in order to acquire a new one from the Digi TransPort. On a Microsoft Windows system you can do this by going to the command line (Start->Run->cmd) and entering `ipconfig /release` followed by `ipconfig /renew`.

3.2 Connecting the Digi TransPort to Ethernet Capable Meters (All Meter Types)

- In the Digi TransPort WebUI go to **Configuration-Network > IP Routing/Forwarding > IP Port Forwarding/Static NAT Mappings**. This is where you will define where to redirect the communications from the head-end server. Note that each meter IP and Port must be known. A typical configuration is below (IP addresses and Ports may differ depending on how the meter is set up):



- After entering each rule hit the **Add** button. When finished hit the **Apply** button and then click on the **Save here** button when it pops up. Hit the **Save All** button when the new window pops up.

- When using **Static NAT Mappings** the IP and Port on the cellular interface must be enabled. By default only the IP port is NAT'd. Go here in the WebUI of the Digi TransPort: **Configuration-Network>Interfaces>Advanced>PPP 1**. Scroll down to the checked box **Enable NAT on this interface** and check the circle for **IP address and Port**. Click on the **Apply** button and **Save All**.

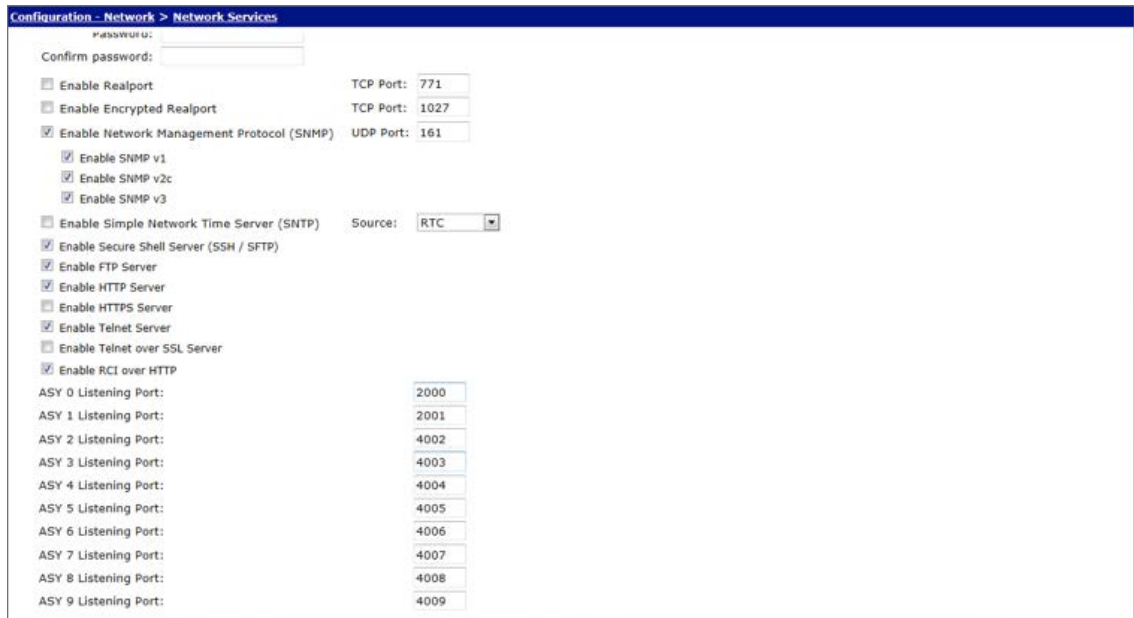
3.3 Connecting the Digi TransPort (WR21 Model Only) to Serial Meters

- Most meters come equipped with RS-232/485 ports to enable communications. The Digi TransPort WR21 serial port can be configured for either RS-232 or RS-485.
- The Digi TransPort WR21 comes defaulted for RS-232 communication (115200 baud, Hardware flow control, 8,n,1). To change these parameters go here in the Digi TransPort WR21 WebUI: **Configuration-Network>Interfaces>Serial>Serial Port 0**. Check the user manual for the particular meter you're connecting too to see what these settings should be. Here is the pinout of the RS-232 port:

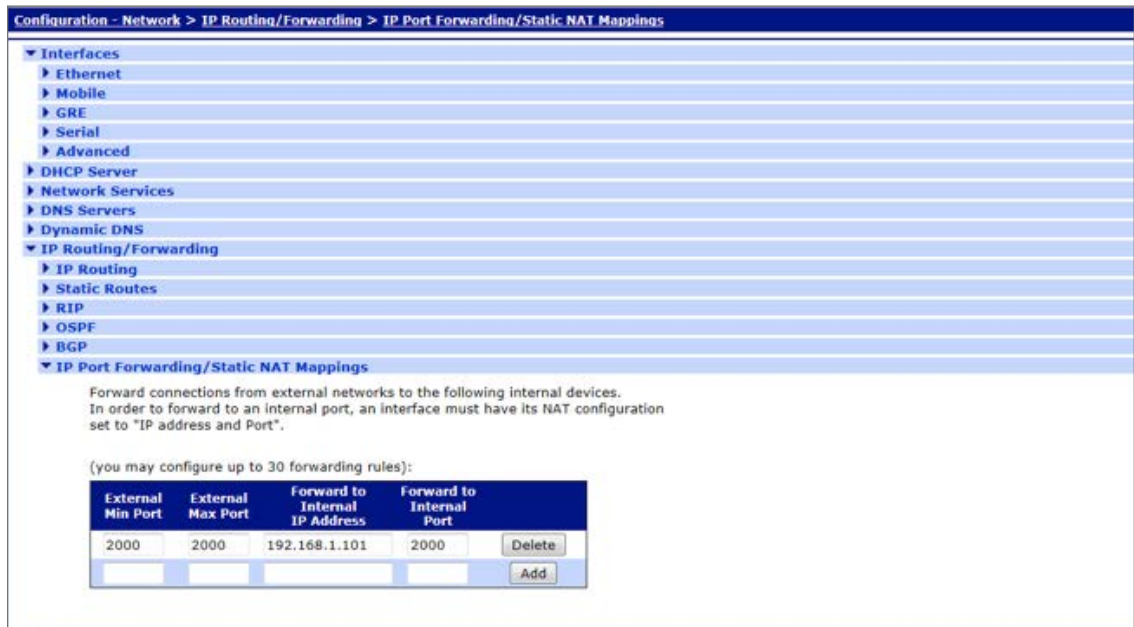
RS-232 Port Pinout

Pin #	Direction	RS-232 DCE	Description
1	Out	DCD	Data Carrier Detect
2	Out	RXD	Receive Data
3	In	TXD	Transmit Data
4	In	DTR	Data Terminal Ready
5	N/A	GND	Ground
6	Out	DSR	Data Set Ready
7	In	RTS	Ready To Send
8	Out	CTS	Clear To Send
9	Out	RI	Ring Indicate

- The serial port needs to be set up as a 'Port' the Digi TransPort WR21 can forward too. To do this go here in the Digi TransPort WR21 WebUI: **Configuration-Network>Network Services**. In the **ASY 0 Listening Port:** window type in the port you want to use. By default this is port 4000 and it can be left as port 4000. In the following example it's been changed to port 2000:



- Now redirect incoming communications to this port by using the port forwarding rules. Go here in the WebUI: **Configuration-Network>IP Routing/Forwarding>IP Port Forwarding/Static NAT Mappings**. Add the rule to forward to the serial port as below.



- Ensure that NAT'ing is applied on both IP address and Port by going here: **Configuration-Network>Interfaces>Advanced>PPP 0**. Make sure the **IP Address and Port** circle is checked under the **Enable NAT on this interface** check box.

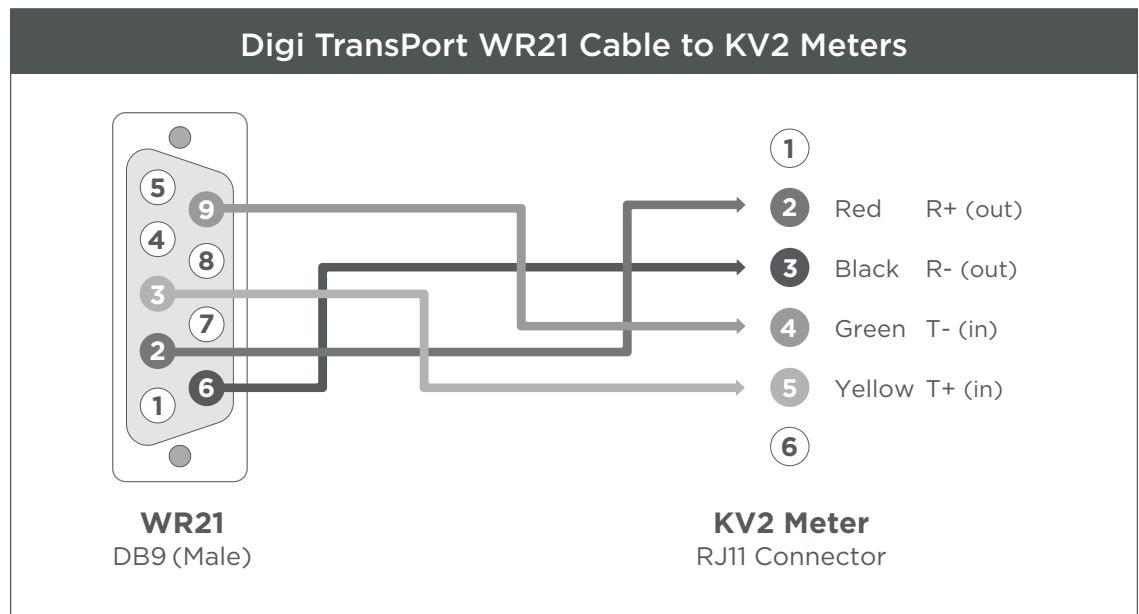
3.4 Connecting the Digi TransPort WR21 to RS-485 Meters

- Similar to the RS-232 instructions, set up the Listening Port and the Port Forwarding rules and ensure the **IP Address and Port** are enabled for PPP 1 interface. For pinouts from the various types of meters to the DB9 of the Digi TransPort WR21 see below in section 4.
- The DB9 of the Digi TransPort WR21 is software selectable for either RS-232 or RS-485. To configure it for RS-485 communication, go here in the WebUI: **Configuration-Network>Interfaces>Serial>Serial Port 0**. Drop the **Advanced** tab down and in the **Async Mode:** box select RS-485. Terminating resistors are software selectable if needed, there is no need to put external terminating resistors in place.

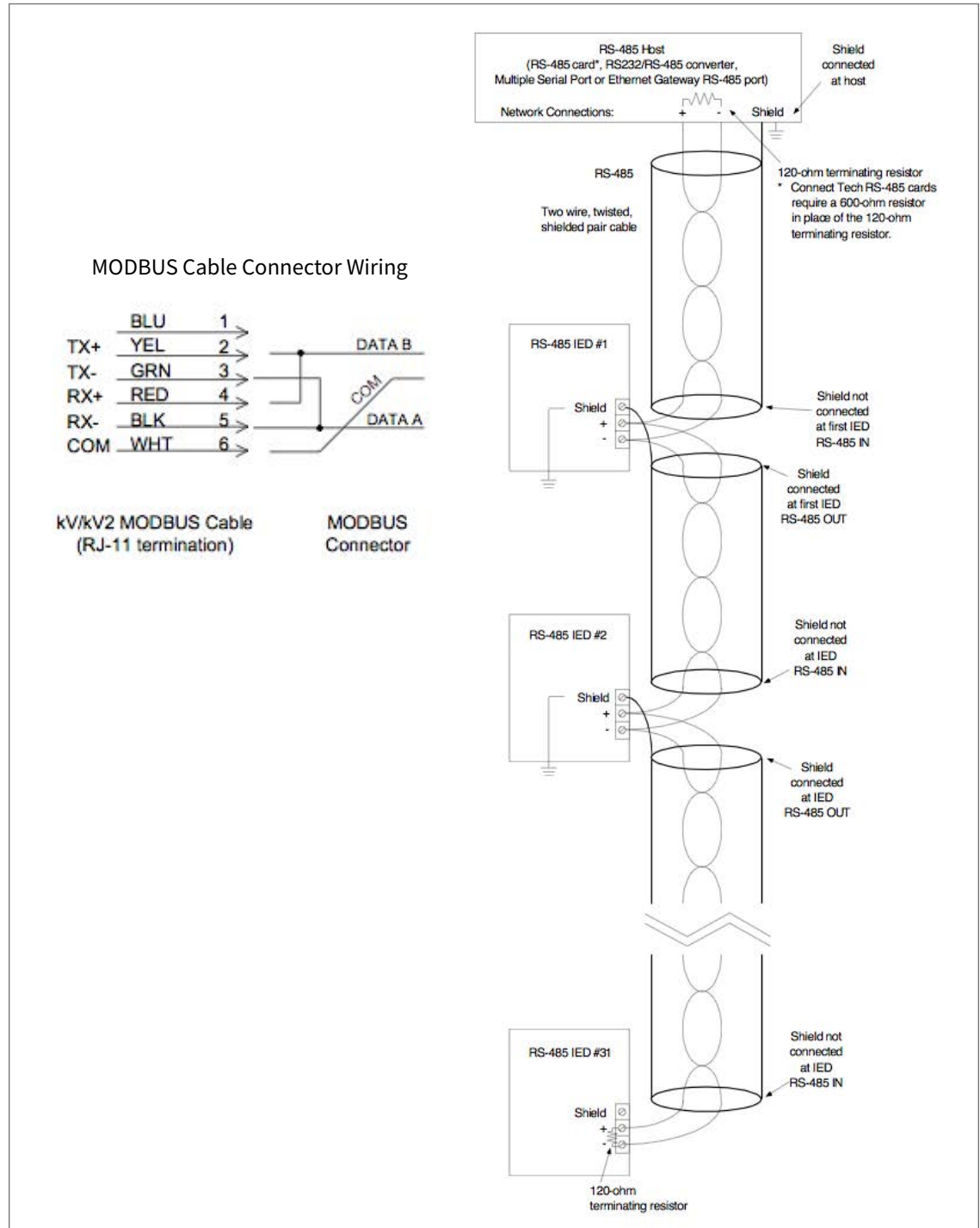
4 Pinouts of Various Meter Types

4.1 GE KV2C Meters

Cable Pinouts to Connect KV2 Meters to Digi TransPort WR21



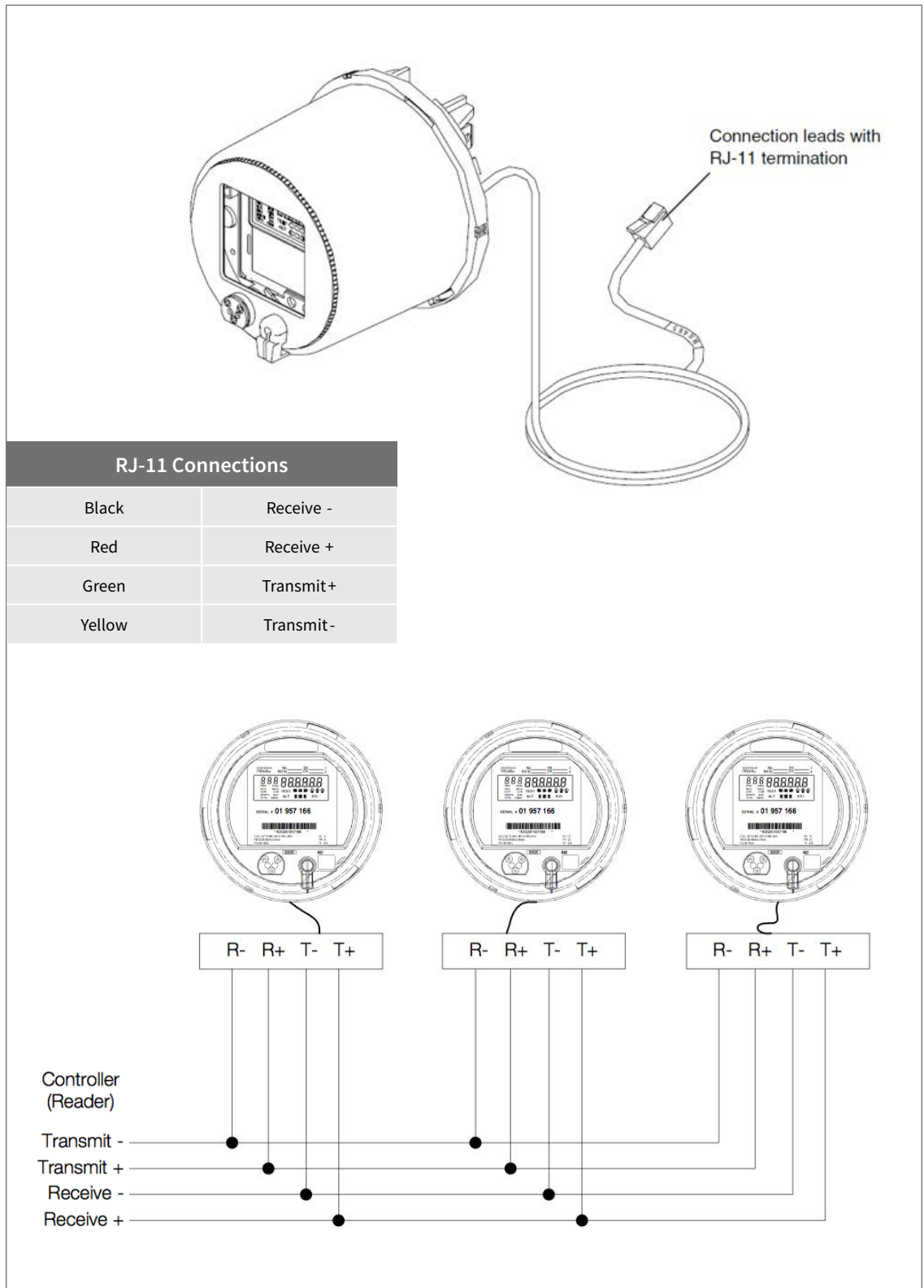
Terminating resistors are only needed at the last meter if multiple meters are connected. A non-terminating resistor is needed at the Digi TransPort WR21.



Modbus Communications Option document. GEH-7282. Pgs. 43, 46

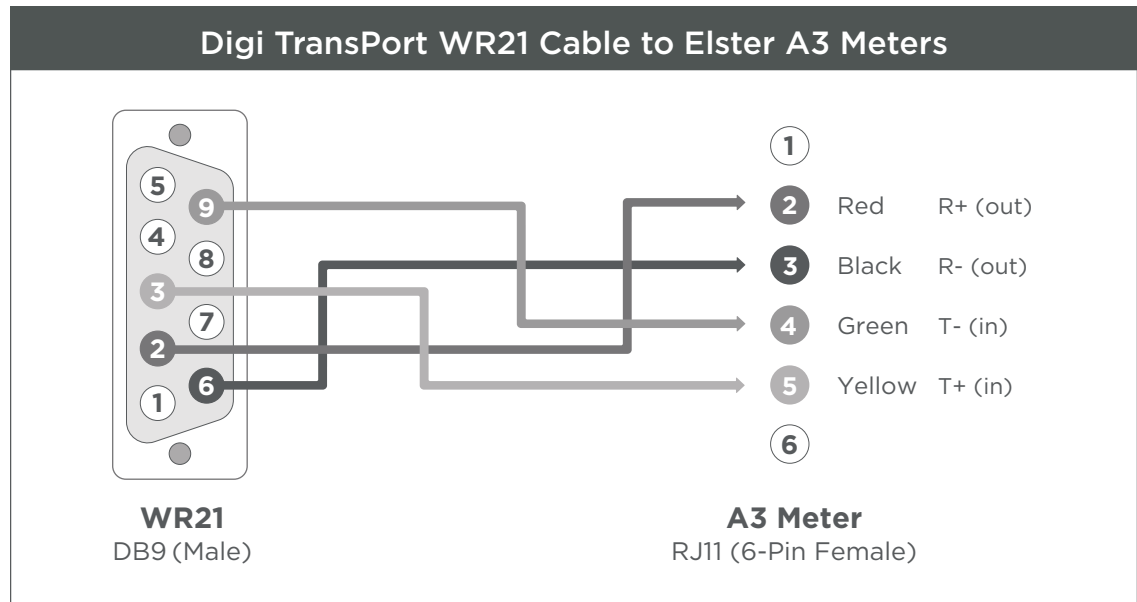
4.2 Elster A3 Meters

Requires optional RS-485 communications board.



Modbus Communications Option document. IL42-4009D. Pgs. 2, 3

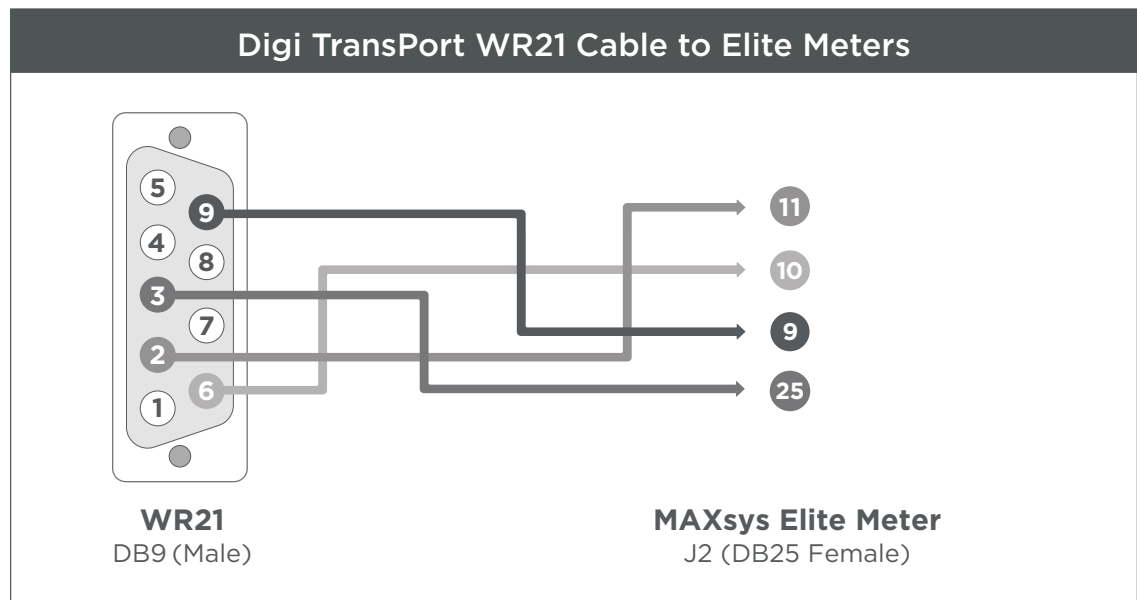
Cable Pinouts to Connect Elster A3 Meters to the Digi TransPort WR21 RS-485 Serial Port



4.3 Landis and Gyr MAXsys Elite Meters

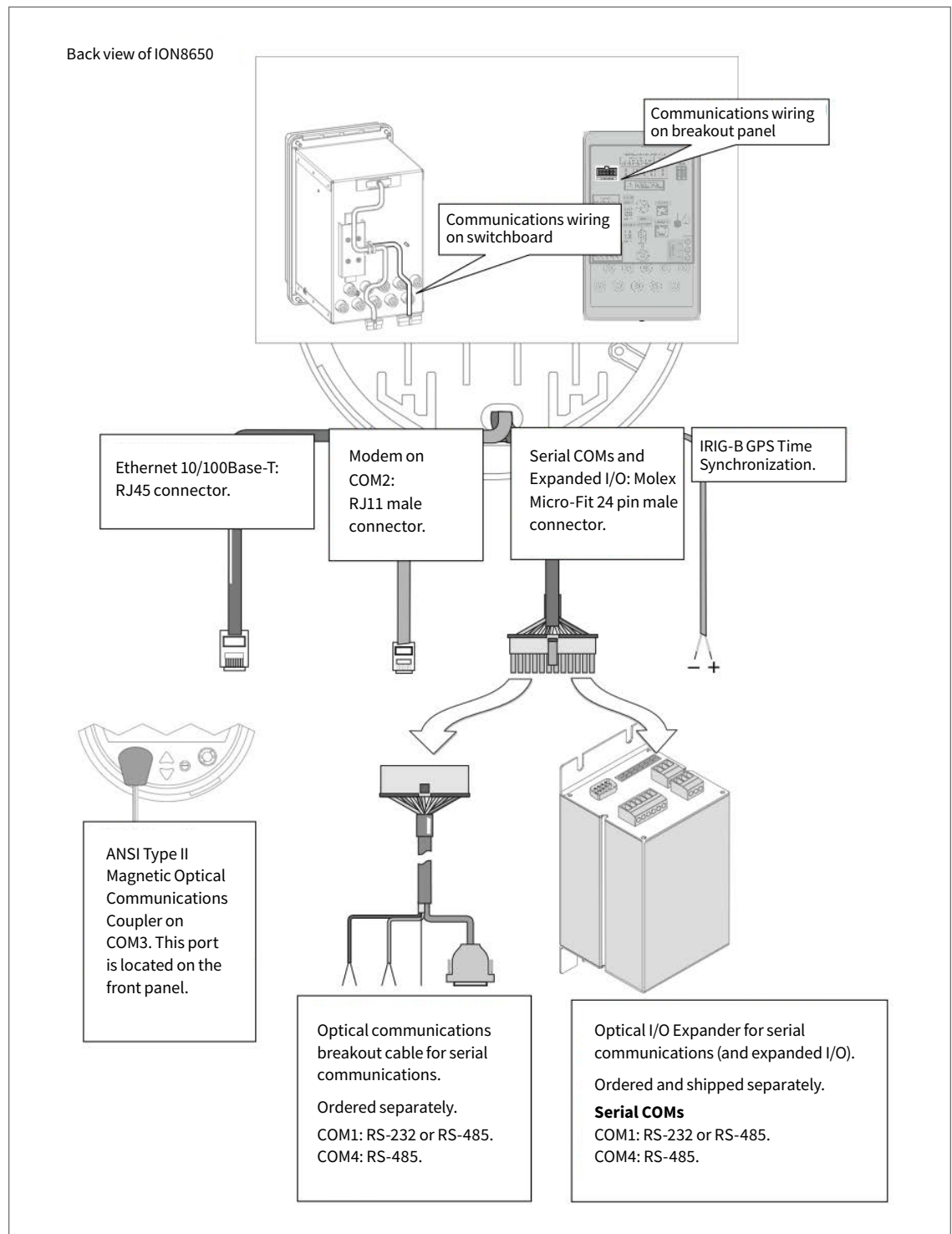
Meter Pinouts RS-232-2,3,4 & RS-485 (J2) DB25 Pinout

<p>Pin 1 NC</p> <p>Pin 2 TX RS-232-2</p> <p>Pin 3 RX RS-232-2</p> <p>Pin 4 NC</p> <p>Pin 5 CL +</p> <p>Pin 6 NC</p> <p>Pin 7 Gnd</p> <p>Pin 8 NC</p>	<p>Pin 9 CTS RS-232-3/485A_IN-</p> <p>Pin 10 *TX RS-232-3/485A_OUT-</p> <p>Pin 11 *RTS RS-232-3/485A_OUT+</p> <p>Pin 12 NC</p> <p>Pin 25 RX RS-232-3/485A_IN+</p> <p>Pin 13 CTS RS-232-4/485B_IN-</p> <p>Pin 14 *TX RS-232-4/485B_OUT-</p> <p>Pin 15 Gnd</p> <p>Pin 16 RX RS-232-4/485B_IN+</p>	<p>Pin 17 CL -</p> <p>Pin 18 Gnd</p> <p>Pin 19 *RTS RS-232-4/485B_OUT+</p> <p>Pin 20 NC</p> <p>Pin 21 R13</p> <p>Pin 22 NC</p> <p>Pin 23 NC</p> <p>Pin 24 NC</p> <p style="text-align: right;"><i>* Used for RS-485 (2-Wire)</i></p>
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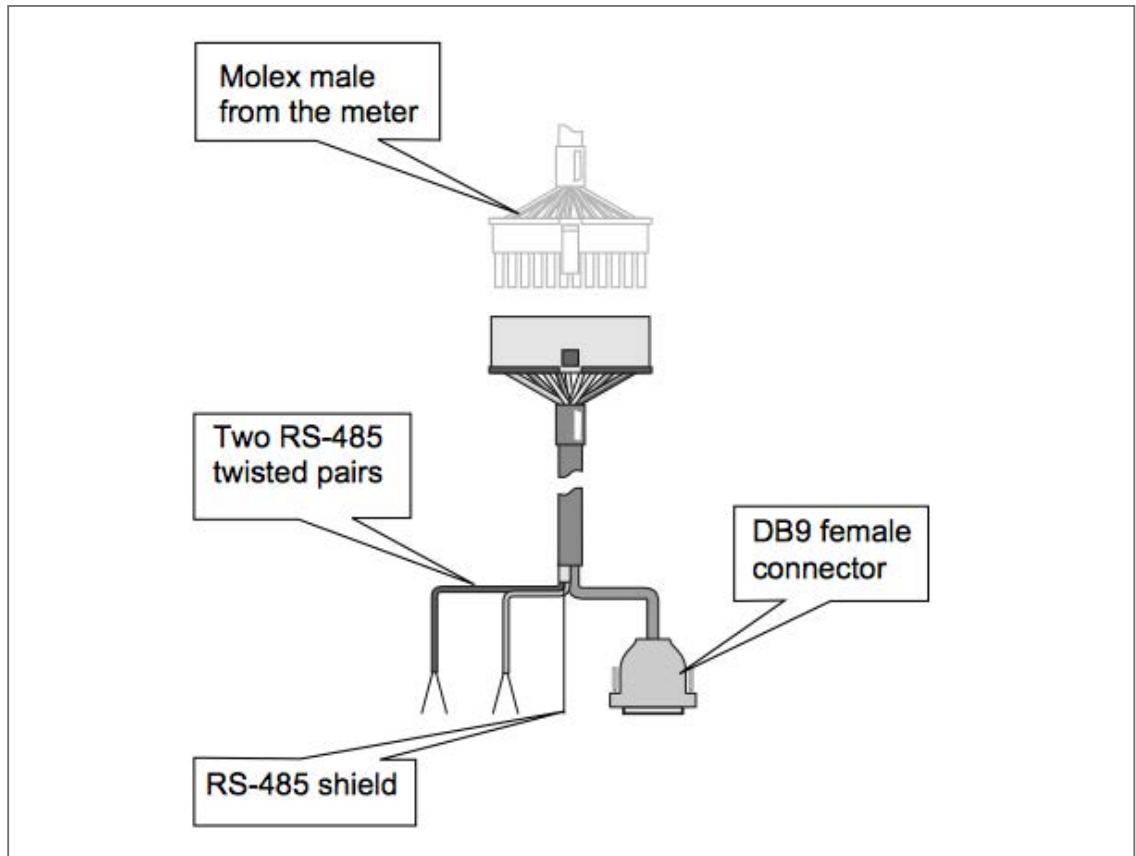


4.4 Schneider Square D ION8650 Meters

The following illustration shows the connection to the communications card.

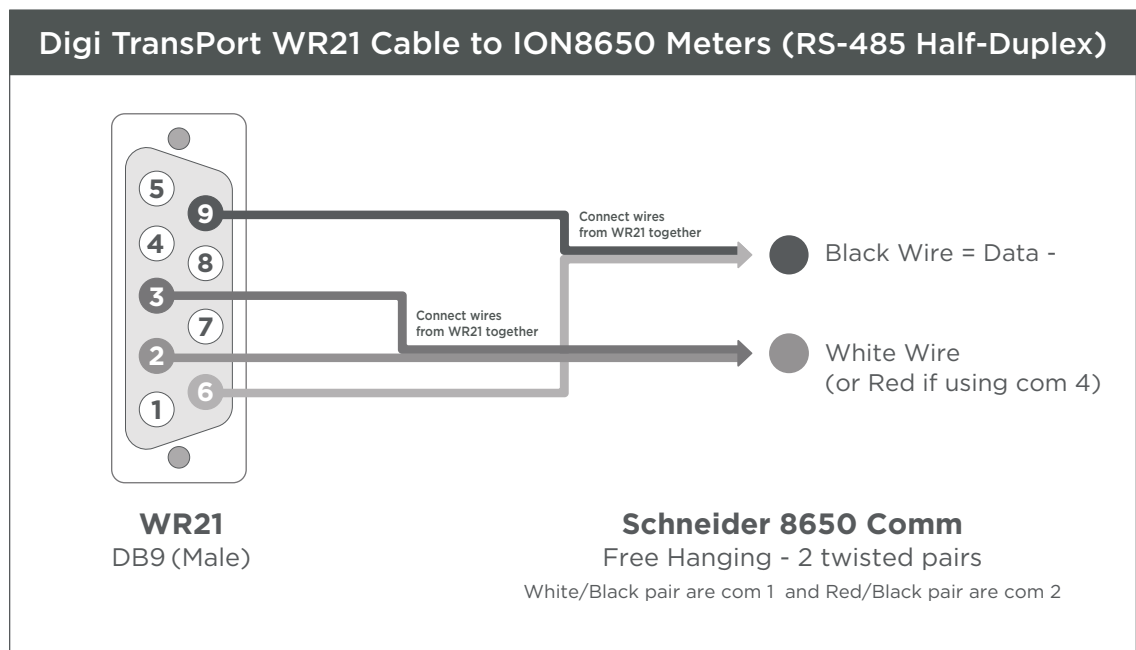


PowerLogic ION8650 – Energy and power quality meter User guide. Pg. 84



PowerLogic ION8650 – Energy and power quality meter User guide. Pg. 93

Cable Pinouts to Connect Schneider ION8650 Meters to Digi TransPort WR21



4.5 ABB/Elster Alpha Power Plus Meters

Identical to Elster A3 Meters in section 5.1. Requires optional RS-485 communications board.

4.6 AMETEC Power Instruments JEMStar Meters

Requires the optional RS-485 board. Half Duplex (two wire) RS-485 only. 120 ohm termination resistor is not required at the Digi TransPort WR21 end of the cable. The Digi TransPort WR21 has an internal termination resistor that is software selectable. It is necessary at the meter end.

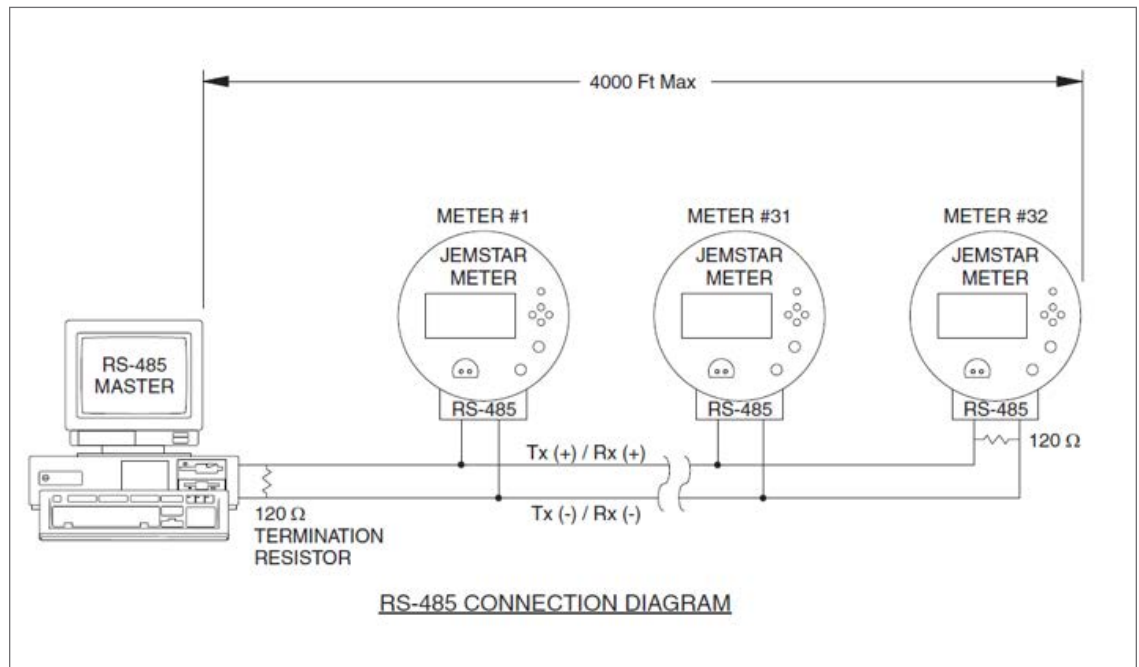
RS-485 Output Connections

Color	Signal
Wht/Grn/Blu	XMT/RCV -
Wht/Grn/Blu	XMT/RCV +

Switchboard RS-485 Output Connections

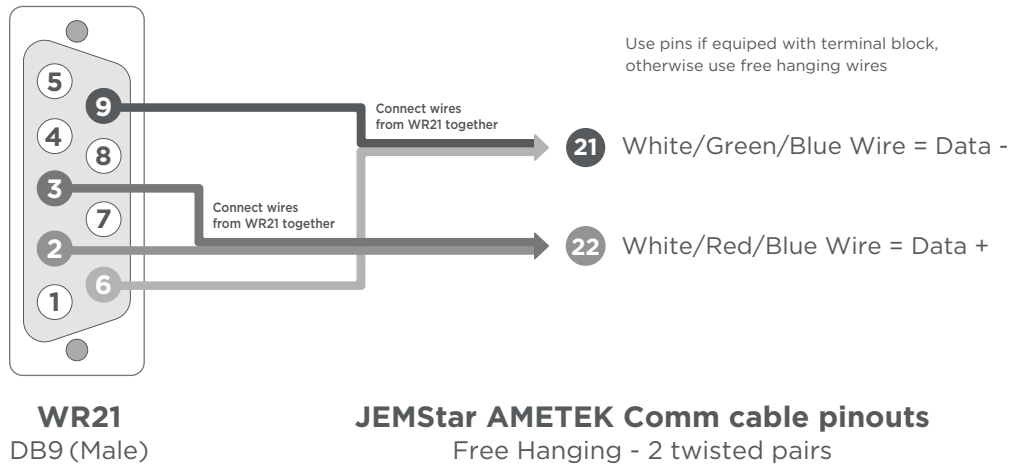
Terminal	Signal
21	XMT/RCV -
22	XMT/RCV +

For Switchboard style meters, the connections are provided on terminal blocks.



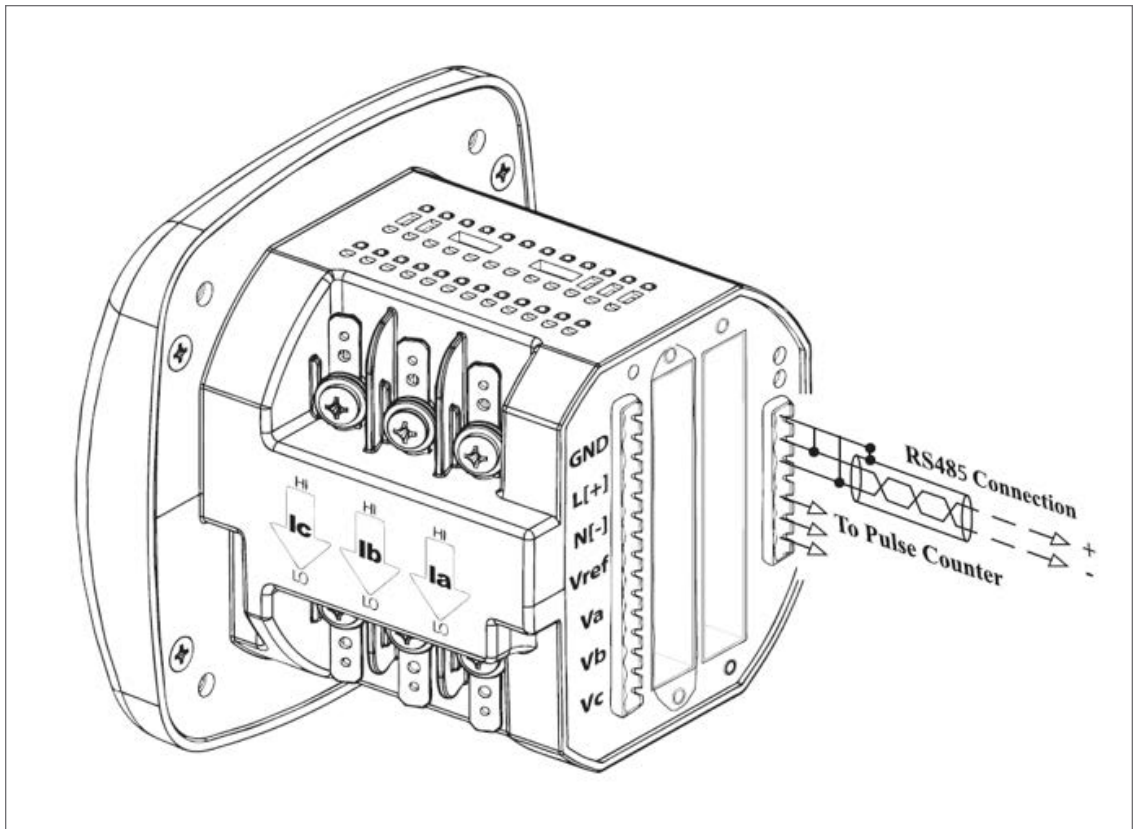
JEMStar Digital Multifunction Electricity Meter User Manual. Pub: 1083-600 Rev S. Pgs. 50, 55

Digi TransPort WR21 Cable to JEMStar AMETEK Meters

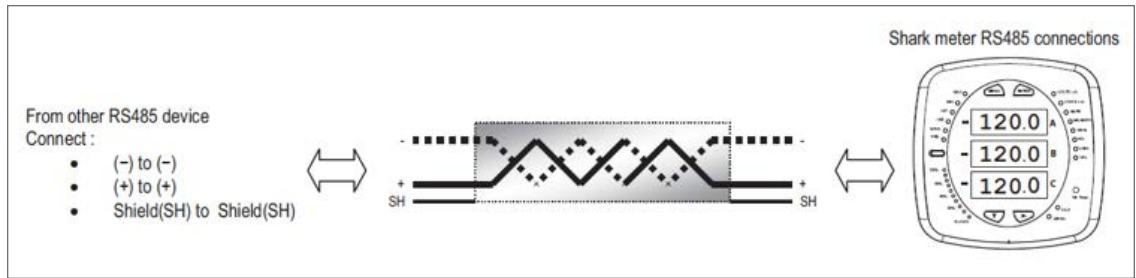


4.7 Shark Meters

Half-Duplex (two wire) RS-485 communication only

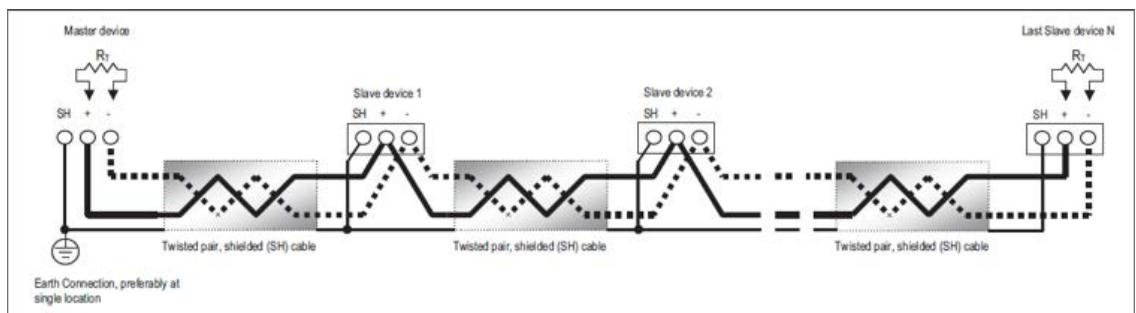


Shark 200 and 200T. Installation and Operation Manual. V1.14. Pg. 5-2

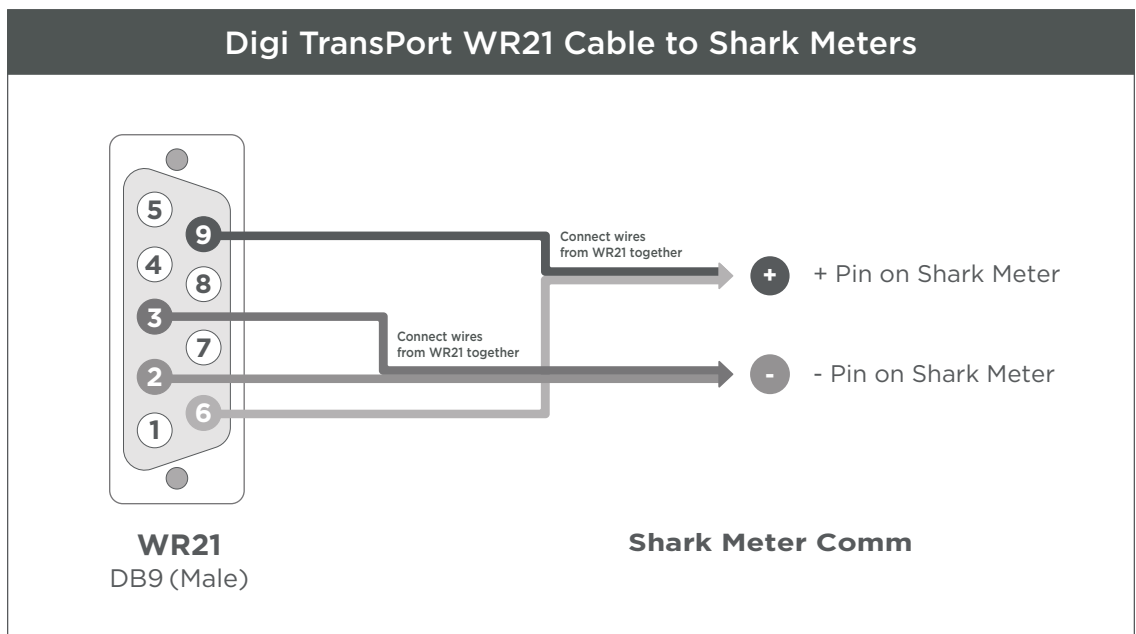


Shark 200 and 200T. Installation and Operation Manual. V1.14. Pg. 5-3

Hooking up multiple Shark meters to a single Digi TransPort WR21. Terminating resistors are only necessary on the last Shark meter. No terminating resistor is needed at the Digi TransPort WR21.



Shark 200 and 200T. Installation and Operation Manual. V1.14. Pg. 5-4



5

Mounting and Power Options for Various Digi TransPort Types (WR21, WR41, WR44) in Metering Applications

COMMON TO ALL DIGI TRANSPORT MODELS

Digi TransPort routers are not designed to be exposed to the weather. They must be installed in enclosures that are rated for at least IP66. Digi has a ready-made unit called the Utility Communication Hub (part number 70001699) that comes with a Digi TransPort WR21 pre-mounted inside. It's already IP66 certified and has the advantages of battery backup and a multi-port switch if more than one Ethernet connection is needed. It also has a built in power supply rated for up to 277Vac. Digi also has several integrator partners who specialize in weatherproof housing and auxiliary power solutions.

Most Digi TransPort models are designed for a wide temperature range (-20° to +75° C typical) so unless you expect extreme temperatures in your area there is no need to ventilate the enclosure. A few inches of open space in an enclosure is usually sufficient to dissipate any heat.

If the enclosure you are using is RF transparent (plastic) you may be able to use the antennas that come with the Digi TransPort. It really depends on how close you are to the carrier towers. It's important that the antennas be at least 4 or 5 inches (more is better) from any metal object. Metal has the effect of detuning the antenna. You should also take care to mount it securely (see options below) and not to get too close to any exposed AC lines.

If you are using a metal enclosure, or need higher gain antennas than what Digi can supply, you'll need to use external antennas. Generally the antennas can be mounted directly on the top of the enclosure but it might sometimes be necessary to mount them remotely (you may need to mount them on a tall poll for instance to get better visibility to a tower). Care must be taken to keep the coaxial cable length to a bare minimum. Long cables introduce RF loss that can wipe out any advantages to remotely mounting the antenna. A good rule of thumb is to keep the coaxial cable at, or less than, 15 feet if you are using RG174 or RG58. Better coaxial cable, like LMR400 for example, can have longer runs. But shorter is always better.

A NOTE ABOUT LTE

In many 3G HSPA and EVDO networks, routers are frequently deployed and configured with two antennas to achieve "receive diversity." (The primary antenna transmits and receives while the secondary antenna is receive only.) With this configuration, the router is better able to cope with multipath interference that occurs when signals bounce off obstructions (e.g., buildings, trees or airplanes) and arrive at the antenna out of phase. Two receive antennas, placed where signals can be best received and combined, can help counteract multipath interference. Conversely, LTE uses multiple input/multiple output (MIMO) where both antennas transmit and receive. While it is possible to use one antenna (and operate the device in SISO mode), two antennas are a better choice for optimum performance. Using one antenna will cause bandwidth to vary based on the RF conditions at the operating site. Application performance will also suffer, sometimes cutting bandwidth as much as 50 percent. Regardless, best practices call for using directly attached antennas.

6 Evaluating Your Signal

In 2G and 3G networks, signal strength was best understood using the received signal strength indicator (RSSI), measured in dBm. That value alone only provides a measure of the total signal including noise, and, of course, noise degrades the performance of a cellular connection. For example, a cellular router installed in an electric substation may pick up a strong cellular signal – but it will still perform poorly due to electromagnetic interference. That’s why it’s important to understand not only the strength of the signal, but also its quality.

Most 2G/3G CDMA and WCDMA (i.e., UMTS/HSPA) devices also report E_c/I_o which is a better indicator of signal quality. However, this metric is less commonly used and not as well understood as RSSI.

For 3G cellular connections, RSSI and E_c/I_o determine signal quality:

RSSI	Signal Strength	E_c/I_o	Signal Quality
> -70 dBm	Excellent	0 to -6	Excellent
-70 dBm to -85 dBm	Good	-7 to -10	Good
-86 dBm to -100 dBm	Poor	-11 to -20	Fair to Poor

With 4G LTE, operators can now take advantage of three new metrics to help indicate when the device has received a “good” LTE signal:

- ➔ **Reference Signal Received Power** – RSSP indicates the signal strength and is roughly analogous to RSSI.
- ➔ **Reference Signal Received Quality** – RSRQ describes the signal quality and is similar to E_c/I_o .
- ➔ **Signal to Interference and Noise Ratio** – SINR (also called SNR) indicates the throughput capacity of the channel. As the name implies, SINR is the strength of the signal divided by the strength of any interference.

These parameters may vary depending on the technology being used. The following table describes the RF conditions that each value range represents.

RF Conditions	RSRP (dBm)	RSRQ (dB)	SINR (dB)
Excellent	≥ -80	≥ 10	≥ 20
Good	-80 to -90	-10 to -15	13 to 20
Mid Cell	-90 to -100	-15 to -20	0 to 13
Cell Edge	≥ -100	≥ -20	≥ 0

For example, a 4G LTE modem might report an RSSI of -68 dBm, but:

RSRP = -102 dBm	RSRQ = -16 dB	SNR = -1.8 dB
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In this case, the signal quality is actually very poor. This could be due to the device being some distance away from the LTE transmitter. It's also possible that something is interfering with the signal, such as a building or other obstructions between the device and the tower.

Ultimately, poor signal quality equals poor performance due to issues such as retransmissions. Not only does poor signal quality degrade performance, it also adds cost to monthly data plans.

7 Digi TransPort Model-Specific Mounting Instructions

If you expect to mount the Digi TransPort router inside your own enclosure, or inside the meter cabinet itself, then use the mounting options described on the following pages.



7.1 Digi TransPort WR21

Two screw holes are on the bottom to mount the Digi TransPort WR21. Digi separately sells a bracket (Part number 76000775) that fits over the Digi TransPort WR21 and has “ears” or tabs that make it easier to mount. Note that to install this bracket the four rubber “feet” must be removed. They are easily pried off with a flathead screw driver. Digi also has a SIM cover (part number 76000787) that prevents anyone from removing the SIM card.

Dimensions of the Digi TransPort WR21 are 100mm x 131mm x 32mm (L x W x H). Note that you should choose an enclosure that allows enough room to connect the power connector, Ethernet cables (and/or the serial cable), and the antennas (or SMA RF connector on a pigtail coax cable to a bulkhead connector if you are going to use antennas external to the enclosure).

Power for the Digi TransPort WR21 can come from any 9-30V DC power supply capable of sourcing 1.5 amps. In extreme high temperature environments you should choose a power supply that can source a higher current do to the typical de-rating of most power supplies. There are two types of connectors that come on a Digi TransPort WR21 depending on which model you order. There is a 2.1mm locking barrel connector type and a more industrial Phoenix connector that has screw down leads. Digi can supply high temperature power supplies for either option. Part number 76000752 for the barrel type and 76000736 with bare leads that can be used with the Phoenix connector type.



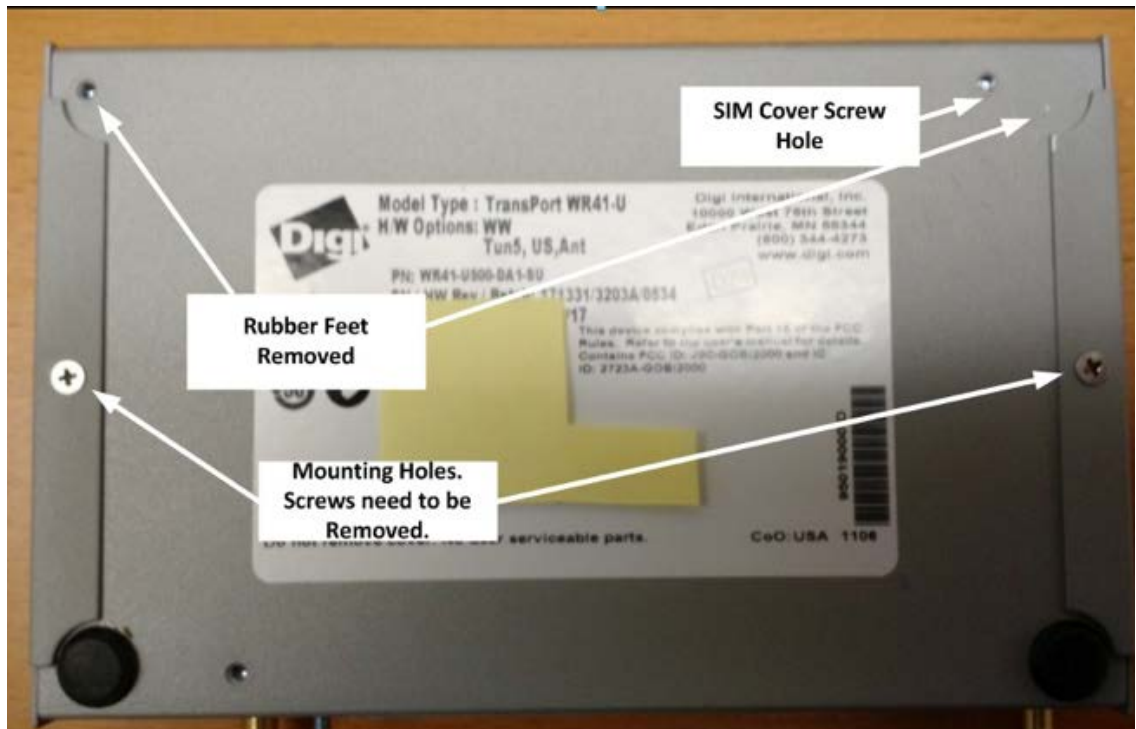
Bottom view of a Digi TransPort WR21.

7.2 Digi TransPort WR41

Two screws are on the bottom to mount the Digi TransPort WR41. These are the screws that hold the top of the case to the bottom. These screws need to be removed and the holes can then be used for mounting. Digi also has a bracket (Part number 76000775, same as the one for the Digi TransPort WR21 above) that fits over the WR41 and has 'ears' or tabs that make it easier to mount. Note that to install this bracket the four rubber 'feet' must be removed. They are easily pried off with a flathead screw driver. Digi also has a SIM cover (Part number 76000787, again the same as the Digi TransPort WR21) that prevents anyone from removing the SIM card.

Dimensions of the Digi TransPort WR41 are 120mm x 173mm x 32mm (LxWxH). Note that you should choose an enclosure that allows enough room to connect the power connector, Ethernet cables (and/or the serial cable), and the antennas (or SMA RF connector on a pigtail coax cable to a bulkhead connector if you are going to use antennas external to the enclosure).

Power for the Digi TransPort WR41 can come from any 8-48V DC power supply capable of sourcing 1.5 amps. In extreme high temperature environments you should choose a power supply that can source a higher current do to the typical de-rating of most power supplies. There is only one connector type for the high temperature version of the Digi TransPort WR41. It's a 4 pin locking Molex connector. Digi has a high temperature power supply specific to the Digi TransPort WR41 (part number 76000790).



Bottom view of a Digi TransPort WR41.

7.3 Digi TransPort WR44

Two screws are on the bottom to mount the Digi TransPort WR44. These are the screws that hold the top of the case to the bottom. These screws need to be removed and the holes can then be used for mounting. Digi also has a bracket (part number 76000778) that fits over the Digi TransPort WR44 and has “ears” or tabs that make it easier to mount. Note that to install this bracket the four rubber “feet” must be removed. They are easily pried off with a flathead screw driver. Digi also has a SIM cover specific to the Digi TransPort WR44 (part number 76000785) that prevents anyone from removing the SIM card.

Dimensions of the Digi TransPort WR44 are 145mm x 210mm x 40mm (LxWxH). Note that you should choose an enclosure that allows enough room to connect the power connector, Ethernet cables (and/or the serial cable), and the antennas (or SMA RF connector on a pigtail coax cable to a bulkhead connector if you are going to use antennas external to the enclosure).

Power for the Digi TransPort WR44 can come from any 9-36V DC power supply capable of sourcing 1.5 amps. In extreme high temperature environments you should choose a power supply that can source a higher current do to the typical de-rating of most power supplies. There is only one connector type for the high temperature version of the Digi TransPort WR44. It’s a 4-pin locking Molex connector. Digi has a DC power cord specific to the Digi TransPort WR44 (part number 76000774) that can be connected to a power supply. A typical “good” power supply is one similar to BEC (Bobbintron Electrical Corp.) part number AP0181-18U.



Bottom view of a Digi TransPort WR44.

PRODUCT DESCRIPTIONS AND PART NUMBERS*

Digi TransPort® 3G/4G LTE Cellular Routers (Sample list)

Product	Description	Part Number
Digi TransPort WR21	4G LTE, 2 Ethernet, 1 DB-9 RS-232/422/485, Enterprise VPN, Extended Temp AC Power Supply	WR21-L52A-DE1-TH
Digi TransPort WR41	4G LTE, 2 Ethernet, 1 DB-25 RS-232/422/485, Enterprise VPN, Extended Temp AC Power Supply	WR41-L5S1-NE1-XH
Digi TransPort WR44	4G LTE, 4 Ethernet, 1 DB-25 RS-232, Enterprise VPN, Extended Temp AC Power Supply	WR44-L5S1-CE1-XH
Digi TransPort WR44R (Rugged)	4G LTE, 4 Ethernet, 1 DB-25 RS-232/422/485, Enterprise VPN, Extended Temp AC Power Supply	WR44-L5S1-CE1-RH

Accessories

Product	Description	Part Number
Antenna	Cellular, Magnet Mount, Dual Band, 4.0 dBi, 14' cable	DC-ANT-DBHG
	Cellular, Direct Mount, Penta Band, 3.2 dBi	76000793
	Cellular, Surface/Through-Hole Mount, Quad Band, 3.15 dBi	76000847
	Cellular, Surface/Through-Hole Mount, Quad Band, 0 dBi	76000846
Antenna Mounting Bracket	L-Shaped Wall-Mount, 16.5mm Hole. Compatibility: 7600846	76000850

* Digi has many different router options available; please see www.digi.com and contact your Digi sales representative for more information.

Accessories (cont.)

Product	Description	Part Number
Cable	Locking Barrel to Bare Wire, 4'	76000732
	SMA Male to SMA Female, 5m	76000830
	DB9 Female to DB9 Male, 6'	76000858
	DB9 Female to DB25 Male, 6', Straight-Thru	76000871
Adapter	SMA Female to SMA Male	76000837
	TNC Female to TNC Male	76000836
	SMA Male to TNC Female	76000838
	SMA Female to TNC Male	76000839
	RJ45 to DB9 Female, 6'	76000855
	RJ45 to DB25 Male, 6'	76000856
	RJ45 to DB25 Female, 6'	76000857
Mounting Bracket	Wall-Mount, Compatibility: Digi Connect® WAN Routers	DC-BKT-CWAN
	Wall-Mount, Compatibility: Digi TransPort WR41 and WR21	76000775
	1U Rack-Mount Shelf	76000840
Other	SIM Card Cover	76000787

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