RS-232 Connections That Work
Connecting Devices or Converters

Overview

Connecting two devices using RS-232 sounds simple, but nearly every day B+B SmartWorx helpa a customer get a converter, isolator or other RS-232 device working by helping correct RS-232 cabling connections. This FAQ will help you troubleshoot and correct similar problems.

Usually inputs are connected to inputs - and outputs to outputs. Often, people do not realize that there are two types of RS-232 ports: DTE and DCE and that, while signal names and pin numbers are the same, signal flow is opposite! The pin labeled TX can be input, and RX the output.

The two port types are complementary – the Output signals on a DTE port are Inputs to a DCE port, and Output signals on a DCE port are Inputs to a DTE port. The signal names match each other and connect pin-for-pin. Signal flow is in the direction of the arrows. See the figures below.

- Computer Signal Connections: (DTE DB9 Device) to Modem (DCE DB25 Device)
  - Straight Cable DB9 to DB25 provides DTE to DCE connection
- Modem Signal Connections: (DCE DB9 Device to Modem (DCE DB25 Device)
  - Crossover DB9 to DB25 cable provides DCE to DCE connection.
    Note: Signal directions reversed if both devices are DTE but pin connections are the same.

Modem Cable - Straight Cable DB9 to DB9

DTE to DCE Connections

Pin# DB9 RS-232 Signal Names		Signal Direction	Pin# DB9 RS-232 Signal Names	
DTE Device (Computer) DB9			DCE Device (Modem) DB9	
#1 Carrier Detector (DCD)	CD	←	#1 Carrier Detector (DCD)	CD
#2 Receive Data (Rx)	RD	←	#2 Receive Data (Rx)	RD
#3 Transmit Data (Tx)	TD	→	#3 Transmit Data (Tx)	TD
#4 Data Terminal Ready	DTR	→	#4 Data Terminal Ready	DTR
#5 Signal Ground/Common (SG)	GND	──	#5 Signal Ground/Common (SG)	GND
#6 Data Set Ready	DSR	←	#6 Data Set Ready	DSR
#7 Request to Send	RTS	→	#7 Request to Send	RTS
#8 Clear to Send	CTS	←	#8 Clear to Send	CTS
#9 Ring Indicator	RI	←	#9 Ring Indicator	RI
Soldered to DB9 Metal - Shield	FGND	──	Soldered to DB9 Metal - Shield	FGND

Modem Cable - Straight Cable DB25 to DB25

DTE to DCE Connections

Pin# DB25 RS-232 Signal Names		Signal Direction	Pin# DB25 RS-232 Signal Names	
DTE Device (Computer) DB25			DCE Device (Modem) DB25	
#1 Shield to Frame Ground	FGND	──	#1 Shield to Frame Ground	FGND
#2 Transmit Data (Tx)	TD	→	#2 Transmit Data (Tx)	TD
#3 Receive Data (Rx)	RD	←	#3 Receive Data (Rx)	RD
#4 Request to Send	RTS	→	#4 Request to Send	RTS
#5 Clear to Send	CTS	←	#5 Clear to Send	CTS
#6 Data Set Ready	DSR	←	#6 Data Set Ready	DSR
#7 Signal Ground/Common (SG)	GND	──	#7 Signal Ground/Common (SG)	GND
#8 Carrier Detector (DCD)	CD	←	#8 Carrier Detector (DCD)	CD
#20 Data Terminal Ready	DTR	→	#20 Data Terminal Ready	DTR
#22 Ring Indicator	RI	←	#22 Ring Indicator	RI

How Can I Identify DTE or DCE Type Connections?

What devices have DTE type RS-232 ports? A DTE device is "Data Terminal Equipment" and includes Computers, Serial Printers, PLC's, Video Cameras, Video Recorders, Video Editors, and most devices which are not used to extend communications. *Think COMPUTER for DTE.*

What devices have DCE type RS-232 ports? A DCE device is "Data Communications Equipment" and includes devices intended to plug directly into a DTE port such as PDA cables, Modems and devices that extend communications like a modem, such as RS-422, RS-485, or Fiber Optic Converters or Radio Modems. *Think MODEM for DCE.*

Modem Cable - Straight Conversion DB9 to DB25

DTE to DCE Connections

DTE Device (Computer) DB9		Signal Direction	DCE Device (Modem) DB25	
Pin# DB9 RS-232 Signal Names			Pin# DB25 RS-232 Signal Names	
#1 Carrier Detector (DCD)	CD		#1 Shield to Frame Ground	FGND
#2 Receive Data (Rx)	RD		#2 Transmit Data (Tx)	TD
#3 Transmit Data (Tx)	TD		#3 Receive Data (Rx)	RD
#4 Data Terminal Ready	DTR		#4 Request to Send	RTS
#5 Signal Ground/Common (SG)	GND		#5 Clear to Send	CTS
#6 Data Set Ready	DSR		#6 Data Set Ready	DSR
#7 Request to Send	RTS		#7 Signal Ground/Common (SG)	GND
#8 Clear to Send	CTS		#8 Carrier Detector (DCD)	CD
#9 Ring Indicator	RI		#20 Data Terminal Ready	DTR
Soldered to DB9 Metal - Shield	FGND		#22 Ring Indicator	RI

Note: Signal Directions Reversed when DB9 is DCE and DB25 is DTE

Rule of Thumb - When connecting a DTE device to a DCE device, match the *signal names*. When connecting two DTE or two DCE devices together, use a Crossover cable. (TD crosses to RD, RTS to CTS, DTR to DSR as shown in Modem to Modem connections. The cable for two computers (DTE) also simulates modem connections to CD/DSR, so it is commonly called a "Null Modem" cable.

Modem to Modem Cable - Crossover Cable DB9 to DB9

DCE to DCE Connections

DCE Device (Modem) DB9		Signal Direction	DCE Device (Modem) DB9	
Pin# DB9 RS-232 Signal Names			Pin# DB9 RS-232 Signal Names	
#1 Carrier Detector (DCD)	CD		#1 Carrier Detector (DCD)	CD
#2 Receive Data (Rx)	RD		#2 Receive Data (Rx)	RD
#3 Transmit Data (Tx)	TD		#3 Transmit Data (Tx)	TD
#4 Data Terminal Ready	DTR		#4 Data Terminal Ready	DTR
#5 Signal Ground/Common (SG)	GND		#5 Signal Ground/Common (SG)	GND
#6 Data Set Ready	DSR		#6 Data Set Ready	DSR
#7 Request to Send	RTS		#7 Request to Send	RTS
#8 Clear to Send	CTS		#8 Clear to Send	CTS
#9 Ring Indicator	RI		#9 Ring Indicator	RI
Soldered to DB9 Metal - Shield	FGND		Soldered to DB9 Metal - Shield	FGND

Note: Signal directions reversed if devices are DTE to DTE - "Null Modem" cable for DTE devices also connects pins #1 & #6 on each side to simulate Carrier (CD) which is required by some Terminal program software.

Modem to Modem Cable - Crossover Cable DB9 to DB25

DCE to DCE Connections

DCE Device (Modem)	DB9		Signal Direction	DCE Device (Modem)	DB25	
Pin# DB9 RS-232 Signal Names				Pin# DB25 RS-232 Signal Names		
#1 Carrier Detector (DCD)	CD			#1 Shield to Frame Ground		FGND
#2 Receive Data (Rx)	RD			#2 Transmit Data (Tx)		TD
#3 Transmit Data (Tx)	TD			#3 Receive Data (Rx)		RD
#4 Data Terminal Ready	DTR			#4 Request to Send		RTS
#5 Signal Ground/Common (SG)	GND			#5 Clear to Send		CTS
#6 Data Set Ready	DSR			#6 Data Set Ready		DSR
#7 Request to Send	RTS			#7 Signal Ground/Common (SG)		GND
#8 Clear to Send	CTS			#8 Carrier Detector		CD
#9 Ring Indicator	RI			#20 Data Terminal Ready		DTR
Soldered to DB9 Metal - Shield	FGND			#22 Ring Indicator		RI

Note: Signal Directions Reversed if both devices are DTE but pin connections are the same.
"Null Modem" cable connects pins #1 & #6 on DB9 side and #6 & #8 on DB25 side for Carrier (CD) used by Terminal programs requiring CD to be high for operation.

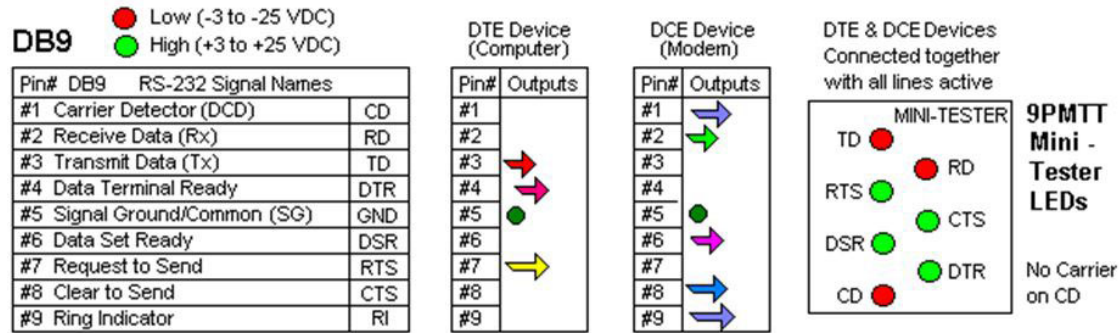## Modem to Modem - Crossover Cable DB25 to DB25

DCE to DCE Connections

DCE Device (Modem)	DB25		Signal Direction	DCE Device (Modem)	DB25	
Pin# DB25 RS-232 Signal Names				Pin# DB25 RS-232 Signal Names		
#1 Shield to Frame Ground	FGND			#1 Shield to Frame Ground		FGND
#2 Transmit Data (Tx)	TD			#2 Transmit Data (Tx)		TD
#3 Receive Data (Rx)	RD			#3 Receive Data (Rx)		RD
#4 Request to Send	RTS			#4 Request to Send		RTS
#5 Clear to Send	CTS			#5 Clear to Send		CTS
#6 Data Set Ready	DSR			#6 Data Set Ready		DSR
#7 Signal Ground/Common (SG)	GND			#7 Signal Ground/Common (SG)		GND
#8 Carrier Detector (DCD)	CD			#8 Carrier Detector (DCD)		CD
#20 Data Terminal Ready	DTR			#20 Data Terminal Ready		DTR
#22 Ring Indicator	RI			#22 Ring Indicator		RI

Note: "Null Modem" cable for DTE to DTE also connects pins #6 & #8 together on each side simulating Carrier (CD) Signal directions are reversed when devices are DTE to DTE.
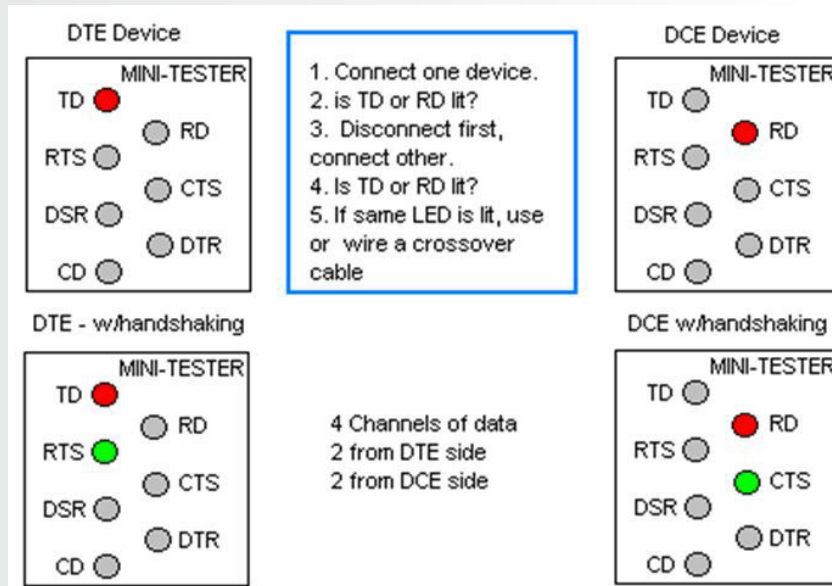
How to Check - Are My Devices Wired As DTE or DCE?

1. **Use Rule of Thumb** - If the device plugs into the computer serial port and works normally, the device is wired as DCE (or the connection cable is a crossover type that makes it work as a DCE). If the device connects to the computer port using a "null modem" crossover cable, it is wired as DTE.

2. **Use RS-232 Line Tester** - A quick and easy way to determine the DTE/DCE port type is to use a RS-232 line tester such as B+B SmartWorx Model# 9PMTT. The tester can show the signal state of any active RS-232 data lines using LEDs lighting Red or Green. Active data lines are output from a device; they may be either High or Low.
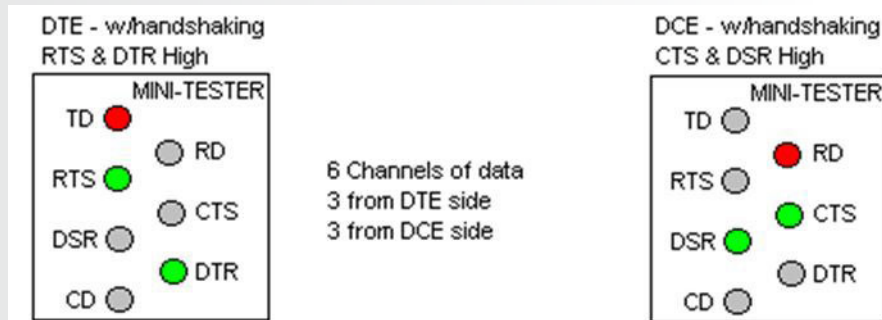
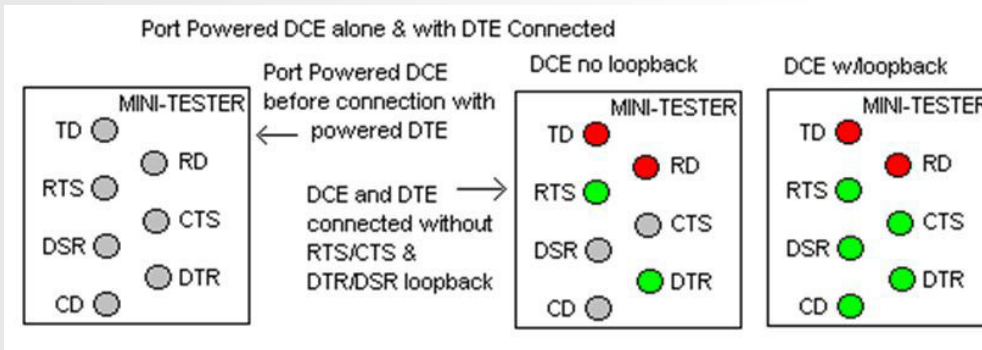## DTE or DCE? - Check for Active Highs or Lows on the Lines When Powered ON

DB9
● Low (-3 to -25 VDC)
● High (+3 to +25 VDC)

Pin# DB9	RS-232 Signal Names	
#1	Carrier Detector (DCD)	CD
#2	Receive Data (Rx)	RD
#3	Transmit Data (Tx)	TD
#4	Data Terminal Ready	DTR
#5	Signal Ground/Common (SG)	GND
#6	Data Set Ready	DSR
#7	Request to Send	RTS
#8	Clear to Send	CTS
#9	Ring Indicator	RI

3. Just plug the tester into either of the two devices, see which lines are lit. Unplug it, then plug it in to the other device, see which lines are lit. See figures.

4. If the same light (TD or RD) is lit, use a crossover cable or null modem connector that swaps the connections for pins #2 and #3 and other pins as needed.

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5. If the device is "port powered" check the active side, then plug in the port-powered device and see if other (TD or RD) LED is lit. If not, try swapping the leads with a null modem cable, see if the other LED now lights. If not, you may not have enough voltage on the handshaking lines of the port to borrow power from.

6. **Use a DC Voltmeter** – Technicians with a DC voltmeter can use it to measure the DC level from signal ground (pin #5 on DB9, pin #7 on DB25) on the connector to pin #2 or pin #3. When the unit is powered and not sending data, the output line will have a DC voltage of minus polarity; 3 Volts to 11 Volts will be typical. The other pin will have little or no voltage. For example, measuring -11 Volts on pin#2 of a DB9 connector, and the line is labeled RD or Rx, then the device is wired as DCE. If measuring the voltage on pin#3, it is DTE.

Measure pin #2 and pin #3 to Ground (pin # 5 - DB9) (pin #7 -- DB25) on the cable from the first device, then on the device you want to connect. If the cable and device have voltage on the same pin, you need to use a crossover or null modem connector that swaps pins #2 & #3 and the other pins.

Electrically active handshaking lines will be negative when not asserted or positive when asserted. (For reference, see line tester figures). Active handshaking lines can be found by measuring each pin for voltage. Output lines will have voltage. On a DTE, DTR and RTS will have voltage if used. On a DCE, DSR and CTS will have voltage and, if a modem with CD (Carrier Detect) and RI (Ring Indicator), these last two will be low until Ring is detected or a Carrier connection is made. If handshaking lines do not have voltage when the device is powered on and ready, and the device does not output them, they may be looped back – RTS to CTS and DTR to DSR. You can turn off the device power and measure for continuity (zero Ohms) between pins to confirm if they are looped back.

Other RS-232 Connection Problems

1. Handshaking lines RTS and CTS not interconnected; DTR and DSR not interconnected. Swap as needed.

2. Programs may use the RTS/CTS connection to check that a device is ready to receive data and respond. If there is No CTS connection, the program will never send data, but wait a long time or timeout with an error. The RTS line may need to be looped back to the CTS input. Data errors can occur if the device actually requires handshaking.

3. Programs may also use the DTR/DSR line connection to check that a cable is connected or that the device is turned on. If there is no DSR signal, the DTR line may need to be looped back to the DSR input. Some devices use DTR handshaking.

4. Each signal required for unit operation must be carried through by the isolator, modem or RS-422 or fiber optic converter. The primary "2 Channels" for RS-232 are Receive & Transmit. There are 2 data flow control channels – RTS and CTS. If these are missing, data is lost, characters are missing or files scrambled.

5. Connections to Telephone Modem/FAX modem - Make sure CD & RI lines are connected.

Recommended B+B SmartWorx Accessories

Always free technical support and more accessories available online to solve your RS-232 data communication and connection problems.

RS-232 Conversion Cables
Model# 232CAM - DB9F to DB25M conversion cable - 1.8 m (6 ft)

RS-232 Null Modem Connectors
Model# MFNM25- DB25M to DB25F - 25 pin male/female
Model# MMNM9 - DB9M to DB9M - 9 pin male/male

RS-232 Line Testers
Model# 9PMTT - DB9F to DB9M - 9 pin female/male

Jumper Boxes
Visit B+B SmartWorx website for jumper boxes for DB9, DB25, DB9/25;
M/F, F/F, & M/M; and DB9 or DB25 to RJ11/RJ12/RJ45 connectors.

RS-232 Crossover Cables
Visit B+B SmartWorx website for DB9 crossover cables for M/F, F/F, M/M
in a variety of lengths.

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