

RS-232 CONNECTIONS THAT WORK! - Connecting Devices or Converters

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

Usually inputs are connected to inputs and outputs to outputs. People don't realize that there are two types of RS-232 ports, DTE and DCE type, and that the signal names and pin numbers are the same, but signal flow is opposite! The pin labeled Tx can be input, and Rx the output.

The two ports 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 figures below)

Modem Cable - Straight Cable DB9 to DB9

DTE Device (Computer) DB9			DTE to DCE Connections	DCE Device (Modem) DB9			
Pin#	DB9	RS-232 Signal Names	Signal Direction	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

Modem Cable - Straight Cable DB25 to DB25

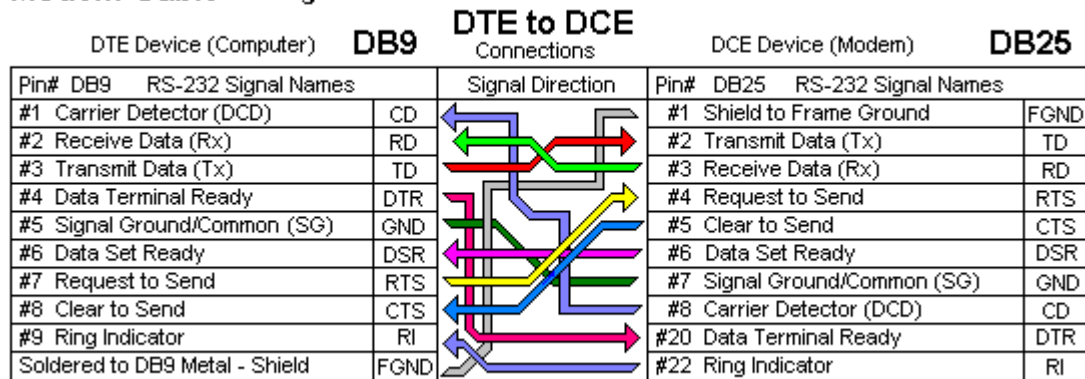
DTE Device (Computer) DB25			DTE to DCE Connections	DCE Device (Modem) DB25		
Pin#	DB25	RS-232 Signal Names	Signal Direction	Pin#	DB25	RS-232 Signal Names
#1	Shield to Frame Ground	FGND	→	#1	Shield to Frame Ground	FGND
#2	Transmit Data (Tx)	TD	→	#2	Transmit Data (Tx)	TD
#3	Receive Data (Rx)	RD	←	#3	Receive 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

How Can I Identify DTE or DCE Type Connections?

What devices have **DTE** type RS-232 ports? A DTE device is "Data Terminal Equipment", this 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", this includes devices intended to plug directly into a DTE port, 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**

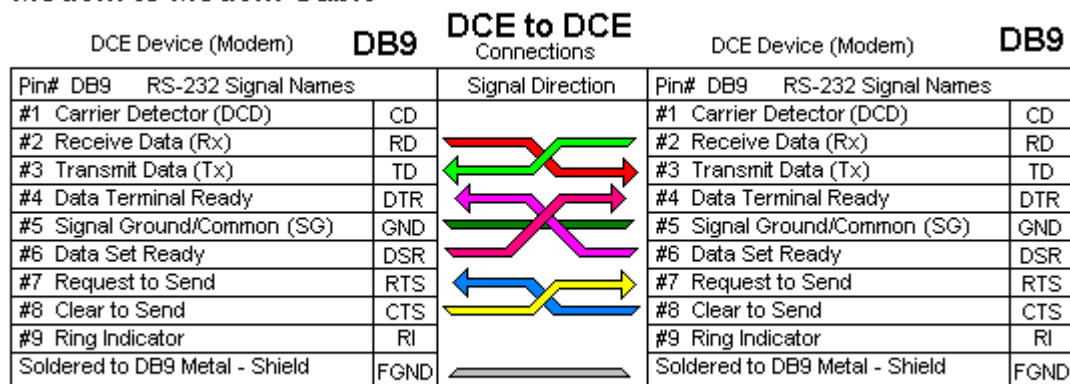
Modem Cable - Straight Conversion DB9 to DB25



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

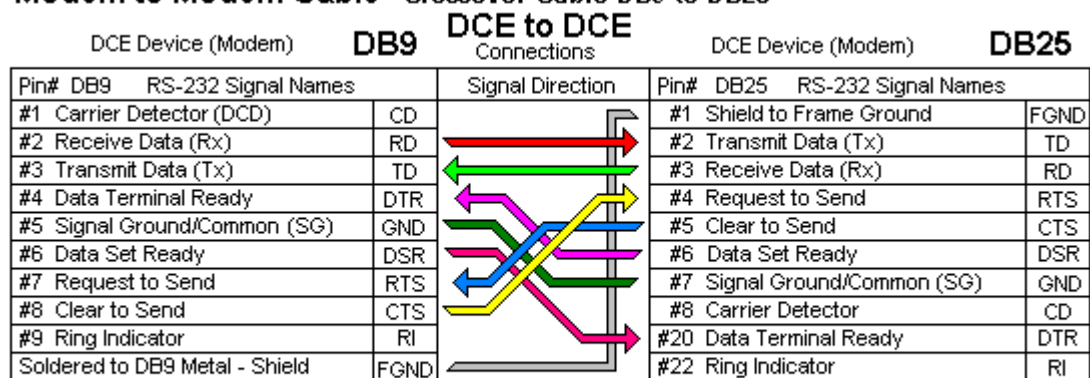
Rule of Thumb: When connecting a DTE device to a DCE device, match the signal names. When connecting two DTE or two DCE devices together, use a Crossover cable. (TD crosses to RD, RTS to CTS, DTR to DSR as shown in Modem to Modem connections. (see 9PMMNM) The cable for two computers (DTE) also simulates modem connections to CD/DSR, so it is commonly called a "Null Modem" cable. (see 232DTE or 232NM9)

Modem to Modem Cable - Crossover Cable DB9 to DB9



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



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 Device (Modem)		DB25	DCE to DCE	Connections	DB25	DCE Device (Modem)		
Pin#	DB25	RS-232 Signal Names		Signal Direction		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.

Are My Devices Wired As DTE or DCE? - How to Check

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 the 9PMTT. The tester can show the signal state of any active RS-232 data lines using LED's 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

● 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

DTE Device (Computer)

Pin#	Outputs
#1	
#2	
#3	→
#4	→
#5	●
#6	
#7	→
#8	
#9	

DCE Device (Modem)

Pin#	Outputs
#1	→
#2	→
#3	
#4	
#5	●
#6	→
#7	
#8	→
#9	→

DTE & DCE Devices Connected together with all lines active

Pin#	Outputs
#1	→
#2	→
#3	→
#4	
#5	●
#6	→
#7	
#8	→
#9	→

MINI-TESTER

TD ● RD

RTS ● CTS

DSR ● DTR

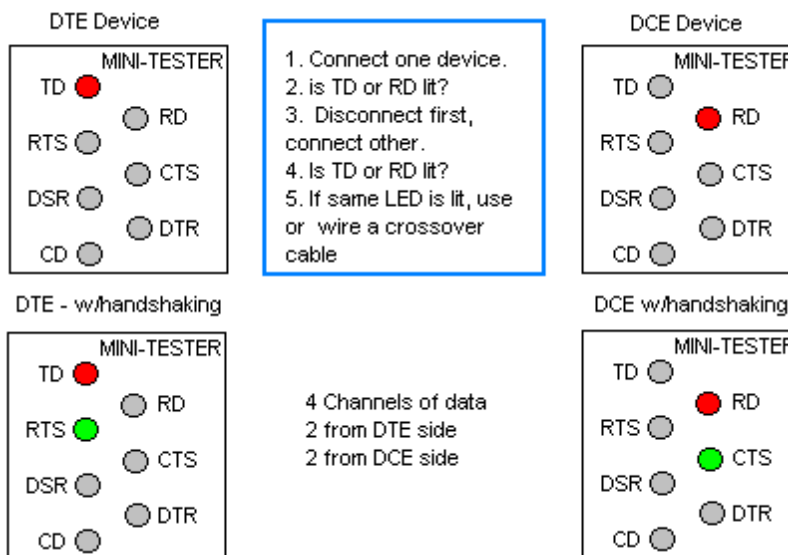
CD ●

9PMTT Mini - Tester LEDs

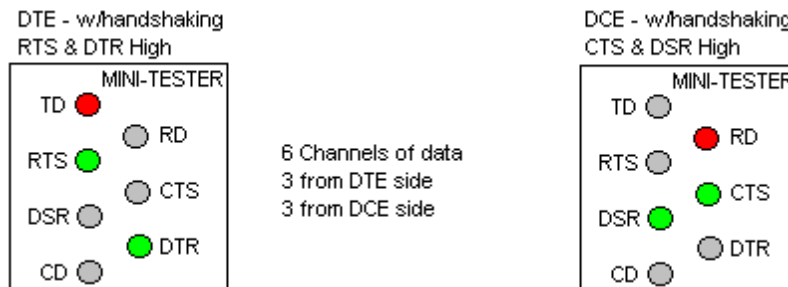
No Carrier on CD

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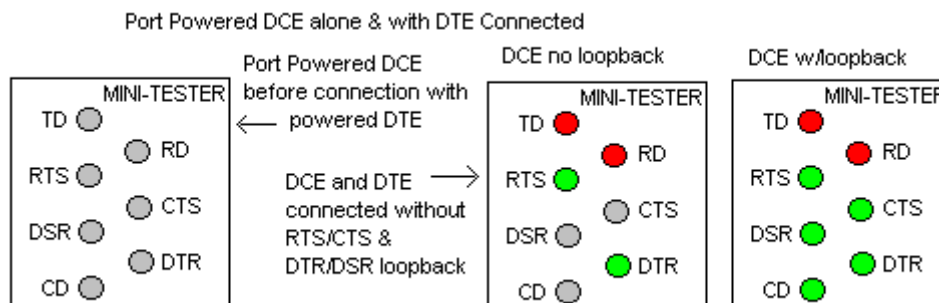
Just plug the tester into either of the two devices, see which lines are lit, unplug it, then plug it in to the other device, see which lines are lit. (see figures).



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.



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 steal power from.



3. *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, we measure -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 we measure the voltage on pin#3, it is DTE.

Measure pin #2 and pin #3 to ground (pin # 5 - DB9) (pin #7 -- DB25) on the on the cable from the first device, the 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. (For DB9 see model 9PMMNM, for DB25 see 232DTE)

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 don't have voltage when the device is powered on and ready, the device doesn't 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 missing, or files scrambled.
5. Connections to Telephone Modem/FAX modem - Make sure CD & RI lines are connected.

Recommended Accessories for Connections

- 232CAM - DB9F to DB25M conversion cable - 6 ft. (1.8 m)
- 232CAMS - DB9F to DB25M conversion/strain relief cable - 6 inches (15 cm)
- 232CAMR - DB9M to DB25F conversion/stain relief cable - 12 inches (30 cm)

RS232 Null Modem Connectors

- 232DTE - DB25F to DB25M - 25 pin female/male
- PMMNM - DB9M to DB9M - 9 pin male/male

RS232 Line Testers

- 9PMTT - DB9F to DB9M - 9 pin female/male
- 232BOB1 - Breakout Box DB25F to DB25M with switches & jumpers

Jumper Boxes

Please refer to our catalog or website for jumper boxes for DB9, DB25, DB9/25, M/F, F/F, & M/M and DB9 or DB25 to RJ11/RJ12 or RJ45 connectors.

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