Verifying Connection

Specification and Verification of Physical Interface

Verifying the physical connection is the primary tasks: if there is no physical connection, none of the higher layers will connect. In our experience, about 85% of all communication failures are related to physical connections.

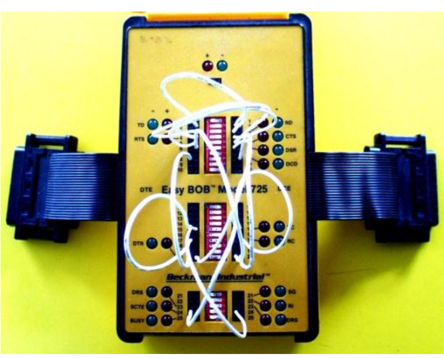
The more pieces are used in a line of communication, the higher the risk of failure, and the higher the cost of maintenance.

It is important to obtain the Host manufacturer's specifications for all used physical interfaces. Even then, verification of the interface is required.

Other essential information is the number of used synchronous and possible asynchronous ports, their physical interfaces, pin-layouts, and configuration. If there is more than 1 used synchronous port, we need to know how: Are all always active, hot standby, warm- or cold standby, is multi-link used, and if so at what layer.

Pin-Layout of Cable from Host to Equipment

Most important to know is the pin layout at the host interface as documented in the manufacturer's specs. If not available, difficult to get, or not current, the pin-layout can be found analyzing the cable from the Host internal interface to a peripheral that has a known interface, such as a modem. Communication cables normally use color coded marked strands, and by removing the connector shells at both ends, the pin-numbers at both ends can be mapped. Otherwise, the mapping can be found by establishing a circuit between both ends using a Multi-Meter (or a simple battery and light bulb). A Multi-Meter, a Break-out-Box (BoB) and/or a Logic Analyzer (or Oscilloscope) maybe required.




Signaling

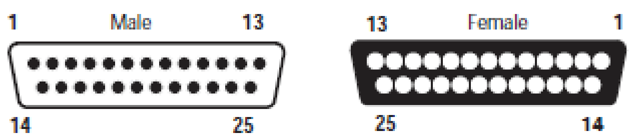
From the signal mapping found above it will be normally possible to deduce the type of signaling used. RS-232 (V.24) does not use differential signals as RS-422 (X.21, EIA-530, RS-449) and V.35. The connector itself may give an indication what signaling is used, but it is not uncommon to use a DB25 connector for V.35 as well.

RS-232 (V.24)

If RS-232, it will be most likely be a 25-pin connector (DB25) and the speed is normally not higher than 19.2 kbps. The CEPT Net2 certification used by the former ZZF (Zentralamt für Zulassung im Fernmeldewesen) in Saarbrücken limited the RS-232 to 19.2 kbps. Today, asynchronous connections of 115 kbps are not uncommon.

1. EIA-232-D (RS-232-D), ITU-TSS (CCITT) V.24/V.28, ISO 2110

A. Original standard pinout on DB25 connectors:



RS-422 (V.11/X.27)

RS-422 uses differential signals for data, clock, and control signals. No Physical Connector is specified. Common physical connections are X.21, EIA-530 and RS-449 (V.36).

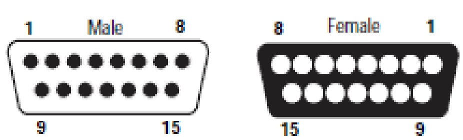
As it is often used for high-speed connections for longer distances, HW control signals are frequently replaced with SW control signals, such as RR (Receiver Ready) and RNR (Receiver Not Ready), or XON/XOFF. Since every differential signal uses two strands, cables can be therefore thinner and lighter. We have implemented RS-422 using RJ45 connectors (EIA/TIA-561).

X.21

If, as is common in Europe, X.21 is used, it will most likely be a 15-pin connector (DB15). X.21 uses only 1 in-put and 1 out-put control, and only one clock signal. Most SCCs (Serial Communication Controllers) can be configured to derive the Transmit Clock (TxC) from the Receive Clock (RxC) pin.

ITU-TSS (CCITT) X.21, ISO 4903

High-speed, X.27-compatible pinout on DB15 (DA15) connectors:



EIA-530 (RS-530)

If, as is common in the US, EIA-530 is used, it will be most likely a 25-pin connector (DB25) just as RS-232 uses. EIA-530 may use 2 or 3 in-put (DSR, DCD, CTS) and 2 out-put control (DTR, RTS), and 2 clock signals (TxC, RxC).

Pinout on DB25 connectors:

RS-449

RS-449 (V.36) is rarely found anymore, because it uses a bulky 37-pin (DB37) connector. We have seen it used by a Siemens EWSD and DSC's DEX (now Alcatel) phone switches. The latter used a RS-449 to V.35 converter right at the Host.

EIA-449 (RS-449), ISO 4902

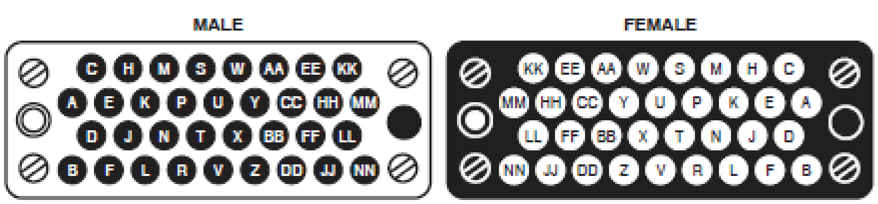
A. Primary channel pinout on DB37 (DC37) connectors:

V.35

If V.35 it will use most likely a Winchester connector, but because of its high price, possibly a DB25 connector. V.35 is very popular in the telecom industry. It uses for data and clock differential signals as RS-422, but control signals are non-differential as in RS-232.

ITU-TSS (CCITT) V.35

Pinout on M/34 ("34-pin M-block") connectors:



Comparative Pinout Table for Common Serial Interfaces

ITU-T. V.24 CIRC.	EIA-232-D INTERFACE			EIA-449 INTERFACE					EIA-530 INTERFACE				ITU-TSS V.35 INTERFACE			ITU-TSS X.21 INTERFACE				SIGNAL FUNCTION AND DIRECTION						
	DB25 PIN	232 CIR.	NAME	DB37 PIN		DB9 PIN	449 CIR.	NAME	DB25 PIN		530 CIR.	NAME	M34 PIN		NAME	DB15 PIN		X.21 CIR.	NAME	GND	DATA		CTRL		TIMING	
				A	B				A	B			A	B		A	B				FR DCE	TO DCE	FR DCE	TO DCE	FR DCE	TO DCE
101	1	AA	Shield	1		1	AA	Shield	1		AA	Shield	A		Shield	1		—	Shield	X						
102	7	AB	Signal Ground	19		5	SG	Signal Ground	7		AB	Signal Ground	B		Signal Ground	8		G	Signal Ground	X						
102a				37		9	SC	Send Common												X						
102b				20		6	RC	Receive Common												X						
103	2	BA	Transmitted Data	4	22		SD	Send Data	2	14	BA	Transmitted Data	P	S	Send Data	2	9	T	Transmit			X				
104	3	BB	Received Data	6	24		RD	Receive Data	3	16	BB	Received Data	R	T	Receive Data	4	11	R	Receive		X					
105	4	CA	Request to Send	7	25		RS	Request to Send	4	19	CA	Request to Send	C		Request to Send	3	10	C	Control					X		
106	5	CB	Clear to Send	9	27		CS	Clear to Send	5	13	CB	Clear to Send	D		Clear to Send								X			
107	6	CC	DCE Ready	11	29		DM	Data Mode	6	22	CC	DCE Ready	E		Data Set Ready								X			
108.2	20	CD	DTE Ready	12	30		TR	Terminal Ready	20	23	CD	DTE Ready	H		Data Terminal Ready									X		
109	8	CF	Received Line Signal Detector	13	31		RR	Receiver Ready	8	10	CF	Received Line Signal Detector	F		Received Line Signal Detector	5	12	I	Indication				X			
110	21	CG	Signal Quality Detector	33			SQ	Signal Quality															X			
111	23	CH	Data Signal Rate Selector (DTE)	16			SR	Signal Rate Selector																X		
112	12 or 23	CI	Data Signal Rate Selector (DCE)	2			SI	Signal Rate Indicator															X			
113	24	DA	Transmitter Signal Elem. Timing (DTE)	17	35		TT	Terminal Timing	24	11	DA	Transmitter Signal Elem. Tim. (DTE)	U	W	Serial Clock Transmit External											X
114	15	DB	Transmitter Signal Elem. Timing (DCE)	5	23		ST	Send Timing	15	12	DB	Transmitter Signal Elem. Tim. (DCE)	Y	AA	Serial Clock Transmit	6	13	S	Signal Element Timing						X	
115	17	DD	Receiver Signal Elem. Timing (DCE)	8	26		RT	Receive Timing	17	9	DD	Receiver Signal Elem. Tim. (DCE)	V	X	Serial Clock Receive										X	
116				32			SS	Select Standby																X		
117				36			SB	Standby Indicator															X			
118	14	SBA	Secondary Transmit Data			3	SSD	Secondary Send Data														X				
119	16	SBB	Secondary Receive Data			4	SRD	Secondary Receive Data													X					
120	19	SCA	Secondary Request to Send			7	SRS	Secondary Request to Send																X		
121	13	SCB	Secondary Clear to Send			8	SCS	Secondary Clear to Send															X			
122	12	SCF	Secondary Received Line Sig. Detector			2	SRR	Secondary Receiver Ready															X			
125	22	CE	Ring Indicator	15			IC	Incoming Call					J		Calling Indicator								X			
126				16			SF	Select Frequency																X		
140	21	RL	Remote Loopback	14			RL	Remote Loopback	21		RL	Remote Loopback	N		Remote Loopback									X		
141	18	LL	Local Loopback	10			LL	Local Loopback	18		LL	Local Loopback	L		Local Loopback									X		
142	25	TM	Test Mode	18			TM	Test Mode	25		TM	Test Mode	NN		Test Mode								X			
				28			IS	Terminal in Service																X		
				34			NS	New Signal																X		
																7	14	B	Byte Timing						X	

Line Speed at Host

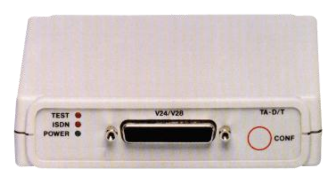
Modem

Modem speeds of synchronous depend on the vintage of the modem and range from 1.2 kbps to 19.2 kbps, although US Robotic's V.Everything supports 56 kbps. Older switches, such as DMS-10 or Stromberg/Carlson use half-duplex Bell 208B, 4.8 kbps. X.25 connections are full-duplex, and are normally 9.6 kbps or 19.2 kbps. Modem connections are normally RS-232 and use a DB25 female receptacle.

CSU/DSU Devices

These devices are more common in North America. Their speed is normally 56 kbps for 56Kbps (DDS service) seldom T1 for 1.544Mbps (T1 and Fractional T1 services). They normally use a V.35 Winchester female connector, but it is possible they use a DB25 female connector with a Winchester adaptor cable. The DB25 pin-layout is normally proprietary, not compatible with RS-232 or EIA-530.

ISDN TA



ISDN Terminal Adaptors are more common in Europe, where they can either use RS-232 DB25 Female, X.21 DB15 Female, or V.36 (RS-449) DB37 Female

If only the D-Channel is used the speed limited is 16 or 9.6 kbps. If the B-Channels are used and bonding is enabled, the speed can be 128 kbps for both B-Channels and 144 kbps if both B and the D-channels are used.

If no bonding of ISDN B-channels is used, the likely speed will be 64 kbps, but it is possible that the speed from the Host to the ISDN Terminal Adaptor is slower. If the speed to the Host is higher than 19.2 kbps, it is less likely that RS-232 (V.24) is used.

Most likely the current line speed is limited by the TA. The PXSe/u can at least support T1/E1 line speeds (we tested error-free 8.192 Mbps 4xE1 for the PXSe and 4.096 Mbps for the PXSu) in full duplex mode. Once the PXSe/u gateway is fully functional, we can then determine the maximum possible supported line speed at the Host.

Who generates the clock signals

Normally, at the physical layer, the site generating the clock signal is called the DCE. Very likely the Modem, DSU/CSU or ISDN Terminal Adaptor (default) will be the DCE, very unlikely the Host. **If the PXSe/u replaces these devices, then it will in general be the DCE, and provide the clock. Because the PXSe/u does not have the speed limit of the replaced devices, it can run at higher lines speeds if supported by the host.**

What control signals (DTR/DSR, RTS/CTS, DCD) are used

If X.21 (15-pin) connector is used, then there is only one input and one output control signal. If RS-232 all control signal could be used. Most communication chips only support 2 input control signals, such as CTS and DCD, and the DSR is often spliced from one of them. If modems are used, the DCD signal indicates connection to the remote modem.

Cable between Host and PXSe/u

As mentioned earlier, we strongly recommend connecting the PXSe/u directly to the physical synchronous port of the Host. Provided the physical connection is non-standard, the signal mapping is known and verified, we will need to obtain the matching plug-in connector to build customized cables. If this is not a feasible solution, we will provide a cable with the same connector as the current device: Modem, CSU/DSU or TA.

For the tests we recommend using a cable with a DB25 end connector. This will allow us to use a standard break-out box in case signals need to be remapped. It will also facilitate the insertion of a Data Line Monitor into the existing connection.

The PXSe uses a high-density Hirose 24-position connector, where the pins 1 to 24 are compatible with the common standards. We do have adapter cables Hirose-DB25, Hirose -DB15, Hirose -Winchester. For redundancy and higher throughput, one PXSe can be connected to 2 Hosts if in close proximity. Cables to the secondary Host may have to be longer. The PXSu uses either a DB25 Male or Female connector, and supports either RS-232, RS-422 or V.35 signalling.

Specification and Verification of the X.25 Protocols

To verify the higher layer protocols we will use a data line monitor (DLM to tap a working communication connection, allowing monitoring, and analyzing each layer. The PXSe/u can function as DLM. It requires a special cable set. Once installed, using a socket interface, we can monitor the communication at each layer and capture the data traffic for later replay and analysis. Having VPN access to the PXS, we will monitor can be done remotely from our location.

X.25 Physical Layer Protocol- X.21bis

This layer establishes the physical connection to the Host. Depending on the physical interface, DTR and DSR have to be "ON" to enter the data transfer state. Additionally LayGO software checks for received FLAGs (0x7E) to enter that state. RTS and CTS can be used in addition to enter an XON state, a sub-state of the data transfer state.

Once in data transfer state, Raw Mode HDLC frames can be sent and received. HDLC frames can be considered as an uninterrupted sequence of non-FLAG/non-ABORT characters inserted in a stream of Flags. Truncated frames are generally terminated by an ABORT (0x7F). The last 2 bytes of a frame usually contain the FCS (Frame Check Sequence) also called CRC (Cyclic Redundancy Check).

LayGO supports timers at all communication layers. If for a configured time-out period there is no traffic at the physical layer, the connection will time-out, disconnect the physical layer and try to reconnect. If unsuccessful, we inform the higher layers that the physical layer is disconnected.

Important for the physical layer to know: number of physical connections, signaling protocol, pin layout, type of connector, clock source and line speed.

X.25 Link Layer Protocol- HDLC/LAPB

Once the physical connection is established and FLAGS are being sent in both directions (flagging) the link layer above can now be established. LAPB (Link Access Procedure Balanced) uses the first 2 bytes for its protocol (if modulo 8). The connection is normally initiated by sending a SABM P=1 (Poll Bit) and awaits a UA F=1 (Final Bit) as response to enter the data transfer state. Other startup sequences disconnect first before connecting. Once in data transfer state frames can be exchanged. If the layer above is not activated, the link layer normally exchanges RR P=1/RR F=1 (IDLE RRs) as heart-beat messages. If there are no responses to the heart-beat after a certain number of retries, the Link Layer disconnects, and informs the layer above.

Important parameter for the Link Layer: T1, T2, T3 Time-Out, and N1 maximum Frame Length, N2 Retry Value, Window Size and modulo 8 or 128.

X.25 Packet Layer Protocol - X.25 Packet Level

Other than LAPB above, the PLP is a multiplexing protocol. It uses the next 3 bytes of the frame for its protocol. Multiple logical channels (LCNs) are used to establish multiple Virtual Circuits (VCs). VCs can be either Permanent (PVC) or Switched (SVC), normally a static subscription feature. Once the link layer is in data transfer state, the PLP will initiate the network connection be sending a Restart Request on LCN0. On receiving a Restart confirmation on LCN0, all circuits are initiated. If PVCs, they immediately enter the data transfer state, if SVCs Call Establishment is used to enter the data transfer state. Once in data transfer state packets can be exchanged. The Packet Layer depends on the Link Layer for error-free transmission. If after a defined time no response is received to a transmitted packet, a Reset is sent. If no Reset Confirmation is received, the SVC is cleared.

Important parameter for the Packet Layer: T20,T21,T22 Time-Out values, Default and Non-Standard Default Packet Length, Window Size, Packet Size, number of VCs, SVC or PVC, usage of M-, Q-, D-bit, and Facility Fields, etc.