

Application Note AN-0014

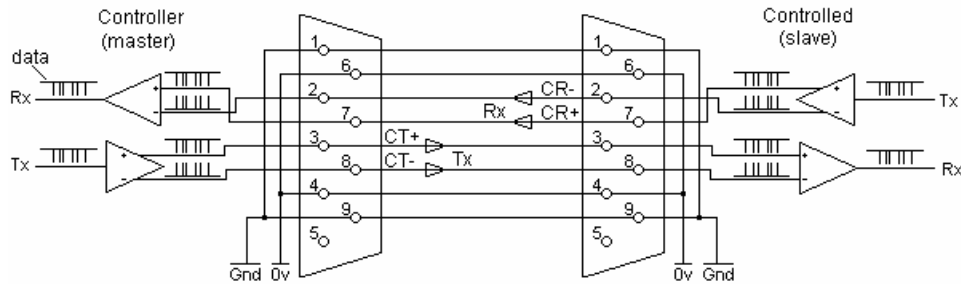
RS422 Data Routers

This application note considers some of the factors involved in RS-422 machine control routing.

The RS-422 Signal

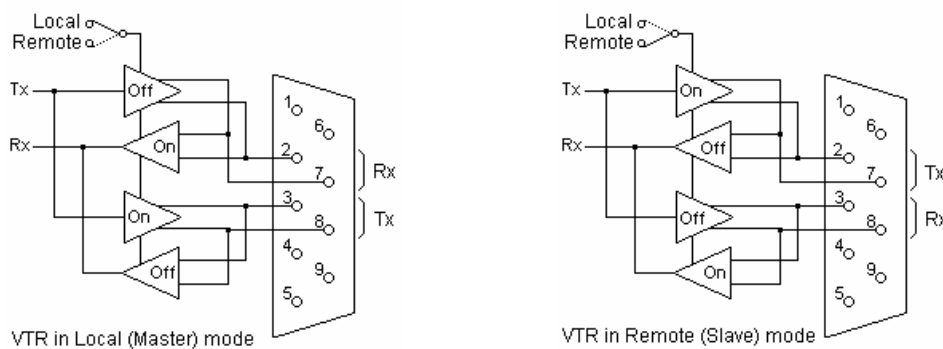
This standard was introduced in 1975 and offers a more robust system than the older RS-232 standard. It provides a balanced line with optional termination. The standard uses a voltage differential of 2v min to 5v max to represent the binary 0's and 1's. The maximum useable cable length depends on the baud rate, the driver/receiver IC's, the cable type, and the amount of electrical noise in the surrounding environment. As a guide, at the typical baud rate of 38400 approximately 1200m of cable can be driven.

For VTR control with RS-422, a separate transmit pair and receive pair are used, making up a bi-directional signal. The Dtype 9 pin connector is almost universally used. The connection between machines uses a 'straight' cable wired pin 1 to pin 1, 2 to 2 etc, as shown below.



The terms CT+, CT- are used to indicate Controller Transmit, and CR+, CR- for Controller Receive. Some VTR manufacturers use pin 5 as a status line, but the function of this is unknown.

Many VTRs have a front panel switch for Local or Remote mode. This switch changes the pins in the D9 connector that are used for Tx and Rx.



This Tx, Rx pin re-assignment was implemented to allow machine-to-machine dubbing using the standard 'straight' cable shown above, but causes problems for routing equipment. Routers with electronic inputs and outputs have to know which pins are Rx and Tx, but this is not possible as it is not known whether the VTR is in Local or Remote mode.

Data Router Operational Requirements

With a standard video router, operators can route a source to as many destinations as required e.g.

Destination	Video Source
MON-1	CAM-1
MON-2	CAM-1
MON-3	CAM-1

With an RS-422 router the signals are travelling in both directions (Tx and Rx) and so one source can only be routed to one destination at any one time. This imposes one of two operating modes on the router system, referred to as

- Mode 1: Last take wins
- Mode 2: Take from idle

Take From Idle

An operator wanting to select an RS-422 source can only select it if it was in the IDLE state. This method therefore requires operators to switch VTR's back to the IDLE source when the RS422 route is no longer required. This is the safest type of operation but can lead to problems if VTR routes are not returned to the IDLE state after use.

Auto Parking (Last Take Wins)

When an operator selects an RS422 source that was already in use, the older route is forced to the IDLE (off) condition. This is a very simple form of operation but can lead to problems when one operator accidentally takes control of a VTR that was already in use by another operator.

Starting condition

Destination	Video Source	RS422 Source
EDIT-1	VTR-1	VTR-1
EDIT-2	VTR-2	VTR-2
EDIT-3	VTR-3	VTR-3

From EDIT-1, select VTR-3

Destination	Video Source	RS422 Source
EDIT-1	VTR-3	VTR-3
EDIT-2	VTR-2	VTR-2
EDIT-3	VTR-3	-IDLE-

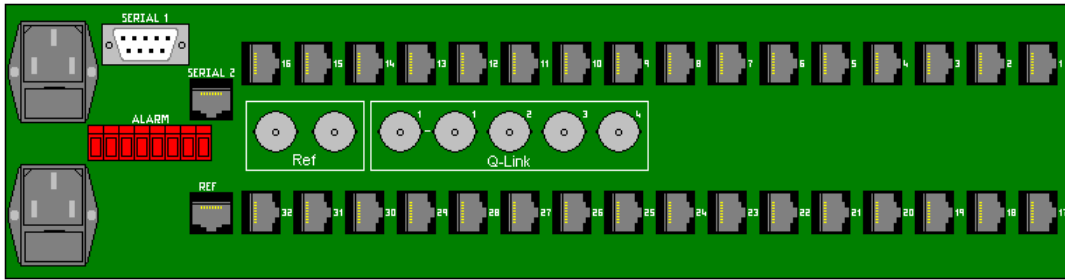
Note that EDIT-3 has lost its VTR connection on the RS422 level, and it has been forced to the idle condition.

Because of this, operators in monitoring only positions should not have access to the RS-422 level. Operators needing control of the RS-422 level should have their control panels default to 'RS-422 level not selected' and have to select this level before making a machine control route.

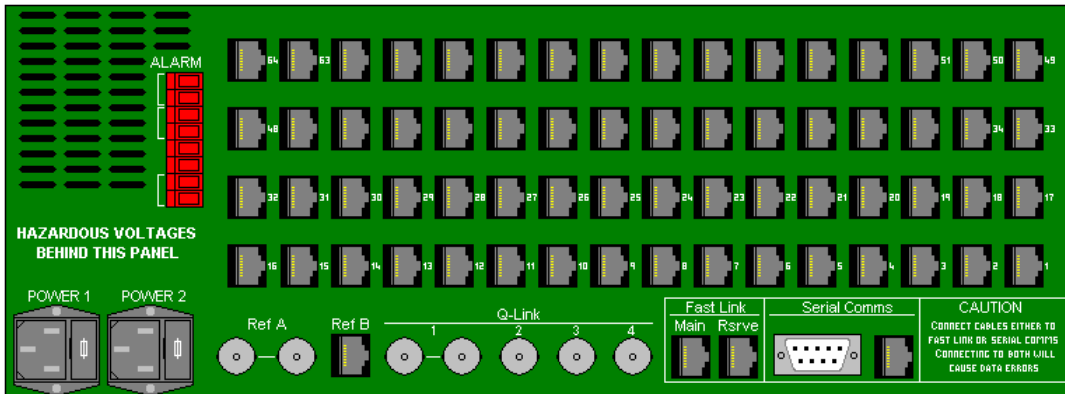
To display this correctly on control panels, the router system uses the last name in the name table, currently name 80 or 160, which by default is set to '-IDLE-', with a special source number, 254. Refer to WinSetup help for more information on configuring the routing system.

RS-422 Port Routers

These have a number of connectors, or ports, but they are NOT allocated as inputs or outputs. For a route assignment any connector can be connected to any other. In addition to port routing the Quartz Q32-PR and Q6400-PR routers also have electronic RS422 transmitter/receiver pin assignment that can assist in certain applications such as machine-to-machine dubbing. Each port pair is controlled from a dual channel SIMM and these are also available in RS232 versions.

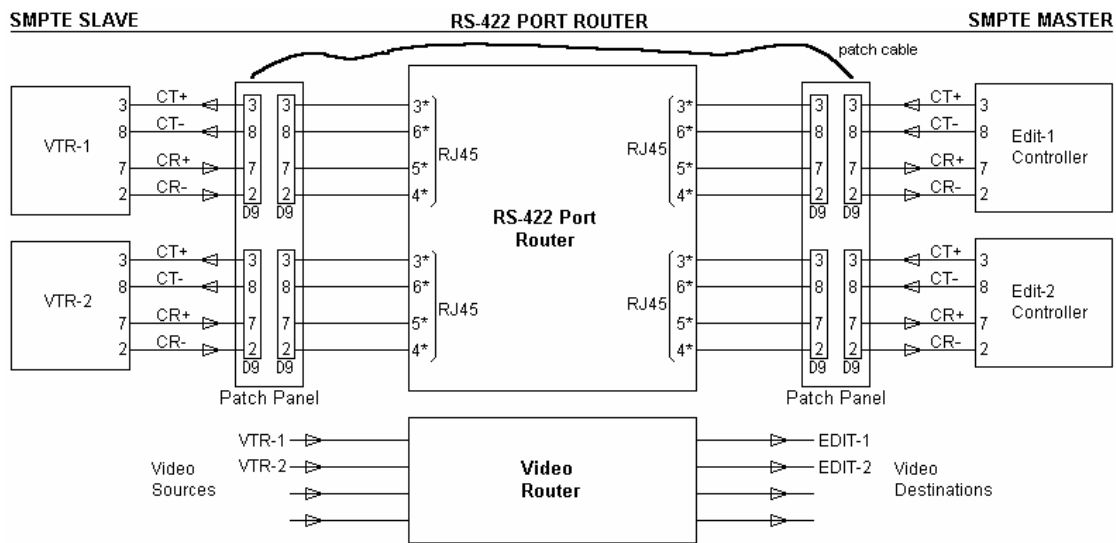


The Quartz Q32-PR Port Router



The Quartz Q6400-PR Port Router

This is the normal choice for machine control routing. This product uses electronic drivers and receivers to handle the RS422 signals, and these are wired to pins on the port connectors.



Note in the above diagram that there are no dedicated Input or Output connectors. The RJ45 Port connectors are configured electronically when the port router detects the electrical properties of the device to which it is connected. Because of this the transmit pins (3 & 6) and the receive pins (5 & 4) may swap over. The main advantage of this type of RS422 router is that the allocation of Edit Controllers and VTR's is fairly flexible such that a system could be built with 4 controllers and 60 VTR's. Also the two VTR's shown can be connected together through the port router to allow machine-to-machine dubbing.

In some applications the automatic assignment of the port router pins can cause problems. One such case is multi-drop RS422 control of one master to many slave devices, or any device that tri-states its RS422 outputs when not driving. This can cause two problems:

- 1) The port router cannot allocate the transmit and receive pins correctly as the tri-stated line does not have an RS422 driver to detect. When the line comes out of tri-state it takes a few milliseconds for the driver to be

detected and this causes a missed or corrupted start of transmission from the device just as it starts to transmit. In these cases the port router can have specific ports set with the normal Master or Slave fixed pin-outs.

2) The port routers RS422 receiver chip picks up noise when the line is tri-stated and passes this on as junk data to equipment at the end of the RS422 line. This problem has largely been eradicated by modifications to the Q32-PR and Q6400-PR RS422 SIMM's in July 2003 to provide 'pull apart' resistors. When this problem does occur, the junk data then can sit in the connected equipments software receive buffer and will cause a problem when processing the next valid message. This is sometimes seen as slow or intermittent operation. The only fix on port routers supplied after July 2003 is to disable auto-detect mode. A different manifestation of the same problem has been seen with camera control systems when the Base Station is put to the Idle route and not connected to an OCP. Stray noise pick-up on the un-driven RS422 lines can cause random changes to the video output. The normal solution to this is to route the Base Station to an unused port rather than Idle as this ensures the Base Station cable is held in the 'no data' state.

Devices that are known to cause these problems when operating are:

Manufacturer	Device Type	Model	Interface
Ash Vale	Slow Motion Ctlr	SM-2a	RS-422
Thomson	Camera Control	OCP-42	RS-422

A second case where the automatic assignment of the port router pins can cause problems is during power up of certain devices. During the remote device power-up the port router electronics receives spurious signals that can cause the auto-detect to sit in the wrong state. Again the solution is to use WinSetup and re-configure the problem device ports to be fixed rather than auto-detect.

Devices that are known to cause this problem at power up are:

Manufacturer	Device Type	Model	Interface
Sony	SVHS	SVO-9620	RS-422
Tascam	DAT	DA-98HR	RS-422

Possibly also Sony SX and IMX VTRs and Pinnacle servers.

All of the above changes may be easier to implement if the problem devices are first grouped together on a set of ports. For further information on software control of port settings see the WinSetup frame definition for a port router and select the Frame System Data tab.

The port router RJ45 pin-out is shown below:

Pin	RS422	RS232
1	0V	0V
2	Sony	n/c
3	Tx+ ^(note 1)	TXD
4	Rx- ^(note 1)	Connects to pin 6
5	Rx+ ^(note 1)	RXD
6	Tx- ^(note 1)	Connects to pin 4
7	n/c	n/c
8	n/c	n/c



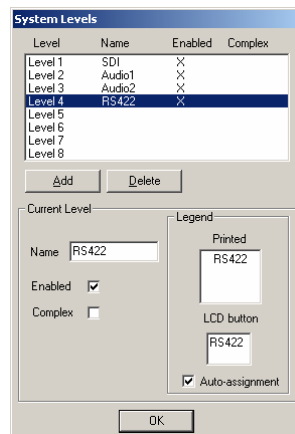
Note 1: The Tx and Rx pair can be auto-assigned (swapped), fixed as Tx/Rx, or fixed as Rx/Tx, depending on the WinSetup configuration.

Configuring Q32-PR & Q6400-PR Port Routers

The Quartz program WinSetup is used to configure all Quartz routers. There are four main stages to configuring a port router, adding a RS422 level, selecting the router type, adding the names to the name table, and configuring the ports.

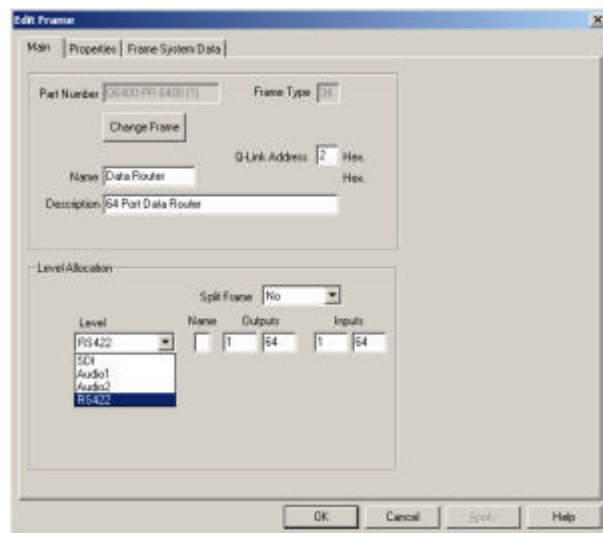
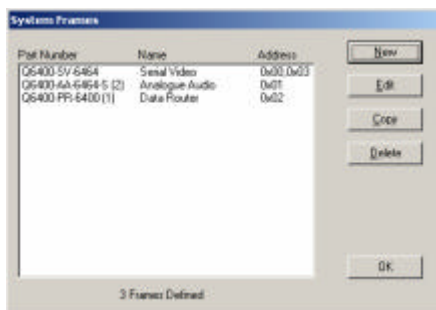
Adding the RS422 Level

From the WinSetup front screen, select Levels, then select the first un-used level and give it a meaningful name such as RS422.



Selecting the Router Type

From the WinSetup front screen, select Frames, New, and then select RS422/Relay. Select the port router type that most matches the type of operation you require, so select Q6400-PR-6400 (1) for Take from Idle, and select Q6400-PR-6400 (2) for Auto-Part or Last Take Wins.



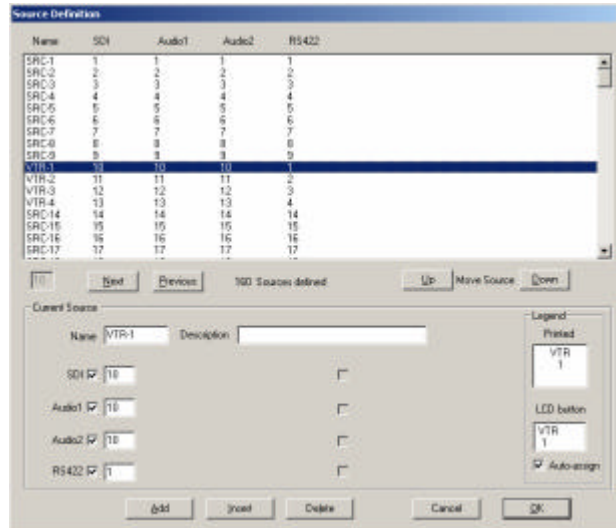
From the Frame dialog, attach the frame to the correct control level, RS422 in the example above.

Generating the Name Table

There are lists of names for the router sources and destinations, referred to as the source and destination name tables.

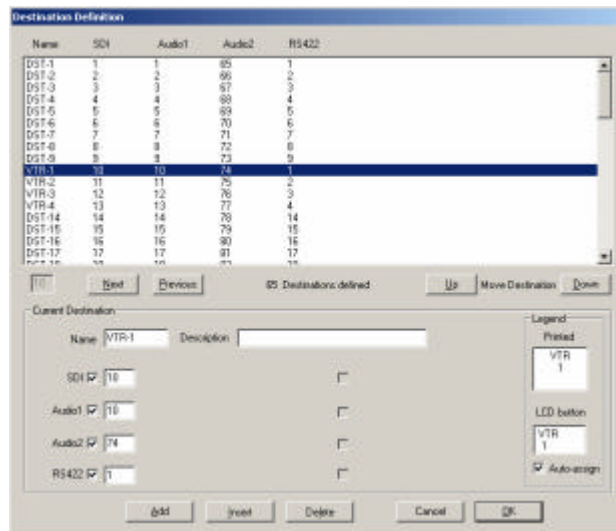
From the WinSetup front screen, select Sources, and add a block of sources if the name table is currently blank.

Add the names of the VTR's to be controlled, VTR-1 to VTR-4 in the example below.

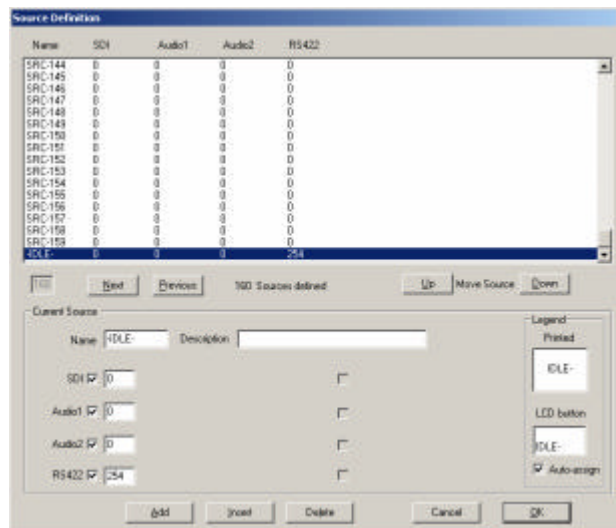


From the WinSetup front screen, select Destinations, and add the VTR destination names.

Important, for FU-0003 controller based systems the source and destination names must both be located on the same rows on the two name tables. In the example above VTR-1 to VTR-4 appear on rows 10-13 of both the source and destination name tables.



Return to the source name table and add the IDLE source in the last position of the name table, name 160 on V5 systems. Add the special input number 254 in the RS422 level.



Configuring the Ports, 2-32 Ports

For port routers with no more than 32 ports the WinSetup, Port Router, System Data Bytes are allocated as below:

0 Baud rate	1 Data bits	2 Parity	3 Boot I/P
4 Protocol dependent	5 Protocol dependent	6 Protocol dependent	7 Protocol dependent
8 Port 1-4 mode	9 Port 5-8 mode	10 Port 9-12 mode	11 Port 13-16 mode
12 Port 17-20 mode	13 Port 21-24 mode	14 Port 25-28 mode	15 Port 29-32 mode

A single system data byte is divided into four two-bit codes to determine the direction of the transceivers for each port in the system. The following shows how system data byte 8 is used to configure the four RS422 ports under its control (Ports 1-4).

System data byte 8

Bit 7 Bit 6 SIMM 1 Port 2 Mode	Bit 5 Bit 4 SIMM 1 Port 1 Mode	Bit 3 Bit 2 SIMM 2 Port 4 Mode	Bit 1 Bit 0 SIMM 2 Port 3 Mode
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Two bit codes are:

- 00 = Auto-detect direction. SIMM will sense the external transmitter and set the Tx/Rx pair accordingly.
- 01 = Sony pin 5. Pin 5 high = Tx on pins 3,6 & Rx on pins 5,4. Pin 5 low = Tx on pins 5,4 & Rx on pins 3,6
- 10 = Controller Mode. Tx on pins 5,4 & Rx on pins 3,6
- 11 = Slave Mode: Tx on pins 3,6 & Rx on pins 5,4

As an example, if the Q6400-PR-32 router was required to be a 16 input (Port 1-16) and 16 output (Ports 17-32) router then the system data bytes would be set to the following:

8 0xFF	9 0xFF	10 0xFF	11 0xFF
12 0XAA	13 0XAA	14 0XAA	15 0XAA

There are two LED's fitted to each RS422 SIMM that show the direction of the port. LD3 shows the direction of the first port and LD4 shows the direction of the second port. The LED illuminates when the port is in Controller mode (Tx on pins 5,4 & Rx on pins 3,6) and is off in Slave mode. In Auto and Sony modes the LED also illuminates to show which is the Tx and RX pairs.

Configuring the Ports, 34-64 Ports

For the port routers larger than 32 ports the WinSetup, Port Router, System Data Bytes are allocated as below:

0 Baud rate	1 Data bits	2 Parity	3 Boot I/P
4 Protocol dependent	5 Protocol dependent	6 Protocol dependent	7 Protocol dependent
8 Port 1-8 mode	9 Port 9-16 mode	10 Port 17-24 mode	11 Port 25-32 mode
12 Port 33-40 mode	13 Port 41-48 mode	14 Port 49-56 mode	15 Port 57-64 mode

A single system data byte is divided into four two-bit codes to determine the direction of the transceivers for each SIMM in the system. Each SIMM I/O card supports two ports, so the configuration granularity is 2 ports. The following shows how system data byte 8 is used to configure the eight RS422 ports under its control (Ports 1-8).

System data byte 8**Bit 7 Bit 6**SIMM 1
Port 1 & 2 Mode**Bit 5 Bit 4**SIMM 2
Port 3 & 4 Mode**Bit 3 Bit 2**SIMM 3
Port 5 & 6 Mode**Bit 1 Bit 0**SIMM 4
Port 7 & 8 Mode

Two bit codes are:

00 = Auto-detect direction. SIMM will sense the external transmitter and set the Tx/Rx pair accordingly.

01 = Sony pin 5. Pin 5 high = Tx on pins 3,6 & Rx on pins 5,4. Pin 5 low = Tx on pins 5,4 & Rx on pins 3,6

10 = Controller Mode. Tx on pins 5,4 & Rx on pins 3,6

11 = Slave Mode: Tx on pins 3,6 & Rx on pins 5,4

There are two LED's fitted to each RS422 SIMM that show the direction of the port. LD3 shows the direction of the first port and LD4 shows the direction of the second port. The LED illuminates when the port is in Controller mode (Tx on pins 5,4 & Rx on pins 3,6) and is off in Slave mode. In Auto and Sony modes the LED also illuminates to show which is the Tx and RX pairs.

RS-485/422 Compatibility

RS-485 is a derivative of the RS-422 standard. All the main operating voltage levels are the same assuring a high degree of compatibility (99%) with Quartz port routers and other equipment. The RS485 standard supports 2-wire and 4-wire modes. The 4-wire mode is the universally preferred and supported option. Check that the device to be connected is using the 4-wire mode. This will be the case if the device connector has a transmit pair (Tx+ & Tx-) and a receive pair (Rx+ & Rx-).

Some RS-485 (and RS-422) devices will tri-state (Hi-Z) their driver when not transmitting, effectively disconnecting the device and rendering it transparent. This may cause problems for the port router when used in auto-detect mode. For these devices, the port routers individual port must be configured to turn off the auto-detect mode. This locks the transmit and receive pairs to their respective connector pins.

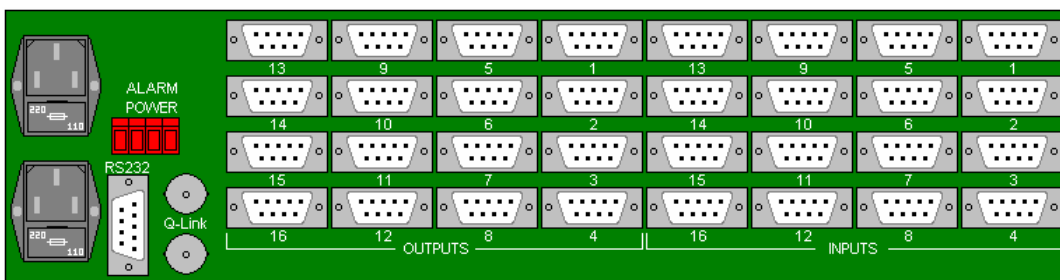
Appendix A: Older Product

As the port routers Q32-PR and Q6400-PR have been used in more and more applications, minor interface problems have been discovered with the SIMM based auto detect circuit when connected to some devices. This means that in some applications the auto-detect circuit has had to be operated in manual mode. The SIMM module has been updated to remove or at least reduce these problems.

SIMM Part Number	Issue	Date	Notes
M-RS-R485-2-00	D1	01-04-04	RS422 pull-apart resistors of 33K used
M-RS-R485-2-00	C2	31-07-03	RS422 pull-apart resistors of 5K6 used
M-RS-R485-2-00	C1	01-07-03	RS422 pull-apart resistors of 3K3 used
M-RS-R485-2-00	B1	07-05-03	RS422 pull-apart resistors positions added to PC-268-B1
M-RS-R485-2-00	A1	27-09-01	First release uses PC-268-A1

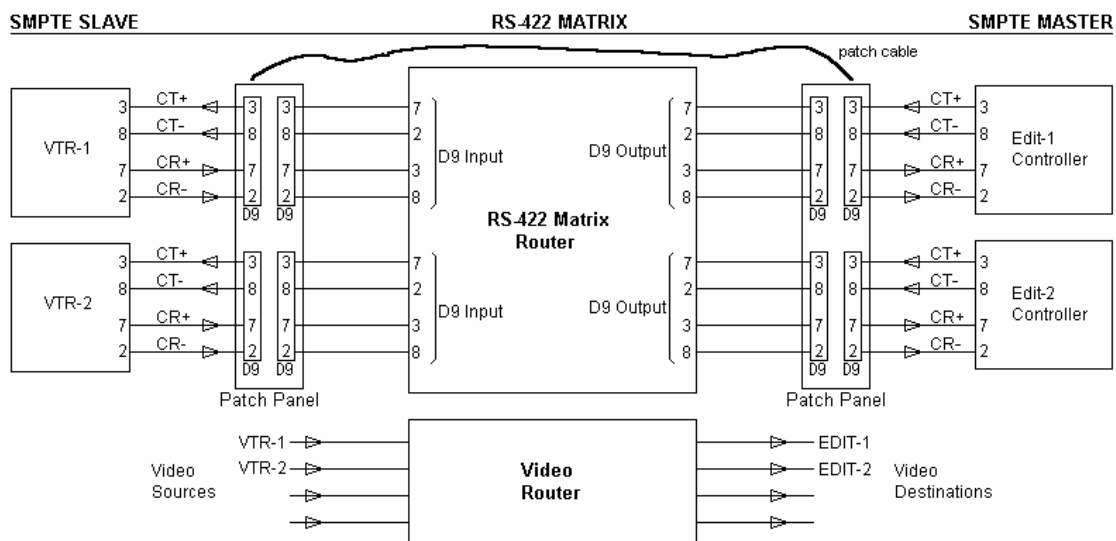
RS-422 Matrix Routers

These have both input and output connectors. For a route assignment an input connector can only be connected to an output connector.



The Quartz Q1600-RS-1616 Matrix Router

This was the preferred choice for machine control routing, but the Q32-PR and Q6400-PR routers for most applications have superseded this product.

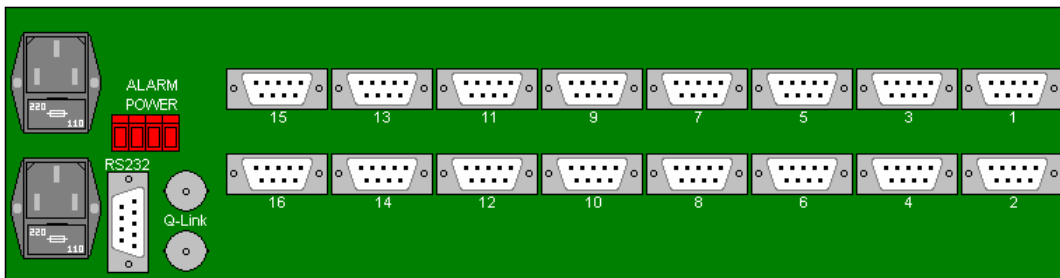


This product uses electronic drivers and receivers to handle the RS422 signals, and these are wired to dedicated pins on the input and output connectors. The above diagram also shows the use of RS422 patch panels that allow the RS422 router to be by-passed for maintenance or to make less common connections not available on the router.

During some edit sequences it is necessary to route a VTR to equipment such as an AVID, and then route the AVID back to a VTR, even the same VTR, for the final record. This requires two routes to be made by the operator. The first route makes the VTR-to-AVID connections (video & audio & RS422) in the 'play' direction. The next route makes the AVID-to-VTR connections (video & audio, but not RS422).

RS-422 Port Routers, Relay Based

This product is similar in concept to the port routers described above but uses relays as the main switching elements.



The Quartz Q1600-RR-1600 Port Router

The Q32-PR and Q6400-PR routers have superseded this product in the majority of applications.

Older Product Software Requirements

The earliest firmware that fully supports RS-422 machine control routers is

Router Type

- Master Router with old fixed processor (no take from idle)
- Master Router with old removable processor (no take from idle)
- Master Router with current removable processor
- RS-422 Router with removable processor
- RS-422 Router GAL (Sierra xpt)
- RS-422 Router GAL (Actel xpt)

Firmware

- SYS-1 V4.04 or later
- PC150-1 V4.07 or later
- PC150-1 V4.34 or V5.02
- PC-150-1 V4.07 or later
- G009 V1.1
- G023 V1.0

Appendix B: RS-422 Matrix Routers: Different Operating Mode

It is possible in some installations to wire the RS422 Matrix Router 'back-to-front'. This works when the RS422 controlling device and is shown below.

