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pickering

USER MANUAL

Model No. **20-750/750A**

GHZ R.F. Switching Matrix Module

Designed & Manufactured by:-

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HELP!!!

If you need assistance with your Pickering Interfaces Switching System: *Switching problems, Programming or Integration within your Test System. – Please ring Pickering Interfaces and ask for "Technical Support".*

Alternatively you may fax, email or connect to our Internet Web Site.

A full set of operating manuals, application notes and software drivers is available on CD ROM.

Contents

Section 1
1.3GHz RF Matrix Module, Type 20-750 5

Section 2
Constructing Large RF Matrix Systems 13

Section 3
Self Test 15

Section 4
Programming 17

Section 5
Front Panel Layout 19

Section 6
Reconfiguring Driver Card to Your Application 23

Section 7
Circuit Diagrams 25

Section 8
Electrical, Environmental, Mechanical & Firmware Specifications 27

Section 1
1.3GHz RF Matrix Module, Type 20-750

1.1 Features

- 8 x 4 R.F. Matrix Expandable to Over 300 Crosspoints
- Bandwidths to 1300MHz
- Built-in Automatic ”Loop Through” Simplifies Construction of Large High Performance RF Matrices (With Minimal Signal Degradation)
- 50 or 75Ω Versions with Choice of BNC or SMA Connectors
- Built-In Self Test
- Very High RF Isolation

1.1.1 Description

Model 20-750 is a high performance 8 x 4 matrix module with a bandwidth of over 1.3GHz with expansion capability to beyond 300 crosspoints, built-in self test and a choice of connector types in both 50Ω and 75Ω versions.

Applications will include routing high frequency signals to and from oscilloscopes, network/spectrum analysers, signal generators and synthesizers, switching high frequency logic and many other situations involving coaxial switching. 75Ω versions are suitable for telecoms and high quality video switching applications.

Easy expansion using automatic “Loop Through” switching, each X and Y input channel has an associated output channel, all un-selected input channels will automatically be switched to the corresponding output channel. This allows for simple expansion (with little performance loss) and permits the user to place matched terminations on all output channels, if required.

For a summary of switching capabilities please refer to table 1.2.

This is a double height module and **must** be mounted in a double height (6U) case.

1.1.2 Front Panel

The module front panels are illustrated in Section 5, they comprise of three elements:

Status Display, 4 LED Indicators:-

Power LED	Connected to system power supply.
Active LED	On whenever one or more matrix switches are closed. For a list of all active crosspoints use the VIEW? command.
Self-Test LED	Active when self-test in progress.
Error LED	Indicates that error found during self-test.
Self-Test Button.	Press to initiate a self-test, this will first clear the matrix, then perform a self-test. While in progress the “Self-Test” LED will be on, if a failure is detected then the “Error” LED will be set on permanently. Use the DIAGNOSTIC? command to find the exact cause of any failure, refer to section 3 for further details. NB: Self-Test button will only respond when matrix is inactive (i.e. no crosspoints set).
Matrix Connector.	Provides connection to and from matrix, 24 x co-axial connectors, 12 entering the matrix and 12” loop through” connections out.

1.1.3 Matrix Range

The 4 members of the 20-750 RF matrix range are given below:

Standard Range **20-750-501** 800MHz BNC Version, 50Ω **20-750-511** 1000MHz SMA Version, 50Ω **20-750A-511** 1.3GHz SMA Version, 50Ω **20-750-701** 800MHz BNC Version, 75Ω **20-750-711** 1000MHz SMA Version, 75Ω Other connector styles may be available, please contact factory for further information.
Matched Terminators
20-789-501 50Ω BNC Terminator Plug 20-789-502 50Ω SMA Terminator Plug 20-789-701 75Ω BNC Terminator Plug 20-789-702 75Ω SMA Terminator Plug
Optimised Matrix Modules are available to special order which are tailored to a specific frequency range.

Other connector styles may be available to special order, please contact sales office to discuss your requirements.

Table 1.1 20-750 Product Order Codes

1.2 Matrix Module Construction

This matrix is constructed using electro-mechanical coaxial relays giving consistent and reliable performance from DC to beyond 1.0GHz. The switching circuitry has been designed to provide the user with a versatile matrix without compromising the RF performance.

Great care must be taken when using this unit to maintain RF performance by not introducing stubs (e.g. “T-junctions” in external cabling), all cabling must be point to point with due attention paid to terminating all RF sources, refer to section 2. Failure to observe basic precautions will seriously degrade performance, particularly return loss (VSWR).

Only one crosspoint may be selected on any one row or column (*i.e. maximum of four selected crosspoints per module*). So if a new crosspoint is selected with one already on in that row or column, then the old crosspoint will first be automatically cleared.

(This facility requires use of EPROMs for the 20-750 and 10-920-921 interface dated after December 1992).

The 20-750 is a complex RF matrix module, so please contact factory if you require further help using or programming this module.



Fig 1.1 20-750 8 x 4 Matrix Module

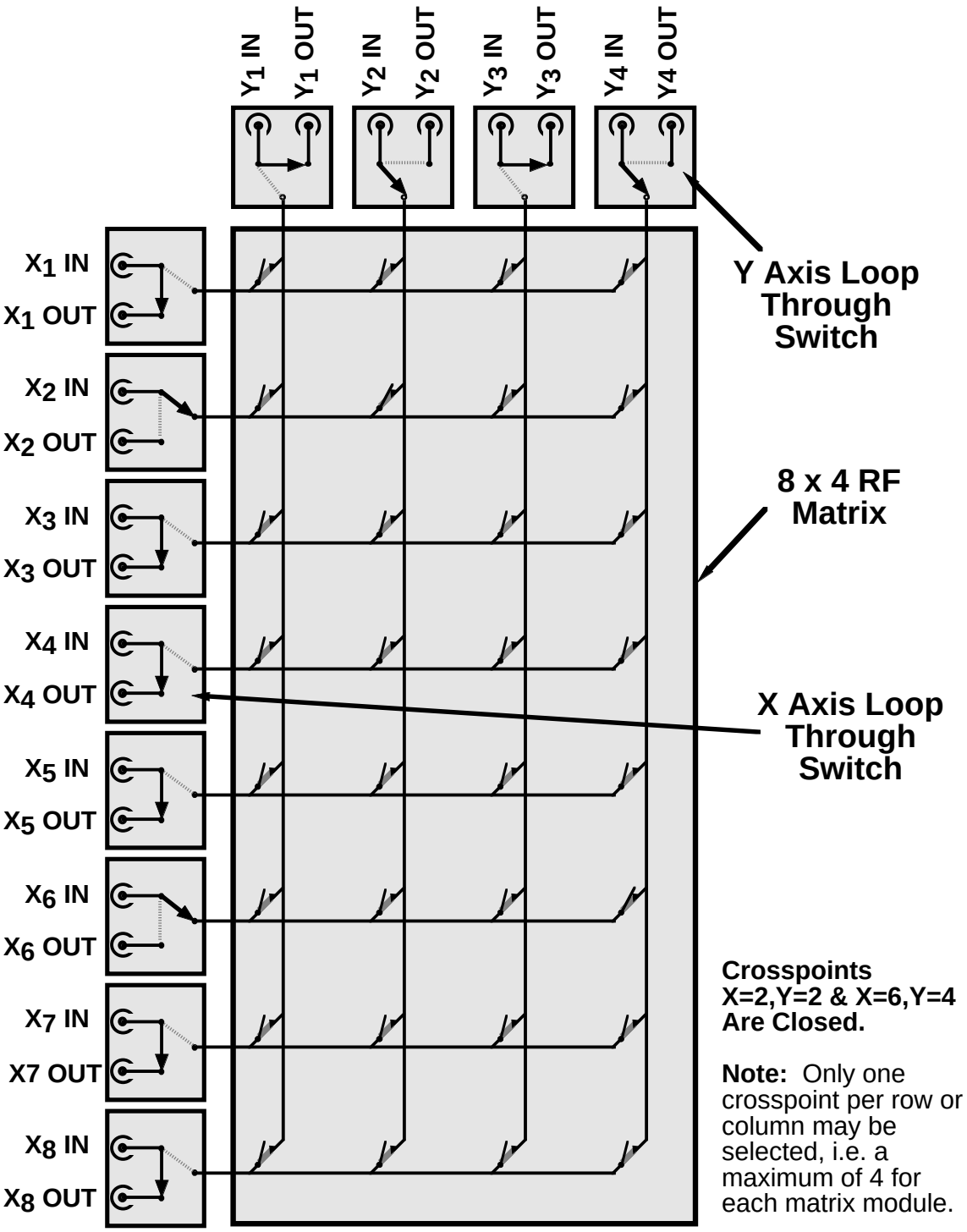


Fig 1.2 Schematic of 8 x 4 RF Matrix Module

1.3 Specification and RF Plots

Specification (All Versions)

Isolation (at 2000MHz)	> 60dB
Crosstalk (at 2000MHz)	> 50dB
Maximum Voltage	100V d.c.
Maximum Power	10W
Maximum Carry Power (900MHz)	15W
Maximum Switch Current	0.1A
On Path Resistance	< 500 mΩ
Off Path Resistance	> 10^8 Ω
Differential Thermal Offset	< 20µV
Expected Life (Low Power)	> $2x10^7$ ops
Expected Life (Max Power)	> $3x10^5$ ops
Switching Time	20mS

Specification (50Ω BNC Version)

Rise Time	< 0.3nS
Max Insertion Loss (0 to 1000MHz)	< 3dB
Max V.S.W.R. (0 to 800MHz)	< 1:1.9

Specification (20-750-511: 50Ω SMA Version)

Rise Time	< 0.3nS
Max Insertion Loss (0 to 1000MHz)	< 3dB
Max V.S.W.R. (0 to 1000MHz)	< 1:1.8

Specification (20-750A-511: 50Ω SMA Version)

Rise Time	< 0.3nS
Max Insertion Loss (0 to 1300MHz)	< 3dB
Max V.S.W.R. (0 to 1300MHz)	< 1:1.8

Specification (75Ω BNC Version)

Rise Time	< 0.3nS
Max Insertion Loss (0 to 1000MHz)	< 3dB
Max V.S.W.R. (0 to 800MHz)	< 1:1.9

Expanded Matrix Typical Performance (50Ω SMA)

Typical performance figures are given below for expanded matrix modules (SMA versions) with both 2 and 4 modules chained together (losses due to coaxial cabling were small).

	2 Modules	4 Modules
Typ Insertion Loss (0 to 1000MHz)	< 2dB	< 3.5dB
Typ V.S.W.R (0 to 1000MHz)	< 1:1.8	< 1:2.0

Please contact factory if more detailed information on expanded matrix performance is required.

Table 1.2 General Specification

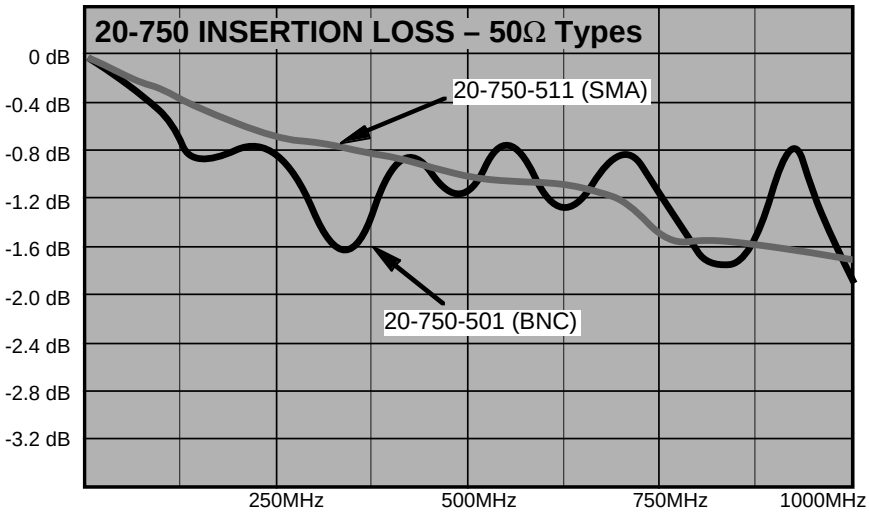


Fig 1.3 Typical Insertion Loss: 8 x 4 Matrix 50Ω

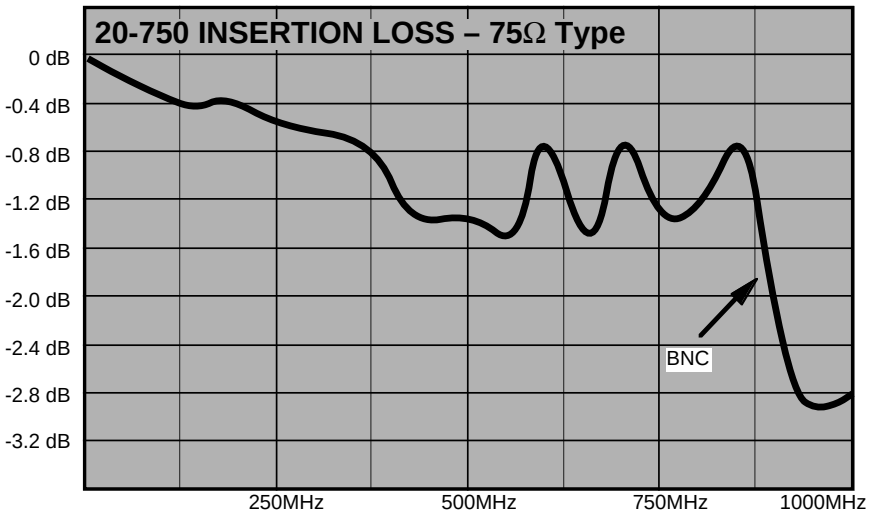


Fig 1.4 Typical Insertion Loss: 8 x 4 Matrix 75Ω

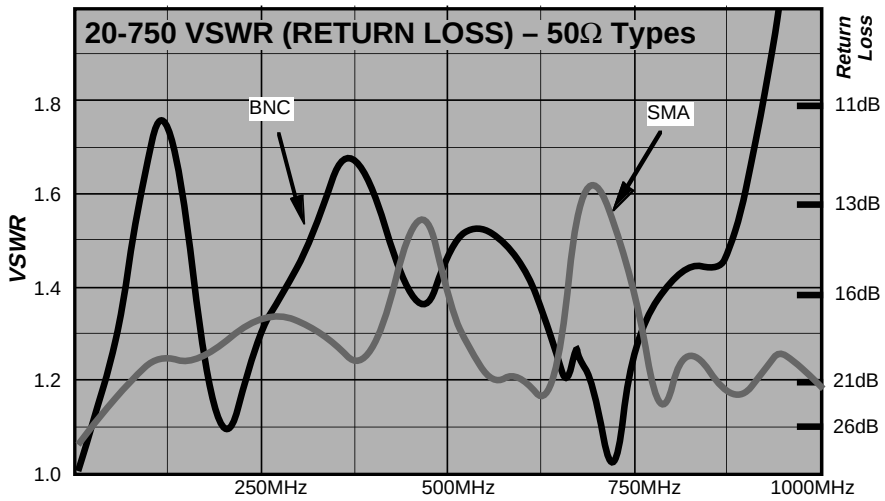


Fig 1.5 Typical Return Loss: 8 x 4 Matrix 50Ω

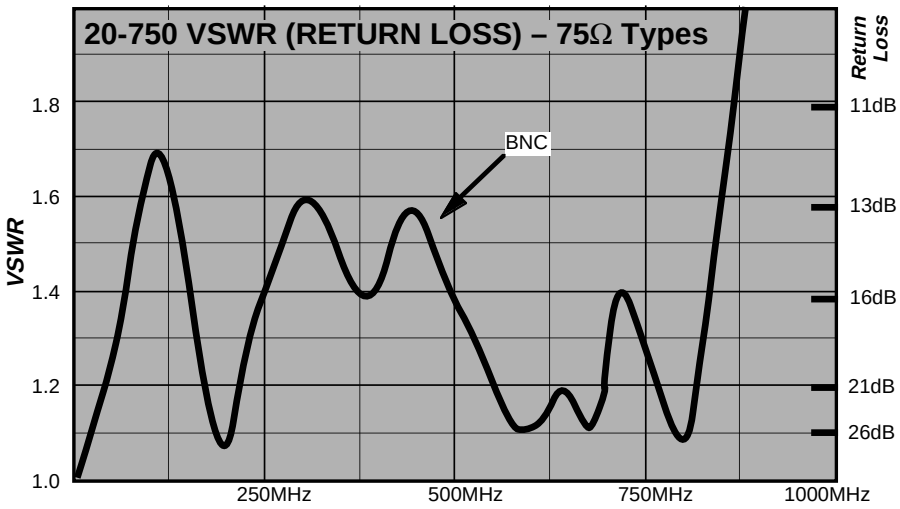


Fig 1.6 Typical Return Loss: 8 x 4 Matrix 75Ω

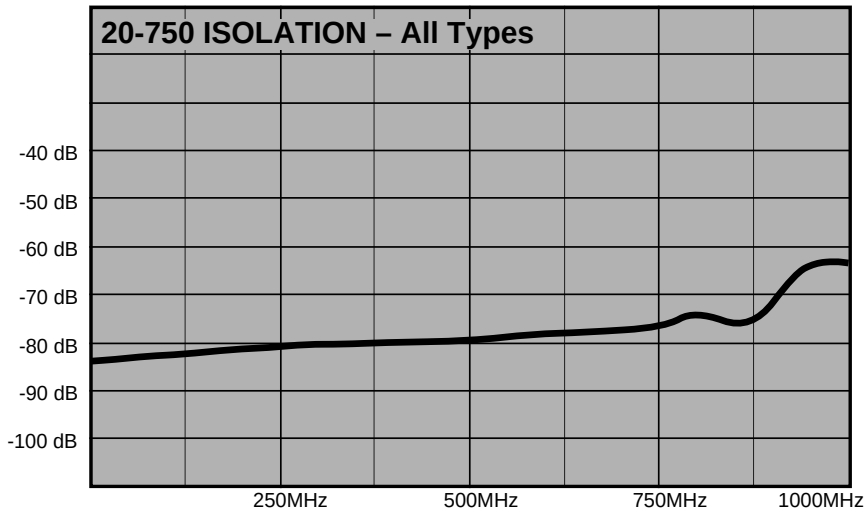


Fig 1.7 Typical Isolation: 8 x 4 Matrix

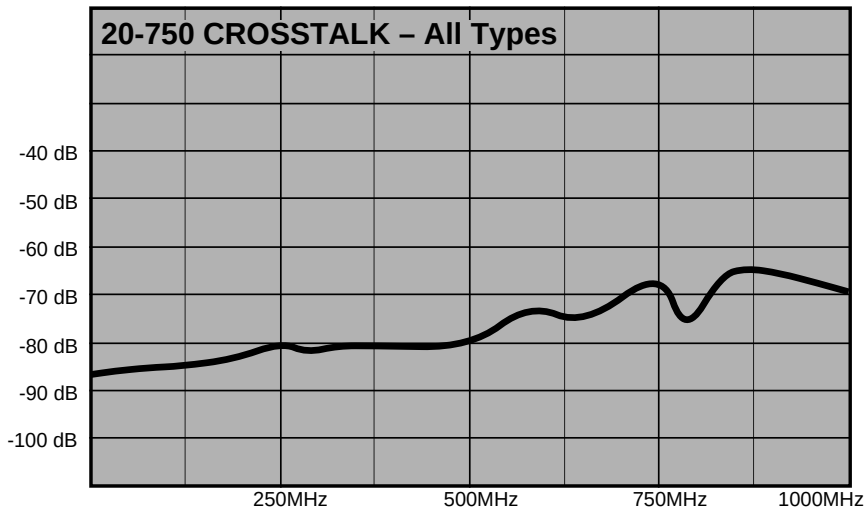


Fig 1.8 Typical Crosstalk: 8 x 4 Matrix

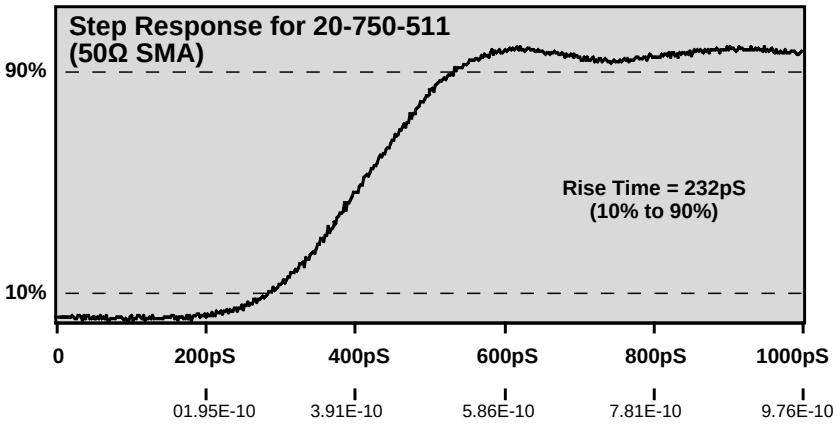


Fig 1.9 Typical Step Response: 8 x 4 Matrix, 50Ω SMA

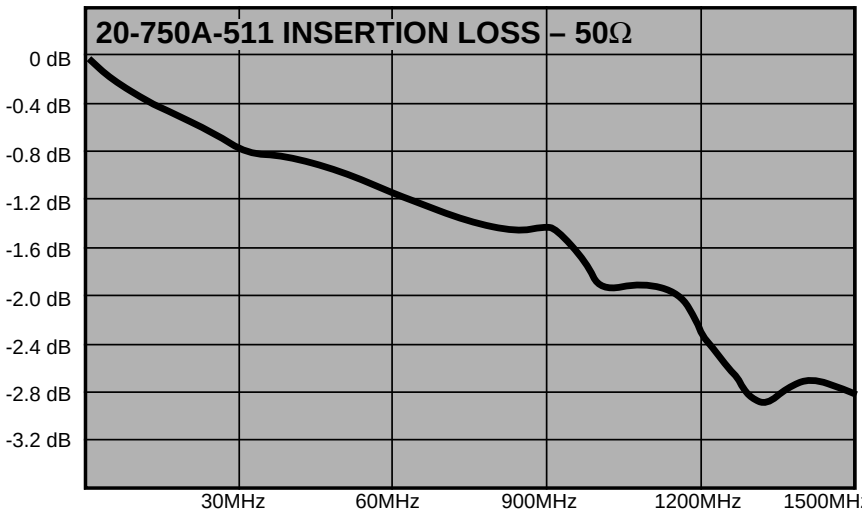


Fig 1.10 Typical Insertion Loss: 20-750A-511, 8 x 4 Matrix 50Ω



Fig 1.11 Typical Return Loss: 20-750A-511, 8 x 4 Matrix 50Ω

Section 2
Constructing Large RF Matrix Systems

2.1 RF Matrix Construction Using Model 20-750

The 20-750 has been designed to allow very easy construction of a large RF matrix, every module has automatic "loop through" switches on each coordinate row and column, thus matrix modules may be daisy-chained with little performance loss.

A typical example of a 16 x 8 matrix is shown in Fig 2.1, here 16 channels on the x axis may be switched to 8 channels on the y axis (maximum of 8 crosspoints may be selected simultaneously), the "loop through" switches on each matrix module ensure that the signal is routed to the correct RF matrix module

2.1.1 Simple Expansion

RF matrix systems may be expanded by simply adding more matrix modules and daisy-chaining the additional modules onto your current matrix, performance will not be greatly reduced, furthermore existing software will need very minimal update (see below).

2.1.2 Automatic Termination of Unselected Lines

The "Loop Through" Switch capability on each matrix module means that if termination of all unused signals is required, then all the user must do is add a terminator to the "loop though" connector at the end of the coaxial daisy-chain. This terminator will then be automatically selected without any further software intervention.

The 20-750 is available with a choice of connector types, however BNC connectors will reduce matrix RF performance, so for applications requiring maximum performance and reliability the SMA versions are usually preferred.

2.1.3 Very Straightforward Software Control

Programming the RF Matrix is very simple, to operate a crosspoint only the x and y coordinates within the whole matrix need be known, the exact location of matrix modules and switches is not required. To program an RF Matrix only three commands need be used:-

MCLOSE a,x,y	This closes the crosspoint at coordinate x, y on matrix a.
MOPEN a,x,y	This opens the crosspoint at coordinate x, y on matrix a.
RESET a	Clears all crosspoints on the addressed matrix.

Each matrix comprises of up to 30 matrix modules (e.g. from 8 x 4 up to 64 x 16), the location of each matrix module within the whole matrix is determined by DIP switches set on each module, refer to section 4.

2.2 "Partially Filled" Matrices

For users requiring very large RF matrix systems the cost of a fully populated matrix may prove prohibitive, in many instances a combination of RF multiplexer input/output and small "core" matrix may prove quite acceptable. This approach may prove to be more effective in terms of both cost and performance, the main draw backs being additional programming complexity and restricted matrix versatility (particularly for future unforeseen requirements). Please contact Pickering if you wish to discuss your matrix application in greater detail.

Pickering can build large RF Matrix systems constructed and tested to your exact requirements, please contact sales office for further details.

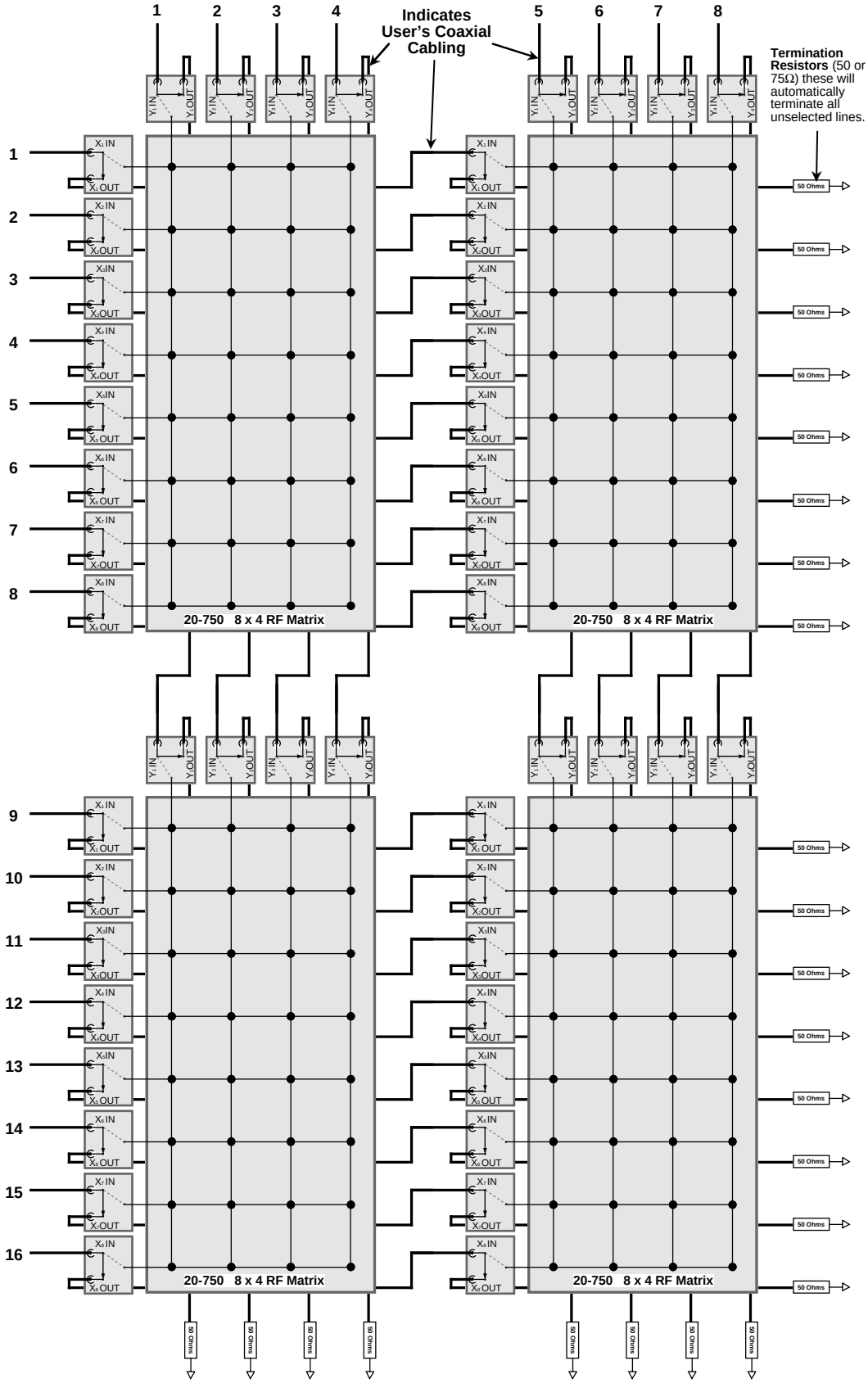


Fig 2.1 Typical Example: 16 x 8 Matrix
(with external terminators on all outputs)

Section 3
Self Test

3.1 Self-Test Function

Self-Test is invoked at power on and may also be operated under software (*TST?) or via a recessed push button. Self-Test pass is indicated on a front panel LED with a full pass/fail description available using the DIAGNOSTIC? command.

Self-Test comprises 2 levels, see Fig 3.1:-

1. **Logic Test**: Checks all logic including on-board microprocessor, relay drivers etc.
2. **Relay Coil Test**: All relay coils are checked for continuity.

Note: **A spare relay** is mounted onto the relay circuit board for fast repair, additional relays are available from Pickering Interfaces.

3.2 Self-Test Operation

Self Test is always run at power on. If self test is run under software control it will firstly **clear the whole matrix** (Manual Test will only function when the module is in a clear state). So it is very important to prepare your external instruments and U.U.T. for this! During self-test all loop-through relays are opened so your external circuitry will see only the loads that have been externally added.

When the self-test has finished the matrix will be returned to an all clear state (i.e. the previous state will not be remembered!).

Please note that because of the long self-test time, that your computer may timeout waiting for the test result (many PC's have default timeouts set to **10 seconds**).

3.3 Detailed Self-Test Reporting using the DIAGNOSTIC? Query

The DIAGNOSTIC? query will give an ASCII string detailing any self test failures. These will include:-

Logic: µP, RAM, EPROM, Relay Drivers, Invalid Link Settings etc.

Relay Coils: Open Circuit Coil. The reference number of the failed relay will be returned (in the range 1 to 64, refer to Fig 7.2 for relay positions).

This string is not intended to be processed by the user's software, it is suitable for copying directly onto the screen of your control computer. This information will then indicate maintenance required (please contact Pickering for further help).

Please Note: If a relay does fail then great care must be taken replacing it.

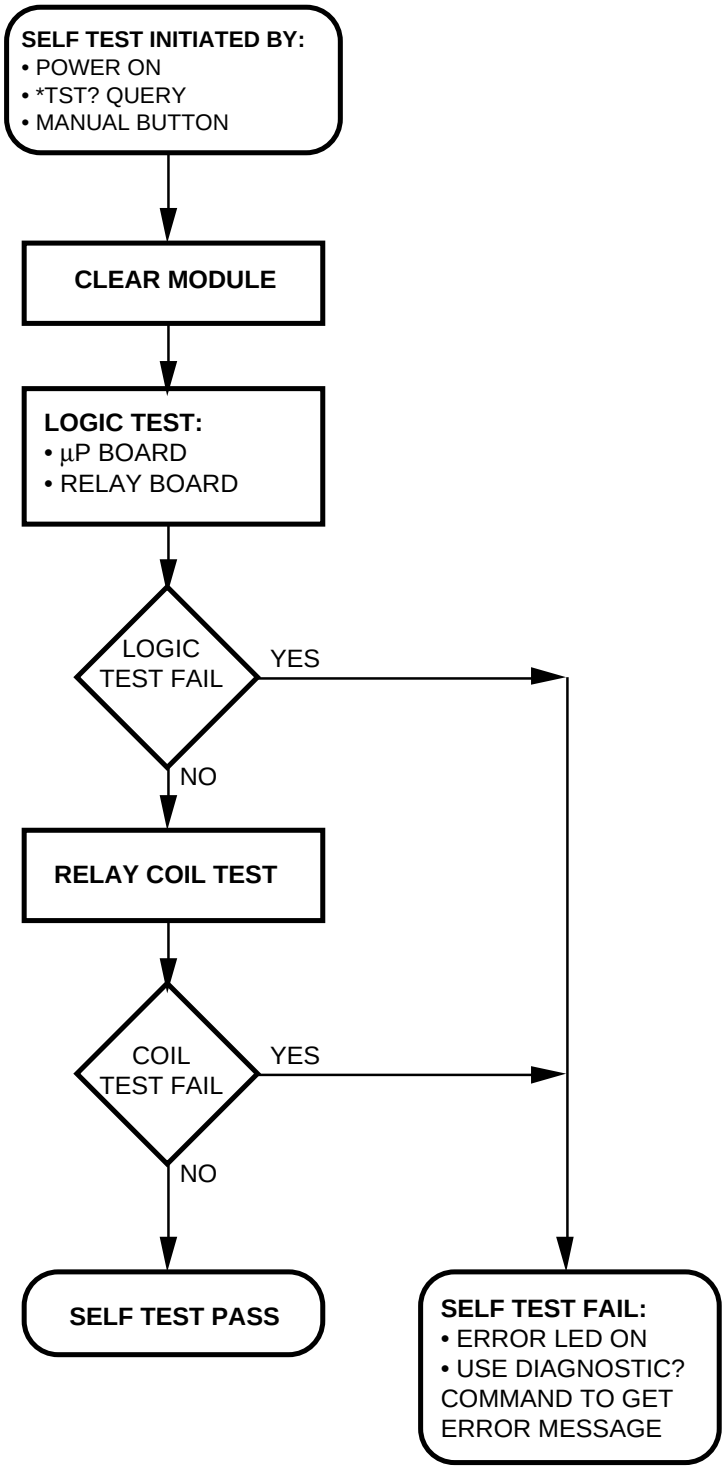
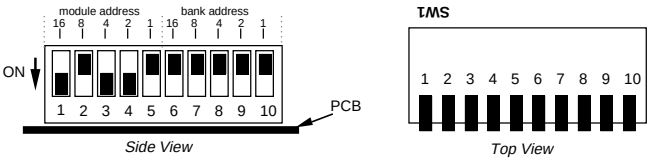


Fig 3.1 Self-Test: Basic Flow Diagram

4.1 Select Module Address

Choose module address (from 0 - 30) using the address select switch (SW1) on the driver card.



The module address selected in the illustration is 22 (i.e. 16 + 4 + 2 = 22).

4.2 Select Module Bank Address

When more than one module is used to make up a large matrix (see Fig 2.1 where four modules are used to make up a 16 x 8 matrix), then all matrix units **must** have the same module address, the location of each module within the matrix is given by its bank address. The matrix bank address is composed of x and y components, these determine the individual matrix modules position within the larger matrix.

X_2	X_1	X_0	Y_1	Y_0

The bank address is constructed using 5 bits, see diagram, 3 bits for x and 2 bits for y. For example bit settings 0 0 1 0 0 represent bank address x = 1, y = 0.

There **must** always be a module present at the base address x = 0, y = 0, otherwise the matrix will not be recognised by the intelligent interface (10-920/921).

If there is a problem with any of the modules used to make up a large matrix then an error will be detected (use the DIAGNOSTIC? query to discover the cause).

4.3 Using the Intelligent IEEE-488.2 or RS-232 Interface

Switching matrices are controlled using the MCLOSE and MOPEN commands:-

To close switch at position X = 5, Y = 3 on matrix with address 11.

```
MCLOSE 11,5,3
```

Now to look at status of matrix 11.

```
VIEW? 11
```
will return “5,3”

To open last switch and close switches at positions X = 1, Y = 1 and X = 2, Y = 2 on matrix 11.

```
MOPEN 11,5,3;MCLOSE 11,1,1;MCLOSE 11,2,2;
```

Now to look at status of matrix 11.

```
VIEW? 11
```
will return “1,1;2,2”

To reset all switches on matrix 11.

```
ARESET 11
```

Now to look at status of matrix 11.

```
VIEW? 11
```
will return “0,0" - 0,0 indicates no coordinates set.

Important Note: Only **ONE CROSSPOINT** may be active on any one row or column at a time, so when setting a new crosspoint on any one row or column the original crosspoint will be automatically cleared!

4.4 Instruction Set

The Matrix module is very easy to program using the Model 10-920 IEEE-488.2 Interface:-

`ARESET a`	Open all switches on device a
`MCLOSE a,x,y`	Close switch at coordinates x,y on matrix a
	Only one crosspoint allowed to be selected on any one row or column. So remember to open the previous crosspoint before selecting the next one on any row/column.
`MOPEN a,x,y`	Open switch at coordinates x,y on matrix a
`RESET`	Open all switches on all modules
`VIEW? a`	View status of device a.

Self Test Functions:-

`DIAGNOSTIC?`	Return diagnostic string (self test fail details, if any)
	Refer to Sec 3.3 for further details
`*TST?`	Execute Full Self Test (IEEE-488.2 query)

4.5 Operating Speed

Matrix operating speed, i.e. the time taken to open or close a crosspoint, is approximately 25mS using the 10-920 IEEE-488.2 interface module. If higher throughput is required please use model 10-921, reducing this time to below 10mS, in addition it has a very much faster I/O buffer rate of 50kBytes per second.

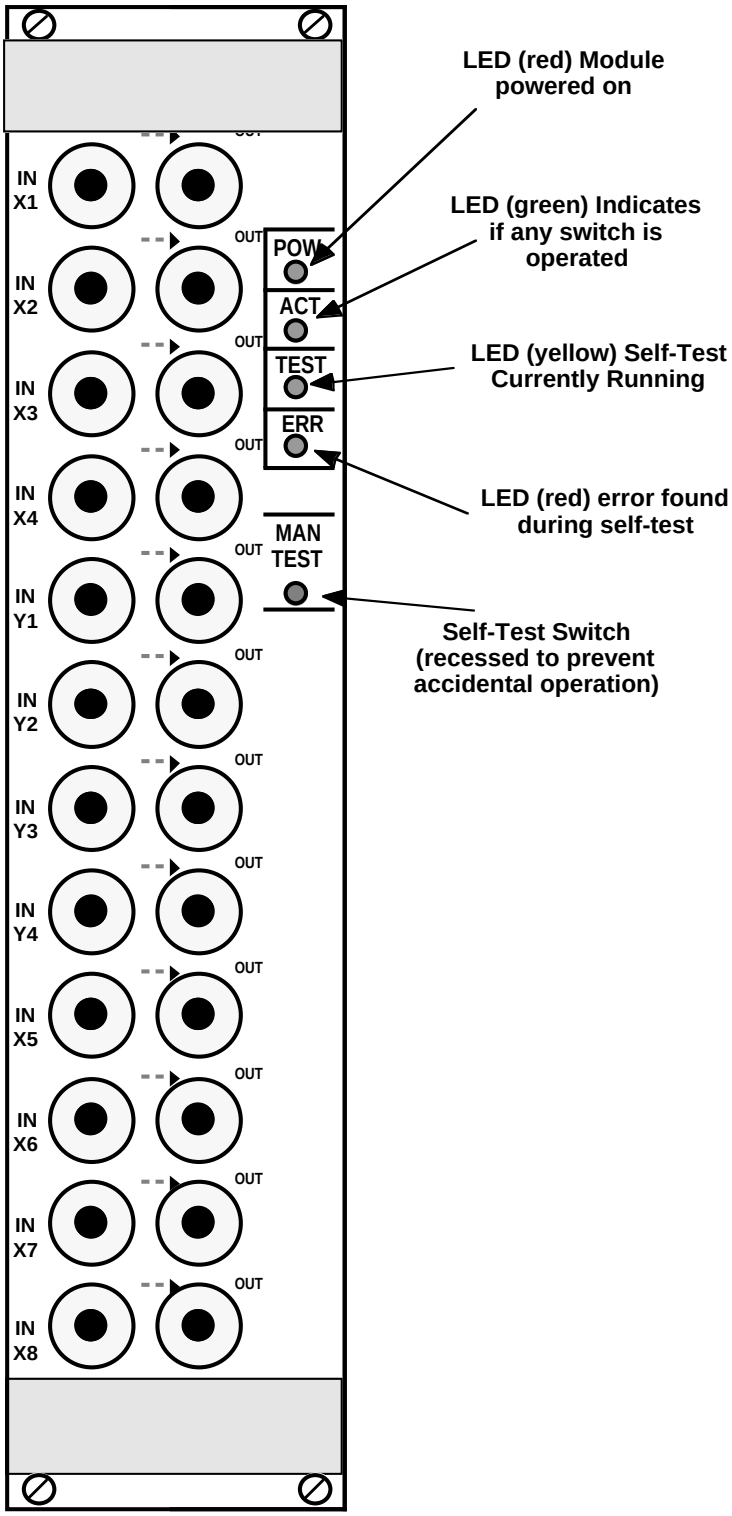


Fig 5.1 20-750-501 Front Panel, BNC Connector Version

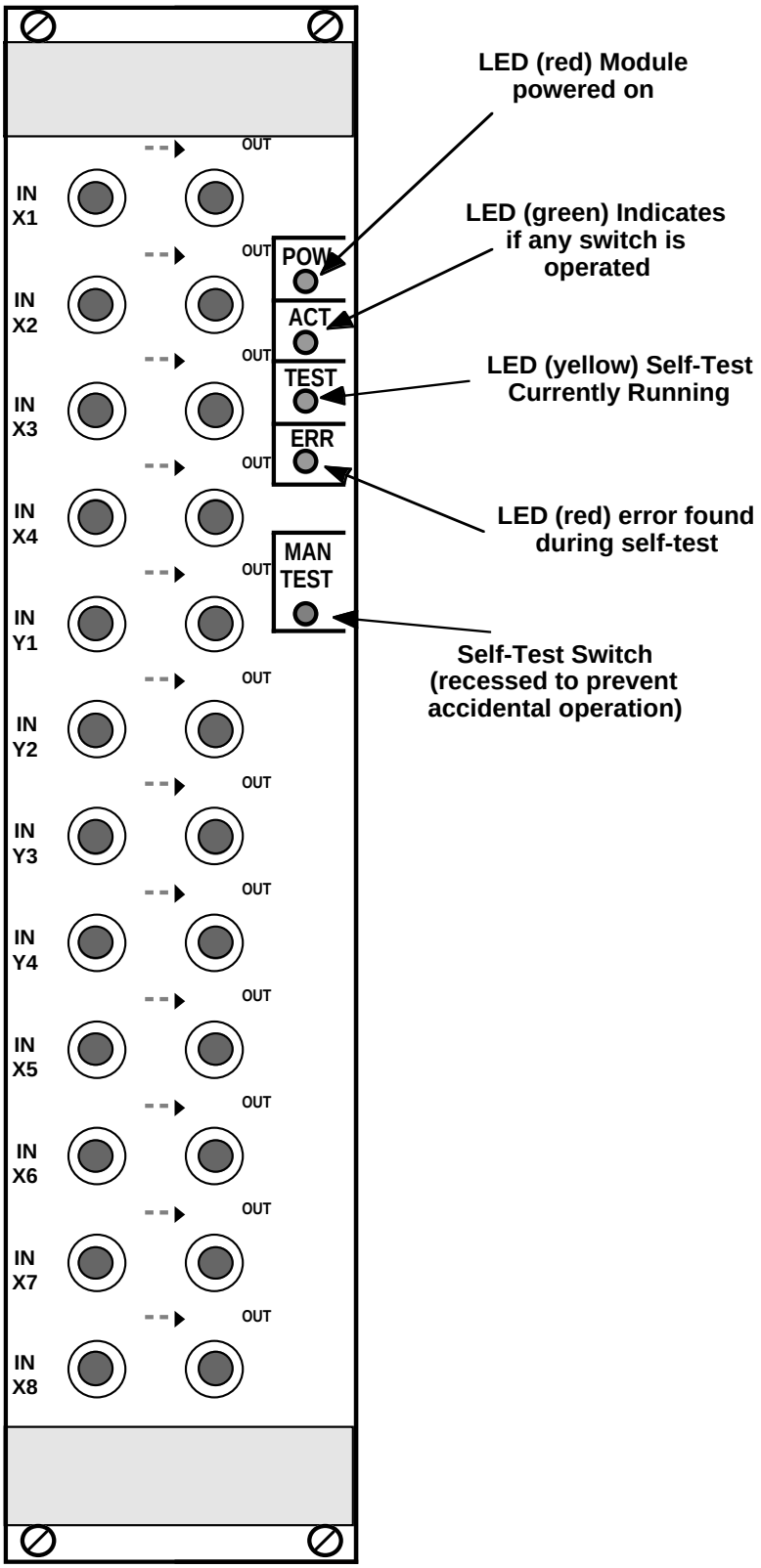


Fig 5.2 20-750-501 Front Panel, SMA Connector Version

RF IN		RF OUT	
X1 IN	_____	X1 OUT	_____
X2 IN	_____	X2 OUT	_____
X3 IN	_____	X3 OUT	_____
X4 IN	_____	X4 OUT	_____
X5 IN	_____	X5 OUT	_____
X6 IN	_____	X6 OUT	_____
X7 IN	_____	X7 OUT	_____
X8 IN	_____	X8 OUT	_____
Y1 IN	_____	Y1 OUT	_____
Y2 IN	_____	Y2 OUT	_____
Y3 IN	_____	Y3 OUT	_____
Y4 IN	_____	Y4 OUT	_____

Table 5.1 Documentation Table for 20-750 RF Matrix **(Suitable for Photocopying)**

Section 6
Reconfiguring Driver Card to Your Application

Your matrix driver card will leave the factory preconfigured, so take **great care** if you wish to change any of the settings. If in doubt contact Pickering for further details.

6.1 Universal Driver Card: Configuration Links

Configuration switches are provided on the driver board at position SW2, on the top edge of the PCB, adjacent to the 10 way address selection lever switch. The five switches, see Fig 6.1, are used as follows:-

Relay Settling Time

There are four choices of relay settling time, this is to allow for different applications and relay types.

1	2	Relay Settling Time †
0	0	4.0ms - default setting
0	1	1.0ms
1	0	0.5ms
1	1	0.0ms

† The “Settled” line is triggered after this delay

6.2 Repeating Self Test with Burn In - *Factory Use Only*

A burn-in test facility is built into the module, this is initiated by pressing the self-test button until the Active LED goes on (around 5 seconds). Here the module will run the usual full self-test together with some additional isolation tests followed by 15 minutes of “switch rattling”, the test procedure will then be repeated. This process may only be stopped by powering off or holding the manual test button in for several seconds.

This feature is for factory use where matrix modules are burned-in prior to undergoing final test.

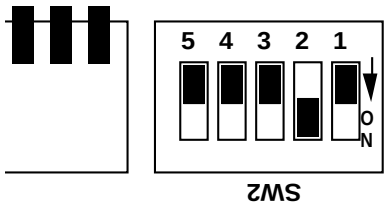


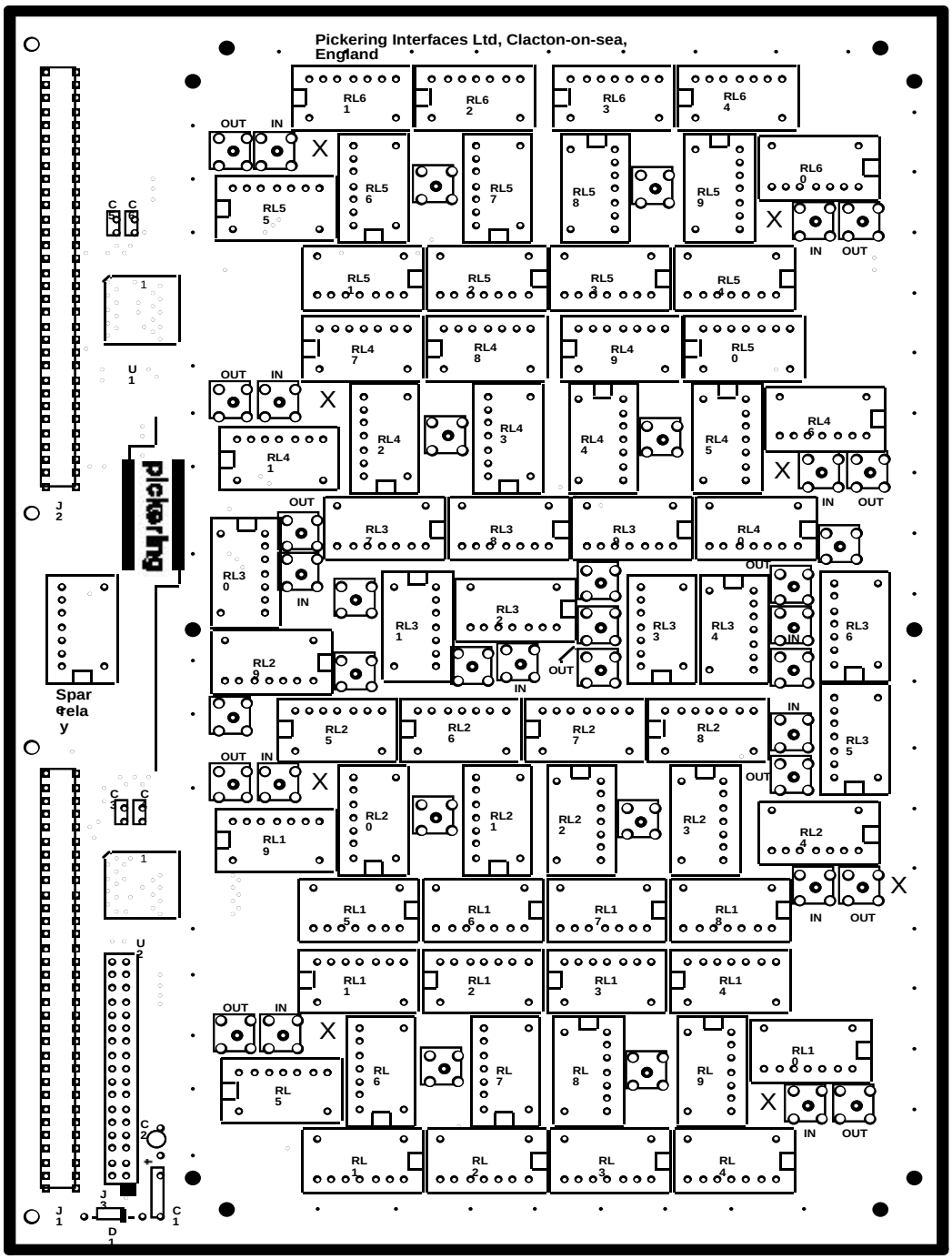
Fig 6.1 Driver Card Configuration Links on SW2

7.1 Model 20-750 8 x 4 Matrix Relay PCB Assembly

PCB Layout

Parts List

Please note that documentation for the driver card is contained in the General Module Information Manual.



Silk screen

Fig 7.2 20-750 8 x 4 Relay PCB Layout

Parts List for GPIB95 Rev0 Relay PCB Assembly

PCB Location	PIL Part Number	Part Description
J1, J2	C/CN/001	Connector DIN 41612 64 Way A/C
J3	C/CN/125	Header 34 pin 2 row
C1	C/CP/004	Cap 100nF, 63V, Ceramic
C2	C/CP/003	Cap 22µF, 16V, Tant
C3. .C6	C.CP/001	Cap 10nF, 63V, Ceramic
D1	C/SC/010	Transorb, 5V
RL1..RL64,Spare	C/RL/046	RF Relay, OMRON G5Y-1
U1, U2	C/IC/035	IC DIG UCN 5818EPF

Section 8
Electrical, Environmental, Mechanical & Firmware Specifications

Environmental

Operating Temperature 0°C to 50°C.

Storage Temperature -20°C to 75°C.

Humidity 95% non-condensing.

Weight, Dimensions and Power Requirements

		20-750
Approx. Weight/g		2100
Dimensions/mm †		
Front Panel Width		60.9
Height		268
Overall Length		189
Power /Current Consumption		
Maximum /mA	5V	250
	12V	800
Minimum	5V	150
	12V	0

† Approx. dimensions. Standard 160mm, 6U, Eurocard, as specified in DIN 41494.

Voltage Supplies

Logic Supply 5Vdc ±5%.

Relay Supply 12Vdc ±10%

Current Firmware Revisions

20-750: 20-750 V 2.00

20-750: 20-750 V 2.10 *(Update for automatic single crosspoint, must be used with 10-921 V1.81 or upwards).*

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