"There Is No Substitute for Experience"

DOW-KEY MICROWAVE

MS, MP, CB Matrix Series

MS-2U18SFRL-4/X-GPIB

CAN BUS RF SWITCH MATRIX

Operator's Manual

Rev 1

THE RF/MICROWAVE SWITCHING TECHNOLOGY SOLUTION COMPANY

Information in this publication supersedes that in all previously published material. Specifications and price change privileges reserved.

Printed in the U.S.A.

Document Number: 49101-259 Revision 1

4822 McGrath Street, Ventura, CA 93003
Tel: (805) 650-0260 Fax: (805) 650-1734
Visit at www.dowkey.com

WARRANTY

Dow-Key Microwave Corporation warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment. This warranty does not apply to defects resulting from product tampering or modification without Dow-Key's express written consent. This warranty also does not apply to software, non-rechargeable batteries, power supplies, or problems arising from normal wear or failure to follow instructions.

To exercise this warranty, contact Dow-Key Microwave headquarters in Ventura, California. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the Dow-Key headquarters. Repairs will be made and the product returned within the quoted period of time, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

NEITHER DOW-KEY MICROWAVE CORPORATION NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS INSTRUMENTS AND SOFTWARE EVEN IF DOW-KEY MICROWAVE CORPORATION HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COSTS OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.

Manual Revision History

The revision history shown below lists all revisions and addendums created for this manual. The revision level increases numerically as the manual undergoes subsequent updates. Addendums are released between revisions and contain important change information that the user should incorporate immediately into the manual. When a new revision is created, all addendum associated with the previous revision of the manual are incorporated into the new revision of the manual. Each new revision includes a revised copy of this history page.

Revision 1 (Document Number 49101-259) ……. May 2013
Original Release

Table of Contents

1 General Information

1.1 Introduction

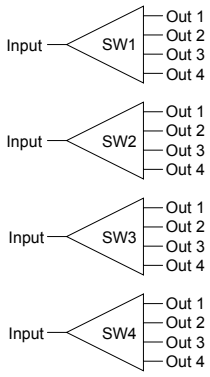
The Dow-Key Microwave MS, MP, CB Switch Matrix series are electromechanical RF matrices. They come equipped with a GPIB (IEEE 488) port which allows the user to easily access the matrix remotely. Other interfaces included are an RS-232 port, an USB (used as virtual serial port) and a CAN Bus port. Any model 2 RU or higher also comes equipped with a touch screen LCD front panel display for manual (Local) operation. These models are not intended to be used to power or control anything other than Dow-Key supplied switches. Connection of other CAN Bus products or other devices not described herein will void quality certifications and the warranty.

This user manual covers all three matrix series since most features are the same among the various models. The user shall focus on the matrix series of interest and skip any section that does not pertain to his matrix.

Information specific to your model (like technical specifications and RF configuration) can be found in appendices at the end of this manual.

1.2 MS Matrices

MS-Series stands for **Multiple Switches**. It is a matrix where a number of independent switches are populated on the rear panel or inside the matrix enclosure. From an RF point of view the switches are not interconnected and all switch's RF ports are available to the user on the rear panel of the matrix. Depending on the size of the switch and the quantities needed, the matrix size can grow from 1RU to 4RU (or even larger).



Example of an MS series matrix with four independent SP4T switches.

Part Numbering Examples:

MS-2U18S-4/X-GPIB A **M**ulti **S**witch matrix with the following characteristics: 2U, 18 GHz, SMA, 4 transfer switches, GPIB

MS-2U26S-4/6T- GPIB A **M**ulti **S**witch matrix with the following characteristics: 2U, 26 GHz, SMA, 4 Terminated SP6T, GPIB

MS-4U18N-12/10- GPIB A **M**ulti **S**witch matrix with the following characteristics: 4U, 18 GHz, N connectors,12 SP10T, GPIB

The part numbering is interpreted as follows:

MS-[chassis size][frequency][connector]-[number of switches]/[type of switch]-[remote control type]

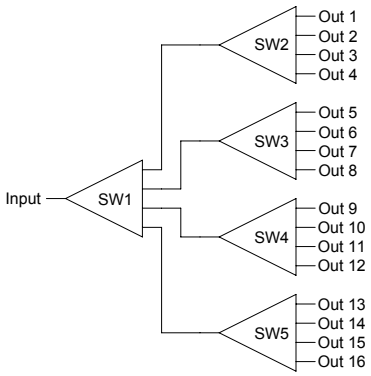
[chassis size]:	1U | 2U | 3U | 4U etc.
[frequency]:	12 (for 12.4 GHz) | 18 (for 18 GHz | 26 (for 26.5 GHz) | 40 (for 40 GHz)
[connector]:	B (for BNC) | N (for N) | S (for SMA) | K (for 2.9 mm)
[number of switches]:	1 | 2 | 3 | 4 | 5 |… |16 (or more if chassis size allows)
[type of switch] :	2T (terminating one port DPDT →terminated SPDT) | X (for DPDT) | 4 (for SP4T) | 6 (for SP6T) | 8 (for SP8T) | 10 (for SP10T) |12 (for SP12T). If switch type is terminated, add 'T' to the number. Example: 6T (terminated SP6T)

[number of switches]/[type of switch]: If different switch types are combined, repeat this section as needed. **Example: MS-1U18S-2/X-2/6T-GPIB**

[remote control type]: ENET (for Ethernet, RS-232, USB) | GPIB (for IEEE-488, USB)

1.3 MP Matrices

MP-Series stands for **Multiplexer**. It is a matrix with one input connecting to many outputs (only one at the time) or, since the RF switches are bi-directional, many inputs connected to one output (only one at the time).
The switches are populated either on the rear panel or inside the matrix chassis. From an RF point of view the switches are interconnected and all input/output RF ports are available to the user on the rear panel of the matrix. Depending on the size of the switch and the quantities needed, the matrix size can grow from 1RU to 4RU (or even larger).



Example of an MP series matrix with 1 input/output and 16 outputs/inputs.

Part Numbering Examples:

MP-4U18S-100-GPIB
A **M**ulti **P**lex matrix with the following characteristics:
4U, 18 GHz, SMA, 100 outputs, GPIB

MP-4U18S-20- GPIB
A **M**ulti **P**lex matrix with the following characteristics:
4U, 18 GHz, SMA, 20 outputs, GPIB

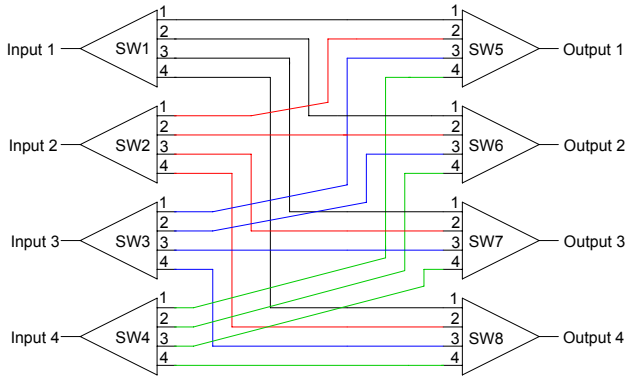
MP-[chassis size][frequency][connector]-[number of ports]-[remote control type]

[chassis size]: 1U | 2U | 3U | 4U etc.
[frequency]: 12 (for 12.4 GHz) | 18 (for 18 GHz) | 26 (for 26.5 GHz) | 40 (for 40 GHz)
[connector]: B (for BNC) | N (for N-type) | S (for SMA) | K (for 2.9 mm)
[number of ports]: 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 (and more ports if chassis size allows)
If ports are internally terminated, add 'T' to the number.
Example: 20T, .. , 100T
[remote control type]: ENET (for Ethernet, RS-232, USB) | GPIB (for IEEE-488, USB)

Note: There is always one only input and a certain number of outputs. So no need to indicate the '1' (for the input).

1.4 CB Matrices

CB-Series stands for **Crossbar**. It is a matrix with several inputs connecting to several outputs. Only one input can be connected to one output at any given time.
The switches are populated inside the matrix chassis and are interconnected so that any input can connect to any output and vice versa. All input/output RF ports are available to the user on the rear panel of the matrix. Depending on the size of the switch and the quantities needed, the matrix size can grow from 2RU to 4RU (or even larger).



Example of a CB series matrix with 4 input and 4outputs.

Part Numbering Examples:

CB-4U18S-10X10-GPIB
A **C**ross**B**ar matrix with following characteristics:
4U, 18 GHz, SMA, 10 inputs 10 outputs, GPIB

CB-4U18N-8X8- GPIB
A **C**ross**B**ar matrix with following characteristics:
4U, 18 GHz, N connectors, 8 inputs 8 outputs, GPIB

CB-2U18S-4X4- GPIB
A **C**ross**B**ar matrix with following characteristics:
2U, 18 GHz, SMA, 4 inputs 4 outputs, GPIB

CB-[chassis size][frequency][connector]-[number of inputs]X[number of outputs]-[remote control type]

[chassis size]:	1U | 2U | 3U | 4U etc.
[frequency]:	12 (for 12.4 GHz) | 18 (for 18 GHz) | 26 (for 26.5 GHz) | 40 (for 40 GHz)
[connector]:	B (for BNC) | N (for N) | S (for SMA) | K (for 2.9 mm)
[number of inputs]:	2 | 3 | 4 | 5 … 10 | 12 | 16| 20 (or more if chassis size allows)
[number of outputs]:	2 | 3 | 4 | 5 … 10 | 12 | 16| 20 (or more if chassis size allows)
[remote control type]:	ENET (for Ethernet, RS-232, USB) | GPIB (for IEEE-488, USB)

1.5 Technical Specifications

Refer to appendix A

1.6 Safety Precaution

Safety precautions should be observed before using this product and any associated instrumentation. This product is intended for use by qualified personnel who recognize the safety precautions required to avoid possible injury.

1.7 Inspection

The Matrices were carefully inspected, both electrically and mechanically before shipment. After unpacking all items from the shipping carton, check for any obvious signs of physical damage that may have occurred during transit. Report any damage to the shipping agent immediately. Save the original packing carton for possible future reshipment. The following items are included with every Model matrix order.

- Switch matrix
- Switch matrix Operation Manual
- Power Cord, Part Number 40203-005

1.8 Maintenance

The matrix requires no periodic maintenance. Should any problems arise, contact Dow-Key Microwave immediately for necessary repairs. These systems are not field repairable.

1.9 Repacking for shipment

Should it become necessary to return the matrices for repair, carefully pack the unit in its original packing carton or the equivalent, and follow these instructions:

- Call the Repair Department at 1-805-650-2327 for a Return Material Authorization (RMA) number.
- Advise as to the warranty status of the matrix.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.

2 System Layout

2.1 Front Panel Layout

2 Note: The matrices shown below are with the LCD on the front panel and rear mounted switches. Matrices with front mounted switches have same dimensions regardless of switch location. See also Appendix A and B.

Figure 2-1 shows the 2U, 3U and 4U Model general layout, which includes:

- 2 handles
- A touch screen LCD

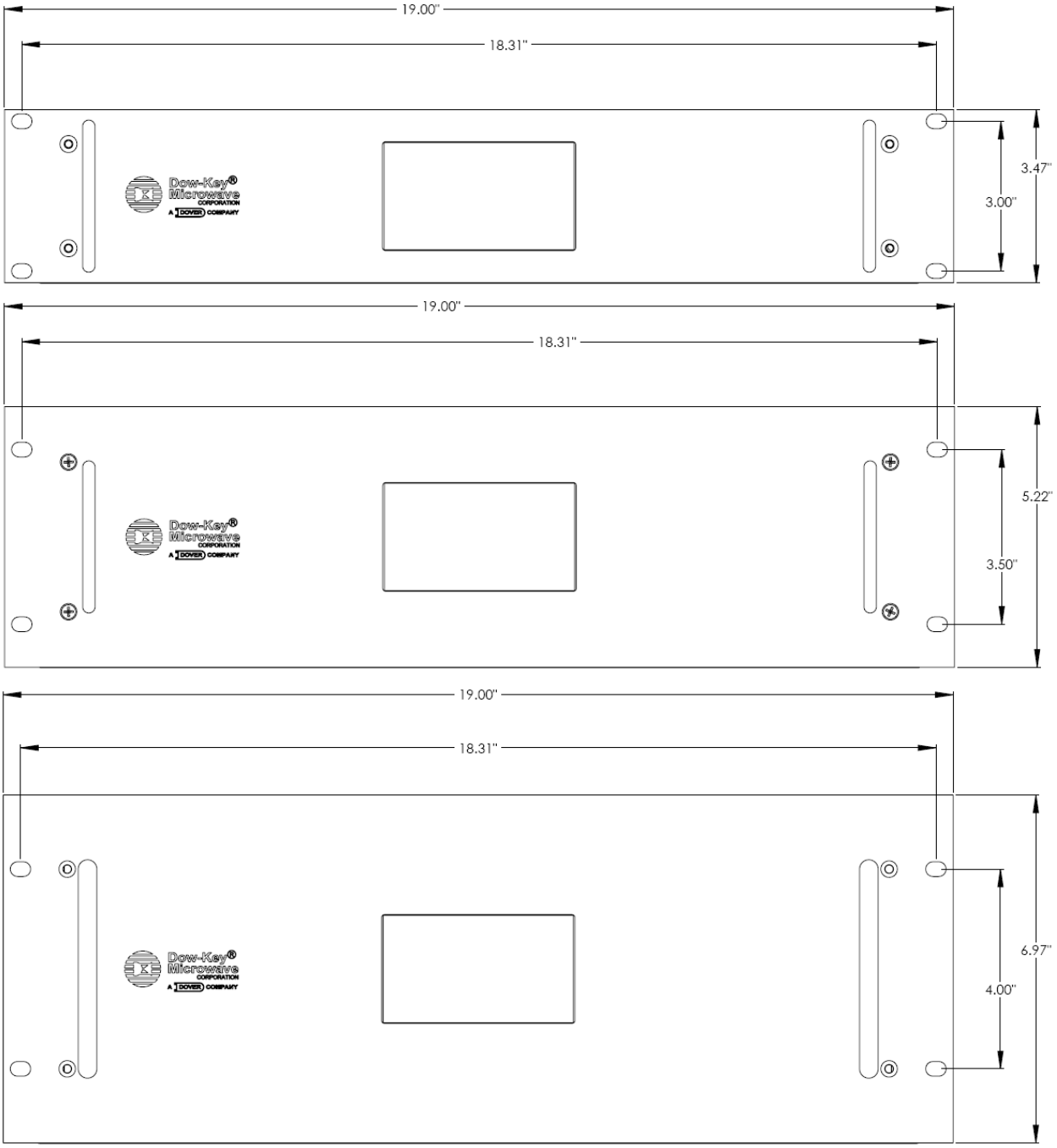


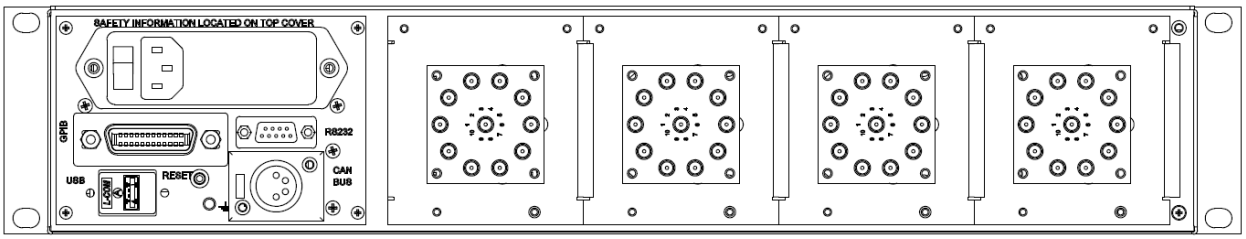
Figure 2-1, 2U, 3U and 4U Front Panel Layout

2.2 Rear Panel Layout for 2U models

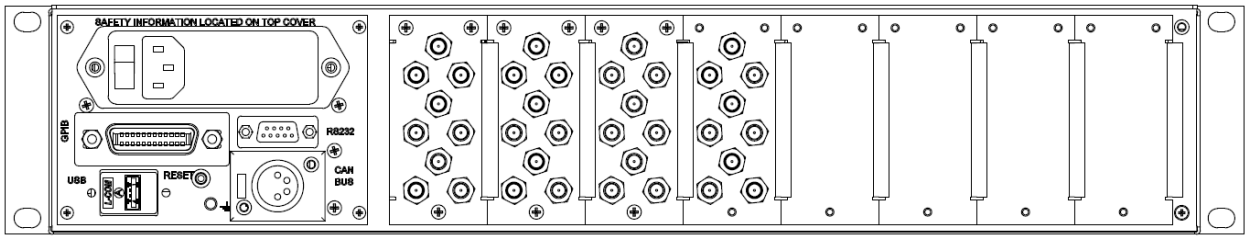
Figure 2-2 shows the general layout of the rear panel of a variety of 2U models. All models have common parts which include:

- Power Entry Module with built in Fuse
- Chassis Ground Post
- 9-Pin D-Sub Female RS232 Connector
- 4-Pin XLR Female CAN Bus Connector
- GPIB (IEEE 488) 25 pin Centronics Connector
- USB type A Connector

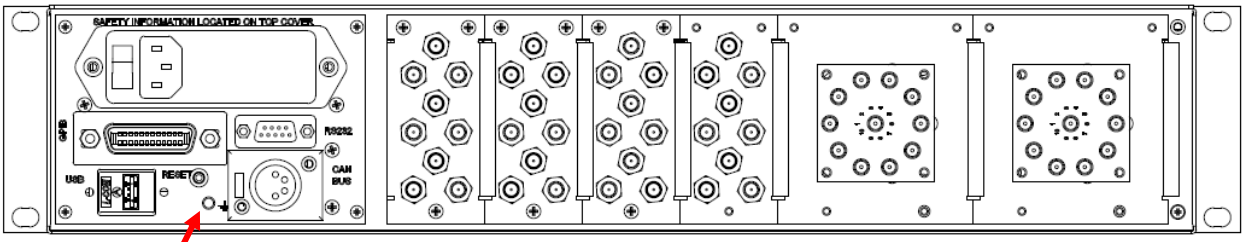
Other parts that are not common to all models are Coaxial RF switches and/or RF connectors.



2U MS series (with external switches)



2U MS series (with internal switches) or MP series or CB series



2U MS series combined with MP series or CB series

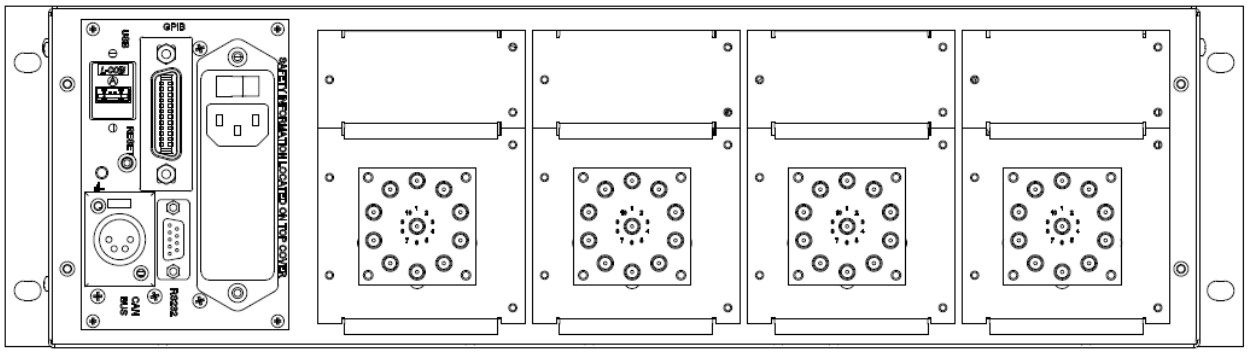
Figure 2-2, Various 2U Models Rear Panel Layout

2.3 Rear Panel Layout for 3U models

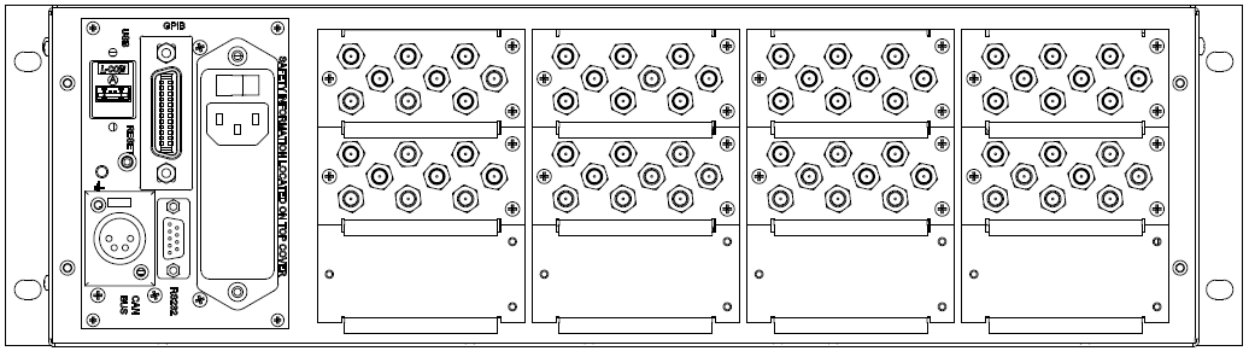
Figure 2-3 shows the general layout of the rear panel of a variety of 3U models. All models have common parts which include:

- Power Entry Module with built in Fuse
- Chassis Ground Post
- 9-Pin D-Sub Female RS232 Connector
- 4-Pin XLR Female CAN Bus Connector
- GPIB (IEEE 488) 25 pin Centronics Connector
- USB type A Connector

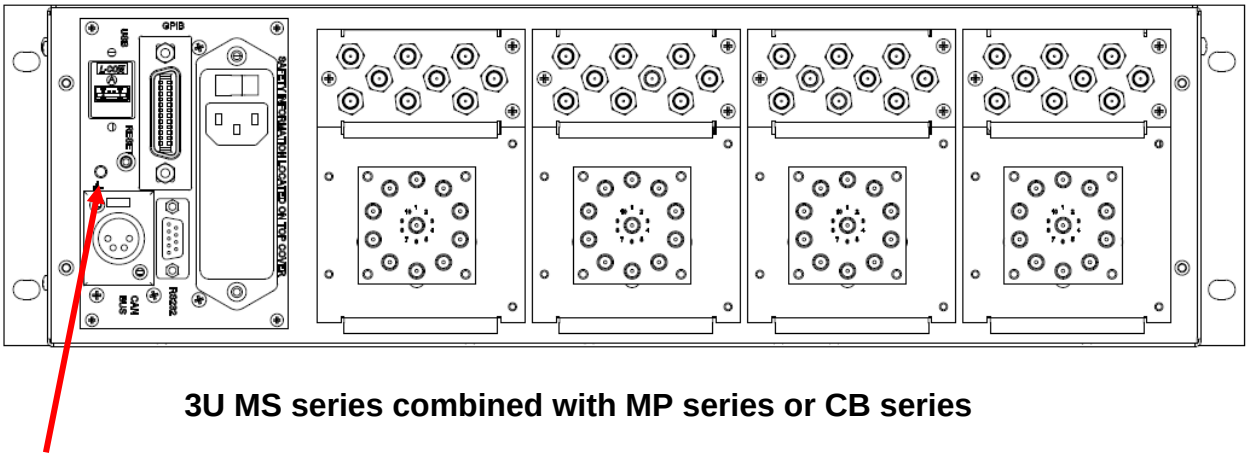
Other parts that are not common to all models are Coaxial RF switches and/or RF connectors.



3U MS series (with external switches)



3U MS series (with internal switches) or MP series or CB series



3U MS series combined with MP series or CB series

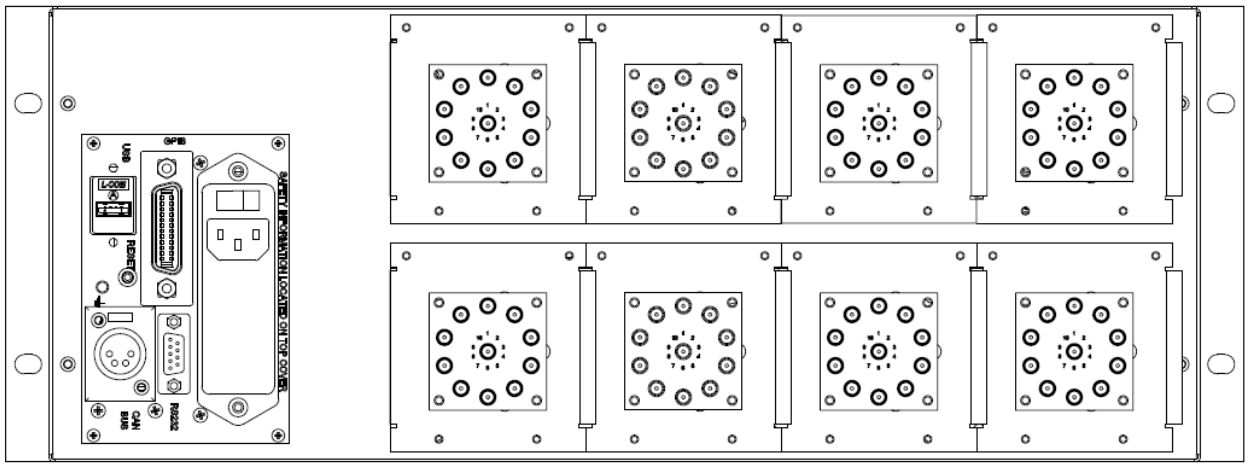
Figure 2-3, Various 3U Models Rear Panel Layout

2.4 Rear Panel Layout for 4U models

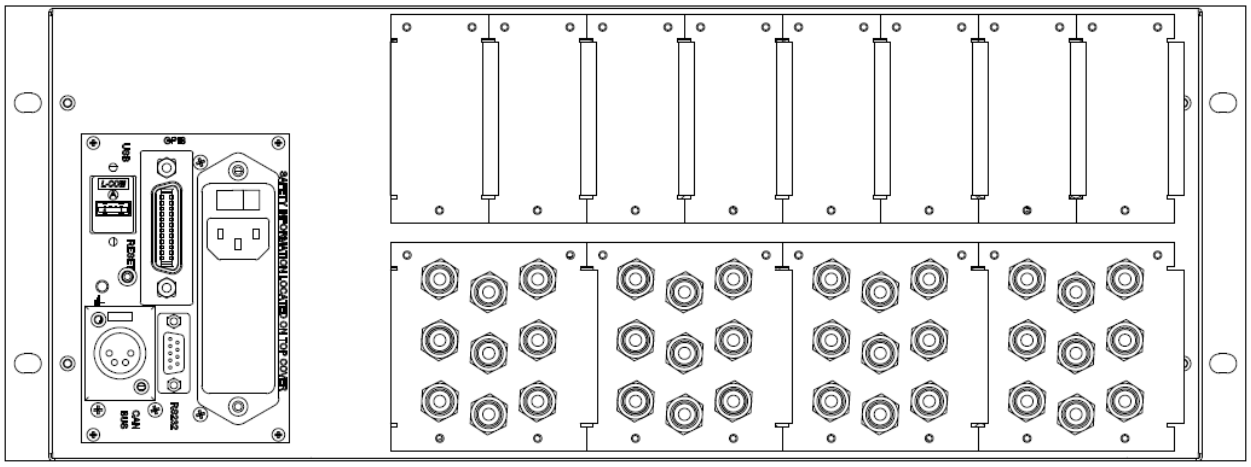
Figure 2-4 shows the general layout of the rear panel of a variety of 4U models. All models have common parts which include:

- Power Entry Module with built in Fuse
- Chassis Ground Post
- 9-Pin D-Sub Female RS232 Connector
- 4-Pin XLR Female CAN Bus Connector
- GPIB (IEEE 488) 25 pin Centronics Connector
- USB type A Connector

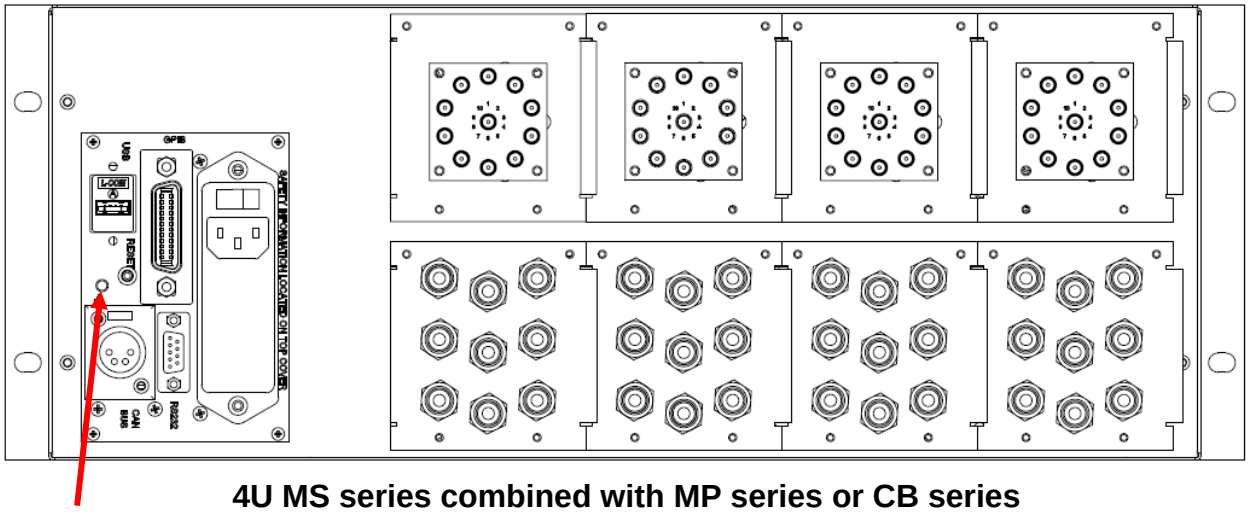
Other parts that are not common to all models are Coaxial RF switches and/or RF connectors.



4U MS series (with external switches)



4U MS series (with internal switches) or MP series or CB series

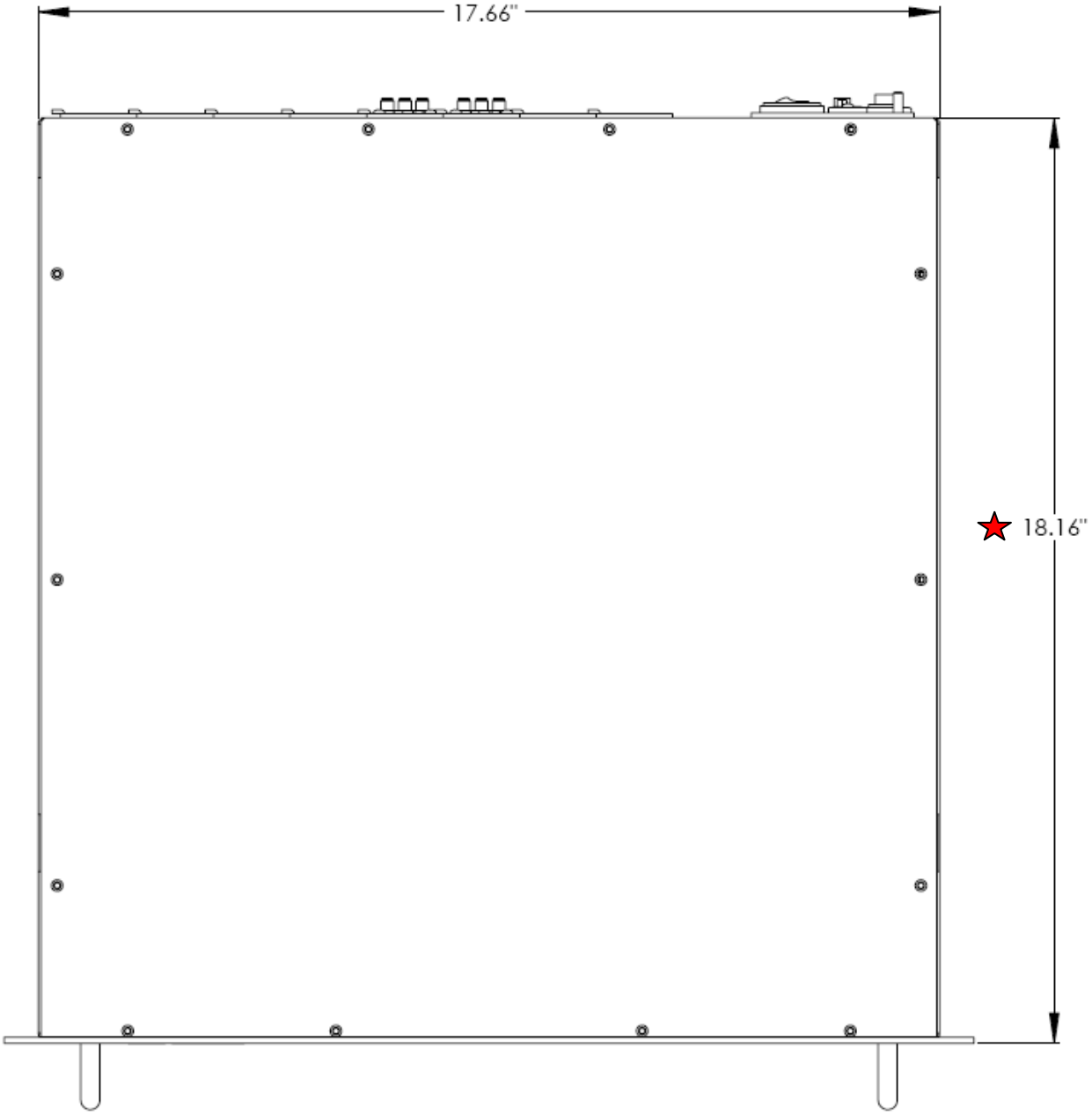


4U MS series combined with MP series or CB series

Figure 2-4, Various 4U Models Rear Panel Layout

2.5 Top View Layout

Figure 2-5 shows the top view layout of all models.



★ Note: The dimension indicated on the drawing is for 3U and 4U models.
For 2 U models the depth dimension is 15.625” D (without handles)

Figure 2-5, Top View of 2U, 3U and 4U Models

2.6 RF configuration

Refer to appendix B.

3 Connections

3.1 Power Connection

3.1.1 Line Voltage

The matrix operates from a line voltage in the range of 110V to 240V at a frequency of 50 or 60Hz. Line voltage selection is automatic.

CAUTION: Operating the unit on an incorrect line voltage may cause damage, possibly voiding the warranty.

3.1.2 Line Power Connection

Perform the following steps to connect the matrix to line power:

1. Connect the female end of the supplied power cord to the grounded AC receptacle on the rear panel.
2. Connect the other end of the supplied power cord to a grounded AC outlet.

WARNING: The power cord supplied with the matrix contains a separate ground for use with grounded outlets. FAILURE TO USE A GROUNDED OUTLET MAY RESULT IN PERSONAL INJURY OR DEATH DUE TO ELECTRIC SHOCK.

3.1.3 Line Fuse Replacement

A rear panel fuse protects the power line input of the matrix. If the line fuse needs replacement, perform the steps below:

WARNING: Disconnect the line cord from the unit before changing the line fuse.

1. The fuse is located in a holder in the power module unit above the AC receptacle (figure 3-1). At top is a small tab, use a small bladed screwdriver to release the fuse holder.
2. Slide the fuse holder out to gain access to the fuse carrier and fuse.
3. Remove the carrier with the blown fuse, and replace with the correct type listed in Table 3-1.

CAUTION: For continued protection against fire or unit damage, replace the fuse only with the type and rating listed.

4. Install the fuse carrier in the fuse holder, then insert the fuse holder back in the power entry module.

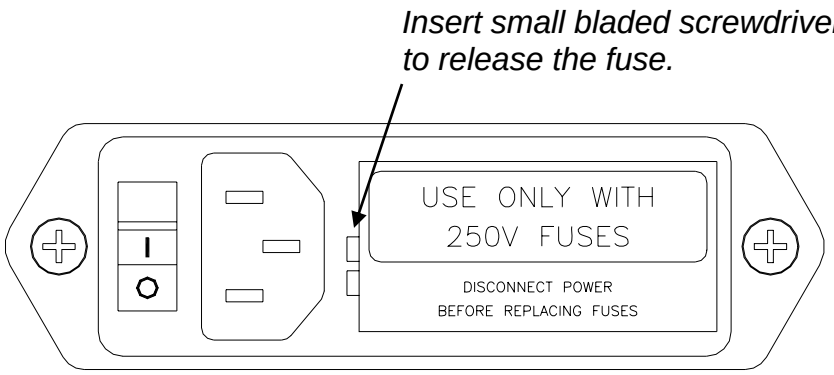


Figure 3-1, Power Entry Module

Line Voltage	Fuse Rating	Manufacturer	Manufacturer Part No.
110-240V	1A, slow blow, 250Vac, ¼" x 1-1/4"	Bel Fuse Inc.	3SB 1-R

Table 3-1, AC Line Fuse Information

3.2 Ground Connection

The rear panel GND ground screw (refer figures 2-2, 2-3 and 2-4) should be connected to safety earth ground using #18 AWG or larger wire.

3.3 RS232 Connection

The switch matrix may be operated over this connection (See Section 6 for a description of the commands). The RS232 connection is configured with these default settings: 9600 Baud, 8 bit data, no parity, 1 stop bit.

The baud rate can be changed thru the touch screen LCD to:
1200, 2400, 4800, 9600, 19200, 38400, 57600,115200 bits/sec

Figure 3-2 and Table 3-2 show the pin numbers and functions for the RS232 female connector.

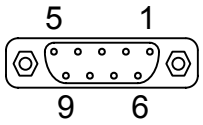


Figure 3-2, RS232 Female Connector Pin Numbers

Pin 1	NC
Pin 2	Transmit
Pin 3	Receive
Pin 4	NC
Pin 5	Ground
Pin 6	NC
Pin 7	NC
Pin 8	NC
Pin 9	NC

Table 3-2, RS232 Female Connector Pin Functions

3.4 CAN Bus Connection

This connection allows the internal matrix controller to be easily interfaced to another Dow-Key Microwave Switch Matrix, using a one-to-one (straight through) cable. This allows a master matrix to control an extension matrix. However, the extension matrix being interfaced must not have any internal, intelligent controller; it must be a simple RF Switch Matrix extension. Furthermore, the switches in the extension matrix being interfaced must have CAN ID's unique to any others connected to the internal master matrix controller. See Section 4 for more information.

Care must also be taken to limit the internal power supply's current draw on the +12 VDC to a maximum of 7 Amps. Note that this includes all switches of the master matrix and the extension matrix combined.

If the total current draw is below 7A, the extension matrix's switches will be powered by the master matrix (thru pins 1 and 4).

In cases where the total current exceeds 7A, the extension matrix needs to have its own internal power supply. In these cases, the interconnection cable shall only use pins 2 and 3 for the CAN bus communication.

Figure 3-3 and Table 3-3 show the pin numbers and functions for the CAN Bus connector.

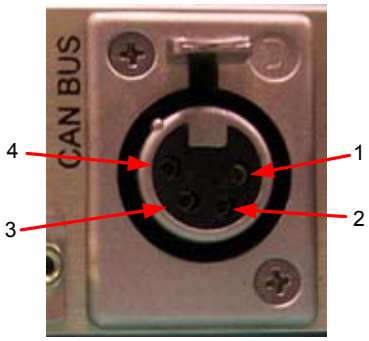


Figure 3-3, CAN Bus Connector Pin Numbers

The mating connector is Deltron 701-0400. The pin outs (embossed on connector faces) are:

1. +12 VDC, 7A max (this current is for master and extension matrices combined. See Individual switch data sheets for current draw).
2. CAN LO
3. CAN HI
4. +12 VDC Return (GND)

Table 3-3, CAN Bus Connector Pin Functions

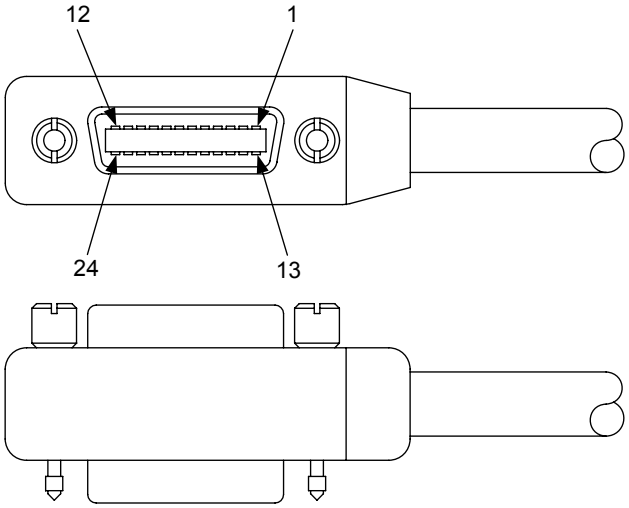
3.5 GPIB Control Connection

On the rear panel of the matrix is a GPIB (IEEE-488) control port which gets connected to the GPIB port of a computer (controller) using a shielded IEEE-488 interface cable with metric mounting screws. Figure 3-4 shows the connector configuration and Table 3-4 shows the signal assignments.

3.5.1 GPIB Control Connector

You can link devices in either a linear, star or combination configuration using a shielded 24-conductor cable. The standard IEEE-488 cable has both a plug and receptacle connector on both ends. This connector is the Amphenol CHAMP or Cinch Series 57 MICRO RIBBON type. See figure 3-4.

Figure 3-4 GPIB Control Connector



The following restrictions apply for normal operation when attaching instruments to the GPIB:

- A maximum separation of 4 meters between any two instruments and an average separation of 2 meters over the entire bus.
- A maximum total cable length of 20 meters.
- No more than 15 devices on the bus, with no less than two-thirds powered on.
- No two instruments having the same address.

If you are unable to meet the above restrictions, the use of bus extenders is recommended.

3.5.2 Interface Signals

The GPIB (IEEE-488) interface system consists of 16 signal lines and 8 ground lines. The 16 signal lines are divided into 3 groups (8 data lines, 3 handshake lines, and 5 interface management lines). See table 3-4 for the signal assignments.

Table 3-4 GPIB Signal Assignments

Pin #	Designation	Type
1	DI01	Data
2	DI02	Data
3	DI03	Data
4	DI04	Data
5	EOI	Management
6	DAV	Handshake
7	NRFD	Handshake
8	NDAC	Handshake
9	IFC	Management
10	SRQ	Management
11	ATN	Management
12	SHIELD	Ground
13	DI05	Data
14	DI06	Data
15	DI07	Data
16	DI08	Data
17	REN	Management
18	GND (DAV)	Ground
19	GND (NRFD)	Ground
20	GND (NDAC)	Ground
21	GND (IFC)	Ground
22	GND (SRQ)	Ground
23	GND (ATN)	Ground
24	SIGNAL GROUND	Ground

3.5.3 Data Lines

The lines DIO1 through DIO8 are used to transfer addresses, control information and data. The formats for addresses and control bytes are defined by the IEEE-488 standard. Data formats are undefined and may be ASCII (with or without parity) or binary. DIO1 is the Least Significant Bit (note that this corresponds to bit 0 on most computers).

3.5.4 Handshake Lines

The three handshake lines (NRFD, NDAC, DAV) control the transfer of message bytes among the devices and form the method for acknowledging the transfer of data. This handshaking process guarantees that the bytes on the data lines are sent and received without any transmission errors and is one of the unique features of the IEEE-488 bus.

The **NRFD** (Not Ready for Data) handshake line is asserted by a listener to indicate it is not yet ready for the next data or control byte. Note that the Controller will not see NRFD released (i.e., ready for data) until all devices have released it.

The **NDAC** (Not Data Accepted) handshake line is asserted by a Listener to indicate it has not yet accepted the data or control byte on the data lines. Note that the Controller will not see NDAC released (i.e., data accepted) until all devices have released it.

The **DAV** (Data Valid) handshake line is asserted by the Talker to indicate that a data or control byte has been placed on the data lines and has had the minimum specified stabilizing time. The byte can now be safely accepted by the devices.

3.5.5 Interface Management Lines

The five interface management lines (ATN, EOI, IFC, REN, SRQ) manage the flow of control and data bytes across the interface.

The **ATN** (Attention) signal is asserted by the controller to indicate that it is placing an address or control byte on the data bus. ATN is released to allow the assigned Talker to place status or data on the data bus. The Controller regains control by reasserting ATN; this is normally done synchronously with the handshake to avoid confusion between control and data bytes.

The **EOI** (End or Identify) signal has two uses. A talker may assert EOI simultaneously with the last byte of data to indicate end-of-data. The Controller may assert EOI along with ATN to initiate a parallel poll. Although many devices do not use parallel poll, all devices should us EOI to end transfers (many currently available ones do not).

The **IFC** (Interface Clear) signal is asserted only by the System Controller in order to initialize all device interfaces to a known state. After releasing IFC, the System Controller is the Active Controller.

The **REN** (Remote Enable) signal is asserted only by the System Controller. Its assertion does not place devices into remote control mode; REN only enables a device to go into remote mode when addressed to listen. When in remote mode, a device should ignore its local front panel controls.

The **SRQ** (Service Request) line is like an interrupt: it may be asserted by any device to request the Controller to take some action. The Controller must determine which device is asserting SRQ by conducting a serial poll. The requesting device releases SRQ when it is polled.

3.6 USB Port

Connecting the matrix to a PC's USB port should result in a "Found New Hardware" event. Follow the instructions until prompted for the new hardware device's driver, which may be located on the CD shipped with the matrix.

After installation, the matrix's USB port will appear as a virtual serial port. Communicate to this port as you would on any RS 232 serial port. The baud rate is 9600 b/s. See sections 3.3 and 7 for more details.

4 Configuring the Matrix for Operation

4.1 Matrix Configuration

The 'brain' inside Dow-Key Matrices, referred to as the "Matrix Controller", has been designed to be as generic as possible in regards to how many switches of what positions it may control. Therefore, the matrix must first be informed as to the set of switches it is able to control before it can operate successfully, and this information must be updated as switches are added and deleted to the matrix or connected to the CAN bus port on the rear of the matrix (see section 3.4). The knowledge of what switches are to be controlled and how many positions each of those switches has is known as the matrix's Configuration Data.
In addition to switch information, the Matrix Configuration also contains other information such as the base MAC address (for Ethernet based matrices), unit's Serial Number, alarm enabling, Model Name, etc. This information must remain intact for the matrix to operate properly.

The matrix configuration is already performed at the factory and does not need to be done by the user unless the Matrix Controller board has been replaced.

Adding and removing switches (see sections 4.2.3) automatically updates the matrix configuration. No further action is required by the user.

The topics discussed in sections 4.2 and 4.3 are not needed during normal operation of your matrix. These sections are here for informational purpose and in the event the RF configuration of the matrix is being modified by adding/removing switches.

4.2 Dow-Key CAN bus switches

A CAN Bus switch may assume a maximum CAN ID of 127. Individual switches delivered by Dow-Key will be programmed with either ID=0 or ID=1, depending on the particular procedure utilized to manufacture the switch. The matrix provides the means to change CAN Bus ID's at will.

A CAN Bus switch may have a maximum of 255 positions (0 through 254). 255 is reserved as a return value indicating that the switch is either in an erroneous position, or is reported to the Operator hen a switch fails to respond to a query for current position.

A switch whose ID is 0 is referred to as a "zero switch", or also a "0 switch". A switch whose ID is other than 0 is referred to as an "N switch".

Zero switches and N switches have different properties:

Only a zero switch may change into an N switch.

An N switch may not change its ID to anything other than 0.

A zero switch will not respond to commands to change or report its position.

A zero switch will not respond to queries as to switch position closure counts.

A zero switch may not be added to a Configuration (see below) as an ID=0.

4.3 Adding and Deleting Switches

The following rules apply when adding a switch to the Matrix Configuration (the desired ID to add is referred to as the “target ID”):

- The desired switch to ADD must be connected to the matrix before executing the ADD procedure.
- If the connected switch is a 0 switch AND the target ID is not yet configured AND a switch possessing the target ID is not already connected, then the 0 switch will change its ID to the target ID and the Configuration will be updated.
- If the connected switch is a 0 switch AND the target ID is already configured AND a switch possessing the target ID is not already connected, AND the 0 switch’s number-of-positions data matches that of the Configuration’s, then the 0 switch will change its ID to the target ID.
- If the connected switch is an N switch AND the target ID=N is not yet a configured ID, then the N switch will be added, i.e. the Configuration will be updated.
- If the connected switch is an N switch AND the target ID=N is already a configured ID, AND the N switch’s number-of-positions data matches that of the Configuration’s, then the N switch will be added, i.e. the Configuration will be updated (actually, the ID isn’t really added since the ID is already configured, however a Configuration match is performed).

The following rules apply when deleting a switch from the Configuration (the desired ID to delete is referred to as the “target ID”):

- Only an N switch may be deleted from a Configuration; 0’s are not Configurable .
- If the N switch to delete is connected and is not a Configured ID, AND a zero switch is not connected, then the N switch will be returned to a 0 switch.
- If the N switch to delete is connected and is already a Configured ID, AND a zero switch is not connected, then the N switch will be removed from the Configuration and its ID set to 0 (i.e. turning the N switch into a 0 switch).
- If the N switch to delete is connected and is already a Configured ID, AND a zero switch is connected, then the N switch will be removed from the Configuration, but the N switch’s ID will remain N.
- If the N switch to delete is not connected and is already a Configured ID, then the ID will be removed from the Configuration

NOTE:

THE MATRIX MUST BE POWER CYCLED AFTER MAKING ANY CHANGES TO THE CONFIGURATION BEFORE THOSE CHANGES BECOME FULLY APPARENT.

NOTE:
Keep unused switches stored as 0 switches. Label switches that are dedicated to particular CAN Bus IDs on the switch’s enclosure.

Example procedure:

Before adding it to the Configuration you need to find the switch's ID. To do this

select **Main Menu>System Settings>Find Switch ID** and then follow the instructions in Section 5.2.3 Find Switch ID.

If you find the switch you wish to add:

Press the BACK key until you see the Main Menu screen. To ADD the switch, select **Main Menu>System Settings>Add Switch.** The LCD will indicate if the switch to add is a 0 switch and then prompt the user with the next available-to-configure ID, or the user may enter a different, un-configured ID.

If the switch's ID is not zero, the LCD will prompt you to add the next available-to-configure ID, and you must enter the connected switch's ID.

If you do NOT find the switch you wish to add:

Example: In order to change a switch's ID from N=x to N=y, it must first be reconfigured as a zero switch.

To do this:

Make sure the N=x switch is connected AND that NO OTHER N=x SWITCHES ARE CONNECTED

Select **Main Menu>System Settings>Delete Switch**

Enter the ID (N=x) of the connected switch and its ID will be set to 0

Briefly disconnect and reconnect the switch to allow the switch's internal firmware to reboot with its new ID as 0

Now the process to add the switch as N=y may be executed via **Main Menu>System Settings>Add Switch.**

Deleting a switch from the matrix configuration data does not require the switch being connected, but when it is its ID will be returned to 0. If it is not connected, it is still removed from the Matrix Configuration Data.

5 Manual (LOCAL) Operation

5.1 The Touch Screen Interface

Power On:

Position the rocker switch on the rear panel of the Matrix to the ON position (Figures 2-2, 2-3 and 2-4) to turn on the matrix.

! Note: The booting sequence will last up to 1 minute. The LCD can appear blank during this time.

The matrix will power up in LOCAL Operating Mode. LOCAL Operating Mode means that the matrix is receiving commands from the front panel (LCD/Touch Screen).

When in LOCAL Operation Mode the matrix will switch automatically in REMOTE mode as soon as commands coming from a remote control computer are received (GPIB, Serial or USB). The only buttons that will respond while in REMOTE mode are:

- From the 'Main Menu' the 'Switch Operations' button.
- From the 'Switching Menu' the 'Current Positions' button.

Other than the above two buttons the matrix will not accept any other local commands until the operator switches to LOCAL mode by pushing the 'Go Local" button on the LCD.

As stated before, to switch to REMOTE Operation Mode the operator needs to send a command (GPIB, Serial or USB) by means of a remote control computer or push on the 'Go Remote' button on the LCD.

All LOCAL operation of the matrix is accomplished via the front panel's Touch Screen LCD. Regions that respond to touches are called Active Areas or Buttons.

IMPORTANT NOTE: The touch screen is best operated with a stylus, rather than a fingertip. The LCD will respond better to a taping action rather than just touching it.

The figure above shows the matrix LCD touch screen (sometimes referred to as the "User Interface", or "UI") at the main menu screen.

Most buttons have a gray background, while indicators will be either green or red. All screens, with exception of the 'Main Menu' screen, will have a green 'back' button to return to the previous screen.

In the above picture the matrix is indicating that there are No Errors (see green indicator) and the matrix is in LOCAL mode (see green indicator).

If an error condition is detected the green 'Error" indicator will illuminate red.

The LCD in the figure above shows the top level of the matrix's operational screen, which happens to be a menu; the gray buttons are used to select menu items. Other screens encountered allow the operator to modify various parameters' values. All such "data fields" are presented with a currently set or default value blinking to promp the operator to modify the value. Some screens present multiple data fields, and a virtual keypad with arrows will appear to navigate around them and change the values.

! Note:

To preserve the life of the LCD, it has a 'screen saver' feature. After 5 minutes the LCD backlight will turn off. To turn it back on, tap anywhere.

The various screens encountered in the matrix's operation contain the following controls:

5.2 Main Menu

5.2.1 Switching Operations

Switch Operations Menu

Set Switch Positions

View the currently set position and change the position of a switch who's ID has been configured to the matrix. Use the arrows to change switch and position numbers.

Refer to Appendix B to set RF switches in different positions.

Current Positions

View the currently set positions of all switches whose ID's have been configured to the matrix. This screen can show a maximum of 30 switches at a time. BACK will bring the Operator back to the Switching Menu.

Remember that a switch position reported as 255 (0xFF) is meant to mean "position unknown", and is often the result of a switch not responding to a query for position.

Note that all Dow-Key switches have "open" defined, but not all switch types have an actual open position (the switch is not closed to any of its RF ports).
For most switches "open" is the default position and is defined as position 0. But for transfer switches there is no "open" condition, hence the default position is pos.1. As a result of this, commanding the switch to pos 0 or pos 1 will have the same result, closing it to its default position 1.

Switching History

View the last 10 switching actions. The latest action is presented first.

Save Positions

Save to non-volatile memory the state of the positions of all switch ID's configured to the matrix, as 1 through 30.

Recall Positions

Recall from non-volatile memory the state of the positions of all switch ID's configured to the matrix, saved as 1 through 30, and set the positions of those switches.

Clear Positions

Cause all switches configured to the matrix to assume their default position. For most switches this is position 0 (open positions). Note that all Dow-Key switches have "open" defined, but not all switch types have an actual open position, such as a transfer switch. In this case, "open" means "close on its default position 1".

Cycle Positions

Step all switches configured to the matrix through all of their positions. NOTE: the Cycle Position function is intended for use at the Dow-Key factory during the assembly process. In fact, the Cycle Position function will generate errors when commanding a Transfer switch to switch from position 0 to position 1, which may be ignored. For this reason, the Operator is discouraged from exercising Cycle Positions.

5.2.2 Error Operations

View the contents of the Error Log (see Section 7.5.1). Each entry is displayed with the oldest being first (First In First Out), showing the Error Record Number (its place in the Error Log), an associated Error Code, an associated Error Data, and a text explanation of the Error.

The Error Data contains various parameters associated with certain Errors. For instance, an Error Code 10 “Switch Did Not Respond” will show the offending switch ID in the Error Data field.

As each error is being read (displayed locally or queried remotely) it will also be removed from the Error Log.

5.2.3 System Settings

System Settings Menu

! Important Note:

The matrix controller is designed to offer the maximum expandability and flexibility possible and therefore has features common to other Dow-Key matrix models. The here described 'Add', 'Delete' and 'Find Switch ID' features are some of those that, although available and fully functioning, should only be used if needed and appropriate.

Switches may be added and deleted from the Matrix Configuration using these commands.

For those matrix models with a custom or fixed RF configuration (in other words where the internal RF switches and its connections are defined on a custom bases or are established and fixed by design), no switch shall be added or removed from the matrix configuration. Not following this instruction will result in a non working matrix!

System Information

View the Dow-Key Matrix Product's Model Number, its Serial Number (set at factory), and the Dow-Key part number and revision level of firmware running on the Matrix Controller.

Add Switch

Add switches to the Matrix Configuration (see Section 4).

Delete Switch

Delete switches from the Matrix Configuration (see Section 4).

Find Switch ID

Discover and view the ID of any switch by following these steps:

1. Using a matrix with at least one unused CAN Bus connector, and leaving the switch in question unconnected, select **Main Menu>System Settings>Find Switch ID.** The screen will indicate that no switch is connected.

2. Connect the switch in question. The screen will now display the unknown switch ID. NOTE: occasionally, the switch will not immediately report its ID; in this case, simply disconnect and reconnect the switch.

3. Multiple switches may be connected and disconnected one at a time while in this screen.

4. NOTE: this operation “puts the matrix’s switches to sleep” thereby rendering the matrix inoperable during the process. ENTER or CLEAR or rebooting returns the matrix to normal.

Temperatures

View current values of a maximum of 4 temperature sensors, and set thresholds at which an Over Temperature alarm should occur. Setting all 4 alarm thresholds to 0° Celsius disables Over Temperature alarms and causes the current temperatures to read out 0° as well; this is the recommended setting for Matrix Products that contain no temperature sensors.

Most standard Models do not feature temperature sensors.

Switch Closure Counts

View the number of times any position of any switch configured to the matrix has been closed upon, to a maximum of 1,000,000.

5.2.4 Ethernet Options

Ethernet Menu

Not applicable to GPIB (IEEE-488) models. This button is not operational.

5.2.5 LCD Options

This LCD has no adjustable parameters.

5.2.6 Set RS232 Baud Rate

View and select the Serial Port's Baud rate from a set of preselected values from 1200 to 115,200 b/s (see Section 3.3).

Use the arrows to change the baud rate settings.

Default value is 9600b/s.

5.2.7 Set GPIB Address

View and see the GPIB address from 1 to 30.

Use the arrows to change the address settings.

Default address is 9.

6 IEEE 488.2 Register model

6.1 Introduction to IEEE 488.2

The topics discussed in sections 4.2 to 4.3 are for the most part transparent to the user during normal operation of the matrix. These sections are here mainly for informational purpose. These sections describe a minimal register model that is required to be able to perform a safe handshaking between the controller and the matrix. In the matrix a status system records various conditions and states in 2 registers. Each of the register groups is made up of several low-level registers called Condition Registers, Event Registers, and Enable Registers.

6.2 Condition Register

A condition register continuously monitors the state of the instrument. The bits in the condition register are updated in real time and the bits are not latched or buffered. This is a read-only register and bits are not cleared when you read the register. A query of a condition register returns a decimal value which corresponds to the binary-weighted sum of all bit set in that register.

6.3 Event Register

An event register latches the various events from the condition register. There is no buffering in this register; while an event bit is set, subsequent events corresponding to that bit are ignored. This is a read-only register. Once a bit is set, it remains set until cleared by a query command (such as *CLS). A query of this register returns a decimal value that corresponds to the binary-weighted sum of all bits in that register.

6.4 Enable Register

An enable register defines which bits in the event register will be reported to the Status Byte resister group. You can write to or read from an enable register. A *CLS command will not clear the enable register but it does clear all bits in the event resister. To enable bit in the enable register to be reported to the Statue Byte register, you must write a decimal value that corresponds to the binary-weighted sum of the corresponding bits.

6.5 The Status Byte Register

The Status Byte register reports conditions from the other registers. Data in the instruments output buffer is immediately reported on the "Message Available" bit (bit 4). Clearing an event register from one of the other registers will clear the corresponding bits in the Status Byte condition register. Reading all messages from the output buffer, including any pending queries, will clear the "Message Available" bit. To set the enable register mask and generate an SRQ (service request), you must write a decimal value to the register using the *SRE command.

Table 6-1 Bit definitions – Status Byte Register

Bit Number	Decimal Value	Definitions
0	1	Free for manufacturer to assign
1	2	Free for manufacturer to assign
2	4	Free for manufacturer to assign
3	8	Free for manufacturer to assign
4 Message Available	16	Data is available in the instruments output buffer
5 Standard Event	32	One or more bits are set in the Standard Event Register (bits must be enabled)
6 Master Summary	64	One or more bits are set in the Status Byte Register (bits must be enabled)
7	128	Free for manufacturer to assign

The Status Byte *condition register* is cleared when:

- The *CLS command is executed.
- One of the event registers in the other registers are read (only the corresponding bits are cleared in the Statue Byte condition register).

The Status Byte *enable register* is cleared when:

- The *SRE 0 command is executed.

6.6 The Standard Event Register

The Standard Event Register reports different types of events that may occur in the instrument. Any or all of these conditions can be reported to the Standard Event summary bit through the *enable register.* To set the enable register mask, you must write a decimal value to the register using the *ESE command.

Table 6-2 Bit definitions – Standard Event Register

Bit Number	Decimal Value	Definitions
0 Operation Complete	1	All commands prior to and including *OPC have been executed.
1	2	Free for manufacturer to assign
2 Query Error	4	The instrument tried to read the output buffer but it was empty. Or a new command line was received before a previous query has been read. Or both the input and output buffers are full.
3 Device Error	8	A self-test or calibration error occurred.
4 Execution Error	16	An execution error occurred.
5 Command Error	32	A command syntax error occurred.
6	64	Free for manufacturer to assign
7	128	Free for manufacturer to assign

The Standard event register is cleared when:

- The *CLS command is executed.
- A query of the event register using the *ESR? Command.

The Standard Event enable register is cleared when:

- The *ESE 0 command is executed.

6.7 IEEE 488.2 Common Commands

This matrix implements common commands that the IEEE-488.2 standard defines. The following contains a list of a subset of these commands. For more details refer to the related section.

Table 6-3 Common Commands

Mnemonic	Name	Section
*CLS	Clear Status Command	7.4.1
*ESE	Standard Event Status Enable Command	7.4.2
*ESE?	Standard Event Status Enable Query	7.4.3
*ESR?	Standard Event Status Register Query	7.4.4
*IDN?	Identification Query	7.4.5
*OPC	Operation Complete Command	7.4.6
*OPC?	Operation Complete Query	7.4.7
*RST	Reset Command	7.4.8
*STB?	Read Status Byte Query	7.4.9
*SRE	Service Request Enable Command	7.4.10
*SRE?	Service Request Enable Query	7.4.11
*WAI	Wait-to-Continue Command	7.4.12

7 Remote Operation

7.1 Introduction to SCPI

SCPI is a command structure that is based on the IEEE-488.2 specification which Dow-key has adapted to work with GPIB, Ethernet, RS-232 and USB controls. The matrix has internal software loaded that uses SCPI command structure. SCPI is the abbreviation of Standard Commands for Programmable Instruments. These commands are standard messages for the (remote) control of programmable instruments, which are sent by the GPIB and/or Ethernet and/or RS-232 and/or USB controller. The principal objective of SCPI is to make the programming of a test system easier for the user. When the basic concepts and command structure of SCPI is understood, it will be easy for the user to write or modify a control program for the matrix.

NOTE: Not all commands for SCPI are compatible with GPIB, Ethernet, RS-232 and USB, only the ones stated in this document.

7.2 Command Syntax Structure

[ROUTe]:SWITch<id>[:VALue] <number>|MAX

- *Square brackets* [ ] indicate optional keywords or parameters.
- *Braces* { } enclosure parameter choices with a command string
- *Triangle brackets* < > enclose parameters for which you must substitute a value.
- *Vertical bar* | separates multiple parameter choices.

The command syntax shows most commands as a mixture of upper and lower case letters. The upper case letters indicate the abbreviated spelling for the command. For shorter program lines, the abbreviated form is used. For better program readability, the long form is used. For example, in the above syntax statement, ROUT and ROUTE are both acceptable forms. Since both upper and/or lower case letters are acceptable, ROUTE, rout and Rout are all acceptable. Other forms, such as RO and ROU are not acceptable and will generate an error.

NOTE: For GPIB no ASCII termination is required, but the End Or Identify (EOI) line shall be asserted at the end of each command.

For RS232 and USB each command must be terminated with a carriage return (0×0D) followed by a line feed (0×0A).

e.g. "ROUT:SWITx n\r\n"
" ROUT:SWITx n; SWITx?\r\n"

Where "\r" stands for carriage return (0×0D) and "\n" stands for line feed (0×0A).

7.3 Command Separators and conventions

- A *colon* (:) is used to separate a command keyword from a lower level keyword.
- A *blank space* is used to separate a parameter from a command keyword.
- A *comma* (,) is used if a command requires more than one parameter.
- A *semicolon* (;) is used to combine multiple commands into one message string. Commands from the same *subsystem* are permitted to skip repeating the upper-level keyword.
  Eg. "*Route:Switch1 8; Switch2 5; Switch3 2*"
- A *colon* is used when linking commands from different subsystems into one message string, allowing a new upper-level keyword to be introduced. Since the keyword is optional, such keyword could also be omitted (see example 2).
  Only the first command requires the colon. Any subsequent commands of the same subsystem do not require the colon (see example 3).

  Ex. 1: "*Route:Switch1 8; Switch2 5; Switch3 2; System:Error?*"
  Ex. 2: "*Route:Switch1 8; Switch2 5; Switch3 2; :Error?*"
  Ex. 3: "*Route:Switch1 8; Switch2 5; Switch3 2; :Error?; Timeout 2; status?*"

- When linking multiple commands the maximum number of characters supported is 220. The limit of 220 characters is valid in transmission and receiving.
- Commands related to the GPIB controller's registers can NOT be concatenated. These commands are *ESE, *ESE?, *ESR?, *STB?, *SRE, *SRE?.
- All messages are in ASCII format (numeric values are represented in decimal format with exception of the MAC address which is expressed in hex format).
- Timing, sequences and action requirements are only shown where applicable and are under the TIMING sub-paragraphs on each command description.
- For RS232 and USB communication: Any string returned by the matrix is terminated with a carriage return **(0×0D)** followed by a line feed **(0×0A)**.

  e.g. "ROUT:SWIT2?\r\n"

  will return

  "1\r\n"

  Where "\r" stands for carriage return (0×0D) and "\n" stands for line feed (0×0A).

- For GPIB communication no ASCII termination is required, but the End Or Identify (EOI) line shall be asserted at the end of each command.

7.4 Common Commands

The following contains the IEEE 488.2 common commands of SCPI that the GPIB controller is compatible with.
The possible error codes assume that the correct syntax is used and, in case of a multiple command string the string is not too long.
If these conditions are not met, any given command can generate these error codes: 3, 4, 30

7.4.1 *CLS

Syntax
*CLS

Description
This command is used to clear the event register in all register groups.

7.4.2 *ESE

Syntax
*ESE <*value*>

Parameters
value Decimal value which corresponds to the binary-weighted sum of the bits you wish to enable in the register.

Description
Enable bits in the Standard Event Status enable register.
The selected bits are then reported to the Status Byte register.
To enable bits in the Standard Event Status enable register, you must write a decimal value that corresponds to the binary-weighted sum of the bits you wish to enable in the register.

Note: This command can NOT be concatenated with other commands. It must be issued as a single command.

7.4.3 *ESE?

Syntax
*ESE?

Description
This query allows the user to determine the current contents of Standard Event Status enable register.
The value returned corresponds to the binary-weighted sum of all bits enabled by the *ESE command.

Note: This command can NOT be concatenated with other commands. It must be issued as a single command.

7.4.4 *ESR?

Syntax
*ESR?

Description
This query allows the user to determine the current contents of Event Status register. Reading the Event Status Register clears it.
The status is returned as a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

Note: This command can NOT be concatenated with other commands. It must be issued as a single command.

7.4.5 *IDN?

Syntax
*IDN?

Result
A string is returned which consists of the following parts:

Model

Model Matrix model number

Possible error codes
None

Example
"*IDN?"

Result
"MS-2U18SFRL-4/X-GPIB"

7.4.6 *OPC

Syntax
*OPC

Description
This command causes the device to set the Operation Complete bit in the Standard Event Register when all pending operations have been finished.

7.4.7 *OPC?

Syntax
*OPC?

Description
This query returns an ASCII character “1” when all pending operations have been finished.

Result
ASCII character “1”.

Possible error codes
None

Example 1
*OPC?

Result
“1”

Example 2
:SWIT1 4; SWIT2 4; *OPC?

Result
“0”

Timing
In example 2 the matrix did not have the time to execute the command. Hence a “0” is returned. A subsequent *OPC? will return a “1” as shown in example 1.
The timing to execute a command depends on the length of the command (in case of concatenated commands). In case of switching commands like on example 2, the controller will first command each switch to set its new position, then query each switch to ensure that the positions are closed and finally respond with a “1” to the **OPC?* query.
As a rule of thumb electromechanical switches require approximately 10-15ms to switch position. But the **OPC?* query will return a “1” only after the switches have not only changed its positions, but rather also confirmed its position. So it is safe to consider some safety margin and expect a response of “1” after about 70ms per switch. As an example if 2 switches are commanded, wait about 140ms before issuing an **OPC?* query that will return a “1”.

7.4.8 *RST

Syntax
*RST

Description
This command performs a device reset.
This will set the instrument so that all switches are in the default state.
For SPnT switches the default state is: all RF ports are open (position 0).
For a transfer switch the default state is: position 1 is closed.

Possible error codes
11, 12, 13

Timing
Before issuing any other command after a **RST* use the following considerations.
The **RST* command is 'translated' by the internal controller board to command, on the CAN bus level, each switch to position 0 (open). The amount of these commands depends on the amount of switches present in the matrix.
Each switch requires approximately 10-15ms to switch position. So to execute a **RST* command (to open all positions without verifying the switch's positions) will require at least n x (10 - 15ms), where n is the number of switches in the matrix.

7.4.9 *STB?

Syntax
*STB?

Description
Query the Status Byte Register
This command is similar to a Serial Poll but is processed like any other instrument command. This command returns the same result as a Serial Poll but the Master Summary bit is not cleared if a Serial Poll has occurred.

Result
STB decimal value which corresponds to the binary-weighted sum of all bits set in the register.

Note: This command can NOT be concatenated with other commands. It must be issued as a single command.

7.4.10 *SRE

Syntax
*SRE <enable_value>

Parameters
Enable_value Value that corresponds to the binary-weighted sum of the bits you wish to enable in the register.

Description
Enable bits in the Status Byte enable register.
To enable bits in the Status Byte enable register, you must write a decimal value that corresponds to the binary-weighted sum of the bits you wish to enable in the register.

Note: This command can NOT be concatenated with other commands. It must be issued as a single command.

7.4.11 *SRE?

Syntax
*SRE?

Description
The *SRE? query returns a decimal value which corresponds to the binary-weighted sum of all bits enabled by the *SRE command.

Result
Returns a decimal value which corresponds to the binary-weighted sum of all bits enabled by the *SRE command.

Example
"*SRE?"
Result was "16"

Note: This command can NOT be concatenated with other commands. It must be issued as a single command.

7.4.12 *WAI

Syntax
*WAI

Description
This command prevents the instrument from executing any further commands or queries until the current commands have been processed.

7.5 System Commands

The following contains the SCPI system commands that the GPIB, RS-232 and USB control is compatible with.

7.5.1 SYST:ERR?

Syntax
SYSTem:ERRor?

Description
Query the instrument's error queue. A record of up to N errors is stored in the instrument's error queue. Errors are retrieved in first-in first-out (FIFO) order. The first error returned is the first error that was stored. Each additional error up to N is read by N subsequent queries (one for each error). For this instrument N=20. The error queue has to be read until no more errors are returned, otherwise the error status is not cleared.

Note: some of the listed error codes are here for backwards compatibility with legacy products and other are reserved for future applications. Not all error codes are applicable to this matrix.

Result
String with the following syntax:

code, message

code: Numeric value with the error code (0 if no error).

Message: String with error message.

Example

"SYST:ERR?"
Result was "1, INVALID CHARACTER", check for more errors.
Description: This error is no longer supported. The error code is maintained and reserved for legacy purposes only.

"SYST:ERR?"
Result was "2, OUTPUT BUFFER OVERFLOW", check for more errors.
Description: This error is no longer supported. The error code is maintained and reserved for legacy purposes only.

"SYST:ERR?"
Result was "3, TOO MANY COMMANDS", check for more errors.
Description: The maximum of 220 characters per command line has been exceeded.

SYST:ERR?"
Result was "4, SYNTAX ERROR", check for more errors.
Description: There is a misspelling in your command or a non-numeric character was included in a command where a number should have been, or use of unrecognized symbols such as %, &, #, etc.

SYST:ERR?"
Result was "5, DATA OUT OF RANGE", check for more errors.
Description: The value transmitted is not acceptable.
Eg. 1: A non existing switch positions has been commanded. Sending *Route:Switch1 8*. When switch 1 is a SP6T (6 position switch)
Eg. 2: This error code is set if the IP address or MAC address is an invalid one. Sending SYSTEM:IPADDRESS 55.57.2 would generate this error code since 4 numbers are required for a valid IP address.

SYST:ERR?"
Result was "6, ILLEGAL PARAMETER VALUE", check for more errors.
Description: This error is no longer supported. The error code is maintained and reserved for legacy purposes only.

SYST:ERR?"
Result was "7, INPUT BUFFER UNDERFLOW", check for more errors.
Description: This error is no longer supported. The error code is maintained and reserved for legacy purposes only.

SYST:ERR?"
Result was "8, MATRIX SOCKET NOT AVAIL", check for more errors.
Description: This error is no longer supported. The error code is maintained and reserved for legacy purposes only.

SYST:ERR?”
Result was “10, SWITCH DID NOT RESPOND,x”, check for more errors.
Description: Switch x did not respond to a position query.
E.g. CAN bus communication failure or damaged switch.

SYST:ERR?”
Result was “11, SWITCH’S RESPONSE INVALID,x”, check for more errors.
Description: Switch x responded but with the wrong response code. This error is related to wrong internal CAN bus communication codes.

SYST:ERR?”
Result was “12, SWITCH’S POSITION INCORRECT,x”, check for more errors.
Description: Switch x reported to be closed on a position different than what it was commanded to be.
E.g. Commanded position is 4, reported position is 3.

SYST:ERR?”
Result was “13, SWITCH’S POSITION UNKNOWN,x”, check for more errors.
Description: Switch x reported to be closed on an unknown position. E.g. A defective / damaged switch.

SYST:ERR?”
Result was “20, MATRIX IS NOT CONFIGURED”, check for more errors.
Description: The configuration file (factory configuration) defining all switches configured inside the matrix has not been uploaded. The matrix does not ‘know’ what and how many switches to control.

SYST:ERR?”
Result was “21, CONFIGURATION FILE IS CORRUPT”, check for more errors.
Description: The configuration file (factory configuration) defining all switches configured inside the matrix is corrupted.

SYST:ERR?”
Result was “22, CONFIGURATION FILE DOES NOT MATCH INSTALLED SWITCHES”, check for more errors.
Description: The configuration file (factory configuration) defining all switch types configured inside the matrix does not match the actual installed switch types.
This error code is generated only at boot up and refers only to answering switches. A switch not answering to CAN messages would result into an error code 10.

SYST:ERR?”
Result was “23, MATRIX CONTAINS A 0 ID”, check for more errors.
Description: The matrix contains a switch that has not been assigned a valid CAN bus address. ID 0 is not a valid CAN bus address.

SYST:ERR?”
Result was “30, COMMAND UNRECOGNIZED”, check for more errors.

Description: This error code is generated when the commanded string does not contain any valid keyword (e.g. Route, System, *IDN?, *RST, ….) at all.

SYST:ERR?”
Result was “36, ID IS OUT OF RANGE”, check for more errors.

Description: A non existing switch ID has been commanded.
Eg. Sending *Route:Switch11 8*. When switch 11 does not exist.

SYST:ERR?”
Result was “50, UNABLE TO AQUIRE IP ADDRESS”, check for more errors.

Description: DHCP is enabled (ON), but the IP address could not be acquired dynamically.
Eg. Ethernet connection cable is disconnected.

SYST:ERR?”
Result was “51, FAN STALL”, check for more errors.

Description: On models with fans equipped with sensors, one or more fans have stalled (only when this alarm has been enabled at the factory).
Note: Not applicable for most models.

SYST:ERR?”
Result was “52, INTERNAL TEMPERATURE EXCEEDS THERSHOLD”, check for more errors.

Description: On models with temperature sensors, one or more temperature sensors has exceeded its alarm threshold (only when this alarm has been enabled at the factory).
Note: Not applicable for most models.

SYST:ERR?”
Result was “53, POWER SUPPLY FAILURE”, check for more errors.

Description: On matrices with redundant power supplies it will indicate that one of the power supplies does not operate.
E.g. Damaged power supply or blown fuse on the power supply.

Result was “0”NO ERROR””, No more errors, error queue is empty.

7.5.2 SYST:SERIALNUMBER?

Syntax
SYSTem:SERIALNUMBER?

Description
Returns the matrix serial number.

Result
n

Possible error codes
None

7.5.3 SYST:STATUS?

Syntax
SYSTem:STATUS?

Description
This command will return all Switch positions, Local/Remote mode, Power supply status, High temperature alarm status, Fan stall alarm and Errors list separated by a semicolon.

Note 1: Power supply status, High temperature alarm status and Fan stall alarm are only returned if enabled.
(Most models do not have redundant power supplies, temperature sensors and fans and therefore will not report this status information)

Note 2: Multiple instances of the same error code will appear multiple times. E.g. if two different switches fail to respond to CAN messages, two instances of error 10 will be returned.
But multiple error instances of the same switch will appear only once.

Result
"SWITx y;SWITx y;SWITx y;…….;SWITx y;LOC;PWR1 OK;PWR2 FAULT;
ERRORS 5,3;0"

SWIT = Switch
X = Switch number (ID)
Y = Switch position
LOC = Local mode
REM = Remote mode
PWR1 = Power supply 1
PWR2 = Power supply 2 (Only for systems with dual power supplies)
TEMP1 = Temperature sensor 1 (Only if temp sensor 1 is enabled)
TEMP2 = Temperature sensor 2 (Only if temp sensor 2 is enabled)
TEMP3 = Temperature sensor 3 (Only if temp sensor 3 is enabled)
TEMP4 = Temperature sensor 4 (Only if temp sensor 4 is enabled)
FAN1 = Fan 1 (Only if Fan sensor 1 is enabled)
FAN2 = Fan 2 (Only if Fan sensor 2 is enabled)
FAN3 = Fan 3 (Only if Fan sensor 3 is enabled)
FAN4 = Fan 4 (Only if Fan sensor 4 is enabled)
ERRORS = Error codes (Each number corresponds to a specific error code described in the user manual. Not all error codes apply to the matrix).

Possible error codes
None

7.5.4 SYST:SCREENSAVER?

Syntax
SYSTem:SCREENSAVER?

Description
This command will return the screen saver time settings n (n is in minutes).
Possible values for n are 0, 2, 3, 4, 5, ……
Note that 1 is not a valid value.

0 = Screen saver is disabled

Possible error codes
5

Factory default value
5

Power on behavior
Keeps last value

***RST effect**
None

7.5.5 SYST:SCREENSAVER x

Syntax
SYSTem:SCREENSAVER x

Description
This command will set the screen saver time settings x (x is in minutes).
Possible values for x are 0, 2, 3, 4, 5, ……
Note that 1 is not a valid value.

0 = Screen saver is disabled

Possible error codes
5

Factory default value
5

Power on behavior
Keeps last value

***RST effect**
None

7.5.6 SYST:GPIBADDRESS?

Syntax
SYSTem:GPIBADDRESS?

Description
This command will return the matrix's GPIB address.

Possible values are 1 to 30

Possible error codes
5

Factory default value
9

Power on behavior
Keeps last value

***RST effect**
None

7.5.7 SYST:GPIBADDRESS x

Syntax
SYSTem:GPIBADDRESS x

Description
This command will set the GPIB address to x.
Possible values for x are 1 to 30.

Possible error codes
5

Factory default value
9

Power on behavior
Keeps last value

***RST effect**
None

7.6 Switch [Module] Command Set

The following contains the switch [module] commands of SCPI that the GPIB / RS 232 / USB control is compatible with.

7.6.1 :SWITch<id>[:VALue] <number>

Syntax

[ROUTe]:SWITch<id>[:VALue] <number>

Description

This command is used to control the position of the switches. The switch specified by the numeric suffix <id> is set to position <number>. Switch positions are specified in a 0 to N fashion, therefore legal values for <number> are from 0 to the maximum number of position for the switch. For example, a SP10T switch has 11 positions, 0 thru 10. Position 0 means the switch is set to its default position.

For most switches the default position is pos 0 (open switch). So in case of a SP10T switch this means no position is closed.

In case of a transfer switch, since it does not have an open position, the default position is pos 1. So commanding it to pos 0 will close it to position 1.

7.6.2 Setting switch x to position n

x = switch [module] address.
n = position to set and must be within the switches parameter.
(Example: SP10T valid positions are 0 thru 10 only).

Examples:

- ROUTE:SWITCHx n
- ROUT:SWITCHx n
- ROUTE:SWITx n
- ROUT:SWITx n
- :SWITCHx n
- :SWITx n
- ROUTE:SWITCHx:VALUE n
- ROUTE:SWITCHx:VAL n
- :SWITx:VAL n

Possible error codes
5, 10, 12, 13

Factory default value
N.a.

Power on behavior
Keeps last value

***RST effect**
SP6T switch: will open all positions
Transfer switch: will close position 1

Timing
The timing to execute a command depends on the length of the command (in case of concatenated commands). In case of switching commands the controller will first command each switch to set its new position, then query each switch to ensure that the positions are closed. Only after this internal verification (that happens automatically) the controller will respond with a “1” to the **OPC?* query and update the error status.
As a rule of thumb electromechanical switches require approximately 10-15ms to switch position.
But the **OPC?* query will return a “1” or the error status is updated only after the switches have not only changed its positions, but rather also confirmed its position. So it is safe to consider some safety margin and expect a response of “1” or an updated error status after about 70ms per switch.
As an example if 2 switches are commanded, wait about 140ms before issuing an **OPC?* query that will return a “1” or issuing an *SYST:ERR?* query or issuing a *ROUTE:SWITCHx?* query.

7.6.3 Requesting Switch x current position

x = switch address.

Examples:
- ROUTE:SWITCHx?
- ROUT:SWITx?
- :SWITx?

Result:
Returns the current position of switch x.

Possible error codes
10, 11, 12, 13

Timing
The timing to execute a command depends on the length of the command (in case of concatenated commands).). In case of switching commands the controller will first command each switch to set its new position, then query each switch to ensure that the positions are closed. Only after this internal verification (that happens automatically) the controller will respond with a “1” to the **OPC?* query and update the error status.
As a rule of thumb electromechanical switches require approximately 10-15ms to switch position.
But the **OPC?* query will return a “1” or the error status is updated only after the switches have not only changed its positions, but rather also confirmed its position. So it is safe to consider some safety margin and expect a response of “1” or an updated error status after about 70ms per switch.
As an example if 2 switches are commanded, wait about 140ms before issuing an **OPC?* query that will return a “1” or issuing an *SYST:ERR?* query or issuing a *ROUTE:SWITCHx?* query.

This page intentionally left blank

GPIB, RS232 and USB Command description for standard matrices

	Command Syntax	Response	Action
1	*IDN?	MS-2U18S-3/10-GPIB	Returns string in 'Model Name' in the configuration file. As a minimum will have model name. Could also have: Vendor, model, serial number, firmware revision (The response shown in this table is just an example).
2	*OPC?	1 or 0	Gives 1 if previous operation was completed and gives 0 if previous operation is still not complete.
3	*RST		Puts all switches in the default position. (Transfer switches in pos.1. Most other switches in pos. 0 = open).
4	ROUTE:SWITCHx y or :SWITCHx y		Closes position y on switch x
5	ROUTE:SWITCHx? or :SWITCHx?	n	Gives current position of switch x
18	SYST:SERIALNUMBER?	n	Returns system serial number
22	SYST:ERR? or SYST:ERROR?	-4,SYNTAX ERROR	Returns system error number and error description. (The response shown in this table is just an example).
23	SYST:STATUS?	SWITx y;SWITx y;SWITx y;… ;SWITx y;LOC;PWR1 OK;PWR2 FAULT; ERRORS 5,3;0	This command will return all Switch positions, Local/Remote mode, Power supply status and Errors list in the error buffer separated by a semicolon.
24	SYST:SCREENSAVER?	n	Returns time setting for the screen saver (n is in minutes)
25	SYST:SCREENSAVER x		Sets time setting for the screen saver (x is in minutes)
26	SYST:GPIBADDRESS?	9	Returns matrix system's GPIB address
27	SYST:GPIBADDRESS x		Sets matrix system's GPIB address to x
31	*CLS		Clear Status Command used to clear the Event Register in all register groups.
32	*ESE		Command used to enable bits in the Standard Event Status Enable register.
33	*ESE?		Query used to read the content of the Standard Event Status Enable register.
34	*ESR?		Query used to read the content of the Event Status Register.
35	*OPC		Sets the Operation Complete bit in the Event Status Register when all pending operations have been finished.
36	*STB?		Query used to read the content of the Status Byte Register.
37	*SRE		Command used to enable bits in the Service Request Enable register.
38	*SRE?		Query used to read the content of the Service Request Enable register.
39	*WAI		This command prevents the matrix from executing any further commands or queries until the current commands have been processed.

Note 1: Missing command numbers are commands reserved for Ethernet matrices and not applicable to GPIB models.

Note 2: Commands related to the GPIB controller's registers **ESE, *ESE?, *ESR?, *STB?, *SRE, *SRE?* can NOT be concatenated.

Note:

1. Commands are **NOT** case sensitive.
2. For GPIB communication no ASCII termination is required, but the End Or Identify (EOI) line shall be asserted at the end of each command.
3. Every command and response on the serial or USB port shall have “\r\n” Carriage return (0x0D) and Line Feed (0x0A) at the end.
4. Multiple commands with same header can be given in a single command line. (See rule # 5 for an exception to this).

   e.g. SYST:IPADDRESS?;TCPPORT?;SERIALNUMBER 2 or ROUTE:SWITCH1 2;SWITCH1?;
   note that the commands have to separated by ‘**;**’
5. Exception to rule # 4 are commands related to the GPIB controller’s registers **ESE, *ESE?, *ESR?, *STB?, *SRE, *SRE?.* These commands can NOT be concatenated.
6. The default GPIB address is: 9
7. In command SYST: SCREENSAVER? and SYST:SCREENSAVER x, the value n and x is in minutes. The default value is 5 (minutes). 0 = no screen saver. Valid values for x are: 0, 2, 3, 4, 5, 6,….

Appendix A

Technical Specifications

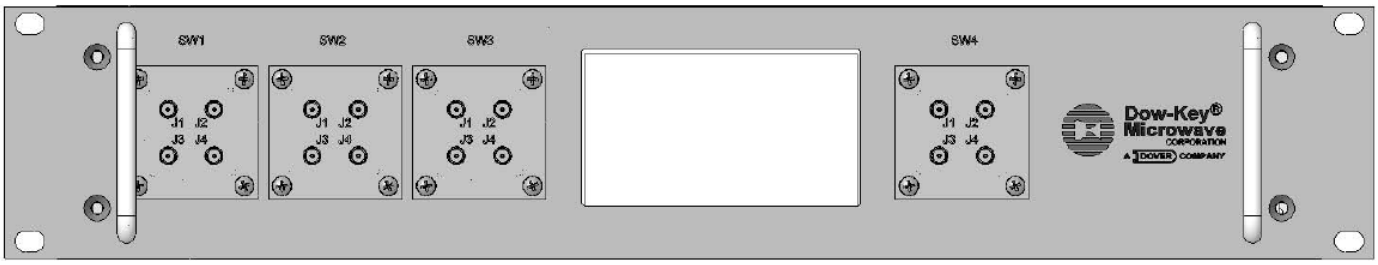
Model:	MS-2U18SFRL-4/X-GPIB
Configuration:	4 Transfer switches mounted on the front panel
RF Connectors:	SMA
Frequency range:	DC to 18 GHz
Return loss (VSWR)	
Insertion loss	
Isolation	
RF Power:	

Frequency (GHz):	**DC - 1**	**1 - 4**	**4 - 8**	**8 - 12**	**12 - 18**
VSWR (Ratio max):	1.10 : 1	1.20 : 1	1.30 : 1	1.40 : 1	1.50 : 1
Insertion Loss (dB max):	0.1	0.2	0.3	0.4	0.5
Isolation (dB min):	85	80	70	65	60
RF Power (Watts CW max):	200	100	50	35	25

Impedance:	50 Ω
Switching Speed:	50ms (per switch)
Operating Temp:	0 to 50 degrees C
Switch Type:	Four Transfer switches Switch p.n. 411L-420832N-ROHS
Line Voltage:	120-240 VAC, 50-60 Hz
Control Interfaces:	GPIB (IEEE 488) Connector RS-232 via 9-pin D-Sub female connector CAN Bus via 4 pin XLR female connector USB type A (used as 'virtual' serial port)
RS-232 Settings:	Settable at 1200, 2400, 4800, **9600** (default), 19200, 38400, 57600,115200 bits/sec, 8 bit data, no parity, 1 stop bit
Dimensions:	3.5" H x 19" W x 15.625" D (without handles)

Appendix A

Front View:



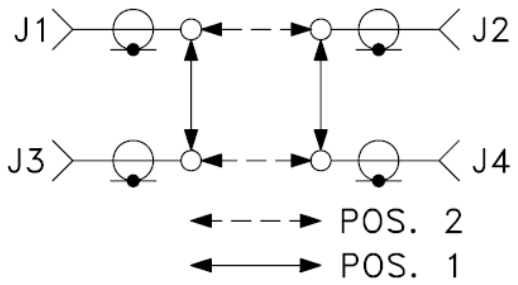
Appendix B

RF Configuration

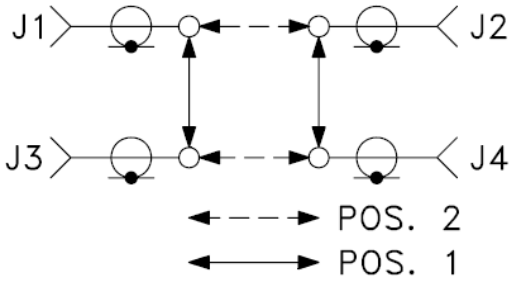
Model: MS-2U18SFRL-4/X-GPIB

Four independent transfer switches (Dow-Key part number: 411L-420832N-ROHS) mounted on the front panel.

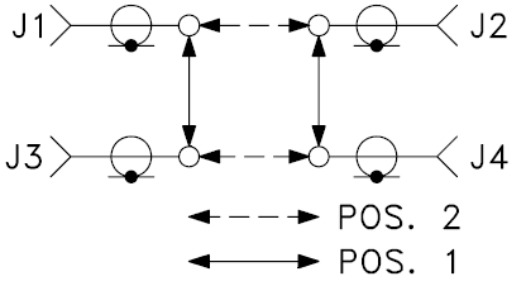
SW1



SW2



SW3



SW4