DOW-KEY MICROWAVE
MMS Mini-Matrix

MMS Series

Operator’s Manual

Rev 2

THE RF/MICROWAVE SWITCHING TECHNOLOGY SOLUTION COMPANY
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.
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 ........................................................................ March 2016
   Original Release

Revision 2 ........................................................................ February 2017
   Various improvements and clarifications
# Table of Contents

1 General Information ........................................................................................................... 1
  1.1 Introduction .................................................................................................................. 1
  1.2 MMS SPDT Matrices .................................................................................................... 2
  1.3 MMS SP6T Matrices .................................................................................................... 2
  1.4 Technical Specifications .............................................................................................. 3
  1.5 Safety Precaution ......................................................................................................... 4
  1.6 Inspection ..................................................................................................................... 4
  1.7 Maintenance ................................................................................................................ 4
  1.8 Repacking for shipment ............................................................................................... 4

2 System Layout .................................................................................................................... 5
  2.1 Front Panel Layout ....................................................................................................... 5
  2.2 Rear Panel Layout ....................................................................................................... 6
  2.3 Top View Layout ....................................................................................................... 7
  2.4 RF configuration ......................................................................................................... 8

3 Connections ......................................................................................................................... 9
  3.1 Power Connection ....................................................................................................... 9
    3.1.1 Voltage ................................................................................................................. 9
    3.1.2 Power Connection ............................................................................................... 9
    3.1.3 Powering Off Safely ............................................................................................ 9
  3.2 USB Port ...................................................................................................................... 10
    3.2.1 Connecting to a RS-232 Port ............................................................................. 10
    3.2.2 Connecting to a USB Port .................................................................................. 12
  3.3 Ethernet Port ............................................................................................................... 13
    3.3.1 TCP/IP Control .................................................................................................. 13
    3.3.2 HTTP Webpage Control .................................................................................... 14
  3.4 Connecting to a Static IP Address ............................................................................... 15

4 Configuring the Mini-Matrix for Operation ....................................................................... 16
  4.1 Mini-Matrix Configuration ......................................................................................... 16
  4.2 Dow-Key GPIO switches ........................................................................................... 16
  4.3 Adding Switches ......................................................................................................... 17

5 The Sequencer .................................................................................................................... 18
  5.1 Sequencer ................................................................................................................... 18

6 SCIP Command Operation ............................................................................................... 19
  6.1 Introduction to SCPI .................................................................................................. 19
  6.2 Command Syntax Structure ...................................................................................... 19
  6.3 Command Separators and conventions .................................................................. 20
  6.4 Common Commands .................................................................................................. 21
    6.4.1 *IDN? ............................................................................................................... 21
    6.4.2 *OPC? .............................................................................................................. 22
    6.4.3 *RST ................................................................................................................. 23
    6.4.4 SET:DHCP ON/OFF ...................................................................................... 23
    6.4.5 GET:DHCP ..................................................................................................... 24
  6.5 System Commands ...................................................................................................... 25
    6.5.1 SYST:ERR? ...................................................................................................... 25
    6.5.2 SYST:ERRALL? ............................................................................................... 25
    6.5.3 SYST:SERIALNUMBER? ............................................................................... 27
    6.5.4 SYST:TCPPORT? ......................................................................................... 28
    6.5.5 SYST:TCPPORT x ......................................................................................... 28
1 General Information

1.1 Introduction

The Dow-Key Microwave Mini-Matrix series models are electromechanical RF miniature benchtop matrices. They come equipped with ENET (Ethernet) and USB ports which allows the user to easily access and control the Mini-Matrix. These models are not intended to be used to power or control anything other than Dow-Key supplied switches.

This user manual covers the Mini-Matrix models. Since most features are the same among the various models, the user shall focus on the Mini-Matrix model of interest and skip any section that does not pertain to his/her Mini-Matrix.

Information specific to the user’s model (like technical specifications and RF configuration) can be found in appendices at the end of this manual.
1.2 MMS SPDT Matrices

**MMS** stands for **Miniature Multiple Switches**. It is a Mini-Matrix where a number of independent latching SPDT (Single Pole Double Throw) and/or SPnT (Single Pole n Throw) switches are populated on the front panel. From an RF point of view the switches are not interconnected and all of the switch’s RF ports are available to the user on the front panel of the Mini-Matrix.

![Diagram showing two switches: SW1 and SW2.](image)

Examples of a Mini-Matrix Models

- with 2 independent SPDT switches
- with 1 independent SP6T switch

**Part Numbering Examples:**

- **MMS-A26S-2TSPDT** is a **Miniature Multi Switch** matrix with following characteristics: A, 26.5 GHz, SMA, 2 Terminated SPDT switches

- **MMS-A26S-2SPDT** is a **Miniature Multi Switch** matrix with following characteristics: A, 26.5 GHz, SMA, 2 non-terminated SPDT switches

The part numbering is interpreted as follows:

MMS-[chassis size][frequency][connector]-[number of switches]/[type of switch]

[chassis size]: A, B, C 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]: SPDT | X (for transfer switch = 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:** **MMS-A26S-2TSPDT-2SPDT** (2 terminated SPDT + 2 non-terminated SPDT)

**Example:** **MMS-A26S-1TSP6T-4SPDT** (1 terminated SP6T + 4 non-terminated SPDT)

Note: not all switch configurations and combinations are possible.
1.3 Technical Specifications

Refer to appendix A
1.4 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.

1.5 Inspection

The Mini-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 Mini-Matrix order.

- Mini-Matrix
- Mini-Matrix Default Network Settings
- Mini-Matrix Operation Manual
- Wall Plug-In power supply

1.6 Maintenance

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

1.7 Repacking for shipment

Should it become necessary to return the Mini-Matrix 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 Mini-Matrix.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.
2 System Layout

2.1 Front Panel Layout

Figure 2-1 shows an example of the MMS-Model general layout, which includes:

- Input, output, and common connectors of all switches in the MMS configuration.
- Indicator LEDs for each position of each switch in the MMS configuration, and one error LED.

![Diagram of Mini-Matrix Front Panel Layout]

Figure 2-1, Example of a Mini-Matrix Front Panel Layout
2.2 Rear Panel Layout

Figure 2-2 shows the Mini-Matrix model rear panel general layout. All models have common parts which include:

- Power Entry Module
- 4 USB 2.0 Ports
- 1 Ethernet Port

Figure 2-2, Mini-Matrix model Rear Panel Layout
2.3 Top View Layout

Figure 2-3 shows the top view layout of all models.
2.4 RF configuration

Refer to appendix B.
3 Connections

3.1 Power Connection

3.1.1 Voltage

The Mini-Matrix operates at a DC voltage of 12V +/- 5%.

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

3.1.2 Power Connection

Perform the following steps to correctly power on the Mini-Matrix:

1. Connect all Ethernet cables and/or USB cables before turning on the Mini-Matrix. This is because the drivers are downloaded on boot up by a Linux kernel.

2. Connect the male end of the supplied wall plug-in power supply to the female receptacle on the rear panel.

3. Connect the other end of the supplied wall plug-in power supply to a grounded AC outlet.

   **Note:** When powering up the Mini-Matrix it takes about 30-40 seconds to boot up and be operational.

3.1.3 Powering Off Safely

There is no power off switch for the Mini-Matrix, so follow the directions below when powering off the Mini-Matrix.

1. Make sure no commands are being executed.

2. Exit out of HyperTerminal, the webpage, or any other control software.

3. Now it is safe to unplug the power.

   **Caution:** Do not power cycle the Mini-Matrix quickly. Power cycling quickly may corrupt the SD card, and the Mini-Matrix will not work properly. Wait a minimum of 10 seconds between power cycles.
3.2 USB Port

Communication with the Mini-Matrix through one of the USB ports can be accomplished by connecting the Mini-Matrix to an RS-232 port on a PC or the USB port on a PC. Either way a few essential items will be needed.

- 2 RS-232 to USB cables (*Note: If the user will be communicating with the Mini-Matrix through the RS-232 port of a PC then only 1 RS-232 to USB cable is needed*)

- 1 null-modem cable

- Depending on the gender of the port connectors a female to female 9 pin D-Sub connector

- Download PuTTY or another SSH (Secure Shell). A SSH is a command interface and protocol for securely getting access to a remote computer or device. The Mini-Matrix is the remote device that will be accessed by the SSH. PuTTY is the SSH used to demonstrate how to connect to the Mini-Matrix.

To communicate with the Mini-Matrix through the USB port, follow the steps in sections 3.2.1 and 3.2.2 below.

### 3.2.1 Connecting to a RS-232 Port

To connect the Mini-Matrix to an RS-232 port of a PC perform the following steps.

1. Connect the USB to RS-232 cable to the Mini-Matrix before turning the Mini-Matrix on. *Note: This is important because the drivers for the cable are installed during the boot up of the Mini-Matrix.*

2. Connect one end of the null-modem cable to the D-Sub connector of the USB to RS-232 cable.

3. Connect the other end of the null-modem cable to the RS-232 port on a PC. Depending on the gender of the D-Sub connectors, a female to female D-Sub connector may be needed.
4. Open PuTTY. Under ‘Connection Type:’ select ‘Serial’. Then select the ‘Serial Line’, this is the RS232 or USB port that the user connected the Mini-Matrix to on the PC. In the example COM1 is used, but it may be different for the user. Set the ‘Speed’ to 9600.

5. Then under ‘Category:’ select ‘Terminal’. Change both the ‘Local echo:’ and the ‘Local line editing:’ to ‘Force on’. After that click ‘Open’ to begin commanding and operating the Mini-Matrix.
3.2.2 Connecting to a USB Port

To connect the Mini-Matrix to the USB port of a PC, two USB to RS-232 cables are required. A simple USB to USB connection from the PC to the Mini-Matrix will not work. This is because both the PC and the Mini-Matrix are hosts. Using two USB to RS-232 cables will overcome this problem.

Perform the following steps.

1. Connect the first USB to RS-232 cable to the Mini-Matrix before turning the Mini-Matrix on. **Note: This is important because the drivers for the cable are installed during the boot up of the Mini-Matrix.**

2. Then connect the null-modem cable to the D-Sub connector of the USB to RS-232 cable that is connected to the Mini-Matrix.

3. Connect the null-modem cable to the RS-232 D-Sub connector of the second USB to RS-232 cable. Then plug the USB side of the cable into the USB port of a PC. Depending on the gender of the D-Sub connectors, a female to female D-Sub connector may be needed.

4. To communicate with the Mini-Matrix, follow steps 4 and 5 in Section 3.2.1.
3.3 Ethernet Port

There are two ways to control the Mini-Matrix using the Ethernet port. One method is through TCP/IP (Transmission Control Protocol/Internet Protocol), which is the basic communication protocol of the internet. The second method for controlling the Mini-Matrix is using the HTTP (Hypertext Transfer Protocol) webpage. HTTP is the foundation of communication on the World Wide Web. The user will need the IP (Internet Protocol) address to control the Mini-Matrix using the Ethernet port. **IMPORTANT: Read section 3.4 to connect to the Mini-Matrix using the Ethernet port. The Mini-Matrix has a default static IP address. It will be necessary to configure a PC to have a similar IP address in order to connect to the Mini-Matrix properly over Ethernet for the first time.**

3.3.1 TCP/IP Control

Follow the steps below to connect to the Mini-Matrix. In the example pictures PuTTY is being used as the SSH (Secure Shell).

1. Open PuTTY and enter the IP address of the Mini-Matrix in the box under ‘Host Name (or IP address)’. Change the ‘Port’ number to ‘10’, and for the ‘Connection Type:’ select ‘Raw’.
   **Note: The default TCP port number is 10. The TCP port can be changed once the user is connected to the Mini-Matrix. The IP address used below is the default IP address of the Mini-Matrix.**
2. Then under ‘Category:’ click on ‘Terminal’. Under ‘Local echo:’ and ‘Local line editing:’ choose ‘Force On’. Then click ‘Open’ at the bottom of the PuTTY Configuration window to begin commanding and operating the Mini-Matrix.

3.3.2 HTTP Webpage Control

The HTTP (Hypertext Transfer Protocol) is the user friendly way to control the Mini-Matrix. If the user is not comfortable with writing SCPI (Standard Commands for Programmable Instruments) then the webpage has many features that make operating the Mini-Matrix easier. The features are covered in depth in Section 7.

To connect to the Mini-Matrix open a web browser, type in the IP address ‘http://10.180.50.233/’, and press enter. This will take the user to the HTTP webpage for controlling the Mini-Matrix. Note: The IP address used is the default static IP address of the Mini-Matrix as delivered.
3.4 Connecting to a Static IP Address

The Mini-Matrix has a default static IP address. This is to allow any customer to connect to the Mini-Matrix even without a DHCP. Once connected to the Mini-Matrix the user will have the option to change the IP address or turn on the DHCP so an IP address can be assigned automatically.

1. Connect the Mini-Matrix to a standalone PC (a PC not connected to a network) using a crossover Ethernet cable. Then turn the Mini-Matrix on.
2. Configure the Standalone PC to have a static IP address similar to the IP address of the Mini-Matrix.

Example:

Mini-Matrix Default IP Address: 10.180.50.233
Standalone PC IP Address: 10.180.50.234

Note: It is important for the IP addresses to have the same first three numbers. Otherwise the PC will not connect to the Mini-Matrix.

3. After connecting to the Mini-Matrix with a standalone PC, ping the Mini-Matrix to make sure a connection has been made.
4. Open 'cmd' and type 'ping nnn.nnn.nnn.nnn' where the nnn.nnn.nnn.nnn is the IP address of the Mini-Matrix. Then press enter. The output will be similar to what is seen below. The IP address used was the IP address in the example in step number 2.

C:\>ping 10.180.50.233

Pinging 10.180.50.233 with 32 bytes of data:

Reply from 10.180.50.233: bytes=32 time=5ms TTL=64
Reply from 10.180.50.233: bytes=32 time=2ms TTL=64
Reply from 10.180.50.233: bytes=32 time=2ms TTL=64
Reply from 10.180.50.233: bytes=32 time=3ms TTL=64

Ping statistics for 10.180.50.233
Packets: Sent=4, Received=4, Lost=0 (0% loss)
Approximate round trip times in milliseconds:
Minimum=2ms, Maximum=5ms, Average=3ms

The Ethernet interface was designed to operate with common network utilities and drivers. If the Matrix fails to communicate, contact your network administrator for additional assistance. If your network administrator is unable to locate the problem, please contact Dow-Key Microwave Corporation at 1-805-650-2327.
4.1 Mini-Matrix Configuration

The ‘brain’ inside Dow-Key Matrices, referred to as the “Mini-Matrix Controller”, has been designed to be as generic as possible in regards to how many switches it may control. Therefore, the Mini-Matrix must first be informed as to the set of switches it will control before it can operate. This information must be updated as switches are added to or taken from the Mini-Matrix. The knowledge of what switches are to be controlled and how many positions each of those switches have is known as the Mini-Matrix’s Configuration Data. In addition to switch information, the Mini-Matrix Configuration also contains other information such as the unit’s Serial Number, Model Name, etc. This information must remain intact for the Mini-Matrix to operate properly.

The Mini-Matrix configuration is already performed at the factory and does not need to be done by the user unless the Mini-Matrix Controller board has been replaced, or switches have been added to or taken from the Mini-Matrix.

4.2 Dow-Key GPIO switches

The maximum number of switches used in a Mini-Matrix is limited by the number of GPIO pins and connectors available on the main controller PCB (Printed Circuit Board). There are connections for up to 8 SPDT latching switches, and connections for up to 2 SP6T latching switches. It is important to note that only latching switches will work in the Mini-Matrix. The Mini-Matrix controller does not provide a constant current to the switch, so a failsafe or a normally open switch will not maintain its position after the initial command. For this reason there are only a few types of switches recommended for use in this Mini-Matrix, and they are listed below.

- TSPDT R521K-420853A (Terminated)
- SPDT R401K-420852A (Not Terminated)
- SP6T R461JK-420853 (Terminated)

Note: All of the switches in the Mini-Matrix are latching switches. The only switches the user should add are the switches listed above, which are all latching switches. For additional information about adding a switch read Section 4.3.
4.3 Adding Switches

As stated in section 4.2, the switches are controlled by GPIO pins, so it is important to add switches to the correct connectors on the PCB (Printed Circuit Board). **Switches must be added to the next available connector that does not share GPIO pins with another switch.** The SP6T switch connectors share GPIO pins with some of the SPDT switch connectors. The table below shows what connections are allowed or not, depending on the switches already connected to the board.  

*Note: Switches must be connected in ascending order according to the table below. After adding a switch the user will have to contact Dow-Key in order to properly configure the Mini-Matrix on the HTTP page.*

Example: If there is one SP6T switch connected to SW1, the next allowed connector for an SPDT would be SW5.

<table>
<thead>
<tr>
<th>SP6T Connection</th>
<th>Unallowed SPDT Connection</th>
<th>Allowed SPDT Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>SW1 – SW8</td>
</tr>
<tr>
<td>SW1</td>
<td>SW1, SW2, SW3, SW4</td>
<td>SW5, SW6, SW7, SW8</td>
</tr>
<tr>
<td>SW2</td>
<td>SW4, SW5, SW6, SW7</td>
<td>SW1, SW2, SW3, SW8</td>
</tr>
<tr>
<td>SW1, SW2</td>
<td>SW1 – SW7</td>
<td>SW8</td>
</tr>
</tbody>
</table>

Figure 4.3-1 shows the different switch connections on the internal PCB
5 The Sequencer

5.1 Sequencer

If the user is not comfortable writing SCPI (Standard Commands for Programmable Instruments) commands, the sequencer provides an easy way to operate the Mini-Matrix. The sequencer is part of the HTTP webpage, and allows the user to designate which switch will be operated, what position will be closed, and the delay between commands. (Minimum delay = 50ms) The user will also be able to loop the commands for a designated number of iterations and remove and add commands at will. In addition to these features the sequencer allows the user to save up to 10 sequencer “programs”. The sequencer also has the added benefit of having a log. This allows the user to see the switch, the position of the switch, and see where any errors occurred during the sequence “program”. See section 7.5 for more details, and instructions for operation.
6 SCPI Command Operation

6.1 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 Ethernet 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 control of programmable instruments, which are sent by the Ethernet 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 are understood, it will be easy for the user to write or modify a control program for the matrix. The Socket Type of the matrix is server while the controlling computer is the client.

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

6.2 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 the user 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.
6.3 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.
- 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.
- 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).*
6.4 Common Commands

The following contains the IEEE 488.2 common commands of SCPI. 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

6.4.1 *IDN?

Syntax
*IDN?

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

Model

Model Mini-Matrix model number

Possible error codes
4

Example
“*IDN?”

Result
“MMS-A26S-2TSPDT”
6.4.2 *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**

4

**Example 1**

*OPC?

**Result**

“1”

**Example 2**

:SWIT1 4; SWIT2 4; *OPC?

**Result**

“0”

**Timing**

In Example 2 the Mini-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 50ms per switch. As an example, if 2 switches are commanded wait about 100ms before issuing an *OPC? query that will return a “1”.

---

22
6.4.3 *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 the latching SPDT the default position is 1.
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 GPIO bus level, each switch to position 0 (open) or 1 depending on the type of switch. 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 an *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.

6.4.4 SET:DHCP ON/OFF

Syntax
SET:DHCP ON
SET:DHCP OFF

Description
This command turns on and off the Dynamic Host Configuration Protocol (DHCP). This is used if a static IP address is wanted or let the DHCP choose an IP address automatically. The default static IP address is 10.180.50.233.

Factory default value
OFF

Possible error codes
4
6.4.5 GET:DHCP

Syntax
GET:DHCP

Description
This command checks if the DHCP is enabled or not. It returns “ON” if DHCP is enabled or “OFF” if DHCP is disabled.

Result
“ON” if the DHCP is on
“OFF” if the DHCP is off

Factory default value
OFF

Possible error codes
4
6.5 System Commands

The following contains the SCPI system commands that are compatible with Ethernet and USB control.

6.5.1 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 Mini-Matrix.

Result
code, message

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

Message: String with error message.

6.5.2 SYST:ERRALL?

Syntax
SYSTem:ERRALL?

Description
This command will return all of the errors in the error queue. Errors are retrieved in first-in first-out (FIFO) order.

Result
code, message

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

Message: String with error message.
Example

SYST:ERR?"
Result was “4, SYNTAX ERROR”, check for more errors.
Description: There is a misspelling in the 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 “10, SWITCH DID NOT RESPOND,x”, check for more errors.
Description: Switch x did not respond to a position query.
E.g. 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 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, MINI-MATRIX IS NOT CONFIGURED”, check for more errors.
Description: The configuration file (factory configuration) defining all switches configured inside the Mini-Matrix has not been uploaded. The Mini-Matrix does not ‘know’ what and how many switches to control.
6.5.3 SYST:SERIALNUMBER?

**Syntax**
SYSTem:SERIALNUMBER?

**Description**
Returns the Mini-Matrix serial number.

**Result**
Serial Number of the Mini-Matrix

**Possible error codes**
4
6.5.4 SYST:TCPPORT?

Syntax
SYST:TCPport?

Description
This command will return the TCP port that is enabled for the Mini-Matrix.

10 = The default TCP port.

Power on behavior
Keeps last value

*RST effect
None

Possible error codes
4

6.5.5 SYST:TCPPORT x

Syntax
SYST:TCPport x

Description
This command will set the TCP port of the Mini-Matrix to the desired value. It is allowed to be a value from 0 to 65535.

The default TCP port is 10.

Note: The Mini-Matrix must be power cycled after changing the TCP port number for it to be implemented. See section 3.1.3 to power cycle the Mini-Matrix safely.

Power on behavior
Keeps last value.

*RST effect
None

Possible error codes
4
6.5.6 SYST:IPADDRESS?

Syntax
SYSTem:IPADDRESS?

Description
This command will return the Mini-Matrix’s IP address.

Power on behavior
Keeps last value.

*RST effect
None

Possible error codes
4

6.5.7 SYST:IPADDRESS xxx.yyy.zzz.aaa

Syntax
SYSTem:IPADDRESS xxx.yyy.zzz.aaa

Description
This command will set the IP address to xxx.yyy.zzz.aaa.

Note: After changing the IP address, the Mini-Matrix must be power cycled for the new IP address to be implemented, and the DHCP must be turned off. See section 3.1.3 to power cycle the Mini-Matrix safely. See section 6.4.4 for commands to turn the DHCP on or off. The default static IP address is 10.180.50.233.

Power on behavior
Keeps last value.

*RST effect
None

Possible error codes
4
6.5.8 SYST:GATEWAY?

**Syntax**
SYSTem:GATEWAY?

**Description**
This command will return the Mini-Matrix’s gateway address.

**Power on behavior**
Keeps last value.

**RST effect**
None

**Possible error codes**
4

6.5.9 SYST:GATEWAY xxx.yyy.zzz.aaa

**Syntax**
SYSTem:GATEWAY xxx.yyy.zzz.aaa

**Description**
This command will set the Mini-Matrix’s gateway address to xxx.yyy.zzz.aaa.

*Note: The Mini-Matrix must be power cycled after changing the gateway for it to be implemented. See section 3.1.3 to power cycle the Mini-Matrix safely.*

**Power on behavior**
Keeps last value.

**RST effect**
None

**Possible error codes**
4
6.5.10 SYST:MASK?

Syntax
SYSTem:MASK?

Description
This command will return the mask of the Mini-Matrix.

Possible Error Codes
5

Factory default value
255.255.255.0

Power on behavior
Keeps last value.

*RST effect
None

Possible error codes
4

6.5.11 SYST:MASK xxx.yyy.zzz.aaa

Syntax
SYSTem:MASK xxx.yyy.zzz.aaa

Description
This command will set mask of the Mini-Matrix to xxx.yyy.zzz.aaa.

*Note: The Mini-Matrix must be power cycled after changing the mask for it to be implemented. See section 3.1.3 to power cycle the Mini-Matrix safely

Possible Error Codes
5

Factory default value
255.255.255.0

Power on behavior
Keeps last value.

*RST effect
None

Possible error codes
4
6.5.12 SYST:MACADDRESS?

Syntax
SYSTem:MACADDRESS?

Description
This command will return the Mini-Matrix’s MAC address in hex format.

Result
aa.bb.cc.dd.ee.ff

Possible error codes
4

6.5.13 SYST:TIMEOUT?

Syntax
SYSTem:TIMEOUT?

Description
The Timeout is used to automatically close the TCP/IP socket after a certain amount of seconds of inactivity on the port.

Returns the Time out setting for the TCP/IP connection (n is in seconds).

Result
Closes the TCP/IP socket after a certain amount of time of inactivity. This is designated by the user.

Possible error codes
4
6.5.14 SYST:TIMEOUT n

Syntax
SYSTem:TIMEOUT n

Description
The Timeout is used to automatically close the TCP/IP socket after a
certain amount of seconds of inactivity on the port.
Sets the Time out setting for the TCP/IP connection (n is in seconds).
\( n = 0 \) means no Time out is set.

Possible error codes
5

Factory default value
0

Power on behavior
Keeps last value

*RST effect
None

Possible error codes
4
6.5.15 SYST:NET?

Syntax
SYSTem:NET?

Description
This command will return the IP address, mask, gateway address, and MAC address.

Result
IPADDRESS: xxx.yyy.zzz.aaa, MASK: 255.255.255.0
GATEWAY: xxx.yyy.zzz.aaa MAC ADDRESS: aa.bb.cc.dd.ee.ff

Possible error codes
4

6.5.16 SYST:VER?

Syntax
SYSTem:VER?

Description
This command returns the current versions of software that the Mini-Matrix is currently operating on.

Result
Number of the current software version.

Possible error codes
4

6.5.17 SYST:SOFTREV?

Syntax
SYSTem:FIRMREV?

Description
This command will return the current software revision the Mini-Matrix is currently operating on.

Result
Number of the current software revision.

Possible error codes
4
6.5.18 SYST:SOFTBUILD?

Syntax
SYSTem:SOFTBUILD?

Description
This command returns current build of the software.

Result
Number of the current software build.

Possible error codes
4

6.5.19 SYST:SOFT?

Syntax
SYSTem:SOFT?

Description
This command returns the software; version, revision, and build on the Mini-Matrix.

Result
Numbers of the current software; version, revision, and build.

Possible error codes
4
6.5.20 SYST:STATUS?

Syntax
SYSTem:STATUS?

Description
This command will return all Switch positions and Errors list separated by a semicolon. The status response will reflect ALL items in the Mini-Matrix, while the error portion of the response is limited to the first 20 errors.

*Note: Multiple instances of the same error code will appear multiple times. E.g. if two different switches fail to respond, but multiple error instances of the same switch will appear only once.*

Result
“SWITx y;SWITx y;SWITx y;…….;SWITx y; ERRORS 5,3;0”

SWIT = Switch
X = Switch number (ID)
Y = Switch position
ERRORS = Error codes (Each number corresponds to a specific error code described in the user manual. Not all error codes apply to the Mini-Matrix). See the examples in section 6.5.2 for a list of the errors.

Possible error codes
4
6.6 Switch Command Set

The following contains the switch commands of SCPI that are compatible with Ethernet and USB control.

6.6.1 :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 positions for the switch. For example, a SP6T switch has 7 positions, 0 thru 6. Position 0 means the switch is set to its default position. For most switches the default position is position 0 (open switch). So in case of a SP6T 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 position 1. So commanding it to position 0 will close it to position 1.

Note: The latching SPDTs used in this Mini-Matrix do not have an “open” position. They must always be in position 1 or position 2. Trying to command one of the SPDTs to open will result in an error.
6.6.2 Setting Switch x to Position n

x = switch address.
n = position to set and must be within the switches parameter.
   (Example: SP6T valid positions are 0 thru 6 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
SPDT 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 their positions, but rather also
confirmed their positions. So it is safe to consider some safety margin and
expect a response of “1” or an updated error status after about 50ms per
switch.
As an example if 2 switches are commanded, wait about 100ms before
issuing an *OPC? query that will return a “1” or issuing an SYST:ERR?
query or issuing a ROUTE:SWITCHx? query.
6.6.3 Requesting Switch x current position

\( x = \text{switch address}. \)

**Examples:**
- ROUTE:SWITCHx?
- ROUT:SWITx?
- :SWITCHx?
- :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 and then query each switch to ensure that the positions are closed. Only after this internal verification (that happens automatically) will the controller 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 will be updated only after the switches have changed and confirmed their positions. So it is safe to consider some safety margin and expect a response of “1” or an updated error status after about 50ms per switch.

As an example if 2 switches are commanded, wait about 100ms before issuing an \(*OPC?\) query that will return a “1” or issuing an \(SYST:ERR?\) query or issuing a \(ROUTE:SWITCHx?\) query.
6.6.4 ROUTE:COUNT?

Syntax
ROUTe:COUNT?
:COUNT?

Description
This command returns how many total cycles the switches have completed. The total count is defined as the sum of the cycles of all positions combined. This returns a value for every switch in the configuration.

Result
Switx n; Switx n …. where ‘x’ is the address of the switch and ‘n’ is the number of cycles that switch has completed.

Possible error codes
4

6.6.5 ROUTE:COUNTx?

x = switch address.
n = number of cycles.

Syntax
ROUTe:COUNTx?
:COUNTx?

Description
This command returns the total number of cycles for switch ‘x’, where ‘x’ is the address of the switch that the user wants to query.

Result
n

Possible error codes
4
6.6.6 ROUTE:COUNTx n?

x = switch address.

n = position of the switch.

**Syntax**

ROUTe:COUNTx n?

:COUNTx n?

**Description**

This command counts how many times switch ‘x’ has cycled to position ‘n’, where ‘x’ is the address of the switch and ‘n’ is the position of the switch. This will give the user how many times only a single position has been cycled.

**Result**

n

**Possible error codes**

4

6.6.7 ROUTE:RESCOUNTx v

x = switch address.

v = value to reset the count to.

**Syntax**

ROUTe:RESCOUNTx v

:RESCOUNTx v

**Description**

This command resets the count of the cycles for switch ‘x’ to a value determined by the user ‘v’. Here ‘x’ is the address of the switch the user wishes to reset, and ‘v’ is the value the user wants to set the count to. The value ‘v’ should be 0 since this command is typically only used if the user replaces a switch.

**WARNING:** This should only be used when replacing a switch and resetting the count to 0.

**Result**

This will set the cycle count of switch ‘x’ to a value ‘v’ determined by the user. The value ‘v’ should set to 0 if the user is replacing the switch.

**Possible error codes**

4
## TCP/IP, HTTP, and USB Command Descriptions for ‘MMS’ Matrices

<table>
<thead>
<tr>
<th>Command Syntax</th>
<th>Response</th>
<th>USB</th>
<th>TCP /HTTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 *IDN?</td>
<td>Matrix model</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>2 *OPC?</td>
<td>1 or 0</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>3 *RST</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>4 ROUTE:SWITCHx y</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>5 ROUTE:SWITCHx?</td>
<td>n</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>6 SET:DHCP ON or SET:DHCP OFF</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>7 GET:DHCP</td>
<td>ON or OFF</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>8 SYST:IPADDRESS?</td>
<td>xxx.yyy.zzz.aaa</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>9* SYST:TCPPOrt?</td>
<td>n</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>10 SYST:TCPPOrt x</td>
<td>n</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>11* SYST:GATEWAY?</td>
<td>xxx.yyy.zzz.aaa</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>12 SYST:GATEWAY x</td>
<td>xxx.yyy.zzz.aaa</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>13* SYST:MACADDRESS?</td>
<td>aa:bb:cc:dd:ee:ff</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>14 SYST:MASK?</td>
<td>xxx.yyy.zzz.aaa</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>15* SYST:MASK x</td>
<td>xxx.yyy.zzz.aaa</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>16 SYST:SERIALNUMBER?</td>
<td>n</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>17 SYST:TIMEOUT?</td>
<td>n</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>18 SYST:TIMEOUT x</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>19 SYST:ERR? or SYST:ERROR?</td>
<td>-4,SYNTAX ERROR</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>20 SYST:ERRALL?</td>
<td>ALL ERRORS</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>21 SYST:STATUS?</td>
<td>SWITx y;SWITx y;SWITx y;...;SWITx ERRORS 5.3.0</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>22 SYST:COUNT?</td>
<td>SWx y; SWx y;...;SWx y</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>23 SYST:COUNTx?</td>
<td>n</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>24 SYST:COUNTx n?</td>
<td>n</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>25 SYST:RESCOUNTx v</td>
<td>√</td>
<td>√</td>
<td>Resets the count for the switch of address ‘x’ to a number ‘v’ (Note: this should only be used if a switch is replaced)</td>
</tr>
<tr>
<td>27 SYST:VER?</td>
<td>xx</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>28 SYST:SOFTREV?</td>
<td>xx</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>29 SYST:SOFTBUILD?</td>
<td>xx</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>30 SYST:SOFT?</td>
<td>Ver: xx; Rev: xx; Build xx</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>
Remote Operation

Note:

1. Commands are **NOT** case sensitive.

2. Every command and response on the serial or USB port shall have “\r\n” Carriage return (0x0D) and Line Feed (0x0A) at the end.

3. 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?;TCPPOORT?;SERIALNUMBER? or ROUTE:SWITCH1 2;SWITCH1?;
   
   note that the commands have to separated by ‘;’

4. The default settings for the Ethernet interface are:
   a. IP Address: 10.180.50.233 (DHCP = OFF)
   b. TCP/IP Port number: 10
   c. Gateway address: 10.180.50.1
   d. Subnet mask: 255.255.255.0
   e. Serial number: 65535
   f. In command SYST:TIMEOUT? The returned value n is in seconds. The default value is 0. 0 = no timeout.

5. Command numbers followed by a * require a system reboot to become effective.
7 Web Page Server (HTTP)

7.1 Web Page Server Control

The Mini-Matrix can be controlled by a web page hosted by the Mini-Matrix over its Ethernet port. The following steps will allow the user to access the web page hosted by the Mini-Matrix.

1. Connect the Mini-Matrix to a PC or company router with an Ethernet cable, and then power on the Mini-Matrix.

2. Type the IP address of the Mini-Matrix in the address bar of a browser as seen below. The IP address used is the default static IP address of the Mini-Matrix. If the IP address has been changed use the current IP address to access the HTTP page.

   ![Image of web page with IP address](http://10.180.50.233)

The following page should appear:

![Image of web page interface](image)

Dow-Key Microwave Corp. - Mini Multi Switch matrix

‘Status’, ‘Control’, or ‘Sequencer’ may be selected. ‘Configuration’ is password protected, and reserved for the sole use by Dow-Key Microwave.
7.2 Matrix Status

Clicking on **Matrix Status** will show the page below.

This page shows the configuration and the positions of the switches. There is an **Error** button on the page as well. This button will be green as long as there are not any errors. If an error does occur the button will be red. Clicking on the red **Error** button will take the user to the **Control** page, and display the errors that have occurred. This will also clear the error buffer, and the button will turn green once again.
7.3 Matrix Control

Clicking on 'Matrix control' will show the page below.

SCPI commands may be typed into the 'Command:' text box and then by clicking the 'Send' button the command will be executed. See Section 6 for the SCPI command list and its syntax.

If the command requires a response from the Mini-Matrix, an answer will be shown next to the 'Answer:' label.

There is also an interactive display of the switches currently connected to the Mini-Matrix. By clicking on the positions on the interactive display, the corresponding position will be closed in the switch. If the desired position is '0' or 'Open', clicking the middle position or 'Open' button will open the switch. **Note:** SPDTs do not have an open position. Clicking on the middle button results in no change of position.

There is also a green 'Error' button. This allows the user to query the Mini-Matrix for errors and will display them next to 'Answer:'. The user still has the option to use SCPI commands to query the Matrix for errors as well.
### 7.4 Mini-Matrix Configuration

Clicking on the "Matrix Configuration" will show the page below.

![Mini-Matrix Configuration Page](image)

The Mini-Matrix configuration page allows for easy configuration of the Mini-Matrix by Dow-Key. The 'Matrix Configuration' page is password protected so the configuration isn't changed accidentally.

**Username:** dowkey

**Password:** 123

There are a maximum of eight switches that can be connected to the Mini-Matrix at one time. As the type of switches and the connections of the switches are chosen, the remaining options are limited so that only valid configurations are possible. Choose what switch is connected where in the drop down menu. If a connection is unused leave as 'None'. It is important to add switches in the correct order to avoid errors with the Mini-Matrix. See section 4.3 for more information about adding switches.

**Note:** The configurations are only for latching switches. Errors will occur if non-latching switches are added to the Mini-Matrix. If a switch is added, the configuration must be updated or the Mini-Matrix will not work properly.
7.5 The Sequencer

Clicking on "Sequencer" will show the page below.

The sequencer allows for many commands (steps) to be implemented, and executed in sequential order. The user has control over each switch, the position of each switch, and the delay in milliseconds (minimum 50ms) between each command (step). The sequencer can handle up to 500 commands (steps) that can be added or deleted by the user. A step can be added by choosing the step number, switch to be commanded, position of the switch, delay of the step, and then clicking 'Insert'. A step can be deleted by typing a step number into the box next to 'Step:', and then clicking 'delete'. A step can be edited by using the 'Change' button. The 'Clear' button will clear all of the steps in the sequencer program. The user has the option to make and save up to 10 sequencer programs. The drop down menu at the top of the page next to 'Sequencer#' shows which sequencer program is currently being used. The 'Run', 'Pause', and 'Stop' buttons allow the user more control over the sequencer. There is an option to loop the sequencer program. To do this type the number of loops the sequencer program should execute in the box next to 'Loop:', and click 'Loop'. The sequencer also has a log. It can be disabled if it is unnecessary by clicking 'Disable Log', or it can be viewed by clicking 'View Log'. For more on the 'Log' read section 7.6. There is an 'Error' button at the bottom of the page that will turn red if an error occurs. Clicking on the 'Error' button will take the user to the control page and display the error.
7.6 The Log

Clicking on ‘View Log’ will show the page below.

The ‘Log’ page records which switches are commanded, the switches position, and the delay. This helps the user debug the system and will output an error if one is detected. This is especially useful when looping the sequencer and the user can not tell when or where the error occurred. The log can also be cleared by clicking the ‘Clear’ button.
Appendix A

Technical Specifications

Model: MMS-Series

Configuration: Up to eight latching SPDT switches mounted on the front panel
Up to two latching SP6T switches mounted on the front panel

RF Connectors: SMA (on front panel)

Frequency range: DC to 26.5 GHz

<table>
<thead>
<tr>
<th>SPDT RF Characteristics (R521K-420853A &amp; R401K-420852A)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency (GHz):</strong></td>
</tr>
<tr>
<td><strong>VSWR (Ratio max):</strong></td>
</tr>
<tr>
<td><strong>Insertion Loss (dB max):</strong></td>
</tr>
<tr>
<td><strong>Isolation (dB min):</strong></td>
</tr>
<tr>
<td><strong>RF Power (Watts CW max):</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SP6T RF Characteristics (R461JK-420853A)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency (GHz):</strong></td>
</tr>
<tr>
<td><strong>VSWR (Ratio max):</strong></td>
</tr>
<tr>
<td><strong>Insertion Loss (dB max):</strong></td>
</tr>
<tr>
<td><strong>Isolation (dB min):</strong></td>
</tr>
<tr>
<td><strong>RF Power (Watts CW max):</strong></td>
</tr>
</tbody>
</table>

Impedance: 50 Ω

Switching Speed: 50ms max

Operating Temp: -25 to +75 degrees C

Switch Type: TSPDT (terminated SPDT): Switch p.n. R521K-420853A
SPDT (non-terminated SPDT): Switch p.n. R401K-420852A
TSP6T: (terminated SP6T): Switch p.n. R461JK-420853A

Operating Voltage: 12 Volts DC +/- 5%

Control Interfaces: Ethernet
USB type A

Dimensions: 3.30” H x 6.29” W x 7.05” D
Appendix B

RF Configuration

Terminated SPDT (TSPDT) Configurations

Model: Mini-Matrix (MMS-A26S-2TSPDT)

Two TSPDT (terminated) switches (Dow-Key part number: R521K-420853A) mounted on the front.

Model: Mini-Matrix (MMS-A26S-4TSPDT)

Four TSPDT (terminated) switches (Dow-Key part number: R521K-420853A) mounted on the front.

Model: Mini-Matrix (MMS-A26S-6TSPDT)

Six TSPDT (terminated) switches (Dow-Key part number: R521K-420853A) mounted on the front.

Model: Mini-Matrix (MMS-A26S-8TSPDT)

Eight TSPDT (terminated) switches (Dow-Key part number: R521K-420853A) mounted on the front.

Non–Terminated SPDT (SPDT) Configurations

Model: Mini-Matrix (MMS-A26S-2SPDT)

Two SPDT (non-terminated) switches (Dow-Key part number: R521K-420852A) mounted on the front.

Model: Mini-Matrix (MMS-A26S-4SPDT)

Four SPDT (non-terminated) switches (Dow-Key part number: R521K-420852A) mounted on the front.

Model: Mini-Matrix (MMS-A26S-6SPDT)

Six SPDT (non-terminated) switches (Dow-Key part number: R521K-420852A) mounted on the front.

Model: Mini-Matrix (MMS-A26S-8SPDT)

Eight SPDT (non-terminated) switches (Dow-Key part number: R521K-420852A) mounted on the front.
Terminated SP6T (TSP6T) Configurations

**Model: Mini-Matrix (MMS-A26S-1TSP6T)**

One TSP6T (terminated) switch (Dow-Key part number: R461JK-420853A) on the front.

**Model: Mini-Matrix (MMS-A26S-2TSP6T)**

Two TSP6T (terminated) switches (Dow-Key part number: R461JK-420853A) on the front.

Terminated SP6T (TSP6T) + Terminated SPDT (TSPDT) Configurations

**Model: Mini-Matrix (MMS-A26S-1TSP6T+2TSPDT)**

One TSP6T (terminated) switch (Dow-Key part number: R461JK-420853A) and two TSPDT (terminated) (Dow-Key part number: R521K-420853A) on the front.

**Model: Mini-Matrix (MMS-A26S-1TSP6T+4TSPDT)**

One TSP6T (terminated) switch (Dow-Key part number: R461JK-420853A) and four TSPDT (terminated) (Dow-Key part number: R521K-420853A) on the front.

**Model: Mini-Matrix (MMS-A26S-2TSP6T+1TSPDT)**

Two TSP6T (terminated) switches (Dow-Key part number: R461JK-420853A) and one TSPDT (terminated) (Dow-Key part number: R521K-420853A) on the front.

Terminated SP6T (TSP6T) + Non – Terminated SPDT (SPDT) Configurations

**Model: Mini-Matrix (MMS-A26S-1TSP6T+2SPDT)**

One TSP6T (terminated) switch (Dow-Key part number: R461JK-420853A) and two SPDT (non-terminated) (Dow-Key part number: R521K-420852A) on the front.

**Model: Mini-Matrix (MMS-A26S-1TSP6T+4SPDT)**

One TSP6T (terminated) switch (Dow-Key part number: R461JK-420853A) and four SPDT (non-terminated) (Dow-Key part number: R521K-420852A) on the front.

**Model: Mini-Matrix (MMS-A26S-2TSP6T+1SPDT)**

Two TSP6T (terminated) switches (Dow-Key part number: R461JK-420853A) and one SPDT (non-terminated) (Dow-Key part number: R521K-420852A) on the front.
Mini-Matrix RF diagram

Note: The switches are bi-directional. Hence each RF port can be considered an input or an output.
Below are two examples of RF block diagrams of:
- Two independent SPDT (or TSPDT) switches.
- One independent SP6T switch.

Matrix p.n. MMS-A26S-2TSPDT or MMS-A26S-2SPDT RF block diagram

Matrix p.n. MMS-A26S-1TSP6T RF block diagram