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DOW-KEY MICROWAVE
MS, MP, CB Matrix Series

MS-2U40K-4/6T-ENET
CAN BUS RF SWITCH MATRIX

Operator’s Manual
Rev 1

THE RF/MICROWAVE SWITCHING TECHNOLOGY SOLUTION COMPANY
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.

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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 49101-360) .............................. February 2017
  Original Release
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1 General Information

1.1 Introduction

The Dow-Key Microwave MS, MP, CB Switch Matrix series are electromechanical RF matrices. They come equipped with an Ethernet port which allows the user to easily access the matrix from anywhere in the world via TCP/IP on 100BaseT networks. 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).

![Diagram of an MS series matrix with four independent SP4T switches.](image)

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

**Part Numbering Examples:**

**MS-2U18S-4/X-ENET**  
Is a **Multi Switch** matrix with following characteristics:  
2U, 18 GHz, SMA, 4 transfer switches, ENET

**MS-2U26S-4/6T-ENET**  
Is a **Multi Switch** matrix with following characteristics:  
2U, 26 GHz, SMA, 4 Terminated SP6T, ENET

**MS-4U18N-12/10-ENET**  
Is a **Multi Switch** matrix with following characteristics:  
4U, 18 GHz, N connectors, 12 SP10T, ENET

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-ENET**
- **[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** is a Multi Plex matrix with following characteristics: 4U, 18 GHz, SMA, 100 outputs, GPIB
- **MP-4U18S-20-ENET** is a Multi Plex matrix with following characteristics: 4U, 18 GHz, SMA, 20 outputs, ENET

**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).

![Diagram of CB Series Matrix with 4 Inputs and 4 Outputs]

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

**Part Numbering Examples:**

- **CB-4U18S-10X10-ENET** is a CrossBar matrix with following characteristics:
  - 4U, 18 GHz, SMA, 10 inputs 10 outputs, ENET

- **CB-4U18N-8X8-ENET** is a CrossBar matrix with following characteristics:
  - 4U, 18 GHz, N connectors, 8 inputs 8 outputs, ENET

- **CB-2U18S-4X4-ENET** is a CrossBar matrix with following characteristics:
  - 2U, 18 GHz, SMA, 4 inputs 4 outputs, ENET

**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

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.

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
- RJ-45 Ethernet Connector
- USB type A Connector

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

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
- RJ-45 Ethernet 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

GND stud

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
- RJ-45 Ethernet 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 a 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.
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.
Table 3-2, RS232 Female Connector Pin Functions

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
</tr>
<tr>
<td>2</td>
<td>Transmit</td>
</tr>
<tr>
<td>3</td>
<td>Receive</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
</tr>
<tr>
<td>5</td>
<td>Ground</td>
</tr>
<tr>
<td>6</td>
<td>NC</td>
</tr>
<tr>
<td>7</td>
<td>NC</td>
</tr>
<tr>
<td>8</td>
<td>NC</td>
</tr>
<tr>
<td>9</td>
<td>NC</td>
</tr>
</tbody>
</table>

### 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](image)

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

1. +12 VDC, 7A max (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 Ethernet Connection

The matrix comes equipped with an Ethernet port (RJ45 connector) which allows the user to easily access the matrix from anywhere in the world via TCP/IP on 100BaseT networks. See Section 4 and Section 6 for descriptions regarding how to connect to, configure, and operate the matrix over this 100BaseT Ethernet connection.

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 6 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 5.2.3 and 7.3) 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 to when 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:

It’s a good idea to keep unused switches stored as 0 switches. Also, if a switch is to be dedicated to a particular CAN Bus ID, it should be marked such on the switch’s enclosure.
Example procedure:

Adding a switch to the Configuration usually starts by finding the ID of the physical switch to add. Select **Main Menu>System Settings>Find Switch ID** and follow the instructions in Section 5.2.3 **Find Switch ID**.

If the switch’s ID is the one desired to add (0 or N), the switch may be left connected and the BACK key may be pressed to return to the Main Menu. 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, LCD will prompt to add the next available-to-configure ID, and the user **must** enter the connected switch’s ID.

Suppose a switch’s ID has been found to be N=x, but a 0 switch is required to add the switch as N=y: Therefore the switch’s ID must first be changed to zero. With the N=x switch connected AND with NO OTHER N=x SWITCHES 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 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.
4.4 Configuring the Ethernet Connection

All devices connected to an Ethernet and communicating via TCP/IP must have a unique IP address and TCP Port number.

The DowKey matrices are programmed at the time of its manufacture to have a Dynamic IP address (Dynamic Host Configuration Protocol is ON). See sections 5.2.4 and 6.7 for more details on how to obtain an IP address dynamically or set it manually as static.

When the IP address is obtained dynamically (DHCP is ON) the IP address is displayed for a few seconds at power up. See section 5.2.4 to display the IP address after boot up is completed.

The matrix is programmed at the time of its manufacture to have the following default settings:

- IP Address: obtained dynamically
- TCP Port Number: 10

See Sections 5.2.4 for instructions on how to set the IP Address and TCP Port Numbers to other values.

4.5 Connection to an Ethernet

The use of a standard “Straight Through” Ethernet cable is required to connect the matrices to an Ethernet LAN hub. Connection to a single computer requires the use of “Crossover” Ethernet cable.
4.6 Testing Ethernet Communication

The matrix’s ability to communicate should be tested once it has been configured and connected to an Ethernet network.

Connection thru a network:
Assuming the matrix’s default IP address setting has not been changed from obtaining the IP address dynamically, take note of its IP address during the boot-up process (or see section 5.2.4 to read its IP address). Assuming the connection has been made with a personal computer connected to the same network and running some version of Microsoft Windows©, select

Start>Run
and type

Ping nnn.nnn.nnn.nnn

where nnn.nnn.nnn.nnn is the matrix IP address previously noted.

Connection to a standalone PC:
If the matrix is connected directly to a standalone PC (rather than a network), set the IP address of the matrix so that the first 3 numbers match the PC’s IP address. The last number must be different.

Example:  PC IP address:  200.169.200.180
          Matrix IP address:  200.169.200.181

Assuming the connection has been made with a personal computer running some version of Microsoft Windows©, select

Start>Run
and type

Ping nnn.nnn.nnn.nnn

where nnn.nnn.nnn.nnn is the matrix IP address. In this example 200.169.200.181
In both the above scenarios a valid and working connection will yield a response similar that shown in the example below:

C:\>ping 200.169.200.181

Ping statistics for 200.169.200.181
Packets: Sent=4, Received=4, Lost=0 (0% loss)
Approximate round trip times in milliseconds:
Minimum=2ms, Maximum=5ms, Average=3ms

The matrix’s 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.
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 in which the LCD can at times appear blank.

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 (Ethernet, 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 (Ethernet, 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, prompting 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 the RF switches in the correct desired 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 this “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 6.5.1). 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 4.3).

Delete Switch
Delete switches from the Matrix Configuration (see Section 4.3).

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.

5. **NOTE:** proper performance of Find Switch ID relies on the behavior of Dow-Key Switch firmware revision 4 and above – revision 3 and below does not allow “putting the switch to sleep”. So, this feature is best executed on a matrix that does not contain switches with firmware revision 3 or less, or those switches will respond with their ID’s as well as the switch in question. The revision of firmware of any switch configured to the matrix may be learned with **Main Menu>System Settings>Switch Information** (see below).

**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.**

On models that do have temperature sensors installed and enabled, the matrix has the ability to detect and display malfunctioning sensors. If the matrix displays any of the following values for any of the 4 sensors, take the appropriate actions to correct it:

- **254:** One of the temperature sensors is shorted out. Contact Dow-Key Microwave for steps on troubleshooting/repairing this malfunction.

- **255:** One of the temperature sensors has an open circuit. One possibility is that the sensors’ connector has come loose and needs to be plugged back into the main controller board. Contact Dow-Key Microwave for steps on troubleshooting/repairing this malfunction.

Reference thermistor DK part number 40206-003 if it would need to be replaced.
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

Actual changes to the Ethernet variables referred to below will not take effect nor be shown on the front panel until the matrix has been powered down and back up.

See Sections 4 and 6 for more information regarding use of Ethernet to control the matrix.

**Ethernet Menu**

*Set/Acquire IP Address*

View and/or modify the current IP Address and Acquisition Mode, Static or Dynamic (DHCP off or on).

*Set Subnet Mask*

View and/or modify the current Subnet Mask.

Note: the Acquisition Mode needs to be Manually (DHCP = OFF) for this parameter to be changed.

*Set Gateway*

View and/or modify the current Gateway.

Note: the Acquisition Mode needs to be Manually (DHCP = OFF) for this parameter to be changed.

*Set Port Number*

View and/or modify the current Port Number. The factory default is 10.

*Set Timeout*

View and/or modify the current Timeout settings (in seconds). The factory default is 0 seconds.

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

Note: A settings of 0 seconds means that the timeout is disabled. The TCP/IP socket will never be closed automatically and only one remote TCP/IP connection at the time is possible.
5.2.5 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.

5.2.6 Set GPIB Address

Not applicable to ENET (Ethernet) models.
6 Remote 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, 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 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. The Socket Type of the matrix is server while your remote control computer is the client.

NOTE: Not all commands for SCPI are compatible with Ethernet, RS-232 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 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: Each command must be terminated with a carriage return (0x0D) followed by a line feed (0x0A).

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

Where “\r” stands for carriage return (0x0D) and “\n” stands for line feed (0x0A).
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. "ROUTE: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 common commands of SCPI that the Ethernet 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

6.4.1 *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-2U40K-4/6T-ENET”
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
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”.


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.
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.
6.5 System Commands

The following contains the system commands of SCPI that the Ethernet and RS-232 control is compatible with.

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 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 THERS HOLD”, 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.
6.5.2 SYST:IPADDRESS?

Syntax
SYSTem:IPADDRESS?

Description
Returns the matrix IP address.

Result
xxx.yyy.zzz.aaa

Possible error codes
None

6.5.3 SYST:IPADDRESS xxx.yyy.zzz.aaa

Syntax
SYSTem:IPADDRESS xxx.yyy.zzz.aaa

Description
Sets system IP address to xxx.yyy.zzz.aaa.

Possible error codes
5

Factory default value
200.169.200.180

Power on behavior
Keeps last value

*RST effect
None

Timing
In order for the new IP address to take effect the matrix needs to be power cycled.
6.5.4 SYST:TCPPORT?

Syntax
SYSTem:TCPPORT?

Description
Returns the matrix TCP Port number.

Result
n
Possible error codes
None

6.5.5 SYST:TCPPORT x

Syntax
SYSTem:TCPPORT x

Description
Sets the matrix TCP Port number to x.

Possible error codes
5

Factory default value
10

Power on behavior
Keeps last value

*RST effect
None

Timing
In order for the new TCP Port to take effect the matrix needs to be power cycled.
6.5.6 SYST:GATEWAY?

Syntax
SYSTem:GATEWAY?

Description
Returns the matrix gateway address.

Result
xxx.yyy.zzz.aaa

Possible error codes
None
6.5.7 SYST:GATEWAY xxx.yyy.zzz.aaa

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

**Description**
Sets matrix gateway address to xxx.yyy.zzz.aaa.

**Possible error codes**
5

**Factory default value**
200.169.200.5
(note: this value might change on your matrix)

**Power on behavior**
Keeps last value

**RST effect**
None

**Timing**
In order for the new Gateway address to take effect the matrix needs to be power cycled.

6.5.8 SYST:MASK?

**Syntax**
SYSTem:MASK?

**Description**
Returns the matrix subnet mask address.

**Result**
xxx.yyy.zzz.aaa

**Possible error codes**
None
6.5.9 SYST:MASK xxx.yyy.zzz.aaa

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

**Description**
Sets the matrix subnet mask address to xxx.yyy.zzz.aaa.

**Possible error codes**
5

**Factory default value**
255.255.255.0

**Power on behavior**
Keeps last value

**RST effect**
None

**Timing**
In order for the new Mask address to take effect the matrix needs to be power cycled.

6.5.10 SYST:MACADDRESS?

**Syntax**
SYSTem:MACADDRESS?

**Description**
Returns the matrix mac address.in hex format

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

**Possible error codes**
None
6.5.11 SYST:SERIALNUMBER?

**Syntax**
SYSTem:SERIALNUMBER?

**Description**
Returns the matrix serial number.

**Result**
n

**Possible error codes**
None

6.5.12 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**
n

**Possible error codes**
None
6.5.13 SYST:TIMEOUT x

Syntax
SYSTem:TIMEOUT x

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).
x = 0 means no Time out is set.

Possible error codes
5

Factory default value
0

Power on behavior
Keeps last value

*RST effect
None
6.5.14 SYST:STATUS?

Syntax
SYSTem:STATUS?

Description
This command will return all Switch positions, Local/Remote mode, Power supply status and Errors list separated by a semicolon. The status response will reflect ALL items in the matrix, while the error portion of the response is limited to the first 20 errors.

Note 1: Redundant power supply status is only returned if enabled. (Most models do not have redundant power supplies 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)

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
6.5.15 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

6.5.16 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
6.5.17 SYST:FIRMWARE?

Syntax
SYST:FIRMWARE?

Description
Returns Dow-Key’s firmware part number running in the matrix controller board

Response (may vary)
49102-127_010

6.5.18 SYST:FIRMREV?

Syntax
SYST:FIRMREV?

Description
Returns Dow-Key’s firmware revision running in the matrix controller board

Response (may vary)
1.0

6.5.19 SYST:TEMPERATUREx?

Syntax
SYST:TEMPeraturex?

Description
Returns the temperature reading of thermistor ‘x’ in degrees Celsius. If ‘0’ is returned, that particular temperature sensor is disabled. ‘x’ can be 1 – 4.

Temperature Range (°C)
0 – 200, 254 – 255

254 – 255 are returned only if there is a malfunction. See Manual (Local) Operation ‘Temperature’ section for additional information.

Response (will vary)
1 45°C

(In the above example, temperature sensor 1 is at 45°C)
6.5.20 SYST:TEMPTHRx?

Syntax
SYST:TEMPTHRx?

Description
Returns the temperature threshold for thermistor ‘x’. If ‘0’ is returned, that particular temperature sensor is disabled. ‘x’ can be 1 – 4.

Threshold Range (°C)
0 – 200

Response (will vary)
1 50°C

(In the above example, temperature sensor 1 is at 50°C)

6.5.21 SYST:TEMPTHRx y

Syntax
SYST:TEMPTHRx y

Description
For setting the temperature threshold for thermistor ‘x’. ‘x’ can be 1 – 4. ‘y’ is the threshold value to be set.

Threshold Range (°C)
0 – 200
6.6 Switch [Module] Command Set

The following contains the switch [module] commands of SCPI that the Ethernet control is compatible with.

6.6.1 :SWIT<id>:VALue <number>

Syntax

[ROUTe]:SWIT<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.
6.6.2 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:**
- \( \text{ROUTE:SWITCH}x \ n \)
- \( \text{ROUTE:SWITCH}x \ n \)
- \( \text{ROUTE:SWIT}x \ n \)
- \( \text{ROUTE:SWIT}x \ n \)
- \( \text{:SWITCH}x \ n \)
- \( \text{:SWIT}x \ n \)
- \( \text{ROUTE:SWITCH}x:\text{VALUE} \ n \)
- \( \text{ROUTE:SWITCH}x:\text{VAL} \ n \)
- \( \text{:SWIT}x:\text{VAL} \ n \)

**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 a SYST:ERR? query or issuing a ROUTE:SWITCHx? query.
6.6.3 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.

6.6.4 ROUTE:SAVEPOSITION x

**Syntax**
ROUTE:SAVEPOSITION x

**Description**
Saves the current switch’s configuration (position settings) in the ‘preset record’ x.

**Preset Records Available**
1-30
6.6.5  ROUTE:RECALLPOSITIONS x

Syntax
ROUTE:RECALLPOSITIONS x

Description
Recalls and sets all switches to the configuration (position settings) previously saved in the 'preset record' x.

6.6.6  ROUTE:POSITIONS?

Syntax
ROUTE:POSITIONS?

Description
Returns the current switch configuration (position settings) x set. If no switch configuration is set, a 0 (zero) is returned.

Response
0-30
6.7 DHCP Command Set

The following contains the DHCP (Dynamic Host Configuration Protocol) commands of SCPI that the Ethernet control is compatible with.

6.7.1 SET:DHCP ON or SET:DHCP OFF

Syntax
SET:DHCP ON | OFF

Description
Turns DHCP mode ON or OFF

Possible error codes
5

Factory default value
ON

Power on behavior
Keeps last value

*RST effect
None

Timing
In order for the new DHCP settings to take effect the matrix needs to be power cycled.

6.7.2 GET:DHCP

Syntax
GET:DHCP

Description
Returns DHCP mode

Result
ON
or
OFF

Possible error codes
None
<table>
<thead>
<tr>
<th>Command Syntax</th>
<th>Response</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 *IDN?</td>
<td>MS-2U40K-4/6T-ENET</td>
<td>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).</td>
</tr>
<tr>
<td>2 *OPC?</td>
<td>1 or 0</td>
<td>Gives 1 if previous operation was completed and gives 0 if previous operation is still not complete.</td>
</tr>
<tr>
<td>3 *RST</td>
<td></td>
<td>Puts all switches in the default position. (Transfer switches in pos.1. Most other switches in pos. 0 = open).</td>
</tr>
<tr>
<td>4 ROUTE:SWITCHx y or :SWITCHx y</td>
<td></td>
<td>Closes position y on switch x</td>
</tr>
<tr>
<td>5 ROUTE:SWITCHx? or :SWITCHx? n</td>
<td></td>
<td>Gives current position of switch x</td>
</tr>
<tr>
<td>6 ROUTE:SAVEPOSITIONS x</td>
<td></td>
<td>Saves the current switch’s configuration (position settings) in the 'preset record' x</td>
</tr>
<tr>
<td>7 ROUTE:RECALLPOSITIONS x</td>
<td></td>
<td>Recalls and sets all switches to the configuration (position settings) previously saved in the 'preset record' x.</td>
</tr>
<tr>
<td>8 ROUTE:POSITIONS?</td>
<td>0 TO 30</td>
<td>Returns the current switch configuration (position settings) x set. If no switch configuration is set, a 0 (zero) is returned.</td>
</tr>
<tr>
<td>9 SET:DHCP ON or SET:DHCP OFF</td>
<td></td>
<td>Turns DHCP mode ON or OFF</td>
</tr>
<tr>
<td>10 GET:DHCP</td>
<td>ON or OFF</td>
<td>Returns DHCP mode</td>
</tr>
<tr>
<td>11 SYST:IPADDRESS? xx.yy.zz.aa</td>
<td>Sets system IP address to xx.yy.zz.aa</td>
<td></td>
</tr>
<tr>
<td>12 SYST:IPADDRESS xx.yy.zz.aa</td>
<td></td>
<td>Sets system IP address to xx.yy.zz.aa</td>
</tr>
<tr>
<td>13 SYST:TCP_PORT? n</td>
<td></td>
<td>Returns TCP port number</td>
</tr>
<tr>
<td>14 SYST:TCP_PORT x</td>
<td></td>
<td>Sets TCP port number to x</td>
</tr>
<tr>
<td>15 SYST:GATEWAY? xx.yy.zz.aa</td>
<td></td>
<td>Returns system gateway address</td>
</tr>
<tr>
<td>16 SYST:GATEWAY xx.yy.zz.aa</td>
<td></td>
<td>Sets system gateway address to xx.yy.zz.aa</td>
</tr>
<tr>
<td>17 SYST:MASK? xx.yy.zz.aa</td>
<td></td>
<td>Returns system subnet mask address</td>
</tr>
<tr>
<td>18 SYST:MASK xx.yy.zz.aa</td>
<td></td>
<td>Sets system subnet mask address to xx.yy.zz.aa</td>
</tr>
<tr>
<td>19 SYST:MACADDRESS? xx.yy.zz</td>
<td></td>
<td>Returns system MAC address</td>
</tr>
<tr>
<td>20 SYST:SERIALNUMBER? n</td>
<td></td>
<td>Returns system serial number</td>
</tr>
<tr>
<td>21 SYST:TIMEOUT? n</td>
<td></td>
<td>Returns Time out setting for TCP/IP connection (n is in seconds)</td>
</tr>
<tr>
<td>22 SYST:TIMEOUT x</td>
<td></td>
<td>Sets Time out setting for TCP/IP connection (x is in seconds)</td>
</tr>
<tr>
<td>23 SYST:ERR? or SYST:ERROR?</td>
<td>-4, SYNTAX ERROR</td>
<td>Returns system error number and error description. (The response shown in this table is just an example).</td>
</tr>
<tr>
<td>24 SYST:STATUS?</td>
<td>SWITx y:SWITx y:SWITx y:SWITx y:LOC:PWR1 OK:PWR2 FAULT; ERRORS 5,3,0</td>
<td>This command will return all Switch positions, Local/Remote mode, Power supply status and Errors list in the error buffer separated by a semicolon.</td>
</tr>
<tr>
<td>25 SYST:SCREENSAVER? n</td>
<td></td>
<td>Returns time setting for the screen saver (n is in minutes)</td>
</tr>
<tr>
<td>26 SYST:SCREENSAVER x</td>
<td></td>
<td>Sets time setting for the screen saver (x is in minutes)</td>
</tr>
<tr>
<td>27 SYST:FIRMWARE?</td>
<td>49102-127_010</td>
<td>Returns Dow-Key’s firmware part number running in the matrix controller board</td>
</tr>
<tr>
<td>28 SYST:FIRMREV?</td>
<td>1.0</td>
<td>Returns Dow-Key’s firmware revision running in the matrix controller board</td>
</tr>
<tr>
<td>29 SYST:TEMPERATUREx?</td>
<td>1 45ºC</td>
<td>Returns the temperature reading of thermistor ‘x’ in degrees Celsius. If ‘0’ is returned, that particular temperature sensor is disabled. ‘x’ can be 1 – 4.</td>
</tr>
<tr>
<td>30 SYST:TEMP_THRx?</td>
<td>1 50ºC</td>
<td>Returns the temperature threshold of thermistor ‘x’ in degrees Celsius. If ‘0’ is returned, that particular temperature sensor is disabled. ‘x’ can be 1 – 4.</td>
</tr>
<tr>
<td>31 SYST:TEMP_THRx y</td>
<td></td>
<td>For setting the temperature threshold for thermistor ‘x’. ‘y’ is the threshold value to be set.</td>
</tr>
</tbody>
</table>
Note:
1. Commands are **NOT** case sensitive.
2. Every command and response on the Ethernet and serial port should 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.
   e.g. SYST:IPADDRESS?;TCPPORT?;SERIALNUMBER 2 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: Assigned dynamically by your server (DHCP = ON)
   b. IP Port number: 10
   c. Gateway address: 200.169.200.5
   d. Subnet mask: 255.255.255.0
   e. In command SYST:TIMEOUT? The returned value n is in seconds. The default value is 0. 0 = no timeout.
5. 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,...
7 Web Page Server (HTTP)

7.1 Web Page Server Control

The matrix may be controlled by way of web pages served by the matrix over its Ethernet port. With the matrix properly connected to an Ethernet (see Section 4), type the matrix’s current IP address into a browser’s Address Bar. The following page should appear:

The Operator may select ‘Matrix Control’, ‘Matrix Configuration’, or ‘Matrix Status’; ‘Factory Configuration’ is reserved for the sole use by Dow-Key Microwave.
7.2 Matrix Control

Clicking on ‘Matrix control’ will show the below page.

Remote mode commands may be typed into the Command text box and then clicking on the ‘Send’ button. See section 6 for the remote command list and its syntax.

If the command implies that the matrix responds (for instance when querying the matrix) the matrix’s response will be shown next to the ‘Answer:’ label.

The bottom half displays the current position of all switches currently configured to the matrix. Their positions may be set by selecting one from a switch’s drop down box and then clicking ‘Set’. Clicking on the ‘Get’ button returns the position of all switches.
7.3 Matrix Configuration

Clicking on ‘Matrix configuration’ will show the below page.

! 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 a Switch’ and ‘Remove a Switch’ 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!

This page also allows setting the temperature alarm threshold of the temperature sensors. This feature is disabled by setting all 4 temperature alarm thresholds to 0°C. Most matrices do not contain any devices that produce significant heat, therefore these models do not feature any temperature sensors. Leave all 4 temperature alarm thresholds to 0°C.
7.4 Matrix Status

Clicking on ‘Matrix status’ will show the below page.

This page displays the current status of alarm sources (power supplies, fans, temperatures).

If the matrix does not have a redundant power supply, fans with stall sensors and temperature sensors, than this page will not display any of this information.

On models that do have temperature sensors installed and enabled, the matrix has the ability to detect and display malfunctioning sensors. If the matrix ‘Status’ page displays any of the following values for any of the 4 sensors, take the appropriate actions to correct it:

254: One of the temperature sensors is shorted out. Contact Dow-Key Microwave for steps on troubleshooting/repairing this malfunction.

255: One of the temperature sensors has an open circuit. One possibility is that the sensors’ connector has come loose and needs to be plugged back into the main controller board. Contact Dow-Key Microwave for steps on troubleshooting/repairing this malfunction.

Reference thermistor DK part number 40206-003 if it would need to be replaced.
8 Bootloader

8.1 Bootloader

The bootloader is a small program that has been loaded onto the microcontroller on the matrix main controller board. It allows you to upload (update) firmware code without using any additional hardware. The bootloader implemented in your matrix allows you to upload firmware thru the serial or USB ports. For matrices with embedded web page (HTTP) the firmware can also be uploaded thru this interface.

*Note: The fastest and preferred method of uploading the firmware is via the HTTP webpage.*

8.2 Updating the firmware via RS232/USB using HyperTerminal

To upload new firmware on to the microcontroller by means of the RS-232 or USB port, follow the instruction here below:

To allow for a faster transfer speed of the firmware file it is recommended to change the serial bus communication baud rate to 115200 bits/sec using the front panel touch screen LCD. Refer to section 5.2.5 for more details on how to do this.

- First establish a communication path with the matrix using the desired communication port. Refer to chapter 3 for more details on how to accomplish this.

- The suggested software tool to use on your PC to communicate with the matrix is “Hyper Terminal” or equivalent. This software tool comes as part of the Windows XP operating system. Configure Hyper Terminal to communicate at 115200 bits/s (or whatever baud rate the matrix is set to), 8 data bits, no parity, 1 stop bit and no flow control.

Since the matrix does not echo the message sent to it, you can also enable “Echo typed characters locally” to see what is being sent out to the matrix. Enabling also “Send line ends with line feeds” and “Append line feeds to incoming line ends” facilitates the reading of the various messages and is therefore recommended.

- In the Hyper Terminal screen type in the command *IDN?* to ensure that the matrix is communicating. The matrix should respond with its part number.

Note that when freshly launched Hyper Terminal might need you to type the *IDN?* command a second time.

- Once communication is established start the upgrade process by typing $UPDATE_START

*Note that this command is case sensitive.*
- The matrix should respond with:
  
  **Bootloader ready! SPI memory available. Erasing. SPI erased!**

- Using Notepad open the executable firmware file with extension .hex you wish to upload.

- Select the entire file by typing the CTRL + A keys and then copy it into the clipboard by typing the CTRL + C keys.

- Back to Hyper Terminal click on the top **Edit** Menu and then on **Paste to Host**. You will see on your PC screen the executable file being sent to the matrix. Depending on the size of the file and the communication speed you selected this step might take a several minutes. (Up to 30 minutes at 9600 bits/s)

- Type the command **$UPLOAD_END**. The matrix should respond with:
  
  **Bootloader closed! Boot memory data ok!**

  **Note that this command is case sensitive.**

- The new firmware is now residing in the main controller’s memory, but is not running yet. To actually instruct the matrix to start executing the newly loaded firmware type the command **$UPDATE_REBOOT** in Hyper Terminal. The matrix should respond with:
  
  **Boot memory data ok! Update done! Rebooting!**

  **Note that this command is case sensitive.**

Depending on what section of the firmware was updated in the main controller, the matrix might or might not reboot completely. Either way the matrix is now running the new firmware.
8.3 Updating the firmware via embedded (HTTP) webpage

To upload new firmware on to the microcontroller by means of the HTTP Webpage follow the instructions here below:

- An Ethernet connection needs to be established with the 5439. The matrix has an embedded webpage that can be accessed by typing the IP address of it into a web browser. Here we are accessing IP address 10.180.55.133:
- Clicking on ‘UPDATE’ will prompt for login information. Username is **update**. Password is **93003**. Once logged in, the below page will load:
- Click on ‘Update Start’ to begin file upload step. It should respond with ‘Bootloader ready! SPI memory available. Erasing. SPI erased!’

Browse to where the .hex update file is stored. Once the file location is selected, click ‘Upload’. After about 60 seconds the webpage will refresh with ‘File was successfully uploaded!’

Clicking on ‘Upload End’ will close the bootloader and display ‘Bootloader closed! Boot memory data OK!’

Finally, clicking on ‘Update Reboot’ will display ‘Boot memory data ok! Update done! Rebooting’ and automatically restart the master unit. Rebooting takes about 60 seconds:
Appendix A

Technical Specifications

Model: MS-2U40K-4/6T-ENET

Configuration: (4) Four terminated latching SP6T switches mounted on the rear panel

RF Connectors: ‘K’ type (on rear panel)

Frequency range: DC to 40 GHz

Return loss (VSWR)
Insertion loss
Isolation
RF Power:

<table>
<thead>
<tr>
<th>Frequency (GHz):</th>
<th>DC - 6</th>
<th>6 - 12</th>
<th>12 - 18</th>
<th>18 – 26.5</th>
<th>26.5 – 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSWR (Ratio max):</td>
<td>1.30 : 1</td>
<td>1.40 : 1</td>
<td>1.50 : 1</td>
<td>1.70 : 1</td>
<td>1.95 : 1</td>
</tr>
<tr>
<td>Insertion Loss (dB max):</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>0.7</td>
<td>0.95</td>
</tr>
<tr>
<td>Isolation (dB min):</td>
<td>70</td>
<td>60</td>
<td>60</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>RF Power (Watts CW max):</td>
<td>40</td>
<td>30</td>
<td>25</td>
<td>15</td>
<td>8</td>
</tr>
</tbody>
</table>

Impedance: 50 Ω

Switching Speed: 50ms (per switch)

Operating Temp: 0 to 50 degrees C

Switch Type: (4) Four terminated latching SP6T. Switch p.n. 561Y-421123N-ROHS

Line Voltage: 120-240 VAC, 50-60 Hz

Control Interfaces: Ethernet via RJ-45 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)

Weight: 14 lbs
Appendix B

RF Configuration

Model: MS-2U40K-4/6T-ENET

Four externally terminated latching SP6T switches (Dow-Key part number: 561Y-421123N-ROHS) mounted on the rear panel.

This switch is a latching externally terminated 6 position switch. Any RF port that is not closed to the common port is terminated to 50 Ohm. The terminations can handle up to 1W of power.