*Solid state*

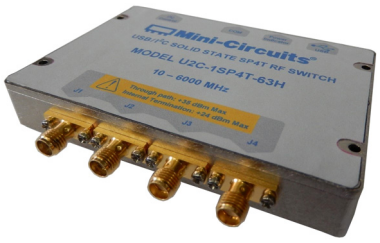
# USB / I²C RF SP4T Switch

# U2C-1SP4T-63H

50Ω 2 to 6000 MHz

## The Big Deal

- **USB** *and* **I²C** power & control
- High speed switch transition, 200 ns
- High power handling (+30 dBm)
- Very High Isolation (80 dB)
- Small case (3.75” x 2.50” x 0.6”)




Case Style: RB2502


**Software Package**

| Model No. | Description | Qty. |
|---|---|---|
| **U2C-1SP4T-63H** | **Single pole four throw RF Switch** | **1** |
| | **Included Accessories** | |
| MUSB-CBL-3+ | 2.6 ft USB cable | 1 |

***RoHS Compliant***

*See our web site for RoHS Compliance methodologies and qualifications*

## Typical Applications

- High volume production testing / ATE
- Design verification testing
- RF signal routing / switch matrices

## Product Overview

Mini-Circuits’ U2C-1SP4T-63H is a low cost, absorptive SP4T switch with USB and I²C control. The fast switching, solid state switch operates from 2 MHz to 6000 MHz with 200 ns typical switch transition speed. High linearity (+55 dBm typ IP3), and high isolation (80 dB typical) allow the model to be used for a wide variety of RF applications.

Full software support is provided for USB control, including our user-friendly GUI application for Windows and a full API with programming instructions for USB and I²C control in both Windows and Linux environments (32-bit and 64-bit systems). The latest version of the full software package can be downloaded from **https://www.minicircuits.com/softwaredownload/solidstate.html** at any time.

The U2C-1SP4T-63H is housed in a compact, rugged metal case (3.75” x 2.50” x 0.6”) with 5 SMA (F) connectors (COM, and J1 to J4), a USB Mini-B and a 9-pin D-sub connector for USB and I²C control and power.

## Key Features

| Feature | Advantages |
|---|---|
| Dual control interface (I2C & USB) | USB provides a quick and easy PC control method with full software support, while I2C allows multiple switches to be controlled in parallel from a microcontroller / embedded system using minimal hardware (2 wire control) |
| RF SP4T absorptive switch | Wideband (2 to 6000 MHz) with low insertion loss (3.7 dB typ.), high isolation (80 dB typ.), and high power rating (+30 dBm through path). |
| High Linearity (IP3 +55 dBm typ.) | Results in little or negligible inter-modulation generation, meeting requirements for digital communications signals |
| DC Blocking at RF ports | Built in blocking capacitors eliminate the need for external DC blocking circuitry at RF ports. |





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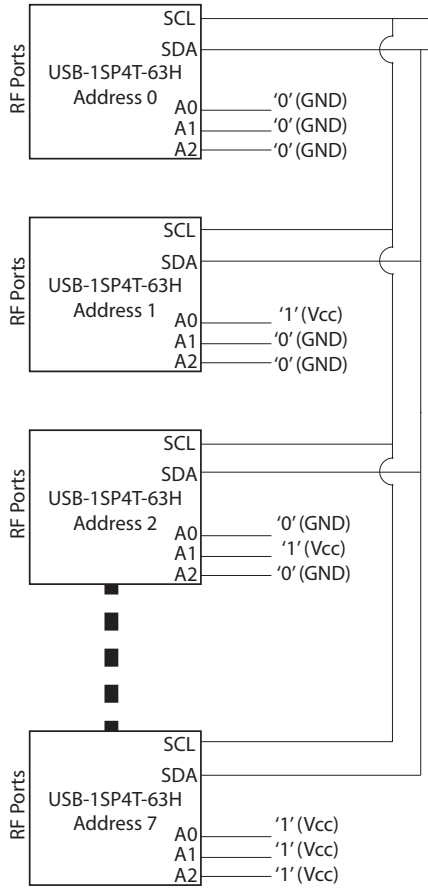
## Electrical Specifications @ 0 to 50°C

| Parameter | Port | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Operating Frequency | | | 2 | | 6000 | MHz |
| Insertion Loss | COM to any active port | 2 to 700 MHz | – | 2.3 | 3.5 | dB |
| | | 700 to 2500 MHz | – | 3.0 | 4.5 | |
| | | 2500 to 5000 MHz | – | 3.8 | 5.5 | |
| | | 5000 to 6000 MHz | – | 4.2 | 6.0 | |
| Isolation | Between any of ports J1 to J4 | 2 to 700 MHz | 82 | 105 | – | dB |
| | | 700 to 2500 MHz | 72 | 90 | – | |
| | | 2500 to 5000 MHz | 53 | 73 | – | |
| | | 5000 to 6000 MHz | 49 | 62 | – | |
| | COM to any terminated port | 2 to 700 MHz | 82 | 105 | – | |
| | | 700 to 2500 MHz | 77 | 95 | – | |
| | | 2500 to 5000 MHz | 58 | 76 | – | |
| | | 5000 to 6000 MHz | 54 | 64 | – | |
| | Disconnected state (COM port open)[1]: COM to J2, J3, or J4 | 2 to 700 MHz | 82 | 105 | – | |
| | | 700 to 2500 MHz | 77 | 95 | – | |
| | | 2500 to 5000 MHz | 58 | 76 | – | |
| | | 5000 to 6000 MHz | 54 | 64 | – | |
| | Disconnected state (COM port open)[1]: COM to J1 | 2 to 700 MHz | 42 | 60 | – | |
| | | 700 to 2500 MHz | 30 | 44 | – | |
| | | 2500 to 5000 MHz | 25 | 34 | – | |
| | | 5000 to 6000 MHz | 25 | 32 | – | |
| VSWR | COM port in all active states [1] | 2 to 700 MHz | – | 1.40 | – | :1 |
| | | 700 to 2500 MHz | – | 1.25 | – | |
| | | 2500 to 5000 MHz | – | 1.25 | – | |
| | | 5000 to 6000 MHz | – | 1.30 | – | |
| | Any port connected to COM | 2 to 700 MHz | – | 1.40 | – | |
| | | 700 to 2500 MHz | – | 1.25 | – | |
| | | 2500 to 5000 MHz | – | 1.25 | – | |
| | | 5000 to 6000 MHz | – | 1.30 | – | |
| | Any terminated port | 2 to 700 MHz | – | 1.15 | – | |
| | | 700 to 2500 MHz | – | 1.15 | – | |
| | | 2500 to 5000 MHz | – | 1.20 | – | |
| | | 5000 to 6000 MHz | – | 1.35 | – | |
| Power Input @1 dB Compression [2,3,4] | COM to any active port | 100 to 6000 MHz | – | +35 | – | dBm |
| IP3 [2,4,5] | COM to any active port | 100 to 6000 MHz | – | +55 | – | dBm |
| Transition Time [6] | – | – | – | 200 | 300 | ns |
| Minimum dwell time [7] | High Speed Mode | – | – | 5 | – | µs |
| Switching Time (USB) [8] | – | – | – | 2 | – | ms |
| Rated voltage | USB or D-Sub port | – | 4.75 | 5 | 5.25 | V |
| Rated Current | | – | – | 30 | 50 | mA |
| Operating RF Input Power [3] | COM to any active port | Hot & Cold Switching | – | – | +30 | dBm |
| | Any active port to COM | Hot & Cold Switching | – | – | +23 | |
| | Any terminated port | – | – | – | +23 | |
| | Through path | 2 to 50 MHz | Max power at through path derates linearly from +30 dBm @ 50 MHz to +18 dBm @2 MHz | | | |
| | | 50 to 6000 MHz | – | – | +30 | |

[1] When switch is at DISCONNECT state (see page 9) COM port will be in OPEN (reflective) state and all output ports (J1-J4) will be absorptive, however J1 port isolation is affected under this configuration, while J2, J3, J4 still maintain the same isolation as in the normal operating conditions.
[2] Do not exceed absolute maximum ratings in table on page 5
[3] Max power at through path derates linearly from +30 dBm @ 50 MHz to +18 dBm @2 MHz
[4] Compression and IP3 may degrade below 100 MHz
[5] IP3 tested with 1 MHz span between signals, +5 dBm per tone.
[6] Transition time spec represents the time that the RF signal paths are interrupted during switching and thus is specified without communication delays.
[7] Minimum dwell time is the shortest time that can be achieved between 2 switch transitions when programming an automated switch sequence.
[8] Switching time(USB) is the time from issuing a single software command via USB to the switch state changing. The most significant factor is the host PC, influenced by CPU load and USB protocol. The time shown is an estimate for a medium CPU load and USB 2.0 connection.

### I²C communication parameters

| Parameter | Conditions | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Voltage levels | Logic High Voltage | Input | 2.0 | – | 3.3 | V |
| | Logic Low Voltage | Input | 0 | – | 0.8 | |
| Clock Frequency | – | | – | – | 400 | kHz |




The I²C is a short-range synchronous communication protocol for simple 2-wire communication with slave devices using clock (SCL) and data (SDA) connections. The U2C-1SP4T-63H interface also includes 3 address pins (A0, A1 and A2), allowing up to 8 switches to be controlled independently from a single master with shared SDA and SCL connections.

All I²C pins in the U2C-1SP4T-63H are connected to an internal pullup resistor so will float to logic 1 when disconnected. This sets a default address of 111 for all units (decimal 7). Addresses from 0 to 7 can be set by externally grounding the relevant address pins (A0, A1 and A2).

The I²C functionality is limited to setting or reading switch states. Control sequences are sent to the switch in several bytes on the data connection, enclosed by a start and stop signal, and clocked at up to 400 kHz. The switch will acknowledge each byte received with a single "ACK" bit (logic 1) on the same data connection.

To send a command to the switch 3 bytes will be sent:

1. Control byte (**1010**$A_2A_1A_0$**R/W**)

   Where:
   **1010** = Control code for U2C-1SP4T-63H
   $A_2A_1A_0$ = 3-bit address for the U2C-1SP4T-63H switch module
   **R/W** = Read / write select bit ('0' to write or '1' to read)
   Example:
   Control byte = **10101000**
   Address = **100** (binary) = 4 (decimal)
   R/W = **0** (write to switch)

2. Switch selector byte (00000001) - U2C-1SP4T-63H contains only 1 switch so this byte is always 00000001.

3. Switch state byte (00000XYZ) - The switch state, represented by a binary string according to the truth table below.

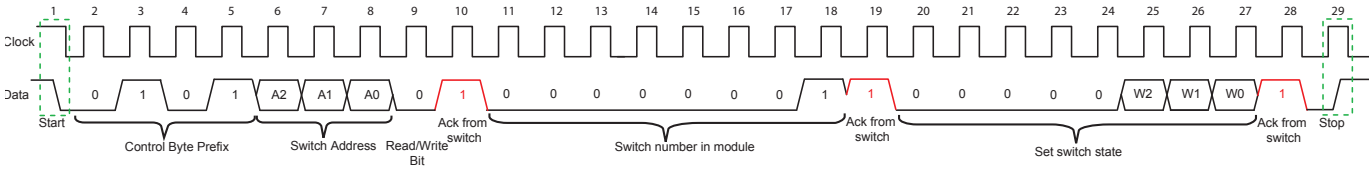
| Switch state | Switch state byte | Port behavior | | | | |
|---|---|---|---|---|---|---|
| | | COM | J1 | J2 | J3 | J4 |
| Disconnected | 0000 0000 | Reflective | Terminated Internally (50Ω) | Terminated Internally (50Ω) | Terminated Internally (50Ω) | Terminated Internally (50Ω) |
| COM -> 1 | 0000 0001 | **Connected to J1** | **Connected to COM** | Terminated Internally (50Ω) | Terminated Internally (50Ω) | Terminated Internally (50Ω) |
| COM -> 2 | 0000 0010 | **Connected to J2** | Terminated Internally (50Ω) | **Connected to COM** | Terminated Internally (50Ω) | Terminated Internally (50Ω) |
| COM -> 3 | 0000 0011 | **Connected to J3** | Terminated Internally (50Ω) | Terminated Internally (50Ω) | **Connected to COM** | Terminated Internally (50Ω) |
| COM -> 4 | 0000 0100 | **Connected to J4** | Terminated Internally (50Ω) | Terminated Internally (50Ω) | Terminated Internally (50Ω) | **Connected to COM** |

In I²C protocol the Data line may not change states while the Clock is high, except for the start and stop signals which enclose each sequence of bytes. While the Clock is high a falling edge (transition from logic 1 to logic 0) signifies the start of a sequence, while a rising edge (transition from logic 0 to logic 1) signifies a stop signal. All other transitions must occur while the clock is low.

### Setting switch state via I²C

The I2C communication sequence to set the switch state is:

1. **Start signal**
2. **Send control byte (write mode)**
3. Receive ACK response from switch
4. **Send switch selector byte**
5. Receive ACK response from switch
6. **Send switch state byte**
7. Receive ACK response from switch
8. **Stop signal**



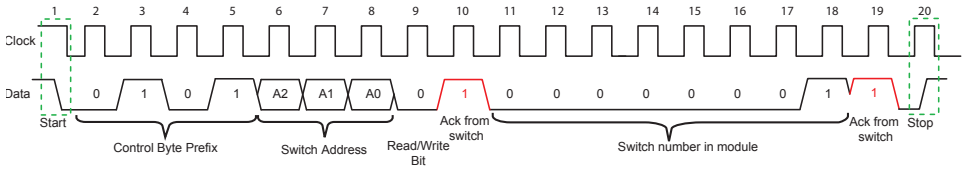

### Legend:

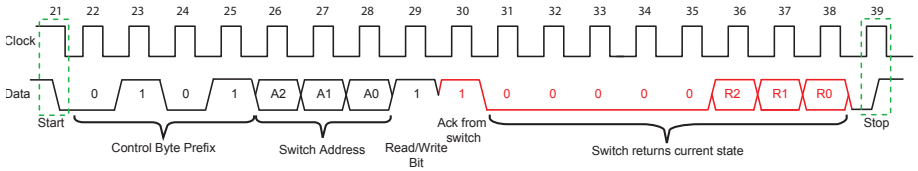
Signal from master to switch
Signal from switch to master

### Reading switch state via I²C

The I2C communication sequence to set the switch state is:

1. **Start signal**
2. **Send control byte (write mode)**
3. Receive ACK response from switch
4. **Send switch selector byte**
5. Receive ACK response from switch
6. **Stop signal**
7. **Start signal**
8. **Send control byte (read mode)**
9. Receive ACK response from switch
10. Receive current switch state
11. **Stop signal**




### Legend:

Signal from master to switch
Signal from switch to master

## Absolute Maximum Ratings

| | |
|---|---|
| Operating Temperature | 0°C to 50°C |
| Storage Temperature | -20°C to 60°C |
| DC supply voltage max. @ USB and pin 4 of D-sub | 6V |
| Voltage on SDA & SCL pins (1 & 2 in D-sub ) | 3.6V |
| Voltage on address pins (6 - 8 in D-sub ) | 3.6V |
| RF power @ 2 - 6000 MHz into termination | +24 dBm |
| RF power @ 2 - 50 MHz into COM or active port | Derate linearly from +35 dBm @ 50 MHz to +20 dBm @2 MHz |
| RF power @ 50 - 6000 MHz into COM or active port | +35 dBm |
| DC voltage @ RF Ports | 16V |

Permanent damage may occur if any of these limits are exceeded. Operating in the range between operating power limits and absolute maximum ratings for extended periods of time may result in reduced life and reliability.

## Connections

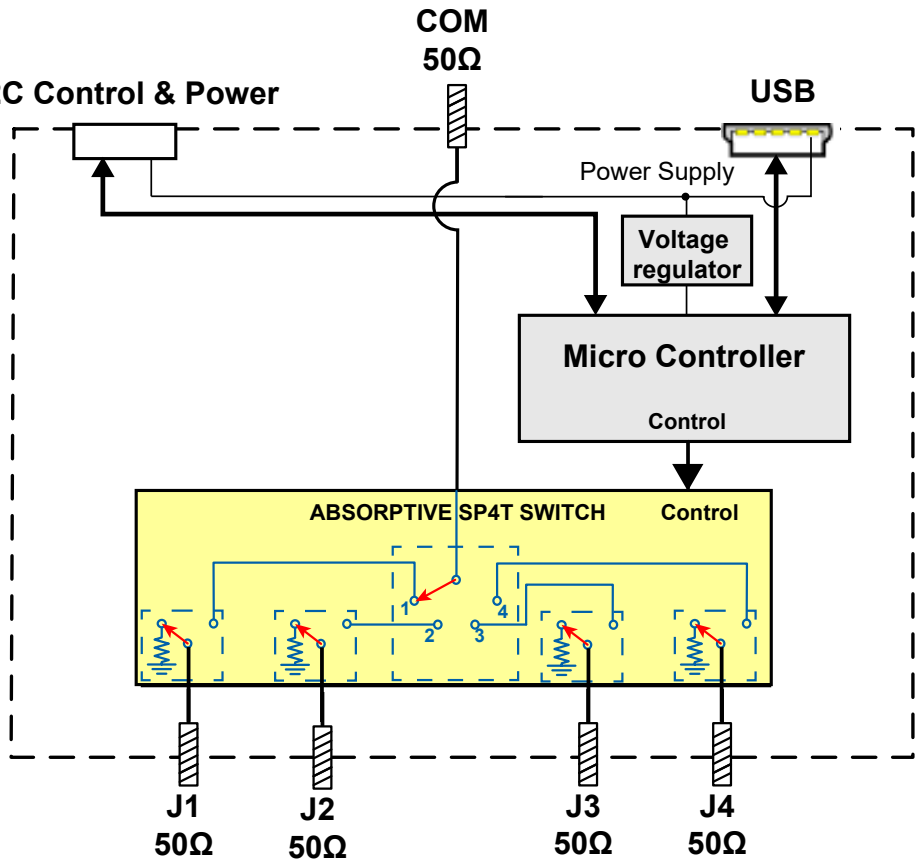
| | |
|---|---|
| RF Switch (J1 to J4, COM) | (SMA female) |
| USB | (USB type Mini-B receptacle) |
| I²C* | (9 pin D-sub female) |

## *9 Pin D-Sub Pin Connections

| PIN Number | Function |
|---|---|
| 1 | SDA |
| 2 | SCL |
| 3 | GND |
| 4 | Vcc |
| 5 | GND |
| 6 | A0 |
| 7 | A1 |
| 8 | A2 |
| 9 | GND |

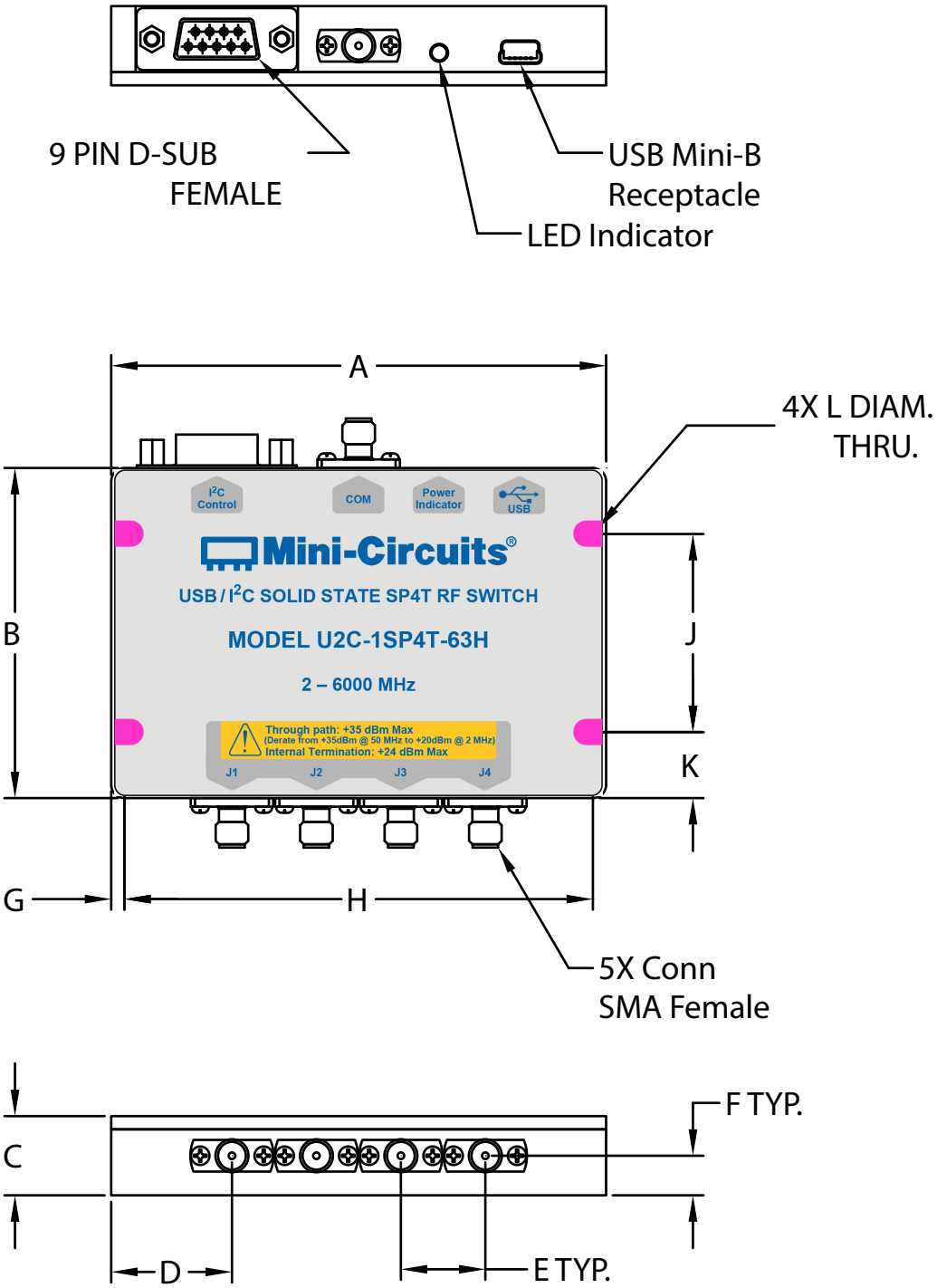
## Block Diagram

**Note:** Power supply is needed from only one port at a time. Power can be supplied via USB or I²C port regardless of the control interface used




Switch in Disconnected state

**Outline Drawing (RB2502)**

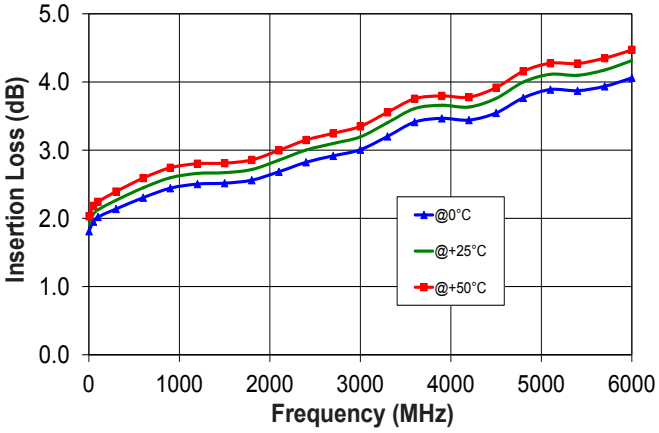



**Outline Dimensions ( inch / mm )**

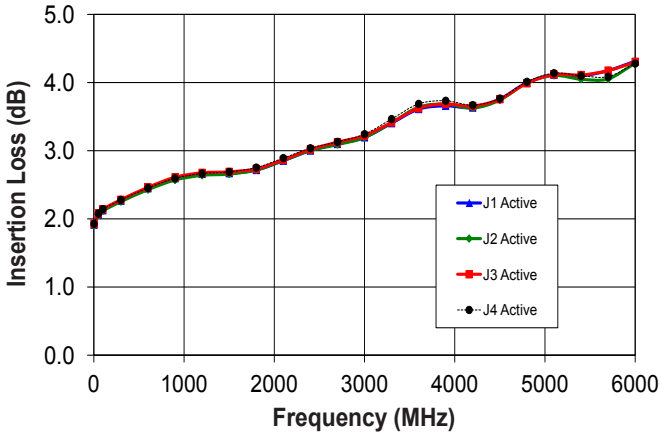
| A | B | C | D | E | F | G | H | J | K | L | WT. GRAMS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **3.75** | **2.50** | **0.60** | **0.915** | **0.640** | **0.300** | **0.10** | **3.55** | **1.50** | **0.50** | **0.106** | **220** |
| 95.25 | 63.50 | 15.24 | 23.24 | 16.26 | 7.62 | 2.54 | 90.17 | 38.10 | 12.70 | 2.69 | |

## Typical Performance Curves

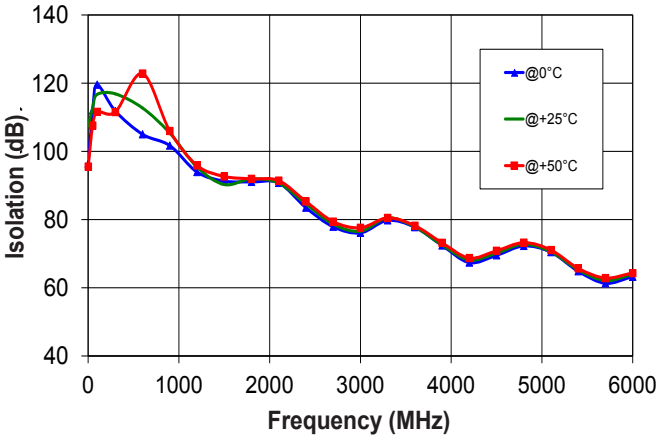
### Insertion Loss J1 Active (over Temp.)



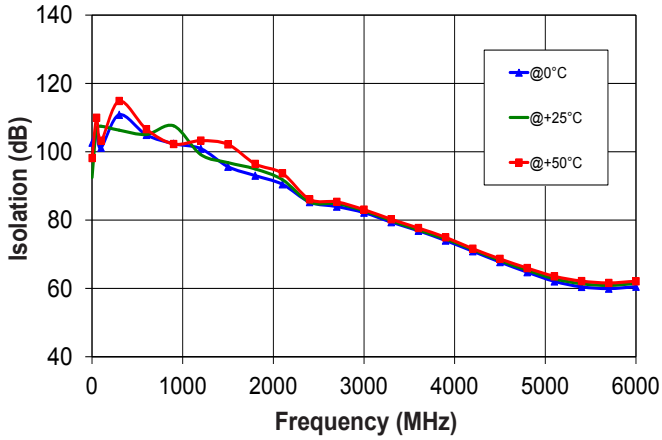

### Insertion Loss J1/2/3/4 Active



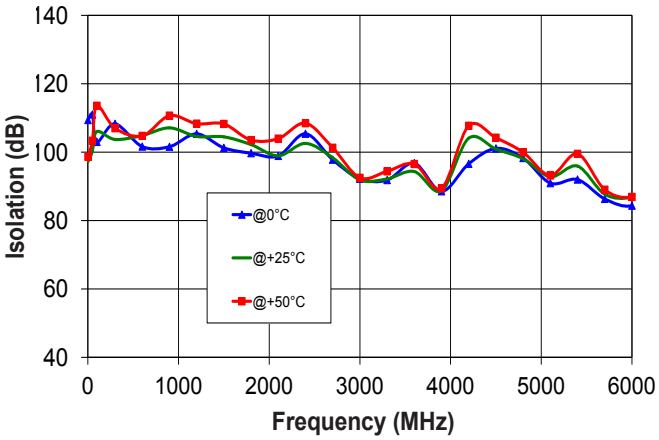

### Isolation COM to J1 (J2 Active)



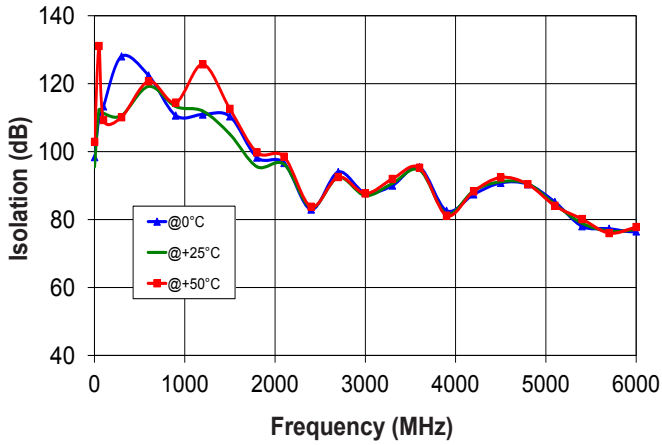

### Isolation COM to J1 (J3 Active)




### Isolation J2 to J3 (J3 Active)

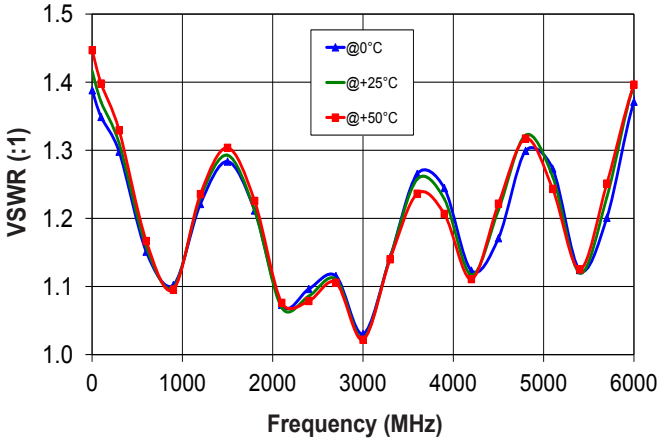



### Isolation J1 to J3 (J2 Active)

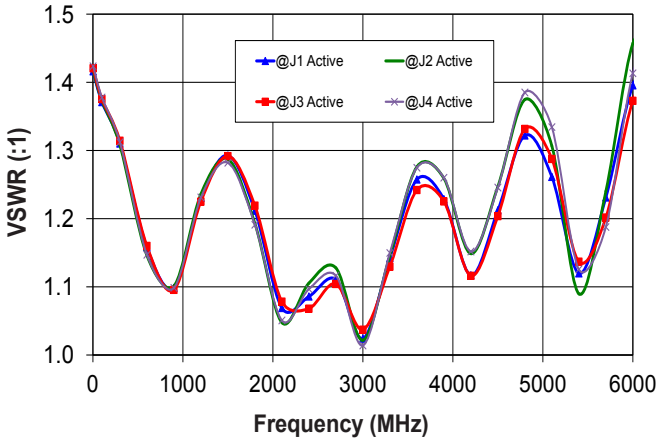


## Typical Performance Curves (Continued)

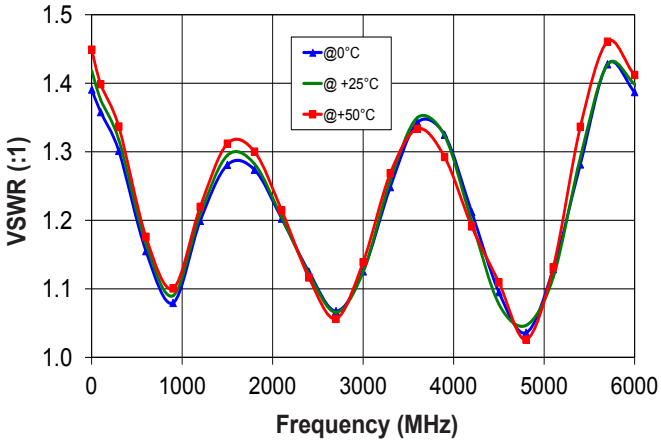
### VSWR @ COM over Temp. (J1 Active)



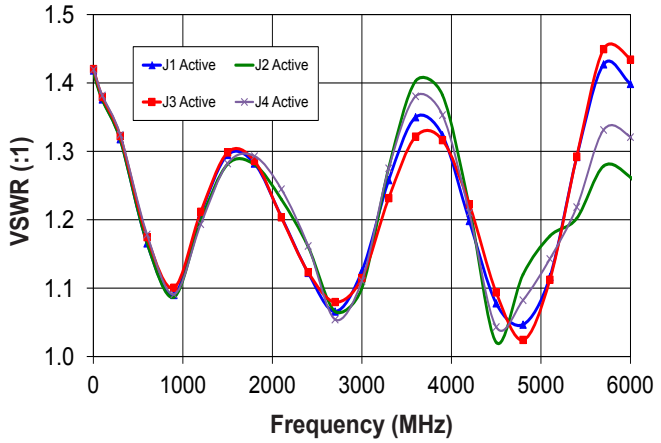

### VSWR @ COM (J1/2/3/4 Active)



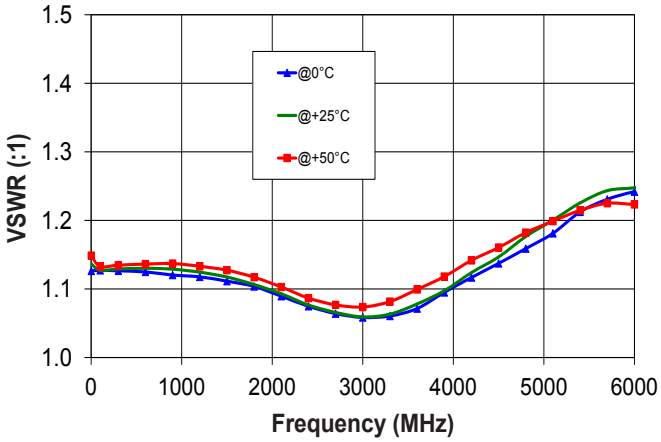

### VSWR @ J1 Active Port over Temp.



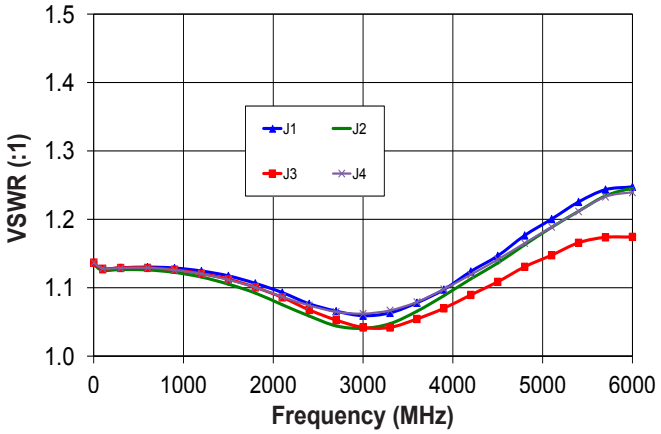

### VSWR @ Active Ports J1/2/3/4




### VSWR @ J1 Terminated over Temp.




### VSWR J1/2/3/4 Terminated Ports



### Software & Documentation Download:

- Mini-Circuits' full software and support package including user guide, Windows GUI, DLL files, programming manual and examples can be downloaded free of charge from **https://www.minicircuits.com/softwaredownload/solidstate.html**
- Please contact **testsolutions@minicircuits.com** for support

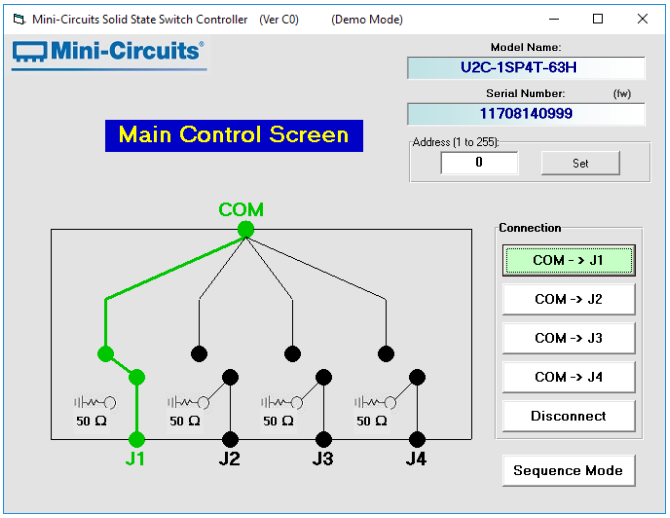
### Minimum System Requirements

| Parameter | Requirements | |
|---|---|---|
| Interface | USB HID or I²C | |
| System requirements | GUI: | Windows 32 & 64 bit systems from Windows 98 up to Windows 10 |
| | USB API (ActiveX & .Net) | Windows 32 & 64 bit systems with ActiveX or .Net support from Windows 98 up to Windows 10 |
| | I²C | Any computer with a suitable I/O port |
| | USB direct programming support | Linux, Windows systems from Windows 98 up to Windows 10 |
| Hardware | Pentium® II or higher, RAM 256 MB | |

### Graphical User Interface (GUI) for Windows

### Key Features:

- Set switch manually
- Set timed sequence of switching states
- Configure switch address and upgrade Firmware




### Application Programming Interface (API)

### Windows Support:

- API DLL files exposing the full switch functionality
  - ActiveX COM DLL file for creation of 32-bit programs
  - .Net library DLL file for creation of 32 / 64-bit programs
- Supported by most common programming environments (refer to application note **AN-49-001** for summary of tested environments)

### Linux Support:

- Full switch control in a Linux environment is achieved by way of USB interrupt commands.

## Ordering, Pricing & Availability Information see our web site

| Model | Description |
|---|---|
| U2C-1SP4T-63H | USB & I²C Single Pole Four Throw Switch |

| Included Accessories | Part No. | Description |
|---|---|---|
|  | MUSB-CBL-3+ | 2.6 ft (0.8 m) USB Cable: USB type A(Male) to USB type Mini-B(Male) |

| Optional Accessories | Description |
|---|---|
| MUSB-CBL-3+ (Spare) | 2.6 ft (0.8 m) USB Cable: USB type A(Male) to USB type Mini-B(Male) |
| MUSB-CBL-7+ | 6.6 ft (2.0 m) USB Cable: USB type A(Male) to USB type Mini-B(Male) |
| USB-AC/DC-5+ | AC/DC +5V power adaptor with USB connector [9,10] |

[9] The USB-AC/DC-5 may be used to provide additional power if needing to connect a number of switches in series exceeding 500mA total current draw.
[10] Includes power plugs for US, UK, EU, IL, AU & China. Plugs for other countries are also available, if you need a power plug for a country not listed please contact testsolutions@minicircuits.com

### Additional Notes

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.

B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.

C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/MCLStore/terms.jsp