

Solid state

# USB/I<sup>2</sup>C/SPI SPDT Switch

## U2C-1SP2T-63VH

50Ω 10 to 6000 MHz

### The Big Deal

- USB and I<sup>2</sup>C and SPI power & control
- High power handling (2W, hot switching)
- Ultra high isolation (110 dB over full frequency range)
- Small case (3.0" x 2.0" x 0.47")



Case Style: NR2563



Software Package

### Typical Applications

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

Model No.	Description	Qty.
U2C-1SP2T-63VH	Single pole double throw RF Switch	1

#### Included Accessories

MUSB-CBL-3+	2.6 ft USB cable	1
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#### RoHS Compliant

See our web site for RoHS Compliance methodologies and qualifications

### Product Overview

Mini-Circuits' U2C-1SP2T-63VH is a high isolation, high power, absorptive SPDT switch with USB, I<sup>2</sup>C and SPI control. The fast switching, solid state switch operates from 10 MHz to 6000 MHz with 700 ns typical transition time. High linearity (+52 dBm typ IP3), and very high isolation (110 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 and programming instructions for 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. Alternatively, the SPI and I<sup>2</sup>C interfaces provide options for controlling multiple switches at once via a simple serial interface (typically using a microcontroller), supporting up to 8 switches connected in parallel with I<sup>2</sup>C or up to 30 switches connected in series with SPI.

The U2C-1SP2T-63VH is housed in a compact, rugged metal case (3.0" x 2.0" x 0.47") with 3 SMA (F) connectors (COM, J1 and J2), a USB Mini-B and three 10-pin digital connector for control and power via USB, I<sup>2</sup>C and SPI.

### Key Features

Feature	Advantages
Multiple control interfaces (I <sup>2</sup> C, SPI & USB)	USB provides a quick and easy PC control method with full software support, while I <sup>2</sup> C allows multiple switches to be controlled in parallel from a microcontroller / embedded system using minimal hardware (2 wire control)
RF SPDT absorptive switch	Wideband (10 to 6000 MHz) with low insertion loss (4 dB typ.), high isolation (110 dB typ.), and high power rating (+33 dBm terminated power).
Daisy chain SPI control	Allows connecting up to 30 units in series to a single power supply and SPI control
High Linearity (IP3 +52 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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[www.minicircuits.com](http://www.minicircuits.com) P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

Rev. B  
M171567  
EDR-11652  
U2C-1SP2T-63VH  
RAV  
181217  
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## Electrical Specifications @ 0 to 50°C

Parameter	Port	Conditions	Min.	Typ.	Max.	Units
Operating Frequency			10		6000	MHz
Insertion Loss	COM to any active port	10 to 700 MHz	-	3.2	4.7	dB
		700 to 2500 MHz	-	4.0	5.5	
		2500 to 5000 MHz	-	4.5	6.0	
		5000 to 6000 MHz	-	5.0	6.5	
Isolation	Between ports J1 & J2 (At all states)	10 to 700 MHz	100	105	-	dB
		700 to 2500 MHz	100	110	-	
		2500 to 5000 MHz	100	105	-	
		5000 to 6000 MHz	100	103	-	
	COM to any terminated port (At all states)	10 to 700 MHz	100	110	-	
		700 to 2500 MHz	100	110	-	
		2500 to 5000 MHz	100	110	-	
		5000 to 6000 MHz	100	105	-	
VSWR	COM port in all active states	10 to 700 MHz	-	1.45	-	:1
		700 to 2500 MHz	-	1.30	-	
		2500 to 5000 MHz	-	1.25	-	
		5000 to 6000 MHz	-	1.30	-	
	Any port connected to COM	10 to 700 MHz	-	1.45	-	
		700 to 2500 MHz	-	1.30	-	
		2500 to 5000 MHz	-	1.30	-	
		5000 to 6000 MHz	-	1.30	-	
	Any terminated port <sup>1</sup>	10 to 700 MHz	-	1.30	-	
		700 to 2500 MHz	-	1.30	-	
		2500 to 5000 MHz	-	1.30	-	
		5000 to 6000 MHz	-	1.30	-	
Power Input @ 1 dB Compression <sup>2,3,4</sup>	COM to any active port	100 to 6000 MHz	-	+39.5	-	dBm
IP3 <sup>2,4,5</sup>	COM to any active port	100 to 6000 MHz	-	+52	-	dBm
Transition Time <sup>6</sup>	-	-	-	0.7	2	µs
Minimum dwell time <sup>7</sup>	High Speed Mode	-	-	5	-	µs
Switching Time (USB) <sup>8</sup>	-	-	-	2	-	ms
Rated voltage	USB or I <sup>2</sup> C control	-	4.75	5	5.25	V
Rated Current		-	-	30	50	mA
Operating RF Input Power <sup>3,9</sup>	-	10 to 600 MHz	Max power derates linearly from +33 dBm @ 600 MHz to +19 dBm @ 10 MHz			dBm
		600 to 6000 MHz	-	-	+33	

<sup>1</sup> VSWR of COM port In disconnected state is the same as of other terminated ports.

<sup>2</sup> Do not exceed absolute maximum ratings in table on page 3

<sup>3</sup> The model can handle Max RF input from both J1 and J2 at once. Max power derates linearly from +33 dBm @ 600 MHz to +19 dBm @ 10 MHz

<sup>4</sup> Compression and IP3 may degrade below 100 MHz

<sup>5</sup> IP3 tested with 1 MHz span between signals, +5 dBm per tone.

<sup>6</sup> Transition time spec represents the time that the RF signal paths are interrupted during switching and thus is specified without communication delays.

<sup>7</sup> Minimum dwell time is the shortest time that can be achieved between 2 switch transitions when programming an automated switch sequence.

<sup>8</sup> 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.

<sup>9</sup> At high power input additional cooling may be needed.

## DC Electrical Specifications for SPI Control

Parameter	Min.	Typ.	Max.	Units
Vcc, Supply Voltage	12	—	24	V
Load on Vcc between In and Out ports	—	0.05	—	Ω
Icc, Supply Current	@24V	15	30	mA
	@12V	—	30	
Control Input Low	-0.3	—	+0.6	V
Control Input High	2.0	—	5.5	V
Control Current	—	400	—	µA

## Absolute Maximum Ratings

Operating Temperature		0°C to 50°C
Storage Temperature		-20°C to 60°C
Max Case Temperature		80°C
DC supply voltage max.	@ USB port (USB or I2C control)	6V
	@ I2C pin 10 (USB or I2C control)	6V
	@ SPI In / Out pins 1-3 (for SPI control)	26V
Voltage on control pins (7 & 8 in I <sup>2</sup> C, 7-9 in SPI )		3.6V
Voltage on address pins (4 - 6 in I <sup>2</sup> C )		3.6V
RF power @ 10 - 600 MHz into any RF port		Derate linearly from +34 dBm @ 600 MHz to +20 dBm @ 10 MHz
RF power @ 600 - 6000 MHz into any RF port		+34 dBm
DC voltage @ RF Ports		12V

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)
I <sup>2</sup> C*	(10 pin Hirose DF11 socket) <sup>8</sup>
SPI In*	(10 pin Hirose DF11 socket) <sup>8</sup>
SPI Out*	(10 pin Hirose DF11 socket) <sup>8</sup>

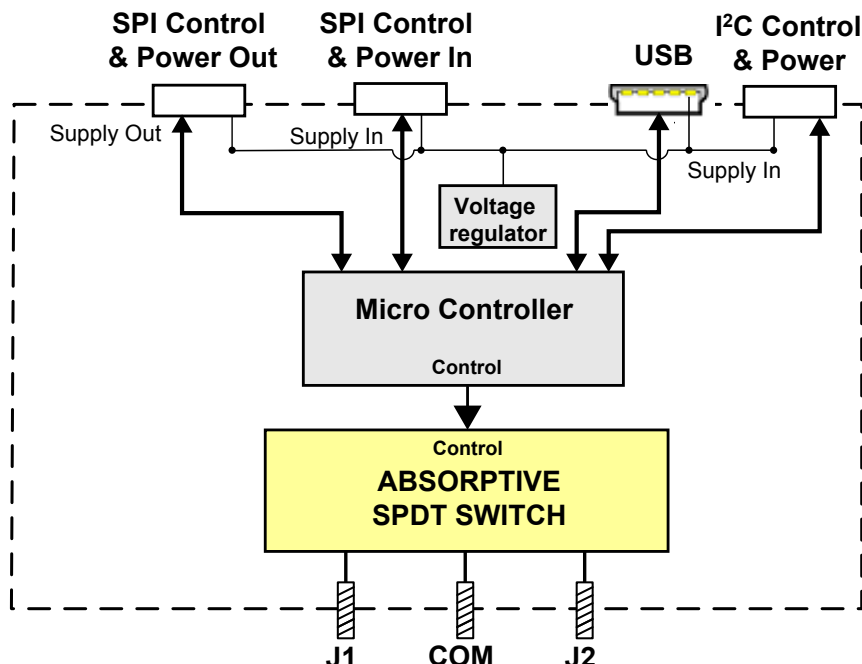
<sup>8</sup> Mating connector is Hirose DF11-10DS-2C(20)

## \*Pin Connections for all Hirose DF11 connectors

Pin Number	I <sup>2</sup> C connector	SPI In	SPI Out
1	GND	Vcc	Vcc
2	GND	Vcc	Vcc
3	GND	Vcc	Vcc
4	A0	GND	GND
5	A1	GND	GND
6	A2	GND	GND
7	SDA	Data In	Data Out
8	SCL	Clock In	Clock Out
9	GND	LE In	LE Out
10	Vcc	Blank in	Blank Out

## Block Diagram

**Note:** Power supply is needed from only one port at a time. Power can be supplied to USB port, I<sup>2</sup>C port, or SPI in port according to the control method used. 'SPI Control & Power Out' port is used only to transfer power and control to additional units when connecting multiple units in "Daisy Chain" configuration.



## SPI Control Interface

The U2C-1SP2T-63VH SPI serial interface consists of 2 control bits per unit that select the desired switch state, as shown in Table 1: Switch Logic Table.

Switch state	A0	A1	Port behavior		
			COM	J1	J2
Disconnected	0	0	Terminated Internally (50Ω)	Terminated Internally (50Ω)	Terminated Internally (50Ω)
COM -> 1	1	0	Connected to J1	Connected to COM	Terminated Internally (50Ω)
COM -> 2	0	1	Connected to J2	Terminated Internally (50Ω)	Connected to COM

The serial interface is a 2-bit serial in, parallel-out shift register buffered by a transparent latch. It is controlled by three-wire SPI protocol using Data, Clock, and Latch Enable (LE) and an additional Lock for added noise immunity and increased flexibility in controlling the units. All signal voltages are compatible with TTL and LVTTTL. The Data and Clock inputs allow data to be serially entered into the shift register, a process that is independent of the state of the LE input. The dual input and output SPI ports allow up to 30 units to be connected in a “Daisy Chain” configuration, all controlled by a single controller.

The LE input controls the latch. When LE is HIGH, the latch is transparent and the contents of the serial shift register control the switch. When LE is brought LOW, data in the shift register is latched.

Lock is used to lock the current state of the switch regardless of LE state or shift register, while allowing the LE to pass to other switches in the chain. If Lock is at logic HIGH the switch will respond to LE normally, when Lock is at logic LOW the switch will not respond to LE. If Lock is not required it can be kept constantly at logic high.

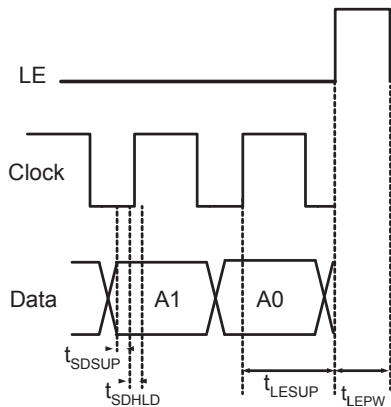
The shift register should be loaded while LE is held LOW to prevent the switch state from changing as data is entered. If multiple units are connected in series, data for all units should be entered before raising the LE to prevent switches assuming unanticipated states. Thus for example if three units are connected in daisy chain all 6 bits of control should be entered before raising the LE(see figures 2-4 for connecting units in daisy chain).

The LE input should then be toggled HIGH and brought LOW again, latching the new data. The timing for this operation is defined by Figure 1: Serial Interface Timing Diagram and Table 2: Serial Interface AC Characteristics.

### Note:

1. LE is connected in parallel to all units in a daisy chain using the switches internal buffers to prevent control current from increasing as more units are connected.
2. Mini-Circuits’ SPI converter, model RS232/USB-SPI, can be used to provide a single USB or RS232 interface for up to 30 daisy-chained U2C-1SP2T-63VH switches, with full software support (optional accessories on page 13).

**Figure 1: Serial Interface Timing Diagram**

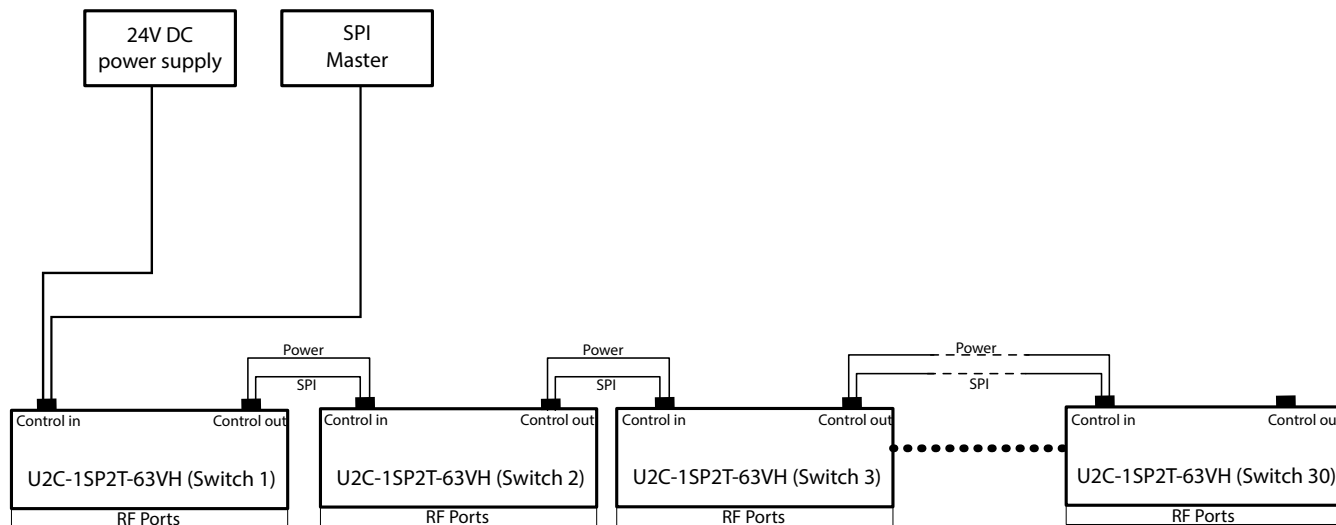


**Table 2. Serial Interface AC Characteristics**

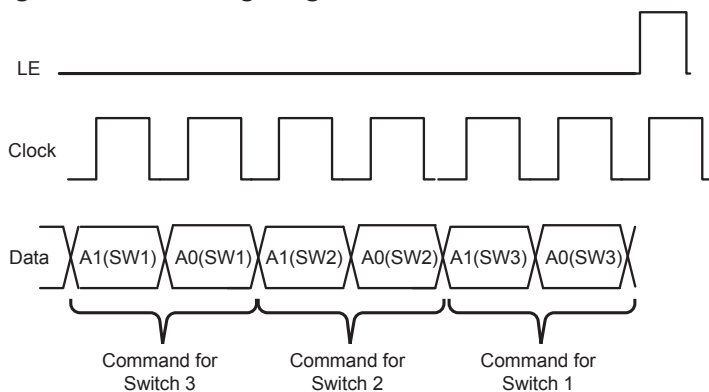
Symbol	Parameter	Min.	Max.	Units
$f_{clk}$	Serial data clock frequency		20	MHz
$t_{clkH}$	Serial clock HIGH time	8		ns
$t_{clkL}$	Serial clock LOW time	14		ns
$t_{LESUP}$	LE set-up time after last clock rising edge	8		ns
$t_{LEPW}$	LE minimum pulse width	8		ns
$t_{SDSUP}$	Serial data set-up time before clock rising edge	8		ns
$t_{SDHLD}$	Serial data hold time after clock falling edge	1		ns

## SPI Control Interface (Daisy Chain)

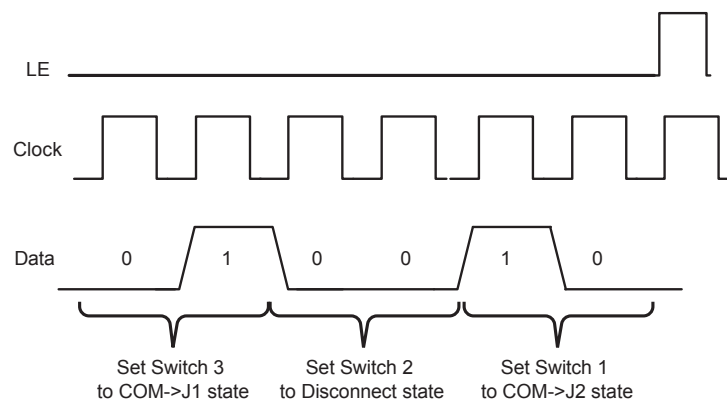
**Figure 2: Connection diagram for multiple units in series**



**Figure 3: SPI Timing Diagram for 3 units in series**

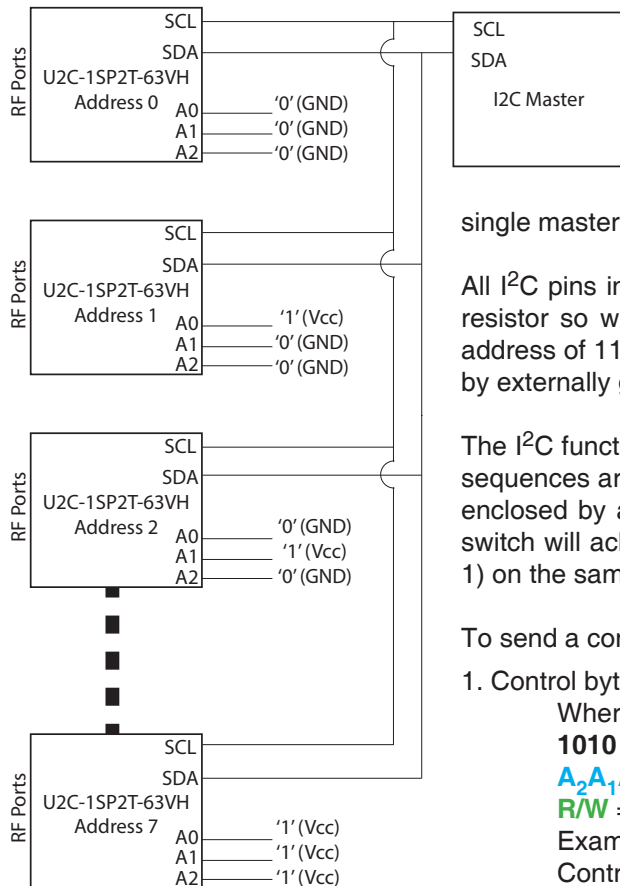


**Figure 4: Example of command for 3 switches in series**



## I<sup>2</sup>C 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 I<sup>2</sup>C is a short-range synchronous communication protocol for simple 2-wire communication with slave devices using clock (SCL) and data (SDA) connections. The U2C-1SP2T-63VH 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 I<sup>2</sup>C pins in the U2C-1SP2T-63VH 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 I<sup>2</sup>C 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<sub>2</sub>A<sub>1</sub>A<sub>0</sub>R/W)

Where:

**1010** = Control code for U2C-1SP2T-63VH

A<sub>2</sub>A<sub>1</sub>A<sub>0</sub> = 3-bit address for the U2C-1SP2T-63VH 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-1SP2T-63VH 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.

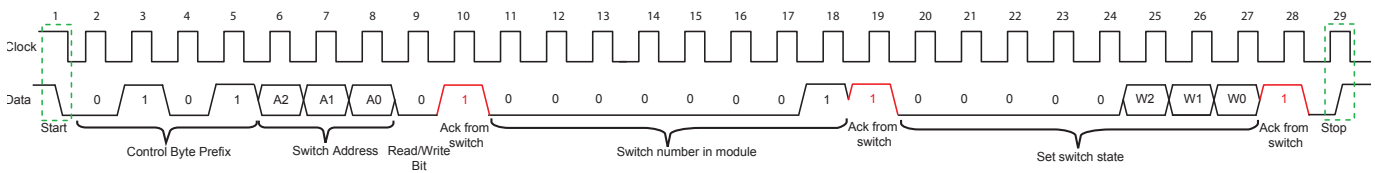
Switch state	Switch state byte	Port behavior		
		COM	J1	J2
Disconnected	0000 0000	Terminated Internally (50Ω)	Terminated Internally (50Ω)	Terminated Internally (50Ω)
COM -> 1	0000 0001	<b>Connected to J1</b>	<b>Connected to COM</b>	Terminated Internally (50Ω)
COM -> 2	0000 0010	<b>Connected to J2</b>	Terminated Internally (50Ω)	<b>Connected to COM</b>

In I<sup>2</sup>C 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 I<sup>2</sup>C

The I<sup>2</sup>C 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



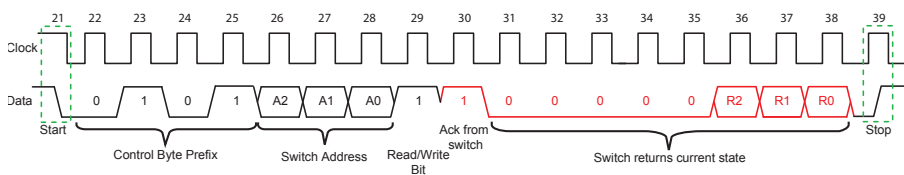
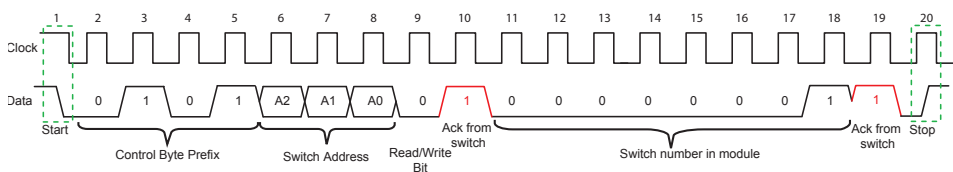
### Legend:

Signal from master to switch —————  
 Signal from switch to master —————

## Reading switch state via I<sup>2</sup>C

The I<sup>2</sup>C communication sequence to set the switch state is:

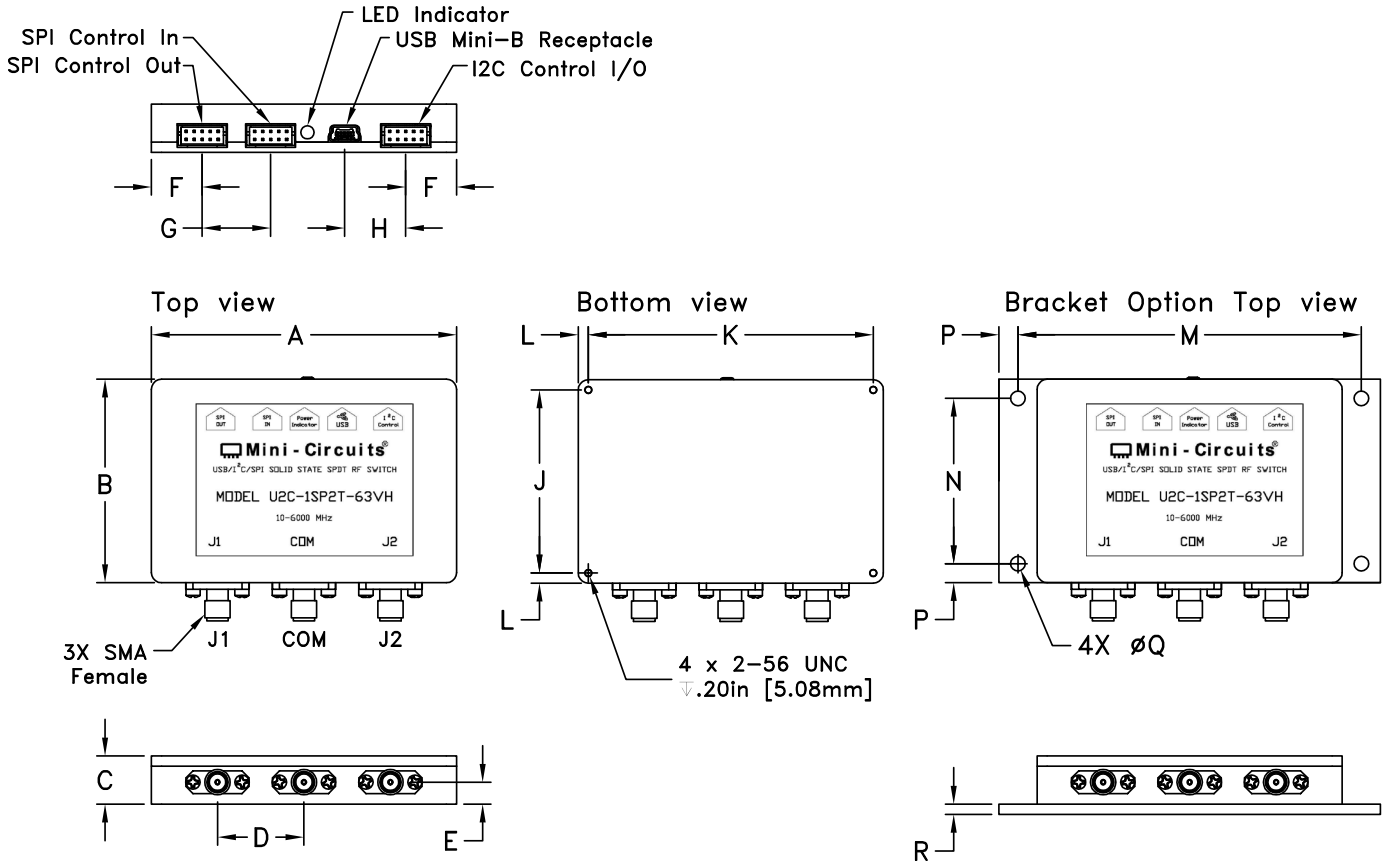
- |                                     |                                     |
|-------------------------------------|-------------------------------------|
| 1. Start signal                     | 7. Start signal                     |
| 2. Send control byte (write mode)   | 8. Send control byte (read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



### Legend:

Signal from master to switch —————  
 Signal from switch to master —————

## Outline Drawing (NR2563)



**Case Material** - Aluminum alloy

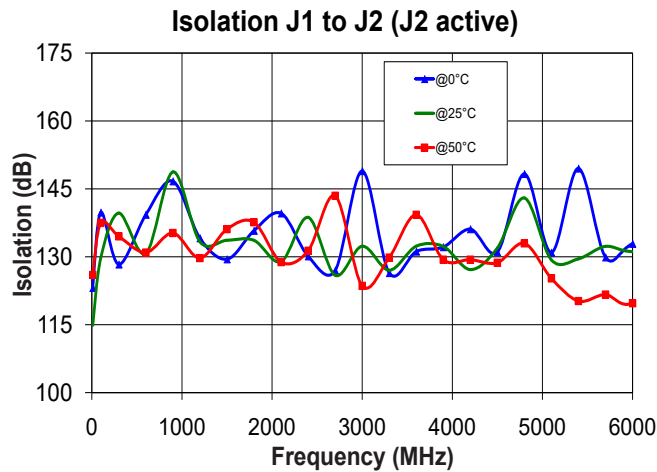
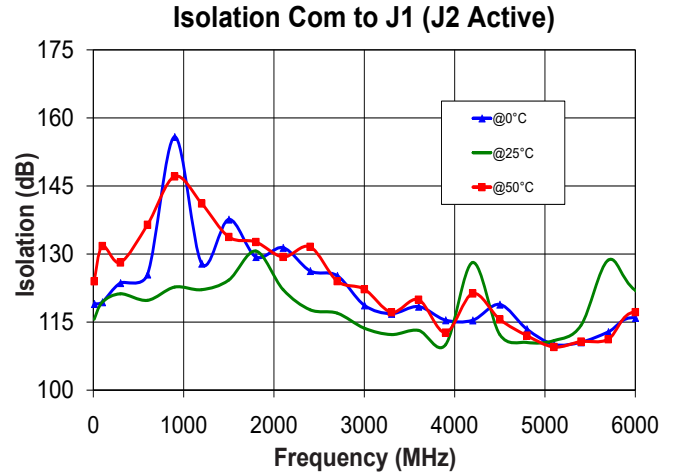
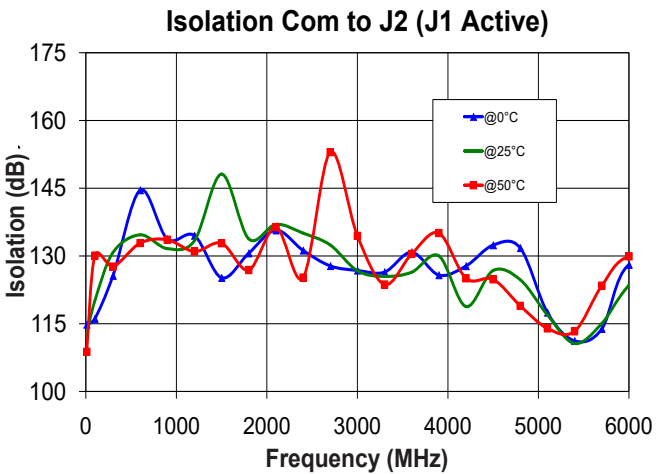
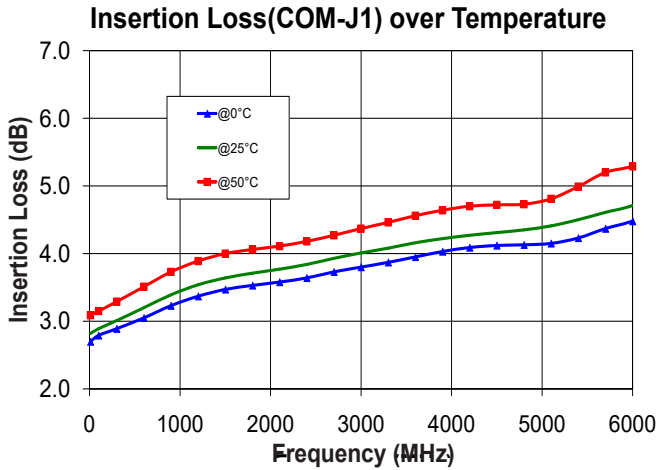
**Case Finish** - Clear chemical conversion coating, non-chrome or trivalent chrome based

### Outline Dimensions (inch / mm)

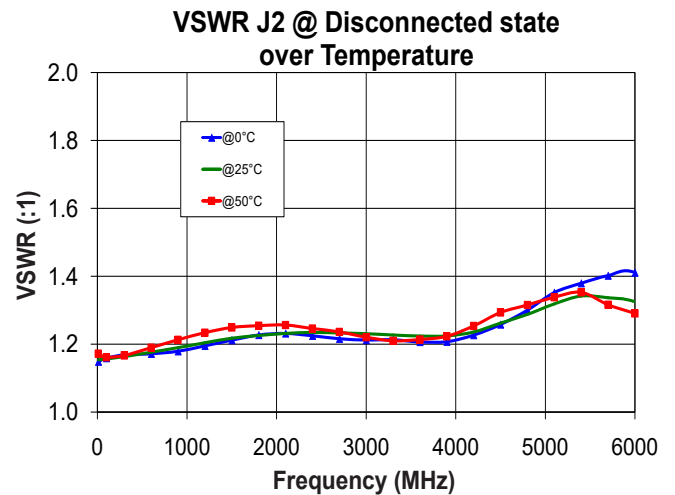
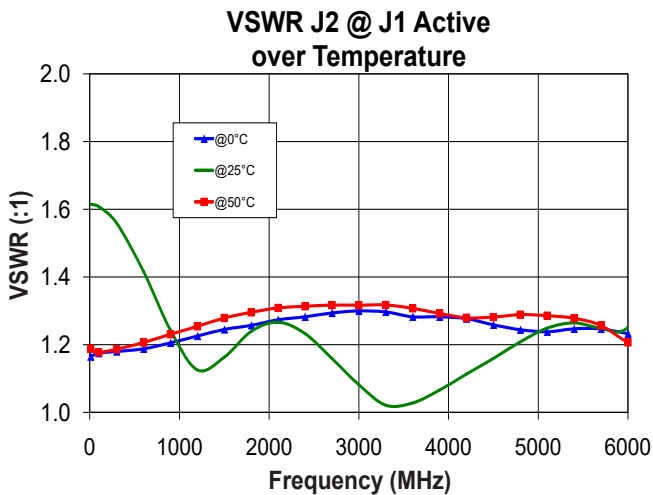
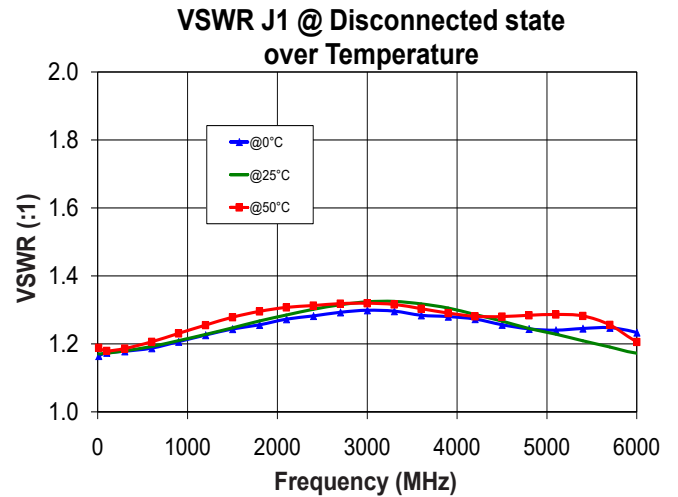
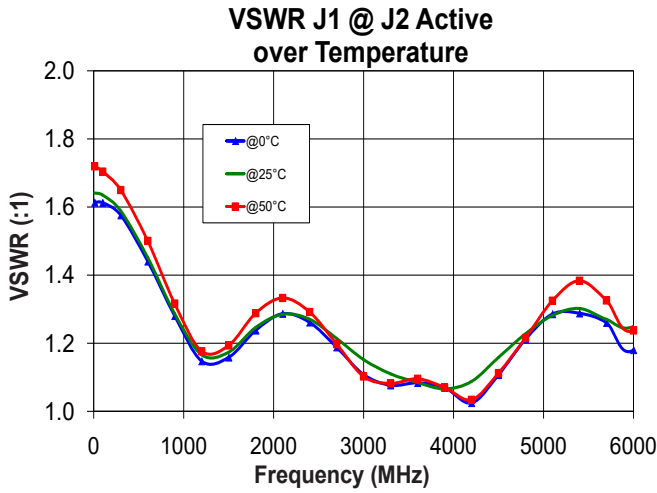
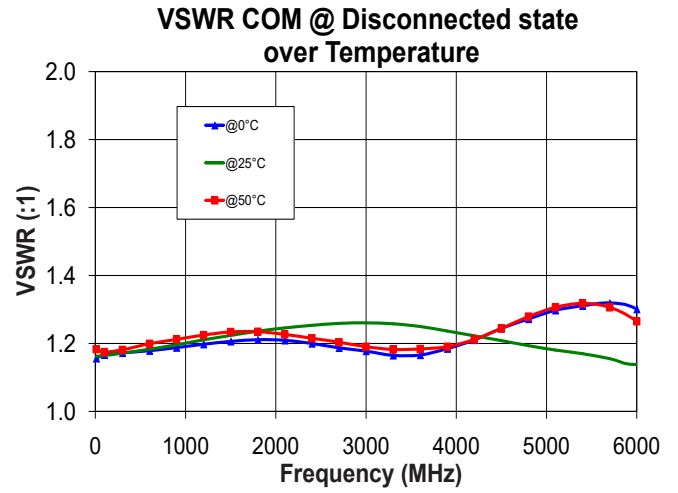
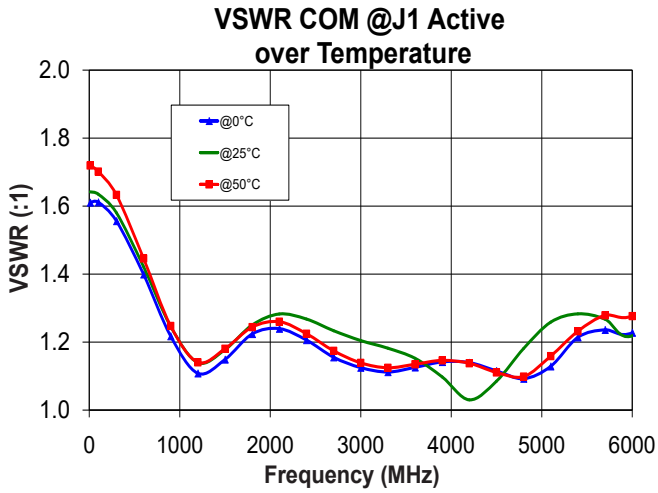
A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	WT. GRAMS
3.000	2.000	0.475	0.850	0.217	0.500	0.672	0.600	1.800	2.800	0.100	3.375	1.625	0.188	0.144	0.100	100
76.20	50.80	12.07	21.59	5.51	12.70	17.07	15.24	45.72	71.12	2.54	85.73	41.28	4.77	3.66	2.54	



Typical Performance Curves



## Typical Performance Curves (Continued)



## 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](mailto:testsolutions@minicircuits.com) for support

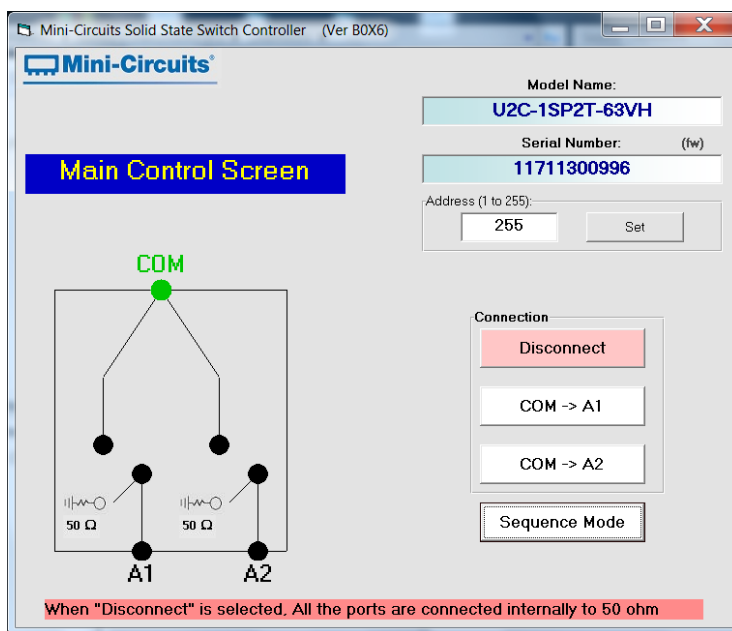
## Minimum System Requirements

Parameter	Requirements	
Interface	USB HID or I <sup>2</sup> C	
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
	I <sup>2</sup> C or SPI	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)

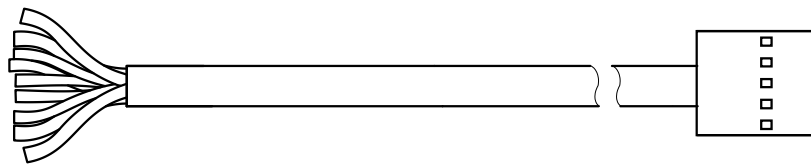
### Linux Support:

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

## Recommended Accessories

An optional cable accessory for SPI and I<sup>2</sup>C control which is available with U2C-1SP2T-63VH, the CBL-DF11-3FPD+ 'pig tail' cable. CBL-DF11-3FPD+ is a shielded cable with a 'pig tail' (bare wires) end allowing customer to assemble their own cable with any connector they need. Cable length is 4.9 feet / 1.5 meters using 32 AWG wires.

**Control Cable CBL-DF11-3FPD+**



Pin Number	when used for SPI control		when used for I <sup>2</sup> C control		Pigtail Wire Color
	Function	Description	Function	Description	
1	Vcc	Supply Voltage	GND	Ground connection	GREEN
2	Vcc	Supply Voltage	GND	Ground connection	GREEN/BLACK
3	Vcc	Supply Voltage	GND	Ground connection	RED
4	GND	Ground connection	A0	Set Address bit A0	ORANGE
5	GND	Ground connection	A1	Set Address bit A1	ORANGE/BLACK
6	GND	Ground connection	A2	Set Address bit A2	BLACK
7	Data	Data for SPI	SDA	Data for I <sup>2</sup> C	RED/BLACK
8	Clock	Clock for SPI	SCL	Clock for I <sup>2</sup> C	BLUE
9	LE	Latch Enable for SPI	GND	Ground connection	WHITE
10	Lock	Lock for SPI	Vcc	Supply Voltage	WHITE/BLACK

Ordering, Pricing & Availability Information see our web site

Model	Description
U2C-1SP2T-63VH	USB & I <sup>2</sup> C Single Pole double 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	Part No.	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)
See Previous page	CBL-DF11-3FPD+	3 ft (0.9 m) I <sup>2</sup> C & SPI Cable: DF11(plug) to Pigtail 32 AWG wires
	USB-AC/DC-5+	AC/DC +5V power adaptor with USB connector <sup>9,10</sup>
See outline drawing	BKT-39-23+	Bracket kit including 3.75" x 2.00" bracket, mounting screws and washers

<sup>9</sup> 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.

<sup>10</sup> 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](mailto:testsolutions@minicircuits.com)

## Additional Notes

- 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.
- Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- 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](http://www.minicircuits.com/MCLStore/terms.jsp)