

# N1810/1/2x Coaxial Switches

N1810UL DC to 4/20/26.5/40/50/67 GHz, SPDT, unterminated

N1810TL DC to 4/20/26.5/40/50/67 GHz, SPDT, terminated

N1811TL DC to 4/20/26.5/40/50/67 GHz, 4-port bypass, terminated

N1812UL DC to 4/20/26.5/40/50/67 GHz, 5-port bypass, unterminated



## High Performance Electromechanical Switches for Microwave and RF Manufacturing Test Systems

In today's fast-moving technical industries, test engineers need components they can count on. Keysight offers a line of latching coaxial switches that combine legendary reliability with the widest range of performance options available today.

### Features

- Broad operating frequency from DC up to 67 GHz
- Minimizes crosstalk with exceptionally high isolation across broad frequencies
- Low insertion loss and SWR
- Multiple configuration selection of SPDT and bypass switches
- Standard or TTL/5V CMOS compatible drive include selection of 5/15/24V coil voltages

## Reduce Downtime

Keysight Technologies is the world leader in innovating and developing microwave accessories for communications and aerospace applications. Our innovative design and strict adherence to quality process control ensure that each switch is guaranteed to perform within warranted specifications for its entire lifetime. With fewer breakdowns and less need to recalibrate, your test system moves quicker with less downtime, creating more throughput and revenue.

## Raise your Standards

All Keysight switches offer excellent repeatability and long life — up to five times the lifecycles of the competition. Add to this aggressive specs for isolation, SWR, and insertion loss, and you have a switch that impresses even the most demanding engineer with its precision and durability.

## Increase Flexibility and Productivity

When you buy your switches from Keysight, you notice a difference. Your test platforms run smoother, longer, and faster, while yielding more viable and valuable measurements. For system that require extra functionality or increased performance, the N181x family of switches has a solution that fits your need. They come with a multiple selection of option which includes option to increased isolation, reduced SWR, standard drive, TTL drive, 5/15/24V drive and position indicator. Both increased isolation and reduced SWR are not available for 40/50/67 GHz

## Technology

Keysight switches are designed with a rectangular coaxial structure like edge-line. This transmission line structure provides for movement of the edge-line center conductor between two fixed, continuous ground planes. The main advantage of this innovation is that the moving contacts can be easily activated yet maintain high-isolation and low insertion loss.

The RF contact configuration is designed for controlled wiping action. Since the outer conductor is not part of the switching function, repeatability and life are improved. The switching action occurs typically within 15 milliseconds, after which permanent magnets latch the contacts to retain the new switch position.

# Operation and Driving

All switches are “break before make,” the switched ports are not connected to each other. This prevents damage to sensitive circuits and enhances test simplicity.

There are two positions for the N181x family of switches. Standard switching is accomplished by applying the supply voltage to pin 5 (+V) and grounding either pin 4 (A) or pin 3 (B) to actuate the mechanism to the desired state. See page 12, pin-out diagram.

Warning minimum switch spacing is 6.0 mm (0.25 inch).

The N181x comes with current interrupt, the drive current is automatically disconnected after the switch is fully latched (15 ms).

Option 401 drives the switch with TTL/5V CMOS compatible logic, which controls the DC power supply to drive the switch.

Option 402 provides electronic indication of switch state. The circuitry consists of two independent commons, which can be connected to outputs corresponding to either position A or B. Because the commons are electrically isolated from each other as well as the drive circuit, this option allows two position signals to be obtained.

# Specifications

Specifications describe the instrument's warranted performance. Supplemental and typical characteristics are intended to provide information useful in applying the instrument by giving typical, but not warranted performance parameters.

Specifications	N1810UL, N1810TL, N1811TL and N1812UL			
Frequency options	DC to 4/20/26.5 GHz	DC to 40 GHz	DC to 50 GHz	DC to 67 GHz
Insertion loss (dB)	DC: 0.35 4 GHz: 0.42 12.4 GHz: 0.56 20 GHz: 0.69 26.5 GHz: 0.80	DC: 0.35 4 GHz: 0.41 12.4 GHz: 0.56 20 GHz: 0.68 26.5 GHz: 0.80 40 GHz: 1.02	DC: 0.20 4 GHz: 0.26 12.4 GHz: 0.40 20 GHz: 0.52 26.5 GHz: 0.62 40 GHz: 0.84 50 GHz: 1.00	DC: 0.35 4 GHz: 0.41 12.4 GHz: 0.56 20 GHz: 0.68 26.5 GHz: 0.80 40 GHz: 0.91 50 GHz: 0.99 67 GHz: 1.12
Isolation (dB)	DC :90 4 GHz: 85 12.4 GHz: 76 20 GHz: 67 26.5 GHz: 60	DC: 100 4 GHz: 95 12.4 GHz: 85 20 GHz: 77 26.5 to 40 GHz: 70	DC: 100 4 GHz: 95 12.4 GHz: 85 20 GHz: 77 26.5 to 50 GHz: 70	DC: 100 4 GHz: 95 12.4 GHz: 85 20 GHz: 77 26.5 to 67 GHz: 70
SWR	DC to 4 GHz: 1.15 4 to 12.4 GHz: 1.25 12.4 to 20 GHz: 1.30 20 to 26.5 GHz: 1.60	DC to 4 GHz: 1.15 4 to 12.4 GHz: 1.25 12.4 to 20 GHz: 1.40 20 to 26.5 GHz: 1.60 26.5 to 40 GHz: 1.80	DC to 4 GHz: 1.15 4 to 12.4 GHz: 1.25 12.4 to 20 GHz: 1.50 20 to 26.5 GHz: 1.60 26.5 to 50 GHz: 1.80	DC to 4 GHz: 1.15 4 to 12.4 GHz: 1.25 12.4 to 20 GHz: 1.30 20 to 26.5 GHz: 1.70 26.5 to 67 GHz: 1.90
Isolation (dB) for Option 301	DC: 125 4 GHz: 120 12.4 GHz: 109 20 GHz: 99 26.5 GHz: 90	N/A	N/A	N/A
Insertion loss (dB) for Option 302	DC: 0.2 4 GHz: 0.27 12.4 GHz: 0.41 20 GHz: 0.53 26.5 GHz: 0.65	N/A	N/A	N/A
SWR for Option 302	DC to 4 GHz: 1.10 4 to 12.4 GHz: 1.20 12.4 to 20 GHz: 1.23 20 to 26.5 GHz: 1.45	N/A	N/A	N/A

**Note:** Option 301 and 302 are only available to frequency option 4/20/26.5 GHz only.  
Option 301: storage and cycling temperature: – 55 °C to +65 °C. Operating temperature: – 25 °C to +65 °C

# Specifications Equations

## Frequency Option 004/020/026:

**Isolation (dB)** =  $90 - (30/26.5)F$ , where F is specified in GHz

**Insertion loss (dB)** =  $0.35 + (0.45/26.5)F$ , where F is specified in GHz

## Frequency Options 040/050/067

**Isolation (dB):**  $100 - (30/26.5)F$ , where F is specified in GHz (formula doesn't apply when  $F > 26.5$  GHz)

**Insertion loss (dB)**

**Option 040:**  $0.35 + (0.45/26.5)F$ , where F is specified in GHz

**Option 050:**  $0.20 + (0.80/50)F$ , where F is specified in GHz

**Option 067:**

$0.35 + (0.45/26.5)F$ , where F is specified in GHz (DC to 26.5 GHz)

$0.59 + (0.53/67)F$ , where F is specified in GHz (26.5 to 67 GHz)

## Option 301 and 302

**Isolation (dB):**  $125 - (35/26.5)F$ , where F is specified in GHz (formula doesn't apply when  $F > 26.5$  GHz)

**Insertion loss (dB):**  $0.20 + (0.45/26.5)F$ , where F is specified in GHz

# Supplemental Specifications and Characteristics

Supplemental characteristics are intended to provide useful information. They are typical but non-warranted performance parameters.

Specifications	N181x Switches
Maximum power rating into internal termination	1 W CW, 7 VDC, 50 W pk, 10 $\mu$ s max pulse duration, not to exceed 1 W average
Into thru path	2 W CW, 10 VDC, 100 W pk, 10 $\mu$ s max pulse duration, not to exceed 2 W average
Hot switching	2 W CW, 10 VDC, 100 W pk, 10 $\mu$ s max pulse duration, not to exceed 2 W average
Coil voltage	5, 15, 24 VDC
Connector	Option 004/020/026: SMA (f) Option 040: 2.92 mm (f) Option 050: 2.4 mm (f) Option 067: 1.85 mm (f)
Switching speed	15 ms
Repeatability	Option 004/020/026: 0.03 dB to 1 million cycles 0.1 dB to 2 million cycles Option 040: 0.03 dB to 1 million cycles 0.20 dB to 2 million cycles Option 050: 0.05 to 2 million cycles Option 067: 0.08 dB to 0.5 million cycles 0.35 dB to 1 million cycles
Life cycles	Option 004/020/026: 2 million Option 040: 2 million Option 050: 2 million Option 067: 1 million
Impedance	50 $\Omega$
Maximum power rating into internal termination	1 W CW, 7 VDC, 50 W pk, 10 $\mu$ s max pulse duration, not to exceed 1 W average
Into thru path	2 W CW, 10 VDC, 100 W pk, 10 $\mu$ s max pulse duration, not to exceed 2 W average
Hot switching	2 W CW, 10 VDC, 100 W pk, 10 $\mu$ s max pulse duration, not to exceed 2 W average
Coil voltage	5, 15, 24 VDC
Connector	Option 004/020/026: SMA (f) Option 040: 2.92 mm (f) Option 050: 2.4 mm (f) Option 067: 1.85 mm (f)

**Option 105:** Switching speed of 25 ms with operating temperature of -25 to -5 degree celcius

**Option 115 and 124:** Switching speed of 25 ms with operating temperature of -25 to -15 degree celcius

# Typical Performance

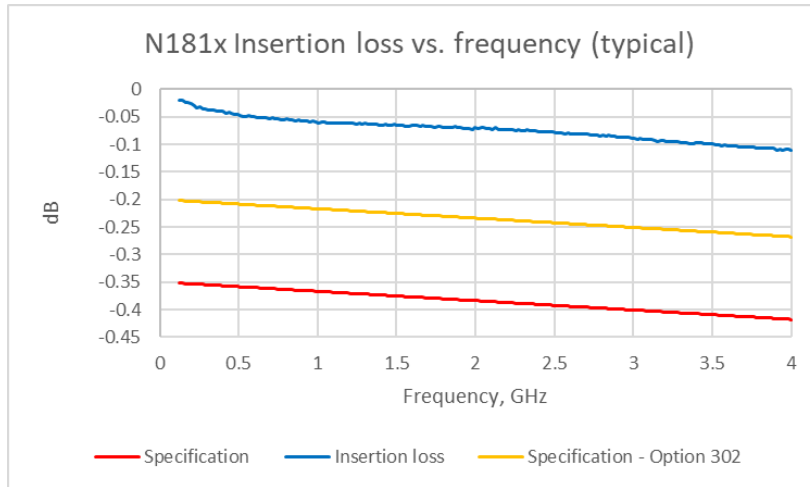


Figure 1. N181x (Option 004) insertion loss vs frequency (GHz) typical

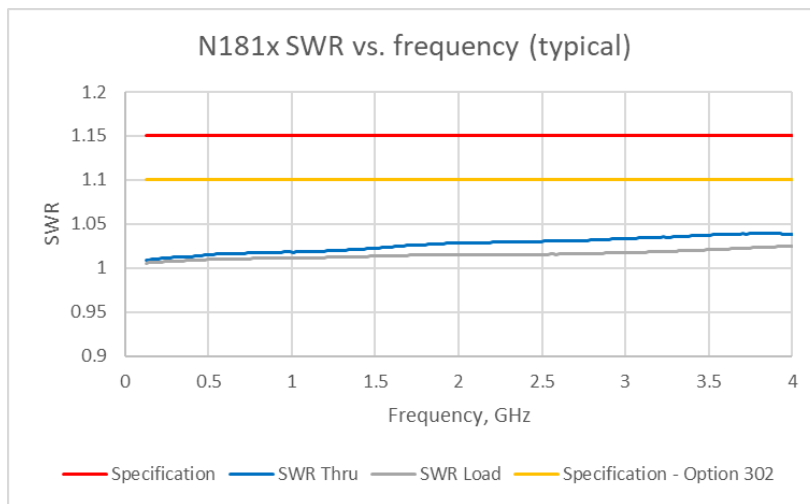


Figure 2. N181x (Option 004) return loss (SWR) vs frequency (GHz) typical

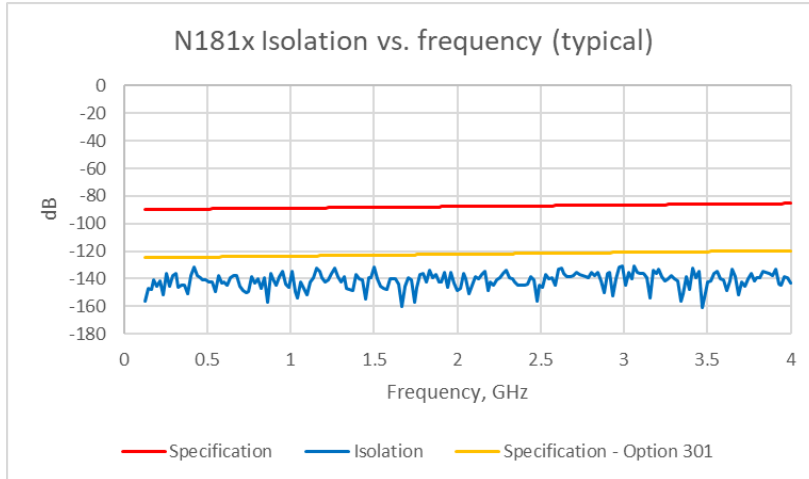


Figure 3. N181x (Option 004) isolation vs frequency (GHz) typical

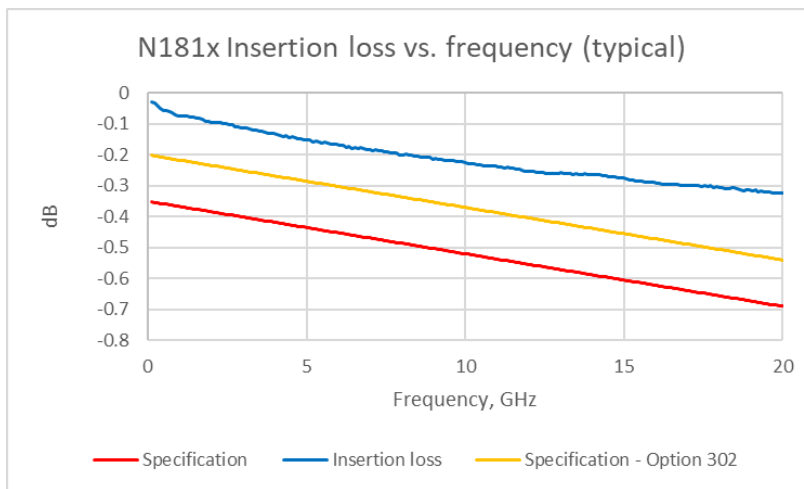


Figure 4. N181x (Option 020) insertion loss vs frequency (GHz) typical

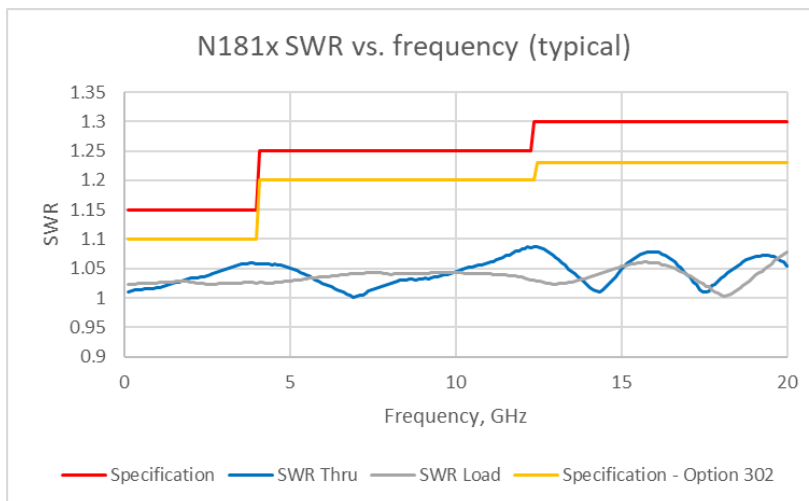


Figure 5. N181x (Option 020) return loss (SWR) vs frequency (GHz) typical



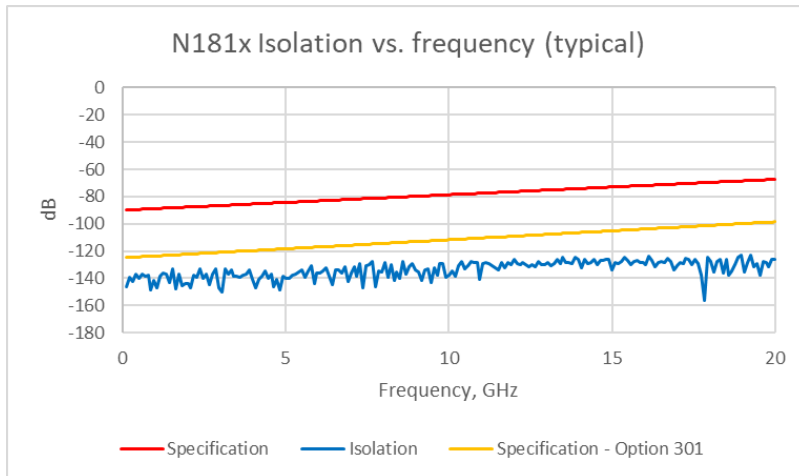


Figure 6. N181x (Option 020) isolation vs frequency (GHz) typical

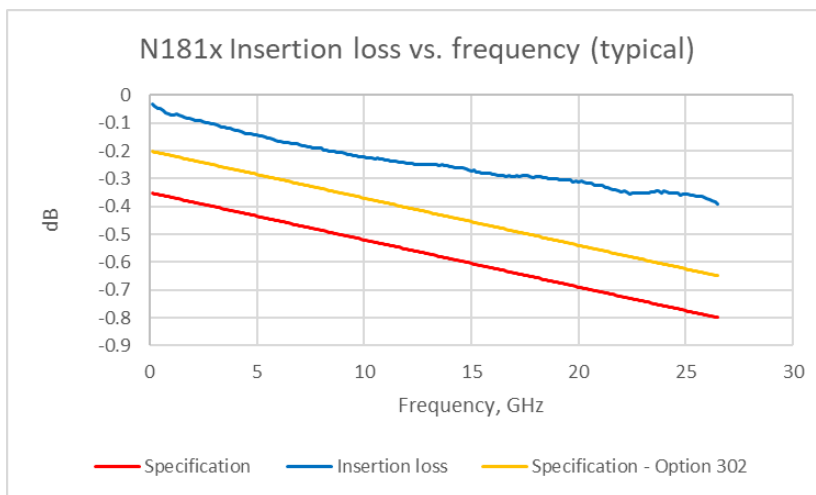


Figure 7. N181x (Option 026) insertion loss vs frequency (GHz) typical

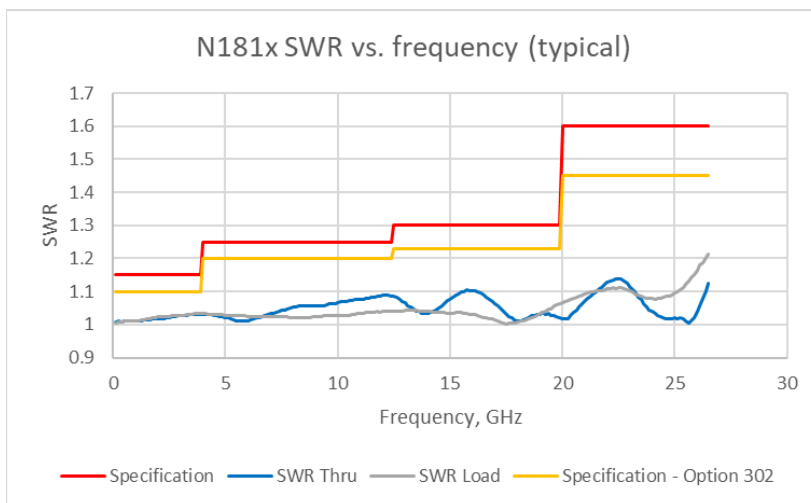


Figure 8. N181x (Option 026) return loss (SWR) vs frequency (GHz) typical

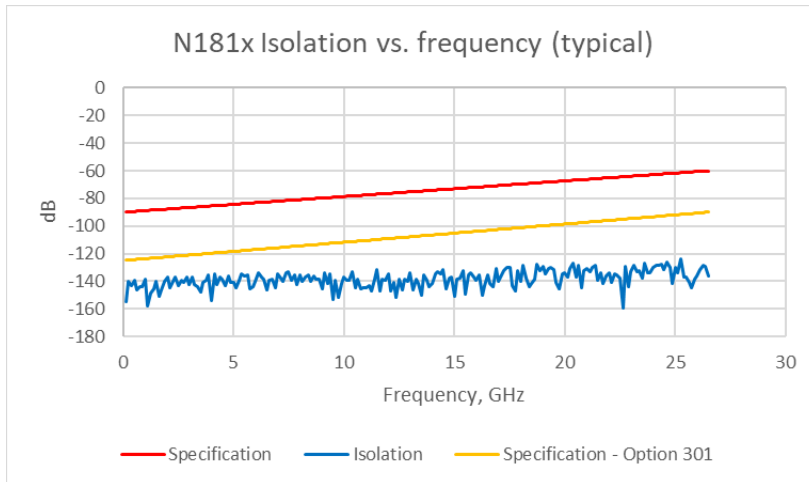


Figure 9. N181x (Option 026) isolation vs frequency (GHz) typical

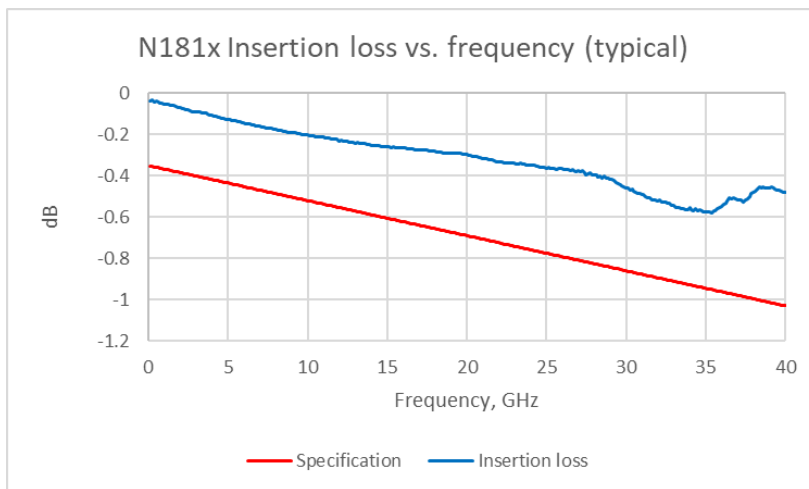


Figure 10. N181x (Option 040) insertion loss vs frequency (GHz) typical

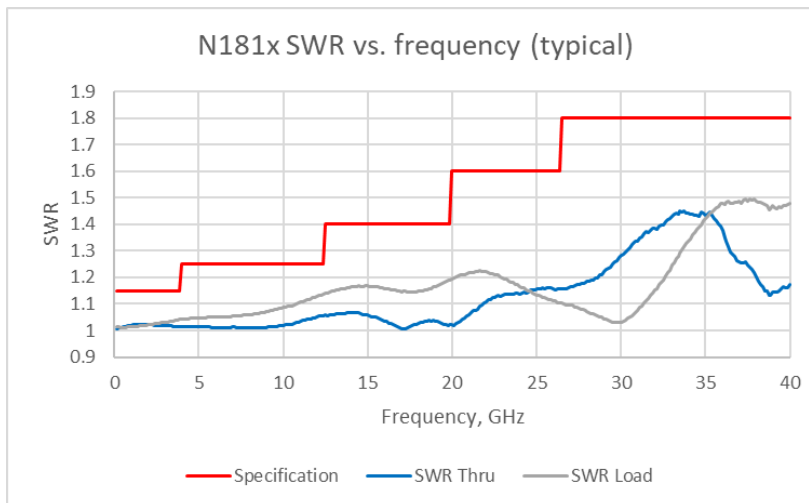


Figure 11. N181x (Option 040) return loss (SWR) vs frequency (GHz) typical

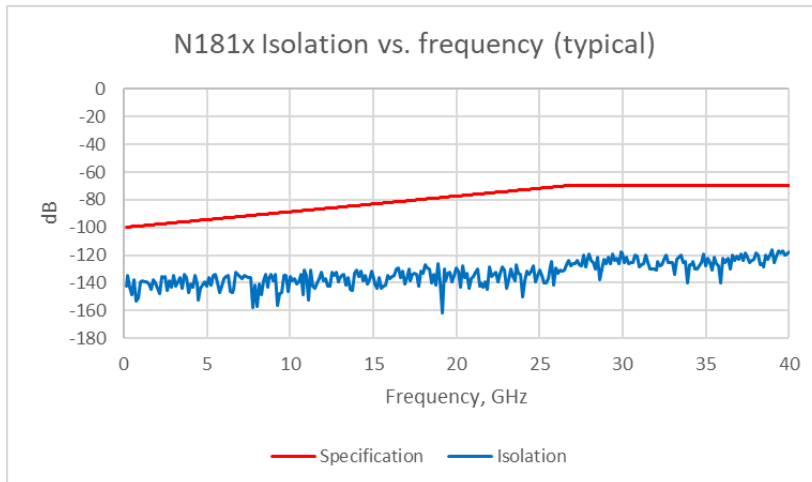


Figure 12. N181x (Option 040) isolation vs frequency (GHz) typical

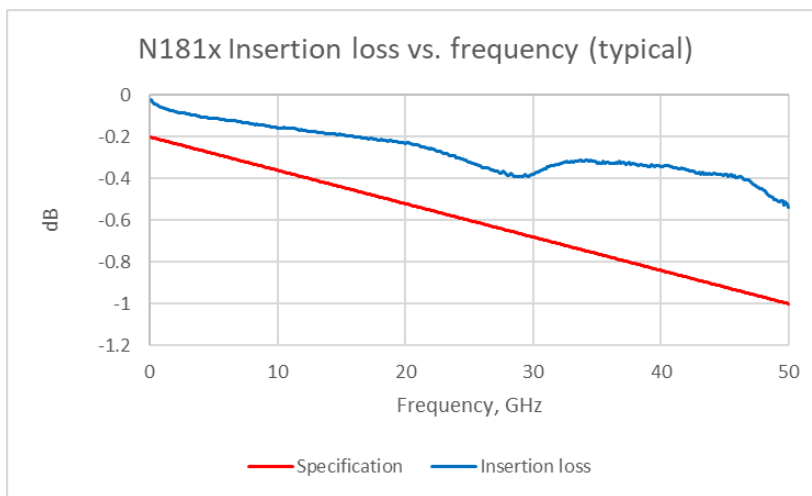


Figure 13. N181x (Option 050) insertion loss vs frequency (GHz) typical

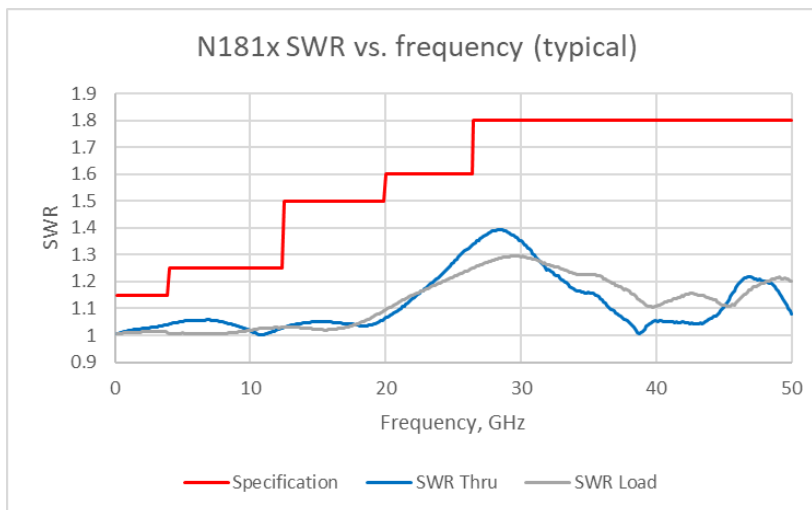


Figure 14. N181x (Option 050) return loss (SWR) vs frequency (GHz) typical

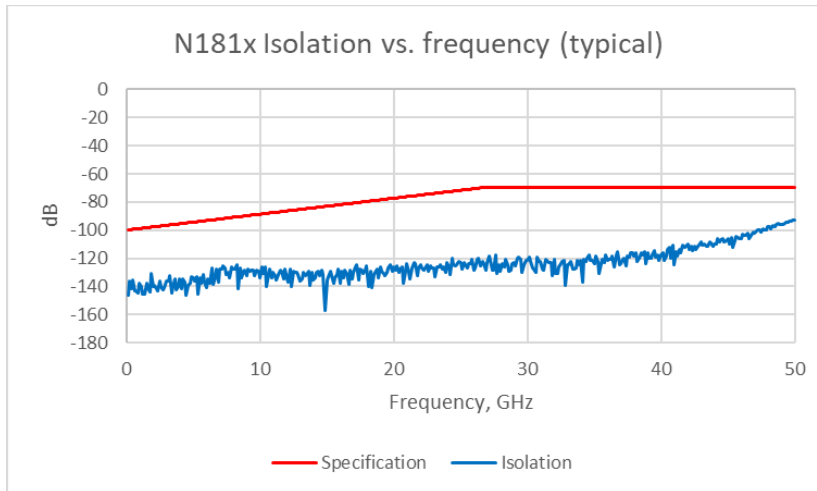


Figure 15. N181x (Option 050) isolation vs frequency (GHz) typical

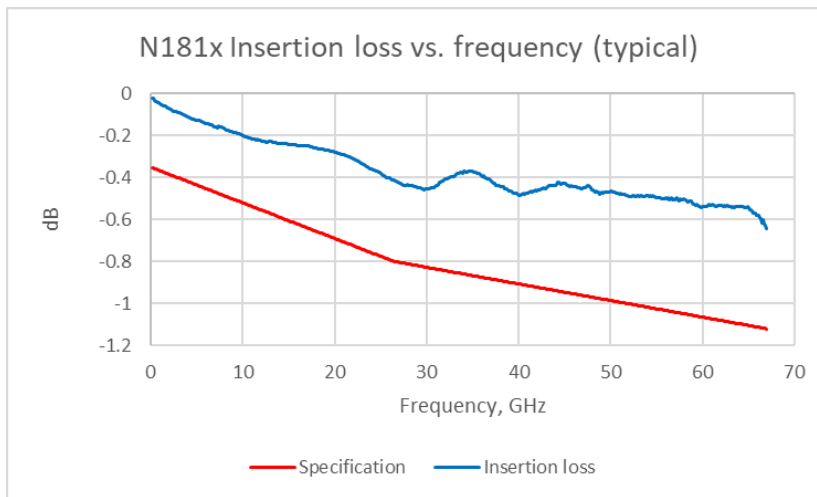


Figure 16. N181x (Option 067) insertion loss vs frequency (GHz) typical

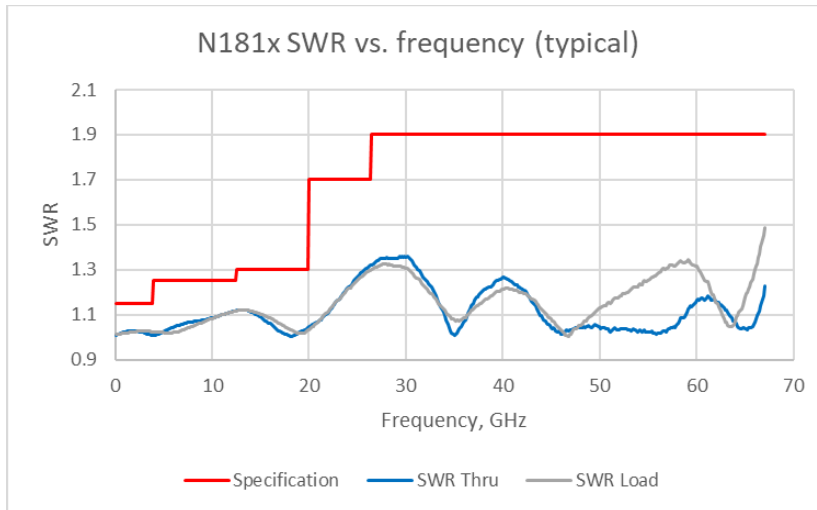


Figure 17. N181x (Option 067) return loss (SWR) vs frequency (GHz) typical

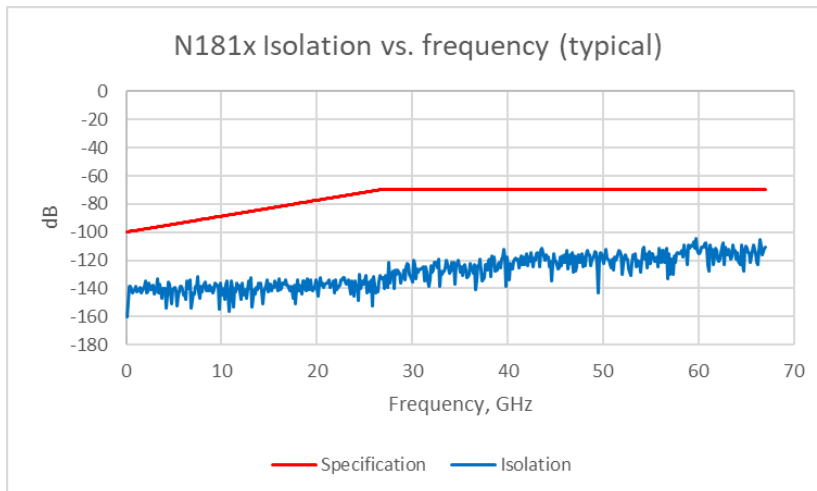
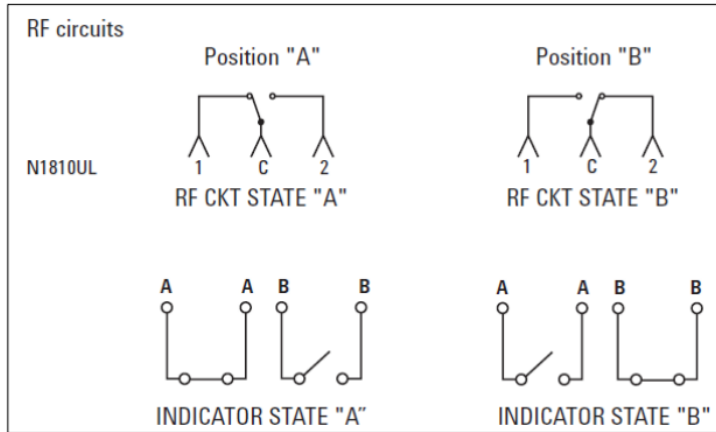


Figure 18. N181x (Option 067) isolation vs frequency (GHz) typical

# Driving the switch

## N1810UL



### Switch drive specifications for N1810UL

Option	Parameter	Conditions	Min	Nominal	Max	Units
105	Supply voltage		4.5	5	7.0	V
	Supply current	Supply voltage = 5 V		300		mA
115	Supply voltage		12.0	15	20.0	V
	Supply current	Supply voltage = 15 V		125		mA
124	Supply voltage		20.0	24	32.0	V
	Supply current	Supply voltage = 24 V		75		mA

### TTL drive specification for N1810UL

Option	Parameter	Conditions	Min	Nominal	Max	Units
401	High level input		3.0		12.0	V
	Low level input		0.0		1.0	V
	Max input current	Input voltage = 12.0 V			1.0	mA
		Input voltage = 3.85 V		0.25	0.5	mA

### Driving the switch\*

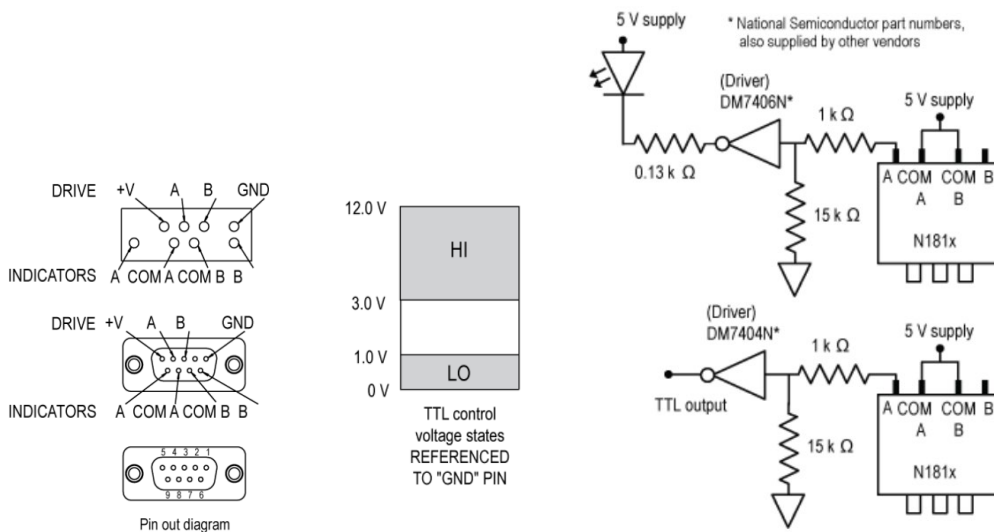
STD drive connect GND to ground		TTL drive connect GND to ground		RF state	Indicator state
A	B	A	B		
GND	OPEN	Hi	Lo	"A"	"A"
OPEN	GND	Lo	Hi	"B"	"B"
GND	GND	Hi	Hi	Indeterminate	NA
OPEN	OPEN	Lo	Lo	Switch remains at previous state	NA

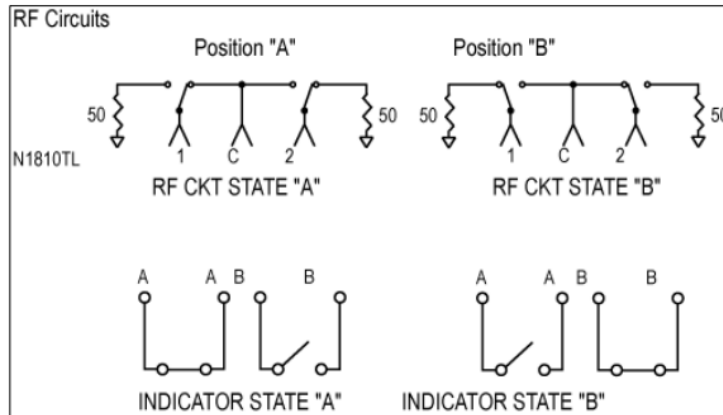
GND	+V -Vsupply (see switch drive specification table, this page)
OPEN*	Maximum leakage current of 50 uA at nominal drive voltage
Hi	3.0 V to 12.0 V
Lo	0.0 V to 1.0 V Warning drive level below – 0.25 V will damage TTL drive circuit!

\* WARNING! Use adapter cable 11764-60011 with 87310A switch driver.  
 WARNING! Minimum switch spacing 6.0 mm (0.25 inch)

### Recommended indicator circuit



## N1810TL



### Switch drive specifications for N1810TL

Option	Parameter	Conditions	Min	Nominal	Max	Units
105	Supply voltage		4.5	5	7.0	V
	Supply current	Supply voltage = 5 V		550		mA
115	Supply voltage		12.0	15	20.0	V
	Supply current	Supply voltage = 15 V		300		mA
124	Supply voltage		20.0	24	32.0	V
	Supply current	Supply voltage = 24 V		200		mA

### TTL drive specification for N1810TL

Option	Parameter	Conditions	Min	Nominal	Max	Units
401	High level input		3.0		12.0	V
	Low level input		0.0		1.0	V
	Max input current	Input voltage = 12.0 V			1.0	mA
		Input voltage = 3.85 V		0.25	0.5	mA

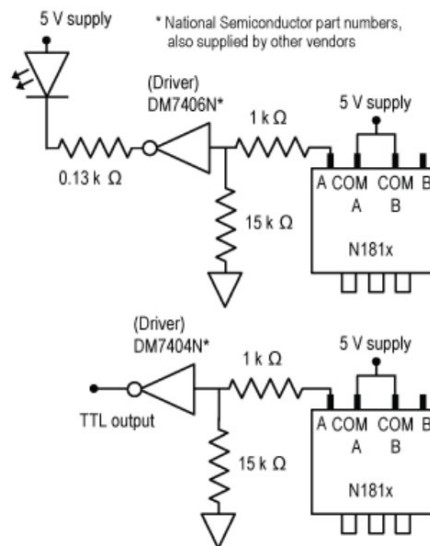
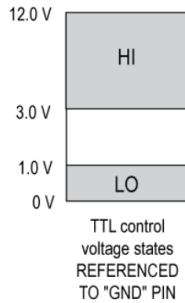
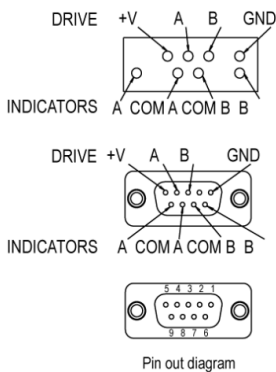


### Driving the switch\*

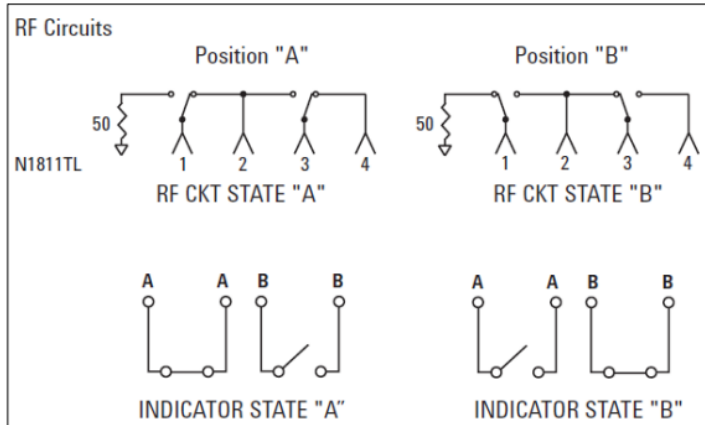
STD drive connect GND to ground		TTL drive connect GND to ground		RF state	Indicator state
A	B	A	B		
GND	OPEN	Hi	Lo	"A"	"A"
OPEN	GND	Lo	Hi	"B"	"B"
GND	GND	Hi	Hi	Indeterminate	NA
OPEN	OPEN	Lo	Lo	Switch remains at previous state	NA

GND +V -Vsupply (see switch drive specification table, this page)  
 OPEN\* Maximum leakage current of 50 uA at nominal drive voltage  
 Hi 3.0 V to 12.0 V  
 Lo 0.0 V to 1.0 V Warning drive level below – 0.25 V will damage TTL drive circuit!  
 \* WARNING! Use adapter cable 11764-60011 with 87310A switch driver.  
 WARNING! Minimum switch spacing 6.0 mm (0.25 inch)

### Recommended indicator circuit



# N1811TL



## Switch drive specifications for N1811TL

Option	Parameter	Conditions	Min	Nominal	Max	Units
105	Supply voltage		4.5	5	7.0	V
	Supply current	Supply voltage = 5 V		550		mA
115	Supply voltage		12.0	15	20.0	V
	Supply current	Supply voltage = 15 V		300		mA
124	Supply voltage		20.0	24	32.0	V
	Supply current	Supply voltage = 24 V		200		mA

## TTL drive specification for N1811TL

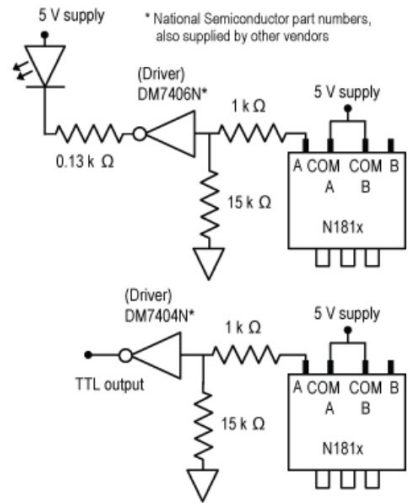
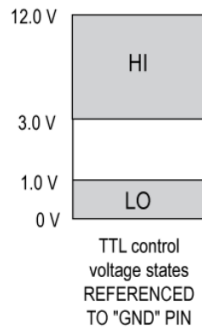
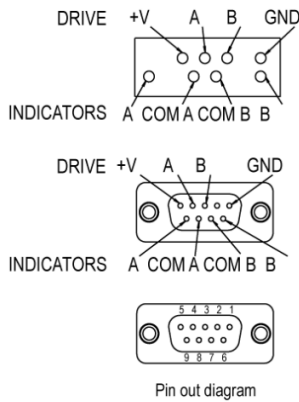
Option	Parameter	Conditions	Min	Nominal	Max	Units
401	High level input		3.0		12.0	V
	Low level input		0.0		1.0	V
	Max input current	Input voltage = 12.0 V			1.0	mA
		Input voltage = 3.85 V		0.25	0.5	mA

### Driving the switch\*

STD drive connect GND to ground		TTL drive connect GND to ground		RF state	Indicator state
A	B	A	B		
GND	OPEN	Hi	Lo	"A"	"A"
OPEN	GND	Lo	Hi	"B"	"B"
GND	GND	Hi	Hi	Indeterminate	NA
OPEN	OPEN	Lo	Lo	Switch remains at previous state	NA

GND +V -Vsupply (see switch drive specification table, this page)  
 OPEN\* Maximum leakage current of 50 uA at nominal drive voltage  
 Hi 3.0 V to 12.0 V  
 Lo 0.0 V to 1.0 V Warning drive level below – 0.25 V will damage TTL drive circuit!  
 \* WARNING! Use adapter cable 11764-60011 with 87310A switch driver.  
 WARNING! Minimum switch spacing 6.0 mm (0.25 inch)

### Recommended indicator circuit



## N1812UL

### Switch drive specifications for N1812UL

Option	Parameter	Conditions	Min	Nominal	Max	Units
105	Supply voltage		4.5	5	7.0	V
	Supply current	Supply voltage = 5 V		550		mA
115	Supply voltage		12.0	15	20.0	V
	Supply current	Supply voltage = 15 V		300		mA
124	Supply voltage		20.0	24	32.0	V
	Supply current	Supply voltage = 24 V		200		mA

### TTL drive specification for N1811TL

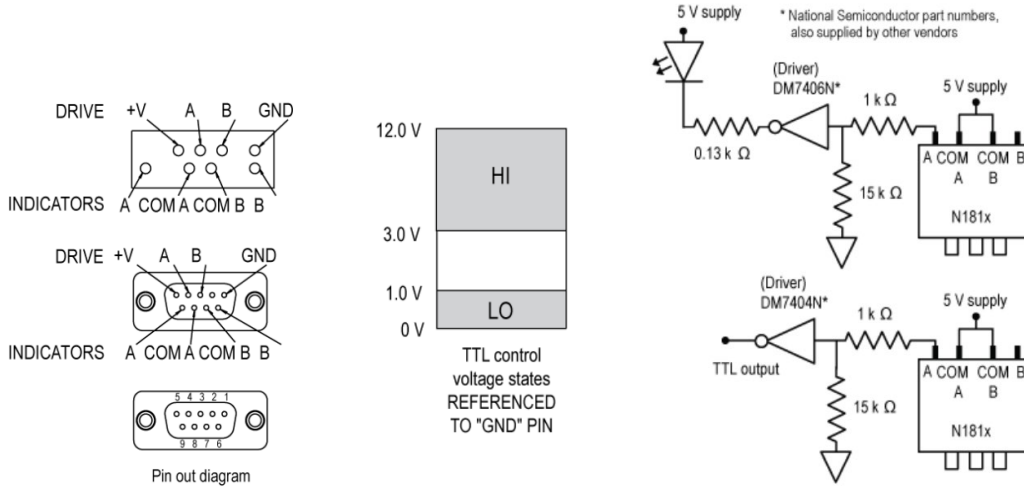
Option	Parameter	Conditions	Min	Nominal	Max	Units
401	High level input		3.0		12.0	V
	Low level input		0.0		1.0	V
	Max input current	Input voltage = 12.0 V			1.0	mA
		Input voltage = 3.85 V		0.25	0.5	mA

### Driving the switch\*

STD drive connect GND to ground		TTL drive connect GND to ground		RF state	Indicator state
A	B	A	B		
GND	OPEN	Hi	Lo	"A"	"A"
OPEN	GND	Lo	Hi	"B"	"B"
GND	GND	Hi	Hi	Indeterminate	NA
OPEN	OPEN	Lo	Lo	Switch remains at previous state	NA

GND +V -Vsupply (see switch drive specification table, this page)  
 OPEN\* Maximum leakage current of 50 uA at nominal drive voltage  
 Hi 3.0 V to 12.0 V  
 Lo 0.0 V to 1.0 V Warning drive level below – 0.25 V will damage TTL drive circuit!  
 \* WARNING! Use adapter cable 11764-60011 with 87310A switch driver.  
 WARNING! Minimum switch spacing 6.0 mm (0.25 inch)

## Recommended indicator circuit



## Environmental Specifications

The switch is designed to fully comply with Keysight Technologies' product operating environment specifications. The following summarizes the environmental specifications for these products (Class B1).

### Environmental condition

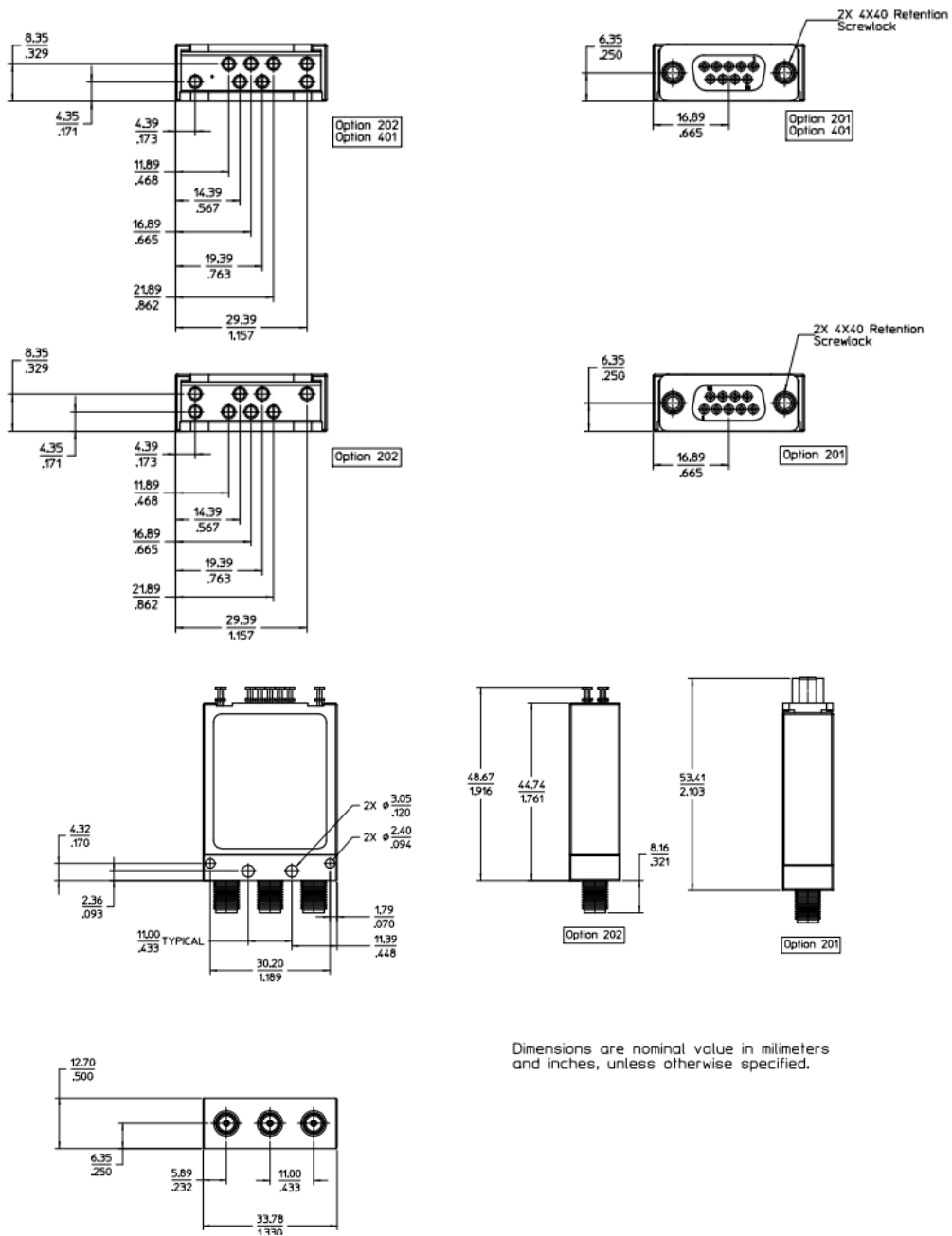
<b>Temperature</b>	
Operating	– 25 °C to +75 °C
Storage	– 55 °C to +85 °C
Cycling	– 55 °C to +85 °C, 10 cycles per MIL-STD 202F, 170D, Condition A (Modified)
<b>Humidity</b>	
Operating	15 to 95% relative humidity
Storage	65 °C, 95% RH, 10 days, MIL-STD 202F, Method 106E
<b>Vibration</b>	
Operating	7 g, 5-2000 Hz at 0.25 in. p-p
Survival	20 g, 20-2000 Hz at 0.06 in. p-p, 4 min/cycle, 4 cycles/axis
Random	2.41 g (rms.) 10 min/axis
Shock	Half sine: 500 g at 0.5 ms, 3 drops/direction, 18 total
Operating	50 g at 6 ms, 6 direction
<b>Altitude</b>	
Operating	4,600 meters (15,000 feet)
Storage	15,300 meters (50,000 feet), MIL-STD 202F, Method 105C, Condition B

# Troubleshoot guide

## Allowable range

Probable cause	Test	Low value	High value	Remedy
Not connected to supply		See drive specifications		Connect +V to power supply
Supply not turned on				Turn on power supply
Supply voltage less than minimum	Measure voltage from control pin to +V	See drive specifications		
Supply current low	Measure current draw with drive pin selected	See drive specifications		Increase drive voltage or reduce drive line resistance
OPEN state leakage current to HIGH	Measure leakage current in OPEN state		50 uA	Select suitable driver that has low leakage current in OPEN state
Select lines not at ground (STD drive)	Measure voltage from drive select pin to ground			Eliminate ground loops and lead high resistance
TTL "LOW" voltage too high	Measure voltage from ground pin to TTL drive pin	See drive specifications		Connect ground pin to ground
TTL "LOW" voltage < 0.0 volts	Measure voltage from ground pin to TTL drive pin	See drive specifications		Eliminate ground loops
TTL GND pin not grounded				Connect GND pin to ground
Driving switch with 87130A				Using adapter cable 11764-60011

# Mechanical Dimensions



Dimensions are nominal value in millimeters and inches, unless otherwise specified.

Figure 15. N1810UL dimension, SPDT, unterminated

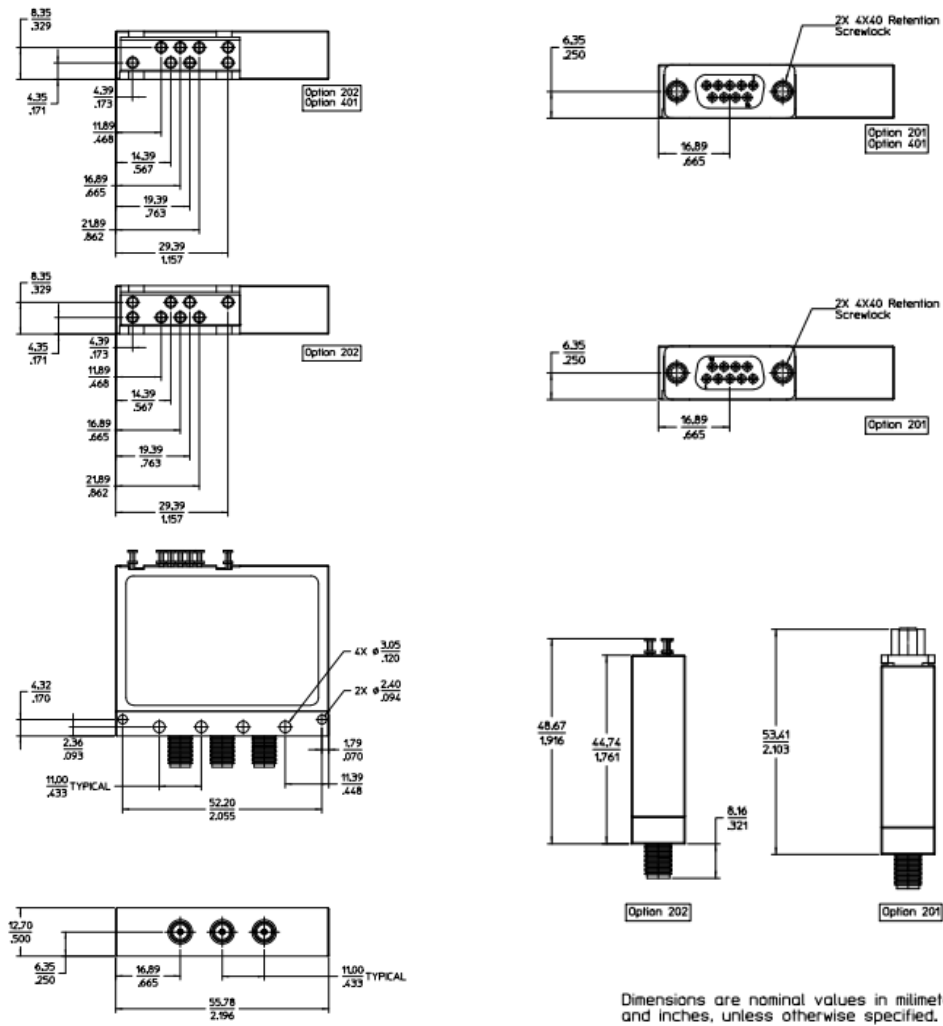
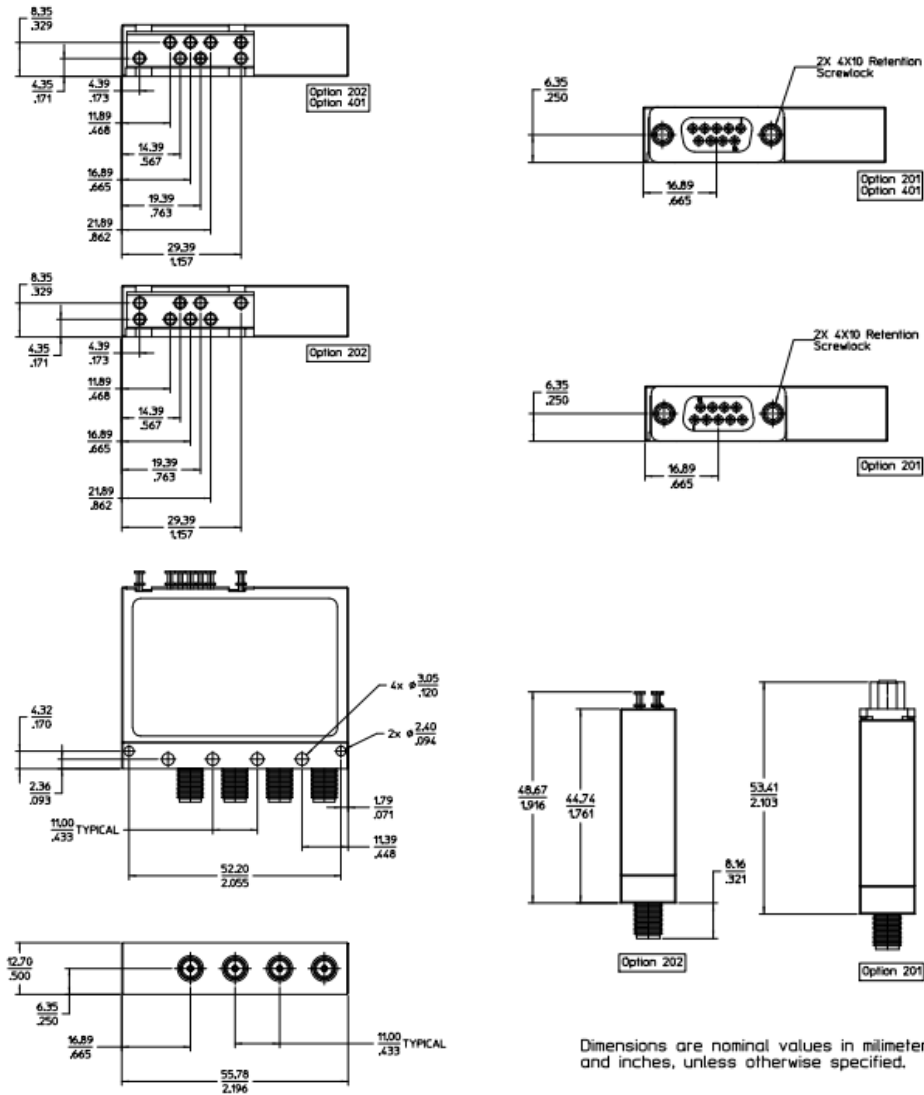


Figure 16. N1810TL dimension, SPDT, terminated.





Dimensions are nominal values in millimeters and inches, unless otherwise specified.

Figure 17. N1811TL dimension, 4-port bypass, terminated

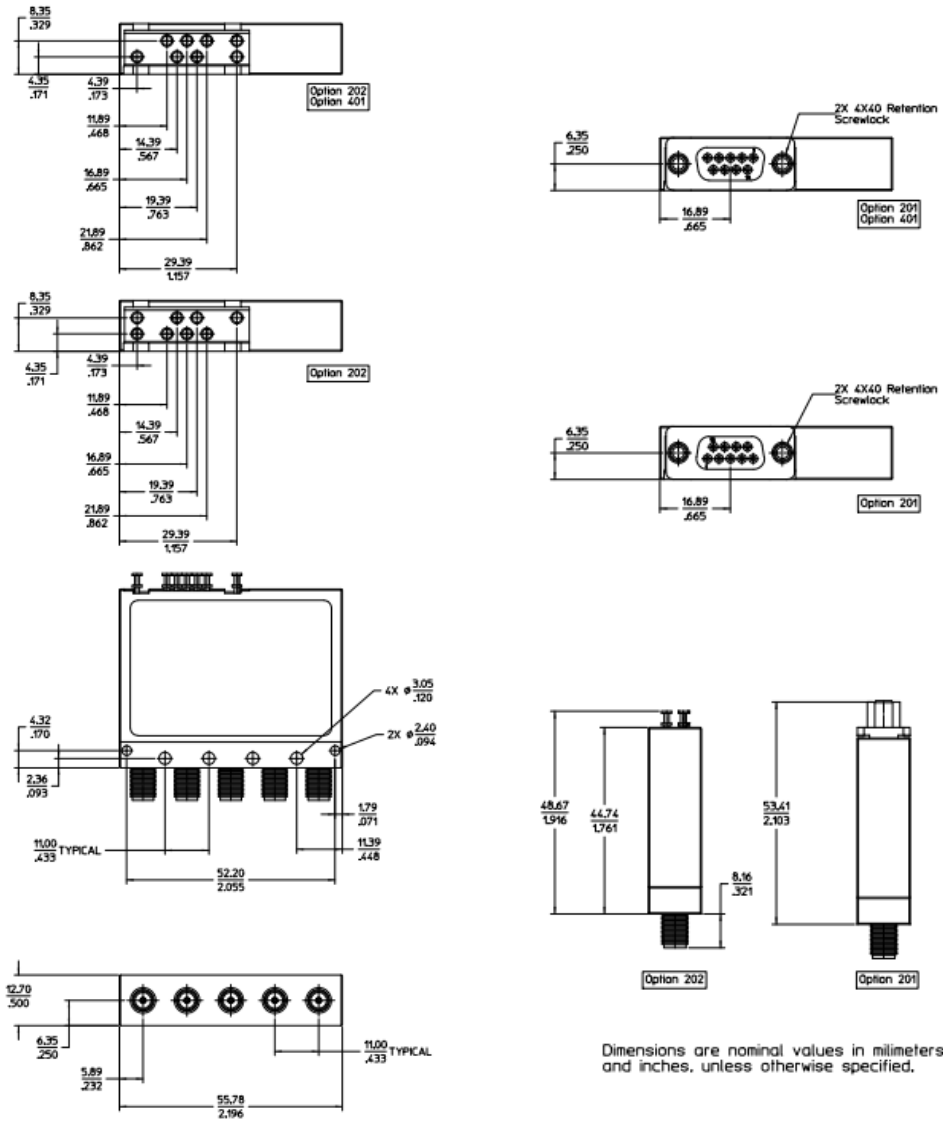


Figure 18. N1812UL dimension, 5-port bypass, unterminated

# Ordering Information

**Required:** Specify one model number, one frequency range, one coil voltage, and one DC connector type (mandatory to select one of each)

**Optional:** Specify RF performance enhancement and drive options (may select any, all or none).

Step	Option
Select model to fit your application (Required)	N1810UL, SPDT unterminated latching N1810TL, SPDT terminated latching N1811TL, 4-port bypass, terminated latching N1812UL, 5-port bypass, unterminated latching
Select a frequency range (Required)	004: DC to 4 GHz 020: DC to 20 GHz 026: DC to 26.5 GHz 040: DC to 40 GHz 050: DC to 50 GHz 067: DC to 67 GHz
Select a coil voltage level (Required)	105*: 5 V 115: 15 V 124: 24 V
Select a DC connector type (Required)	201: D subminiature 9-pin female 202: solder lugs
Select RF performance enhancement (Optional)	301: Increased isolation 302: Reduced standing wave ratio and insertion loss UK6: Calibration certificate with test data
Select drive options (Optional)	401: TTL/CMOS compatible 5 V drive 402: Position indicators

**Note:** Option 301 and 302 are only available to frequency option 4/20/26.5 GHz only.

\*Position indicator provided as default for option 105

## Related Literatures

Keysight Technologies Bench and System Switching Products  
Literature Number 5989-9872EN

Keysight RF and Microwave Switch Selection Guide  
Literature Number 5989-6031EN

Keysight 11713D/E Attenuator/Switch Drivers Configuration Guide  
Literature Number 3120-1217EN

Application Notes Power Handling Capability of Electromechanical Switches  
Literature Number 5989-6032EN

How Operating Life and Repeatability of Keysight's Electromechanical Switches Minimize System Uncertainty  
Literature Number 5989-6085EN

## More RF & Microwave Test Accessories

For selection of more than 300 models of various type of RF and microwave test accessories with operating frequency up to 110 GHz. Go to: [www.keysight.com/find/mta](http://www.keysight.com/find/mta)

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