Agilent N1810/1/2 Coaxial Switches

High Quality Electromechanical Switches for Microwave and RF Manufacturing Test Systems

Technical Overview

- **High repeatability - < 0.03 dB guaranteed up to 5 million cycles**
- **High isolation - > 120 dB @ 4 GHz**
- **Low SWR - < 1.10 @ 4 GHz**
- **Low-insertion loss - < 0.27 dB @ 4 GHz**
- **Long life - > 5 million cycles**

The solution for high-volume wireless communications test

- dc to 4 GHz
- dc to 20 GHz
- dc to 26.5 GHz

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

Reduce downtime

Agilent 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 Agilent 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

For test systems that require extra functionality or increased performance, the N181x family of switches has a solution that fits your need. The options include:

- Reduced SWR
- Increased isolation
- Standard or TTL drive
- 5, 15, 24 volt drive
- Position indicators

Increase productivity

When you buy your switches from Agilent, you notice a difference. Your test platforms run smoother, longer and faster, while yielding more viable and valuable measurements.

Agilent Technologies

Description

N1810UL
Unterminated latching

The Agilent N1810UL is a single-pole double-throw switch available in the frequency range from dc to 26.5 GHz. In precision measurements and monitoring applications where insertion loss repeatability is crucial, these switches operate in excess of 5 million cycles with better than .03 dB of insertion loss repeatability at 25 °C.

N1810TL
Terminated latching

The Agilent N1810TL is a single-pole double-throw switch available in the frequency range from dc to 26.5 GHz. The unused port is terminated 50 ohms, making it ideal for applications where port matching is required.

N1811TL
Terminated latching

The N1811TL is a terminated bypass switch available in the frequency range from dc to 26.5 GHz. The switch's internal load can terminate the device under test when in the bypass mode (up to 1 watt). Because of its compact design, it is ideal for drop-in, drop-out applications.

N1812UL
Unterminated latching

The N1812UL is a versatile, unterminated 5-port switch available in the frequency range from dc to 26.5 GHz. In transfer switch applications, the fifth port can be terminated externally with a high-power termination. It can also be utilized for signal path reversal or as a calibration port.

Technology

Agilent Technologies switches are designed with a rectangular coaxial structure similar to 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

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.

Driving

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 5, 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).

Note: Prior to current interrupts becoming standard on the N181x, Option 403 current interrupt was available for ordering.

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.

General

Input power (into load)	1 W, 7 V dc, 50 W pk, 10 µs max pulse duration, not to exceed 1 W avg
Input power (into thru)	2 W, 7 V dc, 50 W pk, 10 µs max pulse duration, not to exceed 2 W avg
Coil voltage	5, 15, 24 VDC
Connector	SMA (f)

Standard performance specifications - N181x series

Isolation (dB) $= 90 - \left(\dfrac{30}{26.5}\right)$ F, where F is specified in GHz

	dc	4 GHz	12.4 GHz	20 GHz	26.5 GHz
	90	85	76	67	60

Insertion loss (dB) $= 0.35 + \left(\dfrac{.45}{26.5}\right)$ F, where F is specified in GHz

	dc	4 GHz	12.4 GHz	20 GHz	26.5 GHz
	0.35	0.42	0.56	0.69	0.80
SWR		dc-4 GHz	4-12.4 GHz	12.4-20 GHz	20-26.5 GHz
		1.15	1.25	1.30	1.60

Optional high-performance specifications - N181x series

Isolation (dB) $= 125 - \left(\dfrac{35}{26.5}\right)$ F, where F is specified in GHz

	dc	4 GHz	12.4 GHz	20 GHz	26.5 GHz
Option 301[1]	125	120	109	99	90

Insertion loss (dB) $= 0.20 + \left(\dfrac{.45}{26.5}\right)$ F, where F is specified in GHz

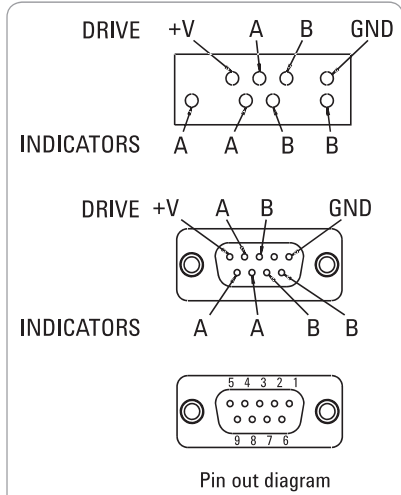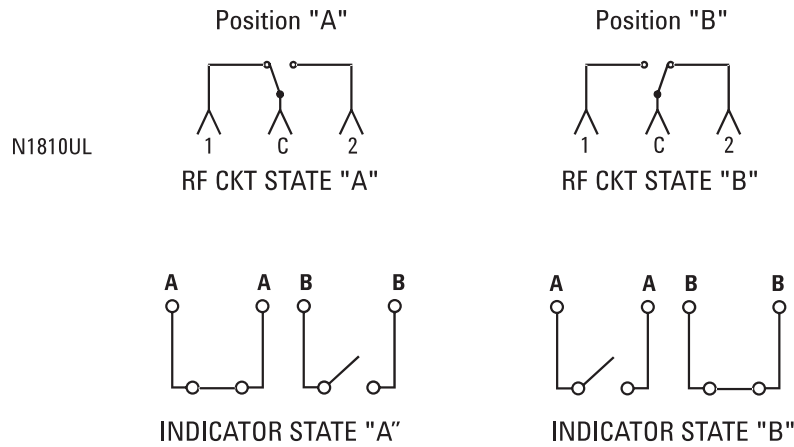|	dc	4 GHz	12.4 GHz	20 GHz	26.5 GHz
Option 302	0.2	0.27	0.41	0.53	0.65
SWR		dc-4 GHz	4-12.4 GHz	12.4-20 GHz	20-26.5 GHz
Option 302		1.10	1.20	1.23	1.45

1. Option 301:
    Environmental: Storage and cycling temperature: -55 C to +65 C
    Environmental: Operating temperature: -25 C to +65 C

N1810UL

N1810UL

RF circuits

Position "A"   Position "B"

N1810UL

1   C   2   1   C   2

RF CKT STATE "A"   RF CKT STATE "B"

A   A   B   B   A   A   B   B

INDICATOR STATE "A"   INDICATOR STATE "B"

DRIVE   +V   A   B   GND

INDICATORS   A   A   B   B

DRIVE   +V   A   B   GND

INDICATORS   A   A   B   B

5 4 3 2 1

9 8 7 6

Pin out diagram
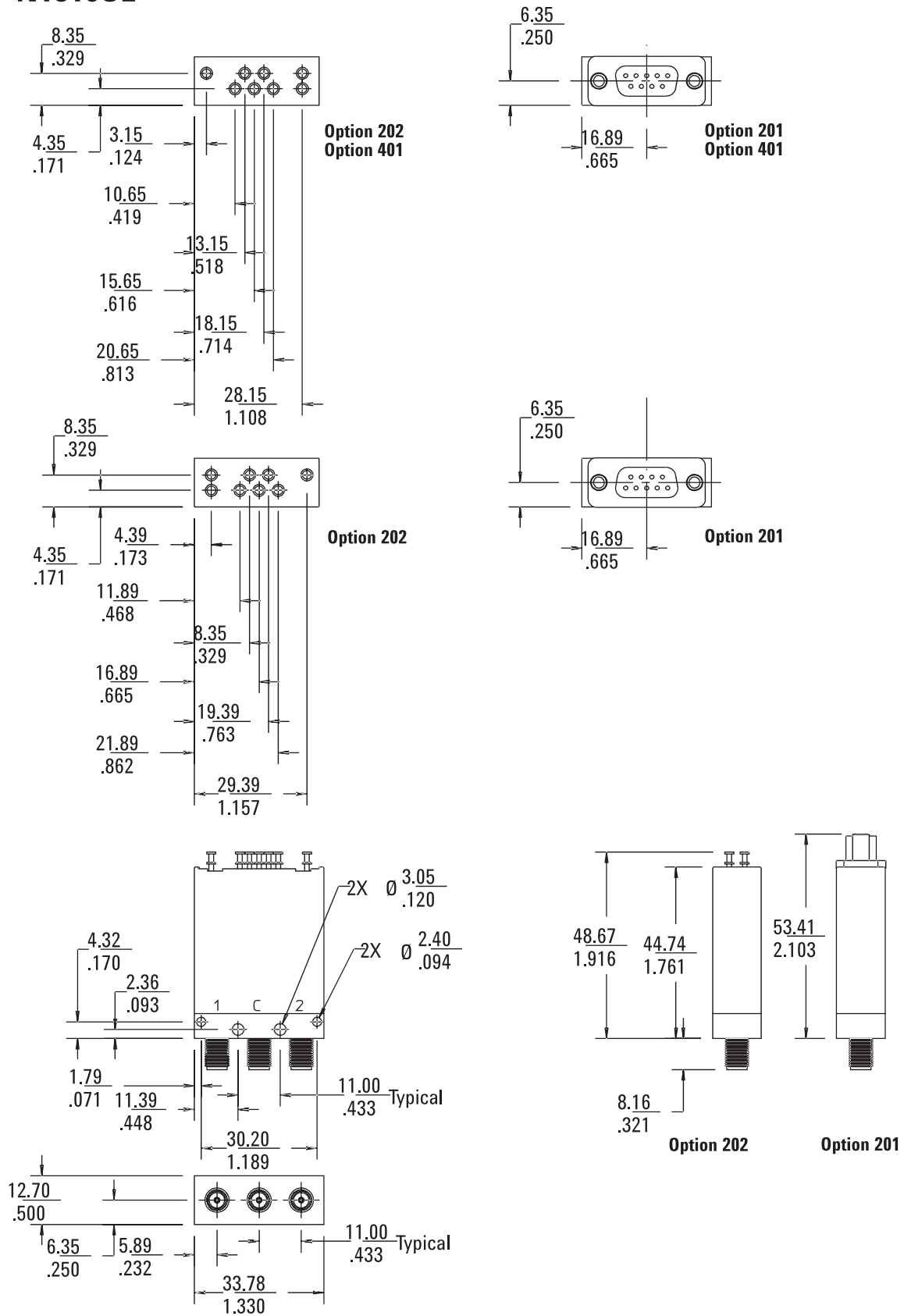
Switch drive specifications N1810UL

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[1]	Supply voltage		12.0	15	20.0	V
	Supply current	Supply voltage = 15 V		125		mA
124[2]	Supply voltage		20.0	24	32.0	V
	Supply current	Supply voltage = 24 V		75		mA.

TTL drive specifications

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

12.0 V

HI

3.0 V

1.0 V

LO

0 V
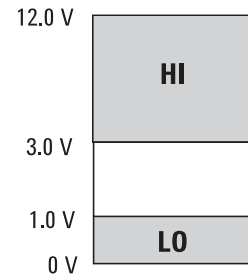
TTL control
voltage states
REFERENCED
TO "GND" PIN

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	Switching disabled **	NA
OPEN	OPEN	Lo	Lo	Switching disabled **	NA

GND: +V - Vsupply (see switch drive specification table, this page)
OPEN*   +V to +v - 1.5 volts
Hi   3.0 V to 12.0 V
Lo   0.0 V to 1.0 V Warning drive level below -.25 V will damage TTL drive circuit!
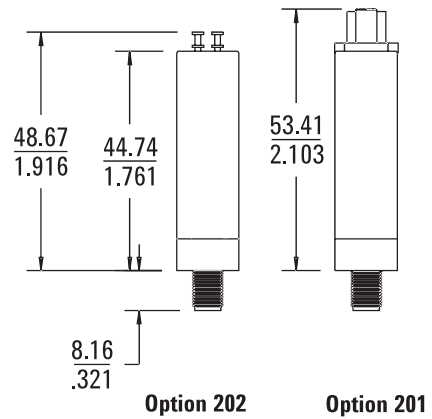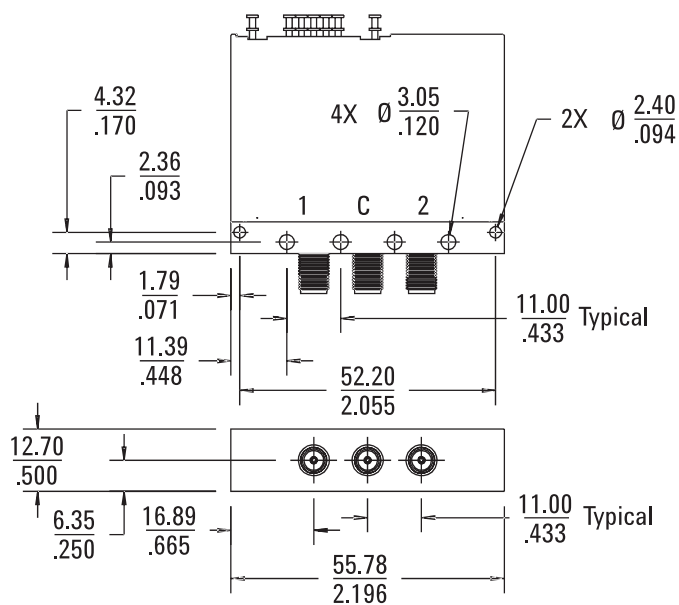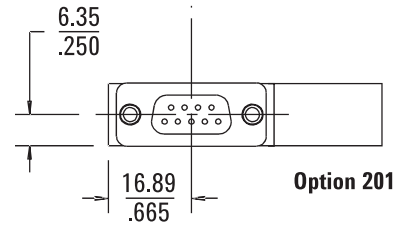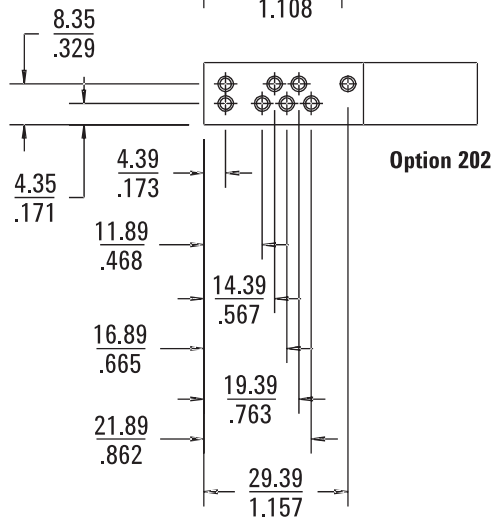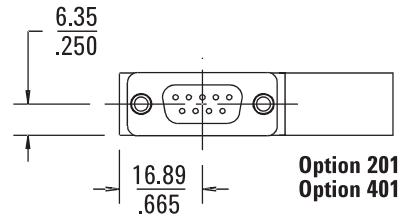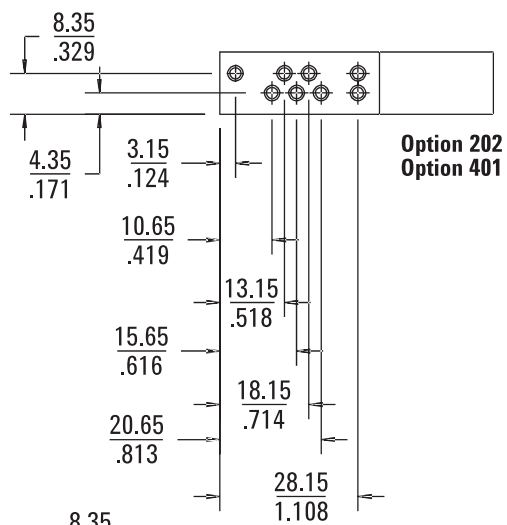   *   WARNING! Use adapter cable 11764-60011 with 87130A switch driver
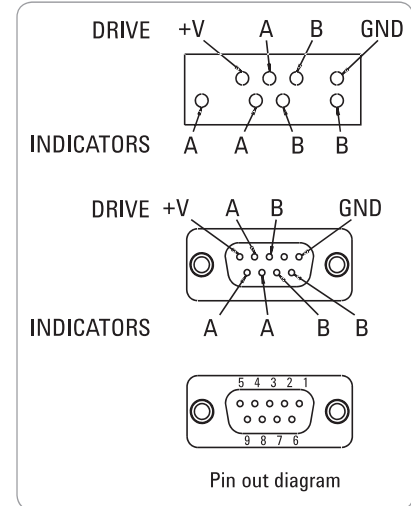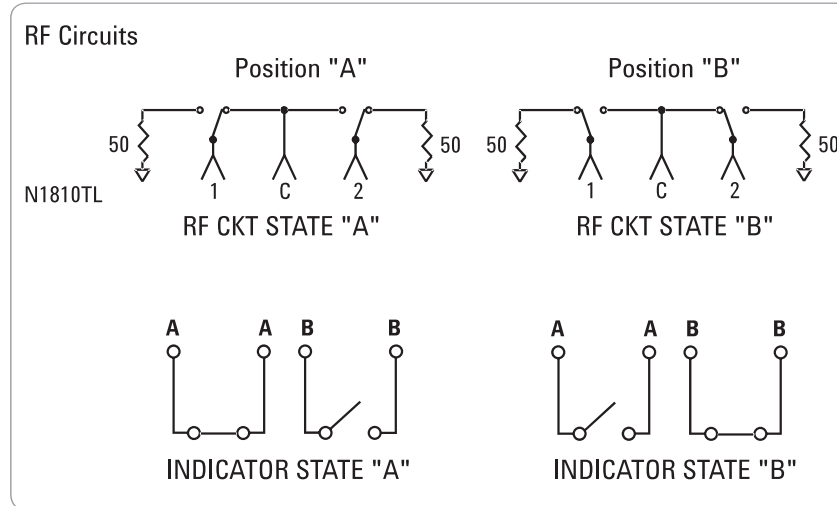   ** WARNING! Driving both select lines will disable switch (see troubleshoot guide)
            WARNING! Minimum switch spacing 6.0 mm (0.25 inch)

1. *Option 115: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum when driven at voltages 18-20 Vdc.*
2. *Option 124: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum when driven at voltages 28-32 Vdc.*

N1810TL

8.35
.329

6.35
.250

4.35
.171

3.15
.124

Option 202
Option 401

16.89
.665

Option 201
Option 401

10.65
.419

13.15
.518

15.65
.616

18.15
.714

20.65
.813

28.15
1.108

8.35
.329

6.35
.250

4.35
.171

4.39
.173

Option 202

16.89
.665

Option 201

11.89
.468

14.39
.567

16.89
.665

19.39
.763

21.89
.862

29.39
1.157

4.32
.170

2.36
.093

4X Ø 3.05
.120

2X Ø 2.40
.094

48.67
1.916

44.74
1.761

53.41
2.103

1   C   2

1.79
.071

11.39
.448

11.00 Typical
.433

52.20
2.055

8.16
.321

Option 202   **Option 201**

12.70
.500

6.35
.250

16.89
.665

11.00 Typical
.433

55.78
2.196

N1810TL

RF Circuits

Position "A"

Position "B"

RF CKT STATE "A"

RF CKT STATE "B"

INDICATOR STATE "A"

INDICATOR STATE "B"

Pin out diagram

Switch drive specifications N1810TL, N1811TL, N1812UL

Option	Parameter	Conditions	Min	Nominal	Max	Units
105	Supply voltage		4.5	5	7.0	V
	Supply current	Supply voltage = 5 V		600		mA
115[1]	Supply voltage		12.0	15	20.0	V
	Supply current	Supply voltage = 15 V		250		mA
124[2]	Supply voltage		20.0	24	32.0	V
	Supply current	Supply voltage = 24 V		150		mA.

TTL drive specifications

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	Switching disabled **	NA
OPEN	OPEN	Lo	Lo	Switching disabled **	NA

GND: +V - Vsupply (see switch drive specification table, this page)
OPEN* +V to +v - 1.5 volts
Hi   3.0 V to 12.0 V
Lo   0.0 V to 1.0 V Warning drive level below -.25 V will damage TTL drive circuit!
   *   WARNING! Use adapter cable 11764-60011 with 87130A switch driver
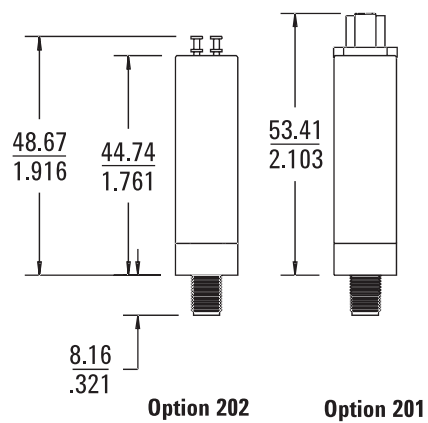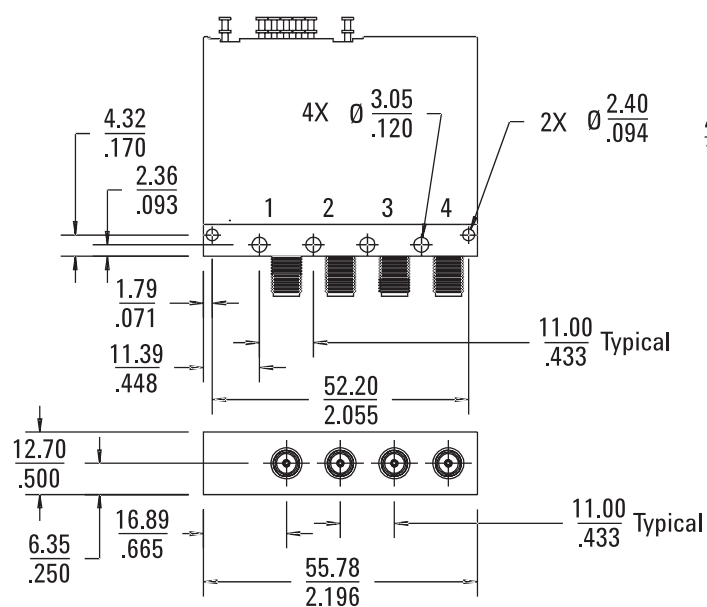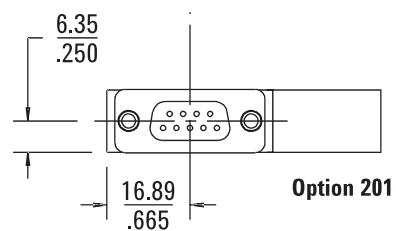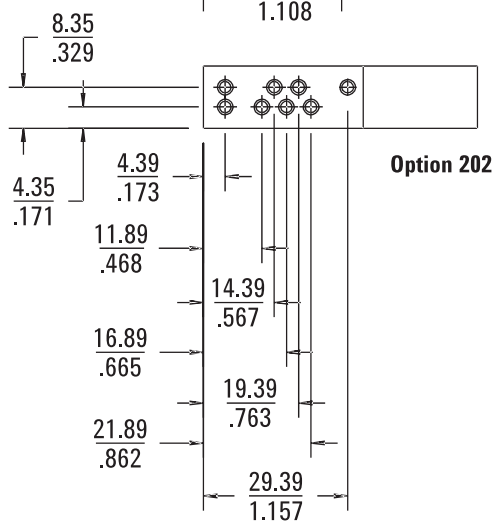   ** WARNING! Driving both select lines will disable switch (see troubleshoot guide)
      WARNING! Minimum switch spacing 6.0 mm (0.25 inch)

1. Option 115: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum when driven at voltages 18-20 Vdc.
2. Option 124: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum when driven at voltages 28-32 Vdc.
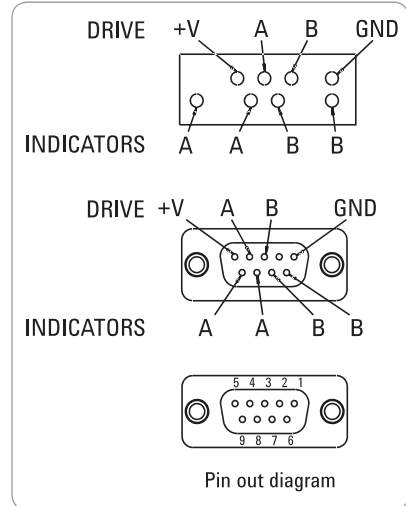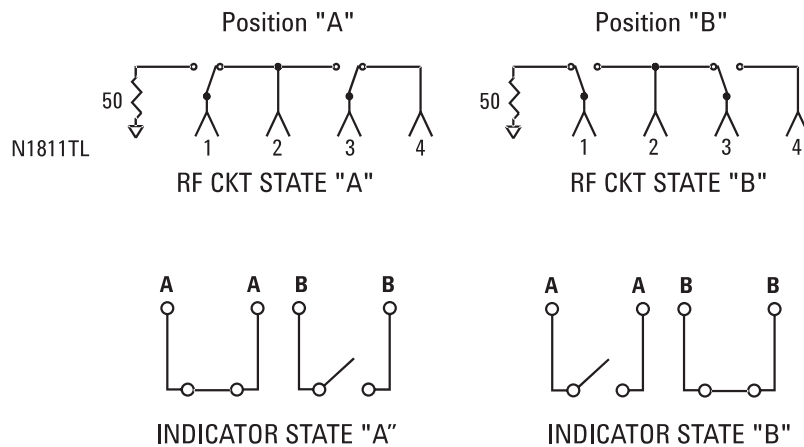

TTL control voltage states REFERENCED TO "GND" PIN

N1811TL

Option 202
Option 401

8.35 / .329

4.35 / .171

3.15 / .124

10.65 / .419

13.15 / .518

15.65 / .616

18.15 / .714

20.65 / .813

28.15 / 1.108

Option 201
Option 401

6.35 / .250

16.89 / .665

Option 202

8.35 / .329

4.35 / .171

4.39 / .173

11.89 / .468

14.39 / .567

16.89 / .665

19.39 / .763

21.89 / .862

29.39 / 1.157

Option 201

6.35 / .250

16.89 / .665

4.32 / .170

2.36 / .093

4X Ø 3.05 / .120

2X Ø 2.40 / .094

1   2   3   4

1.79 / .071

11.39 / .448

52.20 / 2.055

11.00 / .433 Typical

48.67 / 1.916

44.74 / 1.761

53.41 / 2.103

8.16 / .321

Option 202

Option 201

12.70 / .500

6.35 / .250

16.89 / .665

11.00 / .433 Typical

55.78 / 2.196

N1811TL

RF Circuits

Position "A" — RF CKT STATE "A"
Position "B" — RF CKT STATE "B"
N1811TL
50

INDICATOR STATE "A"
INDICATOR STATE "B"

DRIVE +V A B GND
INDICATORS A A B B

DRIVE +V A B GND
INDICATORS A A B B

5 4 3 2 1
9 8 7 6

Pin out diagram

Switch drive specifications N1810TL, N1811TL, N1812UL

Option	Parameter	Conditions	Min	Nominal	Max	Units
105	Supply voltage		4.5	5	7.0	V
	Supply current	Supply voltage = 5 V		600		mA
115[1]	Supply voltage		12.0	15	20.0	V
	Supply current	Supply voltage = 15 V		250		mA
124[2]	Supply voltage		20.0	24	32.0	V
	Supply current	Supply voltage = 24 V		150		mA.

TTL Drive specifications

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	Switching disabled **	NA
OPEN	OPEN	Lo	Lo	Switching disabled **	NA

GND: +V - Vsupply (see switch drive specification table, this page)
OPEN* +V to +v - 1.5 volts
Hi   3.0 V to 12.0 V
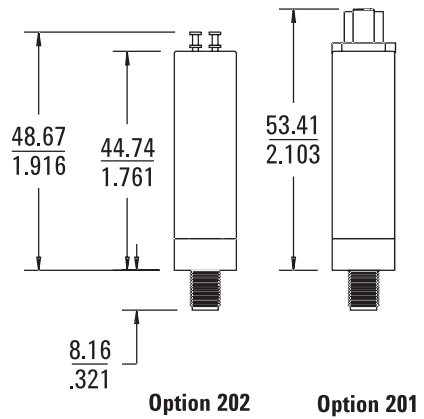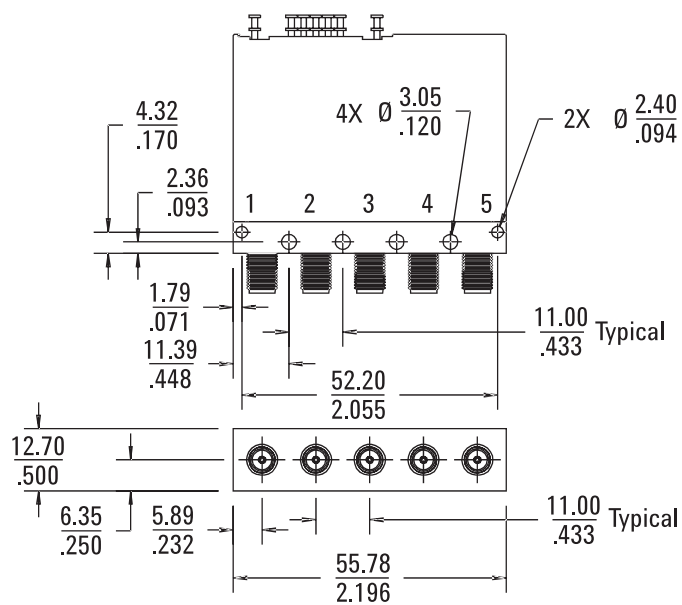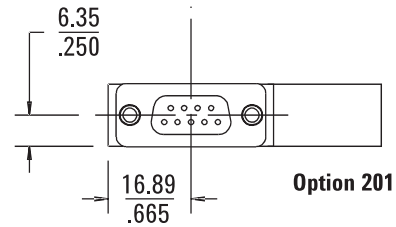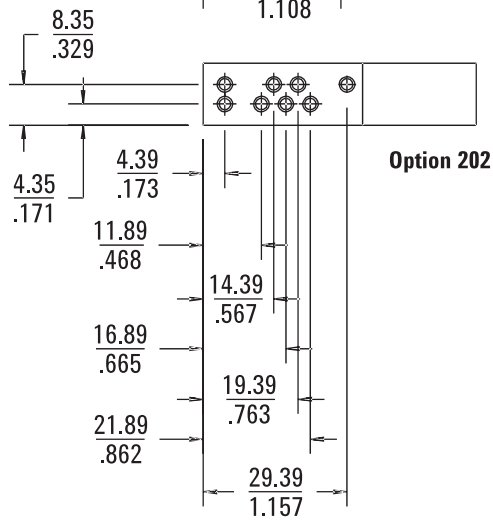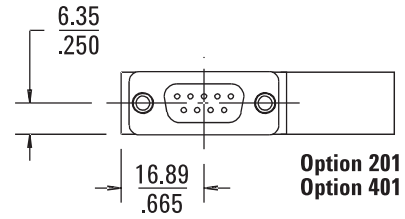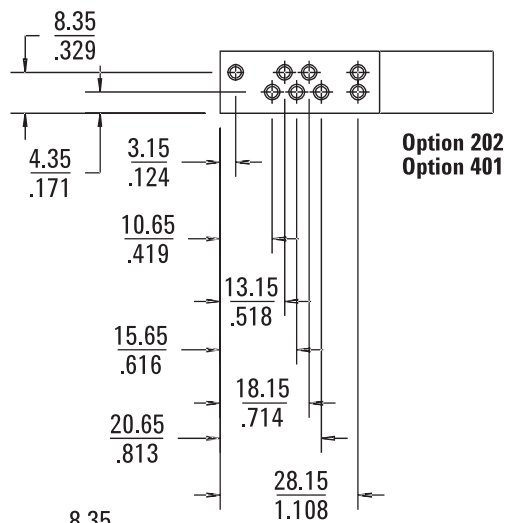Lo   0.0 V to 1.0 V Warning drive level below -.25 V will damage TTL drive circuit!
    *   WARNING! Use adapter cable 11764-60011 with 87130A switch driver
    ** WARNING! Driving both select lines will disable switch (see troubleshoot guide)
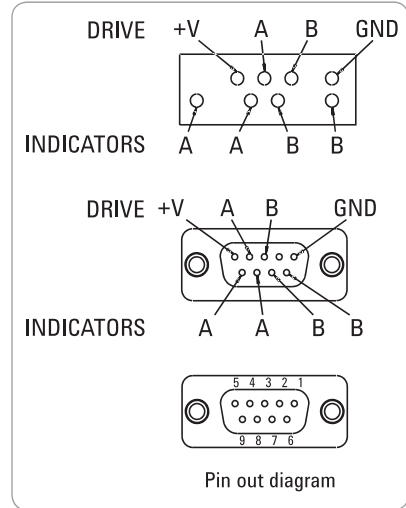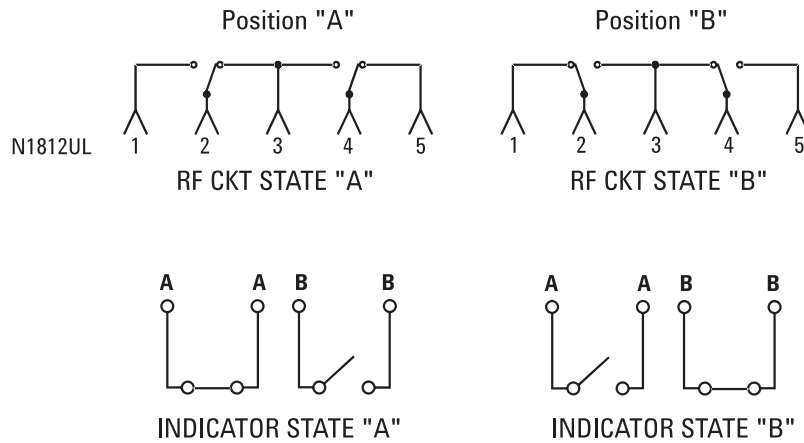   WARNING! Minimum switch spacing 6.0 mm (0.25 inch)

1. Option 115: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum
    when driven at voltages 18-20 Vdc.
2. Option 124: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum
    when driven at voltages 28-32 Vdc.

12.0 V
HI
3.0 V
1.0 V
LO
0 V

TTL control voltage states REFERENCED TO "GND" PIN

N1812UL

$\frac{8.35}{.329}$

$\frac{4.35}{.171}$ $\frac{3.15}{.124}$

$\frac{10.65}{.419}$

$\frac{13.15}{.518}$

$\frac{15.65}{.616}$

$\frac{18.15}{.714}$

$\frac{20.65}{.813}$

$\frac{28.15}{1.108}$

Option 202
Option 401

$\frac{6.35}{.250}$

$\frac{16.89}{.665}$

Option 201
Option 401

$\frac{8.35}{.329}$

$\frac{4.35}{.171}$ $\frac{4.39}{.173}$

$\frac{11.89}{.468}$

$\frac{14.39}{.567}$

$\frac{16.89}{.665}$

$\frac{19.39}{.763}$

$\frac{21.89}{.862}$

$\frac{29.39}{1.157}$

Option 202

$\frac{6.35}{.250}$

$\frac{16.89}{.665}$

Option 201

$\frac{4.32}{.170}$

$\frac{2.36}{.093}$

$4X \; \varnothing \frac{3.05}{.120}$

$2X \; \varnothing \frac{2.40}{.094}$

1   2   3   4   5

$\frac{1.79}{.071}$

$\frac{11.39}{.448}$

$\frac{52.20}{2.055}$

$\frac{11.00}{.433}$ Typical

$\frac{48.67}{1.916}$

$\frac{44.74}{1.761}$

$\frac{53.41}{2.103}$

$\frac{8.16}{.321}$

Option 202   **Option 201**

$\frac{12.70}{.500}$

$\frac{6.35}{.250}$ $\frac{5.89}{.232}$

$\frac{11.00}{.433}$ Typical

$\frac{55.78}{2.196}$

N1812UL

RF Circuits

Position "A"   Position "B"

N1812UL

RF CKT STATE "A"   RF CKT STATE "B"

INDICATOR STATE "A"   INDICATOR STATE "B"

Pin out diagram

TTL control
voltage states
REFERENCED
TO "GND" PIN

Switch drive specifications N1810TL, N1811TL, N1812UL

Option	Parameter	Conditions	Min	Nominal	Max	Units
105	Supply voltage		4.5	5	7.0	V
	Supply current	Supply voltage = 5 V		600		mA
115[1]	Supply voltage		12.0	15	20.0	V
	Supply current	Supply voltage = 15 V		250		mA
124[2]	Supply voltage		20.0	24	32.0	V
	Supply current	Supply voltage = 24 V		150		mA.

TTL drive specifications

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	Switching disabled **	NA
OPEN	OPEN	Lo	Lo	Switching disabled **	NA

GND: +V - Vsupply (see switch drive specification table, this page)
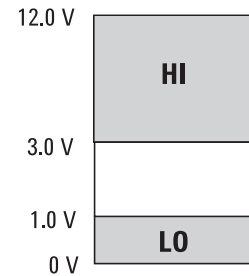OPEN* +V to +v - 1.5 volts
Hi   3.0 V to 12.0 V
Lo   0.0 V to 1.0 V Warning drive level below -.25 V will damage TTL drive circuit!
        *   WARNING! Use adapter cable 11764-60011 with 87130A switch driver
        ** WARNING! Driving both select lines will disable switch (see troubleshoot guide)
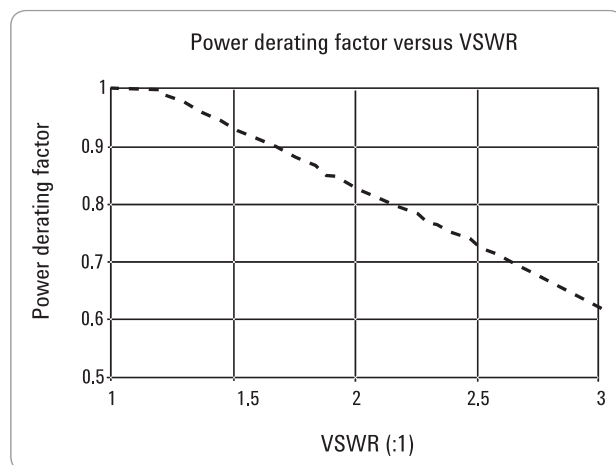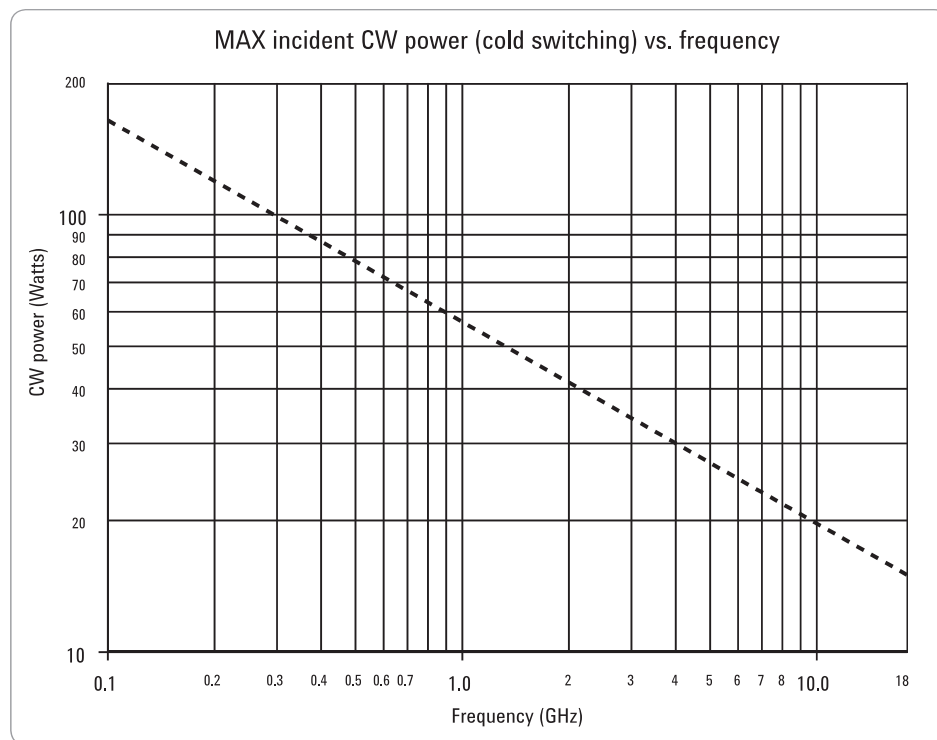   WARNING! Minimum switch spacing 6.0 mm (0.25 inch)

1. Option 115: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum
    when driven at voltages 18-20 Vdc.
2. Option 124: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum
    when driven at voltages 28-32 Vdc.

Supplemental Characteristics

General operating characteristics - N181x series

Switching speed	Repeatability	Life[1,2]	Impedance
< 15 ms	< .03 dB	> 5 million cycles	50 ohms

MAX incident CW power (cold switching) vs. frequency

CW power (Watts) vs Frequency (GHz)

Power derating factor versus VSWR

Power derating factor vs VSWR (:1)

Reference conditions

- Cold switching only (NO hot switching)
- Ambient temperature of 75 °C or less[3]
- Sea level (0.88 derating @ 15,000 ft.)
- Load VSWR < 1.2 (see graph for derating above 1.2 VSWR)
- Power Handling at 25° C is 100 W at 4 GHz

1. Option 115: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum when driven at voltages 18-20 Vdc.
2. Option 124: Characteristic life: 5 million cycles minimum, except 1 million cycles minimum when driven at voltages 28-32 Vdc.
3. Option 301:
   Environmental: Storage and cycling temperature: -55 C to +65 C
   Environmental: Operating temperature: -25 C to +65 C

Environmental

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

Temperature[1]

Operating: -25 to +75 °C
Storage: -55 to +85 °C
Cycling: -55 to +85 °C, 10 cycles per MIL-STD 202F, 170D, Condition A
(modified)

Vibration

Operating: 7 g, 5-2000 Hz @ 0.25 in. p-p
Survival: 20 g, 20-2000 Hz @ 0.06 in. p-p, 4 min/cycle, 4 cycles/axis
Random: 2.41 g (rms.) 10 min/axis
Shock: Half sine: 500 g @ 0.5 ms, 3 drops/direction, 18 total
Operating: 50 g @ 6 ms, 6 directions

Humidity

Operating: 15 to 95 % relative humidity
Storage: 65 °C, 95 % RH, 10 days, MIL-STD 202F, Method 106E

Altitude

Operating: 15,000 feet / 4.6 km
Storage: 50,000 feet / 15.3 km, MIL-STD 202F, Method 105C, Condition B

Troubleshoot guide

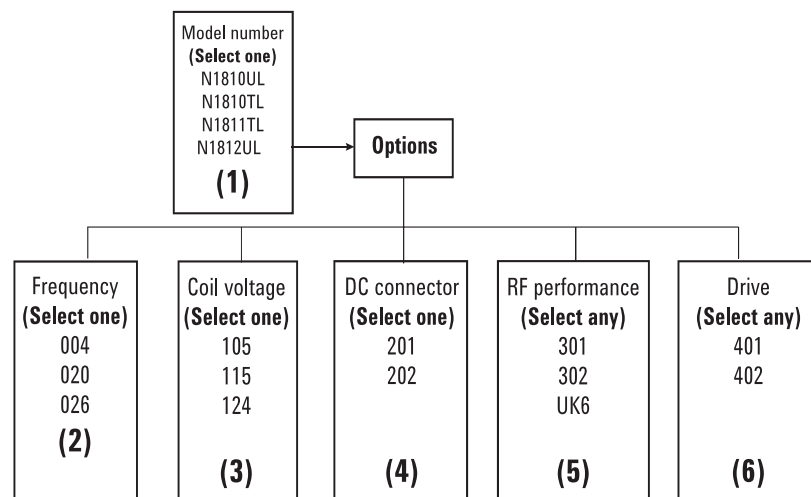| Probable cause	Test	Allowable range Low value	High value	Remedy
Not connected to supply		See drive specifications		Connect +V to power supply
Supply not turned on				Turn on power supply
Supply voltage less than minimum	Measure voltage from control pin to +V	See drive specifications		
Supply current low	Measure current draw with drive pin selected	See drive specifications		Increase drive voltage or reduce drive line resistance
OPEN state voltage too low	Measure voltage from control pin to +V	(+V-1.5) volts	+V volts	
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				Use adapter cable 11764-60011

1. Option 301:
    Environmental: Storage and cycling temperature: -55 C to +65 C
    Environmental: Operating temperature: -25 C to +65 C

Ordering Information

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

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

Ordering example

For an unterminated 5 port switch, operating up to 20 GHz, with 15 volt coils, D-sub connector, high isolation, and TTL, the order should look as follows: N1812UL Opt 020 115 201 301 401.

Switch units beginning with the serial numbers listed below or higher have current interrupt built-in as a default.

- N1810UL-MY07244672
- N1810TL-MY07247927
- N1811TL-MY07244660
- N1812UL-MY07240668

(1)   Select a model to fit your application. (**Required**)
N1810UL – Unterminated latching 3-port
N1810TL – Terminated latching 3-port
N1811TL – Terminated latching 4-port
N1812UL – Unterminated latching 5-port

(2)   Select a frequency range. (**Required**)
004 – DC to 4 GHz
020 – DC to 20 GHz
026 – DC to 26.5 GHz

(3)   Select a coil voltage level. (**Required**)
105* – 5 volts
115 – 15 volts
124 – 24 volts

(4)   Select a DC connector type. (**Required**)
201 – "D" subminiature 9 pin female
202 – Solder lugs

(5)   Select RF performance enhancements. (**Optional**)
301 – Increased isolation
302 – Reduced standing wave ratio and insertion loss
UK6 – Calibration certificate with test data

(6)   Select drive options. (**Optional**)
401 – TTL/CMOS compatible 5 v drive
402 – Position indicators

*Includes options 402

Related Literature

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

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

*Agilent 11713B/C Attenuator/Switch
Drivers Configuration Guide*
Literature Number 5989-7277EN

Application Notes:

*Power Handling Capability of Electro-
mechanical Switches*
Literature Number 5989-6032EN

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

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