

Guide to Selecting a Coaxial Switch

A coaxial switch is an electromechanical relay - a passive component - used to direct RF signals from one path to another path. This type of switch is widely used in signal routing applications where high frequency, high power, and great RF performances are required. It is commonly used in RF applications testing DUT, switching between antennas, SATCOM, Telecom, base stations, avionics, or in any other applications where RF signals need to be routed from one point to another.

Identify Switch Configuration: Poles and Throws

When we talk about coaxial switches, we talk about “poles” and “throws” where number of poles (P) refers to number of input ports and number of throws (T) indicates the output ports. For instance, one input and two output ports are declared as SPDT switch: meaning single-pole-double-throw. You may refer to it as 1P2T as well. So if you have one input and 14 outputs, a SP14T switch will reflect this configuration.

Hence, the first step to select a coaxial switch is to understand the number of paths that need to be routed and select a coaxial switch that meets this requirement. As a result, it will quickly narrow down your choices to few switch series.

Dow-Key coaxial switches are bi-directional such that the same switch can be used for both e.g. 1x2 and 2x1 applications. Also, Dow-Key offers SDPT up to SP14T switches. For larger configurations, multiple switches will need to be cascaded.

Identify Switch Parameters and Characteristics

Let's say your application is to switch between two antenna signals. Right off you know that a SPDT switch is needed. Although it narrows down your selection to a SPDT switch, you are faced with many typical parameters to choose from as specified by the switch industry. We will take a closer look at all

of them; impedance, frequency and connector relation, power handling, coil voltage, actuator types, terminations, indicators, circuit control, and other special options.

Impedance

The standard impedance in a coaxial line for RF power transmission in the U.S. is either 50-ohm or 75-ohm impedance (the reason behind these values ought to be discussed outside the scope of this tutorial series). These industry standards are widely used in coaxial cables and as well in RF applications. Due to transmission theory, it is desired to minimize reflections and maximize power transfer over a wide bandwidth and therefore, impedance matching is critical. To prevent reflection of the signal back into the source, the load must be matched exactly to the source impedance. As a result, it is important to understand whether your transmission line is a 50-ohm (most common) or a 75-ohm (common in broadcasting and video signals) and select a coaxial switch that is designed accordingly. Majority of the coaxial switches in the microwave industry is designed for 50-ohm applications and so is Dow-Key switches.

Dow-Key switches are by default 50-ohm switches unless stated otherwise.

Frequency and Connector Types

Next step in selecting the appropriate coaxial switch for your application is to specify the frequency of your application. Coaxial switches can handle signals as high as 40 GHz, where different switch series support different range of frequencies. Before digging deeper into the Dow-Key switches, it is critical to understand that the frequency range is limited by the type of connector one selects. The reverse can be said as well, that the required frequency limits the type of RF connector one can select.

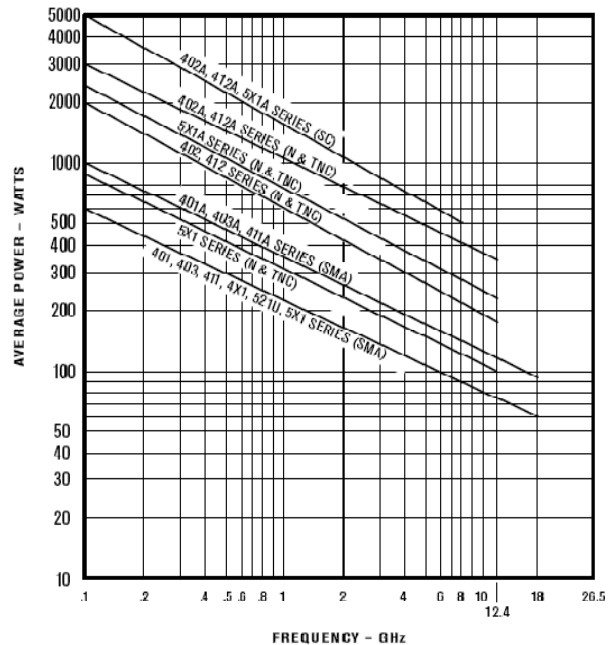
For 40 GHz applications, 2.9 mm connectors must be used as it is designed specifically for high frequency applications. SMA connectors are most commonly used as it can handle up to 27 GHz. Next popular connectors are N and TNC type and they operate up to 12.4 GHz. Lastly, Dow-Key also offers BNC connectors that go to 4 GHz. With better understanding of the limitation each connector type puts on the operating frequency, Dow-Key coaxial switch series are offered with the following connector options:

- DC-4 GHz (with BNC connector)
- DC-12.4 GHz (with N or TNC connector)
- DC-18 GHz (with SMA connector)
- DC-26.5 GHz (with SMA connector)
- DC-40 GHz (with 2.9 mm connector)

RF Power Handling

Power handling capability is often a key specification in an application and in selecting components. How much power a switch can handle depends on the mechanical design, materials, and connector type used in a switch. External factors such as frequency of operation, ambient temperature and altitude over sea level, further limits the power capacity in a switch.

The average power a.k.a. CW (Continues Wave) is summarized in the Power Chart shown below. Note how the power capability decreases as the frequency increases. This power chart is based on ambient temperature (40 degree C), at sea-level, at a VSWR of 1.0:1 and non-switching condition. If any of



this factors changes, the power will be derated. Dow-Key further offers high power options for most switches and this is indicated by the 'A' option. Note that N and TNC connectors can handle higher power compared to the SMA connector at the same frequency. The SC-connector can handle the most power compared to all other connectors.

It is recommended to contact Dow-Key's technical team for peak-power and derated power conditions.

Coil Voltage

Now that we have figured out the most critical specs of a coaxial switch, we are faced with a range of selections that solely depends on the user's preference.



As coaxial switches consist of solenoid coils and are in present of magnets, DC voltage is needed to force the relay to switch to a RF position using magnetic field theory. Therefore, one needs to select a coil voltage. Most common Dow-Key coil voltage options are:

Coil Voltage	Voltage Range
12 Vdc	11-14 Vdc
15 Vdc	13-17 Vdc
24 Vdc	20-28 Vdc
28 Vdc	24-32 Vdc

For other coil voltage requirements contact Dow-Key's technical team.

Actuator Type

An actuator is refereeing to the electromechanical mechanism that transfers the RF contacts from one position to another in a switch. Most Dow-Key actuators use magnetic solenoids acting on a mechanical linkage to the RF contacts. When selecting a switch, you are faced with four different actuator types, depending on the switch series.

Failsafe Type: A failsafe switch by default connects the input to a known output without any power applied to the switch. It requires continuously applied DC voltage to maintain RF connection to any other position. Hence, at power loss a failsafe switch will actuate to its default position.

This option is available with SPDT, 2/3 and Transfer DPDT switches.

Pulse Latching: A latching switch maintains its position and draws continues current to do so, until a pulsed DC voltage commands the switch to change

its position. Hence, at power loss a pulse latched actuator remains in its last position.

This option is available with SPDT, 2/3 and Transfer DPDT switches.

Latching Self Cut-Off: Like the pulse latching actuator the switch stays in its position until a pulsed DC voltage commands the switch to change RF path, and at power loss a latching self cut-off actuator remains in its last position. However, the difference lies in that a self cut-off latching switch only draws current when changing its position and stops drawing current to keep its position. For power sensitive applications, this is the best actuator option.

This option is available with most coaxial switches.

Normally Open: In a normally open switch, all RF paths will remain open by default. The switch needs to be commended through a DC voltage to close a RF path and it draws continuous current to remains in its position. Hence, at power loss a normally open actuator will open all its RF paths.

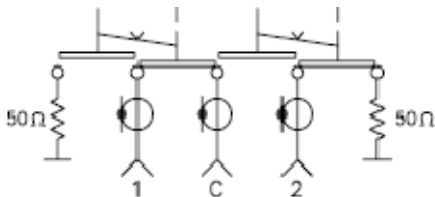
This option is available with multiposition SPnT switches.

Suppression Diodes: Failsafe, Pulse Latching, and Normally Open actuators are also offered with suppression diodes. What it does is to limit voltage spikes or reverse current from entering the electrical circuitry of the switch and therefore prevents the switch from being damaged if such incidents would occur.

Suppression Diodes are by default included in all Latching Self Cut-Off actuators. This feature can be added to non-TTL switches.

Terminations

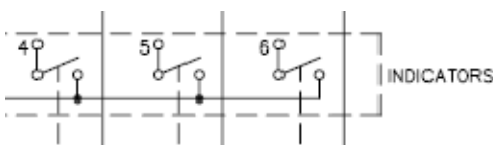
Dow-Key offers terminated switches as an option; either internal or external terminations. A RF coaxial termination provides a resistive power termination, to properly terminate the output port as shown below for a SPDT switch.



Terminations are available in various power ratings and Dow-Key usually offers 2W 50-ohm and 5W 50-ohm terminations.

Indicators

Dow-Key offers mechanical indicators as an option with all coaxial switches. This form of indicator (as shown in below figure for a SPnT switch) closes internally a mechanical path when corresponding RF position is closed. Consequently, when the RF path is off (open) the indicator opens its corresponding mechanical path.



Thus in order to monitor the indication of the switch position, the user needs to create a circuit between the mechanical indicator paths such when the path is closed it closes the external circuit, and when the switch position is off the external circuit will be opened.

Circuit Control

The user has the option to control a coaxial switch with TTL logic or CANBus interface.

TTL logic stands for Transistor-Transistor Logic and is a well known control signal in the digital world. Dow-Key offers both Low and High TTL logic levels with voltage levels as shown below.

	TTL High Option	TTL Low Option
Path is ON ('1')	2.4-5.5 Vdc	0-0.8 Vdc
Path is OFF ('0')	0-0.8 Vdc	2.4-5.5 Vdc

Suppression Diodes are by default included in all TTL options. Naturally, this cannot be combined with actuator types that call out suppression diodes, as this is already included in the TTL option.

CANBus (Controller area Network) switches are designed mainly to be used with our Build Your Own Switch Solution Kit, but it can also be used independently for the software savvy user. CANBus technology provided an easier way to integrate switches into a system level solution compared to TTL logic.

CANBus is a 4-wires serial bus with CAN L and CAN H sending and receiving messages (but not simultaneously). Below chart shows the control pins available on a CANBus switch.

	CANBus
Pin 1	+12 Vdc
Pin 2	CAN L
Pin 3	CAN H
Pin 4	RTN



Special Options

Dow-Key coaxial switches are offered with many options to meet any type of specification and to fit most application.

Extended Temperature: This option extends the standard operating temperature from -25°C to +65 °C to -25 °C to +85 °C.

Epoxy Seal: It extends the standard non-condensing humidly rating from 90% to 95%.

Immersion Seal: It extends the non-condensing humidly rating from 90% to 100% (water proof).

D-sub Connector: Instead of standard terminal pins, a d-sub connector (9-pin, 15-pin, or 25-pin) is available depending on the switch series.

Power Connector: Instead of standard terminal pins, a circular plug is available.

Reverse Polarity: Instead of +Vdc and –COM coil voltage terminals, the reverse polarity –Vdc and +COM is available.

26.5 GHz: Extends the standard DC-18 GHz bandwidth to DC-26.5 GHz. This option is only available for some series.

40 GHz: Extends the standard DC-18 GHz bandwidth to DC-40 GHz. This option is only available for some series.

Flange Mount: Radial switches are not offered with mounting holes. This feature can be available by adding a flange.

Mounting Bracket: If mounting holes required other than the ones available on a flange, this option is offered as an alternative.

Bypass: This options applies to transfer DPDT switches only. One can select to bypass a specific path: J1-J2, J2-J4, J3-J4, or J1-J3.

Low PIM: Extends the standard -110 dBc PIM level to -160 dBc. This option is available for most switches.

Most specials options can be combined and it is recommended to consult with Dow-Key for details.