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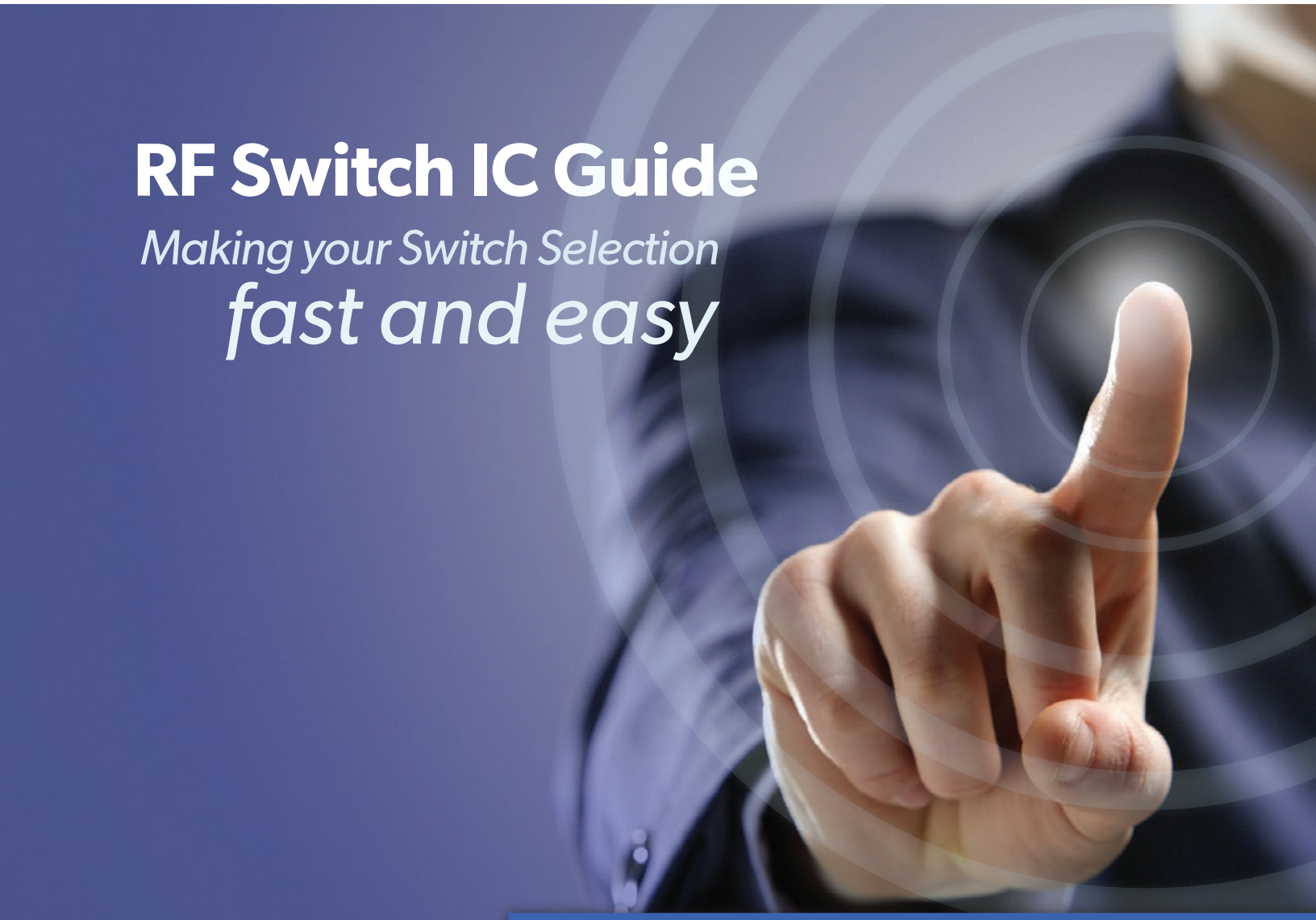
CEL California Eastern Laboratories

2014

RF Switch IC Guide

Making your Switch Selection fast and easy



A World Leader in RF Switch ICs with
Over 50 Years of Wireless Experience

RENESAS

About CEL

California Eastern Laboratories (CEL) is the exclusive sales and marketing partner in the Americas for products made by the Compound Semiconductor Devices Business Division (CSDBD) of Renesas Electronics Corporation, formerly NEC Electronics Corporation. These products include RF components, Optocouplers, Solid State Relays, Lasers and Detectors for Fiber Optics.

CEL serves designers, OEMs and contract manufacturers in the RF & Wireless, Mobilecomm, Multimedia, Broadband Communications, Industrial Control, and Automated Test Equipment (ATE) markets. With over 50 years experience in high frequency design, customer support and fulfillment, CEL is ideally positioned to provide its customers with solutions tailored to meet their specific needs.

CEL maintains extensive inventories and provides engineering and applications assistance at its technical centers in Santa Clara, CA. and Wauconda, IL. The company supports customers through sales offices, sales representatives and distributors in numerous locations.

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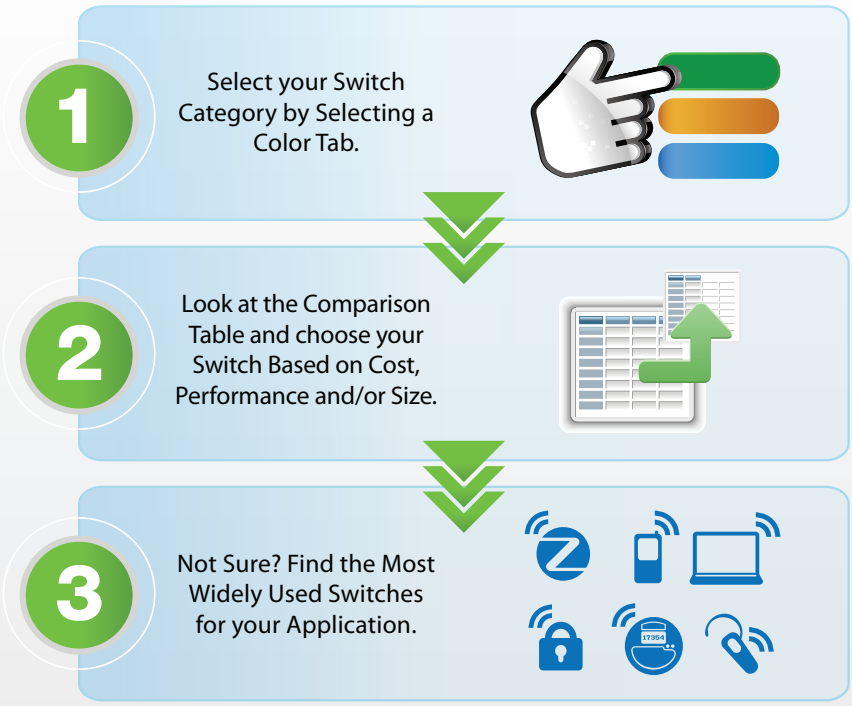
Getting Started as Easy as 1-2-3



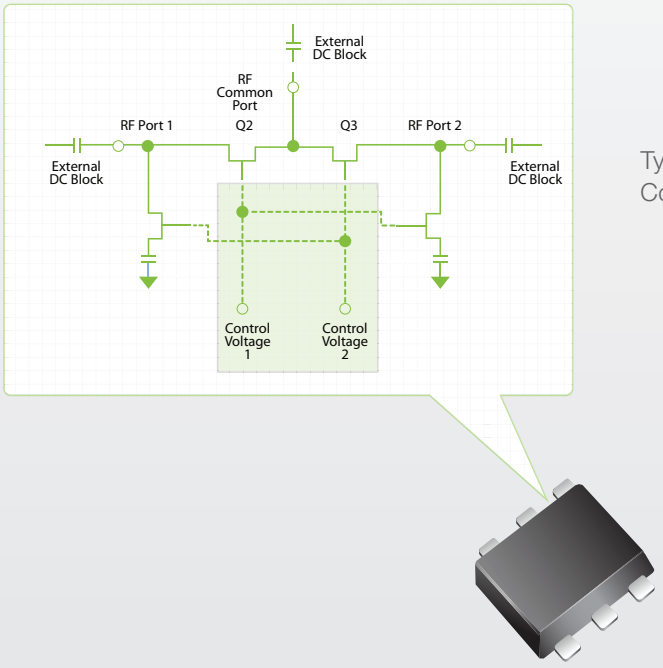
RF Switching Basics

The Basics

An RF switch is a microwave device that routes high frequency signals through transmission paths. CEL Switches are used for diverse applications such as WLAN, Mobile Communications, Wireless Security, Wireless Home Automation, Digital TV and many other RF applications.

CEL offers a broad selection of RF Switches with many configurations, package styles and performance attributes. With so many choices, it's understandable that selecting the right switch can be confusing. Our Wireless Experts make it easier to select the right RF Switch for your application.

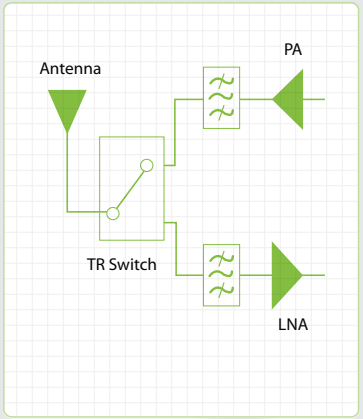
Inside RF Switch ICs: A Closer Look



Typical SPDT with Series-Shunt Configuration.

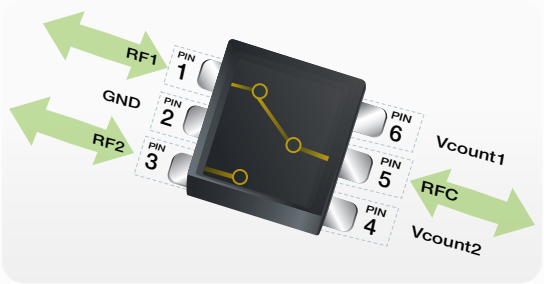
Popular Application Example

This popular application demonstrates a SPDT Switch being used to route a RF signal from either a Transmit path or a Receive path to the system antenna.



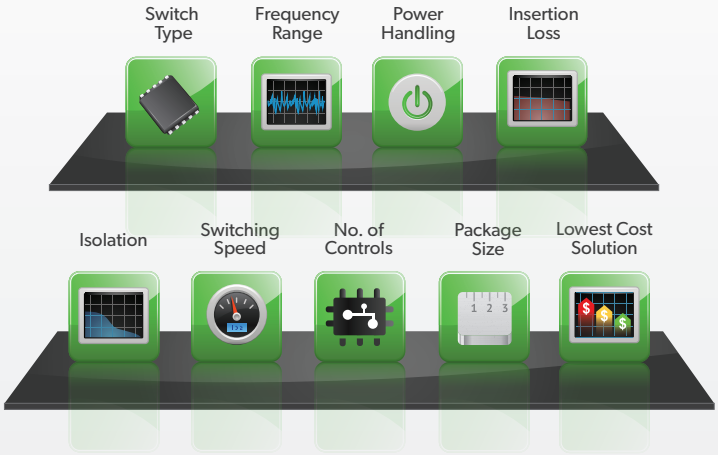
Bidirectional Switch Operation

Our switches are generally bidirectional, meaning that the RF "Throw" ports may be used as input or output ports. See diagram on right.

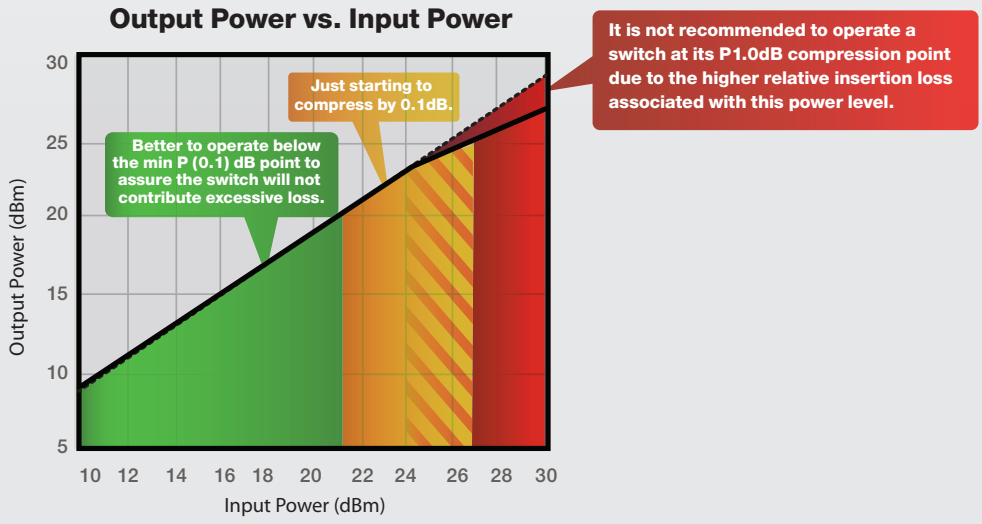


Top Questions to consider before Selecting an RF Switch

1. What ***Switch Type*** do you need? (SPDT, DPDT, etc.)
2. What is the ***RF Frequency Range*** that you need?
3. How much ***Power Handling*** will you need?
4. What ***Insertion Loss*** do you need?
5. What ***Isolation*** do you need?
6. What ***Switching Speed*** are required?
7. What are the ***Number of Controls Lines*** available?
8. What ***Package Size*** is ideal?
9. What is the ***Lowest Cost Solution***?



Power Considerations for your RF Switches



Single Pole Double Throw (SPDT) Switches with 0.1 dB Compression Point < 2 Watts

Continued on the Next Page.

PARAMETERS	UNITS	UPG2408TB	UPG2214TB	UPG2406TK	UPD5713TK	UPG2214TK
Frequency Range	GHz	0.05 to 3.0	0.05 to 3.0	0.01 to 3.0	0.05 to 2.5	0.05 to 3.0
Vsupply	V	–	–	–	1.8, 2.8, 3.6	–
Vcontrol	V	**2.5, 3.0, 5.3**	**1.8, 3.0, 5.3**	**1.8, 3.0, 5.3**	**1.8, 2.8, 3.6**	**1.8, 3.0, 5.3**
Number of Controls	–	2	2	2	**1**	2
Insertion Loss @2.5Gz	dB	0.50	0.35	0.47	0.95	0.35
Insertion Loss @6GHz	dB	–	–	–	–	–
Isolation @2.5GHz	dB	18	26	17	22.5	26
Isolation @6GHz	dB	–	–	–	–	–
Return Loss @2.5GHz	dB	20	20	20	17	20
Return Loss @6.0GHz	dB	–	–	–	–	–
P0.1 dB @2.5GHz	dBm	+29	+23	+29	+17 @1GHz	+23
P0.1 dB @2.5GHz @Vcont =1.8V	dBm	–	+17	+22	–	+17
P0.1dB @6.0GHz	dBm	–	–	–	–	–
P1dB @2.5 GHz	dBm	–	+27	+30.5	+21 @1GHz	+27
P1dB @6.0GHz	dBm	–	–	–	–	–
Input IP3	dBm	+60	+58	+60	–	+58
Harmonics 2nd	dBc	–	-55 @15dBm	-75 @20dBm	–	-55 @15dBm
Harmonics 3rd	dBc	–	-55 @15dBm	-75 @20dBm	–	-55 @15dBm
Control Current	uA	0.3	4	0.2	0.01	4
Supply Current	uA	–	–	–	0.01	–
Switching Speed	ns	50	20	50	30	20
Logic for "ON"	High Low	Low	Low	High	–	Low
Package Size	mm	2.0x2.1x0.9	2.0 x 2.1 x 0.9	1.5 x 1.3 x 0.55	1.5 x 1.3 x 0.55	1.5 x 1.3 x 0.55
Price Rank	–	**Lowest**	→	→	→	→
Applications	–	General Purpose	General Purpose	General Purpose	General Purpose	General Purpose
Advantages	–	Lowest cost general purpose SPDT; Drop-in compatible with the UPG2179	Low cost, High Performance, General Purpose SPDT	Low cost general purpose SPDT in smaller package than the UPG2214TB or UPG2408TB	Single control SPDT	Alternative to UPG2214TB in a smaller package

Note: All values listed are typical performance.

Bold = **Focus Features**

Single Pole Double Throw (SPDT) Switches with 0.1 dB Compression Point < 2 Watts

PARAMETERS	UNITS	UPG2408TK	UPG2422TK	UPG2163T5N	UPG2415TK	UPG2415T6X
Frequency Range	GHz	0.05 to 3.0	**0.05 to 6.0**	**0.5 to 8.0**	**0.5 to 6.0**	**0.05 to 6.0**
Vsupply	V	–	–	–	–	–
Vcontrol	V	2.5, 3.0, 5.3	**1.8, 3.0, 5.3**	2.8, 3.0, 5.0	2.7, 3.0, 5.3	2.7, 3.0, 3.3
Number of Controls	–	2	2	2	2	2
Insertion Loss @ 2.5Gz	dB	0.50	0.35	0.40	0.45	0.45
Insertion Loss @6GHz	dB	–	0.55	**0.50**	0.65	0.55
Isolation @2.5GHz	dB	18	28	**38**	28	28
Isolation @6GHz	dB	–	24	**30**	26	26
Return Loss @2.5GHz	dB	20	20	20	20	20
Return Loss @6.0GHz	dB	–	15	15	15	15
P0.1 dB @2.5GHz	dBm	+29	+28 @3V +32 @5V	–	**+31 @3V** **+35 @5V**	**+31**
P0.1 dB @2.5GHz @Vcont =1.8V	dBm	–	–	–	–	–
P0.1dB @6.0GHz	dBm	–	+28 @3V +32 @5V	–	**+31 @3V** **+35 @5V**	**+31**
P1dB @2.5GHz	dBm	–	+31	+31	**+34**	**+35**
P1dB @6.0GHz	dBm	–	+31	+29	**+34**	**+35**
Input IP3	dBm	+60	+57	+55	**+60 @20dBm**	**+60 @20dBm**
Harmonics 2nd	dBc	–	-80 @20dBm	–	-80 @20dBm	-80 @20dBm
Harmonics 3rd	dBc	–	-80 @20dBm	–	-80 @20dBm	-80 @20dBm
Control Current	uA	0.3	0.1	0.1	0.1	0.1
Supply Current	uA	–	–	–	–	–
Switching Speed	ns	50	40	50	50	50
Logic for "ON"	High Low	Low	High	Low	High	High
Package Size	mm	1.5 x 1.3 x 0.55	1.5 x 1.3 x 0.55	1.5 x 1.5 x 0.37	1.5 x 1.3 x 0.55	1.5 x 1.5 x 0.37
Price Rank	–	→	Same as UPG2408TK	→	→	Highest
Applications	–	General Purpose	Dual Band WLAN	Dual Band WLAN	Higher Power Dual Band WLAN	Higher Power Dual Band WLAN
Advantages	–	Alternative to UPG2406TK with opposite logic	Low cost SPDT specified to 6GHz	SPDT specified to 8GHz with high isolation and low insertion loss	Higher Power SPDT for WLAN Access Points	Higher power SPDT for WLAN Access Points

Note: All values listed are typical performance.

Bold = **Focus Features**

Single Pole Double Throw (SPDT) Switches with 0.1 dB Compression Point > 2 Watts

PARAMETERS	UNITS	UPG2409TB	UPG2409T6X	UPG2176T5N	UPG2009TB	UPG2155TB
Frequency Range	GHz	0.5 to 3.8	**0.05 to 6.0**	**2.3 to 2.7 3.3 to 3.8 4.9 to 5.85**	0.5 to 2.5	0.5 to 2.5
Vsupply	V	–	–	–	–	–
Vcontrol	V	2.7, 3.0, 5.3	2.7, 3.0, 3.3	2.5, 3.0, 5.0	2.7, 2.8, 3.0	2.4, 2.6, 5.0
Number of Controls	–	2	2	2	2	2
Insertion Loss @2.5Gz	dB	0.45	0.45	0.45	**0.40**	0.45
Insertion Loss @6GHz	dB	–	0.65	0.70	–	–
Isolation @2.5GHz	dB	26	30	27	25	17
Isolation @6GHz	dB	–	**27**	21	–	–
Return Loss @2.5GHz	dB	20	20	15	20	20
Return Loss @6.0GHz	dB	–	15	15	–	–
P0.1dB	dBm	+33.5	+34	–	+34	**+37.5**
P0.1dB @Vcont = 1.8V	dBm	–	–	–	–	–
P1dB @2.5GHz	dBm	+35 @3V +37 @5V	+36	+37	–	–
Input IP3	dBm	+60	+60	–	–	–
Harmonics 2nd	dBc	-75 @26dBm	-70 @30dBm	–	-75 @30.5dBm	-70 @31.5dBm
Harmonics 3rd	dBc	-80 @26dBm	-70 @30dBm	–	-75 @30.5dBm	-75 @31.5dBm
Current Control	uA	0.1	0.1	16	1	0.5
Supply Current	uA	–	–	–	–	–
Switching Speed	ns	**100**	**100**	**100**	**150**	1000
Logic for "On"	High Low	High	High	High	High	High
Package Size	mm	2.0 x 2.1 x 0.9	**1.5 x 1.5 x 0.37**	**1.5 x 1.5 x 0.37**	2.0 x 2.1 x 0.9	2.0 x 2.1 x 0.9
Price Rank	–	**Lowest**	→	→	→	Highest
Applications	–	General Purpose including 2.4GHz WLAN Access Points and WiMAX	Dual Band WLAN Access Points and WiMAX	General Purpose including Dual Band WLAN Access Points and WiMAX	General Purpose High Power including AMI	General Purpose including Mobilecomm and AMI
Advantages	–	Lowest cost, higher power SPDT with frequency specified to 3.8GHz	Higher power SPDT with low insertion loss and wide frequency range	High power absorptive SPDT specified to 5.85GHz	Lowest insertion loss SPDT for high power applications	Highest power SPDT

Note: All values listed are typical performance, unless otherwise listed.

Bold = **Focus Features**

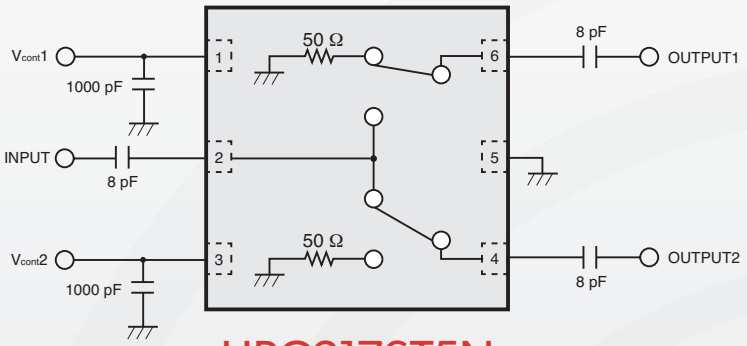
Single Pole Double Throw (SPDT) Absorptive Switch

PARAMERTERS	UNITS	UPG2176T5N
Frequency Range	GHz	**2.3 to 2.7 3.3 to 3.8 4.9 to 5.85**
Vcontrol	V	2.5, 3.0, 5.0
Insertion Loss @2.5Gz	dB	0.45
Insertion Loss @3.8GHz	dB	0.55
Insertion Loss @5.85GHz	dB	0.70
Isolation @2.5GHz	dB	**27**
Isolation @3.8GHz	dB	24
Isolation @5.85GHz	dB	21
Return Loss @2.5GHz	dB	15
Return Loss @6.0GHz	dB	15
P0.1dB @2.5GHz	dBm	–
P0.1dB @6.0GHz	dBm	–
P1dB @2.5GHz	dBm	**+37**
P1dB @6.0GHz	dBm	**+37**
Input IP3	dBm	–
Harmonics 2nd	dBc	–
Harmonics 3rd	dBc	–
Control Current	uA	16
Switching Speed	ns	100
Logic for "On"	High Low	High
Package Size	mm	1.5 x 1.5 x 0.37
Price Rank	–	–
Applications	–	General Purpose including Dual Band WLAN Access Points and WiMAX
Advantages	–	**Absorptive SPDT with high power, high isolation and frequency operation to 5.85GHz**

Note: All values listed are typical performance.

Bold = **Focus Features**

Equivalent Circuit and Evaluation Circuit



UPG2176T5N

Double Pole Double Throw (DPDT) Switches

PARAMETERS	UNITS	UPG2164T5N	UPD5738T6N	UPG2162T5N
Frequency Range	GHz	**2.4 to 2.5 4.9 to 6.0**	0.01 to 2.5	**2.4 to 2.5 4.9 to 6.0**
Vcontrol	V	2.8, 3.0, 5.0	**1.5, 2.8, 3.6**	2.8, 3.0, 5.0
Insertion Loss @2.5Gz	dB	**0.50**	1.60	0.60
Insertion Loss @6GHz	dB	**0.70**	–	0.85
Isolation @2.5GHz	dB	25	15	**35**
Isolation @6GHz	dBm	17	–	**27**
Return Loss @2.5GHz	dBm	15	12	15
Return Loss @6.0GHz	dB	15	–	15
P0.1dB @2.5GHz	dBm	–	15	–
P0.1dB @6.0GHz	dBm	–	–	–
P1dB @2.5GHz	dBm	**+31**	+20	**+31**
P1dB @6.0GHz	dBm	**+29**	–	**+29**
Input IP3	dBm	**+50**	–	**+50**
Control Current	uA	0.1	0.01	0.1
Switching Speed	ns	50	400	150
Package Size	mm	1.5 x 1.5 x 0.37	1.5 x 1.5 x 0.37	1.5 x 1.5 x 0.37
Price Rank	–	**Lowest**	→	Highest
Applications	–	Dual Band WLAN	General Purpose	Dual Band WLAN
Advantages	–	Lowest cost, low insertion Loss	Good performance at low frequency	High isolation alternative to UPG2164T5N

Note: All values listed are typical performance.

Bold = **Focus Features**

Most Widely Used Switch ICs by Application

Wi-Fi and Bluetooth Applications

Segment	Switch Model Number	Switch Type	Page
General Low Band (2.4GHz) Only Wi-Fi	UPG2408TB	SPDT	4
	UPG2406TK	SPDT	4
Dual Band (2.4GHz + 5.8GHz) Wi-Fi	UPG2422TK	SPDT	5
	UPG2163T5N	SPDT	5
	UPG2415TK	SPDT	5
Dual Band Wi-Fi Access Points	UPG2415TK	SPDT	5
	UPG2409T6X	SPDT	6
	UPG2176T5N	SPDT	6, 7

Advanced Metering Infrastructure (AMI) / Automatic Meter Reading (AMR)

Segment	Switch Model Number	Switch Type	Page
General	UPG2409TB	SPDT	6

General Wireless

Segment	Switch Model Number	Switch Type	Page
General	UPG2408TB	SPDT	4
	UPG2214TB	SPDT	4
	UPG2406TK	SPDT	4

What is your Application?

AMR/AMI

ZigBee/ 802.15.4

WLAN/ Wi-Fi

Bluetooth

MobileComm

General Purpose/
Short Range Wireless

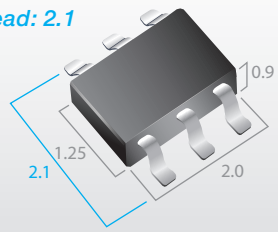
Package Styles and Dimensions

TB Package

1.25 x 2.0 x 0.9

Lead to Lead: 2.1

Top

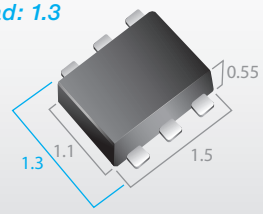


TK Package

1.1 x 1.5 x 0.55

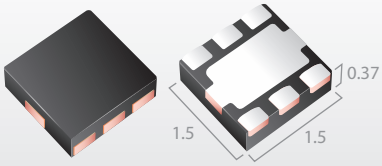
Lead to Lead: 1.3

Top



T5N, T6X Packages

1.5 x 1.5 x 0.37



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