IDTF2912NCGI Datasheet

High Reliability SP2T RF Switch **300kHz to 8000MHz**

General Description

The IDTF2912 is a high reliability, low insertion loss, 50Ω SP2T absorptive RF switch designed for a multitude of wireless and other RF applications. This device covers a broad frequency range from 300kHz to 8000MHz. In addition to providing low insertion loss, the IDTF2912 also delivers excellent linearity and isolation performance while providing a 50Ω termination to the unused RF input port.

The F2912 uses a single positive supply voltage of 3.3V supporting three states using either 3.3V or 1.8V user-selectable control voltage. An added feature includes a Mode CTL pin allowing the user to control the device with either 1-pin or 2-pin control.

Competitive Advantage

IDTF2912 provides extremely low insertion loss; particularly important for RF receiver front-end use.

- ✓ Insertion Loss 0.4dB*
- ✓ IIP3 : +66dBm
- ✓ RF1 to RF2 isolation: 74dB*
- ✓ Negative supply voltage not required
- ✓ Extended temperature -55°C to +125°C

* 1GHz

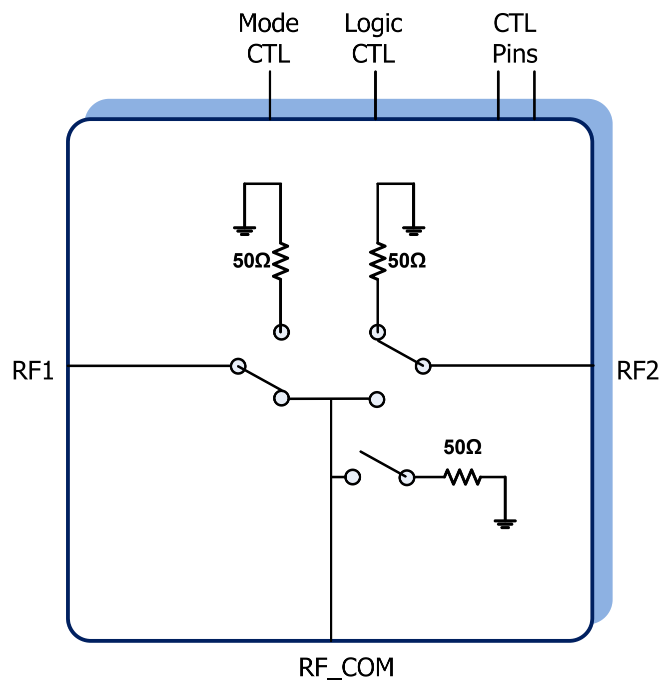
Applications

- Base Station 2G, 3G, 4G
- Portable Wireless
- Repeaters and E911 systems
- Digital Pre-Distortion
- Point to Point Infrastructure
- Public Safety Infrastructure
- WIMAX Receivers and Transmitters
- Military Systems, JTRS radios
- RFID handheld and portable readers
- Cable Infrastructure
- Wireless LAN
- Test / ATE Equipment

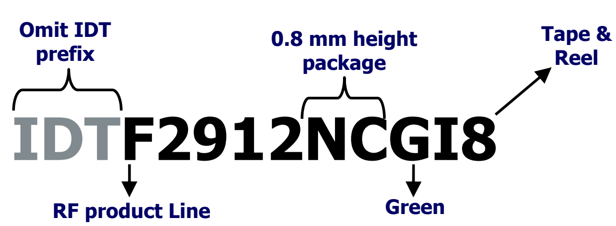
Features

- Very low insertion loss: 0.4dB @ 1GHz
- High Input IP3: +66dBm
- RF1 to RF2 Isolation: 74dB @ 1GHz
- 1-pin or 2-pin device control option
- Low DC current; 20uA using 3.3V logic
- Single positive supply voltage: 3.3V
- 3.3V or 1.8V user-selectable control logic
- Operating temperature -55°C to +125°C
- 4x4 20 pin TQFN package

Device Block Diagram



Ordering Information



ABSOLUTE MAXIMUM RATINGS

GENERAL

Parameter / Condition	Symbol	Min	Max	Unit
VCC to GND	VCC	-0.3	+3.9	V
CTL1, CTL2, LogicCTL	V_{CNTL}	-0.3	Vcc + 0.3	V
RF1, RF2, RF_Com	V_{RF}	-0.3	+0.3	V
Maximum Junction Temperature	T_{Jmax}		+140	°C
Storage Temperature Range	T_{ST}	-65	+150	°C
Lead Temperature (soldering, 10s)	T_{LEAD}		+260	°C
ESD Voltage– HBM (Per JESD22-A114)	V_{ESDHBM}		Class 2 (2000V)	
ESD Voltage – CDM (Per JESD22-C101)	V_{ESDCDM}		Class IV (1500V)	

RF POWER FOR CASE TEMPERATURES UP TO +85°C *

RF1, RF2 (RF1 or RF2 is switched to RF_COM, State 3 and 2)	+33dBm
RF1, RF2 (RF1 or RF2 is NOT switched to RF_COM, State 1, 2 and 3)	+24dBm
RF_COM (RF_COM port is NOT switched to RF1 or RF2, State 1)	+24dBm

RF POWER FOR CASE TEMPERATURES UP TO +105°C*

RF1, RF2 (RF1 or RF2 is switched to RF_COM, State 3 and 2)	+33dBm
RF1, RF2 (RF1 or RF2 is NOT switched to RF_COM, State 1, 2 and 3)	+21dBm
RF_COM (RF_COM port is NOT switched to RF1 or RF2, State 1)	+21dBm

RF POWER FOR CASE TEMPERATURES UP TO +120°C *

RF1, RF2 (RF1 or RF2 is switched to RF_COM, State 3 and 2)	+27dBm
RF1, RF2 (RF1 or RF2 is NOT switched to RF_COM, State 1, 2 and 3)	+18dBm
RF_COM (RF_COM port is NOT switched to RF1 or RF2, State 1)	+18dBm

* Note: RF power limits are reduced if the RF frequency is lower than 400MHz.

Stresses above those listed above may cause permanent damage to the device. Functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

PACKAGE THERMAL AND MOISTURE CHARACTERISTICS

θ_{JA} (Junction – Ambient)	60°C/W
θ_{JC} (Junction – Case) The Case is defined as the exposed paddle	3.9°C/W
Moisture Sensitivity Rating (Per J-STD-020)	MSL 1

IDTF2912 RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Single Supply Voltage	V_{CC}	Using 3.3V logic (Pin 18 low)	2.7		3.6	V
		Using 1.8V logic (Pin 18 high)	3.15		3.45	
Operating Temperature Range	T_{CASE}	Case Temperature	-55		+125	^{O}C
RF Frequency Range	F_{RF}		0.3		8000	MHz
RF1 Port Impedance	Z_{RF1}			50		Ω
RF2 Port Impedance	Z_{RF2}			50		
RF_COM Port Impedance	Z_{RF_COM}			50		

IDTF2912 SPECIFICATION

Typical Application Circuit, V_{CC} = +3.3V, T_C = +25°C, F_{RF} = 1GHz, 2GHz, and or 4GHz as noted below. Input power = 0dBm per tone unless otherwise stated. PCB board trace and connector losses are de-embedded unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Logic Input High Threshold	V_{IH}	For all control pins Pin 18 low for 3.3V logic	***0.7 x VCC***		***3.6***	V
		For all control pins Pin 18 high for 1.8V logic	***1.1*** [1]		***2***	
Logic Input Low Threshold	V_{IL}	For all control pins Pin 18 low for 3.3V logic			***0.3 x VCC***	V
		For all control pins Pin 18 high for 1.8V logic			***0.63***	V
Logic Current	I_{IH}, I_{IL}	For all control pins		180	***500***	nA
DC Current	I_{DC}	Pin 18 low for 3.3V logic		20	***25***	µA
		Pin 18 high for 1.8V logic		126	***153***	
Insertion Loss RF1/RF2 to RF_COM (State 2 or 3)	IL	RF = 1GHz		0.4	***0.6***	dB
		RF = 2GHz		0.5	***0.7***	
		RF = 4GHz		0.6	***0.8***	
Isolation RF1 / RF2 to RF_COM (State 2 or 3)	ISO1	RF = 1GHz	***58***	61.5		dB
		RF = 2GHz	***52***	57		
		RF = 4GHz	50 [2]	52		
Isolation RF1 to RF2 (State 2 or 3)	ISO2	RF = 1GHz	71	74		dB
		RF = 2GHz	60	62		
		RF = 4GHz	46	47		
Return Loss RF_COM (State 1)	RL1	RF = 1GHz		27		dB
		RF = 2GHz		27		
		RF = 4GHz		16		
Return Loss RF_COM (State 2 or 3)	RL2	RF = 1GHz		25		dB
		RF = 2GHz		23		
		RF = 4GHz		26		

IDTF2912 SPECIFICATION (CONT)

Typical Application Circuit, V_{CC} = +3.3V, T_C = +25°C, F_{RF} = 1GHz, 2GHz, 3GHz, and or 4GHz as noted below. Input power = 0dBm per tone unless otherwise stated. PCB board trace and connector losses are de-embedded unless otherwise noted.

Parameter	Symbol	Conditions		Min	Typ	Max	Units
Return Loss RF1, RF2 (State 1)	RL3	RF = 1GHz			27		dB
		RF = 2GHz			27		
		RF = 4GHz			20		
Return Loss RF1, RF2 (State 2 or 3)	RL4	RF = 1GHz			26		dB
		RF = 2GHz			25		
		RF = 4GHz			21		
Input IP2 RF1 / RF2 (State 2 or 3)	IIP2	Pin = +13dBm per tone	RF = 1GHz		102		dBm
			RF = 2GHz		110		
			RF = 3GHz		110		
Input IP3 RF1 / RF2 (State 2 or 3)	IIP3	Pin = +13dBm per tone	RF = 1GHz		66		dBm
			RF = 2GHz		64		
			RF = 3GHz		64		
Input 1dB compression RF1 / RF2 (State 2 or 3) [3]	IP1dB	RF = 2GHz		29	30		dBm
Switching Time[4]	T_{SW}	50% control to 90% RF			1.1		µs
		50% control to 10% RF			0.5		
Maximum Switching Frequency	SW_{FREQ}				25		KHz
Maximum video feed-through RF_COM port	VID_{FT}	5MHz to 1000MHz Measured with 2.5ns risetime, 0 to 3.3V control pulse			5		mV_{pp}
Maximum spurious level on any RF port[5]	$Spur_{MAX}$	RF ports terminated into 50Ω			-145		dBm

1 – Items in min/max columns in ***bold italics*** are Guaranteed by Test.
2 – Items in min/max columns that are not bold/italics are Guaranteed by Design Characterization.
3 – The input 1dB compression point is a linearity figure of merit. Refer to Absolute Maximum Ratings section for the maximum RF input power.
4 – F_{RF} = 1GHz
5– Spurious due to on-chip negative voltage generator. Typical generator fundamental frequency is 2.2 MHz.

Table 1 includes 3 states and provides the truth table for 2-pin control input.

State	Control pin input		RF1, RF2 input / output	
	CTL1 (Pin 17)	CTL2 (Pin 16)	RF1 to RF Com	RF2 to RF Com
1	Low	Low	OFF	OFF
2	Low	High	OFF	ON
3	High	Low	ON	OFF
4	High	High	N/A	N/A

Table 1 - Switch Control Truth Table for 3 states using 2 control pins; pin 16 and pin 17

Table 2 includes 2 states and provides the truth table for 1-pin control input.

State	Control pin input		RF1, RF2 input / output	
	CTL1 (Pin 17)	CTL2 (Pin 16)	RF1 to RF Com	RF2 to RF Com
2	don't care	High	OFF	ON
3	don't care	Low	ON	OFF

Table 2 – Switch Control Truth Table for 2 states using a single control pin 16

Table 3 provides the truth table for selecting the use of either 1 or 2 control pins.

Pin Control Mode	ModeCTL (Pin 19)
2-pin control: CTL1 and CTL2	GND
1-pin control: CTL2	VCC

Table 3 – Mode Control (pin 19) Truth table to use either 1 or 2 control pins

Notes:
1. When RF1 and RF2 ports are both open (State 1), all 3 RF ports are terminated to an internal 50Ω termination resistor.
2. When RF1 or RF2 port is open (State 2 or State 3 OFF condition), the open port is connected to an internal 50Ω termination resistor.
3. When RF1 or RF2 port is closed (State 2 or State 3 ON condition), the closed port is connected to the RF Com port.

Table 4 provides the truth table for selecting the use of either 1.8V logic control or 3.3V logic control.

Logic Voltage	LogicCTL (Pin 18)
1.8V	VCC
3.3V	GND

Table 4 - Logic Control (pin 18) Truth Table

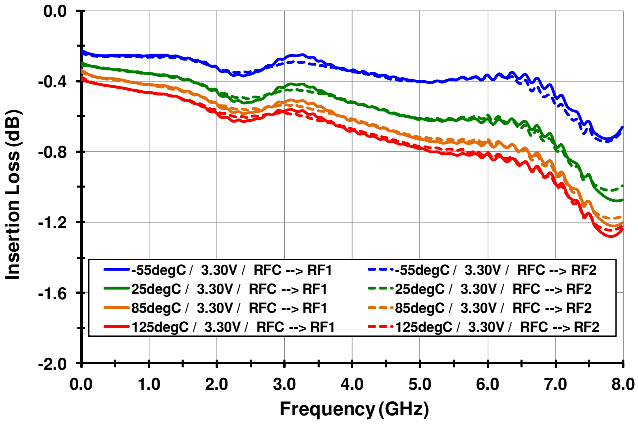
TYPICAL OPERATING CURVE CONDITIONS

Unless otherwise noted, the following conditions apply:

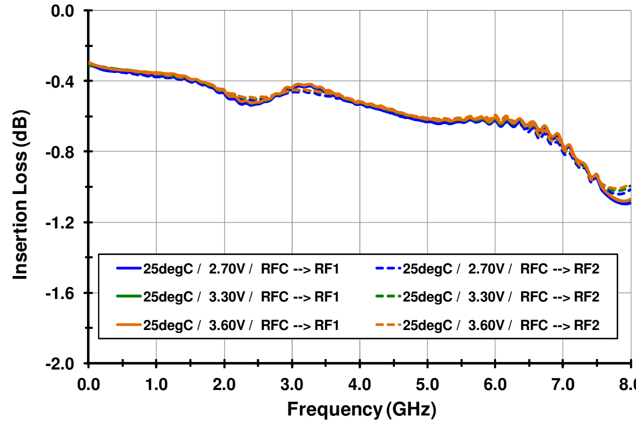
- EVKit loss de-embedded
- Vcc=3.3V
- T_{AMB}=25C
- Small signal parameters measured with P_{IN} = 0dBm.
- Two tone tests P_{IN} =+13dBm/tone with 50 MHz tone spacing.

TYPICAL OPERATING CONDITIONS (-1-)

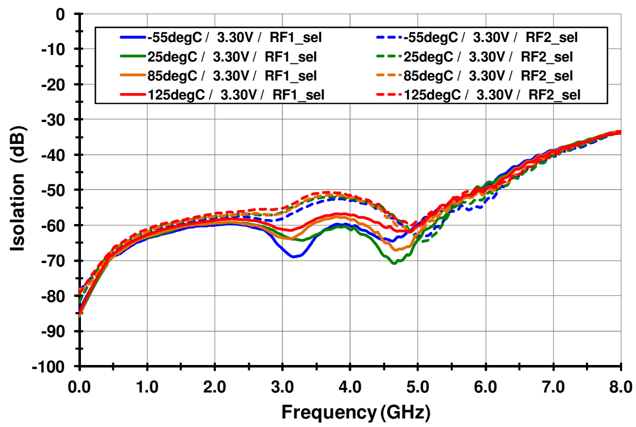
Insertion Loss vs. Temperature



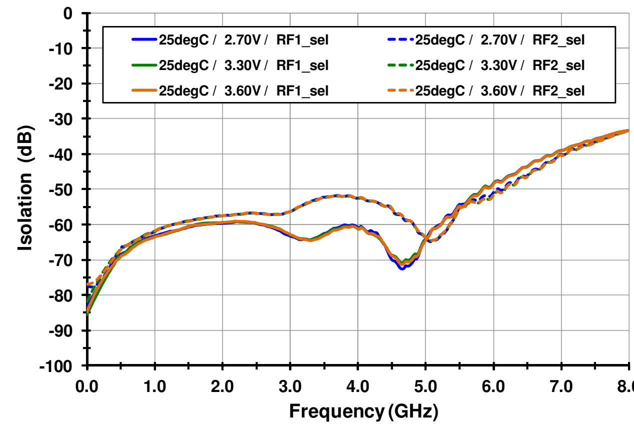
Insertion Loss vs. Voltage



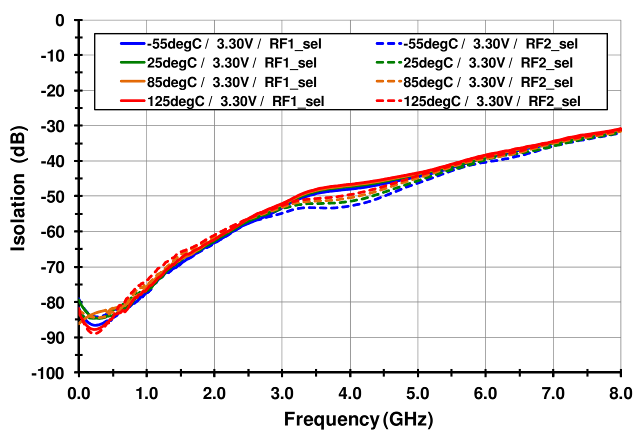
Isolation vs. Temp [RFcom → RF1 / RF2]



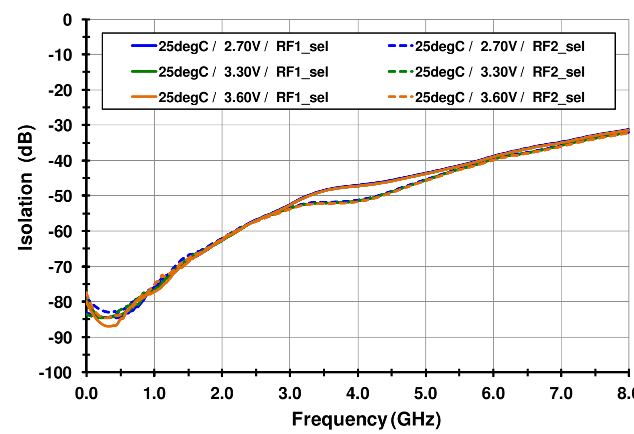
Isolation vs. Voltage [RFcom → RF1 / RF2]



Isolation vs. Temp [RF1 → RF2]

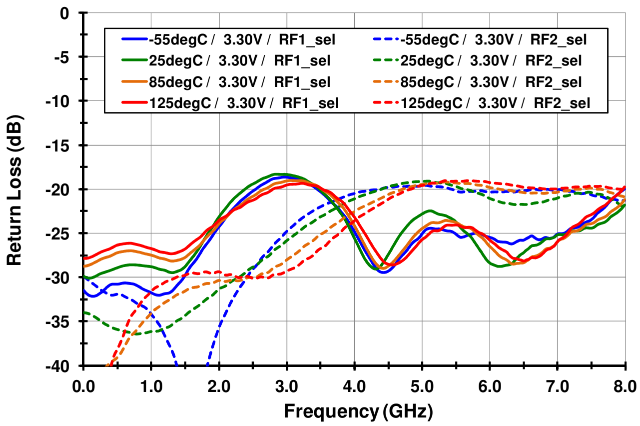


Isolation vs. Voltage [RF1 → RF2]

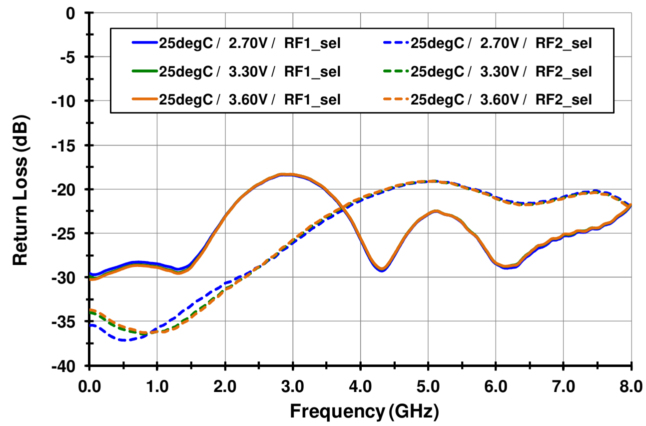


TYPICAL OPERATING CONDITIONS (-2-)

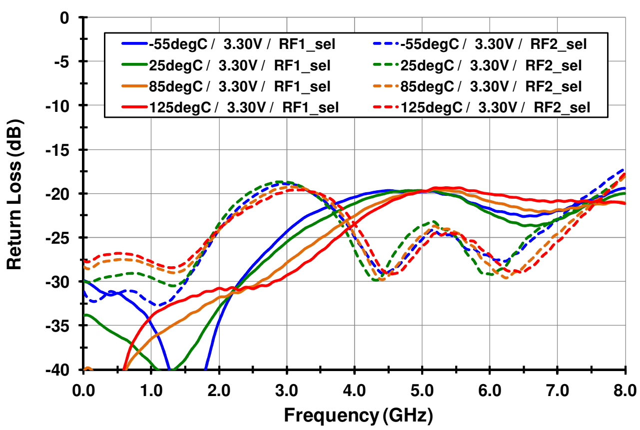
RF1 Return Loss vs. Temp



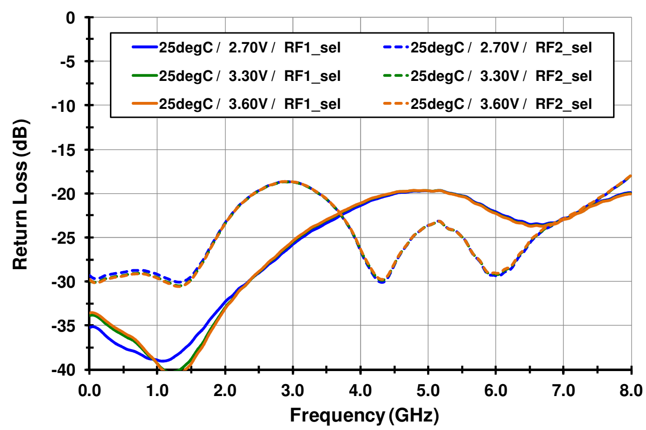
RF1 Return Loss vs. Voltage



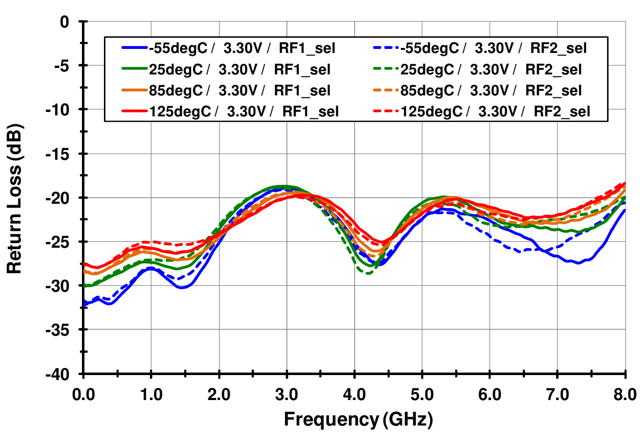
RF2 Return Loss vs. Temp



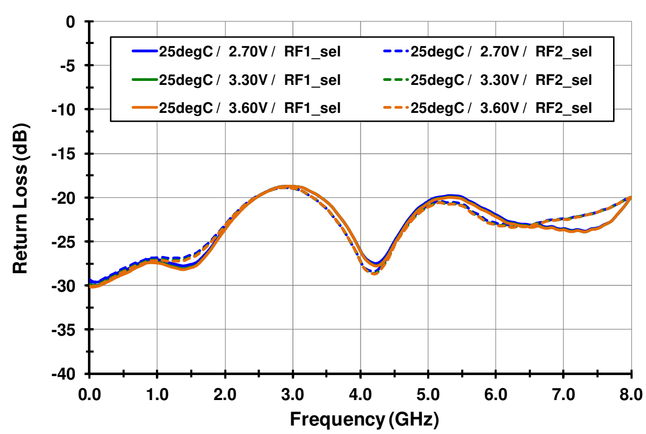
RF2 Return Loss vs. Voltage



RFcom Return Loss vs. Temp

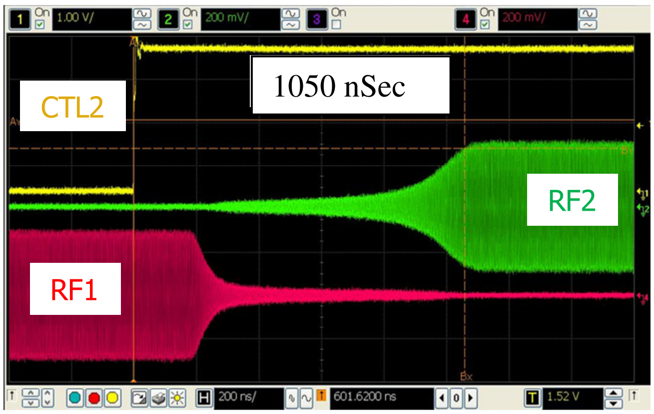


RFcom Return Loss vs.Voltage

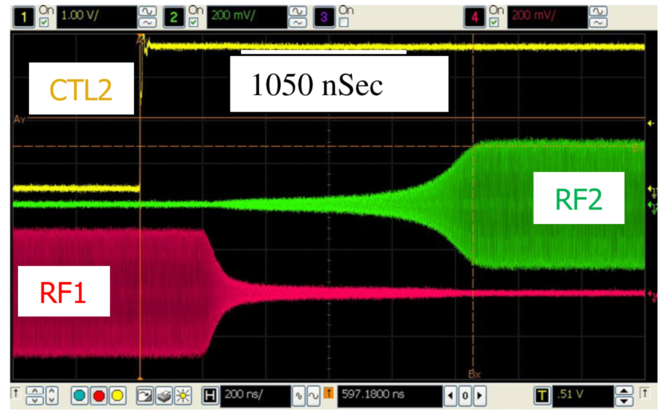


TYPICAL OPERATING CONDITIONS (-3-)

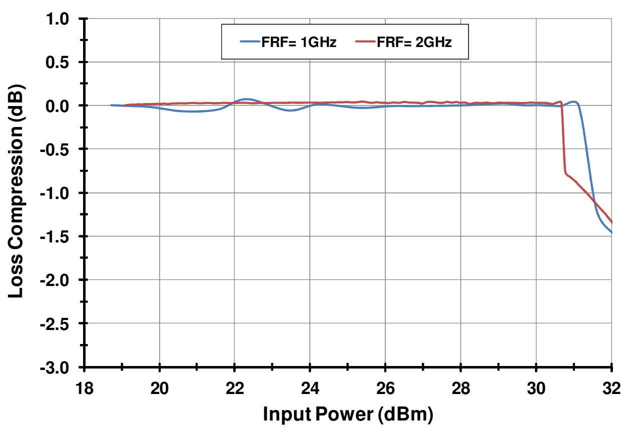
Switching Time [T_{AMB} = 25C, 3.3V]



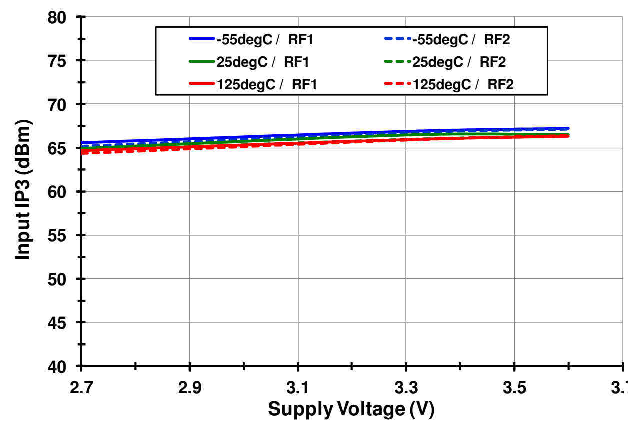
Switching Time [T_{AMB} = -40C, 3.3V]



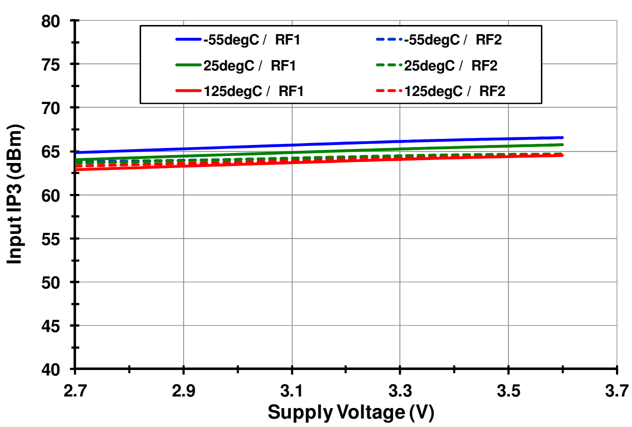
Compression [1 GHz, 2 GHz, RF1]



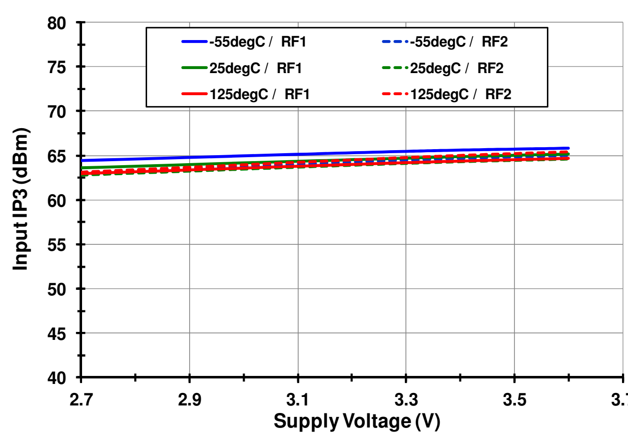
Input IP3 [1 GHz]



Input IP3 [2 GHz]

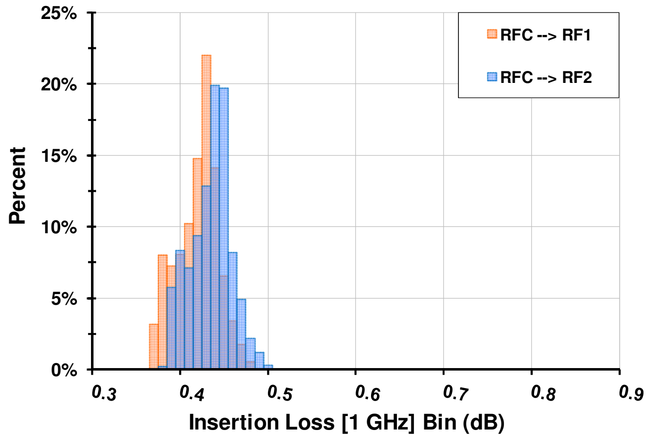


Input IP3 [3 GHz]

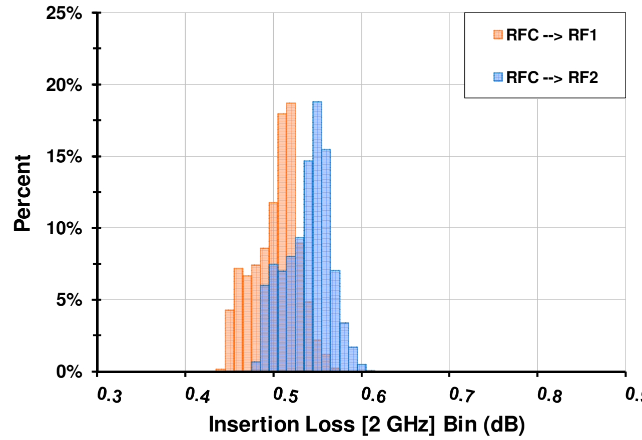


TYPICAL OPERATING CONDITIONS HISTOGRAMS [N=4800, T_{CASE}= 25C] (-4-)

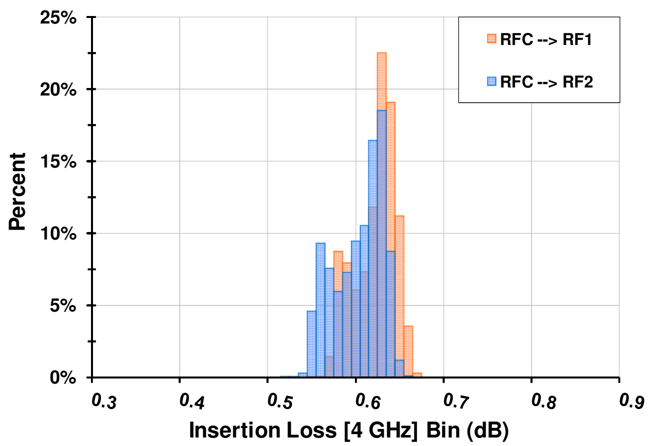
Insertion Loss [RF = 1 GHz]



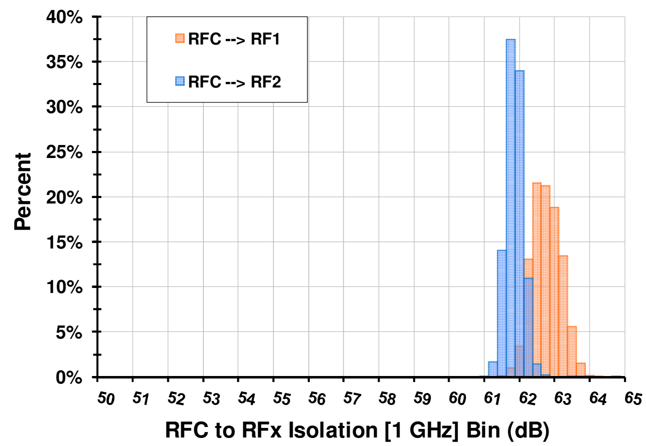
Insertion Loss [RF = 2 GHz]



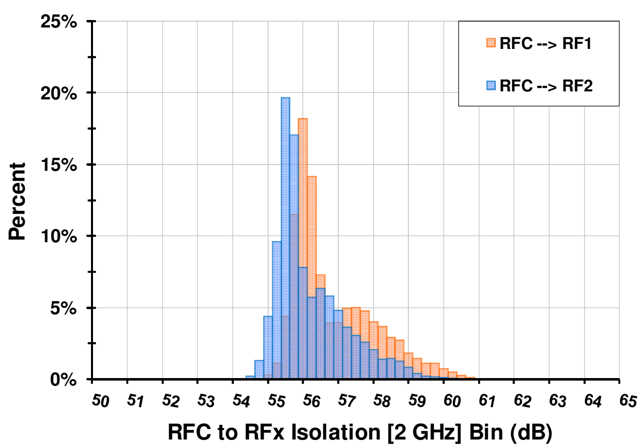
Insertion Loss [RF = 4 GHz]



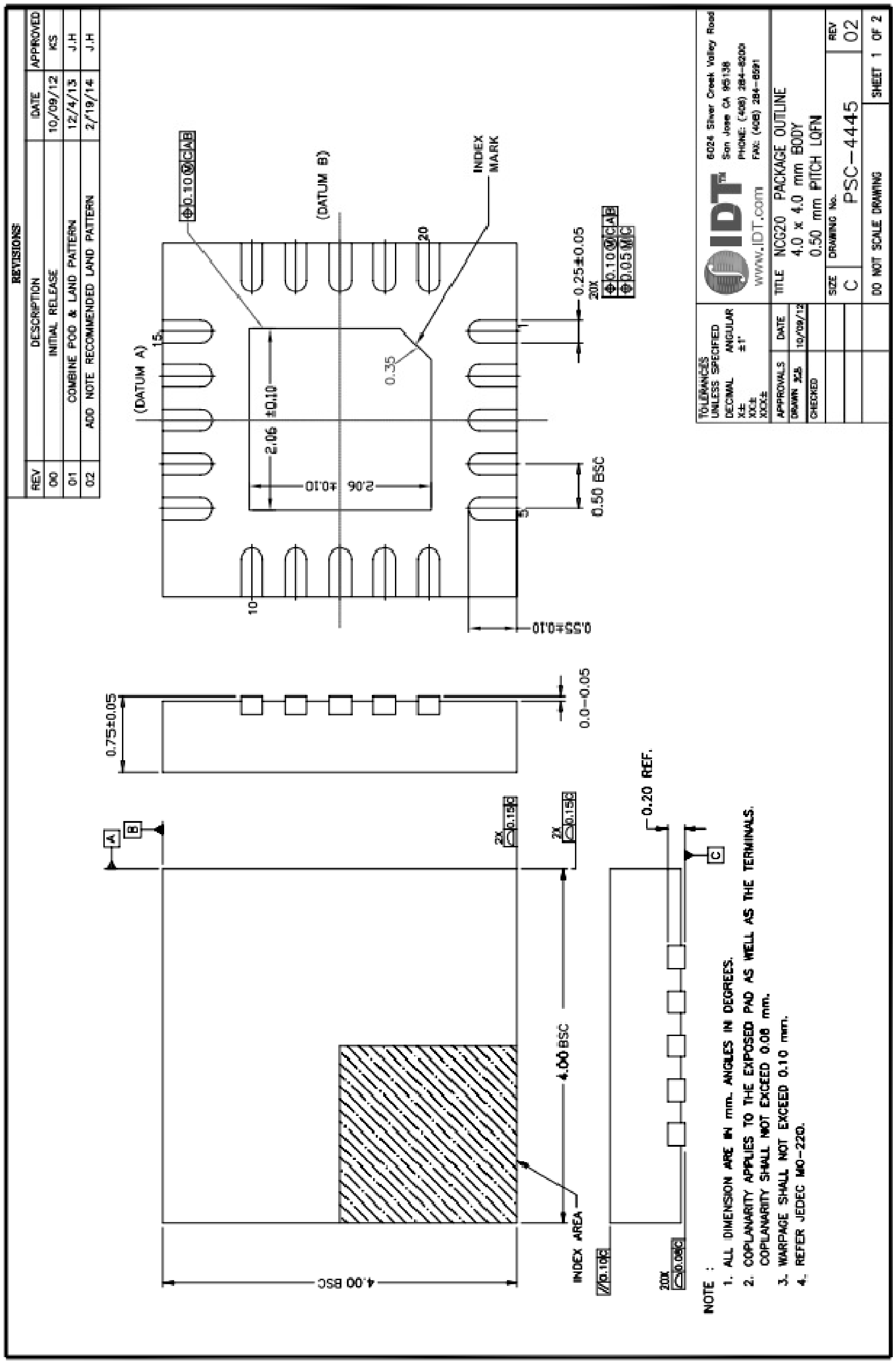
Isolation [RF = 1 GHz]



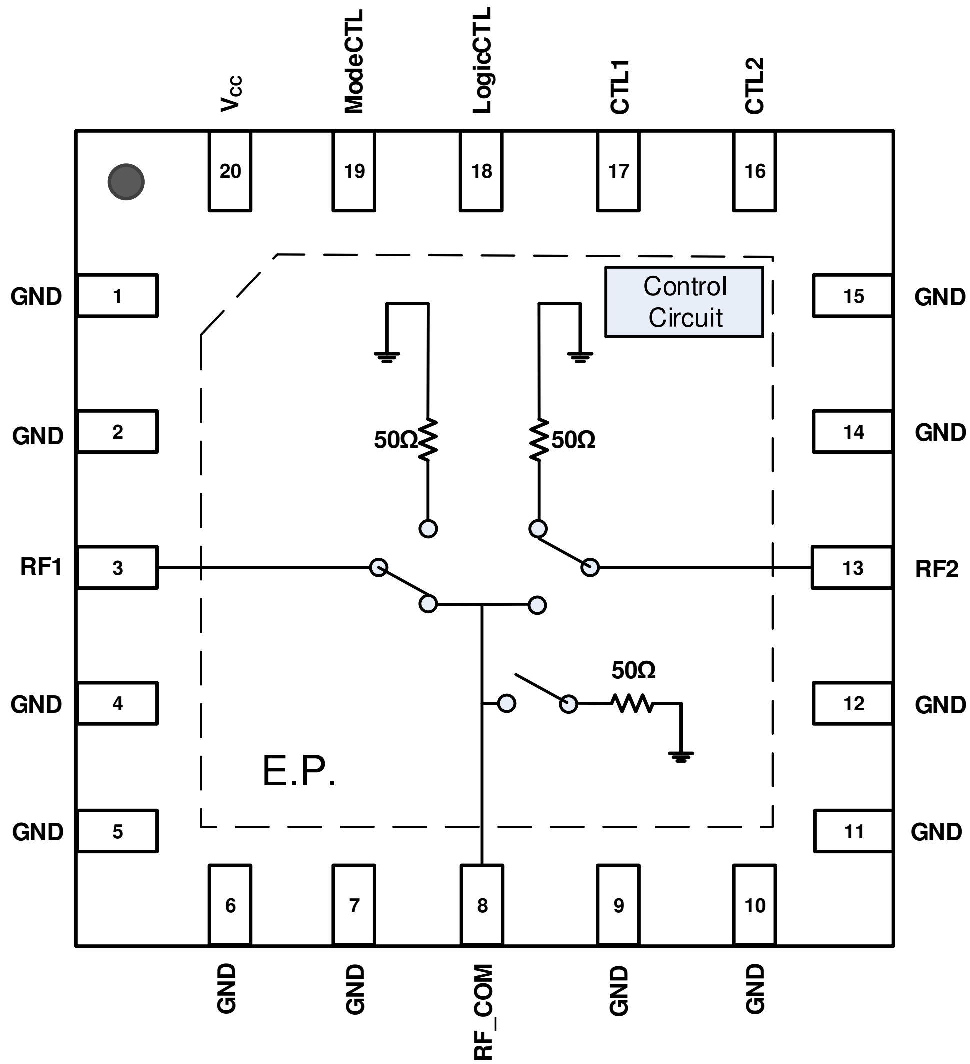
Isolation [RF = 2 GHz]



Package Drawing (NCG20 4x4 20 pin)



PINOUT & BLOCK DIAGRAM



PIN DESCRIPTION

PIN	NAME	FUNCTION
1,2,4,5,6,7,9, 10,11,12,14, 15	GND	Ground these pins as close to the device as possible.
3	RF1	RF1 Port. Matched to 50Ω. If this pin is not 0V DC, then an external coupling capacitor must be used.
8	RF_COM	RF Common Port. Matched to 50Ω. If this pin is not 0V DC, then an external coupling capacitor must be used.
13	RF2	RF2 Port. Matched to 50Ω. If this pin is not 0V DC, then an external coupling capacitor must be used.
16	CTL2	Control 2 – See Table 1 and Table 2 Switch Control Truth Tables for proper logic setting.
17	CTL1	Control 1 – See Table 1 and Table 2 Switch Control Truth Tables for proper logic setting
18	LogicCTL	Logic Control – See Table 4 Logic Control Truth Table. Apply VCC to select 1.8V logic control or GND for 3.3V logic control
19	ModeCTL	Mode Control – See Table 3 Mode Control Truth Table. Apply VCC to select 1-pin control or GND for 2-pin control
20	VCC	Power Supply. Bypass to GND with capacitors shown in the Typical Application Circuit as close as possible to pin.
21	— EP	Exposed Pad. Internally connected to GND. Solder this exposed pad to a PCB pad that uses multiple ground vias to provide heat transfer out of the device into the PCB ground planes. These multiple via grounds are also required to achieve the specified RF performance.

APPLICATIONS INFORMATION

Default Start-up

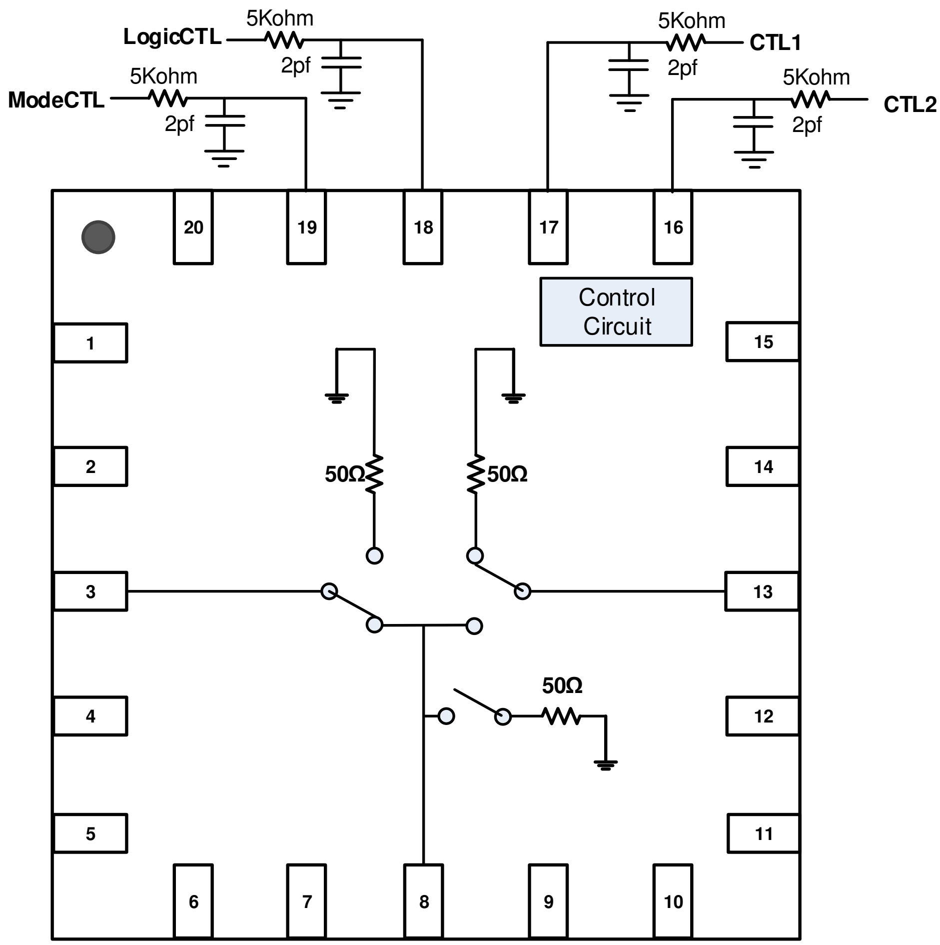
Control pins include no internal pull-down resistors to logic LOW or pull-up resistors to logic HIGH. Upon start-up, all control pins should be set to logic LOW (0) thereby enabling 2 pin switch control, opening both RF1 and RF2 paths, and setting logic control voltage to 3.3V (see above tables for LOW logic states).

Power Supplies

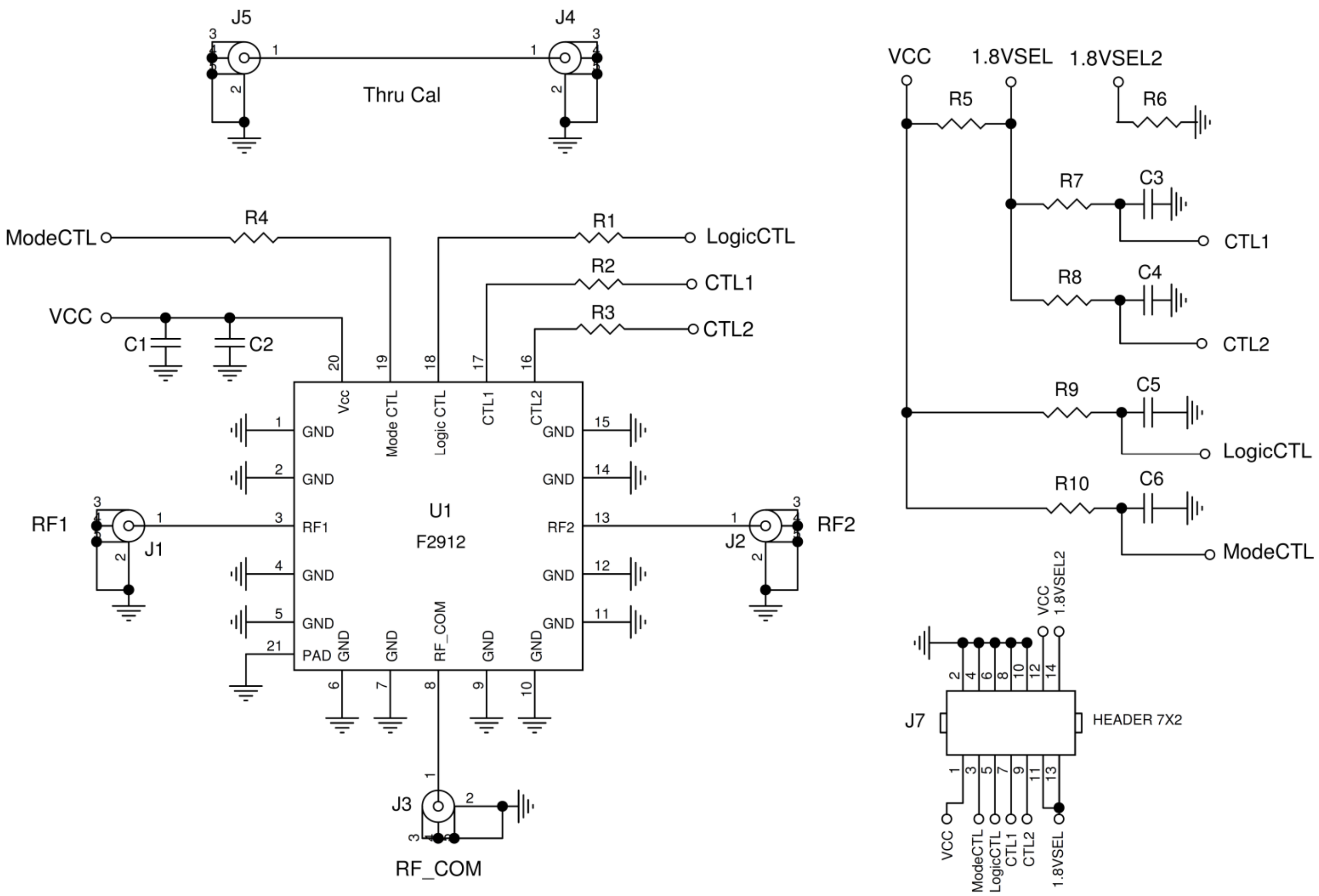
A common VCC power supply should be used for all pins requiring DC power. All supply pins should be bypassed with external capacitors to minimize noise and fast transients. Supply noise can degrade noise figure and fast transients can trigger ESD clamps and cause them to fail. Supply voltage change or transients should have a slew rate smaller than 1V/20uS. In addition, all control pins should remain at 0V (+/-0.3V) while the supply voltage ramps or while it returns to zero.

Control Pin Interface

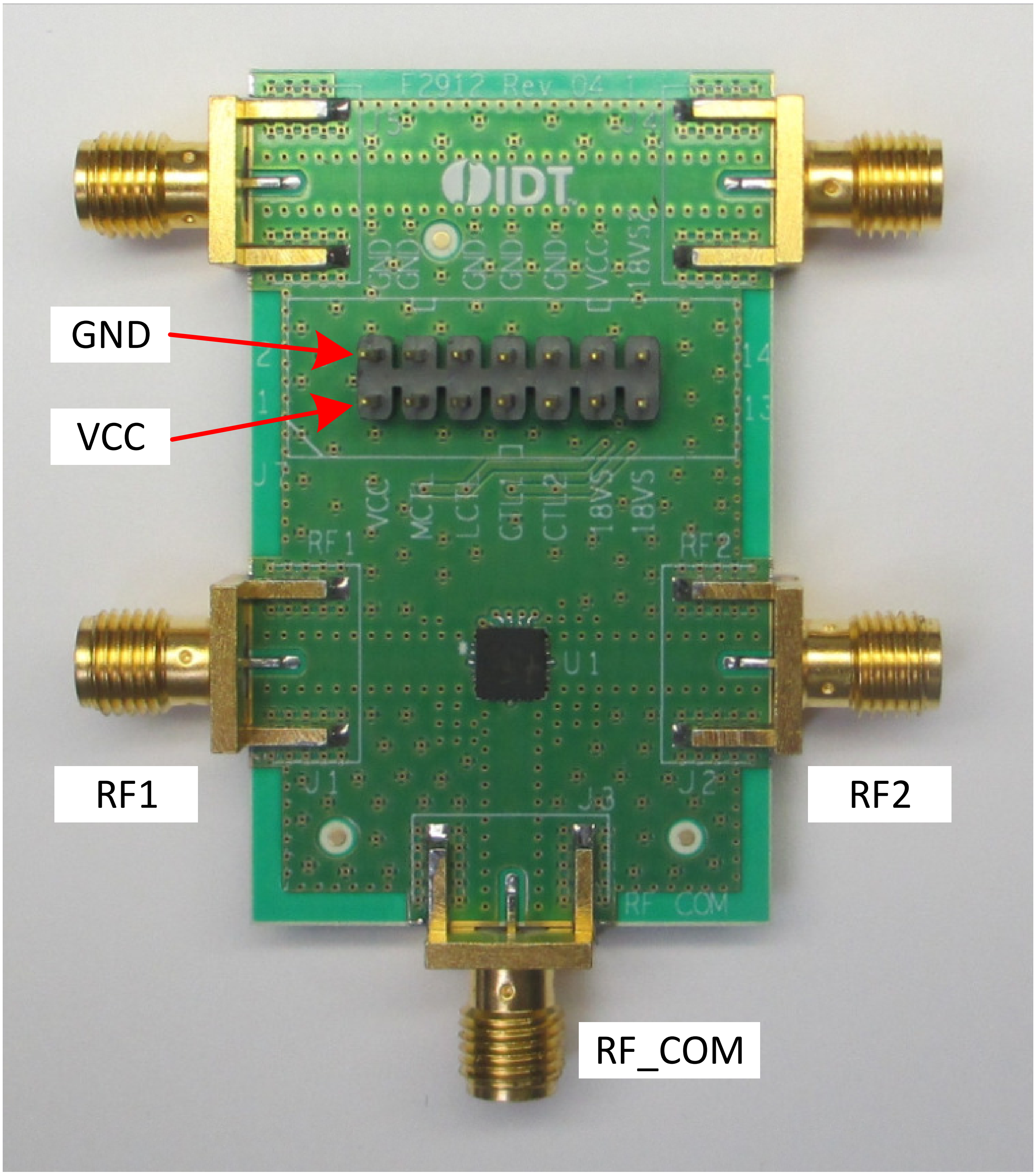
If control signal integrity is a concern and clean signals cannot be guaranteed due to overshoot, undershoot, ringing, etc., the following circuit at the input of each control pin is recommended. This applies to control pins 16, 17, 18, and 19 as shown below.



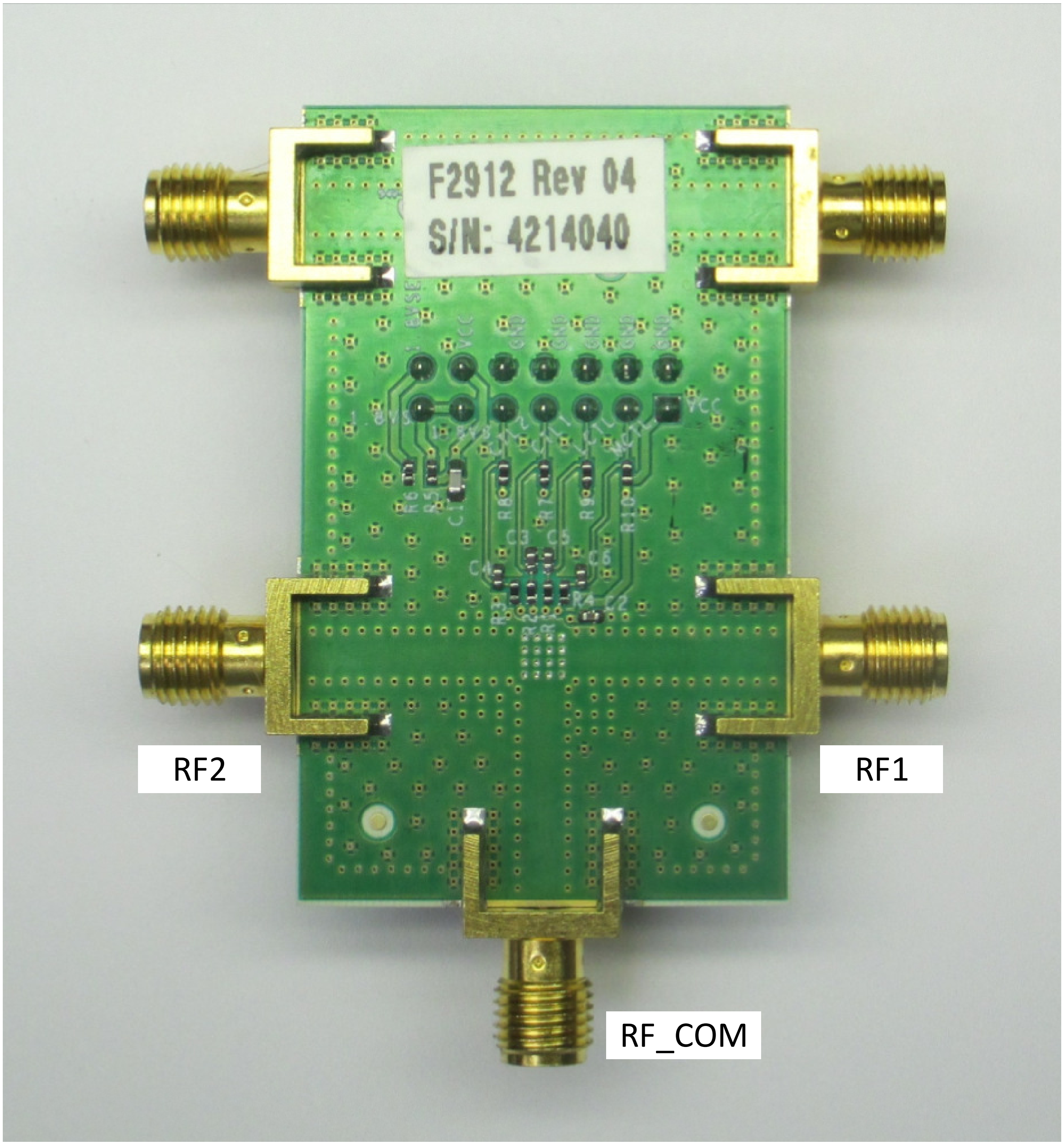
EVKIT / APPLICATIONS CIRCUIT



EVKIT PICTURE / LAYOUT (TOP)



EVKIT PICTURE / LAYOUT (BOTTOM)



EVKIT OPERATION

The F2912 EVkit has a number of control features available. Please refer to the EVkit Application Circuit and EVkit Picture for connections to this part. All bias and logic controls are done using J7 as an interface. See Table 5 for the function of each pin on J7.

J7 PIN	PIN NAME	CONNECTIONS
1	VCC	Pin to supply VCC from an external power supply.
2	GND	Pin to supply GND from an external power supply.
3	ModeCTL	Leave this pin open to select 1-pin control. A pull up resistor on the EVkit provides a logic high. If 2-pin control is desired, ground this pin by using a two pin shunt between this pin and pin 4 (GND). See Tables 1, 2, and 3 for 1-pin and 2-pin control logic.
4	GND	Pin available to shunt to pin 3 to provide a logic low.
5	LogicCTL	If using 1.8V logic for CTL1 and CTL2, leave this pin open. A pullup resistor on the kit provides a logic high. If 3.3V logic is used then ground this pin by using a two pin shunt between this pin and pin 6 (GND) .
6	GND	Pin available to shunt to pin 5 to provide a logic low.
7	CTL1	Used to control the switch state when using the 2-pin control method. Leave this pin open to allow the EVkit pullup resistor to provide a logic high. Connect to pin 8 (GND) with a two pin shunt if a logic low is desired. Actual logic levels applied to this pin depend on the setting of LogicCTL pin. This device can be damage if the incorrect logic level is applied to this pin.
8	GND	Pin available to shunt to pin 7 to provide a logic low.
9	CTL2	Used to control the switch state when using the 1-pin or 2-pin control method. Leave this pin open to allow the EVkit pullup resistor to provide a logic high. Connect to pin 10 (GND) with a two pin shunt if a logic low is desired. Actual logic levels applied to this pin depend on the setting of LogicCTL pin. This device can be damage if the incorrect logic level is applied to this pin.
10	GND	Pin available to shunt to pin 9 to provide a logic low.
11	1.8VSEL	If using 3.3V CTL1 and CTL2 logic, connect this pin to pin 12 (VCC) using a two pin shunt. If using 1.8V logic then leave this pin open.*
12	VCC	Internally connected on PCB to VCC on pin 1.
13	1.8VSEL	If using 1.8V CTL1 and CTL2 logic, connect this pin to pin 14 (1.8VSEL2) using a two pin shunt. If using 3.3V logic then leave this pin open.*
14	1.8VSEL2	If using 1.8V CTL1 and CTL2 logic, connect this pin to pin 13 (1.8VSEL) using a two pin shunt. If using 3.3V logic then leave this pin open.*

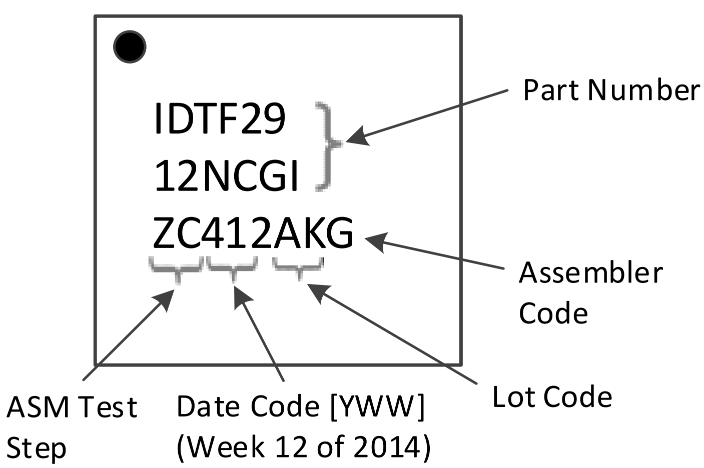
Table 5: EVkit J7 Interface Table

* Never configure the kit to have two pin shunts for both Pin11 to Pin12 and Pin13 to Pin14.

EVKIT BOM

Part Reference	QTY	DESCRIPTION	Mfr. Part #	Mfr.
C1	1	1000pF ±5%, 50V, C0G Ceramic Capacitor (0603)	GRM1885C1H102J	Murata
C2	1	100nF ±10%, 16V, X7R Ceramic Capacitor (0402)	GRM155R71C104K	Murata
C3-C6	4	100pF ±5%, 50V, C0G Ceramic Capacitor (0402)	GRM1555C1H101J	Murata
R1-R4	4	100Ω ±1%, 1/10W, Resistor (0402)	ERJ-2RKF1000X	Panasonic
R5	1	15kΩ ±1%, 1/10W, Resistor (0402)	ERJ-2RKF1502X	Panasonic
R6	1	18kΩ ±1%, 1/10W, Resistor (0402)	ERJ-2RKF1802X	Panasonic
R7-R10	4	1MegΩ ±1%, 1/10W, Resistors (0402)	ERJ-2RKF1004X	Panasonic
J1-J5	5	Edge Launch SMA (0.375 inch pitch ground tabs)	142-0701-851	Emerson Johnson
J7	1	CONN HEADER VERT 7 x 2 POS GOLD	N2514-6002-RB	3M
U1	1	SPDT Switch 4mm x 4mm QFN20-EP	F2912NCGI	IDT
	1	Printed Circuit Board (Current Rev)	F2912 REV 4.1	IDT

TOP MARKINGS



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