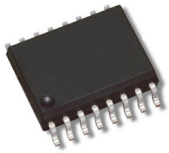
Advanced Data Sheet

STQ-2016

800 - 2500 MHz
Direct Quadrature Modulator



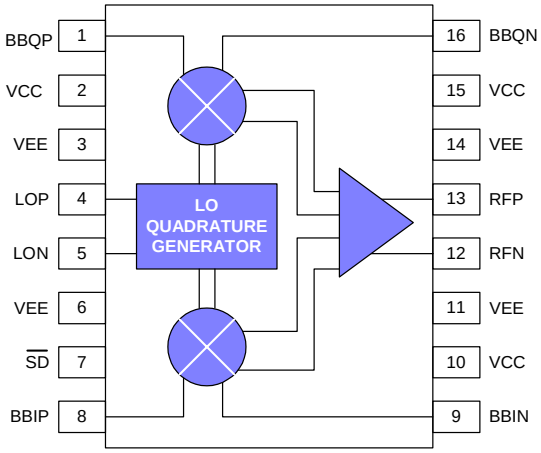
16 pin TSSOP with Exposed Pad
Package Body: 0.20 x 0.17 x 0.04 (inches)
5.0 x 4.4 x 1.0 (mm)

Product Description

The Stanford Microdevices' STQ-2016 is a direct quadrature modulator targeted for use in a wide range of communications systems. This device features a wide 800-2500 MHz operating frequency band, excellent carrier and sideband suppression, and a low broadband noise floor.

The STQ-2016 uses silicon germanium device technology and delivers a typical output power of -10dBm with greater than 60dB IM3 suppression. A shutdown feature is included that, when enabled, attenuates the output by 60dB.

Functional Block Diagram



Product Features

- **800-2500 MHz operating frequency**
- **No external IF filter**
- **Very low noise floor performance**
- **Excellent carrier and sideband suppression**
- **Low LO drive requirements**
- **Shut-down feature**
- **Single 5 volt supply**
- **Supports wideband baseband input**

Applications

- **Digital communication system**
- **Spread spectrum communication systems**
- **Cellular/PCS/DCS/3G transceivers**
- **ISM band transceivers**
- **GMSK, QPSK, QAM, SSB modulators**

Key Specifications

Parameters	Test Conditions (V_S=5.0V, I=73mA, T=25°C)	Unit	Min.	Typ.	Max.
Frequency Range		MHz	800		2500
Output P1dB	f_{LO} = 2000 MHz	dBm		+3	
Carrier Feedthrough	f_{LO} = 2000 MHz	dBm		-40	
Sideband Suppression	f_{LO} = 2000 MHz	dB		40	
Broadband Noise Floor	f_{LO} = 2000 MHz, baseband inputs tied to 1.9V_{DC}, -20MHz offset from carrier	dBm/Hz		-154	
LO Drive Level		dBm	-8	-5	-2
See page 2 for general test conditions					

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Absolute Maximum Ratings

Parameters	Value	Unit
Supply Voltage	6.0	V_{DC}
LO, RF Input	+10	dBm
Min Input Voltage (BBIP, BBIN, BBQP, BBQN)	0	V_{DC}
Max Input Voltage (BBIP, BBIN, BBQP, BBQN)	3	V_{DC}
Operating Temperature	-40 to +85	ºC
Storage Temperature	-65 to +150	ºC

Test Conditions

V_S	+5V
TA	+25ºC
Baseband Inputs	1.9V DC bias, 200kHz frequency, 300mVp-p per pin = 600mVp-p differential drive, I and Q signals in quadrature
LO Input	-5dBm @ 2000 MHz

Product Specifications – RF Output

Parameters	Additional Test Conditions	Unit	Min.	Typ.	Max.
Frequency Range		MHz	800		2500
Output Power		dBm		-11.5	
RF Port Return Loss	matched to 50 ohm ref	dB	14		
Output P1dB		dBm		+3	
Carrier Feedthrough		dBm		-40	
Sideband Suppression		dB		40	
IM3 Suppression	two-tone baseband input @ 600mVp-p differential per tone	dB		65	
Broadband Noise Floor	baseband inputs tied to 1.9V_{DC}, -20MHz offset from carrier	dBm/Hz		-154	
Quadrature Phase Error		deg	-2		+2
I/Q Amplitude Balance		dB	-0.2		+0.2

Product Specifications - Modulation Input

Parameters	Additional Test Conditions	Unit	Min.	Typ.	Max.
Baseband Frequency Input	-3dB bandwidth, baseband inputs terminated in 50 ohms	MHz	DC		1000
Baseband Input Resistance	per pin	kohms		4.4	
Baseband Input Capacitance	per pin	pF		0.5	

Product Specifications - LO Input

Parameters	Additional Test Conditions	Unit	Min.	Typ.	Max.
Usable LO Frequency		MHz	800		2500
LO Drive Level		dBm	-8	-5	-2
LO Port Return Loss	matched to 50 ohm ref	dB	14		

Product Specifications – Miscellaneous

Parameters	Additional Test Conditions	Unit	Min.	Typ.	Max.
Shut-Down Attenuation		dB		60	
Shut-Down Pin Resistance	@ 1MHz	kohm		11.9	
Shut-Down Pin Capacitance	@ 1MHz	pF		5.2	
Shut-Down Input Thresholds		—		CMOS	
Shut-Down Settling Time		ns		<500	
Supply Voltage		V	+4.75	+5	+5.25
Supply Current		mA		73	
Device Thermal Resistance	junction-case	ºC/W		TBD	

Typical Device Performance

Fig.1 SSB Power vs. LO Frequency

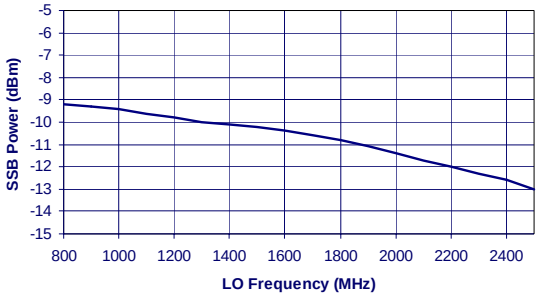


Fig.2 Output P1dB vs. LO Frequency

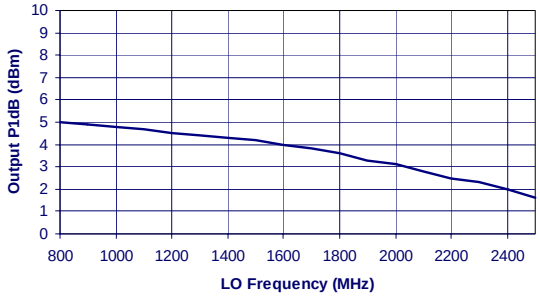


Fig.3 Carrier Feedthrough vs. LO Frequency

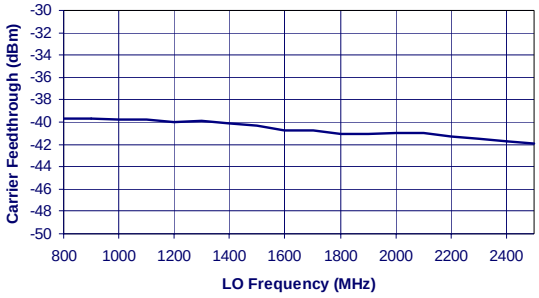


Fig.4 Sideband Suppression vs. LO Frequency

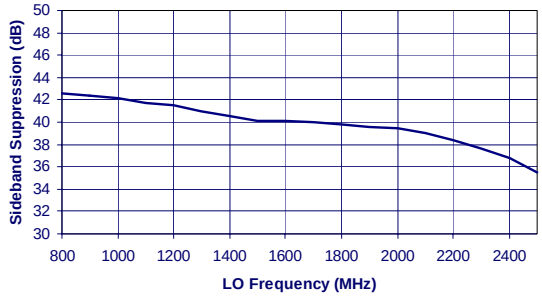
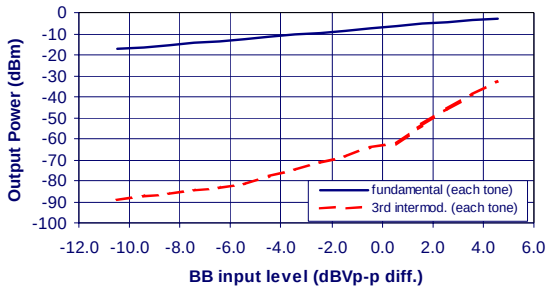


Fig.5 Intermodulation Distortion vs. SSB Output Power



Small Signal S-Parameters

RF Port

Frequency (MHz)	Single-Ended		Differential	
	Mag.	Ang.	Mag.	Ang.
800	0.364	162.7	0.125	89.26
900	0.366	160.3	0.141	86.34
1000	0.368	157.9	0.156	83.74
1100	0.370	155.6	0.171	81.38
1200	0.372	153.3	0.186	79.2
1300	0.374	151.1	0.200	77.18
1400	0.377	148.8	0.214	75.27
1500	0.380	146.6	0.227	73.48
1600	0.383	144.4	0.240	71.77
1700	0.387	142.2	0.253	70.15
1800	0.391	139.9	0.265	68.6
1900	0.395	137.6	0.277	67.12
2000	0.398	135.2	0.289	65.71
2100	0.402	132.7	0.301	64.35
2200	0.404	130.3	0.312	63.04
2300	0.406	128.0	0.322	61.79
2400	0.407	125.7	0.333	60.58
2500	0.408	123.6	0.343	59.41

LO Port

Frequency (MHz)	Single-Ended		Differential	
	Mag.	Ang.	Mag.	Ang.
800	0.948	-29.69	0.106	81.92
900	0.940	-33.43	0.119	80.9
1000	0.931	-37.18	0.132	79.89
1100	0.921	-40.95	0.145	78.88
1200	0.910	-44.75	0.158	77.87
1300	0.898	-48.56	0.171	76.87
1400	0.886	-52.39	0.184	75.86
1500	0.873	-56.25	0.197	74.85
1600	0.859	-60.13	0.210	73.85
1700	0.845	-64.03	0.223	72.84
1800	0.830	-67.96	0.236	71.84
1900	0.814	-71.89	0.248	70.84
2000	0.798	-75.84	0.261	69.84
2100	0.781	-79.79	0.273	68.84
2200	0.765	-83.77	0.286	67.84
2300	0.748	-87.78	0.298	66.85
2400	0.732	-91.83	0.310	65.86
2500	0.716	-95.94	0.322	64.86

Notes:
1. VCC = +5.0V, T = +25ºC.
2. For single-ended S-parameters, the corresponding differential pin is left floating.
3. Data is referenced to the foot of the package lead and does not include the applications circuit.
4. All data simulated.

Pin Out Description

Pin #	Function	Description	Additional Comments
1	BBQP	Q-channel baseband input, positive terminal	Nominal DC bias voltage is 1.9V (biased internally)
2	VCC	Positive supply (+5V)	
3	VEE	Ground	
4	LOP	Local oscillator input, positive terminal	Nominal DC voltage is 2.0V. Input should be AC-coupled.
5	LON	Local oscillator input, negative terminal	Nominal DC voltage is 2.0V. Input should be AC-coupled.
6	VEE	Ground	
7	$\overline{SD}$	Shut-down control	CMOS logic levels. Logic high = normal operation; logic low = shut-down enabled.
8	BBIP	I-channel baseband input, positive terminal	Nominal DC bias voltage is 1.9V (biased internally)
9	BBIN	I-channel baseband input, negative terminal	Nominal DC bias voltage is 1.9V (biased internally)
10	VCC	Positive supply (+5V)	
11	VEE	Ground	
12	RFN	RF output, negative terminal	Nominal DC voltage is 2.4V. Output should be AC-coupled.
13	RFP	RF output, positive terminal	Nominal DC voltage is 2.4V. Output should be AC-coupled.
14	VEE	Ground	
15	VCC	Positive supply (+5V)	
16	BBQN	Q-channel baseband input, negative terminal	Nominal DC bias voltage is 1.9V (biased internally)

Part Number Ordering Information

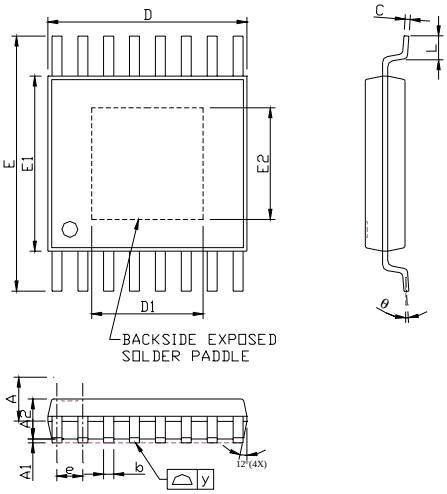
Part Number	Reel Size	Devices/Reel
STQ-2016	TBD	TBD

Caution: ESD Sensitive
Appropriate precaution in handling, packaging and testing devices must be observed.

Part Symbolization

The part will be symbolized with a “TBD” marking designator on the top surface of the package.

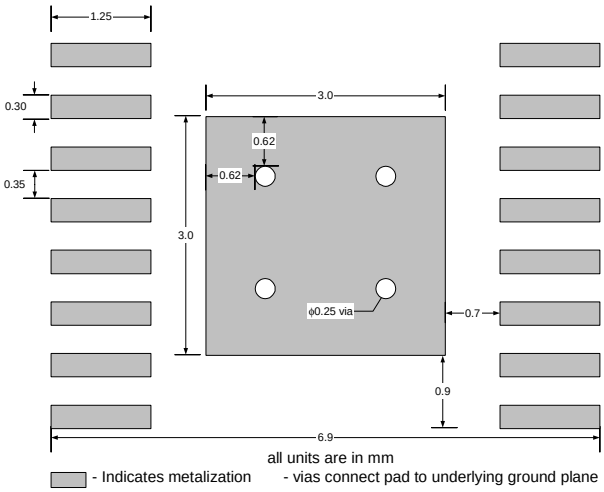
Package Dimensions



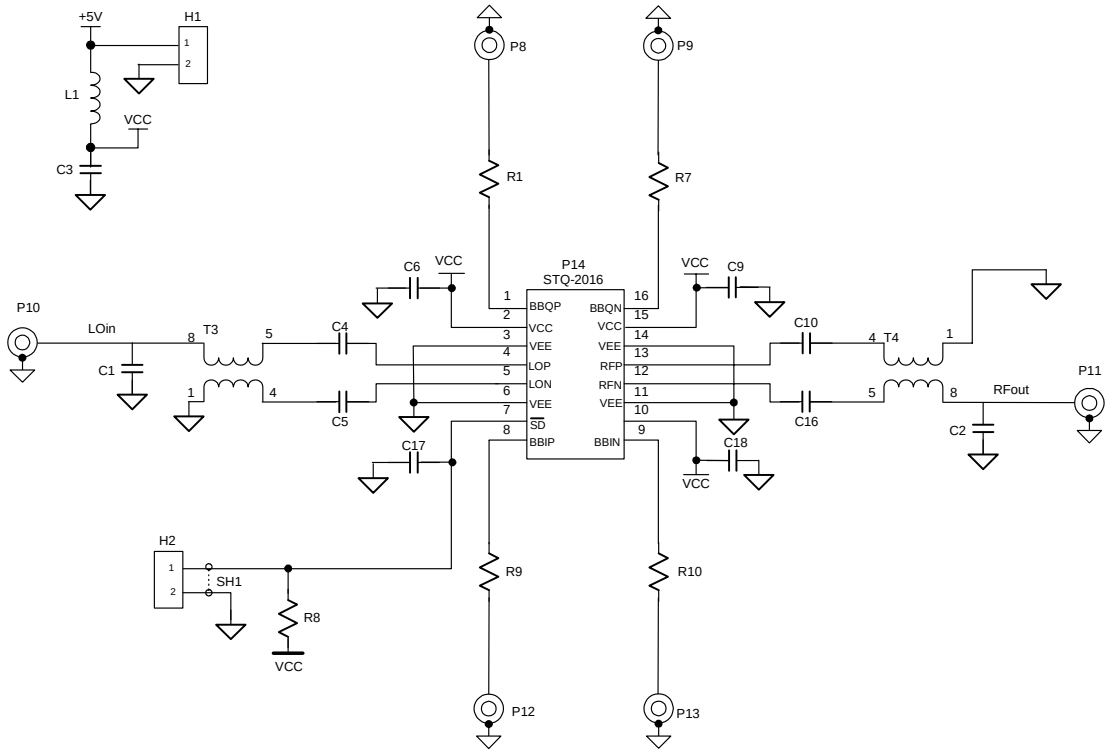
NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH PROTRUSIONS OR GATE BURRS
2. TOLERANCE ±0.1 mm UNLESS OTHERWISE SPECIFIED
3. COPLANARITY : 0.1 mm
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
5. FOLLOWED FROM JEDEC MO-153

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	——	——	1.15	——	——	0.045
A1	0.00	——	0.10	0.000	——	0.004
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19	——	0.30	0.007	——	0.012
C	0.09	——	0.20	0.004	——	0.008
D	4.90	5.00	5.10	0.193	0.197	0.201
D1	——	2.80	——	——	0.110	——
E	——	6.40	——	——	0.252	——
E1	4.30	4.40	4.50	0.169	0.173	0.177
E2	——	2.80	——	——	0.110	——
e	——	0.65	——	——	0.026	——
L	0.45	0.60	0.75	0.018	0.024	0.030
y	——	——	0.10	——	——	0.004
θ	0°	——	8°	0°	——	8°

Test PCB Pad Layout



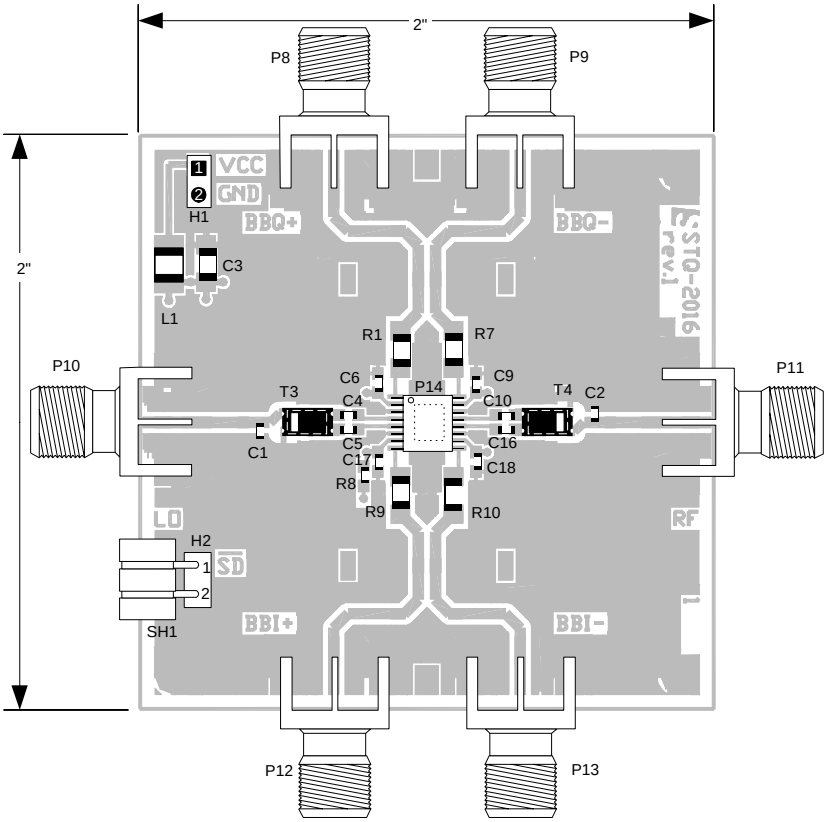
Demo Test Board Schematic



Bill of Materials (for evaluation at 2GHz)

Component Designator	Value	Qty	Vendor	Part Number	Description
P14		1	SMDI	STQ-2016	SiGe Direct Quadrature Modulator
P8, P9, P10, P11, P12, P13		6	Johnson Components	142-0701-851	SMA connector, end launch with tab, for .062” thick board
H1, H2		2	AMP	640453-2	2-pin header, right angle
T3, T4	1:1	2	Panasonic	EHF-FD1619	RF transformer, 1200-2200MHz
L1	1uH	1	Panasonic	ELJ-FA1R0KF2	Inductor, 1210 footprint, ±10% tolerance
R1, R7, R9, R10	200 ohm	4	Venkel	CR1206-8W-2000T	Resistor, 1206 footprint, ±1% tolerance
R8	1 kohm	1	Venkel	CR0603-16W-1001FT	Resistor, 0603 footprint, ±1% tolerance
C1, C2	0.5pF	2	Venkel	C0603COG500-0R5CNE	Capacitor, 0503 footprint ±0.25pF tolerance
C6, C18	6.8pF	2	Venkel	C0603COG500-6R8CNE	Capacitor, 0603 footprint, COG dielectric, ±5% tolerance
C9, C17	1nF	2	Venkel	C0603COG500-102JNE	Capacitor, 0603 footprint, COG dielectric, ±5% tolerance
C3	2.2uF	1	Venkel	C1206Y5V160-225ZNE	Capacitor, 1206 footprint, Y5V dielectric, 16V rating
C4, C5, C10, C16	2.2pF	4	Venkel	C0603COG500-2R2CNE	Capacitor, 0603 footprint, COG dielectric, ±0.25pF tolerance
SH1		1	3M	929950-00	Shunt for 2-pin header

Demo Test Board
(Fully Assembled PCB)



Note: Remove SH1 to enable modulated output.