DATA SHEET

SKY77589-21 Tx-Rx Quad-Band Front-End Module for GSM / GPRS (824-915 MHz) (1710-1910 MHz) w/ Six Linear TRx Switch Ports

Applications

- Quad-band cellular handsets encompassing
  - Class 4 GSM850 / GSM900
  - DCS1800 / PCS1900
  - Class 12 GPRS multi-slot operation
  - EDGE downlink compatible

Features

- High efficiency
  - 42% (GSM850)
  - 45% (GSM900)
  - 39% (DCS1800 / PCS1900)
- Low transmit supply current
  - 1.35 A (GSM850)
  - 1.26 A (GSM900)
  - 0.92 A (DCS1800 / PCS1900)
- 50 Ω matched Input/Output
- Tx–VCO-to-antenna and antenna-to-Rx-SAW filter RF interface
- RF switch affords high linearity, low insertion loss, and 0 V DC on Rx ports
- Small, low profile package
  - 6 mm x 6 mm x 0.9 mm
  - 28-pad configuration

Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to Skyworks *Definition of Green*™, document number SQ04-0074.

Description

SKY77589-21 is a transmit and receive Front-End Module (FEM) with integrated power amplifier control designed in a low profile, compact form factor for quad-band cellular handsets comprising GSM850 / GSM900 and DCS1800 / PCS1900 operation. The SKY77589-21 offers a complete Transmit VCO-to-Antenna and Antenna-to-Receive SAW filter solution. The FEM also supports Class 12 General Packet Radio Service (GPRS) multi-slot operation and EDGE downlink.

The module consists of a GSM850 / GSM900 PA block and a DCS1800 / PCS1900 PA block, impedance-matching circuitry for 50 ohm input and output impedances, Tx harmonics filtering, high linearity / low insertion loss RF switch, and a Power Amplifier Control (PAC) block. One PA block supports the GSM850 / GSM900 bands and the other PA block supports the DCS1800 / PCS1900 bands. Both PA blocks share common power supply pads to distribute current. The output of each PA block and the outputs to the six receive pads are connected to the antenna pad through an RF switch. Six broadband interchangeable receive ports provide flexibility to support multimode and multiband configurations. The GaAs die, the CMOS die, the Switch die, and passive components are mounted on a multi-layer laminate substrate. The assembly is encapsulated with plastic overmold.

Band selection and control of transmit and receive are performed using four external control pads. Refer to the block diagram in Figure 1 below. The band select pad, BS1, BS2, Mode, and TxEN select GSM850, GSM900, DCS, and PCS modes of operation.

Transmit enable TxEN controls receive or transmit mode of the RF switch (Tx = logic 1). Proper timing between transmit enable TxEN and Analog Power Control VRAMP allows for high isolation between the antenna and Tx–VCO while the VCO is being tuned prior to the transmit burst.

The SKY77589-21 is compatible with logic levels from 1.2 V to 2.9 V for BS1, BS2, MODE, and TxEN pads.

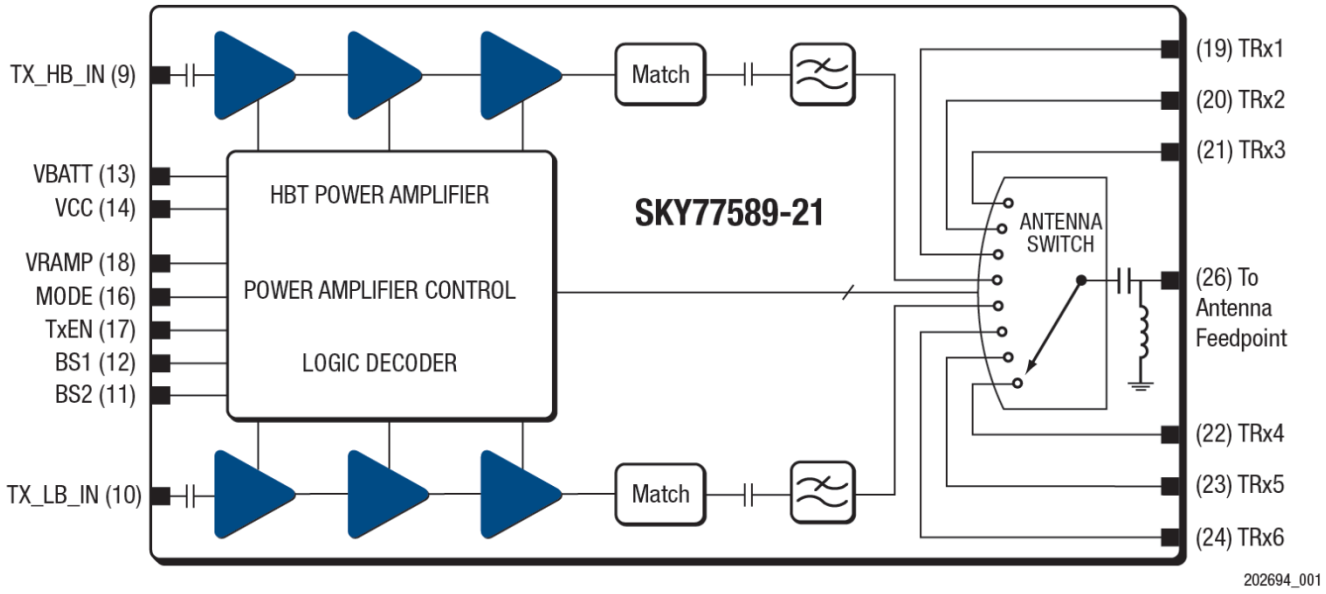


Figure 1. SKY77589-21 Functional Block Diagram

Electrical Specifications

The following tables list the electrical characteristics of the SKY77589-21 Front-End Module. The absolute maximum ratings and recommended operating conditions for the SKY77589-21 are listed in Table 1 and Table 2, respectively. Table 3 specifies the mode control logic and Tables 4 through 9 contain the electrical characteristics of the SKY77589-21 for modes GSM850 / GSM900 and DCS1800 / PCS1900. Figure 2 presents an application schematic for the SKY77589-21.

The SKY77589-21 is a static-sensitive electronic device and should not be stored or operated near strong electrostatic fields. Detailed information on device dimensions, pad descriptions, packaging and handling can be found in later sections of this data sheet.

Table 1. SKY77589-21 Absolute Maximum Ratings

No damage assuming only one parameter is set at limit with all other parameters set at nominal value.

Parameter		Minimum	Nominal	Maximum	Unit
Input Power (P_{IN})		—	—	15	dBm
Supply Voltage (V_{CC}),	Standby[1]	—	—	6	V
	BS1, BS2, MODE, TxEN	—	—	V_{BATT}	
Control Voltage (V_{RAMP})		–0.5	—	V_{BATT}	V
Temperature	Operating[2]	–40	+25	+85	°C
	Storage	–55	+25	+150	

1 *Standby [Supply voltage < 1 µs (measurement to ground)]*

2 *Ambient temperature.*

Table 2. SKY77589-21 Recommended Operating Conditions

Parameter			Minimum	Nominal	Maximum	Unit
Supply Voltage – GMSK[1]		V_{BATT}	3.1	3.5	4.3	V
		V_{CC}	2.5	3.5	4.3	
Operating Case Temperature (T_{CASE})[2]	1-Slot (12.5% duty cycle)		–20	—	+85	°C
	2-Slot (25% duty cycle)		–20	—	+85	
	3-Slot (37.5% duty cycle)[3]		–20	—	+85	
	4-Slot (50% duty cycle)[3]		–20	—	+85	

1 *V_{BATT} and V_{CC} should be common unless DC/DC is used and V_{CC} can be separately supplied.*

2 *Case Operating Temperature refers to the temperature of the GROUND PAD on the underside of the package.*

3 *Maximum output power must be reduced by 6 dB to support 3-slot and 4-slot operation.*

Table 3. SKY77589-21 Mode Control Logic

Mode	Input Control Bits			
	TxEN	MODE	BS1	BS2
Standby	0	0	0	0
LB_GMSK_Tx	1	0	0	1
HB_GMSK_Tx	1	0	1	1
TRx1	0	1	0	0
TRx2	0	1	1	0
TRx3	0	1	0	1
TRx4	0	1	1	1
TRx5	0	0	1	0
TRx6	0	0	0	1

Table 4. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. Operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs; duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

General							
Parameter		**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Supply Voltage		V_{BATT}	—	3.1	3.5	4.3	V
		V_{CC}	—	2.5	3.5	4.3	
Power Control Impedance		Z_{VRAMP}	—	5	—	—	MΩ
BS1 Control Voltage	LOW	V_{BS1_LOW}	—	–0.1	—	0.3	V
	HIGH	V_{BS1_HIGH}		1.2	—	Note 1	
BS1 Current		I_{BS1}	—	—	—	36	µA
BS2 Control Voltage	LOW	V_{BS2_LOW}	—	–0.1	—	0.3	V
	HIGH	V_{BS2_HIGH}		1.2	—	Note 1	
BS2 Current		I_{BS2}	—	—	—	36	µA
MODE Control Voltage	LOW	V_{MODE_LOW}	—	–0.1	—	0.3	V
	HIGH	V_{MODE_HIGH}	—	1.2	—	Note 1	
MODE Select Current		I_{MODE}	—	—	—	36	µA
TxEN Control Voltage	LOW	V_{TxEN_LOW}	—	–0.1	—	0.3	V
	HIGH	V_{TxEN_HIGH}		1.2	—	Note 1	
TxEN Control Current		I_{TxEN}	—	—	—	36	µA
Leakage Current	Standby Mode	I_{QS}	3.1 V ≤ V_{BATT} ≤ 4.3 V BS1 = V_{BS1_LOW} V_{RAMP} ≤ 0.1 V TxEN ≤ $TxEN_{LOW}$ BS2 ≤ V_{BS2_LOW} MODE < V_{MODE_LOW} T_{CASE} = +25 °C P_{IN} ≤ –60 dBm	—	10	25	µA
	WCDMA Mode	I_{QMODE}	3.1 V ≤ V_{BATT} ≤ 4.3 V V_{RAMP} ≤ 0.1 V TxEN ≤ $TxEN_{LOW}$ T_{CASE} = +25 °C P_{IN} ≤ –60 dBm	—	70	120	

[1] *Apply the lesser of 2.9 V or V_{CC}.*

Table 5-1. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. Operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs; duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

GSM850 (Tx_LB) Mode (f = 824 MHz to 849 MHz; 0 dBm ≤ P_{IN} ≤ 6 dBm)						
Parameter	**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	f	—	824	—	849	MHz
Input Power	P_{IN}	—	0	—	6	dBm
Analog Power Control Voltage	V_{RAMP}	Minimum PCL to P_{RATED}	—	—	1.6	V
Power Added Efficiency	PAE	V_{BATT} = 3.5 V P_{OUT} = 33 dBm P_{IN} = 3 dBm duty cycle 1:8 T_{CASE} = +25 °C	—	42	—	%
Supply Current at Rated Power	I_{BATT}_33 dBm	V_{BATT} = 3.5 V P_{OUT} = 33 dBm P_{IN} = 3 dBm duty cycle 1:8 T_{CASE} = +25 °C	—	1.35	—	A
Harmonics	$2f_0$ to $13f_0$	BW = 3 MHz 5 dBm ≤ P_{OUT} ≤ 33 dBm V_{RAMP} controlled[1]	—	–40	–33	dBm
Output Power	P_{OUT_MAX}	V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{IN} = 0 dBm	—	34.4	—	dBm
	$P_{OUT\_MAX\_EXTREME}$	V_{BATT} = 3.1 V –20 °C ≤ T_{CASE} ≤ +85 °C P_{IN} = 0 dBm	31.0	—	—	
Input VSWR	Γ_{IN}	5 dBm ≤ P_{OUT} ≤ 33 dBm V_{RAMP} controlled[1]	—	1.5:1	2.5:1	
Forward Isolation[2]	P_{OUT_RX}	P_{IN} = 6 dBm V_{RAMP} ≤ 0.1 V BS1 = V_{BS1_LOW} BS2 = V_{BS2_LOW} TxEN = V_{TxEN_LOW}	—	–58	–42	dBm
	$P_{OUT\_ENABLED\_TX}$	P_{IN} = 6 dBm V_{RAMP} ≤ 0.1 V BS1 = V_{BS1_LOW} BS2 = V_{BS2_HIGH} TxEN = V_{TxEN_HIGH}	—	–40	–15	

Table 5-2. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs; duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

GSM850 (Tx_LB) Mode (f = 824 MHz to 849 MHz, 0 dBm ≤ P_{IN} ≤ 6 dBm)						
Parameter	**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Coupling of GSM850/900 Tx Output (f_0) to Rx Output pad[2]	CGHI_Tx-Rx_f_0	V_{BATT} + 3.5 V, 5 dBm ≤ P_{OUT} ≤ 33 dBm	—	—	0	dBm
Coupling of GSM850/900 Tx Output ($2f_0$, $3f_0$) to Rx Output pad[2]	CGHI_Tx-DCS_Rx	V_{BATT} + 3.5 V, 5 dBm ≤ P_{OUT} ≤ 33 dBm	—	—	–32	dBm
Spurious	Spur	All combinations of the following parameters: V_{RAMP} = controlled[1] P_{IN} = min. to max. 3.1 V ≤ V_{BATT} ≤ 4.3 V –20 °C ≤ T_{CASE} ≤ +85 °C Load VSWR = 12:1, all phase angles	No parasitic oscillation > –36 dBm			
Load Mismatch	Load	All combinations of the following parameters: V_{RAMP} = controlled[1] P_{IN} = min. to max. 3.1 V ≤ V_{BATT} ≤ 4.3 V –20 °C ≤ T_{CASE} ≤ +85 °C Load VSWR = 20:1, all phase angles	No module damage or permanent degradation			
Rx Band Noise	R_{X_NOISE}	At f_0 + 20 MHz (869 MHz to 894 MHz) RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 33 dBm	—	–85	–83	dBm
		At 1930 MHz to 1990 MHz RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 33 dBm	—	—	–84	
Power Control Dynamic Range	PC_{DR}	—	30	—	—	dB
Power Control Slope	PC_S	V_{BATT} = 3.5 V P_{IN} = 3 dBm P_{OUT} = 5 dBm T_{CASE} = +25 °C	—	65	—	dB/V

[1] VRAMP is calibrated to each PCL at T_{CASE} = +25 °C, VBATT = 3.5 V, PIN = 3 dBm, 50 Ω load.

[2] Terminate all unused RF ports with 50 Ω loads

Table 6-1. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs; duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

GSM900 (Tx_LB) Mode (f = 880 MHz to 915 MHz, 0 dBm ≤ P_{IN} ≤ 6 dBm)						
Parameter	**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Units**
Frequency Range	f	—	880	—	915	MHz
Input Power	P_{IN}	—	0	—	6	dBm
Analog Power Control Voltage	V_{RAMP}	Minimum PCL to P_{RATED}	—	—	1.6	V
Power Added Efficiency	PAE	V_{BATT} = 3.5 V P_{OUT} = 33 dBm P_{IN} = 3 dBm duty cycle 1:8 T_{CASE} = +25 °C	—	45	—	%
Supply Current at Rated Power	I_{BATT}_33 dBm	V_{BATT} = 3.5 V P_{OUT} = 33 dBm P_{IN} = 3 dBm duty cycle 1:8 T_{CASE} = +25 °C	—	1.26	—	A
Harmonics	$2f_0$ to $13f_0$	BW = 3 MHz 5 dBm ≤ P_{OUT} ≤ 33 dBm V_{RAMP} controlled[1]	—	–40	–33	dBm
Output Power	P_{OUT_MAX}	V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{IN} = 0 dBm	—	34.3	—	dBm
	$P_{OUT\_MAX\_EXTREME}$	V_{BATT} = 3.1 V –20 °C ≤ T_{CASE} ≤ +85 °C PIN = 0 dBm	31.00	—	—	
Input VSWR	Γ_{IN}	P_{OUT} = 5 dBm to 33 dBm V_{RAMP} controlled[1]	—	1.5:1	2.5:1	
Forward Isolation[2]	P_{OUT_Rx}	P_{IN} = 6 dBm V_{RAMP} ≤ 0.1 V BS1 = V_{BS1_LOW} BS2 = V_{BS2_LOW} TxEN = V_{TxEN_LOW}	—	–58	–42	dBm
	$P_{OUT\_ENABLED\_Tx}$	P_{IN} = 6 dBm V_{RAMP} ≤ 0.1 V BS1 = V_{BS1_LOW} BS2 = V_{BS2_HIGH} TxEN = V_{TxEN_HIGH}	—	–40	–15	

Table 6-2. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs; duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

GSM900 (Tx_LB) Mode (f = 880 MHz to 915 MHz, 0 dBm ≤ P_{IN} ≤ 6 dBm)						
Parameter	**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Units**
Coupling of GSM850/900 Tx Output (f_0) to Rx Output pad[2]	CGHI_Tx-Rx_f_0	V_{BATT} + 3.5 V, 5 dBm ≤ P_{OUT} ≤ 33 dBm	—	—	0	dBm
Coupling of GSM850/900 Tx Output ($2f_0$, $3f_0$) to Rx Output pad[2]	CGHI_Tx_Rx	V_{BATT} + 3.5 V, 5 dBm ≤ P_{OUT} ≤ 33 dBm	—	—	–32	dBm
Spurious	Spur	All combinations of the following parameters: V_{RAMP} = controlled[1] P_{IN} = min. to max. 3.1 V ≤ V_{BATT} ≤ 4.3 V –20 °C ≤ T_{CASE} ≤ +85 °C Load VSWR = 12:1, all phase angles	No parasitic oscillation > –36 dBm			
Load Mismatch	Load	All combinations of the following parameters: V_{RAMP} = controlled[1] P_{IN} = min. to max. 3.1 V ≤ V_{BATT} ≤ 4.3 V –20 °C ≤ T_{CASE} ≤ +85 °C Load VSWR = 20:1, all phase angles	No module damage or permanent degradation			
Rx Band Noise	R_{X_NOISE}	At f_0 + 20 MHz (935 MHz to 960 MHz) RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 33 dBm	—	–85	–83	dBm
		At f_0 + 10 MHz (925 MHz to 935 MHz) RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 33 dBm	—	—	–76	
		At 1805 MHz to 1880 MHz RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 33 dBm	—	–101	–84	
Power Control Dynamic Range	PC_{DR}	—	30	—	—	dB
Power Control Slope	PC_S	V_{BATT} = 3.5 V P_{IN} = 3 dBm P_{OUT} = 5 dBm T_{CASE} = +25 °C	—	65	—	dB/V

[1] *VRAMP is calibrated to each PCL at T_{CASE} = +25 °C, VBATT = 3.5 V, PIN = 3 dBm, 50 Ω load.*

[2] *Terminate all unused RF ports with 50 Ω loads*

Table 7-1. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs and duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

DCS1800 (Tx_HB) Mode (f = 1710 MHz to 1785 MHz, 0 dBm ≤ P_{IN} ≤ 6 dBm)						
Parameter	**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Units**
Frequency Range	f	—	1710	—	1785	MHz
Input Power	P_{IN}	—	0	—	6	dBm
Analog Power Control Voltage	V_{RAMP}	Minimum PCL to P_{RATED}	—	—	1.6	V
Power Added Efficiency	PAE	V_{BATT} = 3.5 V P_{OUT} = 31 dBm P_{IN} = 3 dBm duty cycle 1:8 T_{CASE} = +25 °C	—	39	—	%
Supply Current at Rated Power	I_{BATT}_31 dBm	V_{BATT} = 3.5 V P_{OUT} = 31 dBm P_{IN} = 3 dBm duty cycle 1:8 T_{CASE} = +25 °C	—	0.92	—	A
Harmonics	$2f_0$ to $7f_0$	BW = 3 MHz, 0 dBm ≤ P_{OUT} ≤ 31 dBm V_{RAMP} controlled[1]	—	–40	–33	dBm
Output Power	P_{OUT_MAX}	V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{IN} = 0 dBm	—	32.0	—	dBm
	$P_{OUT\_MAX\_EXTREME}$	V_{BATT} = 3.1 V –20 °C ≤ T_{CASE} ≤ +85 °C P_{IN} = 0 dBm	29.0	—	—	
Input VSWR	Γ_{IN}	0 dBm≤ P_{OUT} ≤ 31 dBm V_{RAMP} controlled[1]	—	1.5:1	2.5:1	—
Forward Isolation[2]	$P_{OUT\ Rx}$	P_{IN} = 6 dBm V_{RAMP} ≤ 0.1 V BS1 = V_{BS1_LOW} BS2 = V_{BS2_LOW} TxEN = V_{TxEN_LOW}	—	–60	–51	dBm
	$P_{OUT\_ENABLED\_Tx}$	P_{IN} = 6 dBm V_{RAMP} ≤ 0.1 V BS1 = V_{BS1_HIGH} BS2 = V_{BS2_HIGH} TxEN = V_{TxEN_HIGH}	—	–40	–15	

Table 7-2. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs; duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

DCS1800 (Tx_HB) Mode (f = 1710 MHz to 1785 MHz, 0 dBm ≤ P_{IN} ≤ 6 dBm)						
Parameter	**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Units**
Coupling of DCS Tx output to Receive RF output pad[2]	CDCS_Tx-Rx_fo	0 dBm ≤ P_{OUT} ≤ 31 dBm	—	—	5	dBm
Spurious	Spur	All combinations of the following parameters: V_{RAMP} = controlled[1] P_{IN} = min. to max. 3.1 V ≤ V_{BATT} ≤ 4.3 V –20 °C ≤ T_{CASE} ≤ +85 °C Load VSWR = 12:1, all phase angles	No parasitic oscillation > –36 dBm			
Load Mismatch	Load	All combinations of the following parameters: V_{RAMP} = controlled[1] P_{IN} = min. to max. 3.1 V ≤ V_{BATT} ≤ 4.3 V –20 °C ≤ T_{CASE} ≤ +85 °C Load VSWR = 20:1, all phase angles	No module damage or permanent degradation			
Rx Band Noise	R_{X_NOISE}	At f_0 + 20 MHz (1805 MHz to 1880 MHz) RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 31 dBm	—	—	–83	dBm
		925 MHz to 960 MHz RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 31 dBm	—	—	–87	
Power Control Dynamic Range	PC_{DR}	—	35	—	—	dB
Power Control Slope	PC_S	V_{BATT} = 3.5 V P_{IN} = 3 dBm P_{OUT} = 0 dBm T_{CASE} = +25 °C	—	80	—	dB/V

1 *V_{RAMP} is calibrated to each PCL at T_{CASE} = +25 °C, V_{BATT} = 3.5 V, P_{IN} = 3 dBm, 50 Ω load.*

2 *Terminate all unused RF ports with 50 Ω loads*

Table 8-1. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs; duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

PCS1900 (Tx_HB) Mode (f = 1850 MHz to 1910 MHz, 0 dBm ≤ P_{IN} ≤ 6 dBm)						
Parameter	**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Units**
Frequency Range	f	—	1850	—	1910	MHz
Input Power	P_{IN}	—	0	—	6	dBm
Analog Power Control Voltage	V_{RAMP}	Minimum PCL to P_{RATED}	—	—	1.6	V
Power Added Efficiency	PAE	V_{BATT} = 3.5 V P_{OUT} = 31 dBm P_{IN} = 3 dBm duty cycle 1:8 T_{CASE} = +25 °C	—	39	—	%
Supply Current at Rated Power	I_{BATT}_31 dBm	V_{BATT} = 3.5 V P_{IN} = 3 dBm P_{OUT} = 31 dBm duty cycle 1:8 T_{CASE} = +25 °C	—	0.92	0.97	A
Harmonics	$2f_0$ to $6f_0$	BW = 3 MHz, 0 dBm ≤ P_{OUT} ≤ 31 dBm V_{RAMP} controlled[1]	—	–40	–33	dBm
Output Power	P_{OUT_MAX}	V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{IN} = 0 dBm	—	32.0	—	dBm
	$P_{OUT\_MAX\_EXTREME}$	V_{BATT} = 3.1 V –20 °C ≤ T_{CASE} ≤ +85 °C P_{IN} = 0 dBm	29.0	—	—	
Input VSWR	Γ_{IN}	0 dBm P_{OUT} ≤ 31 dBm V_{RAMP} controlled[1]	—	1.5:1	2.5:1	—
Forward Isolation2	P_{OUT_RX}	P_{IN} = 6 dBm V_{RAMP} ≤ 0.1 V BS1 = V_{BS1_LOW} BS2 = V_{BS2_LOW} TxEN = V_{TxEN_LOW}	—	–60	–51	dBm
	$P_{OUT\_ENABLED\_TX}$	P_{IN} = 6 dBm V_{RAMP} ≤ 0.1 V BS1 = V_{BS1_HIGH} BS2 = V_{BS2_HIGH} TxEN = V_{TxEN_HIGH}	—	–40	–15	

Table 8-2. SKY77589-21 Electrical Specifications

Unless otherwise specified: T_{CASE} = –20 °C to max. operating temperature (see Table 2); RL = 50 Ω; pulsed operation with pulse width ≤ 1154 µs; duty cycle ≤ 2:8; 3.1 V ≤ V_{CC} ≤ 4.3 V

PCS1900 (Tx_HB) Mode (ƒ = 1850 MHz to 1910 MHz, 0 dBm ≤ P_{IN} ≤ 6 dBm)						
Parameter	**Symbol**	**Test Condition**	**Minimum**	**Typical**	**Maximum**	**Units**
Coupling of PCS Tx Output to Receive RF Output pad[2]	CPCS_Tx-Rx_ƒo	0 dBm ≤ P_{OUT} ≤ 31 dBm	—	—	5	dBm
Spurious	Spur	All combinations of the following parameters: V_{RAMP} = controlled[1] P_{IN} = min. to max. 3.1 V ≤ V_{BATT} ≤ 4.3 V –20 °C ≤ T_{CASE} ≤ +85 °C Load VSWR = 12:1, all phase angles	No parasitic oscillation > –36 dBm			
Load Mismatch	Load	All combinations of the following parameters: VRAMP = controlled1 P_{IN} = min. to max. 3.1 V ≤ V_{BATT} ≤ 4.3 V –20 °C ≤ TCASE ≤ +85 °C Load VSWR = 20:1, all phase angles	No module damage or permanent degradation			
Rx Band Noise	R_{X_NOISE}	At ƒ0 + 20 MHz (1930 MHz to 1990 MHz) RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 31 dBm	—	—	–83	dBm
		869 MHz to 894 MHz RBW = 100 kHz V_{BATT} = 3.5 V T_{CASE} = +25 °C P_{OUT} = 31 dBm	—	—	–87	
Power Control Dynamic Range	PC_{DR}	—	35	—	—	dB
Power Control Slope	PC_S	V_{BATT} = 3.5 V P_{IN} = 3 dBm P_{OUT} = 0 dBm T_{CASE} = +25 °C	—	80	—	dB/V

[1] *V_{RAMP} is calibrated to each PCL at T_{CASE} = +25 °C, V_{BATT} = 3.5 V, P_{IN} = 3 dBm, 50 Ω load.*

[2] *Terminate all unused RF ports with 50 Ω loads*

Table 9. 77589-21 Electrical Characteristics

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs;
–20 °C ≤ T_{CASE} ≤ +85 °C; 2.5 V ≤ V_{CC} ≤ 4.3 V; Terminate all unused RF ports with 50 Ω during test.

Ports TRx1 to TRx6 *Tx-Rx Mode*							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	3G_Tx/Rx	$f_{3G\_Tx/Rx}$	—	824	—	2170	MHz
Insertion Loss	ANT – 3G_Tx/Rx	$3G_{Tx/Rx}$	824 MHz to 960 MHz T_{CASE} =+25°C	—	0.60	0.95	dB
			1710 MHz to 1990 MHz T_{CASE} =+25°C	—	0.70	0.95	
			2110 MHz to 2170 MHz T_{CASE} =+25°C	—	1.00	1.20	
Isolation	ADJACENT		Ports TRx1 through TRx6 to any other ADJACENT port (824 MHz to 960 MHz)	25	—	—	dB
			Ports TRx1 through TRx6 to any other ADJACENT port (1710 MHz to 1990 MHz)	25	—	—	
	NON-ADJACENT		Ports TRx1 through TRx6 to any other NON-ADJACENT port (824 MHz to 960 MHz)	30	—	—	
			Ports TRx1 through TRx6 to any other NON-ADJACENT port (1710 MHz to 1990 MHz)	30	—	—	
IMD2	$f_{Rx} - f_{Tx}$		Tx Output Power = 20 dBm Blocker Power = –15 dBm Blocker frequency impedance is swept over all phase angles at the WCDMA port. (Minimum VSWR at blocker is 10:1 to model out-of-band duplexer impedance.	—	—	–95	dBm
	$f_{Rx} + f_{Tx}$			—	—	–95	
IMD3	$2f_{Tx} - f_{Rx}$			—	—	–97	
	$2f_{Rx} - f_{Tx}$			—	—	–97	
Leakage from Tx to TRx Ports		P_TRx	—	—	—	5	dBm

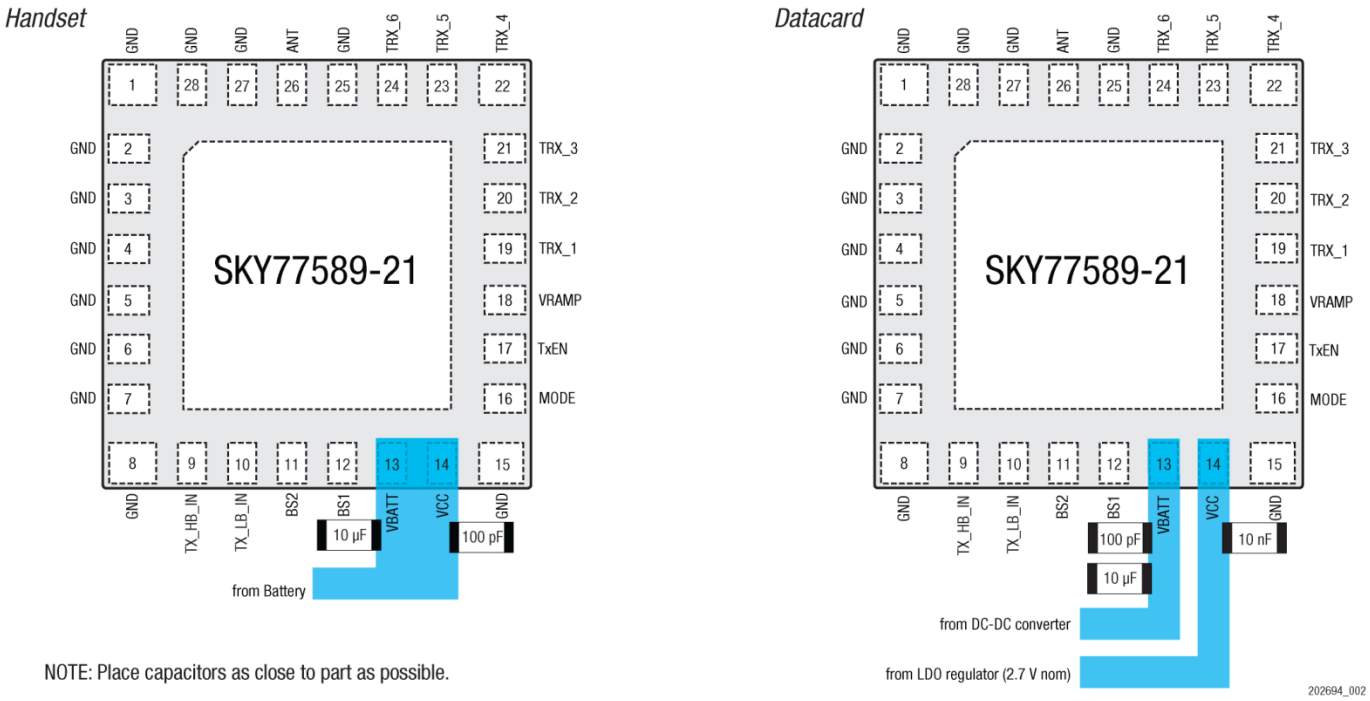
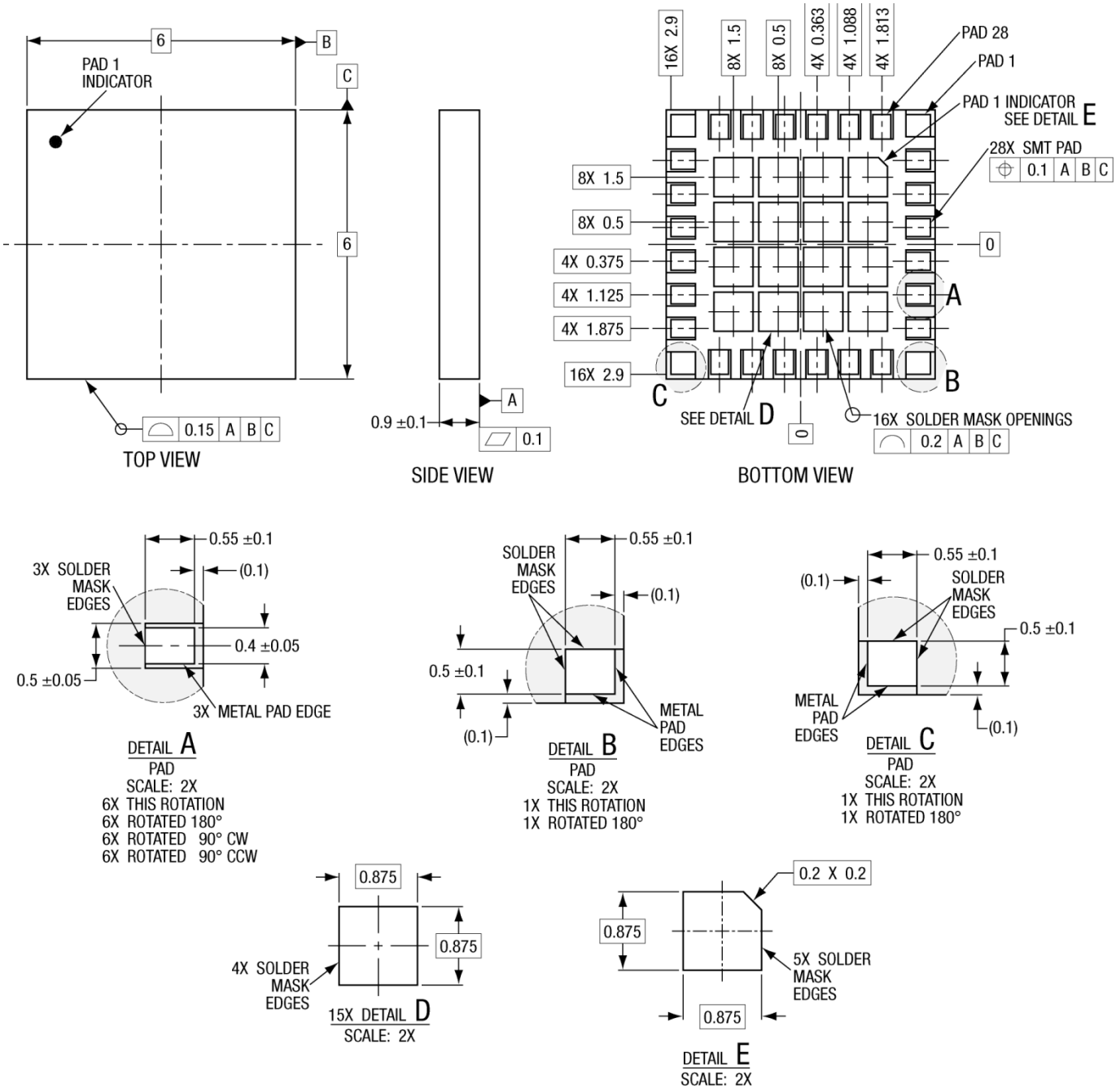


Figure 2. SKY77589-21 Application Schematic Diagram

Package Dimensions

Figure 3 is a mechanical diagram of the pad layout for the SKY77589-21, a 28-pad leadless dual-band Front-End Module. Figure 4 provides a recommended phone board layout footprint for the Front-End Module to help the designer attain optimum thermal conductivity, good grounding, and minimum RF discontinuity for the 50-ohm terminals.



NOTES: Unless otherwise specified.
1. Dimensioning and Tolerancing in accordance with ASME Y14.5M–1994.
2. All dimensions are in millimeters.
3. Pad definitions per details on drawing.

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Figure 3. Dimensional Drawing for 6 mm x 6 mm x 0.9 mm, 28-Pad Package – SKY77589-21 Specific (All Views)

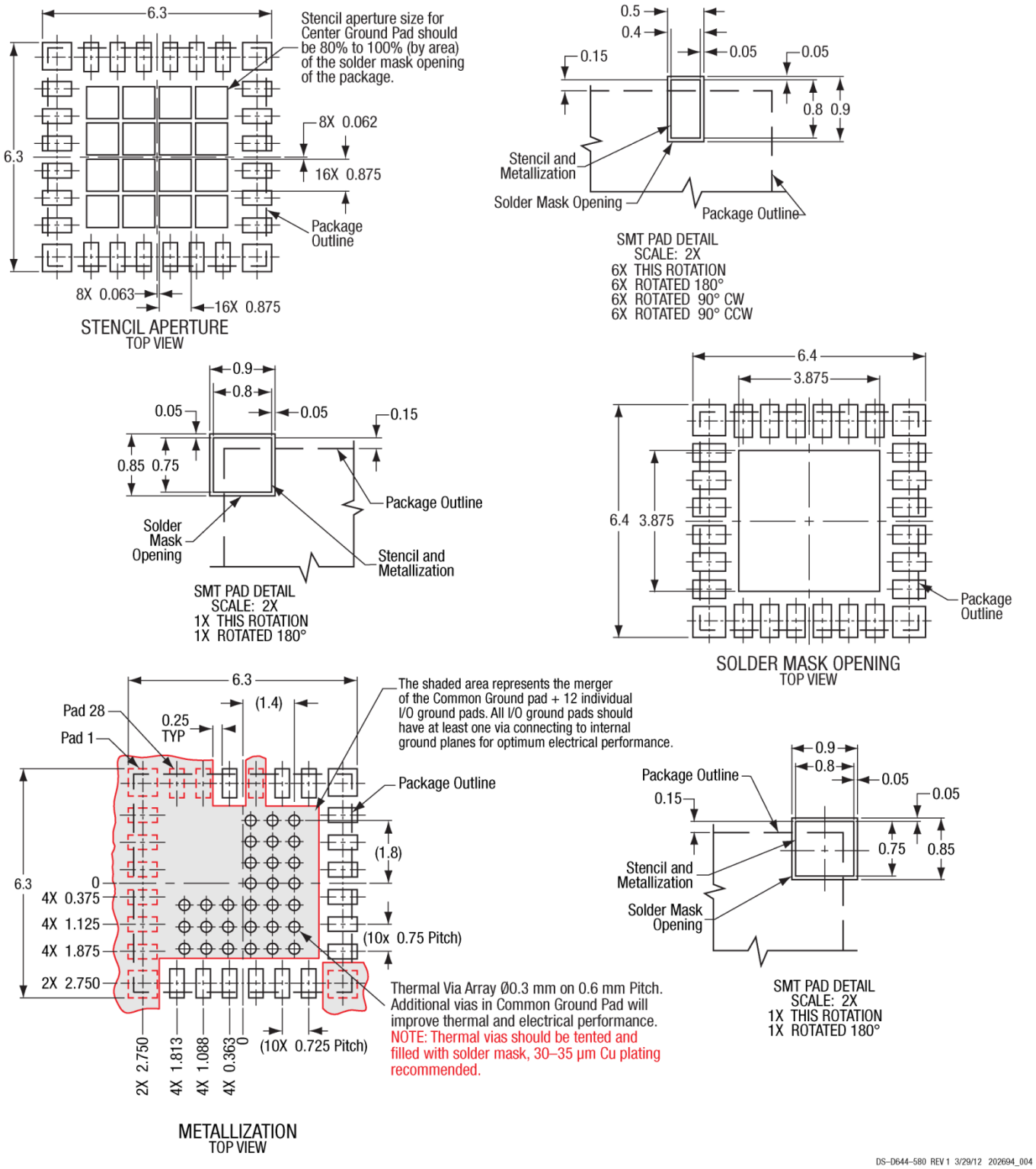
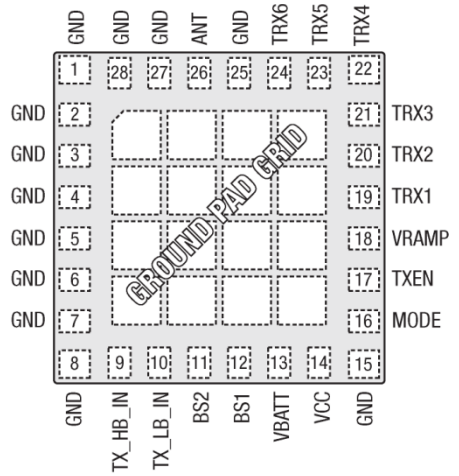


Figure 4. Phone PCB Layout Footprint for 6 mm x 6 mm, 28-Pad Package with Grid-Bottom Solder Mask – SKY77589-21 Specific.

Package Description

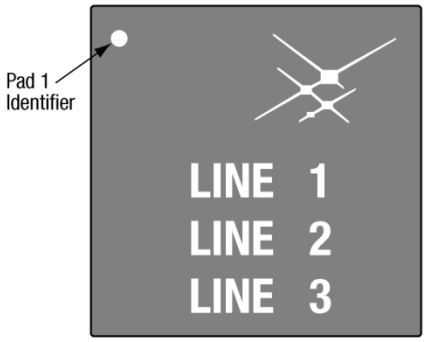
Figure 5 illustrates the device pad configuration and the numbering convention which starts with pad 1 at the lower left, as indicated and increments counter-clockwise around the package. Table 10 lists the pad names and the associated signal descriptions. Figure 6 interprets typical case markings.



Pad layout as seen from Top View looking through package.

202694_005

Figure 5. SKY77589-21 Pad Configuration – 28-Pad Leadless (Top View)



NOTE: Lines 1, 2, 3 have a maximum of 12 characters
Line 1 = Part Number and Version
Line 2 = Lot Number
Line 3 = Year–Week–Country Code (MX)

202694_006

Figure 6. Typical Case Markings

Table 10. SKY77589-21 Pad Names and Signal Descriptions

Pad[1]	Name	Description
9	Tx_HB_IN	Input Tx signal 1710 MHz–1910 MHz
10	Tx_LB_IN	Input Tx signal 824 MHz–915 MHz
11	BS2	Band Select
12	BS1	Band Select
13	VBATT	Battery supply voltage
14	VCC	Switch supply voltage
16	MODE	0 = GMSK
17	TxEN	Enable TxEN
18	VRAMP	Controls power in GMSK mode
19	TRx1	Wideband TRx switch port
20	TRx2	Wideband TRx switch port
21	TRx3	Wideband TRx switch port
22	TRx4	Wideband TRx switch port
23	TRx5	Wideband TRx switch port
24	TRx6	Wideband TRx switch port
26	ANT	PA output to Antenna
Ground Pad Grid		Ground Pad Grid (device underside)

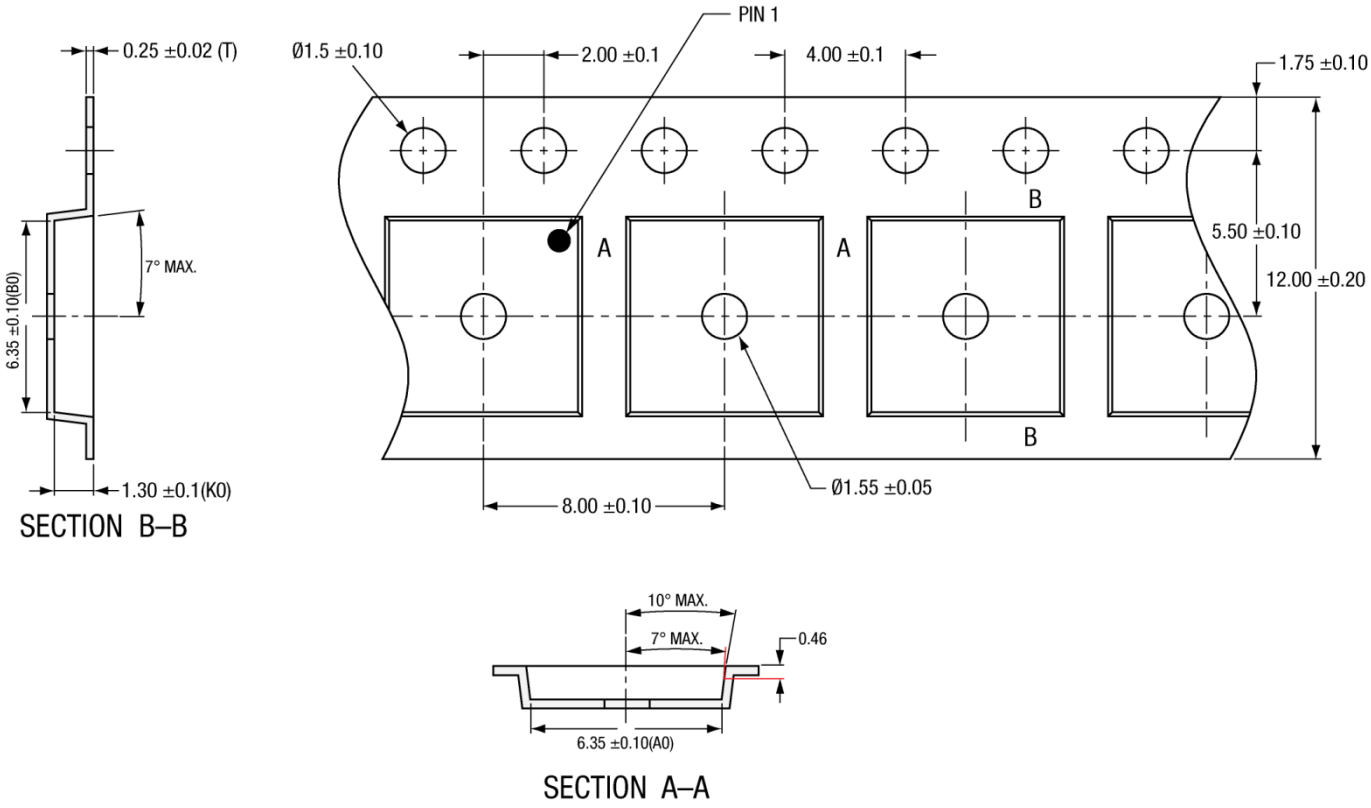
[1] *Pads 1–8, 15, 25, 27, 28 are ground pads.*

Package Handling Information

Because of its sensitivity to moisture absorption, this device package is baked and vacuum-packed prior to shipment. Instructions on the shipping container label must be followed regarding exposure to moisture after the container seal is broken, otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY77589-21 is capable of withstanding an MSL3/260 °C solder reflow. Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. If the part is attached in a reflow oven, the temperature ramp rate should not exceed 3 °C per second; maximum temperature should not exceed 260 °C. If the part is manually attached, precaution should be taken to insure that the part is not subjected to temperatures exceeding 260 °C for more than 10 seconds. For details on attachment techniques, precautions, and handling procedures recommended by Skyworks, please refer to Skyworks Application Note: *PCB Design and SMT Assembly/Rework*, Document Number 101752. Additional information on standard SMT reflow profiles can also be found in the JEDEC *Joint Industry Standard J-STD-020*.

Production quantities of this product are shipped in the standard tape-and-reel format (Figure 7).



NOTES:
1. CARRIER TAPE IS BLACK CONDUCTIVE POLYCARBONATE OR POLYSTYRENE.
2. COVER TAPE IS TRANSPARENT AND CONDUCTIVE.
3. ESD-SURFACE RESISTIVITY IS ≤ 1 X 10^{10} OHMS/SQUARE PER EIA, JEDEC TNR SPECIFICATION.
4. ALL DIMENSIONS ARE IN MILLIMETERS.

CARRIER TAPE OVERMOLD MCM/RFLGA 6 x 6 x 0.85 / 1.1 mm BODY SIZE -193H XXXXXX_YYY

Figure 7. Dimensional Diagram for Carrier Tape Body Size 6 mm x 6 mm x 0.85 / 1.1 mm – MCM

Electrostatic Discharge (ESD) Sensitivity

Attention: Observe Precautions for Handling Electrostatic Sensitive Devices

Electrostatic Discharge (ESD) can damage this device, which must be protected from ESD at all times. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times.

To avoid ESD damage, both latent and visible, it is very important that the product assembly and test areas follow the ESD handling precautions listed below.

- Personnel Grounding
  - Wrist Straps
  - Conductive Smocks, Gloves and Finger Cots
  - Antistatic ID Badges
- Protective Workstation
  - Dissipative Table Top
  - Protective Test Equipment (Properly Grounded)
  - Grounded Tip Soldering Irons
  - Solder Conductive Suckers
  - Static Sensors
- Facility
  - Relative Humidity Control and Air Ionizers
  - Dissipative Floors (less than 1,000 MΩ to GND)
- Protective Packaging and Transportation
  - Bags and Pouches (Faraday Shield)
  - Protective Tote Boxes (Conductive Static Shielding)
  - Protective Trays
  - Grounded Carts
  - Protective Work Order Holders

Ordering Information

Product Name	Order Number	Evaluation Board Part Number
SKY77589-21 Tx-Rx Quad-Band Front-End Module	SKY77589-21	

Revision History

Revision	Date	Description
A	February 14, 2013	Initial Release – Information
B	September 3, 2013	Revise: Figure 2; Tables 5, 6
C	May 12, 2016	Revise: Table 1 (add Operating Temperature); update format.

References

Skyworks Application Note: PCB Design and SMT Assembly/Rework, Document Number 101752

Standard SMT Reflow Profiles: JEDEC Standard J-STD-020

Electrostatic Discharge Sensitivity (ESD) Testing: JEDEC Standard, JESD22-A114 Human Body Model (HBM)

Electrostatic Discharge Sensitivity (ESD) Testing: JEDEC Standard, JESD22-C101 Charged Device Model (CDM).