PRELIMINARY DATA SHEET

SKY77590-51 Tx-Rx FEM for Quad-Band GSM/ GPRS/ EDGE with Six Linear TRx Switch Ports and Dual-Band TD-SCDMA

Applications

- Quad-band GSM/EDGE and Dual-Band TD-SCDMA cellular handsets encompassing
  - Class 4 GSM850/900
  - Class 1 DCS1800/PCS1900
  - Class 12 GPRS multi-slot operation
  - 6 low insertion loss / high linearity interchangeable TRx switch ports
  - Linear EDGE operation
  - TD-SCDMA Bands 34/39

Features

- Small, low profile package
  - 6 mm x 6 mm x 0.85 mm
  - 28-pad configuration
- Low input power range –1 dBm to 6 dBm
- High efficiency
  - 40% GSM850
  - 40% GSM900
  - 35% DCS1800
  - 35% PCS1900
- Tx-VCO-to-antenna and antenna-to-Rx-SAW filter RF interface
- Tx harmonics below –38 dBm
- Current limiting for over-voltage protection and extended battery life
- Input/Output matched internally to 50 Ω
- High impedance control inputs: 20 μA, maximum
- Power control circuitry built-in for improved TRP variation

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

SKY77590-51 is a transmit and receive Front End Module (FEM) designed in a very low profile (0.9 mm) and compact form factor for quad-band cellular handsets comprising GSM850/900, DCS1800, and PCS1900 operation and dual-band TD-SCDMA bands 34 and 39 operation — 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 linear EDGE operation. 3G switch-through support is provided by six dedicated high-linearity ports.

The module consists of a GSM850/900 PA and DCS1800/PCS1900/TD-SCDMA PA block, impedance-matching circuitry for 50 Ω input and output impedances, Tx harmonic filtering, a high linearity/low insertion loss switch, and a CMOS Power Amplifier Control (PAC) block. A custom silicon integrated circuit contains decoder circuitry to control the RF switch while providing a low current, external control interface.

Fabricated in InGaP/GaAs, the Heterojunction Bipolar Transistor (HBT) PA blocks support the GSM850/900 bands and DCS1800/PCS1900 bands and TD-SCDMA bands 34/39. Both PA blocks share common power supply pads to distribute current. The output of the PA block and the outputs to the six receive pads connect to the antenna pad through a high-linearity antenna switch. The 3G and Rx ports feature a 0 volts DC offset level which eliminates the need for external blocking capacitors. The InGaP/GaAs die, switch die, Silicon (Si) controller die, and passive components are mounted on a multi-layer laminate substrate and the entire assembly is encapsulated with plastic overmold.

RF input and output ports of the SKY77590-51 are internally matched to a 50 Ω load to reduce the number of external components on the phone board. Extremely low leakage current of the FEM maximizes handset standby time. Control of transmit and receive RF signal flows, and band selection are performed by four external control pads (see Figure 1 on overleaf). Mode of operation, Tx vs. Rx, and Band (GSM850, GSM900, DCS1800, PCS1900, and Bands 34/39) are controlled with the four logic inputs: Mode, TxEN, BS1, and BS2. Proper timing of the TxEN input and the VRAMP input ensures high isolation between the antenna and Tx-VCO while the VCO is being tuned prior to the transmit burst.

The integrated power amplifier control (PAC) function provides envelope amplitude control while reducing sensitivity to input drive, temperature, power supply, and process variation. Output power variation into mismatch is minimized with Skyworks' True Power control circuit.

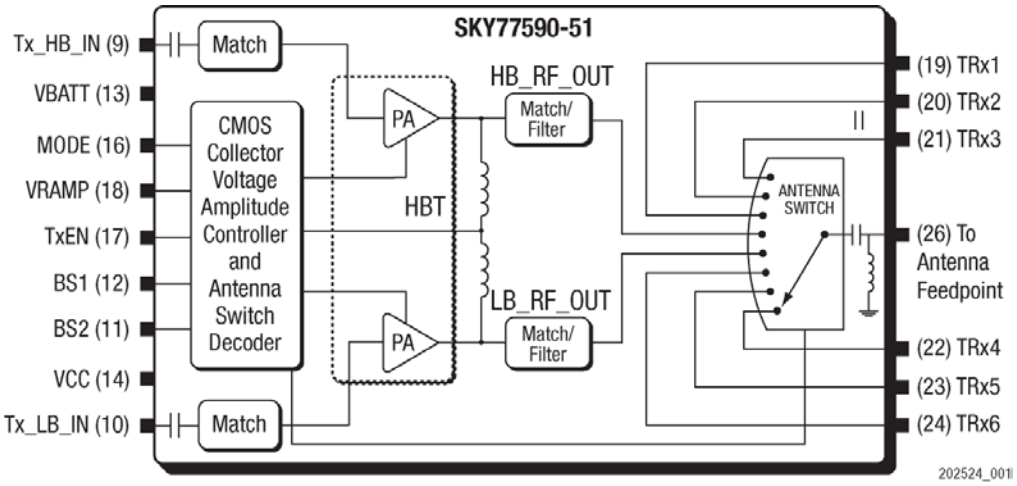


FIGURE 1. SKY77590-51 FUNCTIONAL BLOCK DIAGRAM

Electrical Specifications

The following tables list the electrical characteristics of the SKY77590-51 Front-End Module. Table 1 lists the absolute maximum ratings and Table 2 lists the recommended operating conditions. Table 5 through Table 15 provide the electrical characteristics of the SKY77590-51 for modes GSM850, GSM900, DCS1800, PCS1900, TD-SCDMA Bands 34/39, and 3G including control logic descriptions for the various modes.

The SKY77590-51 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. ABSOLUTE MAXIMUM RATINGS

Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit at a time and all other parameters set at or below their nominal value.

Parameter		Symbol	Minimum	Nominal	Maximum	Unit
Input Power		P_{IN}	—	—	15	dBm
Supply Voltage ≤ 1 µs (measured to GND)		V_{BATT}	—	—	6	V
DC Continuous During Burst[1]		I_{BATT}	—	—	2.5	A
Burst Duty Cycle		D_B	—	—	50	%
Voltage Standing Wave Ratio		VSWR	—	—	20:1	V
Power Control Voltage		V_{RAMP}	–0.3	—	V_{BATT}	V
Transmit Enable Voltage		V_{TxEN}	–0.3	—	See Footnote[2]	V
Mode Control Voltage		V_{MODE}	–0.3	—	See Footnote[2]	V
Band Select Control Voltage		V_{BS1}, V_{BS2}	–0.3	—	See Footnote[2]	V
Temperatures	Operating	T_{CASE}	–30	—	+100	°C
	Storage	T_{STG}	–40	—	+150	
Moisture Sensitivity Level		MSL	—	—	3	
Reflow Solder Temperature (J-STD-020B)		T_{SOLDER}	260	—	—	°C

[1] Applied voltage must be current-limited to specified range.

[2] The lesser of VCC or 2.9 V.

TABLE 2. RECOMMENDED OPERATING CONDITIONS

Unless otherwise specified: –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 V ≤ V_{BATT} ≤ 4.6 V.

Parameter		Symbol	Minimum	Typical	Maximum	Unit
Supply Voltage[1]	GMSK	V_{BATT}	3.0	3.5	4.6	V
	EDGE/ TD-SCDMA		3.0	3.6	4.6	
		V_{CC}	2.5	—	4.6	
Supply Current		I_{BATT}	0	—	2.3	A
Operating Case Temperature[2]	1-Slot (12.5% duty cycle)	T_{CASE}	–20	—	+85	°C
	2-Slot (25% duty cycle)		–20	—	+85	
	3-Slot (37.5% duty cycle)		–20	—	+85	
	4-Slot (50% duty cycle)		–20	—	+85	

[1] V_{BATT} and V_{CC} should be commoned unless DC/DC is used and V_{CC} can be separately supplied.

[2] Case Operating Temperature refers to the temperature at the GROUND PAD on the underside of the package.

TABLE 3. SKY77590-51 INTERFACE IMPEDANCES

Unless otherwise specified: –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 V ≤ V_{BATT} ≤ 4.6 V

Parameter		Symbol	Conditions	Minimum	Typical	Maximum	Units
Impedance System for All RF Ports		Z_{RF}		—	50	—	□
Resistance of: TxEN, BS1, BS2, MODE		R_{GPIO}	DC resistance to ground	—	200	—	kΩ
Capacitance of: TxEN, BS1, BS2, MODE		C_{GPIO}	Capacitance to ground	—	—	2	pF
Current Consumption of: TxEN, BS1, BS2, MODE		I_{GPIO}	V_{GPIO} < 2.9 V T_{CASE} = +25 °C V_{BATT} = 3.6 V	—	—	20	µA
Input Logic Level	Low	V_{IL}		–0.1	—	0.4	V
	High	V_{IH}		1.2	—	2.9	V
Burst Duty Cycle		D_B		12.5	—	50	%
Resistance of V_{RAMP}		R_{VRAMP}	DC resistance to ground	—	200	—	kΩ
Capacitance of V_{RAMP}		C_{VRAMP}	Capacitance to ground	—	—	2	pF
Current Consumption of V_{RAMP}		I_{VRAMP}	V_{RAMP} < 1.45 V	—	—	15	µA
Power Control Voltage		V_{RAMP}		0.2	—	1.6	V
Standby Current		$I_{STANDBY}$	All control lines = 0 V V_{BATT} = 3.5 V T_{CASE} = +25 °C	—	—	20	µA
Rx/3G Current		$I_{RX/3G}$	Rx/3G Mode T_{CASE} = +25 °C	—	—	500	µA
Switching Times	Mode switching time	T_{MODE}	EDGE to GMSK Mode defined as time from mode transition to application of GMSK RF input drive to meet forward isolation PESE	—	—	2	µs
	Band switching time	T_{BAND}	Time required for output power to settle within 0.5 dB of final value after band switch (P_{IN} and VRAMP already applied prior to BS change)	—	—	2	
	Bias switching time	T_{BIAS}	Time required for EDGE gain to settle within 0.5 dB of final value	—	—	1	

TABLE 4. SKY77590-51 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
LB_EDGE_Tx	1	1	0	1
HB_EDGE_Tx	1	1	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
TD-SCDMA	1	1	1	1

TABLE 5. SKY77590-51 ELECTRICAL CHARACTERISTICS (1 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM850/900 *GMSK Mode*							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	GSM850	f	—	824	—	849	MHz
	GSM900			880	—	915	
Input Power		P_{IN}	—	–1	—	6	dBm
Supply Voltage		V_{BATT}	—	3.0	3.5	4.6	V
		V_{CC}	—	2.5	—	4.6	
Supply Current		I_{BATT}	—	—	—	2.3	A
Power Added Efficiency	GSM850	PAE	V_{BATT} = 3.5 V P_{IN} = 3 dBm V_{RAMP} = MAX V_{RAMP}[1] Duty cycle = 1:8 T_{CASE} = +25 °C	—	40	—	%
	GSM900			—	40	—	
Harmonics		$2f_0$ to $15f_0$	BW = 3 MHz 5 dBm ≤ P_{OUT} ≤ 33 dBm		–40	–34	dBm
Output Power		P_{OUT_GMSK}	P_{IN} = –1 dBm V_{BATT} = 3.5 V V_{RAMP} = 1.6 V T_{CASE} = +25 °C	33.3	34.0	—	dBm
		$P_{OUT\_GMSK\_EX}$	P_{IN} = –1 dBm V_{BATT} = 3.0 V V_{RAMP} = 1.6 V	31.0	—	—	
Input VSWR		Γ_{IN}	P_{OUT} ≤ 33 dBm	—	—	2.5:1	
Isolation		ISO_{PDSD}	P_{IN} ≤ 6 dBm TxEN < 0.4 V BS2 = Logic High V_{RAMP} ≤ 0.1 V	—	–62	–46	dBm
		ISO_{PESE}	P_{IN} ≤ 6 dBm TxEN ≥ 1.2 V BS2 = Logic High V_{RAMP} ≤ 0.1 V	—	—	–10	

TABLE 5. SKY77590-51 ELECTRICAL CHARACTERISTICS (2 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8;–20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM850/900 *GMSK Mode*						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Low Power Current	I_{LOW_GMSK}	P_{IN} ≤ 6 dBm P_{OUT} = 5 dBm	—	—	120	mA
Stability	Stab	All combinations of the following parameters: 5 dBm ≤ P_{OUT} ≤ 33 dBm –1 dBm ≤ P_{IN} ≤ 6 dBm Load VSWR = 15:1, all phase angles	No parasitic oscillation > –36 dBm			
Load Mismatch	Load	All combinations of the following parameters: 5 dBm ≤ P_{OUT} ≤ 33 dBm –1 dBm ≤ P_{IN} ≤ 6 dBm Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation			
Noise Power	P_{NOISE_850}	f_0 + 20 MHz (869 MHz to 894 MHz) P_{OUT} ≤ 33 dBm V_{BATT} ≤ 3.5 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–83	dBm
	P_{NOISE_900}	f_0 + 20 MHz P_{OUT} ≤ 33 dBm V_{BATT} ≤ 3.5 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–83	
		f_0 + 10 MHz P_{OUT} ≤ 33 dBm V_{BATT} ≤ 3.5 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–79	
		f_0 – 1805 MHz to 1880 MHz P_{OUT} ≤ 33 dBm V_{BATT} ≤ 3.5 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–86	

[1] MAX V_{RAMP} = V_{RAMP} at P_{OUT} = 33 dBm, 50 Ω load, T_{CASE} =+25 °, V_{BATT} = 3.5 V, P_{IN} = 3dBm.

TABLE 6. SKY77590-51 ELECTRICAL CHARACTERISTICS (1 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM850/900 *EDGE Mode*							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	GSM850	f	—	824	—	849	MHz
	EDGE900			880	—	915	
Supply Voltage		V_{BATT}	—	3.0	3.6	4.6	V
		V_{CC}	—	2.5	—	4.6	
Power Added Efficiency		PAE	V_{BATT} = 3.6 V V_{RAMP} = 1.45 V P_{OUT} = 27.5 dBm T_{CASE} = +25 °C	—	20	—	%
Harmonics		$2f_0$ to $15f_0$	BW = 3 MHz 5 dBm ≤ P_{OUT} ≤ 27.5 dBm	—	–45	–36	dBm
Output Power		P_{OUT_EDGE}	V_{BATT} = 3.6 V V_{RAMP} = 1.45 V T_{CASE} = +25 °C ACPR / EVM / ORFS in specification	27.5	—	—	dBm
		$P_{OUT\_EDGE\_EX}$	V_{BATT} = 3.0 V V_{RAMP} = 1.45 V ACPR / EVM / ORFS in specification	26.0	—	—	
Input VSWR		Γ_{IN}	P_{OUT} ≤ 27.5 dBm	—	—	3:1	
Gain		G_{NOM_850}	V_{BATT} = 3.6 V P_{OUT} = 27.5 dBm V_{RAMP} = 1.45 V T_{CASE} = +25 °C	31.1	32.8	34.4	dB
		G_{NOM_900}		30.7	32.4	34.0	
		G_{EX_850}	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$ V_{RAMP} = 1.45 V	29.3	32.8	35.8	
		G_{EX_900}		29.0	32.4	35.4	
ACPR		$ACPR\_{200}$	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$ Bandwidth = 30 kHz V_{RAMP} = 1.45 V	—	—	–34	dBc
		$ACPR\_{400}$		—	—	–58	
		$ACPR\_{600}$		—	—	–64	
EVM		EVM_{RMS}	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$ V V_{RAMP} = 1.45 V	—	—	5	%
Isolation		ISO_E_{PDSD}	P_{IN} = –45 dBm TxEN < 0.4 V BS2 = Logic High V_{RAMP} ≤ 0.1 V	—	—	–60	dBm

TABLE 6. SKY77590-51 ELECTRICAL CHARACTERISTICS (2 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM850/900 *EDGE Mode*						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Low Power Current	I_{LOW_EDGE}	V_{BATT} = 3.6 V V_{RAMP} = 0.4 V P_{OUT} = 5 dBm	—	—	140	mA
Stability	Stab	All combinations of the following parameters: 5 dBm ≤ P_{OUT} ≤ 27.5 dBm Load VSWR = 15:1, all phase angles	No parasitic oscillation > –36 dBm			
Load Mismatch	Load	All combinations of the following parameters: VRAMP = controlled 5 dBm ≤ P_{OUT} ≤ 27.5 dBm Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation			
Noise Power	P_{NOISE_850}	f_o + 20 MHz (869 MHz to 894 MHz) P_{OUT} ≤ 27.5 dBm V_{BATT} = 3.6 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–82	dBm
	P_{NOISE_900}	f_o + 20 MHz P_{OUT} ≤ 27.5 dBm V_{BATT} = 3.6 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–82	
		f_o + 10 MHz P_{OUT} ≤ 27.5 dBm V_{BATT} = 3.6 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–82	
		f_o = 1805 MHz to 1880 MHz P_{OUT} ≤ 27.5 dBm V_{BATT} = 3.6 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–86	

TABLE 7. SKY77590-51 ELECTRICAL CHARACTERISTICS (1 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM1800/1900 *GMSK Mode*							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	DCS1800	f	—	1710	—	1785	MHz
	PCS1900		—	1850	—	1910	
Input Power		P_{IN}	—	–1	—	6	dBm
Supply Voltage		V_{BATT}	—	3.0	3.5	4.6	V
		V_{CC}	—	2.5	—	4.6	
Power Added Efficiency		$PAE_{GSM1800}$	V_{BATT} = 3.5 V P_{IN} = 3 dBm V_{RAMP} = MAX V_{RAMP}[1] Duty cycle = 1:8 T_{CASE} = +25 °C	—	35	—	%
		$PAE_{GSM1900}$		—	35	—	
Harmonics		$2f_0$ to $7f_0$	BW = 3 MHz 0 dBm ≤ P_{OUT} ≤ 31 dBm 50 Ω		–40	–34	dBm
Output Power		P_{OUT_GMSK}	P_{IN} = –1 dBm V_{BATT} = 3.5 V V_{RAMP} = 1.6 V T_{CASE} =+25 °C	31.0	31.4	—	dBm
		$P_{OUT\_GMSK\_EX}$	P_{IN} = –1 dBm V_{BATT} = 3.0 V V_{RAMP} = 1.6 V	28.5	—	—	
Input VSWR		Γ_{IN}	P_{OUT} ≤ 31 dBm	—	—	2.5:1	
Isolation		ISO_{PDSD}	P_{IN} ≤ 6 dBm TxEN < 0.4 V BS2 = Logic High V_{RAMP} ≤ 0.1 V	—	–52	–46	dBm
		ISO_{PESE}	P_{IN} ≤ 6 dBm TxEN ≥ 1.2 V BS2 = Logic High V_{RAMP} ≤ 0.1 V	—	—	–10	
Low Power Current		I_{LOW_GMSK}	P_{IN} ≤ 6 dBm P_{OUT} = 0 dBm	—	—	100	mA

TABLE 7. SKY77590-51 ELECTRICAL CHARACTERISTICS (2 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM1800/1900 *GMSK Mode*						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Stability	Stab	All combinations of the following parameters: 0 dBm ≤ P_{OUT} ≤ 31 dBm –1 dBm ≤ P_{IN} ≤ 6 dBm Load VSWR = 15:1, all phase angles	No parasitic oscillation >–36 dBm			
Load Mismatch	Load	All combinations of the following parameters: 0 dBm ≤ P_{OUT} ≤ 31 dBm –1 dBm ≤ P_{IN} ≤ 6 dBm Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation			
Noise Power	P_{NOISE_1800}	f_0 + 20 MHz P_{OUT} ≤ 31 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–83	dBm
		f_0 = 925 MHz to 960 MHz P_{OUT} ≤ 31 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–84	
	P_{NOISE_1900}	f_0 + 20 MHz P_{OUT} ≤ 31 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–83	
		f_0 = 869 MHz to 894 MHz P_{OUT} ≤ 31 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–84	

[1] MAX V_{RAMP} = V_{RAMP} at P_{OUT} = 31 dBm, 50 Ω load, T_{CASE} =+25 °, V_{BATT} = 3.5 V, P_{IN} = 3dBm.

TABLE 8. SKY77590-51 ELECTRICAL CHARACTERISTICS (1 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM1800/1900 *EDGE Mode*							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	EDGE1800	f	—	1710	—	1785	MHz
	EDGE1900			1850	—	1910	
Supply Voltage		V_{BATT}	—	3.0	3.6	4.6	V
		V_{CC}	—	2.5	—	4.6	
Power Added Efficiency		$PAE_{GSM1800}$	V_{BATT} = 3.6 V V_{RAMP} = 1.45 V P_{OUT} = 26.5 dBm T_{CASE} = +25 °C	—	22	—	%
		$PAE_{GSM1900}$		—	22	—	
Harmonics		$2f_0$ to $7f_0$	BW = 3 MHz 0 dBm ≤ P_{OUT} ≤ 26.5 dBm	—	–45	–36	dBm
Output Power		P_{OUT_EDGE}	V_{BATT} = 3.6 V V_{RAMP} = 1.45 V T_{CASE} = +25 °C ACPR / EVM / ORFS in specification	26.5	—	—	dBm
		$P_{OUT\_EDGE\_EX}$	V_{BATT} = 3.0 V V_{RAMP} = 1.45 V ACPR / EVM / ORFS in specification	25.0	—	—	
Input VSWR		Γ_{IN}	P_{OUT} ≤ 26.5 dBm	—	—	3:1	
Gain		G_{NOM_1800}	V_{BATT} = 3.6 V P_{OUT} = 26.5 dBm V_{RAMP} = 1.45 V T_{CASE} = +25 °C	32.3	34.1	36.0	dB
		G_{NOM_1900}		31.2	33.0	34.9	
		G_{EX_1800}	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$ V_{RAMP} = 1.45 V	30.6	34.1	37.4	
		G_{EX_1900}		29.5	33.0	36.3	
ACPR		$ACPR_{200}$	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$ Bandwidth = 30 kHz V_{RAMP} = 1.45 V	—	—	–34	dBc
		$ACPR_{400}$		—	—	–58	
		$ACPR_{600}$		—	—	–64	
EVM		EVM_{RMS}	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$ V_{RAMP} = 1.45 V	—	—	5	%
Isolation		ISO_E_{PDSD}	P_{IN} = –45 dBm TxEN < 0.4 V BS2 = Logic High V_{RAMP} ≤ 0.1 V	—	—	–60	dBm
Low Power Current		I_{LOW_EDGE}	P_{OUT} = 0 dBm V_{BATT} = 3.6 V V_{RAMP} = 0.4 V	—	—	140	mA

TABLE 8. SKY77590-51 ELECTRICAL CHARACTERISTICS (2 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM1800/1900 *EDGE Mode*						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Stability	Stab	All combinations of the following parameters: 0 dBm ≤ P_{OUT} ≤ 26.5 dBm Load VSWR = 15:1, all phase angles	No parasitic oscillation >–36 dBm			
Load Mismatch	Load	All combinations of the following parameters: 0 dBm ≤ P_{OUT} ≤ 26.5 dBm Load VSWR = 20:1, all phase angles..	No module damage or permanent degradation			
Noise Power	P_{NOISE_1800}	f_0 + 20 MHz P_{OUT} ≤ 26.5 dBm V_{BATT} = 3.6 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–80	dBm
		f_0 = 925 MHz to 960 MHz P_{OUT} ≤ 26.5 dBm V_{BATT} = 3.6 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–84	
	P_{NOISE_1900}	f_0 + 20 MHz P_{OUT} ≤ 26.5 dBm V_{BATT} = 3.6 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–80	
		f_0 = 869 MHz to 894 MHz P_{OUT} ≤ 26.5 dBm V_{BATT} = 3.6 V T_{CASE} = +25 °C RBW = 100 kHz	—	—	–84	

TABLE 9. SKY77590-51 ELECTRICAL SPECIFICATIONS FOR TD-SCDMA NOMINAL OPERATING CONDITIONS (1880–1920 MHz)

Unless otherwise specified: per Table 2 over dynamic range up to 24 dBm output power.

Parameters		Symbol	Condition	Minimum	Typical	Maximum	Unit
Output Power		P_{OUT}	HPM V_{BATT} = 3.4 V	24	—	—	dBm
Gain		G_{HIGH}	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	31.0	32.5	34.0	dB
Power Added Efficiency		PAE_{HIGH}	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	12.5	—	%
Total Supply Current		I_{CC_HIGH}	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	570	670	mA
Adjacent Channel Leakage power Ratio[1]	1.6 MHz offset	ACLR1.6	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	–41	–37	dBc
	3.2 MHz offset	ACLR3.2	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	–63	–55	
Harmonic Suppression	Second	$f_0$2	$P_{OUT} \leq$ 24 dBm	—	—	–36	dBm
	Third	$f_0$3		—	—	–46	
Tx Noise in Rx Bands	DCS Rx		1805 MHz–1850 MHz	—	—	–131	dBm/Hz
Input Voltage Standing Wave Ratio		VSWR	—	—	—	3.0:1	—
EVM		EVM	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	2	4	%
Rise / Fall Time	DC	T_{ON}DC	—	—	8	10	µs
		T_{OFF}DC	—	—	8	10	
	RF	T_{ON}RF	—	—	3	6	
		T_{OFF}RF	—	—	3	6	
Stability (Spurious output)		S	5:1 VSWR All phases	—	—	–65	dBc
Ruggedness - no damage[2]		Ru	$P_{OUT} \leq$ 24 dBm	10:1	—	—	VSWR

[1] ACLR is expressed as a ratio of total adjacent power to TD-SCDMA modulated in-band, both measured in 1.28 MHz bandwidth at specified offsets and 16% duty cycle.

[2] All phases, time = 10 seconds.

TABLE 10. SKY77590-51 ELECTRICAL SPECIFICATIONS FOR TD-SCDMA NOMINAL OPERATING CONDITIONS (2010–2025 MHz)

Unless otherwise specified: per Table 2 over dynamic range up to 24 dBm output power.

Parameters		Symbol	Condition	Minimum	Typical	Maximum	Unit
Gain		G_{HIGH}	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	29.7	31.2	32.7	dB
Power Added Efficiency		PAE_{HIGH}	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	11	—	%
Total Supply Current		I_{CC_HIGH}	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	630	750	mA
Adjacent Channel Leakage power Ratio[2]	1.6 MHz offset	ACLR1.6	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	–40	–37	dBc
	3.2 MHz offset	ACLR3.2		—	–60	–55	
Harmonic Suppression	Second	$f_0$2	$P_{OUT} \leq$ 24 dBm	—	—	–40	dBm
	Third	$f_0$3		—	—	–46	
Tx Noise in Rx Bands	DCS Rx		1805 MHz–1880 MHz	—	—	–131	dBm/Hz
Input Voltage Standing Wave Ratio		VSWR	—	—	—	3.0:1	—
EVM		EVM	P_{OUT} = 24 dBm V_{RAMP} = 1.45 V	—	2	4	%
Rise / Fall Time	DC	T_{ON}DC	—	—	8	10	µs
		T_{OFF}DC	—	—	8	10	
	RF	T_{ON}RF	—	—	3	6	
		T_{OFF}RF	—	—	3	6	
Stability (Spurious output)		S	5:1 VSWR All phases	—	—	–65	dBc
Ruggedness - no damage[2]		Ru	$P_{OUT} \lneq$ 24 dBm	10:1	—	—	VSWR

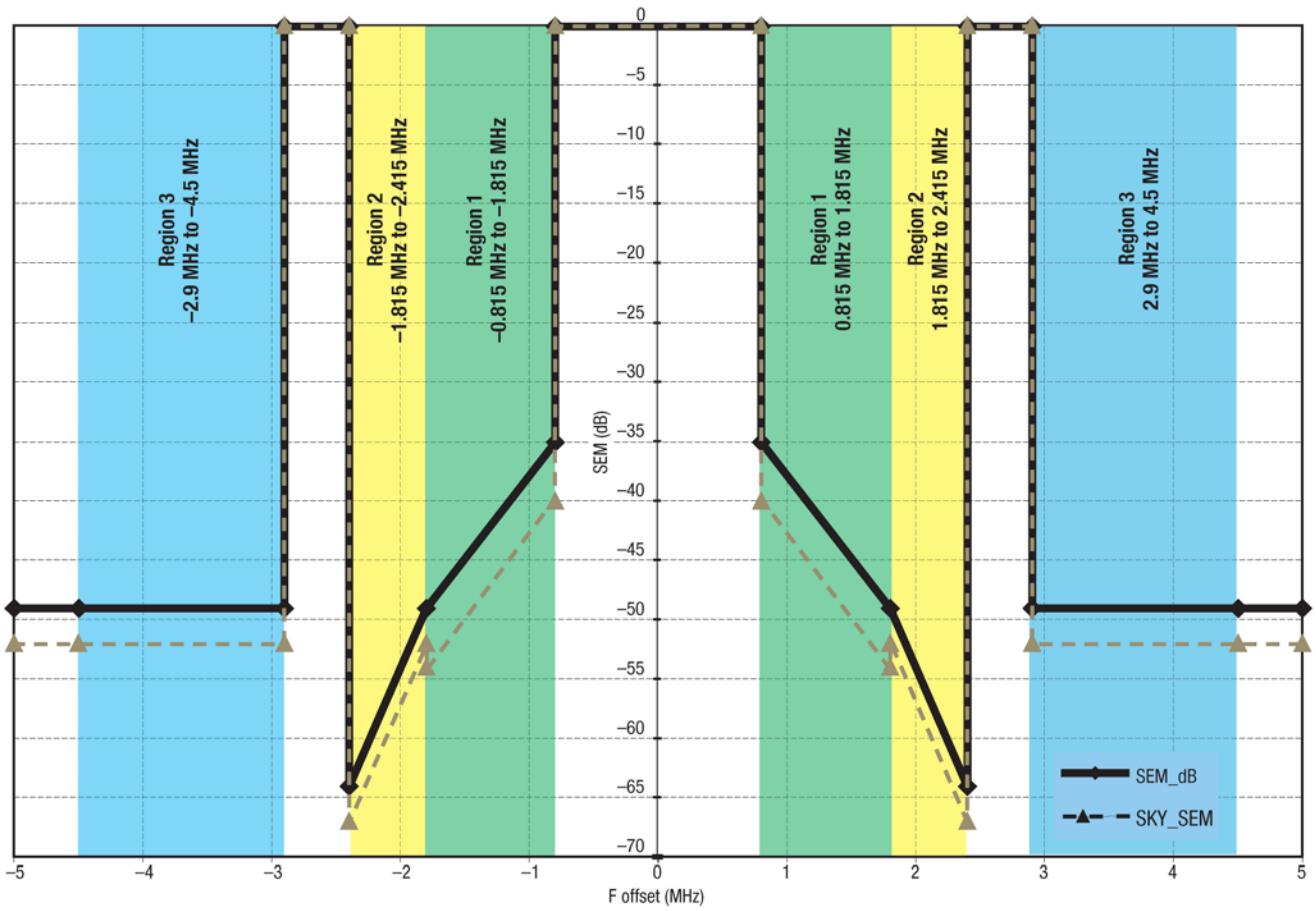
1 ACLR is expressed as a ratio of total adjacent power to TD-SCDMA modulated in-band, both measured in 1.28 MHz bandwidth at specified offsets and 16% duty cycle.

2. All phases, time = 10 seconds.

TABLE 11. SKY77590-51 ELECTRICAL CHARACTERISTICS

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C ≤ T_{CASE} ≤ +85 °C; 3.0 ≤ V_{BATT} ≤ 4.6 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	—	2690	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 2690 MHz T_{CASE} =+25°C	—	1.00	1.20	
Isolation	ADJACENT		Ports TRx1 through TRx6 to any other ADJACENT port (824–960 MHz)	25	—	—	dB
			Ports TRx1 through TRx6 to any other ADJACENT port (1710–1990 MHz)	25	—	—	
			Ports TRx1 through TRx6 to any other ADJACENT port (2110–2690 MHz)	20	—	—	
	NON-ADJACENT		Ports TRx1 through TRx6 to any other NON-ADJACENT port (824–960 MHz)	30	—	—	
			Ports TRx1 through TRx6 to any other NON-ADJACENT port (1710–1990 MHz)	30	—	—	
			Ports TRx1 through TRx6 to any other NON-ADJACENT port (2110–2690 MHz)	20	—	—	
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



SKY77574 MARGIN TO SEM[1]		REGION 3	REGION 2	REGION 1
Typical SEM Margin	24 dBm	6.0	4.0	6.0
Minimum SEM Margin	24 dBm	5.0	3.0	5.0

[1] Test condition: V_{CC} = 3.4 V, T_{CASE} = +25 °C

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FIGURE 2. MARGIN-TO-SEM CHART

Technical Information

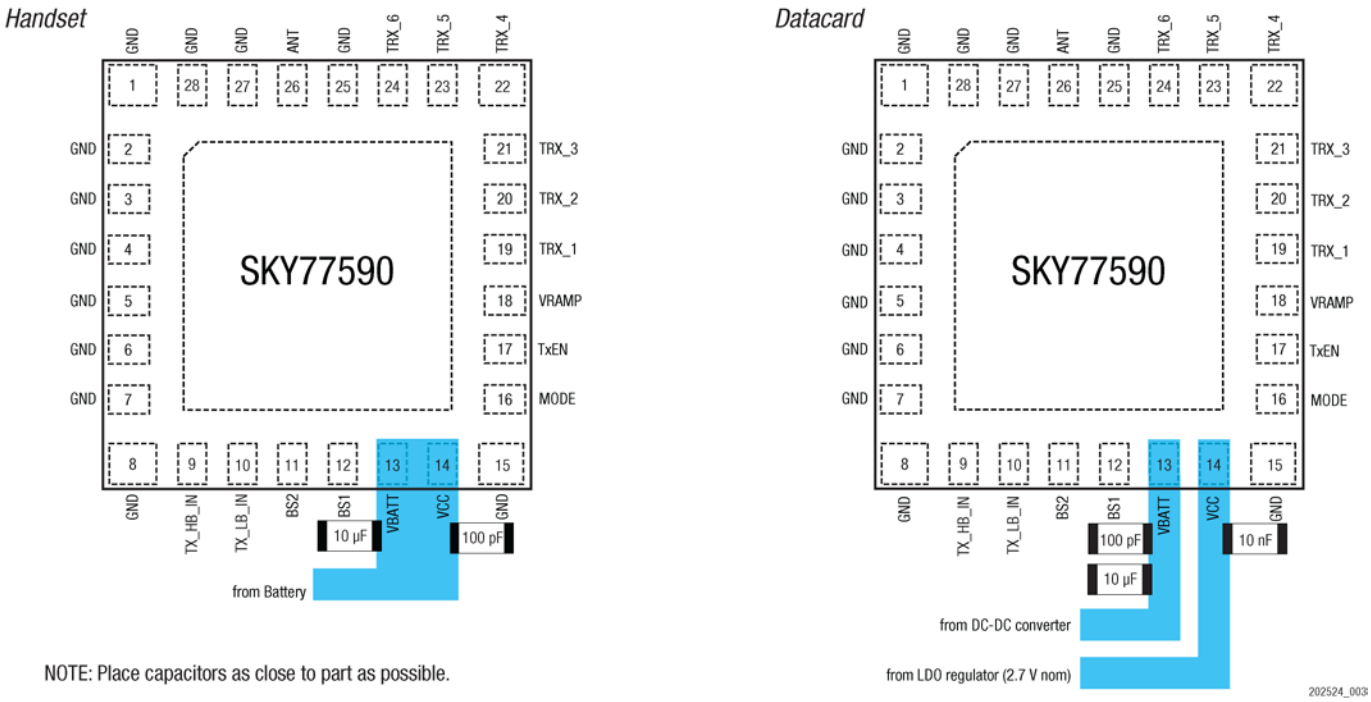
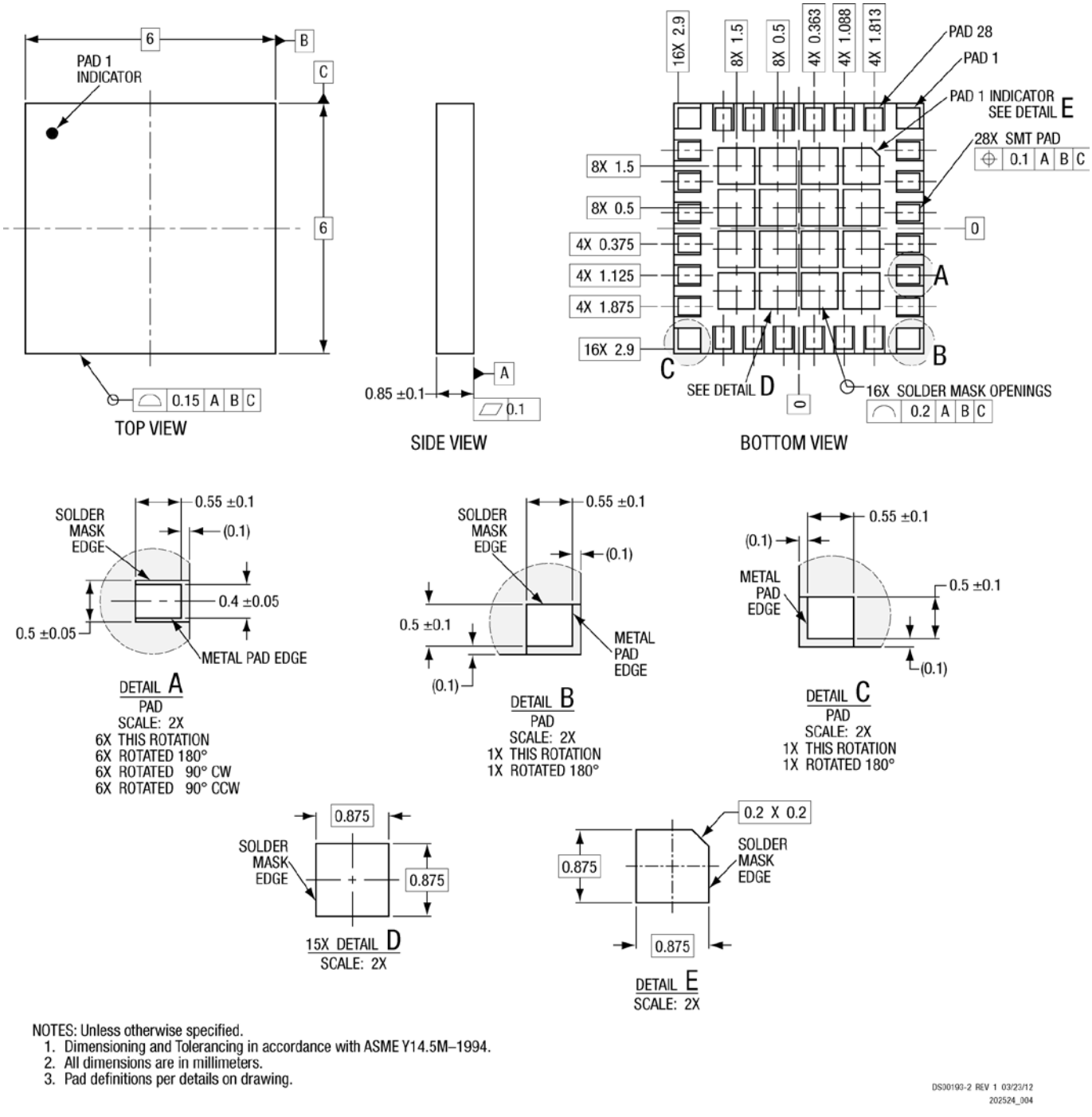


FIGURE 3. SKY77590-51 APPLICATION SCHEMATICS

Package Dimensions

The SKY77590-51 quad-band front-end module is a 6 mm x 6 mm x 0.9 mm, 28-pad, leadless package. Figure 4 is a three-view mechanical drawing of the pad configuration with layout dimensions. Figure 5 provides a recommended phone board layout footprint for the FEM 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 4. DIMENSIONAL DIAGRAM FOR 6 mm x 6 mm x 0.9 mm, 28-PAD LEADLESS PACKAGE – SKY77590-51 (ALL VIEWS)

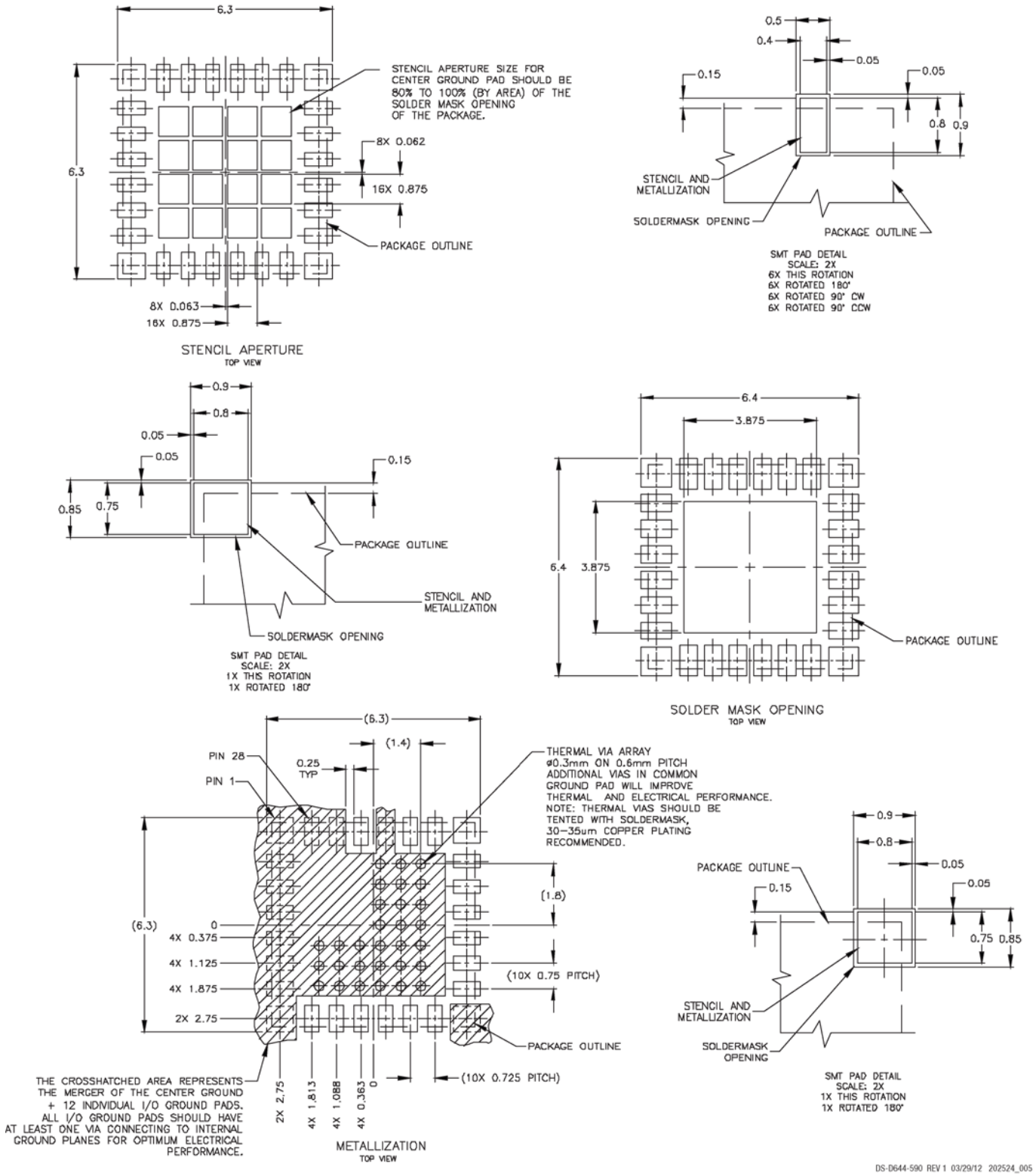
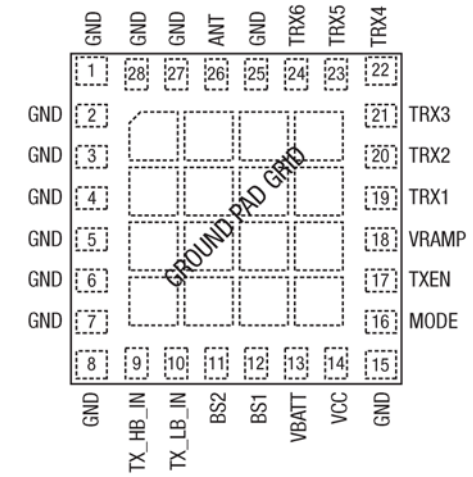


FIGURE 5. PHONE PCB LAYOUT FOR 6 mm x 6 mm, 28-PAD LEADLESS PACKAGE – SKY77590-51 SPECIFIC

Package Description

Figure 6 shows the device pad configuration and the pad numbering convention, which starts with pad 1 in the upper left and increments counter-clockwise around the package. Table 16 lists the pad names and signal descriptions. Figure 7 illustrates the typical case markings.



Pad layout as seen from Top View looking through package.

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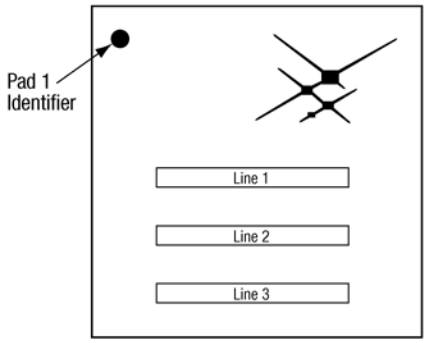
FIGURE 6. SKY77590-51 PAD NAMES AND CONFIGURATION (TOP VIEW)



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)

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FIGURE 7. TYPICAL CASE MARKINGS

TABLE 12. SKY77590-51 SIGNAL DESCRIPTIONS

Pad[1]	Name	Description
9	Tx_HB_IN	Input Tx signal 1710 MHz–2025 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	GMSK / EDGE / TD-SCDMA mode switch (0 = GMSK, 1 = EDGE / TD-SCDMA)
17	TxEN	Enable TxEN
18	VRAMP	Controls power in GSM mode and bias in EDGE/TD-SCDMA
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)

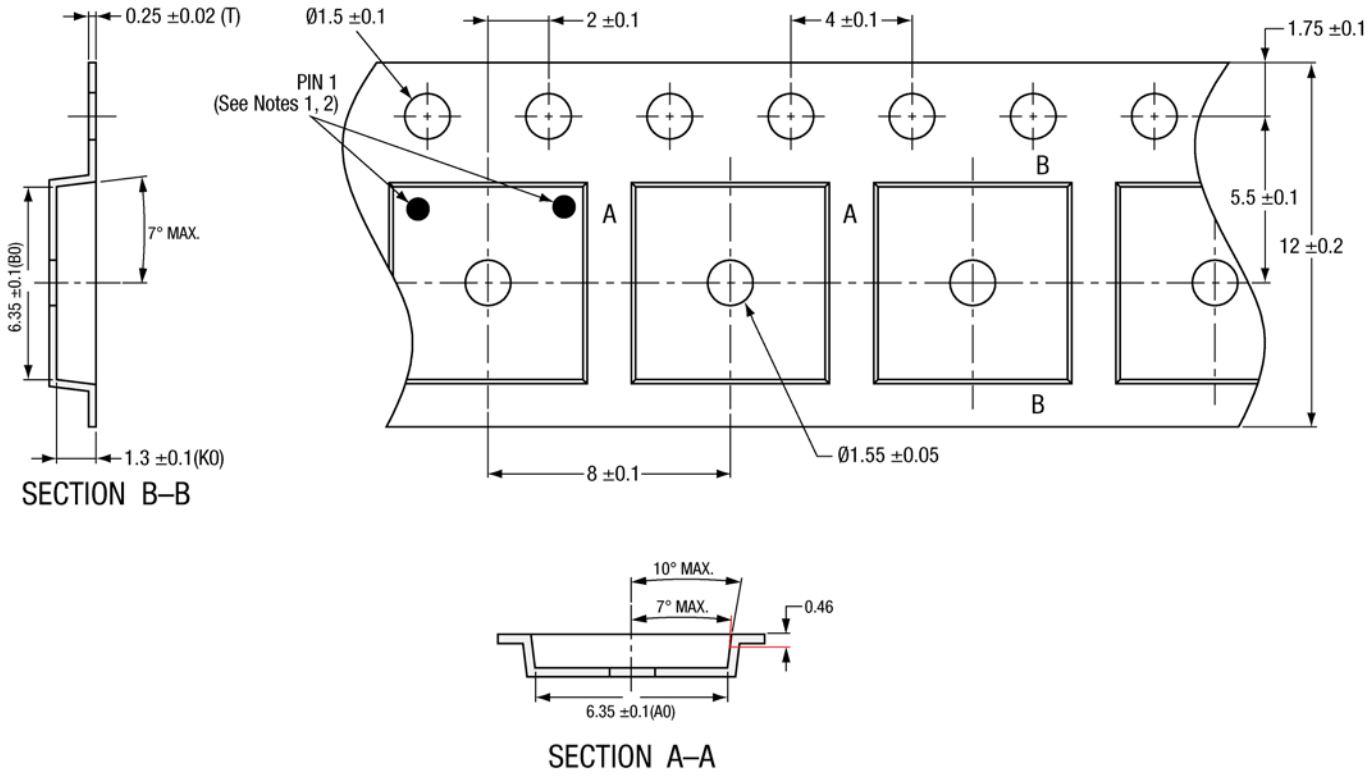
[1] Pads 1–8, 15, 25, 27, 28 are ground pads.

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 relate to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY77590-51 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 Standard J-STD-020*.

Production quantities of this product are shipped in the standard tape-and-reel format (Figure 8).



NOTES:

1. PIN 1 ORIENTATION IS "TOP LEFT" ONLY FOR RFLGA & MCM PRODUCTS LISTED BELOW:
   SKY73022-21 SKY73022-31
   SKY73023-21 SKY73023-31
2. PIN 1 ORIENTATION IS "TOP RIGHT" FOR ALL 6 x 6 mm RFLGA & MCM PRODUCTS EXCEPT THOSE LISTED IN NOTE 1 ABOVE.
3. CARRIER TAPE IS BLACK CONDUCTIVE POLYCARBONATE OR POLYSTYRENE.
4. COVER TAPE IS TRANSPARENT AND CONDUCTIVE.
5. ESD-SURFACE RESISTIVITY IS ≤ 1 X 10^{10} OHMS/SQUARE PER EIA, JEDEC TNR SPECIFICATION.
6. 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 8. DIMENSIONAL DIAGRAM FOR CARRIER TAPE BODY SIZE 6 mm x 6 mm x 0.85 / 1.1 MM – MCM

Ordering Information

Product Name	Order Number	Evaluation Board Part Number
SKY77590-51 Tx-Rx Front-End Module	SKY77590-51	

Revision History

Revision	Date	Description
A	November 8, 2012	Initial Release – Preliminary Information

References

Skyworks Application Note: *SKY77590 Rx-Tx Front-End Modules – Evaluation Board Information and Implementation*, Document Number 202331

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

Standard SMT Reflow Profiles: *JEDEC Standard J–STD–020*