SKYWORKS®

PRELIMINARY DATA SHEET

SKY77910-11 Tx-Rx FEM for Quad-Band GSM / GPRS / EDGE w/ Eight Linear TRx Switch Ports, Dual-Band TD-SCDMA, and TDD LTE Band 39

Applications

- Cellular handsets encompassing Quad-Band GSM/EDGE, Dual-Band TD-SCDMA, and TDD LTE
  - Class 4 GSM850/900
  - Class 1 DCS1800/PCS1900
  - Class 12 GPRS multi-slot operation
  - Linear EDGE operation
  - TD-SCDMA Bands 34/39
  - TDD LTE Band 39

Features

- Small, low profile package
  - 5.5 mm x 5.3 mm x 0.8 mm
  - 38-pad configuration
- Fully programmable MIPI® RFFE control
- Eight low insertion loss / high linearity TRx switch ports
- Integrated noise suppression notch filter for WiFi coexistence
- Built-in IEC-compliant antenna ESD protection
- Integrated broadband directional coupler
- High Efficiency (inclusive of coupler)
  - 40% GSM850 36% DCS1800
  - 40% GSM900 36% PCS1900
- Wide GMSK input power range: –1 dBm to 6 dBm
- Tx-VCO-to-antenna and antenna-to-Rx-SAW filter RF interface
- Tx harmonics below –40 dBm
- Current limiting and over-voltage protection for ruggedness and extended battery life
- Input/Output ports internally matched to 50 Ω load
- 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

The design of the SKY77910-11 Transmit / Receive Front End Module (FEM) offers a complete transmit VCO-to-Antenna and Antenna-to-receive SAW filter solution for advanced cellular handsets comprising quad-band GSM, and linear 2.5G operation. Developed in a very low profile (0.8 mm) and compact form factor, the FEM supports Class 12 General Packet Radio Service (GPRS), EDGE multi-slot operation, and TD-SCDMA and TDD LTE linear transmission. Eight transmit / receive (TRx) ports and an integrated directional coupler enables broadband 3G/4G RF switch-through.

The module consists of a CMOS Power Amplifier (PA) Controller, a low band (LB) PA block supporting GSM850/900 bands, a high band (HB) PA block supporting DCS1800/PCS1900, TD-SCDMA bands 34/39, and TDD LTE band 39, input and output ports internally matched to 50 ohm impedance loads, Tx harmonic filtering, RF switching, and a directional coupler at the antenna output. The custom low-current PA controller includes the Mobile Industry Processor Interface (MIPI) and decoder circuitry to control the RF switch.

Internal matching of all RF ports to a 50 ohm load reduces the number of external components on the phone board. The Heterojunction Bipolar Transistor (HBT) PA blocks, fabricated in GaAs, share common power supply pads to distribute current. Extremely low leakage current of the SKY77910-11 maximizes handset standby time. The PA outputs and the eight TRx pads connect to the antenna pad through a high-linearity, low-loss switch. The TRx ports feature a 0 volts DC offset level that eliminates external blocking capacitors. An integrated directional coupler precludes any external coupler requirement. The GaAs die, the switch die, the CMOS controller, and the passive components mount onto a multi-layer laminate substrate and the entire assembly is encapsulated with plastic overmold. MIPI controls the RF signal flows including mode control and selection of LB or HB PA or TRx port.

In GMSK modes, the PA controller provides envelope amplitude control as a function of VRAMP and reduces sensitivity to input drive, temperature, power supply, and process variations. Skyworks' Finger-Based Integrated Power Amplifier Control (FB-iPAQ) minimizes output power variation into mismatch. Proper timing of MIPI commands and VRAMP input ensures high isolation between the antenna and Tx-VCO while the VCO is being tuned prior to the transmit burst.

In EDGE and TD-SCDMA / TDD LTE linear modes, VRAMP voltage and MIPI-based bias settings optimize PA linearity and efficiency.

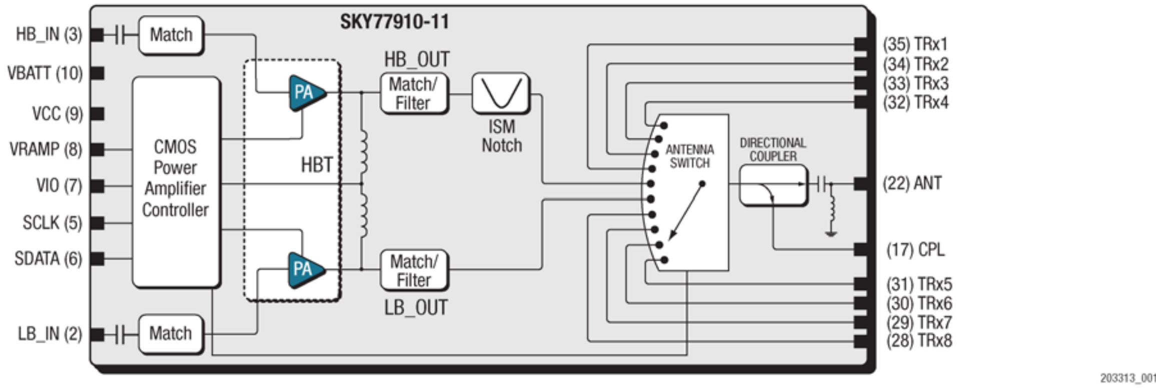


FIGURE 1. SKY77910-11 FUNCTIONAL BLOCK DIAGRAM

Electrical Specifications

The following tables list the electrical specifications of the SKY77910-11 Front-End Module. Table 1 lists the absolute maximum ratings and Table 2 lists the recommended operating conditions. Table 5 through Table 11 provide the electrical specifications of the SKY77910-11 for GMSK, EDGE, TD-SCDMA, and TDD LTE transmission, and TRx port modes including control logic descriptions for the various modes.

The SKY77910-11 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[1]

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[2]		I_{BATT}	—	—	2.5	A
GMSK Burst Duty Cycle		D_B	—	—	50	%
Voltage Standing Wave Ratio		VSWR	—	—	20:1	V
Power Control Voltage		V_{RAMP}	–0.3	—	3.0	V
MIPI Supply Voltage		VIO	—	—	2.0	V
MIPI Data and Clock Voltage		V_{MIPI}	—	—	2.0	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 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.

2 Applied voltage must be current-limited to specified range.

Table 2. SKY77910-11 Recommended Operating Conditions[1]

Unless otherwise specified: 50 Ω system; terminate all RF ports with 50 Ω during test.

Parameter		Symbol	Minimum	Typical[2]	Maximum	Unit
Supply Voltage[3]	GMSK	V_{BATT}	3.0	3.5	4.6	V
	EDGE/TD-SCDMA/TDD LTE		3.0	3.6	4.6	
		V_{CC}	2.5	—	4.6	
GMSK Input Power		P_{IN}	–1	3	6	dBm
Operating Case Temperature[4]	GMSK/EDGE 1–4 Slots (12.5%–50% duty cycle)[5]	T_{CASE}	–20	+25	+85	°C
	TD-SCDMA/TDD LTE		–20	+25	+85	

1 Extreme Test Conditions (ETC) are defined by the applicable min/max values of the parameters.
2 Nominal Test Condition (NTC) is defined by the applicable typical values.
3 V_{BATT} and V_{CC} should be connected unless DC/DC is used and V_{CC} can be separately supplied.
4 Case Operating Temperature refers to the temperature at the GROUND PAD on the underside of the package.
5 Max. output power must be reduced by 6 dB to support 3-slot and 4-slot operation.

Table 3. SKY77910-11 Interface Specifications

Unless otherwise specified: ETC per Table 2.

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Supply Current	I_{BATT}		0	—	2.3	A
GMSK/EDGE Burst Duty Cycle	D_B		12.5	—	50	%
Resistance of V_{RAMP}	R_{VRAMP}	DC resistance to ground	—	—	5	MΩ
Capacitance of V_{RAMP}	C_{VRAMP}	Capacitance to ground	—	—	2	pF
MIPI Supply Voltage	VIO	$V_{RAMP} < 1.45$ V	1.65	1.8	1.95	V
MIPI Signal Levels	V_{MIPI_LOW}		0		0.2 x VIO	
	V_{MIPI_HIGH}		0.8 x VIO		VIO	
Power Control Voltage	V_{RAMP}		0.2	—	2.0	V
Standby Current	$I\_{STANDBY}$	Standby mode NTC VIO = 0 V	—	5	20	µA
TRx Mode Current	I_{TRx}	Any TRx Mode	—	150	300	µA

Table 4. SKY77910-11 MIPI RFFE Register Map (1 of 2)

Bit Position	Description	Default Value	Notes		
Register 0, Address 0x00 (Mode Control)					
7	(Reserved)	0	(Reserved. Set to 0)		
6	(Reserved)	0	(Reserved. Set to 0)		
5	Gain Control	0	0 = nominal Gain, 1 = lower Gain (HB only)		
4:0	Mode Control	00000	0x00 = Standby	0x0B = LB EDGE/Linear Tx	
			0x01 = TRx3	0x0C = Isolation	
			0x02 = TRx2	0x0D = TRx6	
			0x03 = TRx1	0x0E = HB GMSK Tx	
			0x04 = TRx7	0x0F = HB EDGE/Linear Tx	
			0x05 = TRx4		
			0x06 = Isolation		
			0x07 = Isolation		
			0x08 = TRx8		
			0x09 = TRx5		
			0x0A = LB GMSK Tx		
				Other = Reserved – Do Not Use	
Register 1, Address 0x01 (Bias Control)					
7:4	PA stage 3 bias	1000	0000 = 250 µA		
			0001 = 500 µA	0110 = 1750 µA	1011 = 3000 µA
			0010 = 750 µA	0111 = 2000 µA	1100 = 3250 µA
			0011 = 1000 µA	1000 = 2250 µA	1101 = 3500 µA
			0100 = 1250 µA	1001 = 2500 µA	1110 = 3750 µA
			0101 = 1500 µA	1010 = 2750 µA	1111 = 4000 µA
3:0	PA stage 1-2 bias	1000	0000 = 250 µA		
			0001 = 500 µA	0110 = 1750 µA	1011 = 3000 µA
			0010 = 750 µA	0111=2000 µA	1100 = 3250 µA
			0011 = 1000 µA	1000 = 2250 µA	1101 = 3500 µA
			0100 = 1250 µA	1001 = 2500 µA	1110 = 3750 µA
			0101 = 1500 µA	1010 = 2750 µA	1111 = 4000 µA
Register 2, Address 0x02 (Reserved)					
7:0	(Reserved)	0x00	(Reserved)		
Register 3, Address 0x03 (Reserved)					
7:0	(Reserved)	0x00	(Reserved)		
Register 4, Address 0x04 (Reserved)					
7:0	(Reserved)	0x00	(Reserved)		
Register 5, Address 0x05 (Reserved)					
7:0	(Reserved)	0x00	(Reserved)		
Register 6, Address 0x06 (Reserved)					
7:0	(Reserved)	0x00	(Reserved)		

Table 4. SKY77910-11 MIPI RFFE Register Map (2 of 2)

Bit Position	Description	Default Value	Notes
Register 26, Address 0x1A (RFFE Status)			
7:0	SOFTWARE RESET	0	Reset all configurable registers to default values except for USID, GROUP_SID, and PM_TRIG. The RFFE_STATUS register shall reset after it is read. 0: normal operation; 1: software reset.
6	COMMAND_FRAME_PARITY_ERR	0	Command Sequence received with parity error – discard command. The RFFE_STATUS register shall reset after it is read.
5	COMMAND_LENGTH_ERR	0	Command length error. The RFFE_STATUS register shall reset after it is read.
4	ADDRESS_FRAME_PARITY_ERR	0	Address frame with parity error. The RFFE_STATUS register shall reset after it is read.
3	DATA_FRAME_PARITY_ERR	0	Data frame with parity error. The RFFE_STATUS register shall reset after it is read.
2	READ_UNUSED_REG	0	Read command to an invalid address. The RFFE_STATUS register shall reset after it is read.
1	WRITE_UNUSED_REG	0	Write command to an invalid address. The RFFE_STATUS register shall reset after it is read.
0	BID_GID_ERR	0	Read command with a BROADCAST_ID or GROUP_ID. The RFFE_STATUS register shall reset after it is read.
Register 27, Address 0x1B (GROUP_ID)			
7:4	(Reserved)	0000	(Reserved)
3:0	Group SID	0000	Group slave ID
Register 28, Address 0x1C (PM_TRIG)			
7:6	PWR_MODE	00	**NOTE**: When an RFFE Slave is initially powered up and comes out of reset, it enters STARTUP. During STARTUP, all Slave registers shall be set to their default values. Following STARTUP, the Slave shall transition to ACTIVE but immediately transition into LOW POWER to avoid requiring a write on the bus to configure the devices explicitly to LOW POWER. When the Slave is in LOW POWER, charge pumps shall be disabled and the Slave shall be listening to the RFFE bus. 00 = Normal Operation (ACTIVE) 01 = Default Settings (STARTUP) 10 = Low Power (LOW POWER) 11 = Reserved
5	Trigger Mask 2	1	Trigger Enable: 0, Trigger Disable: 1
4	Trigger Mask 1	1	Trigger Enable: 0, Trigger Disable: 1
3	Trigger Mask 0	1	Trigger Enable: 0, Trigger Disable: 1
2	Trigger Register 2	0	Not supported
1	Trigger Register 1	0	(Reserved)
0	Trigger Register 0	0	1 = Latch Register 0,1 contents
Register 29, Address 0x1D (PROD_ID)			
7:0	Product ID	0x8E	Product ID
Register 30, Address 0x1E (MAN_ID)			
7:0	Manufacturer ID	0xA5	Manufacturer ID [7:0]
Register 31, Address 0x1F (USID)			
7:6	(Reserved)	00	(Reserved)
5:4	Manufacturer ID (MSB)	01	Manufacturer ID [9:8]
3:0	User ID	1111	USID = 1111

TABLE 5. SKY77910-11 ELECTRICAL SPECIFICATIONS – GMSK LOW BAND (1 OF 2)

Unless otherwise specified: P_{RATED} = 33 dBm; ETC per Table 2.

GSM850/900 GMSK Mode							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	GSM850	f_0	—	824	—	849	MHz
	GSM900			880	—	915	
Supply Current		I_{BATT}	—	—	—	2.3	A
Power Added Efficiency	GSM850	PAE	P_{OUT} = P_{RATED} NTC Duty cycle = 1:8	—	40	—	%
	GSM900			—	40	—	
Harmonics		$2f_0$ to $13f_0$	BW = 3 MHz 5 dBm ≤ Cal-P_{OUT} ≤ P_{RATED} V_{RAMP} = Cal-V_{RAMP}[1]	—	–40	–33	dBm
Output Power		P_{OUT_GMSK}	P_{IN} = –1 dBm V_{RAMP} = 1.6 V NTC	—	34	—	dBm
		$P_{OUT\_GMSK\_EX}$	P_{IN} = –1 dBm V_{BATT} = 3.0 V V_{RAMP} = 1.8 V	31	—	—	
Input VSWR		Γ_{IN}	P_{OUT} ≤ P_{RATED}	—	—	2.5:1	
Isolation		ISO_{PDSD}	P_{IN} ≤ 6 dBm Forward Isolation Mode V_{RAMP} ≤ 0.1 V	—	–70	–51	dBm
		ISO_{PESE}	P_{IN} ≤ 6 dBm LB_GMSK_Tx Mode V_{RAMP} ≤ 0.1 V	—	—	–15	
Mode Switching Time		T_{MODE_GMSK}	Time from EDGE to GMSK mode transition to application of GMSK RF input drive to meet forward isolation PESE			2	µs

Table 5. SKY77910-11 Electrical Specifications – GMSK Low Band (2 of 2)

Unless otherwise specified: P_{RATED} = 33 dBm; ETC per Table 2.

GSM850/900 GMSK Mode						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Stability	S	All combinations of the following parameters: 5 dBm ≤ P_{OUT} ≤ P_{RATED} 0 dBm ≤ P_{IN} ≤ 6 dBm Load VSWR = 12:1, all phase angles	No parasitic oscillation > –36 dBm			
Load Mismatch	Load	All combinations of the following parameters: 5 dBm ≤ P_{OUT} ≤ P_{RATED} 0 dBm ≤ P_{IN} ≤ 6 dBm Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation			
Noise Power	P_{NOISE_850}	ƒ_Rx = 869 MHz to 894 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–83	dBm
	P_{NOISE_900}	ƒ_Rx = 935 MHz to 960 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–83	
		ƒ_Rx = 925 MHz to 935 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–79	
		ƒ_Rx =1805 MHz to 1880 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–86	
	P_{NOISE_750}	ƒ_Rx = 734 MHz to 757 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz			–83	
	P_{NOISE_ISM}	ƒ_Rx = 2400 MHz to 2500 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz			–106	

[1] Cal-V_{RAMP} = V_{RAMP} at P_{OUT} = Cal-P_{OUT}, NTC

Table 6. SKY77910-11 Electrical Specifications – EDGE Low Band (1 of 2)

Unless otherwise specified: V_{RAMP} = 1.45 V; P_{RATED} = 27.5 dBm; ETC per Table 2.

GSM850/900 EDGE Mode							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	GSM850	f_0	—	824	—	849	MHz
	GSM900			880	—	915	
Power Added Efficiency	GSM850	PAE_{GSM850}	$P_{OUT} = P_{RATED}$ NTC Duty cycle = 1:8	—	18	—	%
	GSM900	PAE_{GSM900}		—	18	—	
Harmonics		$2f_0$ to $15f_0$	BW = 3 MHz 5 dBm ≤ P_{OUT} ≤ P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$	—	–45	–36	dBm
Output Power		P_{OUT_EDGE}	NTC ACPR / EVM / ORFS in specification	27.5	—	—	dBm
		$P_{OUT\_EDGE\_EX}$	ACPR / EVM / ORFS in specification	26.0	—	—	
Input VSWR		Γ_{IN}	P_{OUT} ≤ P_{RATED}	—	—	2.5:1	
Gain		G_{NOM_850}	$P_{OUT} = P_{RATED}$ NTC	31.0	32.5	34.0	dB
		G_{NOM_900}		31.0	32.5	34.0	
		G_{EX_850}	$P_{OUT} = P_{OUT\_EDGE}$, $P_{OUT\_EDGE\_EX}$	29.0	—	35.5	
		G_{EX_900}		29.0	—	35.5	
ACPR		$ACPR_{200}$	$P_{OUT} = P_{OUT\_EDGE}$, $P_{OUT\_EDGE\_EX}$ Bandwidth = 30 kHz	—	–37.5	–34.0	dBc
		$ACPR_{400}$		—	–65.0	–60.0	
		$ACPR_{600}$		—	–75.0	–70.0	
EVM		EVM_{RMS}	$P_{OUT} = P_{OUT\_EDGE}$, $P_{OUT\_EDGE\_EX}$	—	—	4	%
Bias Switching Time		T_{ON_EDGE}	Rx to Tx transition time from final MIPI command and 90% V_{RAMP} to 0.5 db RF settling.	—	—	1	µs

Table 6. SKY77910-11 Electrical Specifications – EDGE Low Band (2 of 2)

Unless otherwise specified: V_{RAMP} = 1.45 V; P_{RATED} = 27.5 dBm; ETC per Table 2.

GSM850/900 EDGE Mode						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Stability	S	All combinations of the following parameters: 5 dBm ≤ P_{OUT} ≤ P_{RATED} Load VSWR = 12:1, all phase angles	No parasitic oscillation > –36 dBm			
Load Mismatch	Load	All combinations of the following parameters: 5 dBm ≤ P_{OUT} ≤ P_{RATED} Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation			
Noise Power	P_{NOISE_850}	ƒ_Rx = 869 MHz to 894 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–82	dBm
	P_{NOISE_900}	ƒ_Rx = 935 MHz to 960 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–82	
		ƒ_Rx = 925 MHz to 935 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–82	
		ƒ_Rx = 1805 MHz to 1880 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–86	
	P_{NOISE_750}	ƒ_Rx = 734 MHz to 757 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–83	
	P_{NOISE_ISM}	ƒ_Rx = 2400 MHz to 2500 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–106	

Table 7. SKY77910-11 Electrical Specifications – GMSK High Band (1 of 2)

Unless otherwise specified: P_{RATED} = 30.5 dBm; ETC per Table 2.

GSM1800/1900 GMSK Mode							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	DCS1800	f_0	—	1710	—	1785	MHz
	PCS1900		—	1850	—	1910	
Power Added Efficiency		$PAE_{\_DCS1800}$	$P_{OUT} = P_{RATED}$ NTC Duty cycle = 1:8	—	36	—	%
		$PAE_{\_PCS1900}$		—	35	—	
Harmonics		$2f_0$ to $7f_0$	BW = 3 MHz 0 dBm ≤ Cal-P_{OUT} ≤ P_{RATED} V_{RAMP} = Cal- V_{RAMP}[1]	—	–40	–33	dBm
Output Power		P_{OUT_GMSK}	P_{IN} = –1 dBm V_{RAMP} = 1.6 V NTC	—	31.5	—	dBm
		$P_{OUT\_GMSK\_EX}$	P_{IN} = –1 dBm V_{BATT} = 3.0 V V_{RAMP} = 1.8 V	28.5	—	—	
Input VSWR		Γ_{IN}	P_{OUT} ≤ P_{RATED}	—	—	2.5:1	
Isolation		$ISO_{\_PDSD}$	P_{IN} ≤ 6 dBm Forward Isolation Mode V_{RAMP} ≤ 0.1 V	—	–65	–53	dBm
		$ISO_{\_PESE}$	P_{IN} ≤ 6 dBm HB_GMSK_Tx Mode V_{RAMP} ≤ 0.1 V	—	—	–15	
Mode Switching Time		$T_{\_MODE\_GMSK}$	Time from EDGE to GMSK mode transition to application of GMSK RF input drive to meet forward isolation PESE	—	—	2	µs

TABLE 7. SKY77910-11 ELECTRICAL SPECIFICATIONS – GMSK HIGH BAND (2 OF 2)

Unless otherwise specified: P_{RATED} = 30.5 dBm; ETC per Table 2.

GSM1800/1900 GMSK Mode						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Stability	S	All combinations of the following parameters: 0 dBm ≤ P_{OUT} ≤ P_{RATED} 0 dBm ≤ P_{IN} ≤ 6 dBm Load VSWR = 12:1, all phase angles	No parasitic oscillation >–36 dBm			
Load Mismatch	Load	All combinations of the following parameters: 0 dBm ≤ P_{OUT} ≤ P_{RATED} 0 dBm ≤ P_{IN} ≤ 6 dBm Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation			
Noise Power	P_{NOISE_1800}	ƒ_Rx = 1805 MHz to 1880 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–83	dBm
		ƒ_Rx = 925 MHz to 960 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–84	
	P_{NOISE_1900}	ƒ_Rx = 1930 MHz to 1990 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–83	
		ƒ_Rx = 869 MHz to 894 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–84	
	P_{NOISE_750}	ƒ_Rx = 734 MHz to 757 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–83	
	P_{NOISE_ISM}	ƒ_Rx = 2400 MHz to 2500 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–106	

[1] Cal-V_{RAMP} = V_{RAMP} at P_{OUT} = Cal-P_{OUT}, NTC

Table 8. SKY77910-11 Electrical Specifications –EDGE High Band (1 of 2)

Unless otherwise specified: V_{RAMP} = 1.45 V; P_{RATED} = 26.5 dBm; ETC per Table 2.

GSM1800/1900 EDGE Mode							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	DCS1800	f_0	—	1710	—	1785	MHz
	PCS1900			1850	—	1910	
Power Added Efficiency		$PAE_{\_DCS1800}$	V_{BATT} = 3.6 V P_{OUT} = P_{RATED} NTC Duty cycle = 1:8	—	18.5	—	%
		$PAE_{\_PCS1900}$		—	19.5	—	
Harmonics		$2f_0$ to $7f_0$	BW = 3 MHz 0 dBm ≤ P_{OUT} ≤ P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$	—	–45	–36	dBm
Output Power		P_{OUT_EDGE}	NTC ACPR / EVM / ORFS in specification	26.5	—	—	dBm
		$P_{OUT\_EDGE\_EX}$	ACPR / EVM / ORFS in specification	25.0	—	—	
Input VSWR		Γ_{IN}	P_{OUT} ≤ P_{RATED}	—	—	2.5:1	
Gain		$G_{\_NOM\_1800}$	P_{OUT} = P_{RATED} NTC	33.0	34.5	36.0	dB
		$G_{\_NOM\_1900}$		33.0	34.5	36.0	
		$G_{\_EX\_1800}$	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$	31.0	—	37.5	
		$G_{\_EX\_1900}$		31.0	—	37.5	
ACPR		$ACPR_{\_200}$	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$ Bandwidth = 30 kHz	—	–37.5	–34.0	dBc
		$ACPR_{\_400}$		—	–65.0	–59.0	
		$ACPR_{\_600}$		—	–75.0	–70.0	
EVM		$EVM_{\_RMS}$	P_{OUT} = P_{OUT_EDGE}, $P_{OUT\_EDGE\_EX}$	—	—	4	%
Mode Switching Time		$T_{\_ON\_EDGE}$	Rx to Tx transition time from final MIPI command and 90% V_{RAMP} to 0.5 dB RF settling	—	—	1	μs

TABLE 8. SKY77910-11 ELECTRICAL SPECIFICATIONS –EDGE HIGH BAND (2 OF 2)

Unless otherwise specified: V_{RAMP} = 1.45 V; P_{RATED} = 26.5 dBm; ETC per Table 2.

GSM1800/1900 *EDGE Mode*						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Stability	S	All combinations of the following parameters: 0 dBm ≤ P_{OUT} ≤ P_{RATED} Load VSWR = 12:1, all phase angles	No parasitic oscillation >–36 dBm			
Load Mismatch	Load	All combinations of the following parameters: 0 dBm ≤ P_{OUT} ≤ P_{RATED} Load VSWR = 20:1, all phase angles	No module damage or permanent degradation			
Noise Power	P_{NOISE_1800}	ƒ_Rx = 1805 MHz to 1880 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–80	dBm
		ƒ_Rx = 925 MHz to 960 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–84	
	P_{NOISE_1900}	ƒ_Rx = 1930 MHz to 1990 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–80	
		ƒ_Rx = 869 MHz to 894 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–84	
	P_{NOISE_750}	ƒ_Rx = 734 MHz to 757 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–83	
	P_{NOISE_ISM}	ƒ_Rx = 2400 MHz to 2500 MHz P_{OUT} = P_{RATED} NTC RBW = 100 kHz	—	—	–106	

Table 9. SKY77910-11 Electrical Specifications – TD-SCDMA Band 39

Unless otherwise specified: VRAMP = 1.45 V; ETC per Table 2.

TD-SCDMA Band 39 (1880–1920 MHz)							
Parameters		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power		POUT_TD_NOM	NTC	24.5	—	—	dBm
		POUT_TD_EX		23.5			
Gain	High Power	GHPM_NOM	POUT = POUT_TD_NOM	30.5	32.0	33.5	dB
		GHPM_EX	POUT = POUT_TD_EX	28.0		35.0	
	Low Power	GLPM	PIN = –35 dBm, VRAMP = 0.3 V	—	24.0	27.0	
Power Added Efficiency		PAEHPM	POUT = POUT_TD_NOM	—	15	—	%
Quiescent Current		ICQ_HPM	PIN ≤ –80 dBm	—	TBD	—	mA
Low Power Mode Current		IBATT_LPM	VRAMP = 0.3 V POUT = 0 dBm NTC		TBD		mA
Adjacent Channel Leakage power Ratio[1]	1.6 MHz offset	ACLR1.6	POUT_TD_NOM	—	–47	–42	dBc
			POUT_TD_EX	—	—	–42	
	3.2 MHz offset	ACLR3.2	POUT_TD_NOM, POUT_TD_EX	—	–64	–60	
Error Vector Magnitude[1]		EVM_RMS	POUT_TD_NOM	—	2	3	%
			POUT_TD_EX	—	2	4	
Harmonic Suppression[1]		ƒ02–ƒ06	POUT ≤ POUT_TD_NOM, POUT_TD_EX, RBW = 1 MHz	—	—	–36	dBm
Tx Noise in Rx Bands[1]	DCS Rx		ƒ_Rx = 1805 MHz to 1850 MHz, POUT = POUT_TD_NOM NTC, RBW = 100 kHz	—	—	–81	dBm
Input Voltage Standing Wave Ratio		VSWR_IN	—	—	—	2.5:1	—
Rise / Fall Time		TONDC	TRx Mode to TDD LTE Tx, from MIPI command and >90% VRAMP to 0.5 dB RF settling	—	TBD	10	μs
		TOFFDC	TDD LTE Tx to TRx Mode, from MIPI command or <10% VRAMP to 30 dB gain drop	—	TBD	10	
Stability		S	VSWR = 12:1 All phases, RBW = 1 MHz	—	—	–36	dBm
Ruggedness - no damage		Ru	All phases, time = 10 seconds	20:1	—	—	VSWR

1 Measured using ETSI TS 125.102 UL reference measurement channel (12.2 kbps), 16% duty cycle.

Table 10. SKY77910-11 Electrical Specifications – TD-SCDMA Band 34

Unless otherwise specified: VRAMP = 1.45 V; ETC per Table 2.

TD-SCDMA Band 34 (2010–2025 MHz)							
Parameters		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power		POUT_TD_NOM	NTC	24.5	—	—	dBm
		POUT_TD_EX		23.5	—	—	
Gain	High Power	GHPM_NOM	POUT = POUT_TD_NOM	30.5	32.5	34.0	dB
		GHPM_EX	POUT = POUT_TD_EX	28.0	—	35.5	
	Low Power	GLPM	PIN = –35 dBm, VRAMP = 0.3 V	—	24.0	27.0	
Power Added Efficiency		PAEHPM	POUT = POUT_TD_NOM	—	15	—	%
Quiescent Current		ICQ_HPM	PIN ≤ –80 dBm	—	TBD	—	mA
Low Power Mode Current		IBATT_LPM	VRAMP = 0.3 V POUT = 0 dBm NTC		TBD		mA
Adjacent Channel Leakage power Ratio[1]	1.6 MHz offset	ACLR1.6	POUT_TD_NOM	—	–44	–40	dBc
			POUT_TD_EX	—	—	–40	
	3.2 MHz offset	ACLR3.2	POUT_TD_NOM, POUT_TD_EX	—	–62	–58	
Error Vector Magnitude[1]		EVM_RMS	POUT_TD_NOM	—	2	3	%
			POUT_TD_EX	—	2	4	
Harmonic Suppression[1]		ƒ02–ƒ06	POUT ≤ POUT_TD_NOM, POUT_TD_EX, RBW = 1 MHz	—	—	–36	dBm
Tx Noise in Rx Bands[1]	DCS Rx		ƒ_Rx = 1805 MHz to 1880 MHz, POUT = POUT_TD_NOM NTC, RBW = 100 kHz	—	—	–81	dBm
Input Voltage Standing Wave Ratio		VSWR_IN	—	—	—	2.5:1	—
Rise / Fall Time		TONDC	TRx Mode to TDD LTE Tx, from MIPI command and >90% VRAMP to 0.5 dB RF settling	—	TBD	10	µs
		TOFFDC	TDD LTE Tx to TRx Mode, from MIPI command or <10% VRAMP to 30 dB gain drop	—	TBD	10	
Stability		S	VSWR = 12:1 All phases, RBW = 1 MHz	—	—	–36	dBm
Ruggedness - no damage		Ru	All phases, time = 10 seconds	20:1	—	—	VSWR

1 Measured using ETSI TS 125.102 UL reference measurement channel (12.2 kbps), 16% duty cycle.

Table 11. SKY77910-11 Electrical Specifications –TDD LTE Band 39
Unless otherwise specified: V_{RAMP} = 1.45 V; ETC per Table 2.

TDD LTE Band 39 (1880–1920 MHz)						
Parameters	**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power[1]	$P_{OUT\_TDLTE\_NOM}$	NTC	23.5	—	—	dBm
	$P_{OUT\_TDLTE\_EX}$		22.5	—	—	
Gain[1] High Power	$G_{HPM\_TDLTE\_NOM}$	$P_{OUT} = P_{OUT\_TDLTE\_NOM}$	30.5	32.0	34.0	dB
	$G_{HPM\_TDLTE\_EX}$	$P_{OUT} = P_{OUT\_TDLTE\_EX}$	28.0	—	35.0	
Low Power	G_{LPM}	P_{IN} = –35 dBm, V_{RAMP} = 0.3 V	—	24.0	27.0	
Power Added Efficiency	PAE_{HPM}	$P_{OUT} = P_{OUT\_TDLTE\_NOM}$	—	13	—	%
Quiescent Current	I_{CQ_HPM}	$P_{IN} \leq$ –80 dBm	—	TBD	—	mA
Low Power Mode Current	I_{BATT_LPM}	V_{RAMP} = 0.3 V P_{OUT} = 0 dBm NTC		50		mA
Adjacent Channel Leakage power Ratio[1]	$EUTRA_{ACLR1}$	$P_{OUT} = P_{OUT\_TDLTE\_NOM}$	—	–42	—	dBc
		$P_{OUT} = P_{OUT\_TDLTE\_EX}$	—	—	–36	
	$UTRA_{ACLR1}$	$P_{OUT} = P_{OUT\_TDLTE\_NOM}$	—	–45	—	
		$P_{OUT} = P_{OUT\_TDLTE\_EX}$	—	—	–39	
	$UTRA_{ACLR2}$	$P_{OUT} = P_{OUT\_TDLTE\_NOM}$	—	–48	—	
		$P_{OUT} = P_{OUT\_TDLTE\_EX}$	—	—	–42	
Error Vector Magnitude[1]	EVM_{RMS}	$P_{OUT} = P_{OUT\_TDLTE\_NOM}$	—	2	3	%
		$P_{OUT} = P_{OUT\_TDLTE\_EX}$	—	2	4	
Harmonic Suppression[2] Second	$f_0 2$	$P_{OUT} \leq P_{OUT\_TDLTE\_NOM}$, $P_{OUT\_TDLTE\_EX}$, RBW = 1 MHz	—	—	–36	dBm
Third	$f_0 3$		—	—	–46	
Tx Noise in Rx Bands[3] ISM Band	$P_{NOISE\_TDLTE\_ISM}$	f_Rx = 2400 to 2500 MHz, $P_{OUT} = P_{OUT\_TDLTE\_NOM}$ – MPR, NTC, RBW = 100 kHz	—	—	–106	dBm
Band 34 Rx	$P_{NOISE\_TDLTE\_B34}$	f_Rx = 2010 to 2025 MHz, $P_{OUT} = P_{OUT\_TDLTE\_NOM}$ – MPR, NTC, RBW = 100 kHz	—	—	–85	
Input Voltage Standing Wave Ratio	$VSWR_{IN}$	—	—	—	2.5:1	—
Rise / Fall Time	$T_{ON}DC$	TRx Mode to TDD LTE Tx, from MIPI command and >90% VRAMP to 0.5 dB RF settling	—	TBD	10	µs
	$T_{OFF}DC$	TDD LTE Tx to TRx Mode, from MIPI command or <10% VRAMP to 30 dB gain drop	—	TBD	10	
Stability	S	VSWR = 12:1 All phases, RBW = 1 MHz	—	—	–36	dBm
Ruggedness - no damage	Ru	All phases, time = 10 seconds	20:1	—	—	VSWR

1 Performance is measured using UL reference measurement channel, 10 MHz. QPSK, 12RB, per ETSI TS 136.101 (Release 12, section A.2.3.2.1-4a).

2 Harmonic suppression is measured using UL reference measurement channel, 1.4 MHz, QPSK, 1RB, per ETSI TS 136.01 (Release 12, section A.2.3.2.1-1).

3 Noise is measured using UL reference measurement channel, 20 MHz, QPSK, 100 RB, per ETSI TS 136.101 (Release 12, section A.2.3.1.1)

Table 12. SKY77910-11 Electrical Specifications – TRx Ports

Unless otherwise specified: any TRx Mode; ETC per Table 2.

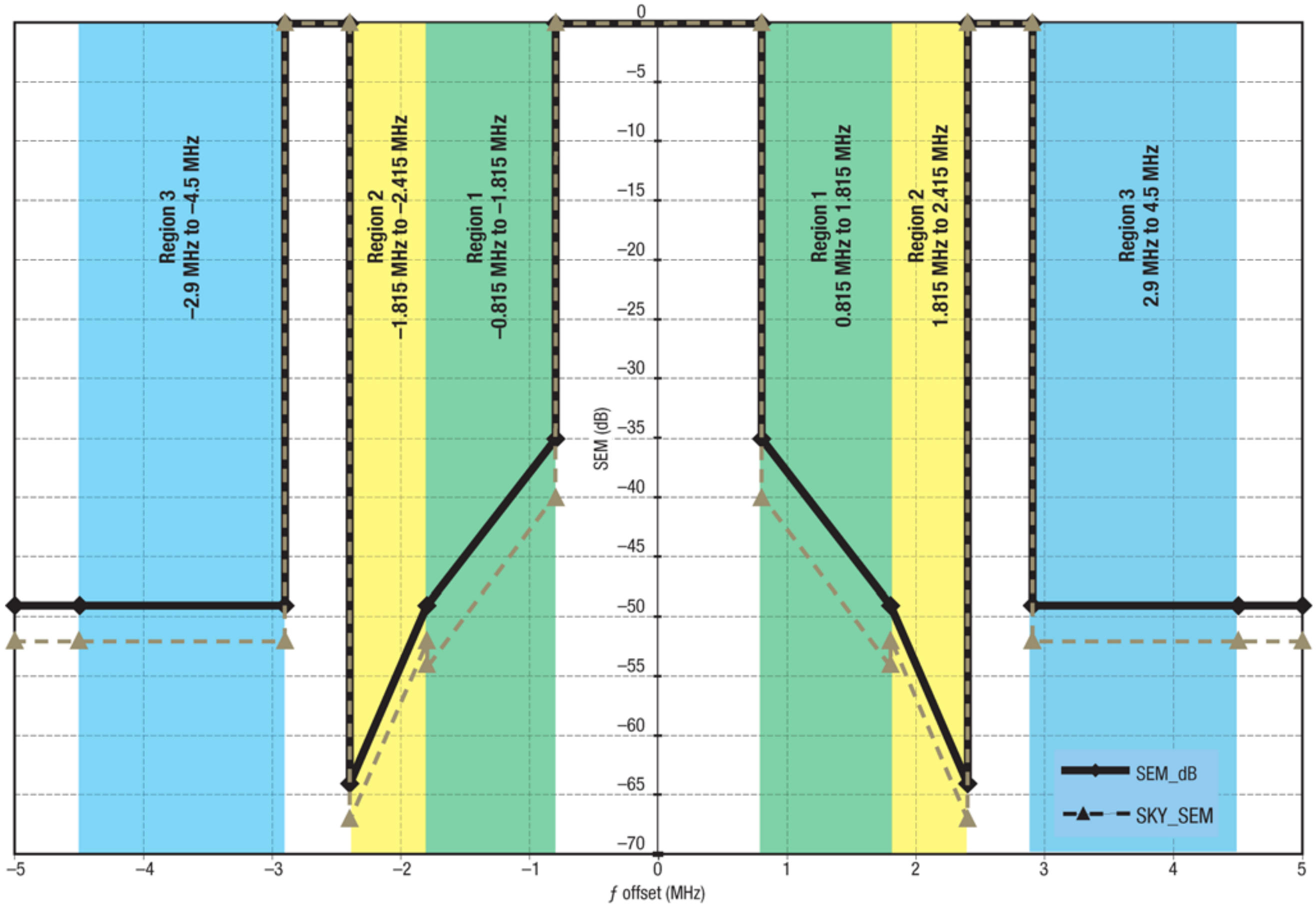
Ports TRx1 to TRx8							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range		ƒ_TRx	—	699	—	2690	MHz
Insertion Loss		Rx_IL_LB	699 MHz to 960 MHz	—	0.70	1.20	dB
		Rx_IL_MB	1710 MHz to 1990 MHz	—	0.80	1.45	
		Rx_IL_HB	2010 MHz to 2690 MHz	—	1.10	1.60	
TRx Mode VSWR[1]		VSWR_TRx	NTC	—	1.5:1	—	VSWR
Isolation	Active TRx port to any adjacent TRx port	ISO_ADJ_TRx_LB	699 MHz to 960 MHz	26	35	—	dB
		ISO_ADJ_TRx_MB	1710 MHz to 1990 MHz	23	30	—	
		ISO_ADJ_TRx_HB	2010 MHz to 2690 MHz	20	25	—	
	Active TRx port to any non-adjacent TRx port	ISO_NONADJ_TRx_LB	699 MHz to 960 MHz	35	40	—	
		ISO_NONADJ_TRx_MB	1710 MHz to 1990 MHz	30	35	—	
		ISO_NONADJ_TRx_HB	2010 MHz to 2690 MHz	25	30	—	
TRx Harmonics		TRx_2fo, TRx_3fo	50 ohm, P_IN_TRx = +27 dBm, NTC			–55	
			VSWR 5:1 at ANT port, P_IN_TRx = +27 dBm, NTC			–50	
2nd Order Intermodulation Distortion ƒ_IMD2 = ǀ ƒ_tx ± ƒ_blocker ǀ		IMD2	Tx Output Power = 20 dBm CW Blocker Power = –15 dBm CW NTC TRx port duplexer termination VSWR ≥ 10:1 at ƒ_blocker, all phases			–105	dBm
3rd Order Intermodulation Distortion ƒ_IMD3 = 2ƒ_tx – ƒ_blocker		IMD3				–105	
Leakage from Tx to TRx Ports		P_TxTRx	Any TX Mode	—	—	5	dBm
Coupling Factor in TRx Mode[2]		CPL_TRx_LB	699 to 960 MHz, NTC		–27 dB		dB
		CPL_TRx_MB	1710 to 1990 MHz, NTC		–23 dB		
		CPL_TRx_HB	2010 to 2690 MHz, NTC		–22 dB		
Coupling Factor Variation over Output VSWR[3]		CPL_SWR_TRx_LB	699 to 960 MHz, VSWR 2.5:1 at ANT port	0.5		–0.5	dB
		CPL_SWR_TRx_MB	1710 to 1990 MHz, VSWR 2.5:1 at ANT port	1.0		–1.0	
		CPL_SWR_TRx_HB	2010 to 2690 MHz, VSWR 2.5:1 at ANT port	1.0		–1.0	
Coupling Factor Variation over Temperature[3,4]		CPL_TV_TRx_LB	699 to 960 MHz	0.5		–0.5	dB
		CPL_TV_TRx_MB	1710 to 1990 MHz	1.0		–1.0	
		CPL_TV_TRx_HB	2010 to 2690 MHz	1.0		–1.0	
Turn-on Time		TON_VBATT	From 50% VBATT and VIO to 0.5 dB RF settling			20	µs
TRx-to-TRx Switch Speed		T_TRxTRx	From MIPI command to 0.5 dB RF settling		2	5	µs

1 Based on the worst of TRx and ANT port reflection coefficients.

2 Defined as the ratio of CPL port to ANT port output power, driven from TRx.

3 Variation with respect to 50 ohm reference.

4 Variation with respect to NTC.



MARGIN TO SEM	REGION 3	REGION 2	REGION 1
Typical SEM Margin[1]	TBD	TBD	TBD
Minimum SEM Margin[2]	TBD	TBD	TBD

[1] NTC, POUT = POUT_TD_NOM
[2] ETC, POUT = POUT_TD_EX

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FIGURE 2. SKY77910-11 – TD-SCDMA MARGIN-TO-SEM CHART

Technical Information

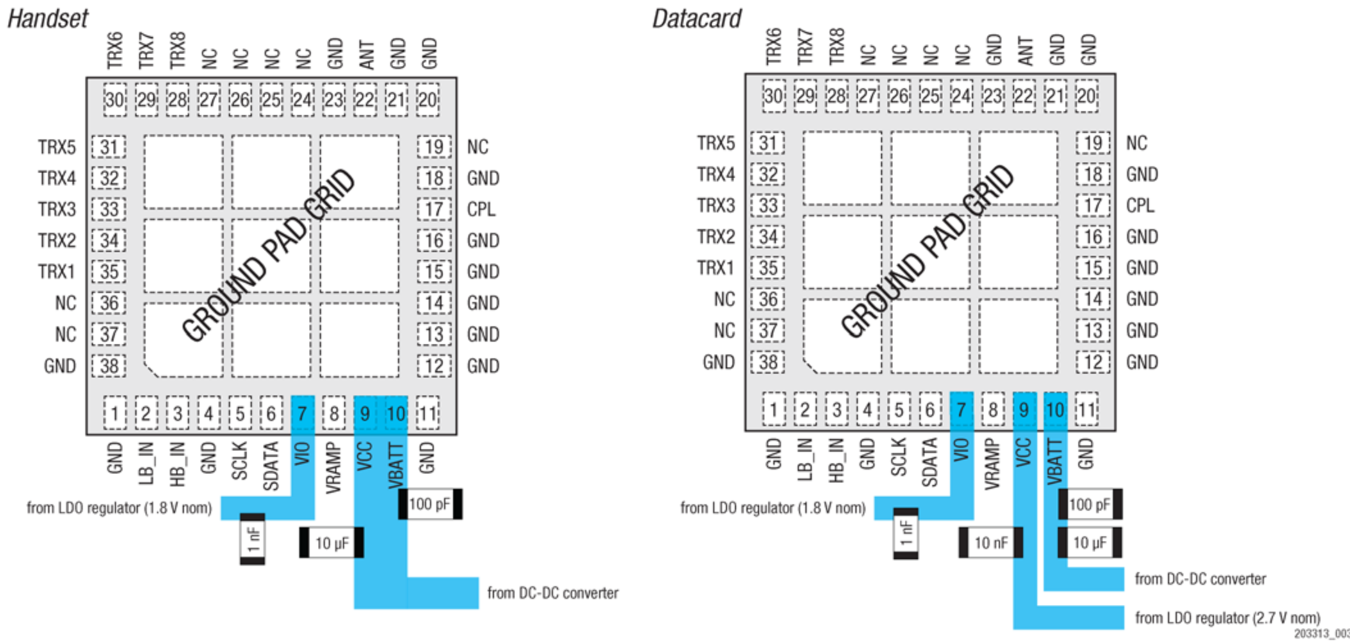


Figure 3. SKY77910-11 Application Schematics

Package Dimensions

The SKY77910-11 quad-band front-end module is a 5.5 mm x 5.3 mm x 0.8 mm, 38-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.

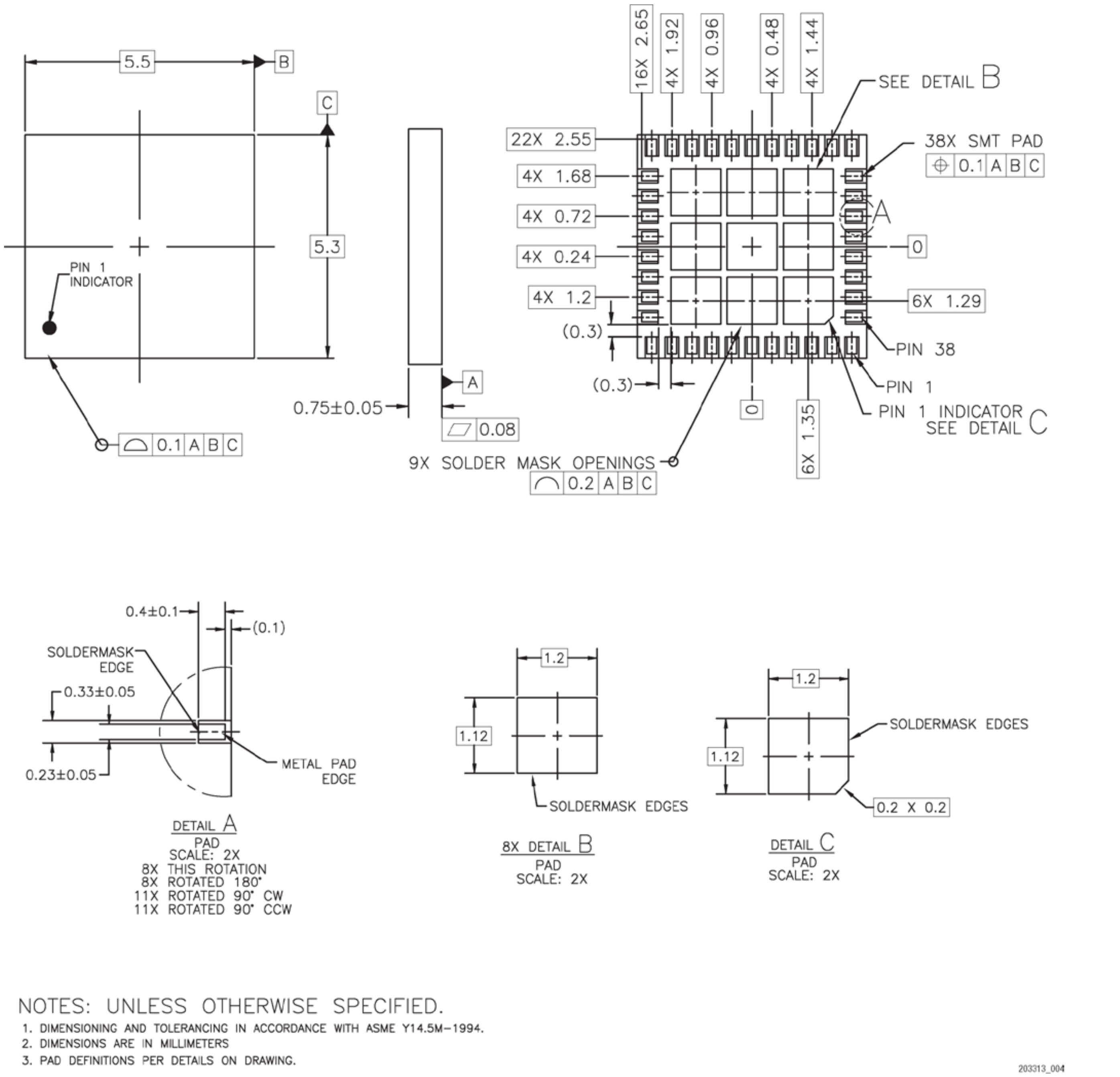


FIGURE 4. DIMENSIONAL DIAGRAM FOR 5.5 mm x 5.3 mm x 0.8 mm, 38-PAD LEADLESS PACKAGE – SKY77910-11 (ALL VIEWS)

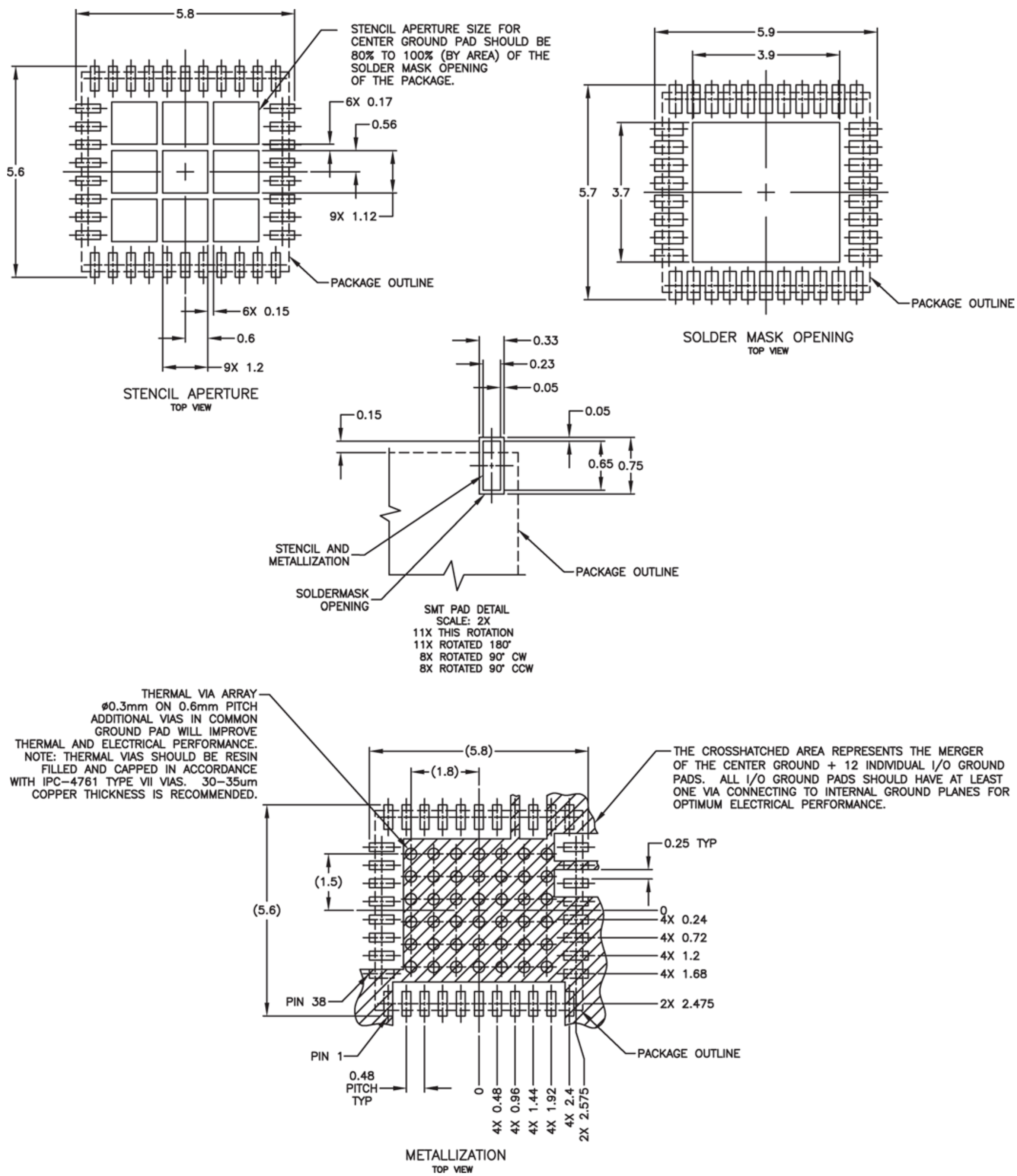


Figure 5. PCB Layout for 5.5 mm x 5.3 mm, 38-Pad Leadless Package – SKY77910-11 Specific

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 13 lists the pad names and signal descriptions. Figure 7 illustrates the typical case markings.

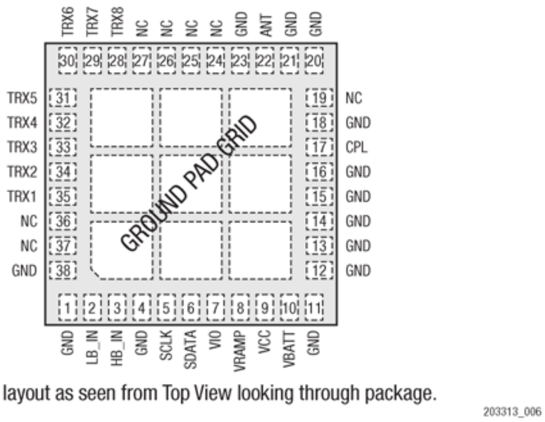


FIGURE 6. SKY77910-11 PAD NAMES AND CONFIGURATION (TOP VIEW)

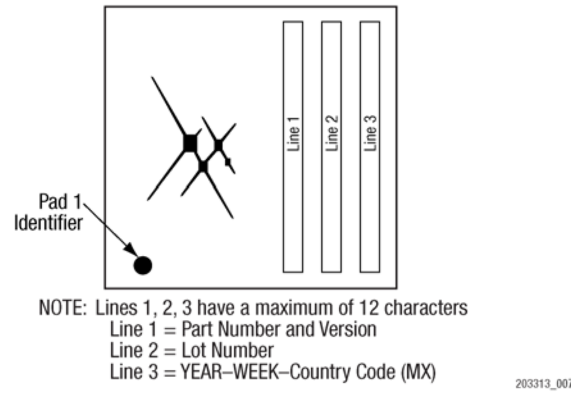


FIGURE 7. TYPICAL CASE MARKINGS

TABLE 13. SKY77910-11 SIGNAL DESCRIPTIONS

Pad[1]	Name	Description
2	LB_IN	RF input to LB PA
3	HB_IN	RF input to HB PA
5	SCLK	MIPI clock
6	SDATA	MIPI serial data
7	VIO	MIPI supply voltage
8	VRAMP	Controls GMSK power; EDGE, TD-SCDMA, TDD LTE bias
9	VCC	Output switch supply voltage
10	VBATT	PA supply voltage
17	CPL	Directional coupler RF output
19	NC	No connection
22	ANT	RF output to antenna
24–27	NC	No connection
28–35	TRx8–TRx1	Wideband TRx switch ports
36–37	NC	PA output to Antenna
Ground Pad Grid		Ground Pad Grid (device underside)

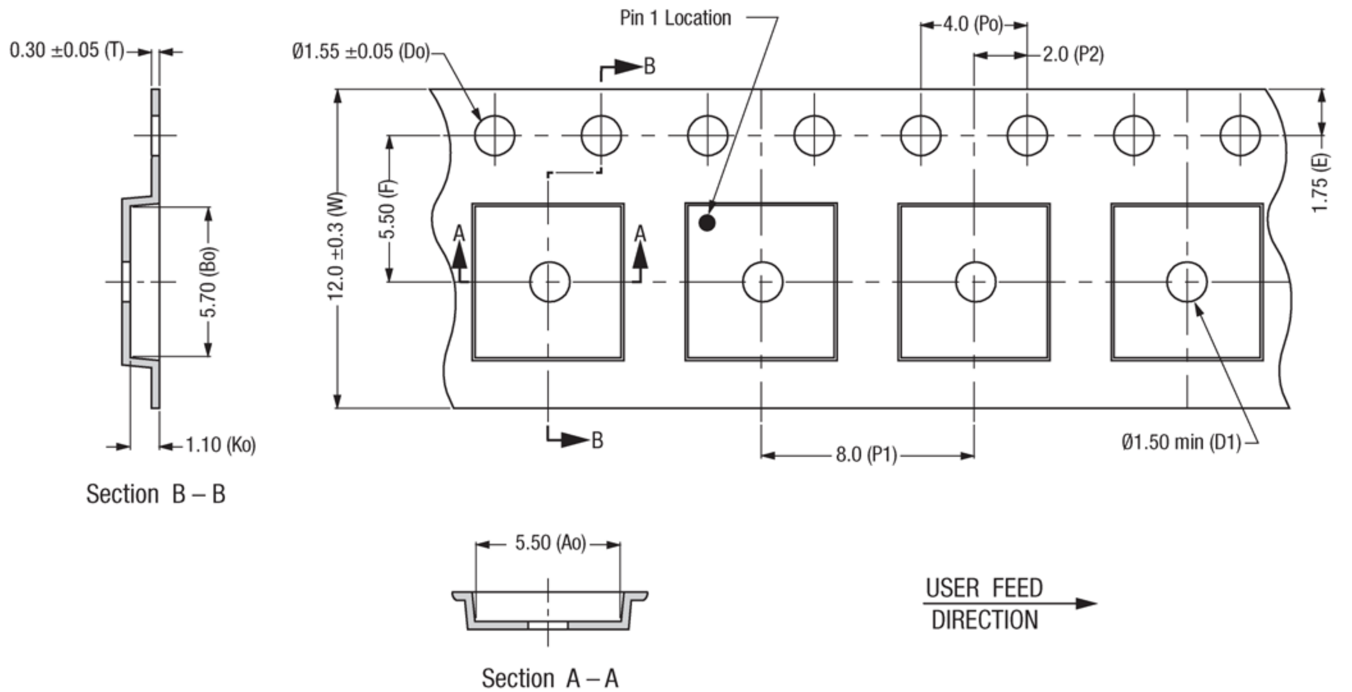
[1] Pads 1, 4, 11–16, 18, 20, 21, 23, and 38 are ground pads.

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 SKY77910-11 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. CARRIER TAPE IS BLACK CONDUCTIVE POLYSTYRENE OR POLYCARBONATE.
2. COVER TAPE IS TRANSPARENT AND CONDUCTIVE.
3. ESD SURFACE RESISTIVITY 10^4 TO 10^{11} OHMS/SQ, PER EIA, JEDEC TAPE AND REEL SPEC.
4. Po/P1 10 PITCHES CUMULATIVE TOLERANCE ON TAPE: ±0.20 mm.
5. Ao & Bo MEASUREMENT POINT TO BE 0.3 mm FROM BOTTOM POCKET.
6. ALLOWABLE CAMBER TO BE 1/100 mm, NON-CUMULATIVE OVER 250 mm.
7. ALL DIMENSIONS ARE IN MILLIMETERS.

Carrier Tape for Body Size 5.3 x 5.5 x 0.80–1.10 mm D232-076D

Figure 8. Dimensional Diagram for Carrier Tape Body Size 5.3 mm x 5.5 mm x 0.85–1.10 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
SKY77910-11 Tx-Rx Front-End Module	SKY77910-11	

Revision History

Revision	Date	Description
A	September 6, 2014	Initial Release – Preliminary Information
B	March 13, 2015	Revise: Figures 4, 7, 8

References

Skyworks Application Note: *PCB Design and SMT Assembly/Rework Guidelines for MCM–L Packages;* Document Number 101752

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

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