

**PRODUCT SUMMARY**

# SKY78191-11 SkyOne® Low Band Tx-Rx Front-End Module for 3G / 4G / 5G Applications with Low Band/High Band 2G

**Applications**

- Multi-band 2G / 3G / 4G / 5G Mobile Devices
- Handsets, Data Cards, M2M
- LTE Advanced Carrier Aggregation (CA)

**Features**

- MIPI® RFFE 2.0 control interfaces w/ 1.8 V nominal supply
- Integrated switched duplexer filters for Bands 8, 12, 20 and 26
- Four auxiliary 3G/4G Tx outputs for external filters
- Four auxiliary 3G/4G TRx ports to support additional bands
- Tx filtering for harmonically-related LB-MB downlink CA
- Integrated low band and high band 2G PAs
- High band 2G works with companion MB/HB modules
- Integrated bi-directional RF coupler with cascade support
- ESD compliant 8 kV on antenna port
- Small, low profile package:
  - 7.6 mm x 6.0 mm x 0.75 mm
  - 56-pad configuration

**3G Features:**

- WCDMA, HSPA+
- CDMA2000 1x RC1, RC3, EVDO (Rev A)

**4G Features:**

- FDD LTE
- Uplink QPSK, 16QAM, 64QAM
- Inter-band Downlink/Uplink CA support

**5G Feature:**

- n28

**Description**

The SKY78191-11 SkyOne® Multimode Multiband Tx-Rx Front-End Module (FEM) supports 2G / 3G / 4G / 5G mobile devices and operates efficiently in 3G / 4G modes. The FEM consists of a low-band 3G/4G PA block, low- and high-band 2G PA blocks, a silicon controller containing the MIPI RFFE interface, RF band switches, antenna switches, a bi-directional coupler, and integrated filters for Bands 8, 12, 20 and 26. Extremely low leakage current maximizes device standby time.

The IC die and passive components are mounted on a multi-layer laminate substrate. The assembly encapsulated in a 7.6 mm x 6.0 mm x 0.75 mm, 56-pad MCM, SMT plastic package allows a highly manufacturable, low cost solution.

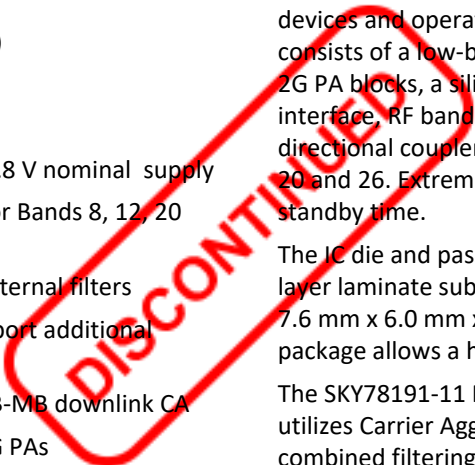
The SKY78191-11 FEM is optimized for LTE Advanced which utilizes Carrier Aggregation for higher data rates. The combined filtering, RF matching, and TRx switching internal to the FEM optimizes performance for popular Downlink (DL) CA band combinations, all in a compact and low cost solution. The FEM contains necessary components between the antenna and RFIC transceiver and is optimized to provide superior Rx sensitivity and Tx efficiency.

Selecting the linear-GMSK operation standard disables VRAMP input, so all PA biasing depends only on MIPI mode selection. The transmitted envelope is then a linear function of RF input.

Selecting VRAMP-enabled operation, the PA controller provides VRAMP control of the GMSK envelope and reduces sensitivity to input drive, temperature, power supply, and process variations. Skyworks' Finger-Based Integrated Power Amplifier Control (FB-iPAC) minimizes output power variation into mismatch.

In EDGE linear mode, VRAMP voltage and MIPI-based bias settings jointly optimize PA linearity and efficiency.

Exceptional RF coexistence planning and system techniques are employed to minimize Rx de-sensitizing ("de-sense").



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.

3G/4G/5G Aux TX OUT Performance (B28/n28)

Conditions:

- Temp = 25 °C, VBATT = 3.4 V
- 3G / 4G Mode: Vcc1/Vcc2 = +3.4 V (APT)
- 5G NR Mode: Vcc1/Vcc2 = see LUT (APT/ET), ZIN = ZOUT = 50 ohms

LTE Signal Configuration:

QPSK/10 MHz/12RB

NR Signal Configuration:

- 1) DFT-s-OFDM QPSK, 20 MHz, 30 kHz, Inner full (MPR = 0), Outer full RB (MPR = 1)
- 2) DFT-s-OFDM 16QAM, 20 MHz, 30 kHz, Inner full RB (MPR = 1), Outer full RB (MPR = 2)
- 3) DFT-s-OFDM 256QAM, 20MHz, 30 kHz, Inner full RB (MPR = 4.5), Outer full RB (MPR = 4.5)

Table 1-1. SKY78191-11 – B28/n28 Performance Data

Parameter	Condition	SKY78191-11 Performance				Units	GBx (Note1)	Notes
		Min	Typ	Max	If this Parameter is Tested in Production (Y/N)			
Frequency	B28/ n28	703		748		MHz		
Maximum output power	LTE MPR = 0, 10 MHz QPSK 12 RB, HPM	APT: 28.5			Screened at Final Test (APT)	dBm	T/C	Note 2
		ET: 29						
	LTE MPR = 0, 1.4/3/5/10/15/20MHz QPSK Partial RB, HPM	APT: 28.5			Screened at Final Test (APT)	dBm	T/C	Note 2
		ET: 29						
	LTE MPR = 1, 1.4/3/5/10/15/20MHz QPSK Full RB, HPM	APT: 27.5			Screened at Final Test (APT)	dBm	T/C	Note 2
		ET: 28						
	LTE MPR = 1, 1.4/3/5/10/15/20MHz 16QAM Partial RB,HPM	APT: 27.5			Screened at Final Test (APT)	dBm	T/C	Note 2
		ET: 26						
	LTE MPR = 2, 1.4/3/5/10/15/20MHz 16QAM Full RB,HPM	APT: 26.5			Screened at Final Test (APT)	dBm	T/C	Note 2
		ET: 27						
	LTE MPR = 2, 5/10/15/20 MHz 64QAM Partial RB, HPM	APT: 26.5			Screened at Final Test (APT)	dBm	T/C	Note 2
		ET: 27						
	LTE MPR = 3, 5/10MHz/15/20 64QAM Full RB, HPM	APT: 25.5			Screened at Final Test (APT)	dBm	T/C	Note 2
		ET: 26						
5G NR DFT-s-OFDM QPSK, 20MHz, 30KHz, Inner full RB (MPR=0), HPM	APT: 28.5			Screened at Final Test (APT)	T/C		Note 2	
	ET: 29							
5G NR DFT-s-OFDM 16QAM, 20MHz, 30KHz, Outer full RB (MPR=1), HPM	APT: 27.5			Screened at Final Test (APT)	T/C		Note 2	
	ET: 28							
5G NR DFT-s-OFDM 16QAM, 20MHz, 30KHz, Inner full RB (MPR=1), HPM	APT: 27.5			Screened at Final Test (APT)	T/C		Note 2	
	ET: 28							
5G NR DFT-s-OFDM 16QAM, 20MHz, 30KHz, Outer full RB (MPR=2), HPM	APT: 26.5			Screened at Final Test (APT)	T/C		Note 2	
	ET: 27							
5G NR DFT-s-OFDM 256QAM, 20MHz, 30KHz, Inner full RB (MPR=4.5), Outer full RB (MPR=4.5), HPM	APT: 24			Screened at Final Test (APT)	dBm	T/C	Note 2	
	ET: 24.5							
Power Backoff (ETC)		1			dB	C	Note 3	
Gain (G) at ANT port	Pout ≤ maximum power, HPM – APT Mode	28	29.5	31.5	Screened at Final Test (APT)	dB	T	

**Table 1-2. SKY78191-11 – B28/n28 Performance Data**

Parameter	Condition	SKY78191-11 Performance				Units	GBx (Note1)	Notes
		Min	Typ	Max	If this Parameter is Tested in Production (Y/N)			
Gain variation over temperature	Pout ≤ maximum power, HPM	-2		+2	Bench Characterization	dB	C	Note 3
Rx band noise power	From Tx at all powers @HPM		-122	-121	Bench Characterization	dBm/Hz	C	Note 4
GPS and GLONASS and Beidou noise	1574–1577 MHz @HPM			-140	Bench Characterization	dBm/Hz	C	
ISM noise	2400–2483.5 MHz			-140	Bench Characterization	dBm/Hz	C	
5 GHz band noise at ANT port	4900–5850 MHz, HPM			-140	Bench Characterization	dBm/Hz	C	
Current Consumption	Pout=MPR-1 (24.5dBm) VCC=3.4V, Modulation:10M50RB 95% DCDC efficiency		490	522	Screened at Final Test (APT Mode)		T/C	
Adjacent channel leakage power ratio (LTE E-UTRA ACLR1)	E-UTRA ACLR POUT ≤ (maximum power – MPR) All Modulation		-39	-36	Screened at Final Test (APT Mode)	dBc	T/C	Note 5
Adjacent channel leakage power ratio (LTE UTRA ACLR1)	UTRA ACLR1 POUT ≤ (maximum power – MPR) All Modulation		-40	-38	Screened at Final Test (APT Mode)	dBc	T/C	Note 5
Adjacent channel leakage power ratio (LTE UTRA ACLR2)	UTRA ACLR2 POUT ≤ (maximum power – MPR) All Modulation		-42	-41	Screened at Final Test (APT Mode)	dBc	T/C	Note 5
5G NR adjacent channel leakage power ratio (ACLR)	DFT-s-OFDM QPSK, 20MHz, 30KHz, 50RB		-39	-36	Screened at Final Test (APT Mode)	dBc	T/C	Note 5
	DFT-s-OFDM QPSK, 20MHz, 30KHz, 100RB		-39	-36	Screened at Final Test (APT Mode)	dBc	T/C	Note 5
	CP-OFDM QPSK 20MHz, 30kHz, 106RB		-39	-35	Screened at Final Test (APT Mode)	dBc	T/C	Note 5
5G NR UTRA adjacent channel leakage power ratio (ACLR1)	DFT-s-OFDM QPSK, 20MHz, 30KHz, 50RB		-40	-38	Screened at Final Test (APT Mode)	dBc	T/C	Note 6
	DFT-s-OFDM QPSK, 20MHz, 30KHz, 100RB		-40	-38	Screened at Final Test (APT Mode)	dBc	T/C	Note 6
	CP-OFDM QPSK 20MHz, 30kHz, 106RB		-40	-38	Screened at Final Test (APT Mode)	dBc	T/C	Note 6
5G NR UTRA adjacent channel leakage power ratio (ACLR2)	DFT-s-OFDM QPSK, 20MHz, 30KHz, 50RB		-42	-41	Bench Characterization (APT Mode)	dBc	C	Note 6
	DFT-s-OFDM QPSK, 20MHz, 30KHz, 100RB		-42	-41	Bench Characterization (APT Mode)	dBc	C	Note 6
	CP-OFDM QPSK 20MHz, 30kHz, 106RB		-42	-41	Bench Characterization (APT Mode)	dBc	C	Note 6
Harmonic 2fo	POUT ≤ maximum power CW			-8	Screened at Final Test (APT Mode)	dBm/MHz	T/C	
Harmonics 3fo	POUT ≤ maximum power CW			-20	Screened at Final Test (APT Mode)	dBm/MHz	T/C	
Harmonics 4fo and higher @Ant Port	POUT ≤ maximum power CW			-20	Screened at Final Test (APT Mode)	dBm/MHz	C	
EVM (LTE)	Pout ≤ (maximum power)		3	5	Bench characterization	% RMS	C	Note 7
5G NR EVM	Pout ≤ maximum power, 256QAM			APT: 1.9 ET: 2.1	Bench characterization	% RMS	C	Note 8

Table 1-3. SKY78191-11 B28/n28 Performance Data

Parameter	Condition	SKY78191-11 Performance				Units	GBx (Note1)	Notes
		Min	Typ	Max	If this Parameter is Tested in Production (Y/N)			
Input VSWR	No external matching		1.5:1	2:1	Bench characterization		C	
Stability, spurious levels (3G/4G/5G NR) @ PA Output	Load VSWR ≤ 6:1 in-band, All phase angles over operating temperature, all power levels, Operating voltage max/min/typ) load VSWR ≤ 6:1			-36	Bench characterization	dBm	C	
Ruggedness (3G/4G)@ PA Output	Load VSWR≤10:1, All phase angles over operating temperature, all power levels, Operating voltage (max/min/typ) Pout≤P_rated+2dB			10:1	Bench characterization		C	

Notes for Table 1

- Note 1: GBx [GBD = Guaranteed by Design (D); Guaranteed by Characterization (C); Guaranteed by ATE Test (T)]
- Note 2: ICQ set to optimize current consumption while ensuring compliance with all RF specifications including ACLR and EVM.
- Note3: Gain specified for VCC2=VCC1=3.4V & recommended B28 MIPI for HPM, 10M12RB Modulation
- Note 4: Conditions as per 3GPP Specifications
- Note 5: LTE ACLR performance should be guaranteed under all LTE modulation waveform specified in 3GPP specification, including QPSK, 16QAM and 64QAM, with all BW and RB configuration.
- Note 6: NR ACLR performance guaranteed for the specified waveforms at nominal conditions (see SKY78191-11 datasheet for description for nominal conditions)
- Note 7: RF measurements shall be made with 3GPP (UTRAN/FDD UE) TS25.101 specification-compliant waveforms.
- Note 8: RF measurements shall be made with 3GPP specification-compliant waveforms. NR EVM specified for DFT-s-OFDM 256 QAM and CP OFDM 256QAM waveforms

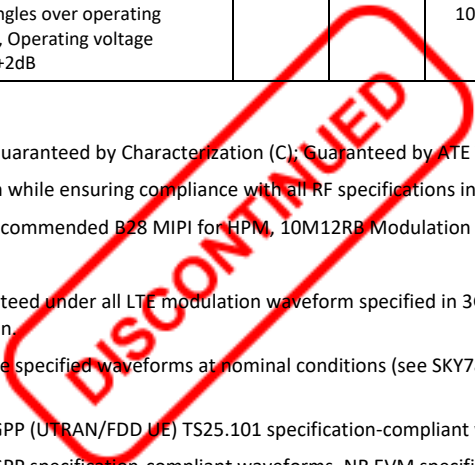


Table 2. NR Timing Sequence

Time Sequence	Typical	Maximum	Remarks	GBx
Turn on/Turn off Time	2	5	Note 9	C
Mode Switch Time	1	2	Note 10	C

Notes for Table 2

- Note 9: after all configurations MIPI programming has been completed, this is the delay from end of the PA enable MIPI write. Turn On is defined as when PA gain is within 0.5dB of maximum gain.Turn Off is defined as when the PA gain is 30dB less than maximum operating gain.
- Note 10: After all configurations MIPI programming has been completed, this is the delay of PA gain settling within ±0.5 dB due to a bias DAC change. The delay is measured from the end of the last MIPI writ

## Ordering Information

Part Number	Part Description	Evaluation Board Part Number
SKY78191-11	SkyOne® Low-Band Tx-Rx Front-End Module	SKY78191-11EK1



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