



# LTE Multi-Band Front-End Modules for the Internet of Things

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In an increasingly connected world, the number of machine to machine connections are forecasted to outpace human connections by 2020. The Internet of Things or “IoT” market is proving to be THE next wave of explosive growth in technology. With expertise in wireless and RF technologies in mobile devices and phones, Skyworks Solutions is well-positioned to capitalize on the opportunities in this ecosystem based on innovative packaging technologies, advanced processes and unparalleled customer support.

Skyworks’ new SKY680xx series LTE multi-band front-end modules are the latest products designed to meet the new demands of emerging IoT applications. These devices are hybrid, multi-band, multi-chip RF front-end (RFFE) modules targeted for low data rate, low Power Wide Area (LPWAN) network applications such as CATM1 and CATNB1 half-duplex system platforms where low standby current, high efficiency and good harmonic rejections are critical for meeting 3GPP Release 13 specifications. These new payload data devices are designed for 10 Kbps–1 Mbps.

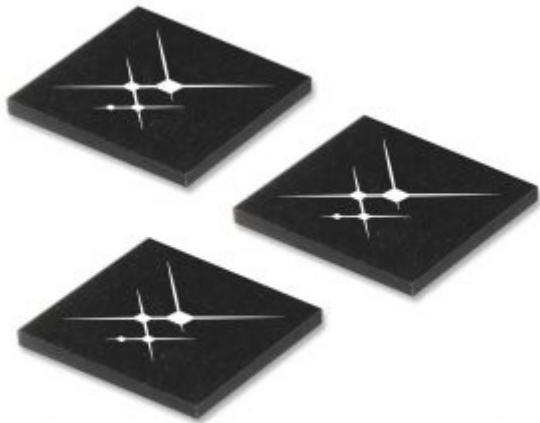


Figure 1: SKY68000, SKY68001, SKY68011

front-end IoT Modules

These cost-optimized modules integrate the entire RF front-end necessary for an LTE multi-band radio operation. Meeting new mobile operator requirements, these three new modules share the same PCB footprint for easy design-in with great versatility. Their application-specific design also reduces front-end complexity and cost.

All operations for this series of FEMs can be programmed via the MIPI® register commands. Different power levels and gain modes in transmit (Tx) mode can be set to meet various baseband transceivers output power level requirements. This flexibility greatly benefits the dynamic range of the entire transceiver for IoT applications with either strong signals or very weak signals.

# SKY68000-21 Dual-band LTE Front-end IoT Module

The high-performance SKY68000-21 module includes Band 4 and 13 Receive (Rx) SAW filters, dual-band (low-band and mid-band) power amplifiers (PAs) with bias controller, Tx low-pass harmonic filter, antenna switch and MIPI® RF front-end controller. The SAW filter's superior performance provides low insertion loss and high out-of-band rejection making this device ideal for meeting the most stringent network requirements. The Tx low pass filter is also optimized for the best harmonic and GPS band noise performance.

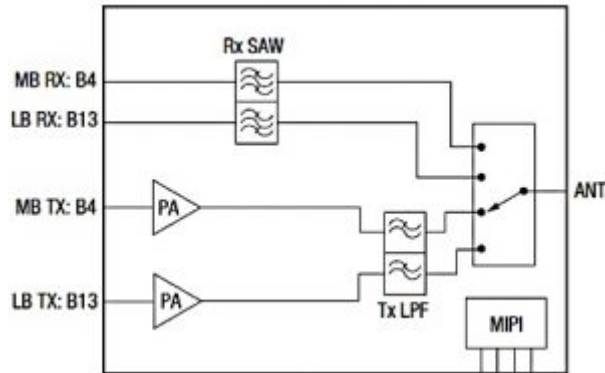


Figure 2: Dual-band LTE CATM1/NB1 module.

Parameter	Test Condition	Typical	Unit
Band coverage	Down Link:		
	LB	746-756	
	MB	2110-2155	
			MHz
Output Power	Up link:		
	LB	777-787	
	MB	1710-1755	
Supply Current, Tx	LB/MB	24	dBm
Gain	LB/MB	300	mA
Power-Added-Efficiency (PAE)	LB/MB	27	dB
Harmonic	LB/MB	27	%
	LB	-55	dBm/MHz
Adjacent-Channel-Leakage –Rejection (ACLR)	MB	-45	
	LB	37	dBc
Noise in GPS Band	MB	35	
	LB	-155	dBm/MHz
Insertion Loss, Rx	MB	-135	
	LB	2.3	dB
Out of band rejection, Rx	MB	2.2	
	LB	35~45	dB
Leakage Current	MB	30~40	
	Sleep mode	0.4	uA

Table 1: The key parameters of SKY68000 module are shown in this table. Supply Voltage = 3.1V, Pout = 24dBm@ antenna port, 1.4MHz/6RB LTE signal.

# SKY68001-21 Universal LTE Front-end IoT Module

The cost optimized SKY68001-21 module includes a broadband low pass filter on the receive side, a dual-band PA with bias controller, Tx low-pass harmonic filter, antenna switch and MIPI® RFFE controller. The broadband low pass filter covers the entire LTE LB and MB for universal LTE CATM1/NB1 band coverage. The RFFE also provides two additional auxiliary ports, which can be used for additional Tx and Rx paths such as 2G fallback support, an additional LTE band, or an external GPS receiver.

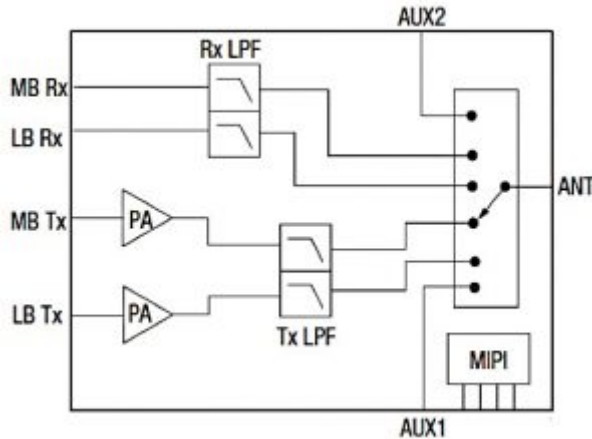


Figure 3: Dual-band LTE CATM1/NB1 module

Parameter	Test Condition	Typical	Unit
Band coverage	Down Link:		
	LB	729-960	
	MB	1805-2170	
			MHz
Band coverage	Up link:		
	LB	699-915	
	MB	1710-1980	
Output Power	LB/MB	24	dBm
Supply Current	LB	290	
	MB	370	mA
Gain	LB	28	
	MB	27	dB
Power-Added-Efficiency (PAE)	LB	28	
	MB	22	%
2nd Harmonic	LB/MB	-40	dBm/MHz
Adjacent-Channel-Leakage –Rejection (ACLR)	LB/MB	36	dBc
Noise in GPS Band	LB	-145	
	MB	-135	dBm/MHz
Insertion Loss, Rx	LB	2.2	
	MB	23	dB
Out of band rejection, Rx	LB	30~45	
	MB	25~45	dB
Leakage Current	Sleep mode	0.4	uA

Table 2: The key parameters of SKY68001 module are shown in this table. Supply Voltage = 3.1V, Pout = 24dBm@ antenna port, 1.4MHz/6RB LTE signal.

# SKY68011-21 LTE Front-end IoT Module

The highly integrated SKY68011-21 module includes a Low Band 12,13,17 filter and Band 2,66 Rx filters, a dual-band power amplifier with bias controller, Tx low-pass harmonic filter, antenna switch and MIPI® RFFE controller. One additional auxiliary port can be used to support external path for flexibility. It can also be used for GSM path adds-on in case where 2G compatibility is required.

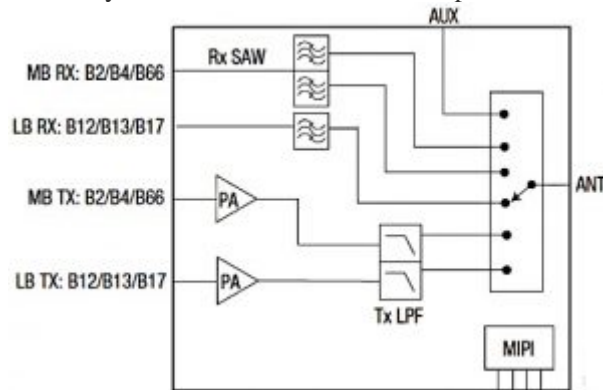


Figure 4: Dual-band LTE CATM1/NB1 module

Parameter	Test Condition	Typical	Unit
Band coverage	Down Link:	729-756	MHz
	LB	1930-1995	
	MB1	2110-2200	
	MB2		
Output Power	Up link:	699-798	dBm
	LB	1710-1980	
	MB		
Supply Current	LB/MB	24	mA
	LB/MB	300	
Gain	LB	28	dB
	MB	26	
Power-Added-Efficiency (PAE)	LB@749 MHz	28	%
	MB@1845 MHz	26	
2nd Harmonic	LB/MB	-40	dBm/MHz
Adjacent-Channel-Leakage -Rejection (ACLR)	LB/MB	34	dBc
Noise in GPS Band	LB/MB	-135	dBm/MHz
Insertion Loss, Rx	LB	2.2	dB
	MB1/MB2	1.9/2.2	
Out of band rejection, Rx	LB	30~40	dB
	MB	25~45	
Leakage Current	Sleep mode	0.4	uA

Table 3: The key parameters of SKY68011 module are shown in this table. Supply Voltage = 3.1V, Pout = 24dBm@ antenna port, 1.4MHz/6RB LTE signal.

## Summary

The SKY680xx series IoT modules demonstrate a high level of integration with multiple critical RF front-end components in a compact package. Their excellent low current, low noise and high efficiency meet requirements for today's most demanding IoT applications. Please consult Skyworks for programming guide details.