LX5584B

2.4GHz 802.11ac Front End Module

Description

The LX5584B is a complete integrated 2.4GHz Front-End Module (FEM) for an IEEE 802.11ac system. It includes a highly linear 2.4GHz Power Amplifier (PA) with power detector, Low Noise Amplifier (LNA) with bypass capability, and SP3T antenna switch. This highly integrated FEM reduces the system footprint, bill of materials, and manufacturing cost.

The LX5584B is available in a 16-pin 3 mm x 3 mm QFN Package.

Features

- 5V Supply Voltage
- Integrated 2.4GHz PA, LNA, and SP3T Tx/Rx/BT Switch
- P_{OUT} = 20dBm (256QAM/40MHz)
- Bypassable Low Noise Figure LNA
- 3 mm x 3 mm QFN package
- RoHS2 Compliant & Halogen Free

Applications

- Tablets
- Access Points
- Mobile Devices
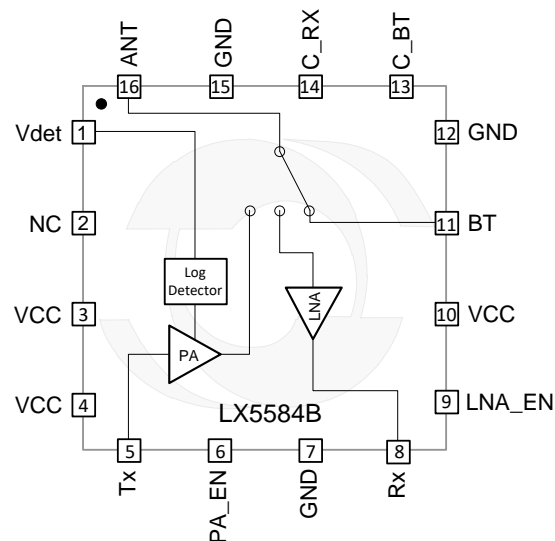- Notebooks
- Gaming

Block Diagram

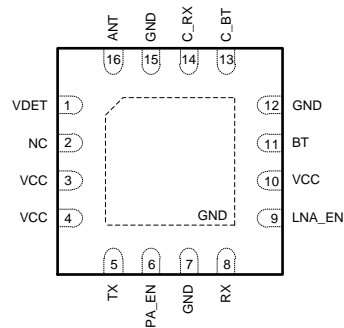**Figure 1** · Functional Block Diagram

Pin Configuration

Figure 2 · Pinout (Top View)

Ordering Information

Ambient Temperature	Type	Package	Ordering Part Number	Packaging Type
-40°C to 85°C	RoHS2 compliant, Pb-free NiPdAu lead finish	QFN 3x3x0.9 16L	LX5584BLQ-TR	Tape and Reel

Pin Description

Pin Number	Pin Designator	Description
1	VDET	Output of transmit power detector
2	NC	No connect
3	VCC	5 V nominal supply voltage
4	VCC	5 V nominal supply voltage
5	Tx	RF is 50 Ohm input to PA. DC is shorted to GND.
6	PA_EN	Power amplifier digital enable
7	GND	Ground
8	Rx	DC blocked 50ohm output of bypassable LNA
9	LNA_EN	LNA digital enable
10	VCC	5 V nominal supply voltage
11	BT	Bluetooth port

Pin Number	Pin Designator	Description
12	GND	Ground
13	C_BT	Bluetooth control pin
14	C_RX	Receiver control pin
15	GND	Ground
16	ANT	DC blocked 50 ohm antenna port

Absolute Maximum Ratings

Parameter	Value	Units
DC Supply Voltage (VCC)	5.5	V
Control Inputs (PA_EN, LNA_EN, C_RX, C_BT)	3.6	V
CW or OFDM Input Power at TX Port	+5	dBm
Maximum Junction Temperature (T_{JMAX})	+150	°C
Operational Ambient Temperature	-40 to +85	°C
Storage Temperature Range	-65 to +150	°C
Peak Package Solder Reflow Temperature (30 seconds maximum exposure)	260	°C
Electrostatic Discharge Human Body Model (HBM), Class 1B	500	V

Note: Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. 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.

Exceeding any Absolute Maximum ratings could cause damage to the device. All voltages are with respect to GND. Currents are positive into, negative out of specified terminal. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" are not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

Thermal Properties

Thermal Resistance	Typ	Units
θ$_{JP}$ Junction to Pad	10.4	°C/W
θ$_{JA}$ Junction to Ambient	44.1	

Note: The θ$_{Jx}$ numbers assume no forced airflow. Junction Temperature is calculated using $T_J = T_A$ + (Power dissipation x θ$_{JA}$) or $T_J = T_P$ + (Power dissipation x θ$_{JP}$). In particular, θ$_{JA}$ is a function of the PCB construction. The stated number above is for a four-layer board in accordance with JESD-51 (JEDEC).

Electrical Characteristics - General

Vcc=5.0V, T$_A$=25°C unless otherwise specified.

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
General Characteristics						
VCC	Supply Voltage VCC		4.75	5	5.25	V
F$_{RF}$	Frequency Range		2.402		2.482	GHz
BW$_{CN}$	Channel Bandwidth		20		40	MHz
V$_{IH}$	Control Logic Levels		3	3.3	3.6	V
V$_{IL}$			0		0.4	V
I$_{CTRL}$	Control Current	3.3V logic level		10		uA
Δt$_{onPA}$ Δt$_{offPA}$	Rx→Tx Switching Time	Difference between falling edge of LNA_EN and time when Tx output has settled to within 90% of its final power.		500		nsec
Δt$_{rxlvl}$	Rx Gain Switching Time	Difference between edge of LNA_EN and time when Rx output has settled to within 90% of its final power.		100		nsec
Δt$_{onLNA,}$ Δt$_{offLNA}$	Tx→Rx Switching Time	Difference between edge of PA_EN and time when Rx output has settled to within 90% of its final power.		500		nsec
T$_{oper}$	Operating temperature range	Case temperature	-40		85	°C
Ru	Ruggedness	P$_{IN}$ = 5 dBm VSWR = 6:1 802.11n	No damage			

Electrical Characteristics - Detector

Vcc=5.0V, T_A=25°C unless otherwise specified.

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
Detector Characteristics						
PD_{RANGE}	Power detector range		5		24	dBm
PD_{SENS}	Power Detector Sensitivity	Vdet RMS Sensitivity measured during the first 16us of the preamble		25		mV/dB
PD_{FREQ}	Power Detector Variation Over Frequency	Vdet RMS variation (Max-Min) At any particular detector voltage, and at any particular supply voltage and temperature, the measured RF output power variation over the sub-band must fall within the limits shown.			1	dB
PD_{VFT}	Power detector variation over supply, process, and temperature	V_{DET} RMS variation (Max-Min) At any particular detector voltage, the measured RF output power variation over P, V, and T must fall within the limits shown.			2	dB
PD_{BW}	Power Detector Variation Over Channel Bandwidth	V_{DET} RMS variation (Max-Min) At any particular detector voltage, the measured RF output power variation over all channel bandwidths.			2	dB
V_{DET}	Power Detector Voltage	DC detector volatage No RF input		300		mV
		RMS detector volatage P_{OUT} = 24 dBm Measured in first 16μs of preamble		910		
Z_{DET}	Detector Output Impedance			2.4		kΩ

Electrical Characteristics - Transmit

Vcc=5.0V, T_A=25°C unless otherwise specified.

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
Tx Characteristics						
RL_{TXIN}	Input Return Loss	TxA port with PA enabled		10		dB
RL_{TXOUT}	Output Return Loss	ANT port with PA enabled		10		dB
$GAIN_{TX}$	Power Gain	Signal gain in operating frequency band.		33		dB
$\Delta GAIN_{TX}$	Power Gain Variation	Over single 40MHz-channel		0.4		dB
		Over entire band		1		
P_{LIN}	Linear Output Power	802.11ac, VHT40, MCS9 Dynamic EVM < -35 dB		20		dBm
		802.11n, HT20, MCS7 Dynamic EVM < -30dB		21		
$DEVM_{FLOOR}$	Dynamic EVM floor	5 < P_{OUT} < 16dBm 802.11ac, VHT40, MCS9		-40		dB
MASK	Spectrum Emission Mask Compliant Power	802.11b, 1 Mbps, Root Cosine		23		dBm
HD2	2nd harmonic	P_{OUT} = 23 dBm Freq = 2.412, 2.437, 2.472GHz 802.11b 1Mbps		-20		dBm/MHz
HD3	3rd Harmonic	P_{OUT} = 23 dBm Freq = 2.412, 2.437, 2.472GHz 802.11b 1Mbps		-40		dBm/MHz
Icc	Operating Current	P_{OUT} = 20 dBm		230		mA
		P_{OUT} = 23 dBm		305		
$I_{CQ,TX}$	Quiescent Current	No RF input. PA enabled		130		mA

Electrical Characteristics - Receive

Vcc=5.0V, T_A=25°C unless otherwise specified.

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
Rx Characteristics						
RL_{RXIN}	Input Return Loss	At Ant port for HG states		15		dB
		At Ant port for bypass Rx states		10		
RL_{RXOUT}	Output Return Loss	At Rx port All RX gain states		15		dB
$GAIN_{RX}$	Small Signal Gain	LNA enabled		13		dB
		LNA bypass state (bypass)		-8		
$\Delta GAIN_{RX}$	Small Signal Gain Variation	Over single 40MHz-channel		0.5		dB
		Over entire F_{RF}		1		
G_{STEP}	Gain step	Gain difference between HG and bypass		21		dB
NF	Noise Figure	LNA enabled, 25°C		2.8		dB
IIP3	Input Third Order Intercept Point	At ANT port with LNA enabled. To be measured with total input power = -10dBm (-13 dBm/tone).		7		dBm
		At ANT port with LNA bypassed. Measured with total input power = 5 dBm (2dBm/tone).		35		
$I_{CQ,RX}$	Operating Current	LNA enabled No RF input		10		mA

Electrical Characteristics - Bluetooth

Vcc=5.0V, T_A=25°C unless otherwise specified.

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
BT Characteristics						
RL_{BTIN}	Input Return Loss	At ANT port Mode = BT		10		dB
RL_{BTOUT}	Output Return Loss	At BT port Mode = BT		15		dB
IL_{BT}	Insertion Loss	ANT to BT port Mode = BT		1.5		dB

When BT port is not used, it must be terminated with 50Ohm load.

Functional State Table

PAEN	LNAEN	C_Rx	C_BT	Default State
0	0	0	0	Sleep mode
1	0	0	0	PA Enabled
0	1	1	0	LNA Enabled, High gain mode
0	0	1	0	LNA Bypassed
0	0	0	1	Bluetooth
¹ Logic HI / LOW voltage ranges are as defined previously.				
² All control signals must be driven. Operation Mode is undefined if any control signal is floating.				

Part Markings
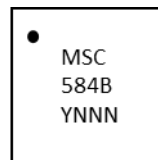
Figure 3 · Typical Part Markings

Package Outline Dimensions

The package is halogen free and meets RoHS2 and REACH standards.

(MSL1, 260°C per JEDEC J-STD-020)

DIMENSION	Millimeters	
	MIN	MAX
A	0.8	1.0
A1	0.018	0.023
L	0.2	0.4
b	0.2	0.3
D	2.95	3.05
D2	1.6	1.8
E	2.95	3.05
E2	1.6	1.8
e	0.50 BSC	
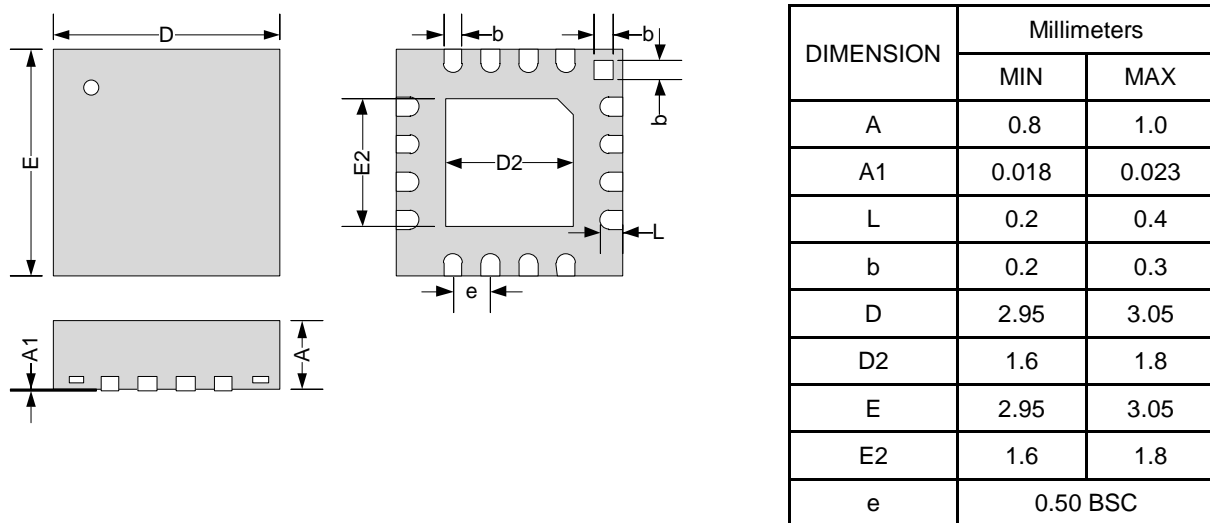
Figure 4 · 16 Pin QFN Package Dimensions
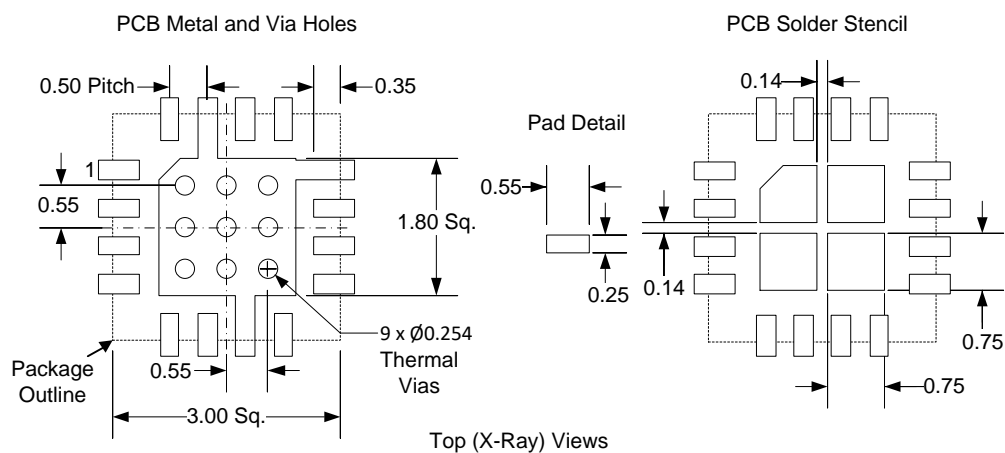
Notes:
1. All dimensions are in millimeters.
2. Unless specified dimensions are symmetrical about center lines.
3. OSP or NiAu planar surface finish recommended.
4. Non-Solder Mask Defined (NSMD) pads recommended for terminal pads.
5. Recommended tented thermal vias as shown with vias filled with solder.
6. Stencil thickness < 0.15mm.
7. Aperture design for thermal pads using multiple openings with 60 to 80% solder paste coverage.

Figure 5 · PCB Layout Footprint (Top View)

Evaluation Board Schematic
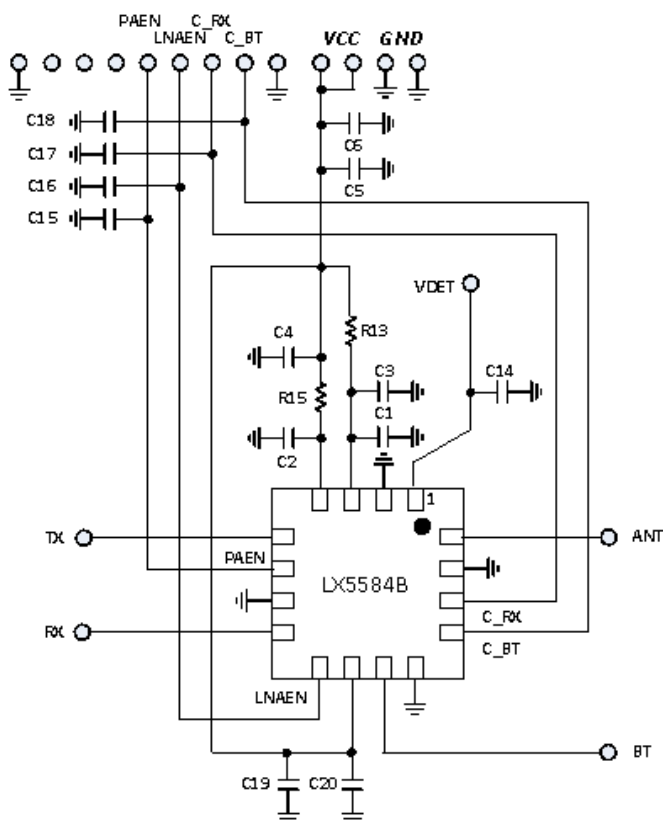
Figure 6 · Evaluation Board Schematic

Evaluation Board BOM

Part Number	Value	Package Size	Component
GRM1555C1H100JZ01D	10pf	0402	C1,C2
GRM1555C1H120FA01D	12pf	0402	C14, C15
GRM1555C1H101JZ01D	100pf	0402	C20
GRM1555C1H471JA01D	470pf	0402	C16,C17,C18
GRM155R60J105KE19D	1uf	0402	C3, C4, C19
GRM188R71A105KA61D	1uf	0603	C5
F981C475MMA	4.7uf	0603	C6
ERJ-3BQJ2R7V	2.7 ohm	0603	R13
ERJ-2RKF10R0X	10 ohm	0402	R15

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