ZL70120 MICS-Band RF Base Station Module (BSM)

Features

- Complete MICS-Band[1] RF Telemetry Radio Solution
- Generic RF Base Station Module Designed to Interact with Implantable Medical Devices Based on the ZL70102 and ZL70101 Family of Products
- Integrated 2.45-GHz Wake-Up Transmitter
- Compact Design and Small Size to Fit Most Applications
- Fully Shielded Package
- Rich Functionality (access to the ZL70102 features)
- Designed to Meet Regulatory Requirements (FCC, ETSI, and IEC)

Applications

- Programming Base Stations
- Home/Remote Monitoring Applications
- Mobile Applications (handheld or belt-worn)
- Implantable Medical Devices for Cardiac Rhythm Management, Neurostimulators, Drug Delivery, Sensors, and Diagnostics

Description

The ZL70120 BSM implements all RF-related functions needed to deploy the external device functions in a MICS-band RF telemetry system. Figure 1 shows its major functions:

- ZL70102-based MICS-band RF transceiver with an integrated matching network, bandpass filters for suppression of unwanted blockers, and an extra receiver LNA for maximized receiver sensitivity.
- 2.45-GHz Wake-Up Transmitter supporting wake-up of implants using the ultra-low-power 2.45-GHz wake-up mode of the ZL70102.
- RSSI filter and logarithmic amplifier simplifying Clear Channel Assessment (CCA) required by the Medical Implantable Communications Service (MICS) standard.
- 24-MHz XO reference frequency for the 400-MHz and 2.45-GHz subsystems.

Ordering Information

ZL70120MNG 44-pad LCC

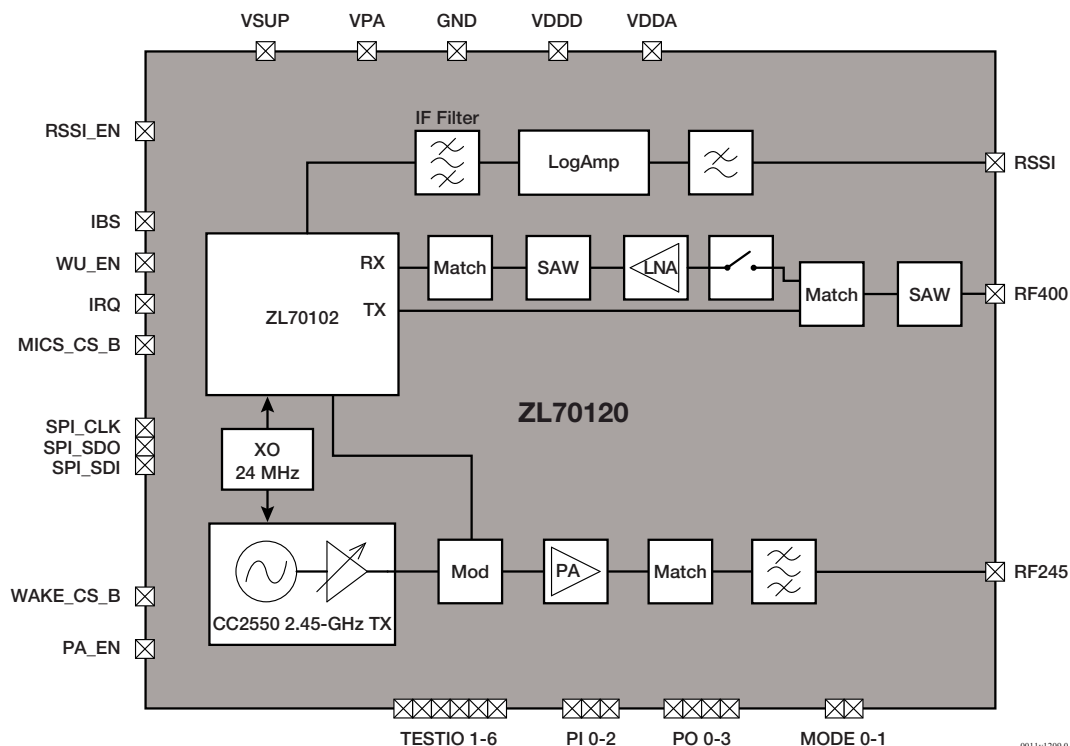Please refer to "Package Overview" on page 4-6 for details.

Figure 1 • **ZL70120 Block Diagram**

---

1 MICS is a subset of MedRadio.

Table of Contents

List of Figures

List of Tables

1 – Product Description

The ZL70120 MICS-Band RF Base Station Module (BSM) is a complete, high-performance, easy-to-use RF module that is based on the ZL70102 MICS-band transceiver IC, which is used for implantable medical applications. The ZL70102 is designed to provide good performance while consuming extremely low power.

The ZL70120 RF base station module integrates additional circuitry and functionality required to deploy a complete radio solution for external applications. This reduces the complexity of implementing a MICS-band base station to placing one single package on an application board.

Please refer to Table 1-1 below for all documents related to the ZL70102 family of products. These documents can be found on Microsemi's website or by contacting Microsemi's CMPG sales for more information.

Table 1-1 • **Related Documentation**

Product	Document(s)	Description
ZL70102 MICS-Band RF Transceiver	ZL70102 Datasheet	The ZL70102 MICS-Band RF Transceiver is designed specifically for use in implantable medical devices (such as pace makers and neurostimulators). It also supports external applications (such as programmers and patient controllers).
	ZL70102 Design Manual	
ZL70321 MICS-Band RF Standard Implant Module (SIM)	ZL70321 Datasheet	The ZL70321 SIM is a ZL70102-based implant-grade RF module.
ZLE70102 Application Development Kit (ADK)	ZLE70102 ADK Users Guide	The ADK combines hardware and software to provide an end-to-end MICS-band communication system based on the ZL70120 Base Station Module and the ZL70321 Standard Implant Module. Additionally, source code with programming examples is available with a source code license agreement (SCLA).
CC2550 2.4-GHz RF Transmitter	CC2550 Datasheet[1]	The CC2550 2.45-GHz RF Transmitter is used in the 2.45-GHz ISM wake-up circuit in the ZL70120 Base Station Module.

Note:

1. *Can be found on TI's website at www.ti.com/product/cc2550*

2 – Functional Description

General

The ZL70120 is a complete MICS-band RF telemetry radio solution for external applications such as programming base stations, home/remote monitoring units, and handheld or belt-worn applications. The ZL70120 integrates the ZL70102 and all of the additional circuitry and functionality required to deploy a complete radio solution for external applications.

The ZL70120 contains the following main subsystems:

- MICS-band RF transceiver based on the ZL70102
- 2.45-GHz Wake-Up Transmitter
- MICS-band RSSI filter

To support these subsystems the module also contains the following functions:

- 24-MHz crystal oscillator (XO) reference frequency used by both the MICS-band transceiver and the 2.45-GHz Wake-Up Transmitter
- Enable/disable function to facilitate power saving for the different core circuits
- Supply decoupling
- General purpose digital I/O

For a hardware and software example of the ZL70120 in a base station application, the ZLE70102 Application Development Kit (ADK) featuring the ZL70120 base station module is available for our customers. Please refer to the ZLE70102 ADK documentation for more information.

Power Supply Requirements

The ZL70120 module is powered by two VSUP supply pads and one VPA supply pad (refer to Figure 2-1). The VSUP pads provide power to all circuits except the 2.45-GHz PA, which is powered by the VPA pad. The module contains supply decoupling to isolate the RF signals from the supply lines.

A 100-nF decoupling capacitor between the VPA and VSUP pad and GND is recommended, as illustrated in Figure 2-1.
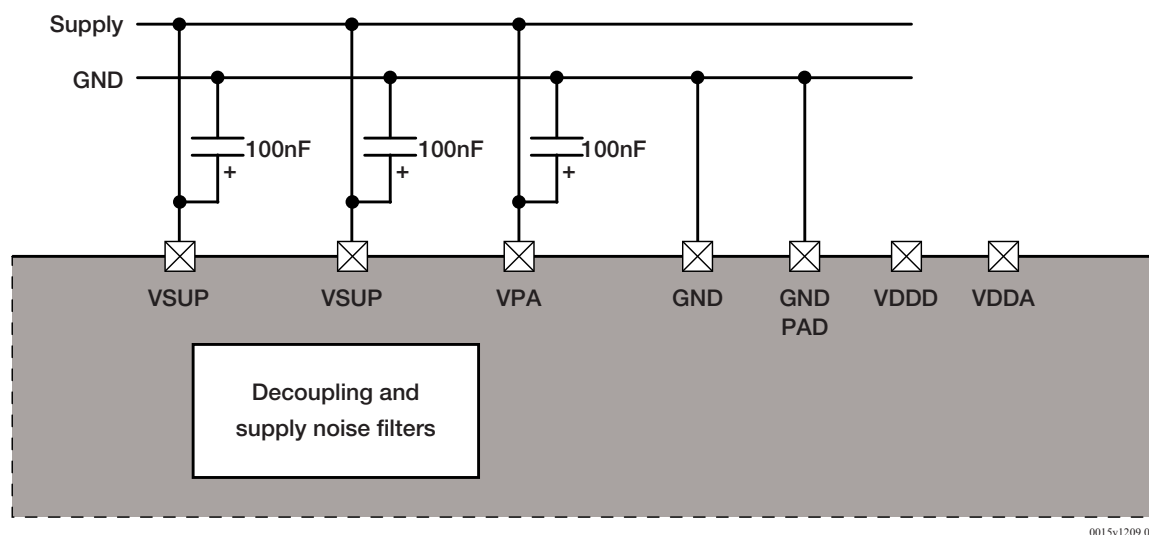

Figure 2-1 • Supply and Decoupling Circuit

The CC2550 2.45-GHz transmitter requires a maximum power-up ramp-up time of 5ms from 0V to 1.8V to ensure a proper power-on reset. There is also a minimum of 1ms between power off and power on. The total VSUP decoupling within the module is 700nF.

The VDDD and VDDA pads are test pads that should not be loaded or used in the user application. They are connected to the internal digital and analog voltage regulators of the ZL70102 chip.

Supply noise at 450kHz should also be avoided since this might interfere with the base band of the ZL70102 receiver.

MICS-Band Transceiver

The MICS-band transceiver (Figure 2-2) is based on the ZL70102 chip. Please refer to the ZL70102 Data Sheet and the ZL70102 Design Manual for detailed information on the chip.

The 24-MHz reference frequency XO is shared between the ZL70102 MICS-band transceiver and the 2.45-GHz transmitter; please refer to "24-MHz XO" below.

The SPI bus is the application interface to the ZL70120 base station module and is shared between the ZL70102 transceiver and the CC2550 2.45-GHz transmitter. The MICS_CS_B pad is used to enable the SPI bus on the ZL70102. Please refer to the ZL70102 documentation regarding the other digital interface lines (IBS, WU_EN, IRQ). The WAKE_CS_B pad is used to enable the SPI bus on the CC2550 2.45-GHz transmitter (refer to Figure 2-4 on page 2-4).
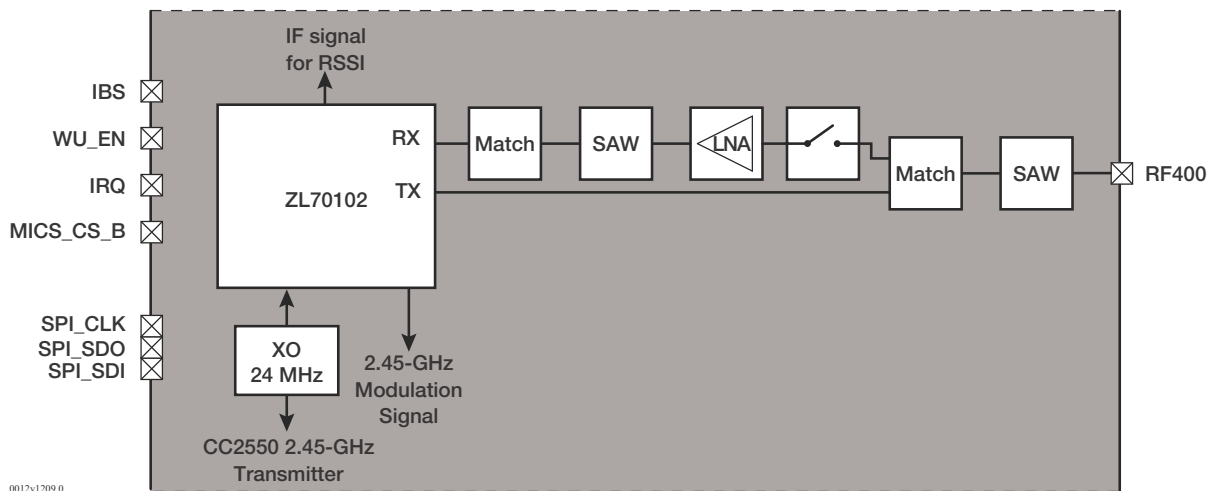
Figure 2-2 • **MICS-Band RF Transceiver Circuit**

24-MHz XO

The ZL70120 module has an integrated 24-MHz crystal oscillator that is used as a reference frequency for both the ZL70102 MICS-band transceiver and the 2.45-GHz wake-up transmitter. The XO is enabled or disabled automatically when the ZL70102 is awake or asleep, respectively. To guarantee stable operation, neither the ZL70102 nor the CC2550 should be accessed on the SPI bus until the radio ready interrupt is received from the ZL70102. This allows for the required startup time for the 24-MHz XO. There is no adjustment required on the 24-MHz XO.

MICS-Band Transceiver Sleep Control

The ZL70102 chip can be disabled by setting the IBS input low. The system is enabled by setting the IBS input high.

The ZL70102 is equipped with a main watchdog that resets the system after 5 seconds if there is no communication ongoing. This feature ensures that the system does not violate the regulatory requirements by mistake. Normally for a base station application, the application processor sets the IBS pin high to wake-up the ZL70102 and waits for the radio ready interrupt. Once the interrupt has been received, the application processor disables the watchdog so that the ZL70102 does not go to sleep after 5 seconds. Typically, the only time the main watchdog is enabled in a base station is when the base station is searching for implants, is starting a session, or is in a session. Please refer to Chapter 7 of the ZL70102 Design Manual for details on how the main watchdog functions.

MICS-Band Transceiver Matching Network

The MICS-band transceiver circuit has a high-performance matching network with the following characteristics:

- Matched to 50Ω for simple connection to the antenna
- LNA to maximize the receiver sensitivity
- Dual MICS-band SAW filters to protect against unwanted blockers like TETRA
    - Second SAW also acts like a bandpass filter to suppress unwanted emissions during transmit

General Purpose I/O

The ZL70120 module provides access to all of the ZL70102 I/Os (Figure 2-3).
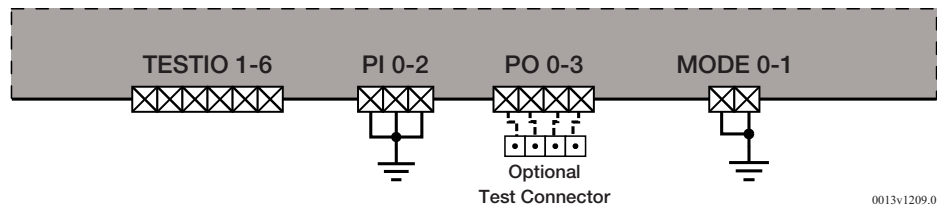
Figure 2-3 •   General Purpose I/O

Table 2-1 shows which signals are available to the users for programming and which are used by internal functions of the module and are available to users for monitoring purposes only. Please refer to the ZL70102 Data Sheet and the ZL70102 Design Manual for more details.

Table 2-1 •   I/O Signals for the ZL70120 Module

ZL70102 Signal	User Programmable	Comment
TESTIO1..4	**Yes**	Analog test bus input/output
TESTIO5..6	No	450-kHz IF signal output used by the RSSI filter and log amp
PI0..2	**Yes**	Digital inputs (ground if not used)
PO0	No	2.45-GHz OOK wake-up modulation signal
PO1	No	Transmit/receive control
PO2..3	**Yes**	Digital outputs
MODE0..1	**Yes**	Ground for normal operation

MICS-Band Transceiver Calibrations

The following ZL70102 registers have to be adjusted for optimum transmit power. Please refer to Chapter 10 of the ZL70102 Design Manual for further programming details.

Receiver LNA Gain Settings

The ZL70120 module contains an additional external LNA that is used together with the internal LNA in the ZL70102. The gain of the ZL70102 400-MHz LNA has to be adjusted and the setting is a compromise between sensitivity and blocking performance. The recommended setting for *reg_rf_rxrflnagaintrim* is 8.

Transmit Bandwidth

The modulation filtering of the MICS-band transmit signal is set by *reg_mac_txiframpdelay*. The value set is a compromise between link BER and keeping the transmit spectrum within regulatory requirements. The recommended value for *reg_mac_txiframpdelay* is 12 for data rates of 200 or 400 kbit/s.

Transmitter and Receiver Tuning Capacitor

The transmitter and receiver tuning capacitors may be adjusted to optimize transmit power and receiver sensitivity, respectively.

Transmitter Unwanted Emission Suppression

The ZL70102 should be used in its linear PA mode in the ZL70120. In this mode there are ZL70102 registers available to minimize the transmitter unwanted emissions. Proper setting of these registers are necessary to meet the regulatory requirements.

Transmitter Power Control

The transmit power needs to be adjusted such that the radiated power from the device in which the BSM is installed does not exceed −16 dBm EIRP. The ZL70102 has a wide range of power control settings to accommodate a wide variation in base station antenna performance. The ZL70102 registers *reg_rf_txrfpwrdefaultset* and *reg_rf_txrf_sel_ctrl* can be used to adjust transmit power.

2.45-GHz Wake-Up Transmitter

The 2.45-GHz Wake-Up Transmitter (Figure 2-4) is used to send wake-up messages to an implant that uses the ultra-low-power wake-up mode of the ZL70102. This wake-up scheme provides a very power-efficient method for waking up the ZL70102 transceiver from a sleep state.
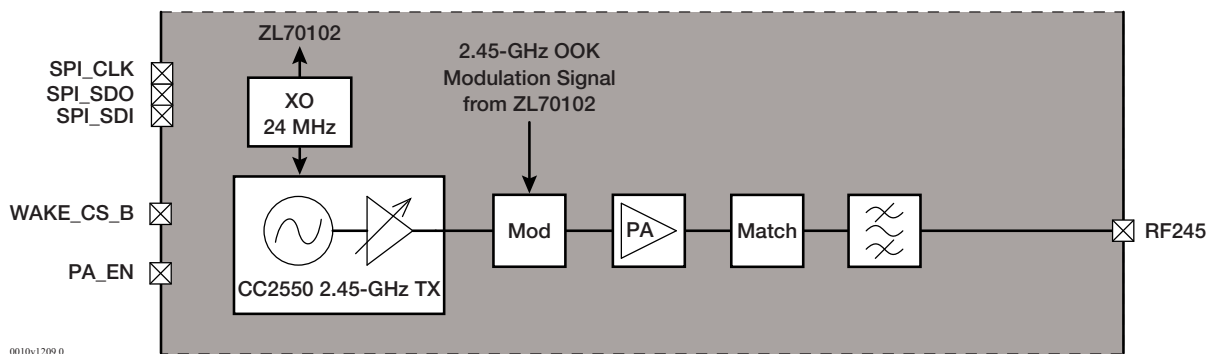

Figure 2-4 • 2.45-GHz Wake-Up Transmitter Circuit

The 2.45-GHz transmitter chain is based on the Texas Instruments CC2550 2.4-GHz transmitter and uses the synthesizer and power control blocks of that chip. The modulation, power amplifier, and remaining functions are implemented outside the CC2550. This data sheet and other documentation provided with the ZL70120 module is

intended to provide basic information needed to implement and use the module. For more details on the 2.4-GHz synthesizer, power control, programming, and register names referenced in this document, please refer to the Texas Instruments CC2550 data sheet.

The SPI bus used to communicate with the CC2550 is shared with the ZL70102 chip. Set the WAKE_CS_B input low to communicate with the CC2550 chip through the SPI bus.

2.45-GHz Sleep Control

The 2.45-GHz Wake-Up Transmitter can be disabled to save power.

The CC2550 transmitter and the PA have to be enabled/disabled separately.

- The PA is controlled through the PA_EN control signal and is active when PA_EN is high.
- The CC2550 has multiple low power states to which it can be programmed. Please refer to the CC2550 data sheet for details to determine which low power state is appropriate for your application.

2.45-GHz Synthesizer Frequency Control

The synthesizer shares the reference frequency generated by the 24-MHz XO with the ZL70102 chip. The 24-MHz XO is enabled only when the ZL70102 chip is awake. Please refer to "24-MHz XO" on page 2-2 for more information.

The synthesizer has to be configured to support a suitable frequency range for the target application. This is controlled by six of the CC2550's registers (Table 2-2), where the three FREQx registers form a three-byte FREQ variable.

Table 2-2 • **2.45-GHz Synthesizer Control Registers**

Register	Address	Field	Recommended Value in Hex (decimal)	Description
MDMCFG0	8'h14	CHANSPC_M	8'hC7 (199)	Channel spacing (mantissa)
MDMCFG1	8'h13[1:0]	CHANSPC_E	2'h03 (3)	Channel spacing (exponential factor)
FREQ2	8'h0D	FREQ[23:22]	2'h01 (1)	Frequency control word (Note 1)
		FREQ[21:16]	6'h64 (100)	
FREQ1	8'h0E	FREQ[15:8]	8'h00 (0)	
FREQ0	8'h0F	FREQ[7:0]	8'h00 (0)	
CHANNR	8'h0A	CHAN[7:0]		Channel number (in number of steps)

Note:

1. *Bits FREQ[23:22] are read-only and are fixed at binary 01.*

Based on the recommended settings from Table 2-2 above, the base frequency (f_{base}) is 2400 MHz and the channel spacing (f_{chspc}) is 333.252 kHz, providing a channel center frequency range from 2400 MHz to 2484.979 MHz covering the 2.45-GHz ISM band from 2400 to 2483.5 MHz.

Depending on the target application, the channel spacing and frequency range can be optimized. Please refer to the examples in Table 2-3, based on a 2400-MHz base frequency.

Table 2-3 • **Optional 2.45-GHz Synthesizer Settings**

Desired Step Size and Range	CHANSPC_E	CHANSPC_M	f_{step} [kHz]	f_{max} [MHz]
375 kHz, maximum range	3	8'hFF (255)	374.268	2495.438
333 kHz, recommended setting	3	8'hC7 (199)	333.252	2484.979
250 kHz, medium range	3	8'h55 (85)	249.756	2463.688
200 kHz, limited range	3	8'h11 (17)	199.951	2450.987
100 kHz, limited range	2	8'h11 (17)	99.976	2425.494

2.45-GHz Power Control

The CC2550 can be programmed into 256 different power codes but the output power is not monotonic as a function of code. Microsemi recommends finding the optimal power code for each unit in a production environment.

2.45-GHz Transmitter Configuration

The CC2550 must be configured to produce a CW signal. The OOK modulation is performed external to the CC2550 by the PO0 signal from the ZL70102.

Please use the programming sequence in Table 2-4 to configure the transmitter before use.

Table 2-4 •   **2.45-GHz Transmitter Configuration**

#	Register	Address	Setting	Comment
1	PATABLE(0)	8'h3E	Power code	Suitable power code
2	MDMCFG0	8'h14	CHANSPC_E	Refer to "2.45-GHz Synthesizer Frequency Control" on page 2-5
3	MDMCFG1	8'h13	CHANSPC_M	Refer to "2.45-GHz Synthesizer Frequency Control" on page 2-5
4	FREQ2	8'h0D	8'h64	2400-MHz nominal frequency
5	FREQ1	8'h0E	0	
6	FREQ0	8'h0F	0	
7	CHANNR	8'h0A	CHANNR	Channel number (in number of steps)
8	MDMCFG2	8'h12	8'h30	OOK mode, no coding, no preamble
9	DEVIATN	8'h15	0	No frequency deviation
10	MCSM0	8'h18	8'h18	Autocalibrate when going from the idle state to the TX state; also sets the PO_TIMEOUT to approximately 149 – 155 µs as recommended if the XO is stable during startup
11	PKTCTRL0	8'h08	8'h32	No whitening, static asynchronous data, no CRC, infinite packet length

Issue an STX (8'h35) command strobe to put the CC2550 into transmit state.

The remaining registers have power-on-reset default values that do not have to be changed by writing to the register.

MICS-Band RSSI Filter

The RSSI filter circuit (Figure 2-5) uses the ZL70102 IF signal by porting the I branch of the internal IF signal through TESTIO5 and TESTIO6 to the filter. The IF bandpass filter has a 450-kHz center frequency with an F_3 bandwidth of 200 kHz and is compliant with ETSI EN 301 839-1 and FCC 47CFR95.268(a)(1).
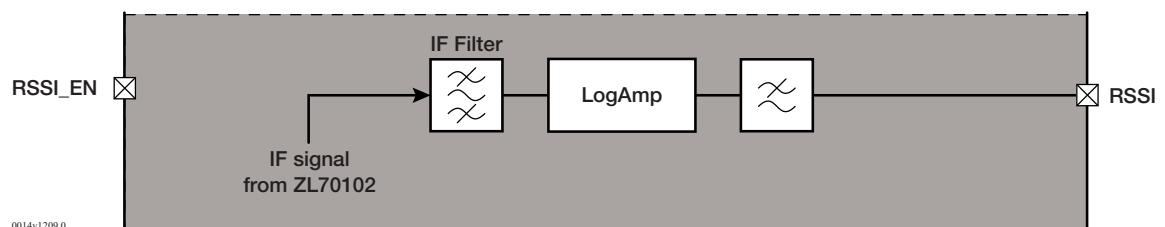
Figure 2-5 •   **RSSI Filter Circuit**

The output from the IF filter is fed into the logarithmic amplifier that outputs a voltage signal proportional to the IF signal level in dB.

With no input signal present, receiver noise gives an output RSSI voltage of 0.83V typical. This equates to a level of about −116dBm. The RSSI output is logarithmic with a slope of 24mV/dB.

The procedure for setting up the ZL70102 for RSSI measurements is described in the ZL70102 Design Manual (Section 12.1). The ZLE70102 ADK source code also gives a programming example.

3 – Electrical Specifications

Tables 3-1 through 3-8 provide the absolute maximum ratings and other electrical characteristics for the ZL70120. Voltages are with respect to ground (GND) unless otherwise stated.

Absolute Maximum Ratings

Table 3-1 • **Absolute Maximum Ratings**

ID	Parameter	Symbol	Limits				Note
			Min.	Typ.	Max.	Unit	
1.0	Supply voltage	V_{SUP}	0		3.6	V	
1.1	PA supply voltage	V_{PA}	0		3.6	V	
1.2	Storage temperature	T_{stg}	–40		+125	°C	Note 1

Note:

1. *Device may be powered during burn-in but operation is not guaranteed.*

Recommended Operating Conditions

The recommended operating conditions in Table 3-2 define the nominal conditions for the device.

Table 3-2 • **Recommended Operating Conditions**

ID	Parameter	Symbol	Limits			Note
			Min.	Max.	Unit	
2.0	Supply voltage	V_{SUP}	3.0	3.5	V	Note 1
2.1	PA supply voltage	V_{PA}	3.0	3.5	V	Note 1
2.2	Operating temperature	T_{op}	0	+55	°C	

Note:

1. *It is recommended that V_{SUP} and V_{PA} operate at the same voltage.*

Electrical Characteristics

Default register and mode settings are assumed unless noted.

Electrical testing during production is used to ensure that delivered parts fulfill the limits defined herein. In some cases it is not possible to perform electrical testing or the testing has been carried out in a different way. These exceptions are marked in the "Exceptn" column of Tables 3-3 to 3-8 when relevant; refer to legend below.

① These parameters are guaranteed by production tests but with different limits to what is specified in the data sheet. This is due to limitations in the capabilities of the automated test equipment. The production tests that are carried out have been correlated to tests carried out in the lab environment.

② These parameters are guaranteed by production tests; however, these may be carried out in a different manner to that defined in the data sheet.

③ These parameters are tested during production test but the limits are for design guide only.

④ These parameters are for design aid only: not guaranteed and not subject to production testing.

⑤ Typical values according to the specified condition. If no conditions are specified, then the typical figures are at 25°C and V_{SUP} = 3.3V. Typical values are for design aid only: not guaranteed and not subject to production testing.

Digital Interface

The characteristics in Table 3-3 are valid for the following interconnects:

- Digital inputs: RSSI_EN, IBS, WU_EN, MICS_CS_B, SPI_CLK, SPI_SDI, WAKE_CS_B, PA_EN, MODE0, MODE1, PI0, PI1, PI2
- Digital outputs: IRQ, SPI_SDO, PO0, PO1, PO2, PO3

Table 3-3 • **Digital Interface**

ID	Parameter	Symbol	Limits					Note
			Min.	Max.	Unit	Exceptn	
3.0	Digital I/O input low	V_{IL}	0	300	mV	②	Note 1
3.1	Digital I/O input high	V_{IH}	V_{SUP} – 300	V_{SUP}	mV	②	Note 2
3.2	Digital I/O output low	V_{OL}	0	150	mV	②	
3.3	Digital I/O output high	V_{OH}	V_{SUP} – 150	V_{SUP}	mV	②	
3.4	Maximum SPI clock rate	f_{clk}		4	MHz	④	Note 3

Notes:

1. *V_{IL} is the required input voltage to ensure internal signal switching from high to low.*

2. *V_{IH} is the required input voltage to ensure internal signal switching from low to high.*

3. *Default value. The maximum clock rate can be programmed to 1, 2, or 4 MHz.*

Performance Characteristics

Current Consumption

Table 3-4 • **Current Consumption**

ID	Parameter	Symbol	Min.	Typ.	Max.	Unit	Exceptn	Note
4.0	Sleep state	I_{sleep}		4	10	µA	⑤	Note 1
4.1	2.45-GHz wake-up state	I_{wakeup}		300	400	mA	⑤	Note 2
4.2	MICS-band session	$I_{session}$		12	24	mA	⑤	Note 3

Notes:

1. *All circuits disabled.*

2. *All circuits enabled.*

3. *MICS-band session with 2.45-GHz wake-up transmitter circuit disabled.*

MICS-Band Transmitter

Table 3-5 • **MICS-Band Transmitter**

ID	Parameter	Symbol	Limits					Note
			Min.	Typ.	Max.	Unit	Exceptn	
5.0	Transmitter maximum output power	$P_{TX400max}$	−4	−1		dBm	⑤	
5.1	Transmitter minimum output power	$P_{TX400min}$			−22	dBm	④	
5.2	Transmitter emission bandwidth (at −20dB points)	f_{micsBW}			300	kHz	②	
5.3	Transmitter unwanted emissions 401.75 to 405.25MHz	E_{mics1}			−20	dBc		Note 1
5.4	Transmitter unwanted emissions outside the MICS band 30 to 88MHz	E_{mics2}			−45	dBc'	④	Note 2
5.5	Transmitter unwanted emissions outside the MICS band 88 to 216MHz	E_{mics3}			−42	dBc	④	Note 2
5.6	Transmitter unwanted emissions outside the MICS band 216 to 401.75MHz and 405.25 to 960MHz	E_{mics4}			−39	dBc	②	Note 2
5.7	Transmitter unwanted emissions outside the MICS band above 960MHz	E_{mics5}			−31	dBc	④	Note 2
5.8	Transmitter off and receiver spurious emissions ≤ 1GHz	E_{mics6}			−57	dBm	④	
5.9	Transmitter off and receiver spurious emissions > 1GHz	E_{mics7}			−47	dBm	④	
5.10	Transmitter off and receiver wideband noise output ≤ 1GHz	N_{mics1}			−107	dBm/Hz	④	
5.11	Transmitter off and receiver wideband noise output > 1GHz	N_{mics1}			−97	dBm/Hz	④	
5.12	Frequency stability	f_{stab}			±30	ppm	④	

Notes:

1. Emissions outside the channel bandwidth f_{micsBW}.

2. Referenced to a output power level of −16dBm.

MICS-Band Receiver

Table 3-6 • **MICS-Band Receiver**

ID	Parameter	Symbol	Limits					Note
			Min.	Typ.	Max.	Unit	Exceptn	
6.0	Receiver sensitivity at 200 kbit/s	P_{RX200}		−96	−93	dBm	③ ⑤	
6.1	Receiver sensitivity at 400 kbit/s	P_{RX400}		−91	−86	dBm	③ ⑤	
6.2	RSSI sensitivity	P_{RSSI}		−116	−112	dBm	⑤	Note 1
6.3	Receiver blocking 20 MHz from wanted signal	P_{blkRX}	0			dBm	④	
6.4	TETRA blocking level	$P_{blkTETRA}$	−30			dBm		
6.5	Receiver input IP3	IIP3	−48	−46		dBm	④ ⑤	

Notes:

1. *Used for CCA measurements.*

2.45-GHz Wake-Up Transmitter

Table 3-7 •   2.45-GHz Wake-Up Transmitter

ID	Parameter	Symbol	Limits					Note
			Min.	Typ.	Max.	Unit	Exceptn	
7.0	Wake-up transmitter maximum output power	$P_{WakeTXmax}$	17	21		dBm	⑤	
7.1	Wake-up transmitter minimum output power	$P_{WakeTXmin}$		−10		dBm	④ ⑤	Note 1
7.2	Wake-up transmitter output power step resolution	$P_{WakeTXstep}$		1		dB	④ ⑤	
7.3	Wake-up transmitter spurious emission 300 MHz to 1 GHz	$E_{WakeTX1}$			−36	dBm	③	
7.4	Wake-up transmitter spurious emission 1 to 12.5 GHz	$E_{WakeTX2}$			−30	dBm	③	Note 2
7.5	Wake-up transmitter spurious emission 1.8 to 1.9 GHz and 5.15 to 5.3 GHz	$E_{WakeTX3}$			−47	dBm	④	
7.6	Wake-up transmitter wideband noise 30 MHz to 1 GHz	$N_{WakeTX1}$			−86	dBm/Hz	④	
7.7	Wake-up transmitter wideband noise 1 to 12.5 GHz	$N_{WakeTX2}$			−80	dBm/Hz	④	
7.8	Wake-up transmitter wideband noise 1.8 to 1.9 GHz and 5.15 to 5.3 GHz	$N_{WakeTX3}$			−97	dBm/Hz	④	
7.9	Wake-up transmitter 99% power bandwidth	$f_{WakeTXBW}$		1.6	5.22	MHz	⑤	
7.10	Wake-up transmitter OOK power ratio	WtxOOK	36	50		dB	⑤	
7.11	Wake-up transmitter modulation envelope rise time	$t_{WakeTXrise}$	70	170	360	ns	⑤	Note 3
7.12	Wake-up transmitter modulation envelope fall time	$t_{WakeTXfall}$	90	120	500	ns	⑤	Note 4
7.13	Wake-up transmitter nominal minimum frequency	$f_{WakeTXnom}$		2400		MHz	① ⑤	Note 5
7.14	Wake-up transmitter maximum frequency	$f_{WakeTXmax}$		2484.979		MHz	③ ⑤	Note 5
7.15	Wake-up transmitter frequency step	$f_{WakeTXstep}$		333.252		kHz	④ ⑤	Note 5
7.16	Wake-up transmitter frequency hop time	$t_{WakeTXhop}$			100	µs	④	
7.17	Wake-up transmitter synthesizer startup time	$t_{WakeTXstart}$			1	ms	④	

Notes:

1. *Based on program setting.*
2. *Except for 1.8 to 1.9 and 5.15 to 5.3 GHz.*
3. *Rise time from 10% to 90% of signal.*
4. *Fall time from 90% to 10% of signal.*
5. *Frequency range and step can be programmed. Refer to "2.45-GHz Synthesizer Frequency Control" on page 2-5 for more information.*

ESD

Table 3-8 • **ESD**

ID	Parameter	Symbol	Min.	Max.	Unit	Note
			Limits			
8.0	ESD	V_{ESD}	500		V	Note 1

Note:

1. *Human Body Model (HBM).*

4 – Mechanical Specifications

Pad List

Table 4-1 describes each pad on the ZL70120 LCC, and Table 4-2 provides definitions of the pad types listed in Table 4-1.

Proper ground is essential for good and stable performance. Please ensure all ground pads are connected.

Table 4-1 • **ZL70120 Pad List**

Pad	Symbol	Description	Type	Notes
1	GND	Ground supply connection (RF).	RFGND	
2	RF400	Antenna RF input and output for the MICS band.	RF	
3	GND	Ground supply connection (RF).	RFGND	
4	NC	Internal signal. Do not connect.	INT	
5	RSSI_EN	Used to enable RSSI output.	DI	
6	RSSI	RSSI output, an analog voltage.	AO	
7	GND	Ground supply connection (RF).	RFGND	
8	RF245	Wake-up transmitter RF output.	RF	
9	GND	Ground supply connection (RF).	RFGND	
10	GND	Ground supply connection.	GND	
11	VPA	Positive supply for the wake-up transmitter PA stage (3.3V typical).	SUP	
12	GND	Ground supply connection.	GND	
13	PA_EN	Used to enable the wake-up transmitter PA.	DI	
14	TESTIO5	Internal signal. Provides the MICS-band IF signal to the RSSI filter.	INT	
15	TESTIO6		INT	
16	TESTIO1	Analog test bus pad 1.	A	
17	TESTIO2	Analog test bus pad 2.	A	
18	WAKE_CS_B	Used to enable wake-up transmitter SPI bus interface.	DI	
19	NC	Internal signal.	INT	
20	TESTIO3	Analog test bus pad 3.	A	
21	TESTIO4	Analog test bus pad 4.	A	
22	GND	Ground supply connection.	GND	
23	VSUP	Positive supply connection (3.3V typical).	SUP	
24	GND	Ground supply connection.	GND	
25	IRQ	MICS-band interrupt request output.	DO	
26	IBS	Implant / base mode selection. Used to enable/disable the MICS-band transceiver.	DI	
27	WU_EN	Access to the ZL70102 WU_EN pad. Normally grounded in base station applications.	DI	

Table 4-1 • **ZL70120 Pad List (continued)**

| Pad	Symbol	Description	Type	Notes
28	MICS_CS_B	Used to enable the MICS-band ZL70102 SPI bus interface.	DI	
29	SPI_CLK	Clock for SPI bus interface.	DI	
30	SPI_SDO	Data output for SPI bus interface.	DO	
31	SPI_SDI	Data input for SPI bus interface.	DI	
32	VDDD	Internal signal, not for customer use. (Digital voltage regulator output of MICS-band IC. Sensitive to noise.)	INT	
33	GND	Ground supply connection.	GND	
34	MODE1	Mode 1 pad. Should be grounded for normal operation.	DI	
35	MODE0	Mode 0 pad. Should be grounded for normal operation.	DI	
36	PI2	Programmable input 2.	DI	
37	PI1	Programmable input 1.	DI	
38	PI0	Programmable input 0.	DI	
39	PO3	Programmable output 3.	DO	
40	PO2	Programmable output 2.	DO	
41	PO1	Internal signal. Used to control transmit/receive switching.	INT	
42	PO0	Internal signal. Used to provide the wake-up OOK signal to the 2.45-GHz transmitter.	INT	
43	VDDA	Internal signal, not for customer use. (Analog voltage regulator output of MICS-band IC. Sensitive to noise.)	INT	
44	VSUP	Positive supply connection (3.3V typical).	SUP	

Pad Type Definitions

Table 4-2 • **Pad Type Definitions**

Type	Description
SUP	Supply pad.
GND	Ground pad.
RF	RF pad. Ensure proper isolation and track impedance.
RFGND	RF ground pad.
AO	Analog output pad.
A	Analog pad (input and output).
DI	Digital input pad.
DO	Digital output pad.
INT	Internal signal. These signals are used inside the module and are made available only for Microsemi production testing.

Package Dimensions

Figure 4-1 and Figure 4-2 show the ZL70120 package dimensions and pad configuration, respectively.
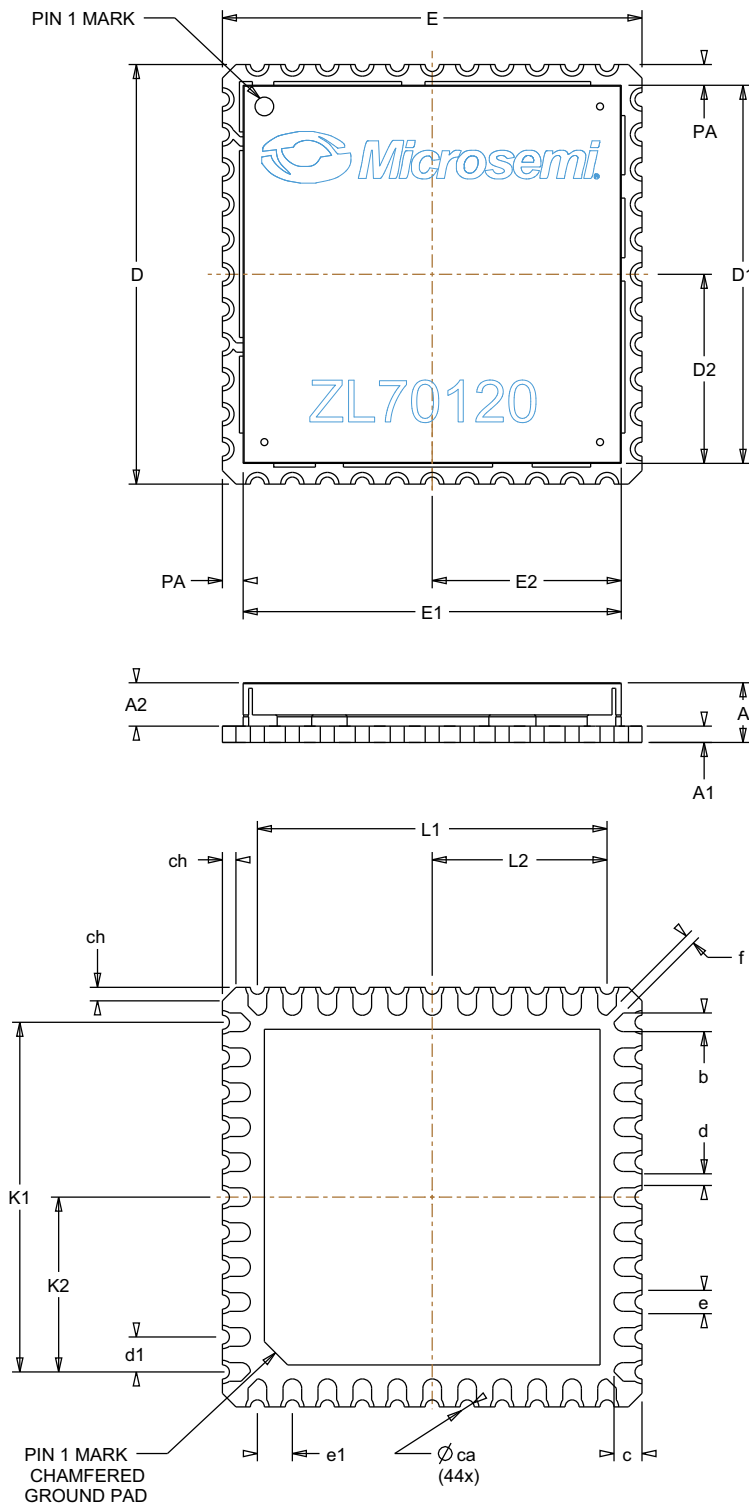
SYM	MIN	NOM	MAX
A	.120 (3.05)	.136 (3.45)	.152 (3.86)
A1	-10%	.035 (0.89)	+10%
A2	.088 (2.24)	.093 (2.36)	.098 (2.49)
E	.890 (22.61)	.900 (22.86)	.910 (23.11)
D	.890 (22.61)	.900 (22.86)	.910 (23.11)
E1	.806 (20.47)	.811 (20.60)	.816 (20.73)
E2	.406 (10.30) BSC		
D1	.806 (20.47)	.811 (20.60)	.816 (20.73)
D2	.406 (10.30) BSC		
PA	0.037 (0.94)	0.045 (1.14)	0.053 (1.35)
K1	.750 (19.05) BSC		
K2	.375 (9.53) BSC		
L1	.750 (19.05) BSC		
L2	.375 (9.53) BSC		
e1	.075 (1.91) BSC		
d1	.075 (1.91) BSC		
b	-	.040 (1.02)	-
c	-	.060 (1.52)	-
d	-	.025 (0.64)	-
e	-	.050 (1.27)	-
f	-	.021 (0.53)	-
ca	-	.030 (0.76)	-
ch	-	.030 (0.76)	-

Dimensions in inch (mm in brackets)

0020v1210.0

Figure 4-1 •   ZL70120 Package Dimensions
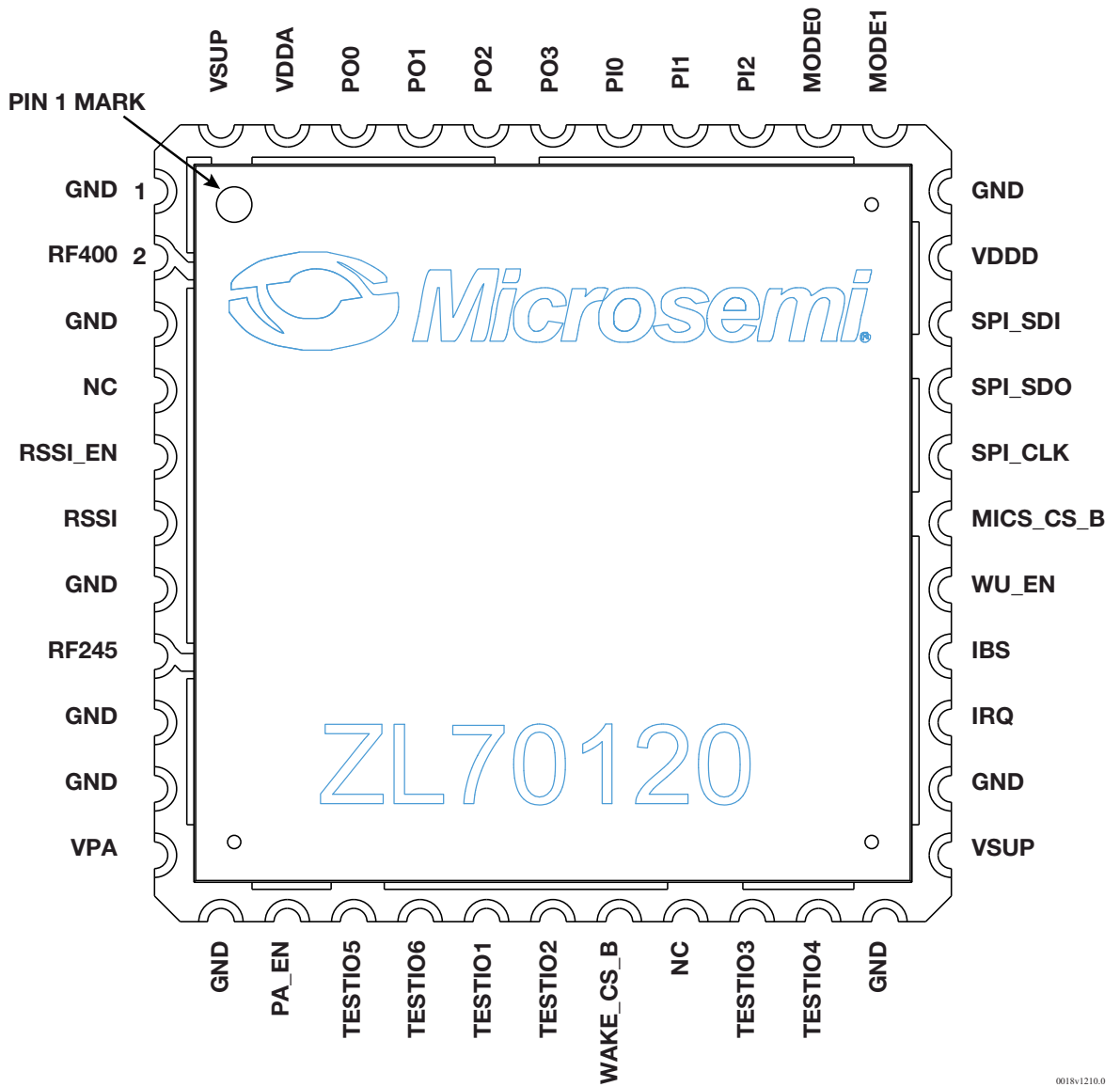
Figure 4-2 • **ZL70120 Pad Configuration**

PCB Layout Recommendations

PCB Layout

Figure 4-3 shows the recommended PCB layout for the ZL70120. Dimensions are in inches. The layout is recommended only and can be changed depending on individual requirements or customer processes.

It is recommended that the stencil aperture for the ground pad square be split into smaller squares to help reduce voiding and overpasting.
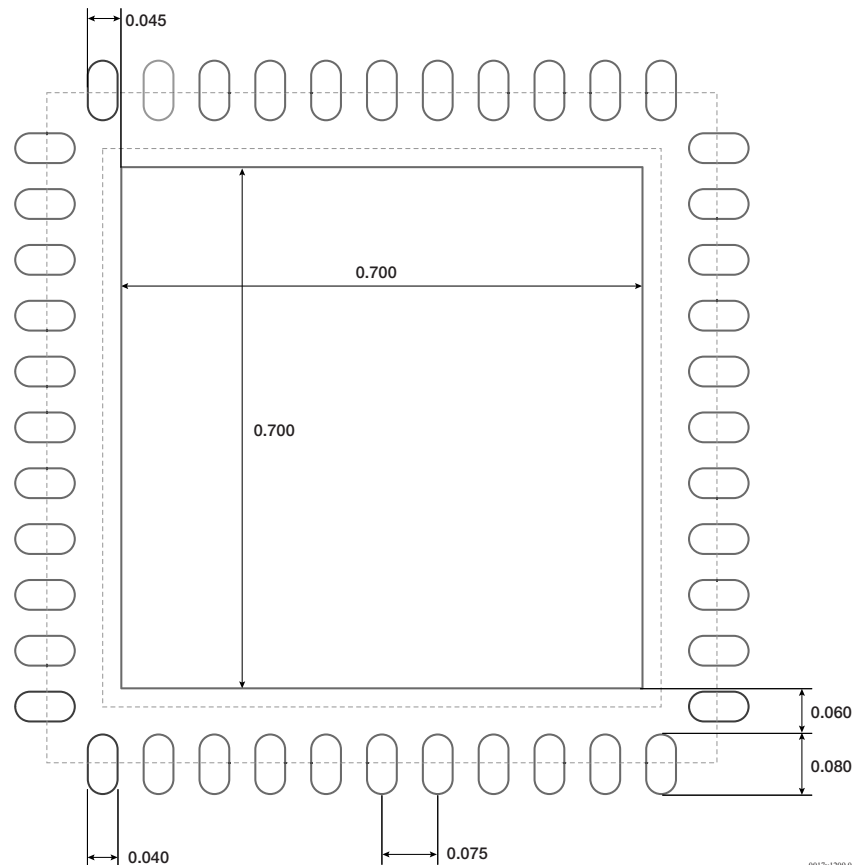

Figure 4-3 • **Recommended PCB Layout**

RF Pads

The interconnect between the RF circuits within the module and external 50-Ω tracks inevitably has some impedance discontinuity due to the module pad and the pad on the PCB to which the module is soldered.

The module has been characterized on a board with pads as shown in the layout in Figure 4-3. The ground-plane spacing was 0.227 mm and the material FR4. If the application board has a smaller ground plane spacing or a higher dielectric constant material, then measures should be taken to reduce the pad capacitance for the RF245 connection. Possibilities are using smaller pads or placing a ground plane slot under the pad.

RF Tracks

A tracking impedance of 50 Ω should be used for the signals connecting to the RF245 and RF400 pads. The tracking for the RF400 should also be kept away from any circuits that could create interference in the MICS frequency range.

Module Assembly

Soldering Profile

It is recommended that the module be attached using an automated pick-and-place machine and reflow oven. The reflow profile should be based upon JESD-20-C, ensuring that the maximum and minimum parameters of the standard are not exceeded when creating a profile for the customer's chosen assembly.

The module should not be reflowed hanging upside down as the lid alloy is the same as that used for the components. Also, the part may drop during reflow. Therefore, the module needs to be assembled to the side that is reflowed last.

A soldering atmosphere of nitrogen provides the best wetting and minimal lid discoloration, but reflow can also be undertaken in air.

The solder alloys to be used are preferably either a lead-free SAC 0305 or 0405 alloy or a leaded Sn63 Pb37 using a 100-µm stencil with aperture sizes inset by 25µm of the pad size, as a starting datum (customer to review during prototype build stage).

The product is designed to be cleaned, but this is at the customer's discretion depending upon their assembly requirements.

Hand Assembly and Rework Recommendations

It is at the customer's discretion to hand-assemble the product, though the following recommendations are given:

- The castellations around the edge of the product could be used to hand-solder the product onto the customer's board. Extra length in the pad design should be considered to allow for a good fillet up the castellation.
- Lead-free SAC 0305 or 0405 or leaded Sn63 Pb37 solder alloys are preferred. A suitable soldering iron should be run along each castellation to form a good solder joint. Care must be taken not to directly touch the lid or lid pads, to minimize thermal damage. It is recommended that IPC-A-610 is followed for solder joint conformity.
- Extra flux may be added, though cleaning considerations must be taken into account as flux could spit up onto the module. Ensure soldering time is kept to a minimum, to reduce thermal stresses.
- Any rework operations undertaken need to be verified by the customer to ensure that no damage comes to the product being removed. Microsemi does not guarantee the product reliability once it has been reworked.

Package Overview

Table 4-3 provides additional specifications for the ZL70120 MICS-Band RF Base Station Module (BSM).

Table 4-3 • **Package Overview**

Package	Delivery Form	Temp Range (°C)	Pb Free	Implant Grade	Application Area	
					Implant Devices	External Devices
44-pad LCC	Trays, bake, and dry pack	0 to +55	Yes	No[1]	No	Yes

Notes:

1. *Not for implantable use.*

5 – Typical Application Example

Figure 5-1 is a typical application circuit for a base station. For a detailed circuit example, please refer to the BSM200 documentation included with the ZLE70102 ADK. The BSM200 is a base station application that features the ZL70120 base station module.

Figure 5-1 shows a typical base station application example with two separate 50-Ω single-band antennas.
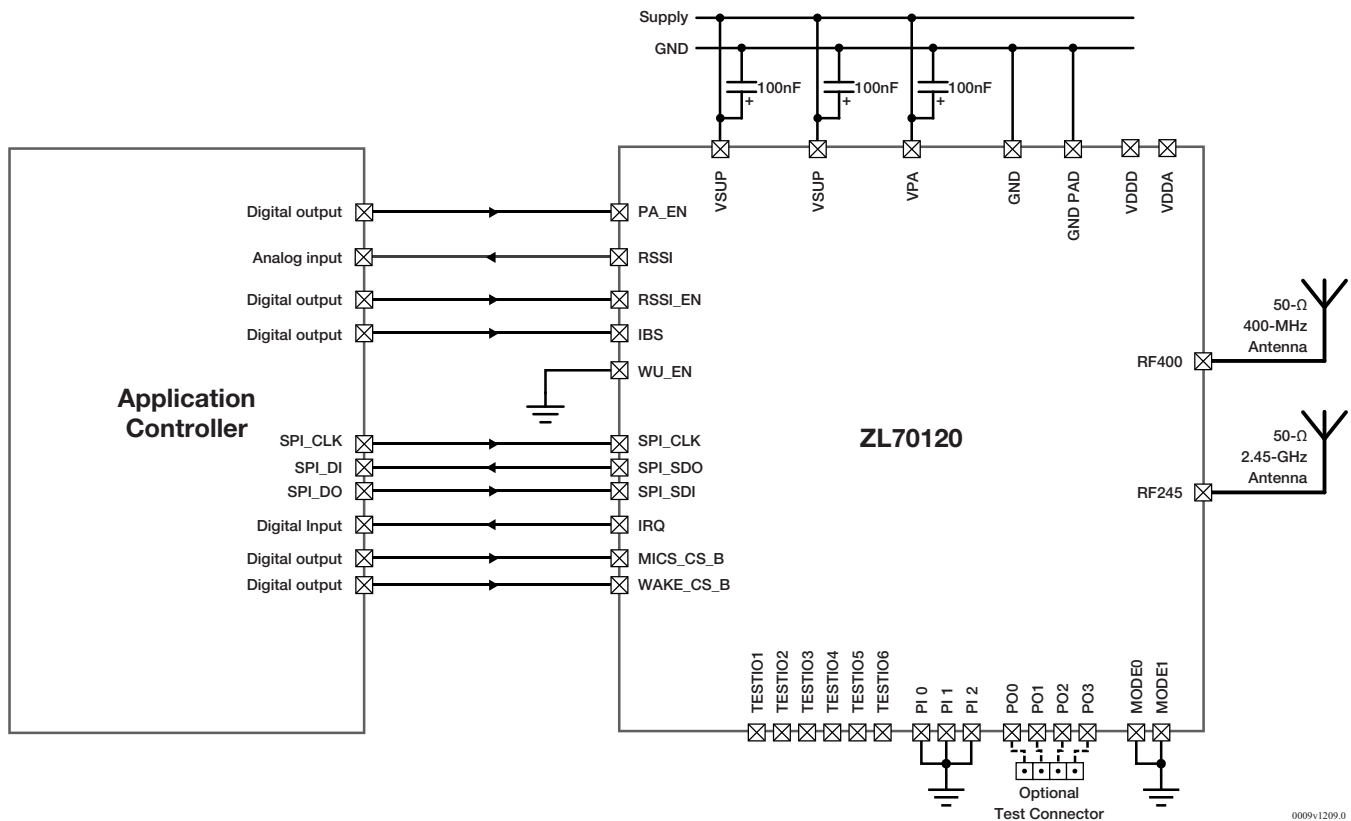

Figure 5-1 •   **Typical Application Example with Two Single-Band Antennas**

Comments:

1. Please refer to "Power Supply Requirements" on page 2-1 for more information on supply considerations.
2. Access to PO0..3 could be useful for measurements and debugging during product development and evaluation, even if the PO pads are not used in the final application.
3. Ground the PI0..2 on the application PCB if they are not used.

Antenna Considerations

In the example shown in Figure 5-1 on page 5-1, two separate 50-Ω single-band antennas are used.

If a dual-band antenna is used, a duplex filter has to be implemented (Figure 5-2). Please refer to the documentation for the BSM200 board that comes with the ZLE70102 ADK for one example. Note that the actual implementation of the duplex filter has to be adapted to the antenna used.
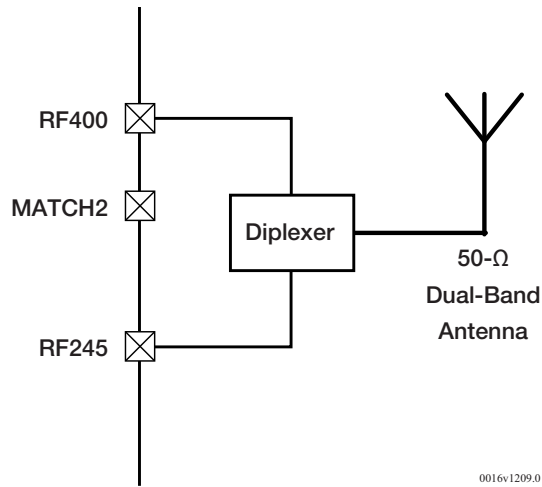

Figure 5-2 • **Dual-Band Antenna**

6 – Quality

The ZL70120 is delivered as a 44-pad LCC package; for further details please refer to "Ordering Information" on page I and "Package Overview" on page 4-6.

The ZL70120 is intended for base station applications and for nonimplantable applications. It is not approved for use in implantable products.

Manufacturing processes are carried out in ISO9001-approved facilities and all products are fully tested and qualified to ensure conformance to this data sheet.

The following additional stages are implemented among others:

- Enhanced Change Notification: A comprehensive system of change notification and approval is invoked. No major changes to the product are made without notification to and/or approval from the customer.

- Enhanced Record Retention: Quality records are retained for the expected duration of production and use of end products.

7 – Glossary

Term	Definition
ADK	Application Development Kit
BER	Bit Error Ratio
BSM	Base Station Module
CCA	Clear Channel Assessment
CRC	Cyclic Redundancy Check
CSP	Chip Scale Package
CW	Continuous Wave
EIRP	Effective Isotropic Radiated Power
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission (USA)
FR4	Flame Retardant 4
HBM	Human Body Model
Hex	Hexadecimal
I/O	Input/output
IC	Integrated Circuit
ICD	Implantable Cardioverter Defibrillator
IEC	International Electrotechnical Commission
IF	Intermediate Frequency
IMD	Implantable Medical Device
IP3	Third-order Intercept Point
ISM	Industrial, Scientific, and Medical
LCC	Leadless Chip Carrier
LGA	Land Grid Array
LNA	Low-Noise Amplifier
LogAmp	Logarithmic Amplifier
µC	Microcontroller
MAC	Media Access Controller
Max. *or* MAX	Maximum
MICS	Medical Implantable Communication Service
Min. *or* MIN	Minimum
Mod	Modulation

Term	Definition
NOM	Nominal
OOK	On/Off Keying
PA	Power Amplifier
PCB	Printed Circuit Board
QFN	Quad-Flat No-Lead
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RX	Receive
SAC	SnAgCu (tin-silver-copper alloy)
SAW	Surface Acoustic Wave
SIM	Standard Implant Module
SPI	Serial Peripheral Interface
SYM	Symbol
TETRA	Terrestrial Trunked Radio
TX	Transmit
Typ.	Typical
XO	Crystal Oscillator

8 – Datasheet Information

List of Changes

The following table lists substantive changes that were made in the ZL70120 MICS-Band RF Base Station Module (BSM) datasheet (139283):

Revision	Changes	Page
Revision 4 (February 2013)	Added footnote regarding MedRadio.	I
	Changed heading name to "Power Supply Requirements" for consistency with other datasheets.	2-1
	Minor spelling and grammar corrections were made under "Soldering Profile" and in Table 4-3.	4-6
	Changed datasheet category from Preliminary to Production.	All
Preliminary Revision 3 (October 2012)	Added CC2550 name where relevant in Chapter 2 text and in Figure 1, Figure 2-2, and Figure 2-4.	I, 2-1 to 2-5
	Since GDO0 is an internal signal, removed reference to GDO0 pad in Chapter 2 text, "Digital Interface", Figure 1, Figure 2-3, and Figure 5-1. Also marked as NC in Table 4-1 and Figure 4-2.	I, 2-3, 2-5, 2-6, 3-2, 4-1, 4-4, 5-1
	Chapter 1 "Product Description" was truncated, removing product family descriptions that can be found in the ZL70102 Data Sheet. A list of related documentation was added.	1-1
	Changed capacitor recommendation between VPA and ground to 100 nF in "Power Supply Requirements" and Figure 2-1 and Figure 5-1.	2-1, 5-1
	Logically reorganized discussion regarding MICS-band transceiver in Chapter 2 "Functional Description". For example, subsections "24-MHz XO" and "General Purpose I/O" were moved under "MICS-Band Transceiver". The subsections under "MICS-Band Transceiver Calibrations" were also reorganized and truncated (instead, refer to the ZL70102 Design Manual for programming details).	2-2 to 2-4
	Added statement about WAKE_CS_B pad to "MICS-Band Transceiver".	2-2
	Rewrote part of "24-MHz XO" paragraph to clarify criteria for stable operation of XO.	2-2
	Rewrote part of "MICS-Band Transceiver Sleep Control" with normal operation information for base stations. Removed paragraph discussing nonrecommended configuration.	2-3
	Removed bullet regarding receiver switch from "MICS-Band Transceiver Matching Network".	2-3
	Rewrote "General Purpose I/O" (and replaced table) to more clearly show which signals are user programmable and which are for monitoring only.	2-3
	Removed sections "MICS Receiver Optimization" and "Receiver Tuning Capacitor" and "MICS Transmit/Receive Switch Control" (instead, refer to the ZL70102 Design Manual for details).	2-4 to 2-4
	Under "Transmit Bandwidth" removed 800 kbit/s data rate. Also clarified other data rates and related value(s) relevant to *reg_mac_txif_rampdelay*.	2-4

Revision	Changes	Page
Revision 3, continued	Under "Transmitter Unwanted Emission Suppression" corrected text (linear PA mode) to be consistent with terminology used ZL70102 Design Manual.	2-4
	Truncated "2.45-GHz Sleep Control" to remove reference to block interference and to replace incomplete description of CC2550 operation with a reference to the CC2550 datasheet.	2-5
	Modified "2.45-GHz Synthesizer Frequency Control" to clarify criteria for stable operation of XO. Also removed equation and changed related text (now refers to base frequency and channel spacing versus nominal frequency and frequency step, respectively).	2-5
	Added row and note to Table 2-2 regarding bits [23:22] of FREQ variable. Changed order of columns.	2-5
	Changed order of columns and changed labels in Table 2-3 for clarity.	2-5
	Truncated "2.45-GHz Power Control" section including removing table and related text (instead refer to the CC2550 documentation for information). Added new recommendation statement.	2-6
	In Table 2-4 changed both setting and comment for MCSM0.	2-6
	In "MICS-Band RSSI Filter" changed bandwidth to F_3 for IF bandpass filter.	2-6
	Under "MICS-Band RSSI Filter", removed numbered instructions for achieving an RSSI value (instead refer to the ZL70102 Design Manual and/or the ZLE70102 ADK source code).	2-6
	In Table 3-1, removed condition column, deleted note, and added a new note for storage temperature.	3-1
	Added note for supply and PA voltage in Table 3-2.	3-1
	Rolled previous "General Notes on Limits" section into beginning of "Electrical Characteristics" and added a related column called "Exceptn" to all subsequent tables in Chapter 3.	3-2 to 3-7
	In Table 3-4 clarified parameter descriptions and corrected notes.	3-3
	In Table 3-6 removed row for parameter of receiver sensitivity at 800 kbit/s.	3-5
	In Table 3-7 removed note for $P_{WakeTXmax}$ and removed max value for $T_{WakeTXmin}$.	3-6
	In Table 4-1, clarified that value of 3.3 V is typical (at VPA and VSUP) and that VDDD and VDDA are not for customer use. (As previously noted, also changed internal signal at Pad 19 to symbol "NC".)	4-1
	After moving Table 4-3 to Chapter 4 as part of chapter restructuring, deleted first column containing ordering information (instead refer to "Ordering Information" on page I).	4-6
	Rewrote introductory paragraph in Chapter 5 "Typical Application Example" to state relationship of BSM200 to ZL70120.	5-1
	In Figure 5-1, corrected pad name to SPI_CLK. (As previously noted, also removed reference to GDO0 pad and changed capacitor recommendation to 100 nF.)	5-1
	Under "Antenna Considerations", merged single- and dual-band into a single section and removed heading/paragraph on diversity.	5-2
	Removed chapter "Typical Programming Operations" (instead refer to ZL70102 Design Manual).	N/A

Revision	Changes	Page
Revision 3, continued	Rewrote "Quality" chapter, including but not limited to removing bullets related to die acceptance testing and adding bullet for enhanced records retention.	6-1
	Name change from Zarlink to Microsemi. Included changing overall document format and chapter structure, changing company name in text, and modifying the name and logo in Figure 4-1 and Figure 4-2. As part of chapter restructuring, the previously separate chapters "Pad List", "PCB Layout Recommendations", "Module Assembly", and "Ordering Information" (now called "Package Overview") were all moved under Chapter 4 "Mechanical Specifications". "Glossary" and "Datasheet Information" chapters were added.	All
	Spelling and grammar were corrected throughout the document, clarifying a number of inconsistencies or ambiguities that may have existed.	All
	The versioning system for datasheets has been changed. Datasheets are assigned a revision number that increments each time the datasheet is revised.	N/A
Advance v1.0 (September 2011)	First release of advance datasheet	All
Advance v0.1 (December 2010)	Early draft of advance datasheet	All

Datasheet Categories

In order to provide the latest information to designers, some datasheet parameters are published before data has been fully characterized from silicon devices. The data provided for a given device is designated as either "Product Brief," "Advance," "Preliminary," or "Production." The definitions of these categories are as follows:

Product Brief

The product brief is a summarized version of a datasheet (advance or production) and contains general product information. This document gives an overview of specific device and family information.

Advance

This advance version contains initial estimated information based on simulation, other products, devices, or speed grades. This information can be used as estimates, but not for production. This label is used only when the data has not been fully characterized.

Preliminary

The preliminary datasheet contains information based on simulation and/or initial characterization. The information is believed to be correct, but changes are possible.

Production

The production version contains information that is considered to be final.

Safety Critical, Life Support, and High-Reliability Applications Policy

The products described in an advance status document may not have completed the Microsemi qualification process. Products may be amended or enhanced during the product introduction and qualification process, resulting in changes in device functionality or performance. It is the responsibility of each customer to ensure the fitness of any product (but especially a new product) for a particular purpose, including appropriateness for safety-critical, life-support, and other high-reliability applications. Consult the Microsemi CMPG Products Group Terms and Conditions for specific liability exclusions relating to life-support applications. A reliability report covering all of the CMPG Products Group's products is available from Microsemi upon request. Microsemi also offers a variety of enhanced qualification and lot acceptance screening procedures. Contact your local sales office for additional reliability information.