ZL70123 Datasheet
MICS-Band RF Base Station Module (BSM)

Microsemi

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Microsemi Corporate Headquarters
One Enterprise, Aliso Viejo,
CA 92656 USA
Within the USA: +1 (800) 713-4113
Outside the USA: +1 (949) 380-6100
Fax: +1 (949) 215-4996
Email: sales.support@microsemi.com
www.microsemi.com

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1 Revision History

The revision history describes the changes that were implemented in the document since the initial release. The changes are listed by revision, starting with the most current publication.

1.1 Revision 3

The following is a summary of the substantive changes in revision 3 of this document, dated February 2018.

- Item 1. Updated Figure 9, page 21, to reflect standard marking format (without engineering mark).
- Item 2. Updated the ordering code to remove engineering mark from part number in Table 16, page 23.
- Item 3. Removed preliminary marking from cover and footings throughout the document.

This version contains information that is considered to be final.

1.2 Revision 2

The following is a summary of the substantive changes in revision 2 of this document, dated October 2017.

- Item 1. Minor rewording in 2.1 Introduction, page 3, and 2.3.1 Typical Application Example, page 5, and 3.1 General, page 7.
- Item 2. Updated RoHS bullet in 2.2 Features and Specifications, page 3.
- Item 3. Modified Figure 2, page 5, and added related comment 3.
- Item 4. Modified second and fourth paragraphs of 3.1.1 Power Supply Requirements, page 7.
- Item 5. Changed pad label in Figure 4, page 7.
- Item 6. Reworded the last paragraph of 3.2 MICS-Band Transceiver, page 8, to correct the cross-reference locations for pad descriptions, including removal of reference to WAKE_CS_B which is more appropriately covered in 3.3 2.45-GHz Wake-Up Transmitter, page 9.
- Item 7. Reworded 3.2.1 MICS-Band Transceiver Enable/Disable Control, page 8.
- Item 8. Replaced Table 2, page 9.
- Item 9. Replaced second paragraph of section 3.3 2.45-GHz Wake-Up Transmitter, page 9.
- Item 10. Modified first sentence of 3.3.1 Sleep Control, page 10.
- Item 11. Modified first sentence in 3.3.2 Synthesizer Frequency Control, page 10.
- Item 12. Changed output range and output power resolution in section 3.3.3 Power Control, page 11.
- Item 13. Changed condition, maximum limit, or note column for several parameters in Table 6, page 12, removed two rows and their related notes, and modified Note 5.
- Item 14. Changed typical limits for all parameters in Table 9, page 14, added Exceptn for I_{idle}, and modified both parameter description and related note for I_{wakeup}.
- Item 15. In Table 10, page 15, changed minimum and typical limits for maximum output power ($P_{TX400max}$) and added related note, and modified Exceptn column for several parameters.
- Item 14. In Table 11, page 16, modified Exceptn column for several parameters, and changed limits and note for RSSI sensitivity (P_{RSSI}).
- Item 16. Changed typical limits and/or Exceptn column for several parameters in Table 12, page 17, and removed two rows.
- Item 17. In Table 14, page 19, changed type column for several pads, and changed descriptions for PA_ADJ, WAKE_CS_B, PO0, PO1, IBS, VPA, and RF245 to clarify.
- Item 18. Removed two rows from Table 15, page 20, and added a new row (PWR) to the table.
- Item 19. Updated part number and corrected the position of the A1 pad in Figure 9, page 21.
- Item 20. In 6.2 Soldering Profile, page 22, add paragraph and bullet text regarding floor life and dry-baking.
- Item 21. In Table 16, page 23, updated the ordering code and added one column.
- Item 22. Added preliminary marking to cover and footings throughout the document, as marking had been inadvertently omitted in first release.

- Item 23. Made naming changes throughout the document for accuracy and consistency, including changing ZLE70103 ADK to ZL70103 ADK, ZL70123 to ZL70123 module, ZL70103 to ZL70103 transceiver, and CC2500 to either CC250 2.4-GHz RF Transceiver or CC2500 device.

This release was a preliminary datasheet. Such preliminary datasheets may be based on simulation or initial characterization and are subject to change.

1.3 Initial Release

Revision 1 of this document, dated November 2016, was the initial release of the datasheet. This release was a preliminary datasheet. Such preliminary datasheets may be based on simulation or initial characterization and are subject to change.

2 Overview

2.1 Introduction

The ZL70123 MICS-Band RF Base Station Module (BSM) is a complete, high-performance, easy-to-use RF module that is based on the ZL70103 MICS-band transceiver IC, which is used for implantable medical applications. The ZL70103 transceiver is designed to provide good performance while consuming extremely low power.

The ZL70123 is a next-generation base station module designed for use in external medical equipment to monitor and control implantable devices. A simplified replacement of its predecessor ZL70120 base station module, it is lower cost, smaller size, lower power, and includes improvements such as:

- Internal RSSI filter
- Improved sensitivity[1]:
  - 2FSK-fallback (200 kbit/s raw): −102 dBm
  - 2FSK-Barker5 (40 kbit/s raw): −107 dBm
  - 2FSK-Barker11 (18.18 kbit/s raw): −110 dBm
- Improved adjacent/alternate channel rejection
- Approximately 30% reduction in average/peak current
- Approximately 60% reduction in footprint

Figure 1, page 4, shows the ZL70123 block diagram. The ZL70123 module integrates additional circuitry and functionality required to deploy a complete radio solution for external applications in a MICS-band RF telemetry system. The ZL70123 module implements all RF-related functions and reduces the complexity of implementing a MICS-band base station to placing one single package on an application board.

2.2 Features and Specifications

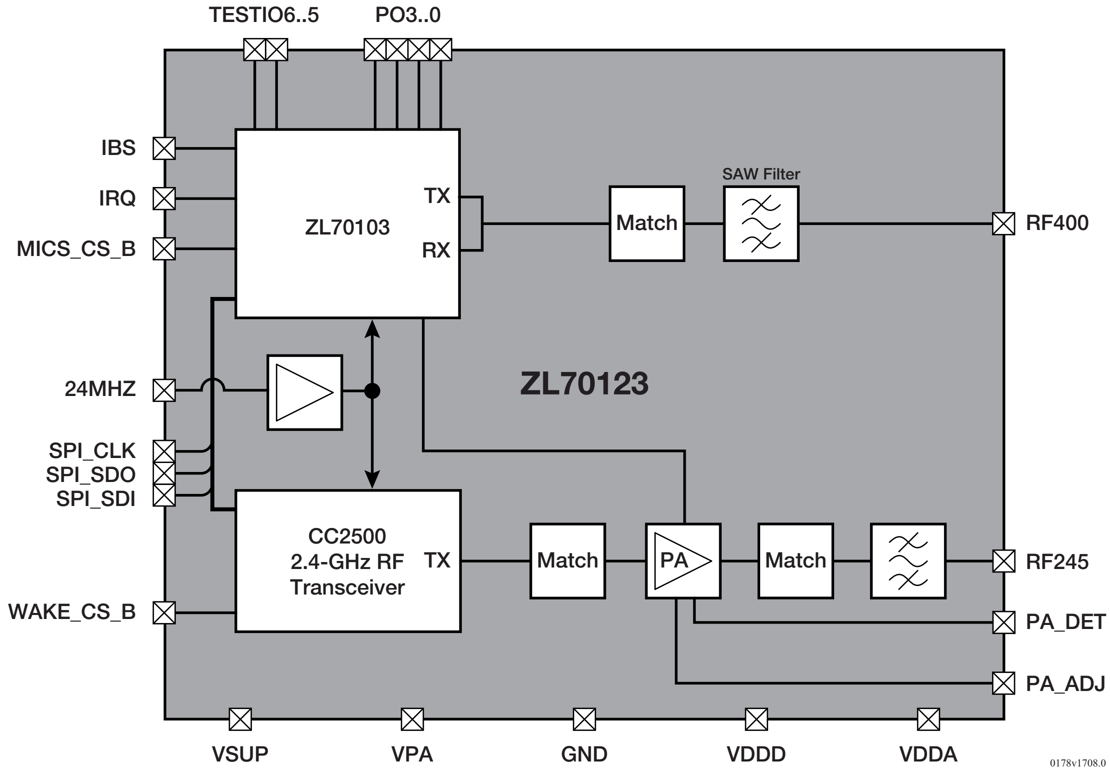
The ZL70123 module features include:

- Complete MICS-band[2] RF telemetry radio solution
- Generic RF base station module designed to interact with implantable medical devices that are based on the ZL70101, ZL70102, and ZL70103 family of products
- Compact design and small size to fit any base station application
- Fully shielded package
- Rich functionality (access to the ZL70103 features)
- Designed to meet regulatory requirements (FCC, ETSI, etc.)
- RoHS compliance

1. *Measured at the 50-ohm ports of the module (RF400 and RF245) and based on a Packet Error Rate (PER) of 10%.*
2. *The MICS band is a subset of the designated MedRadio frequency band.*

2.2.1 Block Diagram

Figure 1 • **ZL70123 Block Diagram**



2.3 Target Applications

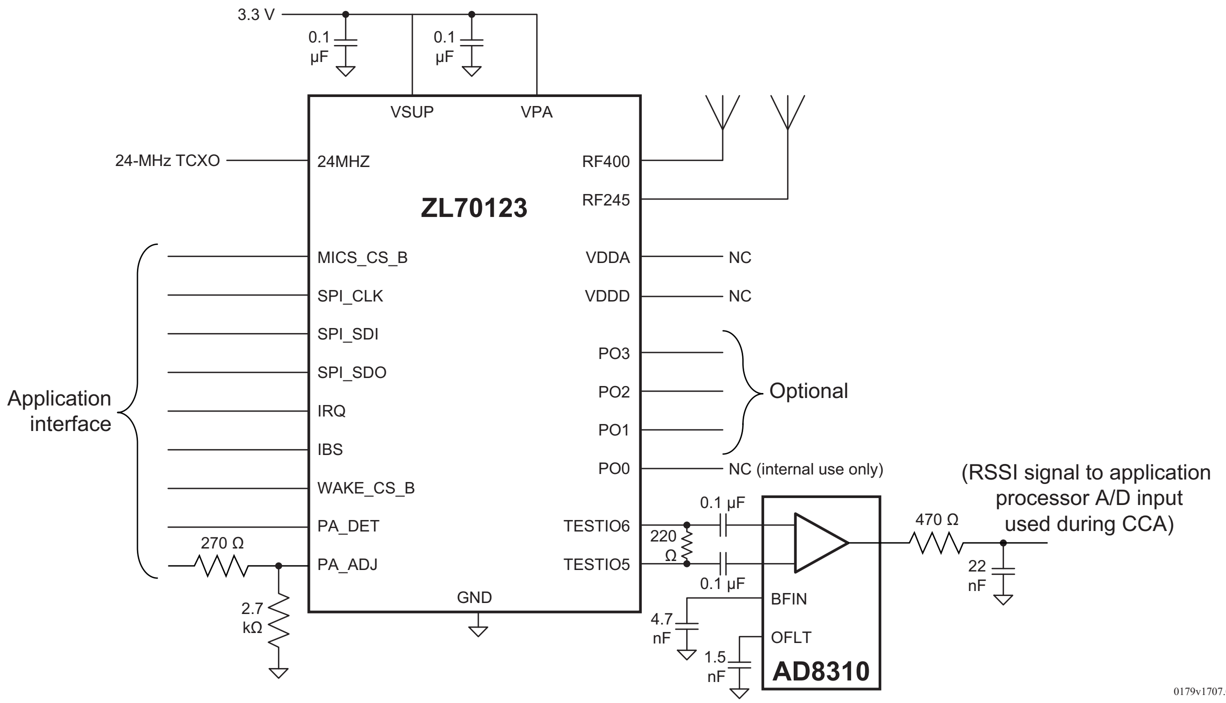
End applications may include:

- Base station applications
    - Programmers used in operating rooms or clinics
    - Bedside monitors
    - Patient controllers

2.3.1 Typical Application Example

Figure 2, page 5, is a typical application circuit for a base station with two separate 50-Ω single-band antennas. For a detailed circuit example, please refer to the BSM300 documentation included with the ZL70103 ADK. The BSM300 is a base station application that features the ZL70123 module.

Figure 2 • **Typical Application Example with Two Single-Band Antennas**



Comments:

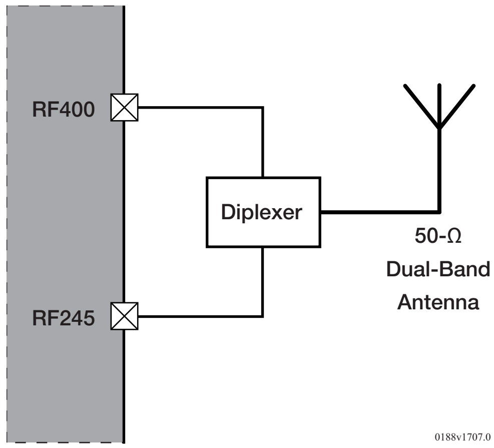
1. Please refer to Section 3.1.1 Power Supply Requirements, page 7, for more information on supply considerations.
2. Access to PO3..0 could be useful for measurements and debugging during product development and evaluation, even if the PO pads are not used in the final application.
3. The external resistor network on the PA_ADJ pad sets the bias point for the 2.45-GHz wake-up PA and provides additional filtering of spurious emissions from the 2.45-GHz wake-up transmitter. If the bias voltage to the resistor network is connected to a digital output of the application processor, then: (a) when the 2.45-GHz wake-up transmitter is in use, the application processor can output logic-high to provide a 3.3-volt bias voltage, and (b) when the 2.45-GHz wake-up transmitter is not in use, the application processor can output a logic-low to reduce power consumption. Alternatively, in the event that power savings is not important to the application, the bias voltage to the resistor network can be connected directly to the 3.3-volt supply.

2.3.1.1 Antenna Considerations

In the example shown previously (Figure 2, page 5), two separate 50-Ω single-band antennas are used.

If a dual-band antenna is used, a diplex filter has to be implemented as shown in Figure 3, page 6. Please refer to the documentation for the BSM300 board that comes with the ZL70103 ADK for one example. Note that the actual implementation of the diplex filter has to be adapted to the antenna used.

***Figure 3* • Dual-Band Antenna**



2.4 Related Documentation

Table 1, page 6, lists the documentation related to the ZL70103 family of products. These documents can be found on Microsemi's website or by contacting Microsemi's CMPG sales for more information.

Table 1 • Related Documentation

Product	Document(s)	Description
ZL70103 MICS-Band RF Transceiver	ZL70103 Datasheet, ZL70103 Design Manual	The ZL70103 MICS-Band RF Transceiver is designed specifically for use in implantable medical devices (such as pacemakers and neurostimulators). It also supports external applications (such as programmers and patient controllers).
ZL70323 MICS-Band RF Miniaturized Standard Implant Module (MiniSIM)	ZL70323 Datasheet	The ZL70323 MiniSIM is a ZL70103-based implant-grade RF module.
ZL70103 Application Development Kit (ADK)	ZL70103 ADK Users Guide	The ADK combines hardware and software to provide an end-to-end MICS-band communication system based on the ZL70123 MICS-Band RF Base Station Module and the ZL70323 Miniaturized Standard Implant Module (MiniSIM). Additionally, source code with programming examples is available with a source code license agreement (SCLA).
CC2500 2.4-GHz RF Transceiver	CC2500 Datasheet[1]	The CC2500 2.4-GHz RF Transceiver is used in the 2.45-GHz ISM wake-up circuit in the ZL70123 module.

1. Can be found on TI's website at www.ti.com/product/cc2500

3 Functional Descriptions

3.1 General

The ZL70123 module 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 ZL70123 module integrates the ZL70103 transceiver and all of the additional circuitry and functionality required to deploy a complete radio solution for external applications.

The ZL70123 module contains the following main subsystems:

- MICS-band RF transceiver based on the ZL70103 MICS-band transceiver
- 2.45-GHz wake-up transmitter based on the CC2500 2.4-GHz RF Transceiver

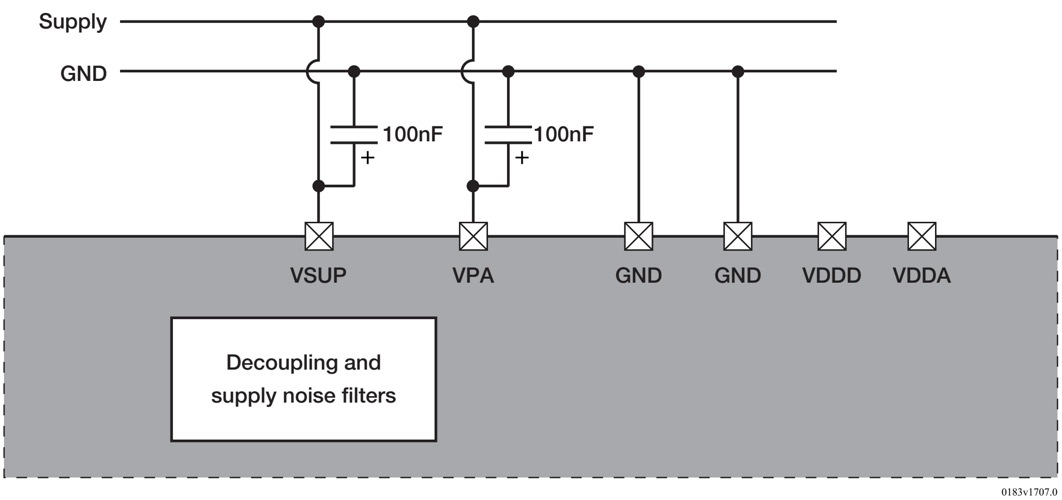
For a hardware and software example of the ZL70123 module in a base station application, the ZL70103 Application Development Kit (ADK) featuring the ZL70123 module is available for our customers. Please refer to the ZL70103 ADK documentation for more information.

3.1.1 Power Supply Requirements

The ZL70123 module is powered by a VSUP supply pad and a VPA supply pad (refer to Figure 4, page 7). The VSUP pad provides 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 is recommended close to the VSUP and VPA pads and between the VPA and VSUP pads and GND, as illustrated in Figure 4, page 7. Please refer to the ZL70103 ADK BSM300 base station board for a recommended layout.

Figure 4 • **Supply and Decoupling Circuit**



The CC2500 2.4-GHz RF Transceiver 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 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 ZL70103 chip.

Supply noise at 450kHz should also be avoided since this might interfere with the base band of the ZL70103 receiver.

3.2 MICS-Band Transceiver

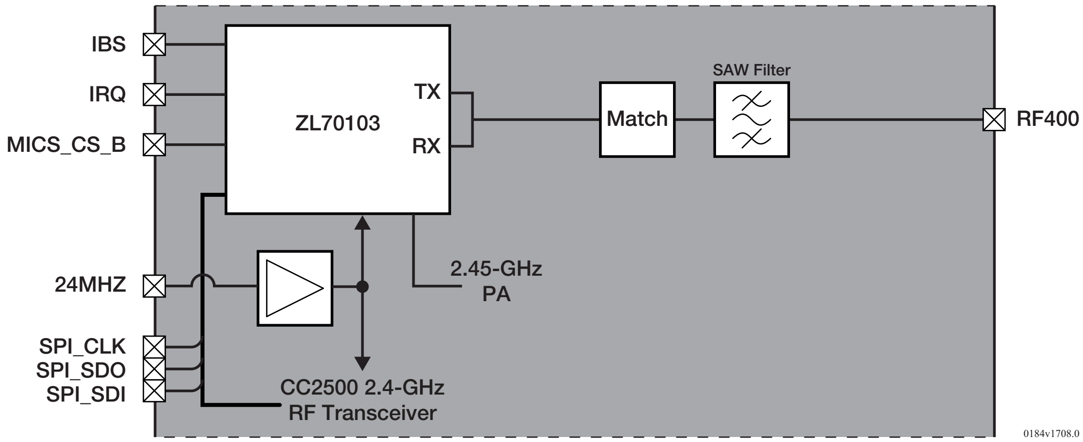
The MICS-band transceiver (Figure 5, page 8) is based on the ZL70103 chip. Please refer to the ZL70103 Datasheet and the ZL70103 Design Manual for detailed information on the chip.

The 24-MHz reference clock is shared between the ZL70103 MICS-band transceiver and the CC2500 2.4-GHz RF Transceiver.

The SPI bus is the application interface to the ZL70123 module and is shared between the ZL70103 MICS-band transceiver and the CC2500 2.4-GHz RF Transceiver. The MICS_CS_B pad is used to enable the SPI bus on the ZL70103 transceiver.

The IBS pad is described below. Please refer to the ZL70103 documentation regarding the other digital interface lines (for example, the IRQ pad).

Figure 5 • **MICS-Band RF Transceiver Circuit**



3.2.1 MICS-Band Transceiver Enable/Disable Control

The IBS pad of the ZL70123 module controls the wake/sleep state of the ZL70103 device and enables/disables the 24-MHz reference clock buffer and the 2.45-GHz PA. Normally, after power up, the ZL70123 module is in the sleep state with the IBS pad low. When the application processor is ready to communicate with the device, it begins by asserting the IBS pad to a logic-high level. This causes the ZL70103 device to wake up and to initialize to the CHECK COMMAND IDLE state, where the ZL70103 device waits for a command. Also at this time, the ZL70103 device asserts the interrupt pad high to inform the application processor that the ZL70103 transceiver is awake and ready for use. Users need to be aware that the main watchdog timer is enabled at this time and returns the ZL70103 transceiver to the sleep state after approximately 5 seconds unless the watchdog timer is disabled. If the application processor requires the ZL70103 transceiver to remain operational, then the application processor must disable the main watchdog. When the application processor no longer needs the MICS-band, the application processor may optionally return the IBS pad to a logic-low level thus entering the ZL70103 transceiver into the sleep state.

3.2.2 MICS-Band Transceiver Matching Network

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

- Matched to 50 Ω for simple connection to the antenna
- MICS-band SAW filter to protect against out-of-band interference including blockers

3.2.3 General Purpose I/O

The ZL70123 module provides access to ZL70103 I/Os as shown in Figure 6, page 9.

Figure 6 • **General Purpose I/O**

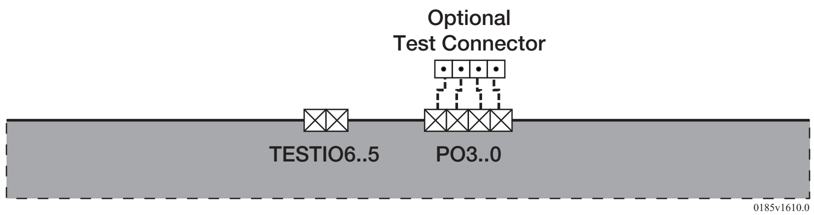


Table 2, page 9, shows which signals are available to the users for programming and which are used by internal functions of the ZL70123 module and are available to users for monitoring purposes only. Please refer to the ZL70103 Datasheet and the ZL70103 Design Manual for more details.

Table 2 • **I/O Signals for the ZL70123 Module**

ZL70103 Signal	Usage	Comment
TESTIO6..5	Reserved	Analog output used to drive the 450-kHz IF signal to an external log amp for RSSI measurements during a CCA
PO0	Reserved	Digital output used for the 2.45-GHz OOK wake-up modulation signal to the PA; this signal may be monitored by users during product development
PO3..1	Application	Digital outputs available to the application for monitoring internal signals of the ZL70103 device

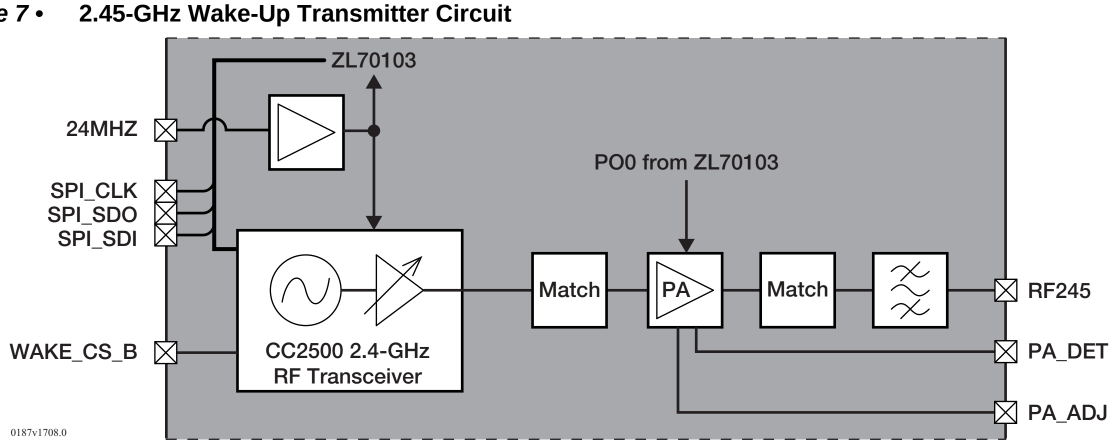
3.2.4 MICS-Band Transceiver Calibrations

Please refer to Chapter 10 of the ZL70103 Design Manual for calibrations required for base station applications.

3.3 2.45-GHz Wake-Up Transmitter

The 2.45-GHz wake-up transmitter (Figure 7, page 9) is used to send wake-up messages to an implant that uses the ultra-low-power wake-up mode of the ZL70103 transceiver. This wake-up scheme provides a very power-efficient method for waking up the ZL70103 transceiver from a sleep state.

Figure 7 • **2.45-GHz Wake-Up Transmitter Circuit**



The output frequency and output power level at the RF245 pad are controlled by the CC2500 device. The gain of the PA is fixed (approximately 26dB) and the amplifier bias input is modulated by the PO0 pad from the ZL70103 device. The PO0 pad can also be programmed to a logic-high, providing for a continuous wave (CW) output. The PA_DET pad allows users to monitor a DC level that is proportional to the output power level of the PA. The PA_ADJ pad is used to set the nominal bias point for the PA-on condition and also provides for external adjustment of the internal filter that controls the rise/fall time of the PA turn-on and turn-off. This reduces the bandwidth of the modulation spectrum of the 2.45-GHz output, allowing for regulatory compliance.

The SPI bus used to communicate with the CC2500 device is shared with the ZL70103 chip. When accessing the CC2500 device on the SPI bus, use the WAKE_CS_B (active low) input to select this device.

3.3.1 Sleep Control

The CC2500 2.4-GHz RF Transceiver can be programmed to the sleep state via the SPI bus. It has multiple low-power states to which it can be programmed. Please refer to the CC2500 datasheet for details to determine which low-power state is appropriate for your application.

3.3.2 Synthesizer Frequency Control

The synthesizer uses the same 24-MHz reference clock as the ZL70103 chip. The synthesizer has to be configured to support a suitable frequency range for the target application. This is controlled by six of the CC2500's registers (Table 3, page 10), including the three FREQx registers that form a three-byte FREQ variable.

Table 3 • **Synthesizer Control Registers**

Description	Register	Address	Field	Recommended Value in Hex (decimal)
Channel spacing (mantissa)	MDMCFG0	0x14	CHANSPC_M	8'hC7 (199)
Channel spacing (exponential factor)	MDMCFG1	0x13[1:0]	CHANSPC_E	2'h03 (3)
Frequency control word (Note 1)	FREQ2	0x0D	FREQ[23:22]	2'h01 (1)
			FREQ[21:16]	6'h24 (36)
	FREQ1	0x0E	FREQ[15:8]	8'h00 (0)
	FREQ0	0x0F	FREQ[7:0]	8'h00 (0)
Channel number (in number of steps)	CHANNR	0x0A	CHAN[7:0]	User defined

1. Bits FREQ[23:22] are read-only and are fixed at binary 01. The recommended values for FREQ2, FREQ1, and FREQ0 set the base frequency to 2.4GHz.

Based on the recommended settings from Table 3, page 10, the base frequency (f_{base}) is 2400MHz and the channel spacing (f_{chspc}) is 333.252kHz, providing a channel center frequency range from 2400MHz to 2484.979MHz and covering the 2.45-GHz ISM band from 2400MHz to 2483.5MHz.

Depending on the target application, the channel spacing and frequency range can be optimized. Please refer to the examples in Table 4, page 10, based on a 2400-MHz base frequency.

Table 4 • **Optional Synthesizer Settings**

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

3.3.3 Power Control

As can be seen in Figure 7, page 9, the CC2500 transmitter output drives the onboard PA input. The PA has a gain of approximately 26dB. To adjust for different output levels, the CC2500 device is used to vary the input to the power amplifier, allowing for an output range of approximately +23dBm to −35dBm (PO0 is a logic high) at the output pad RF245. The resolution of the output power can be adjusted by approximately 0.3-dB to 0.4-dB steps. For more information on the CC2500 device, please refer to the CC2500 datasheet and the DN014 design note on the Texas Instruments website.

3.3.4 Transmitter Configuration

Please use the programming sequence in Table 5, page 11, to configure the transmitter before use. The CC2500 device must be configured to produce a CW signal. The OOK modulation is performed external to the CC2500 device by the PO0 signal from the ZL70103 device.

Table 5 • **Transmitter Configuration Sequence**

#	Register	Address	Setting	Comment
1	PATABLE(0)	0x3E	(Power code)	Suitable power code (refer to Section 3.3.3 Power Control, page 11)
2	MDMCFG0.CHANSPC_E	0x14	2’h03	Refer to 3.3.2 Synthesizer Frequency Control, page 10
3	MDMCFG1	0x13	8’hC7	Refer to 3.3.2 Synthesizer Frequency Control, page 10
4	FREQ2	0x0D	8’h64	Refer to 3.3.2 Synthesizer Frequency Control, page 10
5	FREQ1	0x0E	8’h00	Refer to 3.3.2 Synthesizer Frequency Control, page 10
6	FREQ0	0x0F	8’h00	Refer to 3.3.2 Synthesizer Frequency Control, page 10
7	CHANNR	0x0A	User defined	The eight-bit unsigned channel number, which is multiplied by the channel spacing setting (step size) and added to the base frequency.
8	MDMCFG2	0x12	8’h30	OOK mode, no coding, no preamble
9	DEVIATN	0x15	8’h00	No frequency deviation
10	MCSM0	0x18	8’h18	Autocalibrate when going from the idle state to the TX state; also sets the PO_TIMEOUT to approximately 149 – 155µs as recommended if the XO is stable during startup
11	PKTCTRL0	0x08	8’h32	No whitening, static asynchronous data, no CRC, infinite packet length

Issue an STX (8’h35) command strobe to put the CC2500 device into the transmit state.

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

4 Electrical Specifications

Table 6, page 12, through Table 13, page 18, provide the absolute maximum ratings and other electrical characteristics for the ZL70123 module. Voltages are with respect to ground (GND) unless otherwise stated.

4.1 Absolute Maximum Ratings

Table 6 • **Absolute Maximum Ratings**

ID	Parameter	Symbol	Condition	Limits			Unit	Note
				Min.	Typ.	Max.		
1.0	Supply voltage	V_{SUP}		−0.3		3.6	V	Note 1
1.1	PA supply voltage	V_{PA}		−0.3		3.6	V	Note 1
1.2	Digital I/O voltage	V_{IOD}		VSS−0.3		V_{SUP}+0.3	V	Note 1,2
1.3	Analog I/O voltage	V_{IOA}		VSS−0.3		V_{PA}+0.3	V	Note 1,3
1.4	Storage temperature	T_{stg}	Unpowered	–40		+125	°C	
1.5	Burn-in temperature	T_{bi}	3.3V on VSUP and VPA			+125	°C	Note 4
1.6	Electrostatic discharge (human body model)	V_{ESD}	Any			500	V	Note 5

1. Application of voltage beyond the stated absolute maximum rating may cause permanent damage to the device or cause reduced reliability.
2. Applies to digital interface pads, including IBS, WAKE_CS_B, MICS_CS_B, SPI_CLK, SPI_SDI, SPI_SDO, 24MHZ, PO3..0, and IRQ.
3. Applies to analog interface pads, including PA_DET, PA_ADJ and TESTIO6..5.
4. Device may be powered during burn-in but operation is not guaranteed.
5. Applied one at a time on all I/O pads. Exceeding these values may cause permanent damage. Functional operation under these conditions is not implied.

4.2 Recommended Operating Conditions

The recommended operating conditions in Table 7, page 12, define the nominal conditions for the device.

Table 7 • **Recommended Operating Conditions**

ID	Parameter	Symbol	Limits			Unit	Note
			Min.	Typ.	Max.		
2.0	Supply voltage	V_{SUP}	3.1	3.3		V	Note 1
2.1	PA supply voltage	V_{PA}	3.1	3.3		V	Note 1
2.2	Operating temperature	T_{op}	0	25	+55	°C	

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

4.3 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 8 to 13 when relevant; refer to legend below.

① These parameters are guaranteed by production tests but with different limits to what is specified in the datasheet. 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 datasheet.

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.

4.3.1 Digital Interface

The characteristics in Table 8, page 13, are valid for the following interconnects:

- Digital inputs: IBS, MICS_CS_B, SPI_CLK, SPI_SDI, WAKE_CS_B, 24MHZ
- Digital outputs: IRQ, SPI_SDO, PO0, PO1, PO2, PO3

Table 8 • **Digital Interface**

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

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 1MHz, 2MHz, or 4MHz.

4.3.2 Performance Characteristics

4.3.2.1 Current Consumption

Table 9 • **Current Consumption**

ID	Parameter	Symbol	Limits Min.	Typ.	Max.	Unit	Exceptn	Note
4.0	Sleep state	I_{sleep}		3		µA	⑤	Note 1
4.1	Idle state	I_{idle}		6.5		mA	③	Note 2
4.2	Start session state	I_{wakeup}		56		mA	⑤	Note 3
4.3	MICS-band session	$I_{session}$		12.2		mA	⑤	Note 4

1. All circuits disabled.
2. ZL70103 in the CHECK COMMAND IDLE state and all other circuits disabled.
3. 400-MHz TX/RX occurring in conjunction with 2.45-GHz wake-up packet transmissions (at 20 dBm output power). When 2.45-GHz wake-up is configured for a CW at maximum power output, the typical current is 249 mA.
4. MICS-band session with 2.45-GHz wake-up transmitter circuit disabled.

4.3.2.2 MICS-Band Transmitter

Table 10 • **MICS-Band Transmitter**

ID	Parameter	Symbol	Limits Min.	Typ.	Max.	Unit	Exceptn	Note
5.0	Maximum output power	$P_{TX400max}$	–7	–3.5		dBm	①	Note 1
5.1	Minimum output power	$P_{TX400min}$			–22	dBm	④	
5.2	Emission bandwidth (at –20 dB points)	f_{micsBW}			300	kHz	④	
5.3	Unwanted emissions 401.75 MHz to 405.25 MHz	E_{mics1}			–20	dBc	④	Note 2
5.4	Unwanted emissions outside the MICS band 30 MHz to 88 MHz	E_{mics2}			–45	dBc	④	Note 3
5.5	Unwanted emissions outside the MICS band 88 MHz to 216 MHz	E_{mics3}			–42	dBc	④	Note 3
5.6	Unwanted emissions outside the MICS band 216 MHz to 401.75 MHz and 405.25 MHz to 960 MHz	E_{mics4}			–39	dBc	④	Note 3
5.7	Unwanted emissions outside the MICS band above 960 MHz	E_{mics5}			–31	dBc	④	Note 3
5.8	Transmitter off and receiver spurious emissions ≤ 1 GHz	E_{mics6}			–57	dBm	④	
5.9	Transmitter off and receiver spurious emissions > 1 GHz	E_{mics7}			–47	dBm	④	
5.10	Transmitter off and receiver wideband noise output ≤ 1 GHz	N_{mics1}			–107	dBm/Hz	④	
5.11	Transmitter off and receiver wideband noise output > 1 GHz	N_{mics1}			–97	dBm/Hz	④	
5.12	24-MHz clock input frequency stability	f_{stab}			±5	ppm		

1. With *reg_rf_txrf_sel_ctrl* equal to 0x17 (linear mode and PA drive level of 2) and *reg_rf_txrfpwrdefaultset* equal to 0x3F (PA output power setting).
2. Emissions outside the channel bandwidth f_{micsBW}.
3. Referenced to a output power level of −16 dBm.

4.3.2.3 MICS-Band Receiver

Table 11 • **MICS-Band Receiver**

ID	Parameter	Symbol	Limits Min.	Typ.	Max.	Unit	Exceptn	Note
6.0	Sensitivity (4FSK)	P_{RX_4F}		−79		dBm	⑤	Notes 1, 2
6.1	Sensitivity (2FSK)	P_{RX_2F}		−91		dBm	⑤	Note 1
6.2	Sensitivity (2FSK-fallback)	$P_{RX\_2F\_FB}$		−102		dBm	⑤	Note 1
6.3	Sensitivity (2FSK-fallback with Barker5 spreading)	$P_{RX\_2F\_FB\_B5}$		−107		dBm	⑤	Note 1
6.4	Sensitivity (2FSK-fallback with Barker11 spreading)	$P_{RX\_2F\_FB\_B11}$		−110		dBm	⑤	Note 1
6.5	RSSI sensitivity	P_{RSSI}		−116		dBm	⑤	Note 3
6.6	Blocking 20 MHz from wanted signal	P_{blkRX}	0			dBm	④	
6.7	TETRA blocking level	$P_{blkTETRA}$	−30			dBm		

1. The sensitivity is based on the application circuit in Figure 2, page 5, at the reference point of the RF400 pad. This value represents a packet error rate of 10%.
2. 4FSK is an unevaluated mode for the ZL70103. Specifications for this mode are provided for guidance only. Contact Microsemi Application Support if use of this mode is required.
3. Based on the application circuit in Figure 2, page 5.

4.3.2.4 2.45-GHz Wake-Up Transmitter

Table 12 • **2.45-GHz Wake-Up Transmitter**

			Limits					
ID	**Parameter**	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**	**Exceptn**	**Note**
7.0	Wake-up transmitter maximum output power	$P_{WakeTXmax}$	21	23		dBm	⑤	
7.1	Wake-up transmitter minimum output power	$P_{WakeTXmin}$		−66		dBm	④ ⑤	Note 1
7.2	Wake-up transmitter output power step resolution	$P_{WakeTXstep}$		0.4		dB	④ ⑤	Note 2
7.3	Wake-up transmitter spurious emission 30 MHz to 1 GHz	$E_{WakeTX1}$			−54	dBm/100kHz	④	
7.4	Wake-up transmitter spurious emission 1 GHz to 12.5 GHz	$E_{WakeTX2}$			−30	dBm/MHz	④	
7.5	Wake-up transmitter wideband noise 30 MHz to 1 GHz	$N_{WakeTX1}$			−86	dBm/Hz	④	
7.6	Wake-up transmitter 99% power bandwidth	$f_{WakeTXBW}$		3.0	5.22	MHz	⑤	
7.7	Wake-up transmitter OOK power ratio	WtxOOK	36	50		dB	⑤	
7.8	Wake-up transmitter modulation envelope rise time	$t_{WakeTXrise}$		130	300	ns	⑤	Note 3
7.9	Wake-up transmitter modulation envelope fall time	$t_{WakeTXfall}$		130	500	ns	⑤	Note 4
7.10	Wake-up transmitter nominal minimum frequency	$f_{WakeTXnom}$		2400		MHz	⑤	Note 5
7.11	Wake-up transmitter maximum frequency	$f_{WakeTXmax}$		2483.5		MHz	③ ⑤	Note 5
7.12	Wake-up transmitter frequency step	$f_{WakeTXstep}$		333.252		kHz	④ ⑤	Note 5
7.13	Wake-up transmitter frequency hop time	$t_{WakeTXhop}$			100	µs	④	
7.14	Wake-up transmitter synthesizer startup time	$t_{WakeTXstart}$			1	ms	④	

1. Based on program setting.
2. Based on the CC2500 fine trim.
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 3.3.2 Synthesizer Frequency Control, page 10, for more information.

4.3.2.5 ESD

Table 13 • **ESD**

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

1. Human Body Model (HBM).

5 Pad Descriptions

The ZL70123 module has 29 pads, which are described in this section.

5.1 Pad List

Table 14, page 19, describes each pad on the ZL70123 LGA, and Table 15, page 20, provides definitions of the pad types listed in Table 14, page 19.

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

Table 14 • **ZL70123 Pad List**

Pad	Symbol	Description	Type	Notes
A1	24MHZ	24 MHz reference clock input.	DI	
A2	SPI_SDI	Data input for SPI bus interface.	DI	
A3	SPI_CLK	Clock for SPI bus interface.	DI	
A4	MICS_CS_B	Used to enable the MICS-band ZL70103 SPI bus interface.	DI	
A5	SPI_SDO	Data output for SPI bus interface.	DO	
A6	GND	Ground supply connection.	GND	
B1	VDDD	Internal signal, not for customer use. (Digital voltage regulator output of MICS-band IC. Sensitive to noise.)	PWR	
B2	TESTIO6	Provides the MICS-band IF signal externally.	A	
B3	TESTIO5	Provides the MICS-band IF signal externally.	A	
B4	IRQ	MICS-band interrupt request output.	DO	
B5	VSUP	Positive supply connection (3.3V typical).	PWR	
B6	PA_ADJ	Input that sets the bias point for the 2.45-GHz wake-up PA and also allows for additional filtering of spurious emissions out of the PA (for details, refer to application circuit in Figure 2, page 5).	A	
C1	PO2	Programmable output 2.	DO	
C6	WAKE_CS_B	Used to enable the SPI bus interface on the CC2500 2.4-GHz RF Transceiver.	DI	
D1	PO3	Programmable output 3.	DO	
D6	PO0	Programmable output 0, not recommended for customer use. (Used by the ZL70123 module for controlling the on-off keying of the 2.45-GHz wake-up transmitter.)	DO	
E1	PO1	Programmable output 1. Typically used to monitor the ZL70123 module's (or ZL70103) transmit or receive state. Other uses of this output are allowed.	DO	
E2	IBS	Implant / base mode selection. Used to control the wake/sleep state of the ZL70103 device and enables/disables the 24-MHz reference clock buffer and the 2.45-GHz PA.	DI	
E3	VDDA	Internal signal, not for customer use. (Analog voltage regulator output of MICS-band IC. Sensitive to noise.)	PWR	
E4	VPA	Positive supply for the 2.45-GHz wake-up transmitter PA stage (3.3V typical).	PWR	

Table 14 • **ZL70123 Pad List *(continued)***

Pad	Symbol	Description	Type	Notes
E5	PA_DET	Provides a DC representation of the 2.45-GHz output power.	A	
E6	GND	Ground supply connection.	GND	
F1	GND	Ground supply connection.	GND	
F2	GND	Ground supply connection.	GND	
F3	RF400	Antenna RF input and output for the MICS band.	RF	
F4	GND	Ground supply connection.	GND	
F5	RF245	2.45-GHz wake-up transmitter RF output.	RF	
F6	GND	Ground supply connection.	GND	
CTR	GND	Ground supply connection.	GND	

5.1.1 Pad Type Definitions

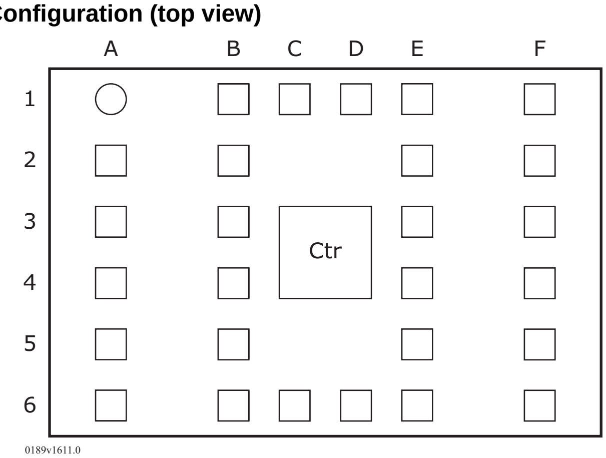
Table 15 • **Pad Type Definitions**

Type	Description
PWR	Power supply pad.
GND	Ground pad.
RF	RF pad. Ensure proper isolation and track impedance.
A	Analog pad (input and output).
DI	Digital input pad.
DO	Digital output pad.

5.2 Pad Diagram

The following illustration is a representation of the pad configuration for the ZL70123 package.

Figure 8 • **ZL70123 Pad Configuration (top view)**

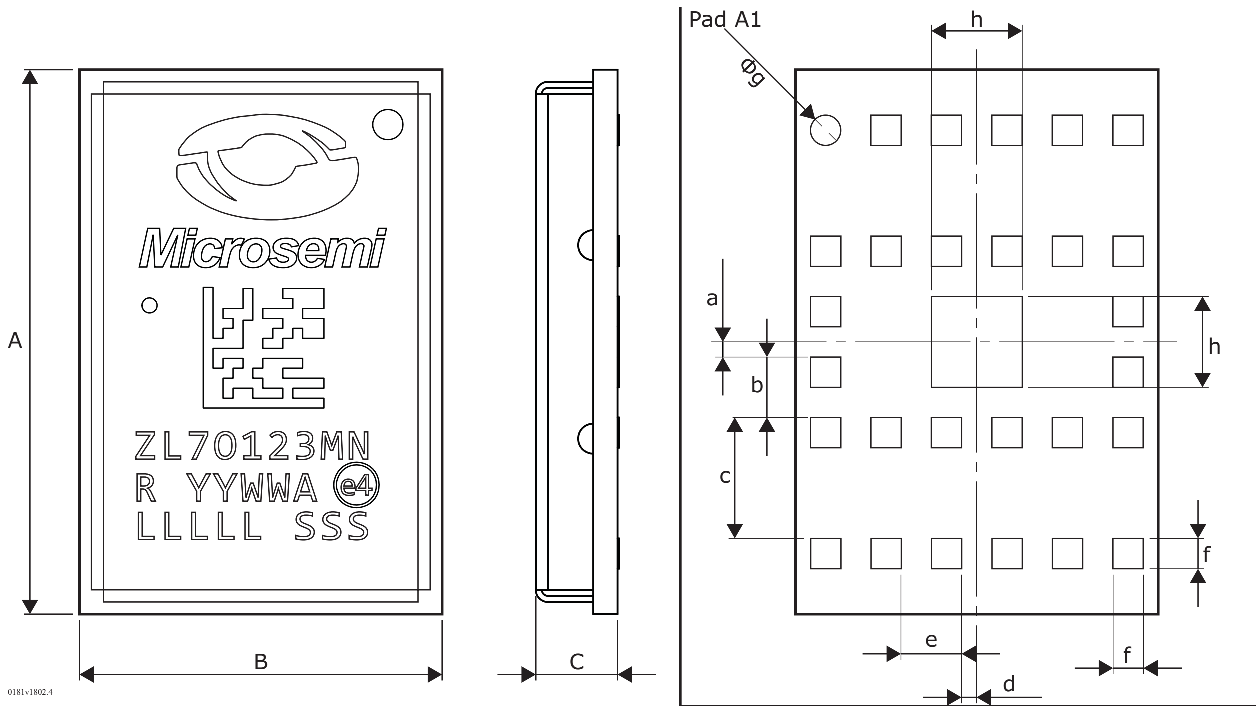


6 Package Information

6.1 Package Dimensions

Figure 9, page 21, shows the ZL70123 package dimensions and markings.

Figure 9 • **ZL70123 Package Dimensions**



Common Dimensions			
Symbol	**Minimum**	**Nominal**	**Maximum**
A	17.9	18	18.1
B	11.9	12	12.1
C	–	–	2.95
a	–	0.5	–
b	–	2	–
c	–	4	–
d	–	0.5	–
e	–	2	–
f	–	1	–
g	–	1 dia	–
h	–	3	–

Notes:

1. All dimensions are in millimeters.
2. Drawing not to scale.
3. Part markings:
   a. R is product revision code.
   b. YYWW represents year and week of assembly.
   c. A is assembly location code.
   d. Circled “e4” is Pb-free and precious metal finish RoHS indicator.
   e. LLLLL is five-digit hexadecimal batch lot number.
   f. SSS is three-digit batch serial number.

6.2 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 25 µm of the pad size, as a starting datum (customer to review during prototype build stage).

The module is classified as MSL level 3 at 260°C (J-STD_020C). Therefore it has the following limitations:

- Floor life: 168 hours at a maximum of 30°C/60% relative humidity.

If these conditions are exceeded then the part needs to be dry-baked at 125°C for 17 hours, as per J-STD-033B "Standard for Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices."

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

6.3 Quality

The ZL70123 module 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 datasheet.

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

7 Ordering Information

The ZL70123 module is available in the following package option.

Table 16 • **Ordering and Package Overview**

Ordering Code	Temp Range (°C)	Package	Delivery Form	Pb Free	Implant Grade
ZL70123MNG7	0 to +55	29-pad Land Grid Array (LGA), 12-mm × 18-mm	Trays, bake, and dry pack	Yes	No[1]

1. Not for implantable use.