BT8951D2

Audio Player Microcontroller

Versions: 0.0.1
2022.09.20

Declaration

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Revision History

Date	Version	Comments	Revised by
2022-09-20	0.0.1	First draft	Leo

Table of Contents

1 Product Features

CPU and Flexible IO

- High performance 32 Bit RISC-V processor Core and HIFI 4 DSP;
- RISC-V maximum speed 125MHz and HIFI 4 maximum speed 270MHz;
- Program memory: internal 16Mbit flash;
- On-chip RAM 892KB;
- Flexible GPIO pins with Programmable pull-up and pull-down resistors;
- Support GPIO wakeup or interrupt;

Bluetooth Radio

- Compliant to Bluetooth 5.3 and BLE specification (QDID: 193597);
- Support LE audio BIS/CIS;
- TX output power +8dBm in typical;
- RX Sensitivity with -94.5dBm @EDR;
- RX Sensitivity with -95.5dBm @ 1M BLE;
- RX Sensitivity with -93dBm @ 2M BLE;

BT Profile

- A2DP/AVDTP/AVRCP/RFOMM/HFP/HSP /SPP/HID;

Audio Interface

- Audio codec with 24bit stereo DAC and 24bit ADC;
- Support flexible audio EQ adjust;
- Support Sample rate 8, 11.025, 12, 16, 22.05, 32, 44.1, 48,96,192, 384KHz;
- Three channels MIC amplifier input;
- Three channels high performance audio ADC with 102dB SNR, support single-ended and differential mode;
- High performance stereo audio DAC with 106dB SNR, support single-ended and differential mode;

Peripheral and Interfaces

- Support low power VAD application,such as KWS and customized offline voice commands recognition;
- Dual-microphone feed-forward and feed-back Active Noise Cancellation (FF/FB ANC);
- Dual-MIC Environmental Noise Cancellation (ENC);
- Support Low power Touch Key;
- Support Low power enter ear detect;
- Three multi-function 32-bit timers, support Capture and PWM mode;
- Support Low power enter ear detect;
- SPI Master/slave interface;
- Two SD Card Host controller;
- Two Hardware IIC support 400K;
- Hardware Quad-decoder;
- WatchDog;
- Three full-duplex UART;
- Sixteen Channels 10-bit SARADC;
- Build in PMU, such as charger/buck/LDO; Support dual-buck low power application and support single-buck low cost application;
- VUSB for charger, wakeup, communication, reset functions;
- Support 4.35V/4.2V high voltage battery;

Applications

- Bluetooth TWS Headset;

Package

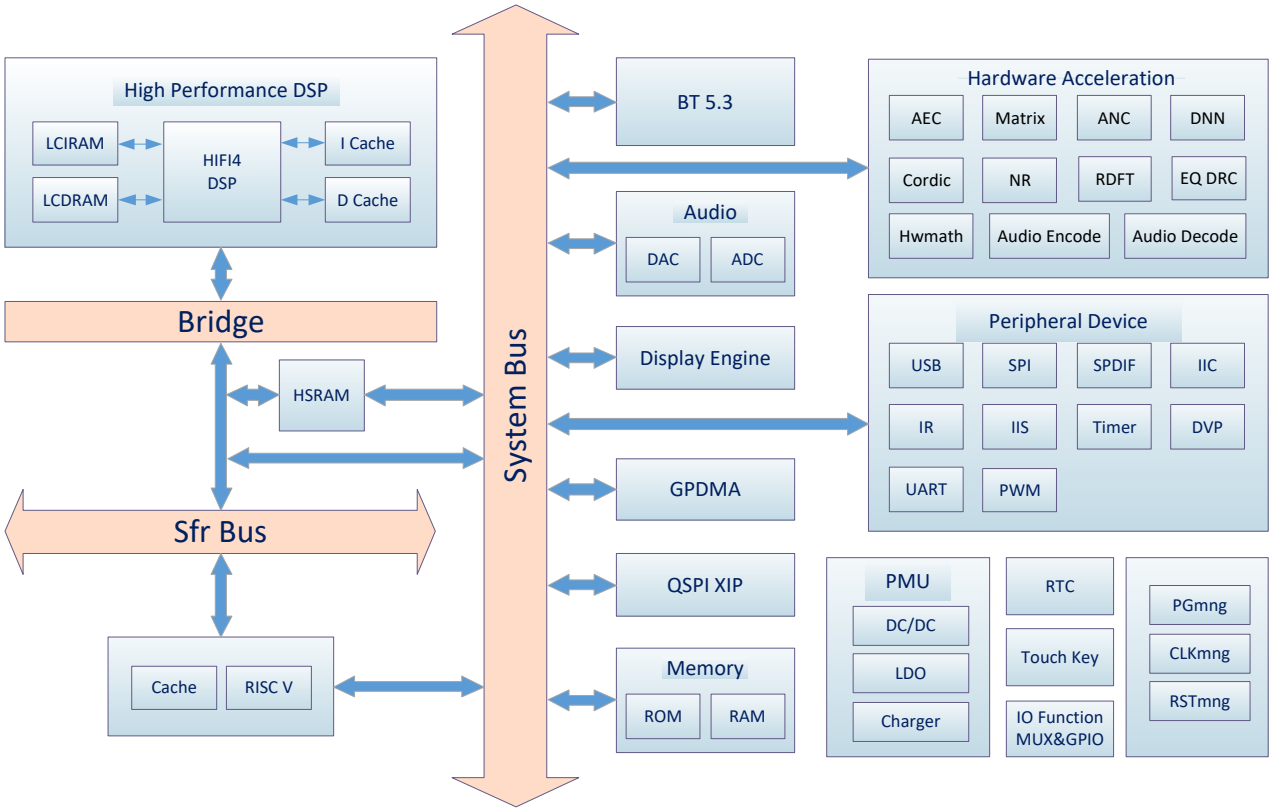
- QFN40 4*6;

Temperature

- Operating temperature: -40℃ to +85℃;
- Storage temperature: -65℃ to +150℃;

2 Block Diagram

SoC Architecture



3 Package Definition

3.1 Pin Assignment

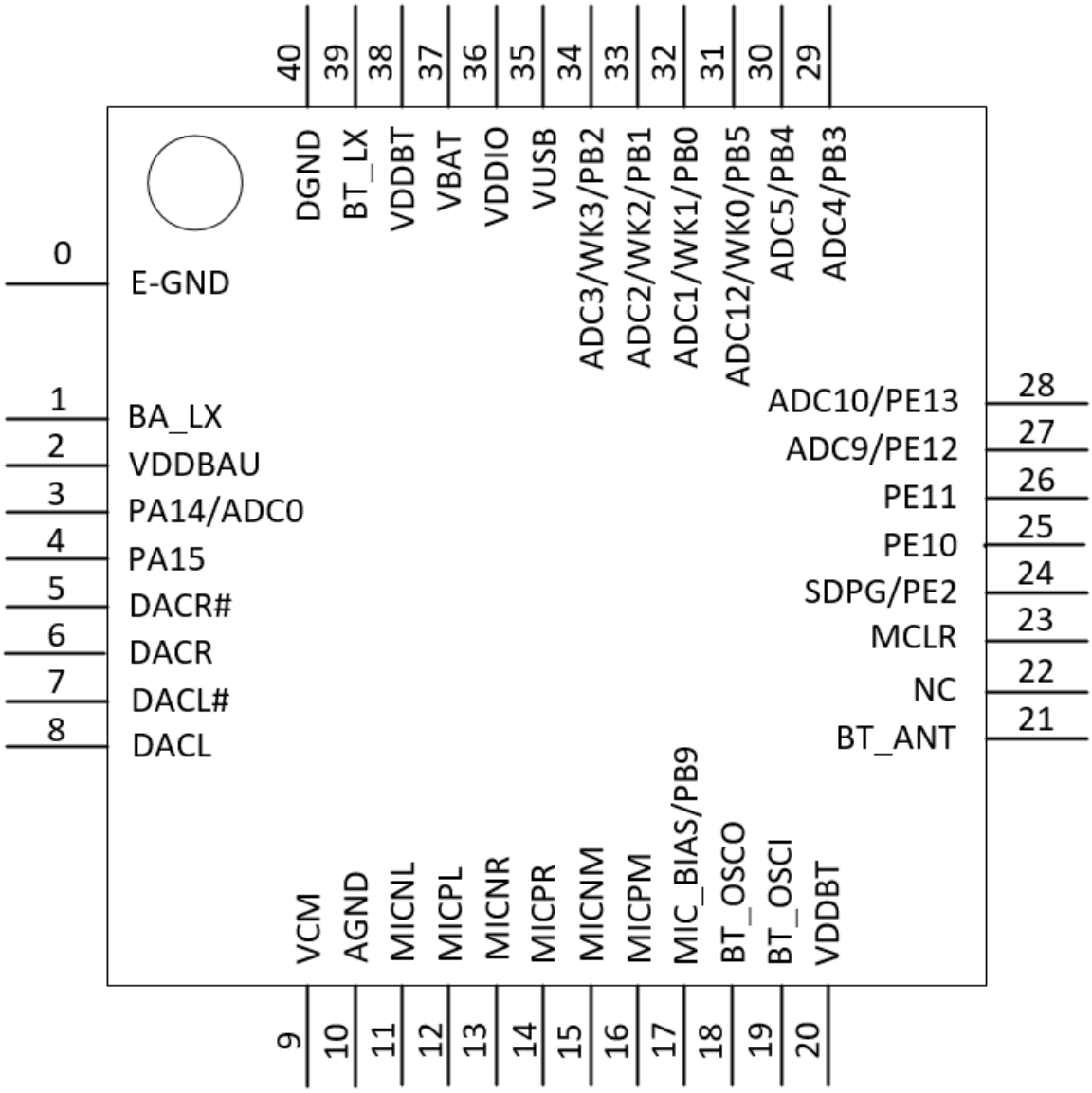


Figure 3-1 Pin assignment for QFN40

3.2 Pin Descriptions

Table 3-2 QFN40 pin description

Pin No.	Name	Type	Function
0	E-GND	GND	E-pad Ground
1	BA_LX	A	Inductor interface of VDDBA BUCK
2	VDDBAU	PWR	VDDBA power supply for audio
3	PA14/ADC0	I/O	ADC0 SDOCLK-G1 SD1D0-G1 IIC0SDA-G1/G6 SPI0CLK-G1 SPI1CLK-G1 QSPI1CLK-G1 8080LCD_D[4] RX0-G1 PWM1-T3-G3 PA14
4	PA15	I/O	SDODAT-G1 SD1D1-G1 IIC0SCL-G6 IIC1SDA-G1 SPI0DO_DAT-G1 SPI1DO_DAT-G1 QSPI1DOUT-G1 8080LCD_D[3] TX0-G1 HSTRX-G1 PWM2-T3-G3 PA15
5	DACR#	A	DAC differential R#
6	DACR	A	DAC R
7	DACL#	A	DAC differential L#
8	DACL	A	DAC L
9	VCM	PWR	DAC VCM
10	AGND	GND	DAC Ground
11	MICNL	A	Microphone left channel negative input
12	MICPL	A	Microphone left channel positive input
13	MICNR	A	Microphone right channel negative input

14	MICPR	A	Microphone right channel positive input
15	MICNM	A	Microphone middle channel negative input
16	MICPM	A	Microphone input
17	MIC_BIAS/ PB9	I/O	MIC_BIAS ADC6 PB9
18	BT_OSCO	A	24M OSC output
19	BT_OSCI	A	24M OSC input
20	VDDBT	PWR	BT power
21	BT_ANT	A	BT ANT
22	NC	—	—
23	MCLR	A	MICR
24	SDPG/PE2	I/O	SD Power Gate TX0-G5 PE2
25	PE10	I/O	SD1CMD-G3 TX0-G6 HSTRX-G6 PWM0-T4-G5 IR_G9 TMRCAP3_G9 DSP_JTAG_TDI PE10
26	PE11	I/O	SD0CMD-G4/G5/G6 SD1CLK-G3 IIC0SCL-G4 IIC1SCL-G4 SPI0DI-G4 SPI1DI-G4 PWM0-T3-G5 DSP_JTAG_TDO PE11
27	ADC9/PE12	I/O	ADC9 QDEC-A-G3 SD0CLK-G4/G5/G6/G7 SD1D0-G3 IIC0SDA-G4 SPI0CLK-G4 SPI1CLK-G4 RX0-G7 RX1-G2 PWM1-T3-G5 DSP_JTAG_TMS PE12

28	ADC10/PE13	I/O	ADC10 QDEC-B-G3 SD0DAT-G4 SD1D1-G3 IIC1SDA-G4 SPI0DO_DAT-G4 SPI1DO_DAT-G4 TX0-G7 TX1-G2 HSTRX-G7 PWM2-T3-G5 IR_G10 TMRCAP3_G10 DAP_JTAG_TCK PE13
29	ADC4/PB3	I/O	ADC4 SDDAT0-G5/SDCMD-G7 IIS0DI-G3 IIC0SCL-G5 SPI0DO_DAT-G5 SPI1DO_DAT-G5 TX0-G3 HSTRX-G3 PWM1-T4-G5 TMRCAP4_G1 PB3
30	ADC5/PB4	I/O	ADC5 SDDAT0-G6/G7 IIC0SDA-G5 SPI0CLK-G5 SPI1CLK-G5 RX0-G3 HSTRX-G4 PWM2-T4-G5 TMRCAP5_G1 PB4
31	ADC12/WK0/PB5	I/O	WK0 ADC12 WKUP5 IPB5
32	PB0/ADC1/WK1	I/O	WK1 ADC1 SD0CMD-G2 IIS0LRCK-G1/G3 IIS0DI-G4 IIC0SCL-G2 IIC1SCL-G2 SPI0DI-G2 SPI1DI-G2 TX2-G1

			PWM0-T3-G2 PB0
33	PB1/WK2/ADC2	I/O	WK2 ADC2 QDEC-A-G2 SD0CLK-G2 IIS0BCLK-G1/G3 IIC0SDA-G2 SPI0CLK-G2 SPI1CLK-G2 RX0-G2 RX2-G1 PWM1-T3-G2 PB1
34	PB2/WK3/ADC3	I/O	WK3 ADC3 QDEC-B-G2 SD0DAT-G2 IIS0DO_DAT-G1/G3 IIC1SDA-G2 SPI0DO_DAT-G2 SPI1DO_DAT-G2 TX0-G2 HSTRX-G2 PWM2-T3-G2 IR_G4 TMRCAP3_G4 PB2
35	VUSB	PWR	VUSB power input
36	VDDIO	PWR	VDDIO power output
37	VBAT	PWR	VBAT power input
38	VDDBT	PWR	BT power
39	BT_LX	A	Inductor interface of VDDBT BUCK
40	DGND	GND	Digital Ground

Note: I/O: Digital input/output; I : Digital input; A : Analog Pin; PWR: Power Pin; GND: Ground.

4 Characteristics

4.1 PMU Parameters

Table 4-1 PMU Parameters

Sym	Characteristics	Min	Typ	Max	Unit	Conditions
VUSB	Charger Voltage input	4.6	5.0	5.5	V	
VBAT	Voltage input	3.0	3.7	4.5	V	
Ich	Charger Current input	5	-	200	mA	Configurable with 5-bit

Table 4-2 VDDIO LDO Parameters

Sym	Characteristics	Min	Typ	Max	Unit	Conditions
VDDIO	3.3V LDO voltage output	-	3.3	-	V	Light Loading condition
△V VDDIO	Output Mismatch 1-sigma	-	56	-	mV	VDDIO=3.3v
ILOAD	Maximum output current	-	-	150	mA	@VBAT=3.6v
ISC	Short Circuit Current Limit	-	-	300	mA	@VBAT=3.8v

Table 4-3 VDDBT LDO/BUCK Parameters

Sym	Characteristics	Min	Typ	Max	Unit	Conditions
VDDBT	1.2V LDO/BUCK voltage output	-	1.2	-	V	Light Loading condition
△VVDDBT	Output Mismatch 1-sigma	-	20	-	mV	VDDBT=1.2v
ILOAD	Maximum output current	-	-	60	mA	@VBAT=3.0v
ISC	Short Circuit Current Limit	-	-	200	mA	@VBAT=3.8v

Table 4-4 VDDCORE LDO Parameters

Sym	Characteristics	Min	Typ	Max	Unit	Conditions
VDDCORE	0.8V LDO voltage output	-	0.8	-	V	Light Loading condition
△VVDDCORE	Output Mismatch 1-sigma	-	13	-	mV	VDDCORE=0.8v
ILOAD	Maximum output current	-	-	60	mA	@VBAT=3.6v
ISC	Short Circuit Current Limit	-	-	120	mA	@VBAT=3.8v

4.2 IO Parameters

Table 4-5 I/O Parameters

GPIO—Electrical Characteristics							
Symbol	Description	Related GPIO	Min	Typical	Max	Units	Conditions
VIL	Low-level input voltage	-	-0.3	-	1.27	V	VDDIO=3.3V
VIH	High-level input voltage	-	2.03	-	3.6	V	VDDIO=3.3V
Driver Ability 1	Output Driver Ability 1	-	-	32	-	mA	VDDIO=3.3V
Driver Ability 0	Output Driver Ability 0	-	-	8	-	mA	VDDIO=3.3V
RPUP0	Internal pull-up resister 0	-	8	10	12	KΩ	-
RPUP1	Internal pull-up resister 1	-	0.24	0.3	0.36	KΩ	-
RPUP2	Internal pull-up resister 2	-	160	200	240	KΩ	-
RPDN0	Internal pull-down resister 0	-	8	10	12	KΩ	-
RPDN1	Internal pull-down resister 1	-	0.24	0.3	0.36	KΩ	-
RPDN2	Internal pull-down resister 2	-	160	200	240	KΩ	-

4.3 Audio DAC Parameters

Table 4-6 Audio DAC Parameters

Mode	Sym	Characteristics	Min	Typ	Max	Unit	Conditions
Differential Mode	SNR	-	-	106.435	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Output -1.7dBV with 10K loading Fin=1KHz
	THD+N	-	-	-83.848	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Output -1.7dBV with 10K loading Fin=1KHz
	Output Range	Maximum output voltage	-	-2.83	-	dBVrms	32ohm Loading
VCMBUF Mode	SNR	-	-	103.372	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Output -1.7dBV with 10K loading Fin=1KHz
	THD+N	-	-	-73.605	-	dB	VCM cap=1uF

Mode	Sym	Characteristics	Min	Typ	Max	Unit	Conditions
				(stereo) -81.125 (mono)			VDDDAC cap=1uF with A-wt filter Output -1.7dBV with 10K loading Fin=1KHz
	Output Range	Maximum output voltage	-	-2.943	-	dBVrms	32ohm Loading
AC Coupling Mode	SNR	-	-	102.778	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Output -1.7dBV with 10K loading@220uF AC coupling Cap Fin=1KHz
	THD+N	-	-	-70.331 (stereo) -78.272 (mono)	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Output -1.7dBV with 10K loading@220uF AC coupling Cap Fin=1KHz
	Output Range	Maximum output voltage	-	-2.773	-	dBVrms	32ohm Loading

4.4 Audio ADC Parameters

Table 4-7 Audio ADC Parameters

Parameter	Conditions	Min	Typ	Max	Unit
Resolution	-	-	-	24	bit
Output Sample Rate,F_{sample}	-	8	-	384	KHz
SNR	VCM cap=1uF VDDDAC cap=1uF Fin=1KHz B/W=20Hz~20KHz A-Weighted 0.79Vrms Input Fsample=48KHz	-	102	-	dB
THD+N	VCM cap=1uF VDDDAC cap=1uF Fin=1KHz B/W=20Hz~20KHz A-Weighted 0.79Vrms Input Fsample=48KHz	-	-85	-	dB
PGA Gain	Analog Gain Resolution=3dB	0	/	42	dB

4.5 Audio ClassD Parameters

Table 4-8 Audio ClassD Parameters

Mode	Sym	Characteristics	Min	Typ	Max	Unit	Conditions
Sample AD Mode	SNR	-	-	91.864	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Fin=1KHz
	THD+N	-	-	-61.714	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Fin=1KHz
	Output Range	Maximum output voltage	-	6.35	-	dBVrms	10kohm Loading
NS AD Mode	SNR	-	-	91.72	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Fin=1KHz
	THD+N	-	-	-66.569	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Fin=1KHz
	Output Range	Maximum output voltage	-	6.35	-	dBVrms	10kohm Loading
Sample BD Mode	SNR	-	-	95.682(L) 91.864(R)	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Fin=1KHz
	THD+N	-	-	-64.644	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Fin=1KHz
	Output Range	Maximum output voltage	-	6.35	-	dBVrms	10kohm Loading
NS BD Mode	SNR	-	-	93.899(L) 92.409(R)	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Fin=1KHz
	THD+N	-	-	-66.149	-	dB	VCM cap=1uF VDDDAC cap=1uF with A-wt filter Fin=1KHz
	Output Range	Maximum output voltage	-	6.5	-	dBVrms	10kohm Loading

4.6 BT Parameters

Table 4-9 BT Parameters

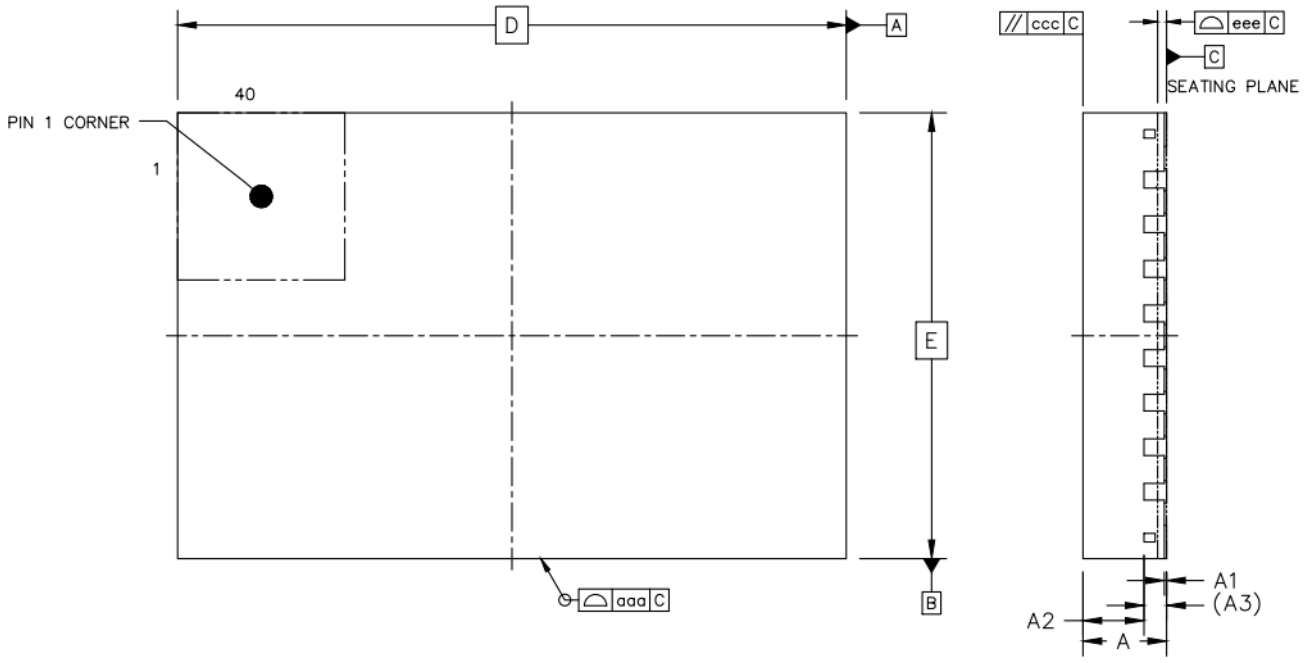
Characteristics	Min	Typical	Max	Unit	Conditions
Transmit Power	-	6	8	dBm	Maximum TX power 2-DH5 packet
RMS DEVM	-	7	-	%	
Peak DEVM	-	18	-	%	
EDR Relative Transmit Power	-	0	-	dB	
Sensitivity @ Basic Rate	-	-92.5	-	dBm	BER=0.1%, using DH5 packet
Sensitivity @ EDR	-	-94.5	-	dBm	BER=0.01%, using 2-DH5 packet
Sensitivity @ 1M BLE	-	-95.5	-	dBm	37 bytes BER=0.1% or NAK=30%
Sensitivity @ 2M BLE	-	-93	-	dBm	37 bytes BER=0.1% or NAK=30%

4.7 Current Parameters

Table 4-10 Current Parameters

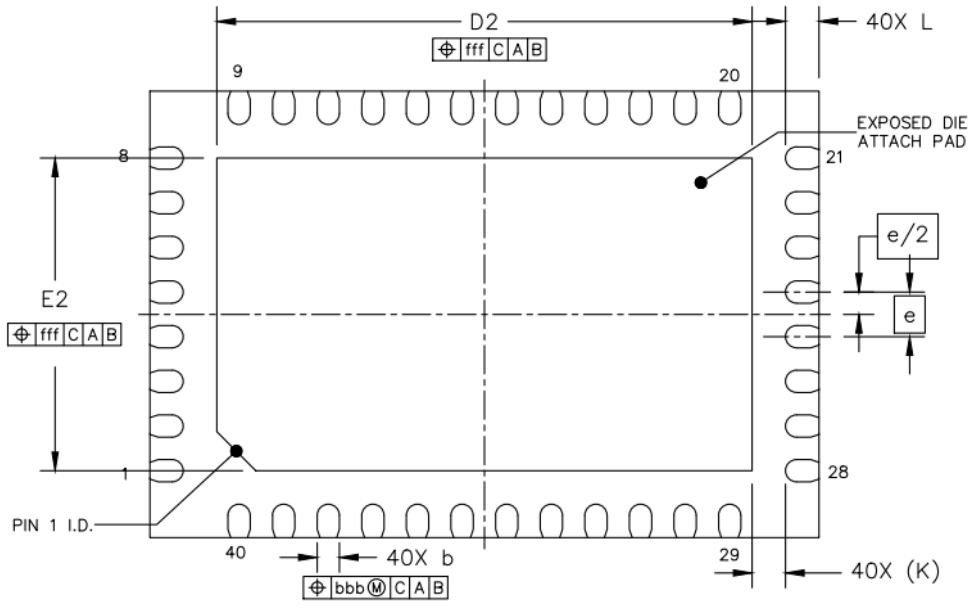
With DC-DC	Parameter	Average Current Typ	Unit	Conditions
Sniff	Sniff Interval：500ms	150	uA	3.8V input, room temp BLE mode, +6dBm TX Power
PowerDown	-	20	uA	3.8V input, room temp, 24M OSC Running, RTC Running
PowerDown	-	4	uA	3.8V input, room temp

5 Package Information



TOP VIEW

SIDE VIEW



BOTTOM VIEW

		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.7	0.75	0.8
STAND OFF		A1	0	0.02	0.05
MOLD THICKNESS		A2	---	0.55	---
L/F THICKNESS		A3		0.203 REF	
LEAD WIDTH		b	0.15	0.2	0.25
BODY SIZE	X	D		6 BSC	
	Y	E		4 BSC	
LEAD PITCH		e		0.4 BSC	
EP SIZE	X	D2	4.7	4.8	4.9
	Y	E2	2.7	2.8	2.9
LEAD LENGTH		L	0.2	0.3	0.4
LEAD TIP TO EXPOSED PAD EDGE		K		0.3 REF	
PACKAGE EDGE TOLERANCE		aaa		0.1	
MOLD FLATNESS		ccc		0.1	
COPLANARITY		eee		0.08	
LEAD OFFSET		bbb		0.07	
EXPOSED PAD OFFSET		fff		0.1	

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