



Telink

Product Specification for Telink Multi-Standard Wireless Module

ML7218D1-MERCURY-M0-PE11

PS-ML7218D1-MERCURY-E1

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Keyword

Bluetooth[®] LE; Zigbee; Thread; 2.4 GHz, rich set of peripherals

Brief

This specification is dedicated for Telink multi-standard wireless Module ML7218D1-MERCURY-M0-PE11.

In this specification, function block diagram, key features, and electrical specifications of the module are introduced.

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Version	Change Description
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Table of Contents

1 Overview.....	7
1.1 Block Diagram.....	7
1.2 Key Features	8
1.2.1 General Features	8
1.2.2 CPU and Memory	10
1.2.3 RF Features.....	10
1.2.4 Features of Power Management Module	11
1.2.5 Bluetooth LE Features	11
1.2.6 Zigbee Features.....	12
1.2.7 RF4CE Features.....	12
1.2.8 OpenThread Features	12
1.2.9 Matter Features	12
1.2.10 Timer Features	12
1.2.11 RZ Features	13
1.2.12 Certification	13
1.3 Typical Applications	13
1.4 Ordering Information.....	13
1.5 Package Information	14
1.5.1 Module Dimensions.....	14
1.5.2 PCB Footprint and Land Pattern.....	14
1.6 Pin Layout	16
2 Electrical Specifications.....	20
2.1 Absolute Maximum Rating	20
2.2 Recommended Operating Conditions.....	20
2.3 DC Characteristics.....	20
2.4 AC Characteristics.....	22
2.4.1 RF Performance.....	22
2.5 ESD Characteristics.....	26
2.6 Storage Conditions	26
2.7 Soldering Profile	27
3 Schematics	28
3.1 Reference Schematic	28
3.2 BOM (Bill of Material)	28

List of Figures

Figure 1-1 Function Block Diagram of the Module	7
Figure 1-2 Block Diagram of the Chip.....	8
Figure 1-3 Package of ML7218D1-MERCURY-M0-PE11	14
Figure 1-4 PCB land pattern of ML7218D1-MERCURY-M0-PE11	15
Figure 1-5 Pin Assignment	16
Figure 2-1 Reflow Profile.....	27
Figure 3-2 Reference Schematic	28

List of Tables

Table 1-1 Ordering Information of ML7218D1-MERCURY-M0-PE11	13
Table 1-2 Pin Function of ML7218D1-MERCURY-M0-PE11	16
Table 1-3 GPIO Pin Mux of ML7218D1-MERCURY-M0-PE11	18
Table 2-1 Absolute Maximum Rating.....	20
Table 2-2 Recommend Operating Conditions.....	20
Table 2-3 RX/TX Current and Sleep Current.....	21
Table 2-4 Digital Inputs/Outputs	22
Table 2-5 RF Performance Characteristics	22
Table 2-6 HBM/CDM Results	26
Table 3-7 BOM Table for ML7218D1-MERCURY-M0-PE11	28

1 Overview

The ML7218D1-MERCURY-M0-PE11 is a general-purpose module for Bluetooth low energy, 802.15.4 and 2.4GHz proprietary. The ML7218D1-MERCURY-M0-PE11 supports standards and industrial alliance specifications including Bluetooth LE, Zigbee/R4CE, Thread, and 2.4GHz proprietary standard. Thread and Zigbee share the same radio physical layer (modulation, occupied bandwidth, power level, channel frequency). The ML7218D1-MERCURY-M0-PE11 combines the features and functions needed for high quality wireless IoT equipments into a single module.

1.1 Block Diagram

The module is built around the chip TL7218D1. The function block diagram of the module and the chip block diagram are as shown in the figure below.

Figure 1-1 Function Block Diagram of the Module

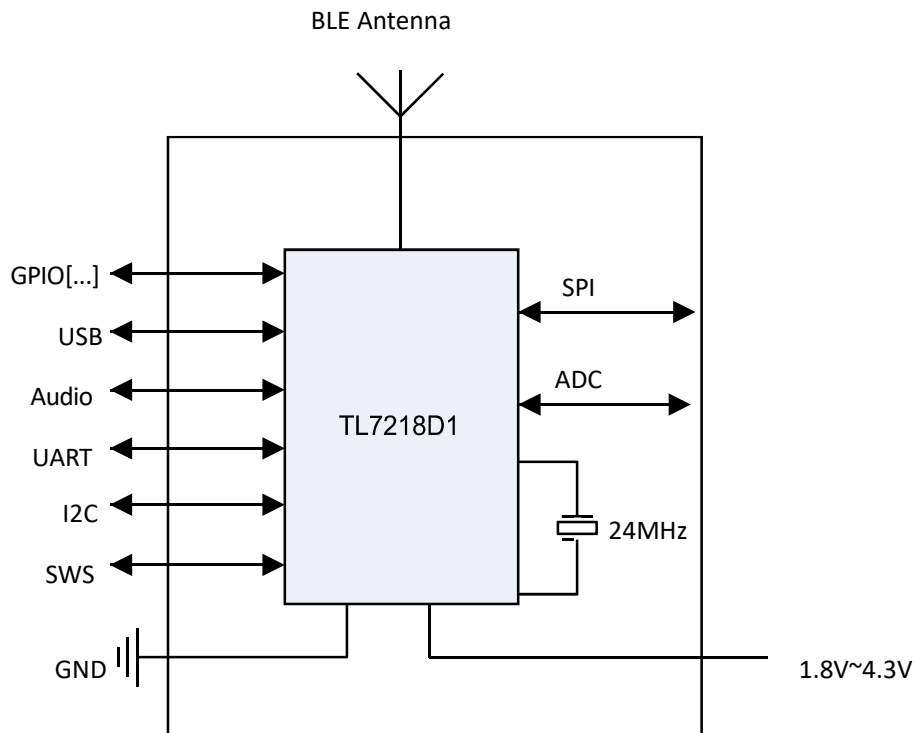
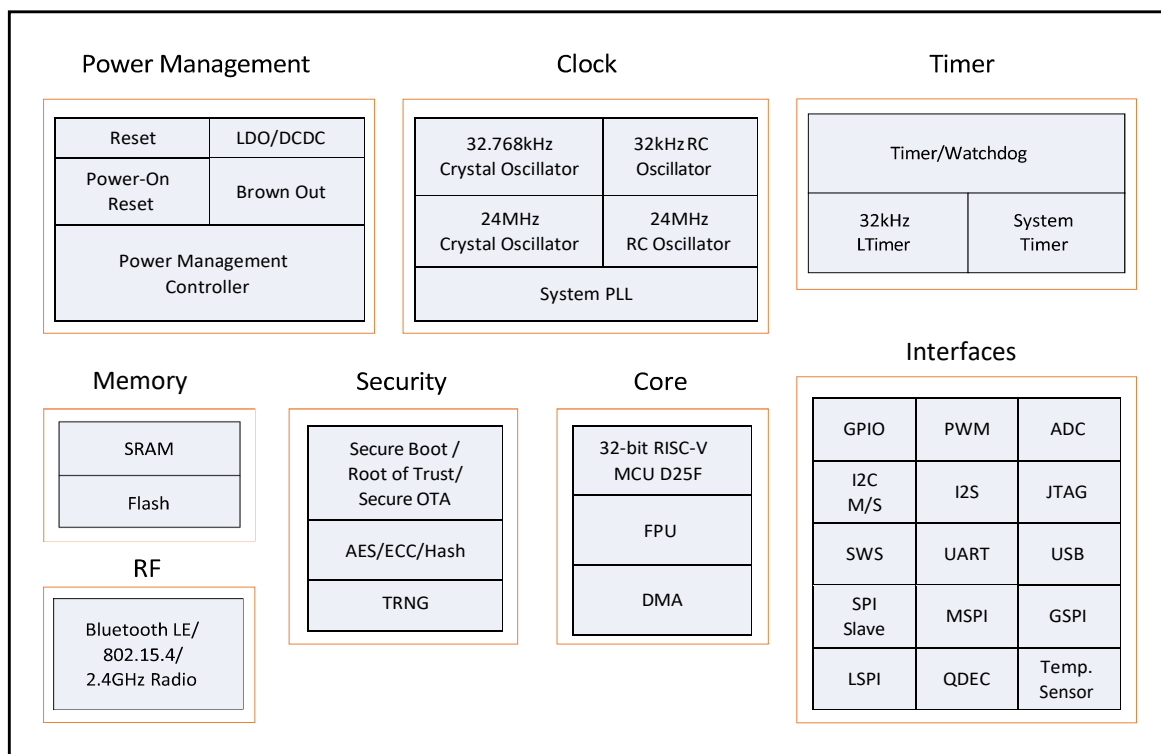


Figure 1-2 Block Diagram of the Chip


The chip TL7218D1 integrates a powerful 32-bit RISC-V MCU, 512 KB SRAM including 256 KB retentionSRAM, with 2 MB embedded flash, 12-bit ADC, PWM, flexible IO interfaces, and other peripheral blocks required for IoT applications.

1.2 Key Features

1.2.1 General Features

General features are as follows:

1. Supports 128-bit Unique ID (UID)
2. Security solution
 - Root of Trust
 - Secure Boot
 - Secure OTA
 - Firmware encryption
 - Secure Debug Port Control
 - Signature and verification based on RSA2048 or ECC256
 - Embedded hardware AES block cipher with 128-bit & 256-bit keys and software AES-CCM
 - Embedded hardware acceleration for elliptical curve cryptography (ECC) including ECC-P192, ECC- P256, ECC-P384, ECC-P512, ECDSA+ECDH, ED25519, and Curve25519
 - Embedded hardware acceleration for Hash function including SHA-1, SHA-2, SHA-256, SHA-384, and SHA-512

- Secure Key Accessing
- 3. RTC and other timers
 - Clock source of 24 MHz & 32.768 kHz Crystal and 24 MHz & 32 kHz embedded RCoscillator
 - Two general 32-bit timers with four selectable modes in active mode
 - Watchdog timer
 - A low-frequency 32 kHz timer available in low power mode
 - A low-frequency 32 kHz Platform-Level Machine Timer (PLMT)
- 4. A rich set of digital and analog interfaces
 - Up to 20 GPIOs
 - 4 different SPI channels
 - MSPI: Memory SPI
 - Up to 48 MHz SPI clock
 - Supports quad/dual/signal data line
 - Supports Nor-Flash interface
 - Supports PSARM interface
 - Supports 4-channel CS_N for Multi-SPI Slave
 - GSPI: Global SPI
 - Up to 48 MHz SPI clock
 - Supports quad/dual/signal data line
 - Supports PSRAM interface
 - Supports Nor-Flash interface
 - Supports 4-channel CS_N for Multi-SPI Slave
 - LSPI: LCD SPI
 - Up to 48 MHz SPI clock
 - Supports quad/dual/signal data line
 - Supports TFT panel interface
 - Supports TFT panel interface without internal RAM
 - SPI Slave (SSPI): SPI Slave for external accessing
 - 2x I2C
 - 3x I2S
 - 3x UART with hardware flow control and 7816 protocol support
 - Supports SWS debug interface
 - SWS interface for whole system
 - USB 2.0 device, Full Speed
 - Up to 7 channels of differential PWM
 - IR transmitter with DMA
 - Deep diming synchronization function
 - Preventing dead zones function
 - Enhanced resolution with dithering function
 - IR Learning hardware

- Hardware accelerator for learning
 - BOM-saving for external components
 - One quadrature decoder (QDEC), two-phase input selectable
 - Single-channel AMIC (Analog MIC) and Dual-channel DMIC with common audio chain
 - 12-bit auxiliary ADC
 - Low power comparator
 - Supports RZ (Return to Zero)
 - Supports PDM interface
 - Supports PEM (Peripheral Event Matrix)
5. Supports OTA upgrade and Secure Boot switch, allowing convenient product feature roll outs and upgrades
 6. Operating temperature range: -40°C ~ +85°C

1.2.2 CPU and Memory

1. 32-bit RISC-V micro-controller, D25F
 - Instruction and data cache controller (16 KB I-Cache and 8 KB D-Cache)
 - Maximum running speed up to 240 MHz
 - Integrated DSP extension instructions
 - SIMD Data Processing Instructions
 - Partial-SIMD Data Processing Instructions
 - 64-bit Profile Instructions
 - Non-SIMD Instructions
 - Overflow Status Manipulation Instructions
 - RISC-V RV32I base integer instruction set
 - RISC-V RVC standard extension for compressed instructions
 - RISC-V RVM standard extension for integer multiplication and division
 - RISC-V RVA standard extension for atomic instructions
 - RISC-V “F” standard extensions for single-precision floating-point
2. Memory architecture
 - Program memory: 2 MB embedded flash
 - 512KB SRAM including 256KB retention SRAM
 - Supply PSRAM from 2MB to 16MB
 - 8K bits OTP (One Time Program)
 - ROM for Secure Boot solution

1.2.3 RF Features

RF features include:

1. Bluetooth/802.15.4/2.4 GHz RF transceiver in worldwide 2.4 GHz ISM band
2. Bluetooth LE 1 Mbps and 2 Mbps, Long Range 125 kbps and 500 kbps, Hyper-length
3. Bluetooth High Accuracy Distance Measurement (AKA Channel Sounding) pre-standard version
4. Bluetooth LE AoA/AoD location features

5. IEEE 802.15.4 compliant, 250 kbps, and proprietary 2 Mbps High-Rate mode
6. 2.4 GHz proprietary 1 Mbps/2 Mbps/250 kbps/500 kbps mode
7. Supports flexible 2.4G link layer with configurable packet format
8. Rx Sensitivity: -96 dBm @ Bluetooth LE 1 Mbps, -93 dBm @ Bluetooth LE 2 Mbps mode, -104.5 dBm @ Long Range 125 kbps, -99 dBm @ Long Range 500 kbps; -103 dBm @ 802.15.4
9. TX output power: up to +10dBm @ GFSK modulation
10. 50 Ω matched single-pin antenna input
11. RSSI monitoring with +/-1 dB resolution
12. Auto acknowledgment, retransmission and flow control
13. Supports PTA (Packet Traffic Arbitrator) for Wi-Fi co-existence

1.2.4 Features of Power Management Module

Features of power management module include:

1. Power supply
 - VDD (battery): 1.8 V ~ 4.3 V
 - VBUS (USB): 4.5 V ~ 5.5 V
2. Embedded LDO and DCDC
 - DCDC for 1.8 V flash with bypass LDO
 - DCDC for chip with bypass LDO
3. Battery monitor for low battery voltage detection
4. Brownout detection/shutdown and Power-On-Reset
5. Supports power reduction in different Clock Scenarios
6. IO power supply configurable 1.8 V or 3.3 V
7. Low power consumption:
 - Whole chip, BLE Receive: 1.6 mA @ BLE Rx 4.2 V DCDC mode; 2.0 mA @ BLE Rx 3.3 V DCDC mode, 5.5 mA @ BLE Rx LDO mode
 - Whole chip, BLE Transmit: 2.5 mA @ BLE Tx 4.2 V DCDC mode; 3.1 mA @ BLE Tx 0dBm, 3.3 V DCDC mode, 8.8 mA @ BLE Tx 0dBm LDO mode
 - Deep sleep with external wakeup (without SRAM retention): 0.8 μ A
 - Deep sleep with 32K RC oscillator and SRAM retention: 1.7 μ A (with 32 KB SRAM retention)

1.2.5 Bluetooth LE Features

Bluetooth LE features include:

1. Qualified Bluetooth[®] LE 6.0, main features include:
 - 1Mbps, 2Mbps, Long Range S2 (500 Kbps), S8 (125 Kbps)
 - High duty cycle non-connectable ADV
 - Extended ADV
 - LE channel selection algorithm #2
2. Bluetooth SIG Mesh support
3. Bluetooth based location and indoor positioning support with AoA and AoD (aka Bluetooth 6.0)

4. Bluetooth ISO channel support (aka Bluetooth 6.0) with broadcast and connected mode

1.2.6 Zigbee Features

Zigbee features include:

1. Supports Zigbee Pro R23, compatible with Zigbee Pro R22 and Zigbee Pro R21, supports Touchlink
2. Supports devices including Coordinator, Router and End Device
3. Supports Zigbee Direct protocol
4. Supports Sink mode and Proxy mode of Green Power

1.2.7 RF4CE Features

RF4CE features include:

1. Compliant to IEEE 802.15.4
2. Utilizes the industry standard AES-128 security scheme
3. Low-power and low-latency control for remote control products
4. Simple and intuitive discovery and pairing mechanism

1.2.8 OpenThread Features

OpenThread features include:

1. Implement all Thread networking layers (IPv6, 6LoWPAN, IEEE 802.15.4 with MAC security, Mesh Link Establishment, Mesh Routing)
2. Supports Full Thread Device (FTD) and Minimal Thread Device (MTD)
3. Supports rich applications
 - IPv6 configuration and raw data interface
 - UDP sockets
 - CoAP client and server
4. Thread and Zigbee share the same radio physical layer (modulation, occupied bandwidth, power level, channel frequency)

1.2.9 Matter Features

Matter features include:

1. Supports Matter over Thread
2. Supports Multi-Admin works across & with multiple ecosystems

1.2.10 Timer Features

1. The SoC has two timers: timer0 and timer1
2. Both timers support four modes:
 - Mode 0 (System Clock Mode)
 - Mode 1 (GPIO Trigger Mode)
 - Mode 2 (GPIO Pulse Width Mode)
 - Mode 3 (Tick Mode)

3. The input capture function and output compare function of timer0 and timer1 are new
4. The Input Capture function can be used with mode 0 and mode 3
5. The Output Compare function can be used with the mode
6. The Input Capture function and the Output Compare function can work at the same time
7. New Input Capture function for System Timer

1.2.11 RZ Features

1. The RZ (Return to Zero) module adopts single wire return to zero code protocol for communication transmission, and can drive serial or parallel pixel ICs
2. RZ Code Timing can be configured flexibly to match different Pixel ICs
3. There are two addressing modes for pixel ICs:
 - Serial sequential addressing
 - Parallel random addressing
4. The RZ module has no CPU intervention during transmission
5. DMA handling data is bounded by 8 bits

1.2.12 Certification

1. RF certification: TBD
2. Environmental certification: RoHS/REACH

For CE:

Hereby, [Name of manufacturer] declares that the radio equipment type [designation of type of radio equipment] is in compliance with Directive 2014/53/EU.

1.3 Typical Applications

The ML7218D1-MERCURY-M0-PE11 is an ideal module for IoT applications. Its typical applications include, but are not limited to the following:

- Smart RF remote control
- Keyboard, mouse, dongle
- Smart home device
- Smart lighting device
- Wireless HID
- Wearable device
- Asset tracking device

1.4 Ordering Information

Table 1-1 Ordering Information of ML7218D1-MERCURY-M0-PE11

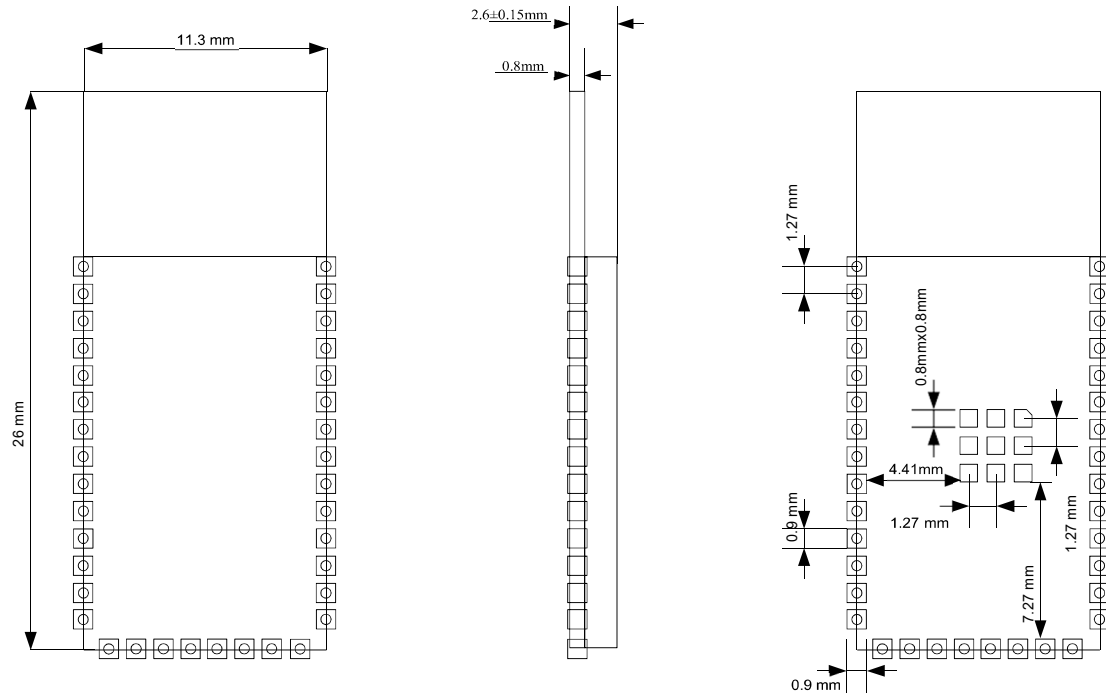
Product Series	Ordering No.	Package	SRAM	Flash	Temperature Range
ML7218D1-MERCURY	ML7218D1-MERCURY-M0-PE11	11.3x26 mm	512 KB	2 MB	-40°C~+85°C

1.5 Package Information

1.5.1 Module Dimensions

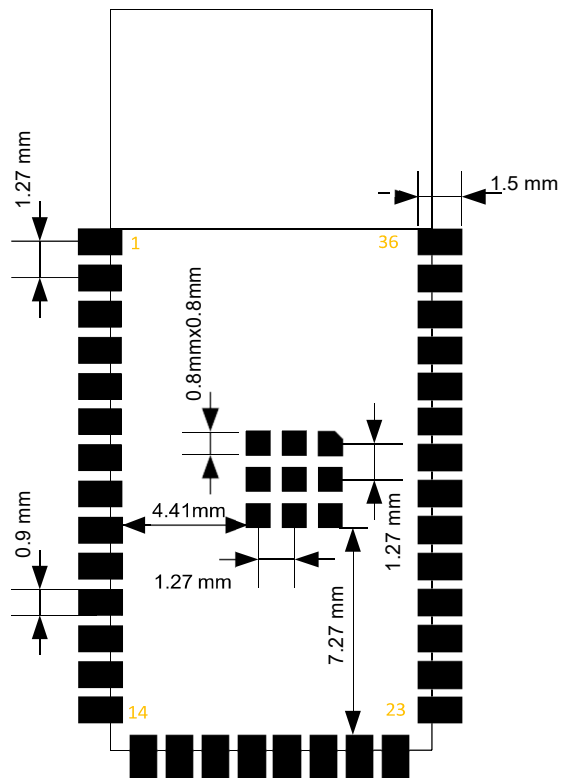
The Package dimensions of ML7218D1-MERCURY-M0-PE11 are shown below.

Figure 1-3 Package of ML7218D1-MERCURY-M0-PE11



1.5.2 PCB Footprint and Land Pattern

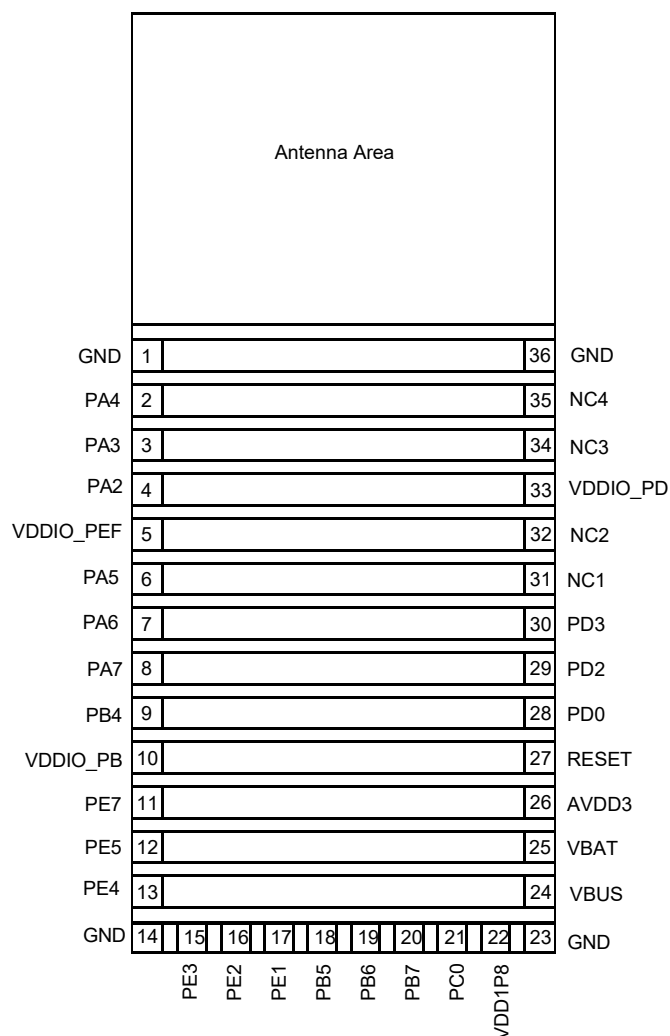
The PCB footprint and land pattern of the module is shown as below.

Figure 1-4 PCB land pattern of ML7218D1-MERCURY-M0-PE11


1.6 Pin Layout

Pin assignment of the module is shown below.

Figure 1-5 Pin Assignment



Functions of 36 pins are described in table below.

Table 1-2 Pin Function of ML7218D1-MERCURY-M0-PE11

No.	Pin Name	Type	Description
1	GND	GND	Ground
2	PA[4]	GPIO	GPIO PA[4]
3	PA[3]	GPIO	GPIO PA[3]
4	PA[2]	GPIO	GPIO PA[2]
5	VDDIO_PEF	PWR	IO voltage for PE1 ~ PE5, PE7, PA2 ~ PA4, configurable to 3.3V or 1.8V



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PA[5]	GPIO	GPIO PA[5]	Product Specification for Telink ML7218D1-MERCURY-M0-PE11

No.	Pin Name	Type	Description
7	PA[6]	GPIO	GPIO PA[6]
8	PA[7]	GPIO	GPIO PA[7]
9	PB[4]	GPIO	GPIO PB[4]
10	VDDIO_PB	PWR	IO voltage for PB4 ~ PB7, PC0 and PA7, configurable to 3.3V or 1.8V
11	PE[7]	GPIO	GPIO PE[7]
12	PE[5]	GPIO	GPIO PE[5]
13	PE[4]	GPIO	GPIO PE[4]
14	GND	GND	Ground
15	PE[3]	GPIO	GPIO PE[3]
16	PE[2]	GPIO	GPIO PE[2]
17	PE[1]	GPIO	GPIO PE[1]
18	PB[5]	GPIO	GPIO PB[5]
19	PB[6]	GPIO	GPIO PB[6]
20	PB[7]	GPIO	GPIO PB[7]
21	PC[0]	GPIO	GPIO PC[0]
22	VDDO1P8	PWR	1.8V LDO output
23	GND	GND	Ground
24	VBUS	PWR	5V USB power supply
25	VBAT	PWR	Battery power supply
26	AVDD3	PWR	3.3V analog power supply
27	RESET	RESET	Reset pin
28	PD[0]	GPIO	GPIO PD[0]
29	PD[2]	GPIO	GPIO PD[2]
30	PD[3]	GPIO	GPIO PD[3]
31	NC	-	Not connected
32	NC	-	Not connected
33	VDDIO_PD	PWR	IO voltage for PD0, PD2 ~ PD3, configurable to 3.3V or 1.8V
34	NC	-	Not connected

No.	Pin Name	Type	Description
35	NC	-	Not connected
36	GND	GND	Ground

GPIO pin mux functions of ML7218D1-MERCURY-M0-PE11 are shown in the table below.

Table 1-3 GPIO Pin Mux of ML7218D1-MERCURY-M0-PE11

Pad	Default	Function1	Function2	Analog Function
PA[2]	GPIO	All functions ^a	SWM	-
PA[3]	GPIO	All functions	SWM	-
PA[4]	GPIO	All functions	SWM	-
PA[5]	GPIO	-	DM	-
PA[6]	GPIO	-	DP	-
PA[7]	SWS	-	SWS	-
PB[4]	GPIO	All functions	SWM	sar_in/lc_cmp_in
PB[5]	GPIO	All functions	SWM	sar_in/lc_cmp_in
PB[6]	GPIO	All functions	SWM	sar_in/lc_cmp_in
PB[7]	GPIO	All functions	SWM	sar_in/lc_cmp_in
PC[0]	SSPI_CN	All functions	SSPI_CN	-
PD[0]	GPIO	All functions	SWM	Audio in/sar in
PD[2]	GPIO	All functions	SWM	32K xc2/led_strip_in2
PD[3]	GPIO	All functions	SWM	32K xc1/diag_hv_ana
PE[1]	GPIO	-	LSPI_CK	-
PE[2]	GPIO	-	LSPI_MOSI	-
PE[3]	GPIO	-	LSPI_MISO	-
PE[4]	GPIO	-	LSPI_IO2	-
PE[5]	GPIO	-	LSPI_IO3	-
PE[7]	GPIO	All functions	SWM	-

- a. “All functions” include 90 functions: SWM, RZ_TX, MSPI_CN1, LSPI_CN, TMR1_CMP, TMR0_CMP, PWM6_N, PWM6, PWM_SYNC, KEYS, SSPI_SO, SSPI_SI, SSPI_CK, SSPI_CN, I2S2_CLK, I2S2_DAT1, I2S2_LR1, I2S2_DAT0, I2S2_LR0, I2S2_BCK, SDM1_N, SDM1_P, SDM0_N, SDM0_P, UART2_RTX, UART2_TX, UART2_RTS, UART2_CTS, IR_LEARN, ATSEL_5, ATSEL_4, GSPI_CN3, GSPI_CN2, GSPI_CN1, I2C1_SCL, I2C1_SDA, RX_CYC2LNA, ATSEL_3, ATSEL_2, ATSEL_1, ATSEL_0, BT_STATUS, BT_ACTIVITY, WIFI_DENY, TX_CYC2PA, MSPI_CN3, MSPI_CN2, DMICO_DAT, DMICO_CLK, I2S1_CLK, I2S1_DAT1, I2S1_LR1, I2S1_DAT0, I2S1_LR0, I2S1_BCK, I2S0_CLK, I2S0_DAT1, I2S0_LR1, I2S0_DAT0, I2S0_LR0, I2S0_BCK, CLK_7816, UART1_RTX, UART1_TX, UART1_RTS, UART1_CTS, UART0_RTX, UART0_TX, UART0_RTS, UART0_CTS, I2C_SDA, I2C_SCL, GSPI_MOSI, GSPI_MISO, GSPI_IO2, GSPI_IO3, GSPI_CK, GSPI_CN0, PWM5_N, PWM4_N, PWM3_N, PWM2_N, PWM1_N, PWM0_N, PWM5, PWM4, PWM3, PWM2, PWM1, PWM0.

2 Electrical Specifications

NOTE: The electrical characteristics currently listed in this section are target specifications and only provided for reference. Some data may be updated according to actual test results.

2.1 Absolute Maximum Rating

Table 2-1 Absolute Maximum Rating

Characteristics	Sym.	Min.	Max.	Unit	Test Condition
Supply voltage	VBAT	-0.3	4.3	V	-
USB voltage	VBUS	-0.3	5.5	V	-
Voltage on input pin	V_{in}	-0.3	VDD+0.3	V	-
Output voltage	V_{out}	0	VDD	V	-
Storage temperature range	T_{Str}	-65	150	°C	-
Soldering temperature	T_{Sld}	-	260	°C	-

NOTE:

- Stresses above those listed in “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.
- VDD stands for IO voltage, the IO voltage for the GPIO pin refers to the specific group it belongs.

2.2 Recommended Operating Conditions

Table 2-2 Recommend Operating Conditions

Item	Sym.	Min.	Typ.	Max.	Unit	Condition
Power supply voltage	VBAT	1.8	3.7	4.3	V	-
USB supply voltage	VBUS	4.5	5.0	5.5	V	-
Supply rise time (from 1.6 V to 1.8 V)	T_R	-	-	10	ms	-
Operating temperature range	T_{Opr}	-40	-	85	°C	-

2.3 DC Characteristics

Unless otherwise stated, the general test conditions are: T = 25°C.

Table 2-3 RX/ TX Current and Sleep Current

Item	Sym.	Min	Typ.	Max	Unit	Conditions
RX current	I_{RX}	-	1.6 ^a	-	mA	Whole chip, 4.2 V DCDC, BLE mode ^b
		-	2.0	-	mA	Whole chip, 3.3 V DCDC, BLE mode
		-	5.5	-	mA	Whole chip, LDO mode
TX current	I_{TX}	-	2.5	-	mA	Whole chip @ 0 dBm with 4.2 V DCDC, BLE mode
		-	3.1	-	mA	Whole chip @ 0 dBm with 3.3 V DCDC, BLE mode
		-	8.8	-	mA	Whole chip @ 0 dBm LDO mode
Deep sleep with 32 KB SRAM retention	I_{Deep1}	-	1.7	-	μA	Without 32K RC ^c
Deep sleep with 64 KB SRAM retention		-	2.3	-	μA	
Deep sleep with 128 KB SRAM retention		-	3.7		μA	
Deep sleep with 256 KB SRAM retention		-	6.6		μA	
Deep sleep without SRAM retention	I_{Deep2}	-	0.8	-	μA	
Deep sleep with 32 KB SRAM retention	I_{Deep3}	-	2.1	-	μA	With 32K RC ^d
Deep sleep with 64 KB SRAM retention		-	2.7	-	μA	
Deep sleep with 128 KB SRAM retention			4.1		μA	
Deep sleep with 256 KB SRAM retention			7.0		μA	
Deep sleep without SRAM retention	I_{Deep4}	-	1.2	-	μA	

a. The current data is based on the test results of the chip for evaluation kit, and they will be updated after all chips are tested.

- b. The complete test conditions for TX/RX current: (1) turn off the clock and power of the modules irrelevant to RF; (2) hold the modules irrelevant to RF; (3) disable PLL clock and RC_24M to make the Pad_24M is the only clock source for cclk; (4) stall the MCU.
- c. Without 32K RC: The wakeup source is external signal from GPIO input, the internal 32K RC is disabled.
- d. With 32K RC: The wakeup source is 32K RC, it is enabled.

Table 2-4 Digital Inputs/Outputs

Item	Sym.	Min.	Typ.	Max.	Unit	Conditions
Input high voltage	V_{IH}	0.7*VDD	-	VDD	V	-
Input low voltage	V_{IL}	VSS	-	0.3*VDD	V	-
Output high voltage	V_{OH}	0.9*VDD	-	VDD	V	-
Output low voltage	V_{OL}	VSS	-	0.1*VDD	V	-

2.4 AC Characteristics

NOTE: The data in this section is only provided for reference and will be updated according to actual test results.

2.4.1 RF Performance

Unless otherwise stated, the general test conditions are: VDD = 4.2 V, T = 25°C.

Table 2-5 RF Performance Characteristics

Item		Sym.	Min.	Typ.	Max.	Unit	Conditions
RF frequency range		-	2400	-	2483.5	MHz	Programmable in 1 MHz step
Data rate		Bluetooth LE/2.4G proprietary 1 Mbps, ±250 kHz deviation Bluetooth LE/2.4G proprietary 2 Mbps, ±500 kHz deviation Bluetooth LE 125 kbps, ±250 kHz deviation Bluetooth LE 500 kbps, ±250 kHz deviation IEEE 802.15.4 250 kbps, ±500 kHz deviation 2.4GHz proprietary 250 kbps, ±62.5 kHz deviation 2.4GHz proprietary 500 kbps, ±125 kHz deviation					
Bluetooth LE 1 Mbps RF_RX Performance (±250 kHz Deviation)							
Sensitivity	1 Mbps	-	-	-96	-	dBm	-
Frequency offset tolerance		-	-200	-	+200	kHz	-
Co-channel rejection		-	-	8	-	dB	Wanted signal at -67 dBm

Item		Sym.	Min.	Typ.	Max.	Unit	Conditions
In-band blocking rejection (equal modulation interference)	+1/-1 MHz offset	-	-	-4/-3	-	dB	Wanted signal at -67 dBm
	+2/-2 MHz offset	-	-	-41/-41	-	dB	
	≥ 3 MHz offset	-	-	-49	-	dB	
Image rejection		-	-	-38	-	dB	Wanted signal at -67 dBm; image frequency = RF_channel - 2MHz
Bluetooth LE 1 Mbps RF_TX Performance							
Output power, maximum setting		-	-	8	-	dBm	-
Output power, minimum setting		-	-	-24	-	dBm	-
Programmable output power range		-	34			dB	-
Modulation 20 dB bandwidth		-	-	1.4	-	MHz	-
Bluetooth LE 2 Mbps RF_RX Performance (±500 kHz Deviation)							
Sensitivity	2 Mbps	-	-	-93	-	dBm	-
Frequency offset tolerance		-	-300	-	+300	kHz	-
Co-channel rejection		-	-	8	-	dB	Wanted signal at -67 dBm
In-band blocking rejection	+2/-2 MHz offset	-	-	-4/-4	-	dB	Wanted signal at -67 dBm
	+4/-4 MHz offset	-	-	-35/-35	-	dB	
	> 6 MHz offset	-	-	-39	-	dB	
Image rejection		-	-	-25	-	dB	Wanted signal at -67 dBm; image frequency = RF_channel - 3 MHz

Item		Sym.	Min.	Typ.	Max.	Unit	Conditions
Bluetooth LE 2 Mbps RF_TX Performance							
Output power, maximum setting		-	-	8	-	dBm	-
Output power, minimum setting		-	-	-24	-	dBm	-
Programmable output power range			34			dB	-
Modulation 20 dB bandwidth		-	-	2.5	-	MHz	-
Bluetooth LE 125 kbps RF_RX Performance (±250kHz Deviation)							
Sensitivity	125 kbps	-	-	-104.5	-	dBm	-
Frequency offset tolerance		-	-200	-	+200	kHz	-
Co-channel rejection		-	-	2	-	dB	Wanted signal at -79 dBm
In-band blocking rejection (equal modulation interference)	+1/-1 MHz offset	-	-	-6/-6	-	dB	Wanted signal at -79 dBm
	+2/-2 MHz offset	-	-	-38/-38	-	dB	
	≥ 3 MHz offset	-	-	-48/-48	-	dB	
Image rejection		-	-	-27	-	dB	Wanted signal at -79 dBm; image frequency = RF_channel - 2 MHz
Bluetooth LE 125 kbps RF_TX Performance							
Output power, maximum setting		-	-	8	-	dBm	-
Output power, minimum setting (resolution)		-	-	-24	-	dBm	-
Programmable output power range		-	34			dB	-
Modulation 20 dB bandwidth		-	-	1.4	-	MHz	-

Item		Sym.	Min.	Typ.	Max.	Unit	Conditions
Bluetooth LE 500 kbps RF_RX Performance (± 250 kHz Deviation)							
Sensitivity	500 kbps	-	-	-99	-	dBm	-
Frequency offset tolerance		-	-200	-	+200	kHz	-
Co-channel rejection		-	-	4	-	dB	Wanted signal at -72 dBm
In-band blocking rejection (equal modulation interference)	+1/-1 MHz offset	-	-	-6/-6	-	dB	Wanted signal at -72 dBm
	+2/-2 MHz offset	-	-	-42/-41	-	dB	
	≥ 3 MHz offset	-	-	-55	-	dB	
Image rejection		-	-	-40	-	dB	Wanted signal at -72 dBm; image frequency = RF_channel - 2 MHz
Bluetooth LE 500 kbps RF_TX Performance							
Output power, maximum setting		-	-	8	-	dBm	-
Output power, minimum setting		-	-	-24	-	dBm	-
Programmable output power range		-	34			dB	-
Modulation 20 dB bandwidth		-	-	1.4	-	MHz	-
Zigbee/RF4CE/6LoWPan/Thread RF_RX Performance (IEEE 802.15.4 250 kbps ± 500 kHz Deviation)							
Sensitivity	250 kbps	-	-	-103	-	dBm	-
Frequency offset tolerance		-	-300	-	+300	kHz	-
Adjacent channel rejection (-1/+1 channel)		-	-	-38/-38	-	dB	Wanted signal at -82 dBm
Adjacent channel rejection (-2/+2 channel)		-	-	-38/-38	-	dB	Wanted signal at -82 dBm
Zigbee/RF4CE/6LoWPan/Thread RF_TX Performance (IEEE 802.15.4 250 kbps)							

Item	Sym.	Min.	Typ.	Max.	Unit	Conditions
Output power, maximum setting	-	-	8	-	dBm	-
Output power, minimum setting (resolution)	-	-	-24	-	dBm	-
Programmable output power range	-	34			dB	-
Modulation 20 dB bandwidth	-	-	2.7	-	MHz	-
Error vector magnitude	EVM	-	-	2%	-	Max (10 dBm) power output

2.5 ESD Characteristics

Table 2-6 HBM/CDM Results

Model	ESD Sensitivity Pass: +/-2KV	V Class
HBM	±2KV	JEDEC JS-001-2024
CDM	±500V	JEDEC22-C101F
Contact	±2KV	IEC 61000-4-2 (ESD)

2.6 Storage Conditions

The SoC series is applicable to Moisture Sensitivity Level 3 (based on JEDEC Standard).

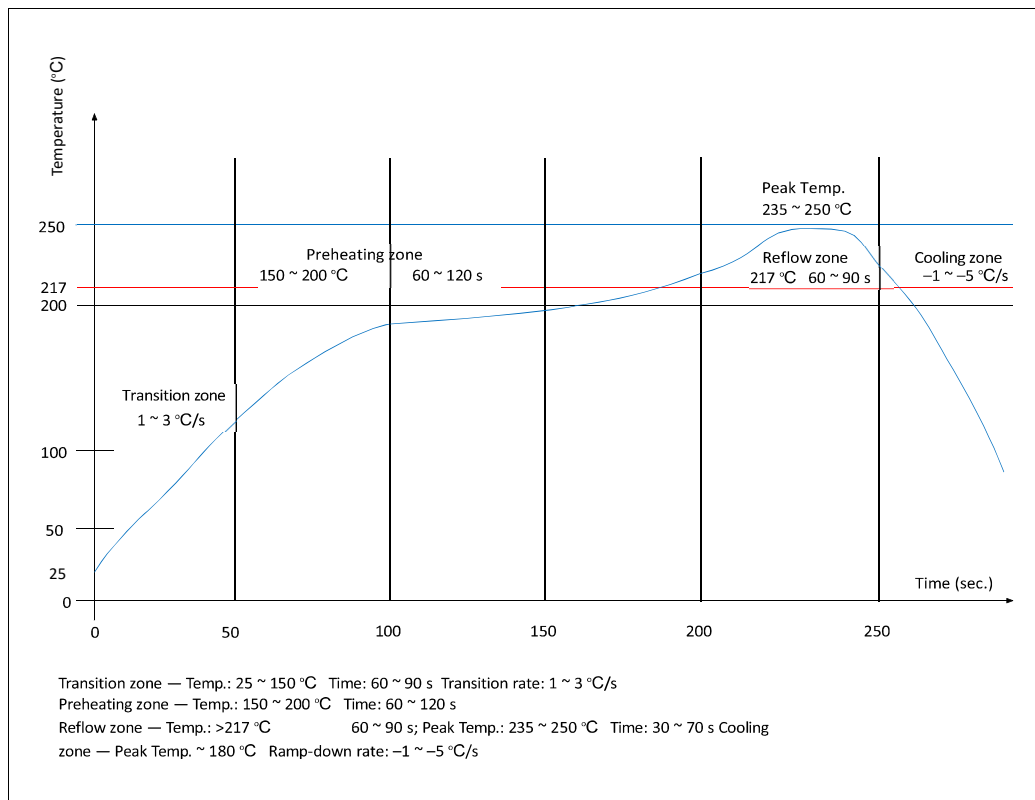
- Calculated shelf life in sealed moisture barrier bag (MBB): 12 months at <40°C and <90%relative humidity (RH)
- Peak package body temperature: 260°C
- After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be
 - Mounted within: 168 hours of factory conditions <=30°C/60% RH, or
 - Stored at <10% RH
- Devices require bake before mounting, if:
 - Humidity Indicator Card reads >10% when read at 23 ± 5°C
 - Both of the conditions in 3 are not met
- If baking is required, devices may be baked for 24 hours at 125 ±5°C

Note: If device containers cannot be subjected to high temperature or shorter bake times are desired, please refer to IPC/JEDEC J-STD-033 for bake condition.

2.7 Soldering Profile

The reflow profile is shown below. It is recommended that the module be soldered in a single reflow

Figure 2-1 Reflow Profile

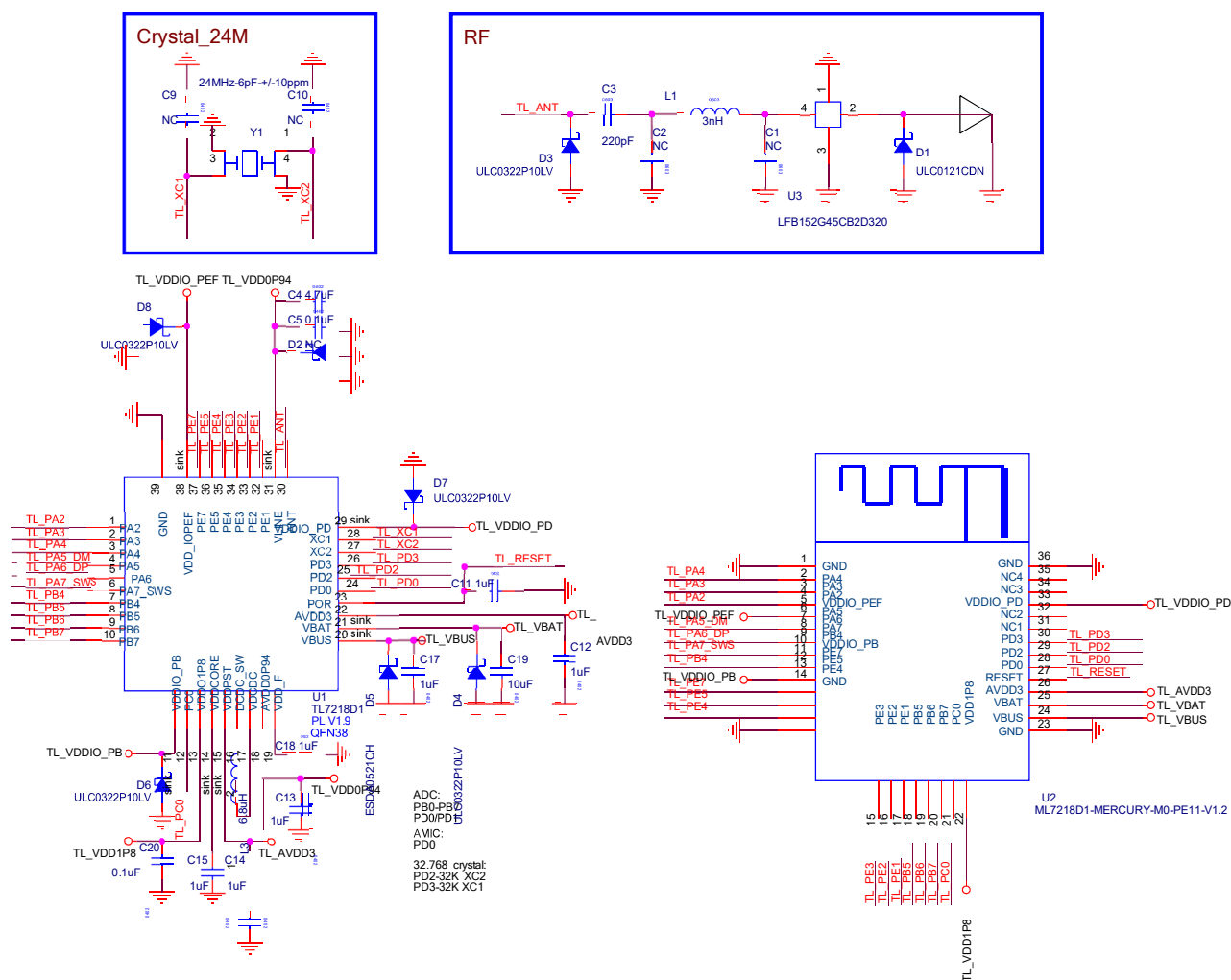


3 Schematics

3.1 Reference Schematic

The reference schematic of ML7218D1-MERCURY-M0-PE11 is shown below.

Figure 3-2 Reference Schematic



3.2 BOM (Bill of Material)

The bill of material table for ML7218D1-MERCURY-M0-PE11 reference design is listed as below.

Table 3-7 BOM Table for ML7218D1-MERCURY-M0-PE11

Qty	Reference	Value	Description	Mfr.	Part Number
7	C11, C12, C13, C14, C15, C17, C18	1uF	CAP CER 1UF 6.3V X5R 10% 0201	muRata	GRM033R60J105MEA2D
2	C5, C20	0.1uF	CAP CER 0.1UF 6.3V X5R 10% 0201	muRata	GRM033R60J104ME19

Qty	Reference	Value	Description	Mfr.	Part Number
2	C12, C14	2.2uF	CAP CER 2.2UF 6.3V X5R 10% 0201	muRata	GRM033R60J225ME47D
1	C4	4.7uF	CAP CER 4.7uF 6.3V 20% X5R 0402	muRata	GRM035R60J475ME15D
1	C1	10uF	CAP CER 10uF 10V 20% X5R 0402	Samsung	CL05A106MP5NUNC
1	C3	220pF	CAP CER 220pF 25V 10% X7R 0201	muRata	GRM033R71E221KA01D
1	L1	3nH	Inductor 3nH±0.3nH 0201	muRata	LQG15HS3N0S02D
1	L3	6.8uH	IND FIXED 6.8uH 1.2A 20% 0.33OHM 1008	muRata	DFE252012F-6R8M=P2
1	U1	LFB152G 45CB2D3 20	Bandpass Filter, Insertion Loss 1.50 dB 2450.00 MHz fo ± 50.00 MHz SMD- 4P,0.5x1mm	muRata	LFB152G45CB2D320
1	U2	TL7218D1	IC MCU RSIC-V F2MB R512KB 1.8-4.3V QFN38	Telink	TL7218D1E11T38R
1	Y1	24MHz	Crystal seam 24MHz 10ppm 12pF 2016	HOSONIC	E1SB24E00000SE
1	D1	ULC0121 CDN	TVS DIODE 1VWM 0.35pF DFN0603-2	Leiditech	ULC0121CDN
5	D3, D4, D6, D7, D8	ULC0322 P10LV	TVS DIODE 3VWM 0.6pF DFN0603-2	Leiditech	ULC0322P10LV
1	D5	ESDA052 1CH	TVS DIODE 5VWM 15pF DFN0603-2	Leiditech	ESDA0521CH

FCC

OEM/Integrators Installation Manual

Important Notice to OEM integrators

1. This module is limited to OEM installation ONLY.
2. This module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).
3. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations
4. For FCC Part 15.31 (h) and (k): The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with Part 15 Subpart B, the host manufacturer is required to show compliance with Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions). The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in Part 15 Subpart B or emissions are compliant with the transmitter(s) rule(s).

The Grantee will provide guidance to the host manufacturer for Part 15 B requirements if needed.

Important Note

notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to TELINK that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the USI, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

End Product Labeling

When the module is installed in the host device, the FCC/IC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: "Contains FCC ID: OEOM7218D1MRM0"

"Contains IC: 33993-M7218D1MRM0 "

The FCC ID/IC ID can be used only when all FCC/IC compliance requirements are met.

Antenna Installation

- (1) The antenna must be installed such that 20 cm is maintained between the antenna and users,
- (2) The transmitter module may not be co-located with any other transmitter or antenna.
- (3) Only antennas of the same type and with equal or less gains as shown below may be used with this module. Other types of antennas and/or higher gain antennas may require additional authorization for operation.

Antenna type	Bluetooth	Zigbee
PCB Antenna	1.9	1.9

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC/IC authorization is no longer considered valid and the FCC ID/IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC/IC authorization.

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required

regulatory information/warning as show in this manual.

Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

List of applicable FCC rules

This module has been tested and found to comply with part 15 requirements for Modular Approval. The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

This device is intended only for OEM integrators under the following conditions: (For module device use)

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

IC

Industry Canada Statement

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."

Radiation Exposure Statement

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

This device is intended only for OEM integrators under the following conditions: (For module device use)

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

- 1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs, et
- 2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or colocation with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du

Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 33993-M7218D1MRM0".

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante:
"Contient des IC: 33993-M7218D1MRM0".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.

Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

For CE:

Hereby, TELINK SEMICONDUCTOR (SHANG HAI) CO., LTD. declares that the radio equipment type ML7218D1-MERCURY-M0-PE11 is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address: <https://www.telink-semi.cn/>

The device could be used with a separation distance of 20cm to the human body

