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WiFi / Bluetooth Module Data Sheet

**Cypress CYW43438 WLAN / BT + ST Micro STM32F412 MCU
for 802.11b/g/n & Bluetooth® 4.1**

Electric Imp P/N : imp004m
MURATA P/N : LBEE5ZZ1MD-011

***This Datasheet is preliminary version, and subject
to change without notice.***

Revision history

Issued Date	Revision Code	Revision Page	Changed Items	Change Reason
Jul. 6. 2016			First Issue	
Sep. 9. 2016	A	P3 P4 P6 P15 P17	2. Part Number 4.1. Dimensions 4.2. Terminal Configurations 11. Land pattern (Top View) 13. Tape and Reel Packing	
Oct. 11. 2016	B	P3 P4 P6 P10 P12	2. Part Number 4.1. Dimensions (LMK) 42 Terminal Configurations 8. Power up sequence 9. RF Characteristics	
Oct. 13. 2016	C	P6 P8 P9 P10 P11 P16 P17	4.2. Pin configurations 4.3. Pin mux table 5. LED drive 6. Phototransistor 7. SPI flash requirements 9. Operating condition 10. External 32kHz crystal 14. Reference circuit 15. Recommended components	
Oct. 20. 2016	D	P10	6. Phototransistor	Correct imp003 reference
Oct. 21. 2016	E	P3	1. Scope	Update cloud information
Mar. 14. 2017	F	P5	4.1. Dimensions	Correct Pin 1 Marking
Apr. 13. 2017	G	P5 P12	4. Dimensions, Marking and Terminal Configurations 9. Operating Condition	Correct Top view design Correct the range of VDD_WLAN, VDDA_MCU and VDD_IO_MCU
Apr. 20. 2017	H	P5	4.1. Dimensions	Correct the marking.
Jun. 27. 2017	I	P3	1. Scope	Wording
Jul. 29. 2017	J	P1	Part number	Updated from temp to production part number
		P15	7. SPI flash requirements	Added SPI commands
		P16	8. Required wiring for Bluetooth operation	Added Bluetooth connections
		P23	15. Reference circuit	
		P17	9. Absolute Maximum Rating	Correction
		P24	16.3 Flash memory	Updated part number recommendations
P34	20. Regulatory Requirements	Added FCC and IC regulations for modular certification		

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Please be aware that an important notice concerning availability, standard warranty and use in critical applications of Murata products and disclaimers thereto appears at the end of this specification sheet.

1. Scope

This specification is for the LBEE5ZZ1MD (imp004m) module that provides connectivity to the internet via WiFi. The fully maintained, secure OS that is part of the Electric Imp cloud service comes pre-loaded.

- 802.11 b/g/n 1x1 WiFi
 - 802.11b 17dBm (typ.)
 - 802.11g 13dBm (typ.)
 - 802.11n 12dBm (typ.) [20MHz channels]
 - RX Sensitivity -98dBm (typ.) [@1Mbps]
 - On-board antenna
 - Supports WEP, WPA, WPA2, WPS

- Bluetooth 4.1
 - BTLE support for WiFi configuration using GATT
 - Automatically shares antenna with WiFi
 - Optional: requires 4 MCU pins and stack license fee to enable functionality in commercial products

- 32-bit Cortex M4 processor
 - Robust embedded operating system with fail-safe firmware updates
 - Virtual machine for customer firmware
 - 256kB of application bytecode flash
 - Over 190kB of free application RAM

- Electric Imp OS & service
 - Robust embedded operating system with fail-safe, secure OS & Application updates
 - Pre-provisioned MAC address & per-device secrets
 - TLS1.2-RSA-ECDHE (forward secrecy) connection to cloud
 - Elliptic curve challenge-response to prevent device impersonation
 - Fully featured cloud VM for every device for easy integration with RESTful APIs
 - Open source integrations with AWS, Azure, etc services

- LED drive for red/green status LEDs

- Phototransistor input for Electric Imp's patented BlinkUp™ technology for easy configuration from any smartphone, tablet, or web browser

- 18 user selectable I/Os
 - GPIO, PWM, Analog input, SPI, UART, I2C
 - Dedicated SPI bus for local storage

- Low power 14uA (typ.) sleep mode
 - Option for coin cell RTC battery backup

- Compliant with the RoHS directive

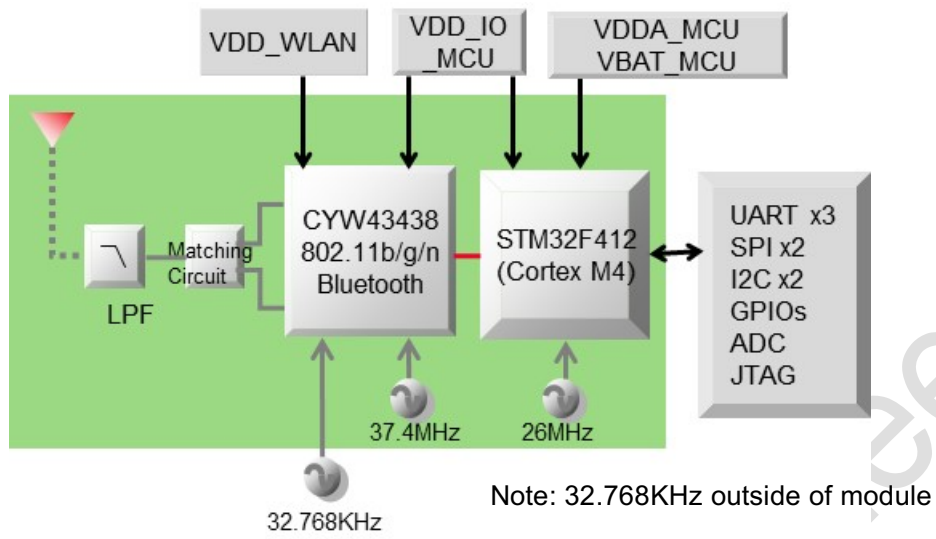
2. Part Number

Sample Part Number
LBEE5ZZ1MD-TEMP

Production Part Number
LBEE5ZZ1MD-011

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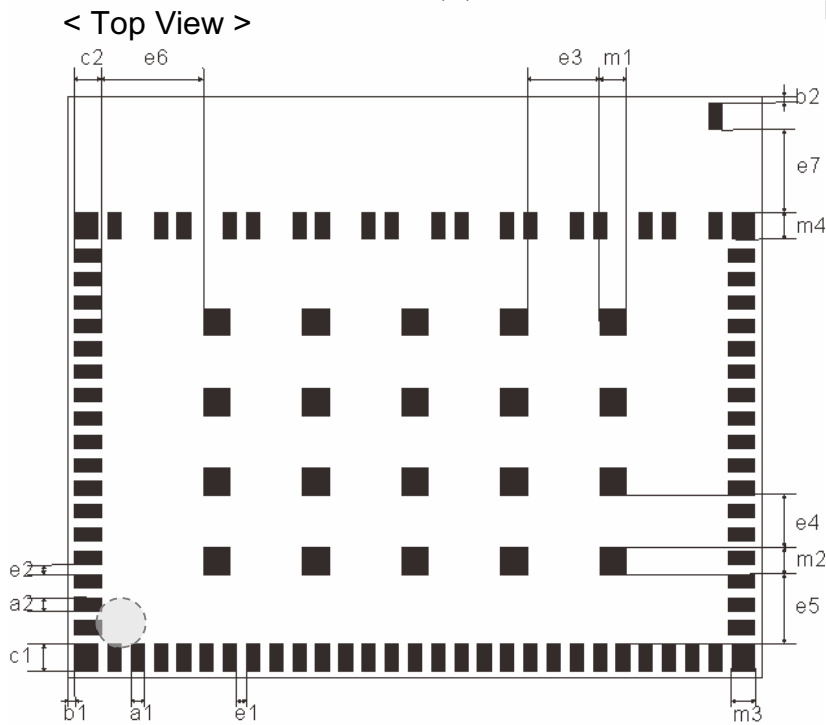
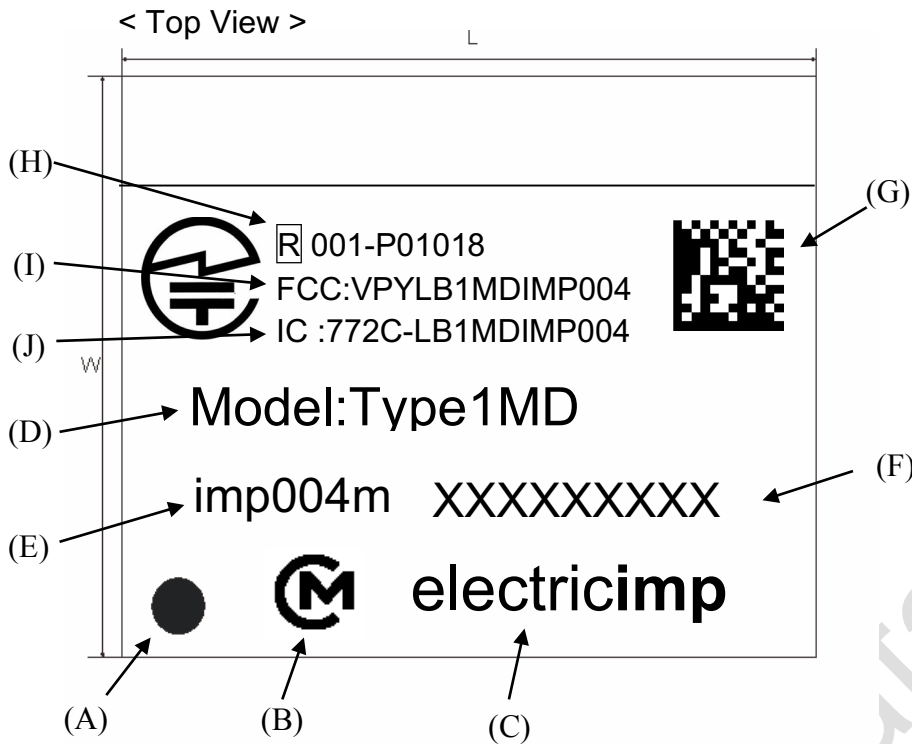
3. Block Diagram



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4. Dimensions, Marking and Terminal Configurations

4.1. Dimensions



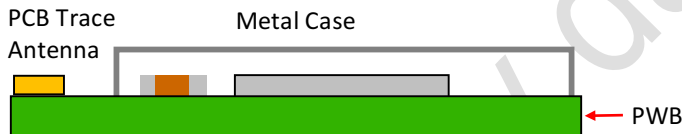
Mark	Dimensions	Mark	Dimensions	Mark	Dimensions
L	21.0 +/- 0.2	W	17.5 +/- 0.2	T	2.3 max.
a1	0.4 +/- 0.1	a2	0.4 +/- 0.1	b1	0.2 +/- 0.2
b2	0.2 +/- 0.2	c1	0.8 +/- 0.1	c2	0.8 +/- 0.1
e1	0.3 +/- 0.1	e2	0.3 +/- 0.1	e3	2.2 +/- 0.1
e4	1.6 +/- 0.1	e5	2.1 +/- 0.1	e6	3.1 +/- 0.1
e7	2.5 +/- 0.1	m1	0.8 +/- 0.1	m2	0.8 +/- 0.1
m3	0.7 +/- 0.1	m4	0.8 +/- 0.1		

(unit : mm)

Marking

Marking	Meaning
(A)	Pin 1 Marking
(B)	Murata Logo
(C)	Electric Imp Logo
(D)	Murata Module Type
(E)	Imp Module Type
(F)	Inspection Number
(G)	2D code
(H)	Japanese Type certification No.
(I)	FCC certification ID
(J)	IC certification No.

Structure



Mounting

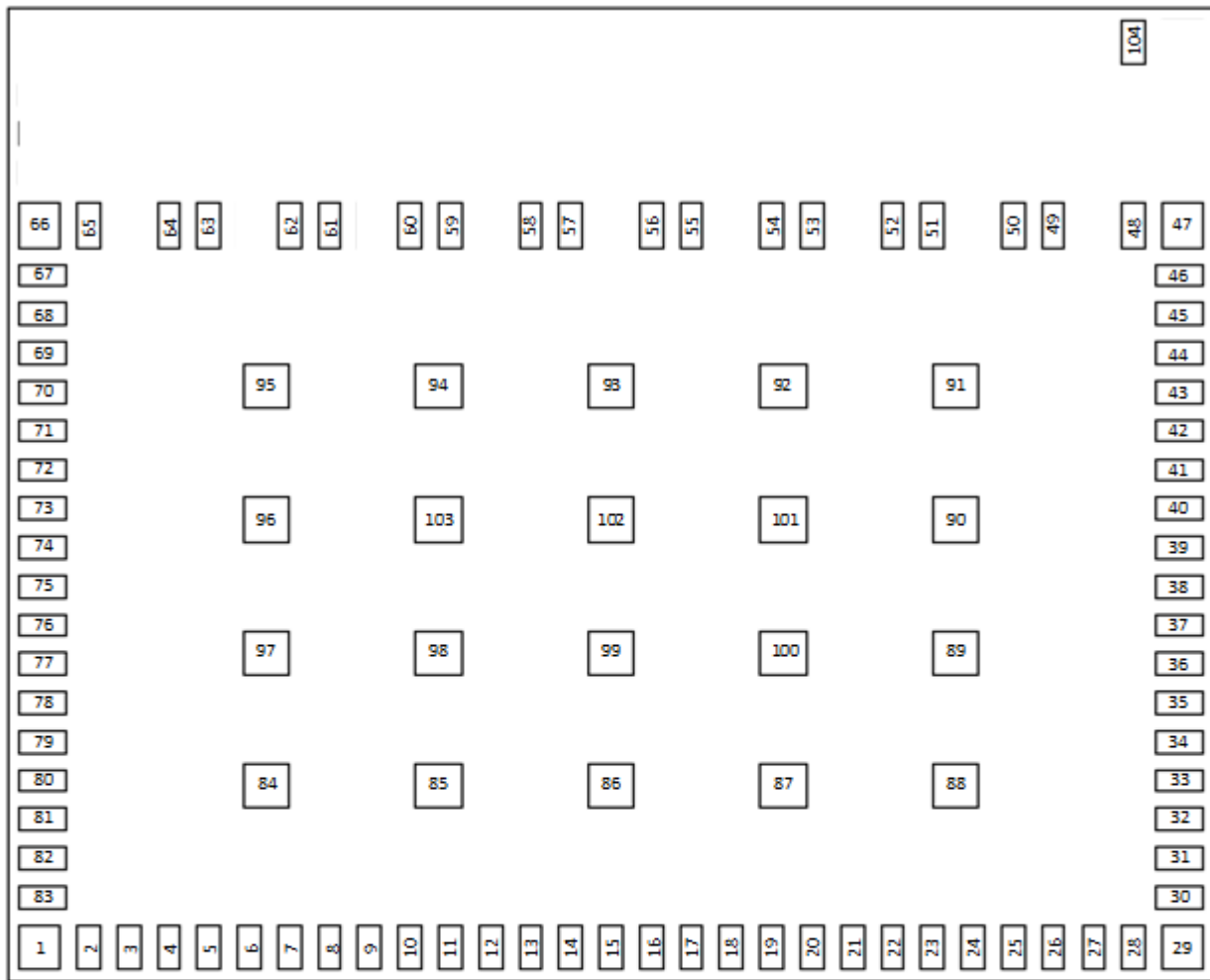
The module is designed to be mounted on the edge of the board, with the antenna section hanging off in free space. The antenna is tuned for free space operation. Please see the design guide on Electric Imp dev center website at <http://www.electricimp.com/docs> for more information.



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4.2. Terminal Configurations

Top view (through package)



No.	Name	Type	Description
1	GND	GND	
2	CLK_REQ	O	Reference clock request. As the clock is internal, this pin does not need to be connected
3	BT_REG_ON	I	Enable Bluetooth power. Leave NC if Bluetooth is not used (active high)
4	NC	-	No Connect
5	pinM	I/O	GPIO, i2cNM SDA, PWM
6	pinN	I/O	GPIO, i2cNM SCL, PWM
7	pinP	I/O	GPIO, i2cQP SDA, PWM, IRQ
8	pinW	I/O	GPIO, uartBCAW CTS, ADC, IRQ & wake from deep sleep (active high)
9	GND	GND	
10	pinA	I/O	GPIO, uartBCAW RTS, spiAHSR MOSI, ADC, PWM
11	pinB	I/O	GPIO, uartBCAW TX, ADC, PWM, IRQ
12	pinC	I/O	GPIO, uartBCAW RX, ADC, IRQ
13	LPO_IN	I	Sleep Clock (for both WiFi & Bluetooth). If low power WiFi operation – or Bluetooth operation – is required, this pin should be connected to pinE. Otherwise, ground this pin.
14	pinD	I/O	GPIO, ADC, PWM, IRQ
15	pinE	I/O	GPIO, IRQ
16	pinK	I/O	GPIO, spiGJKL SCLK, ADC, PWM
17	pinL	I/O	GPIO, spiGJKL NSS, ADC, IRQ
18	GND	GND	
19	VDD_IO_MCU	PWR	MCU/WLAN VIO
20	GND	GND	
21	pinQ	I/O	GPIO, uartQ TX, i2cQP SCL, IRQ
22	pinR	I/O	GPIO, spiAHSR NSS, IRQ
23	pinS	I/O	GPIO, spiAHSR SCLK, IRQ
24	PSU_ENABLE	O	Active high when WiFi needs 2.7v+
25	pinF	I/O	GPIO, uartFGJH TX
26	pinG	I/O	GPIO, uartFGJH RX, spiGJKL MOSI
27	pinH	I/O	GPIO, uartFGJH CTS, uartHJ TX, spiAHSR MISO, IRQ
28	pinJ	I/O	GPIO, uartFGJH RTS, uartHJ RX, spiGJKL MISO, pulse counter
29	GND	GND	
30	LED_RED	O	Red LED drive
31	LED_GREEN	O	Green LED drive
32	OPTO_IN	I	Phototransistor input
33	OPTO_BIAS	O	Phototransistor supply
34	FLASH_MOSI	O	SPI flash connection
35	FLASH_SCLK	O	SPI flash connection
36	FLASH_CS_L	O	SPI flash connection

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37	FLASH_MISO	I	SPI flash connection
38	NC	-	
39	RESET_L	I	MCU reset, internally pulled up
40	VSSA/VREF-	GND	Must be connected to GND
41	OSC32_OUT	O	32kHz xtal connection
42	OSC32_IN	I	32kHz xtal connection (ground if no xtal fitted)
43	GND	GND	
44	VBAT_MCU	PWR	MCU VBAT input
45	VDDA_MCU	PWR	MCU VDDA input
46	VDD_WLAN	PWR	WLAN VBAT input
47-70	GND	GND	
71	BT_UART_TXD	O	Bluetooth UART transmit. Leave NC if not used
72	BT_UART_RTS	O	Bluetooth UART ready to send. Leave NC if not used
73	BT_UART_RXD	I	Bluetooth UART receive. Leave NC if not used
74	BT_UART_CTS	I	Bluetooth UART clear to send. Leave NC if not used
75-76	GND	GND	
77	BT_HOST_WAKE	O	Signal to wake host (from Bluetooth core). Leave NC if not used
78-81	NC	-	
82	BT_DEV_WAKE	I	Signal to wake Bluetooth core (from host). Leave NC if not used
83	NC	-	No Connect
84-103	GND	GND	
104	NC	-	Note this pad should not be touching any PCB

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4.3. Pin Mux table

Pin	Uart BCAW	uart FGJH	uart HJ	uart Q	i2c NM	i2c QP	spi AHSR	spi GJKL	ADC	PWM	Pulse count	State change
pinA	RTS						MOSI		Yes	Yes		
pinB	TX								Yes	Yes		Yes
pinC	RX								Yes			Yes
pinD									Yes	Yes		Yes
pinE												Yes
pinF		TX										
pinG		RX						MOSI				
pinH		CTS	TX				MISO					Yes
pinJ		RTS	RX					MISO			Yes	
pinK								SCLK	Yes	Yes		
pinL								NSS	Yes			Yes
pinM					SDA					Yes		
pinN					SCL					Yes		
pinP						SDA				Yes		Yes
pinQ				TX		SCL						Yes
pinR							NSS					Yes
pinS							SCLK					Yes
pinW	CTS								Yes			Yes

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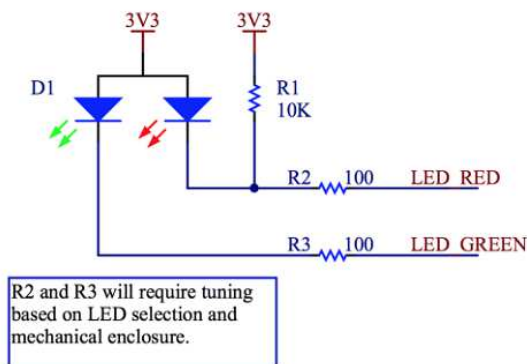
5. LED drive

The indicator LED should be bicolor, because red, green and amber (red+green) are used to indicate status.

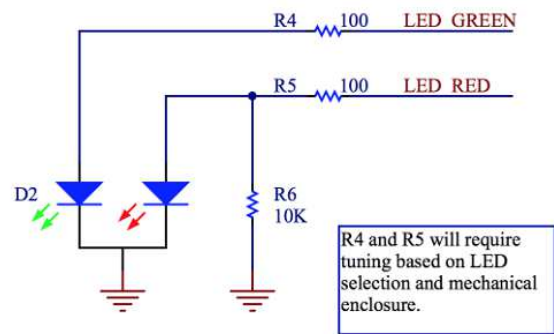
The LED drive pins will auto-detect common anode or common cathode parts. The detection is done by looking to see which way up the LED_RED pin is idling at boot; to ensure this works correctly, please place a 10k resistor in parallel with the red LED.

The current drive on these pins is 20mA maximum. Please refer to section 15 for the recommended LEDs.

<Common anode diagram>



<Common cathode diagram>



Two specific LED codes indicate errors when talking to the SPI flash:

SPI flash not found	amber	red	off
SPI flash error	red	amber	off

If you encounter either of these codes, then this indicates an electrical connection issue or an incompatible flash part.

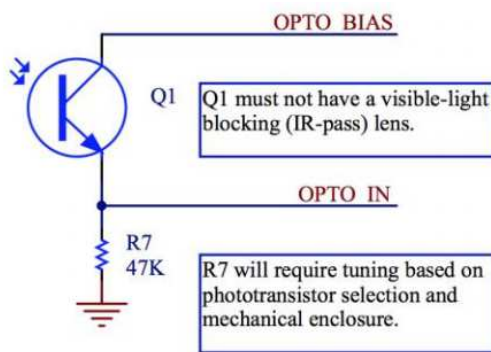
6. Phototransistor

The phototransistor is used to receive BlinkUp configuration data. The bias resistor connected between OPTO_IN and GND may need to be adjusted to ensure adequate sensitivity and response time - in general you need at least 500mV swing on the OPTO_IN pin between black and white states, with the worst (dimmiest) BlinkUp sender you can find. More information and sample code to tune blinkup is available on the Electric Imp dev center website.

End-user BlinkUp send data at between 30 and 60 bits per second, depending on the user's device. For factory configuration, data is typically sent at 142 bits per second using red LED(s) in a test fixture. If your application does not require optical configuration, config can be sent electrically at 142 bits per second from another micro using the OPTO_IN pin. Please contact us for more details.

It is also recommended to place 0402, 13pF capacitor footprints (Murata GRM1555C1H130JA01) close to the imp004m between OPTO_BIAS and GND, and OPTO_IN and GND. If issues are seen with RF coupling onto the blinkup circuit, then these components will address the issue by presenting a low impedance in the 2.4GHz band.

Please refer to paragraph 15 for the recommended phototransistors.



7. SPI flash requirements

An external SPI Flash part is required for operation, which must be pre-loaded with the correct WiFi firmware image before assembly. The required image is available from the Electric Imp dev center website at <http://www.electricimp.com/docs>

The minimum size of the SPI Flash is 8Mbit (1MB), and the maximum size is 128Mbit (16MB). The area below address 0xC2000 (776kB) is the pre-programmed area. The remainder of the flash device is made available to user code programmatically, and may optionally be pre-programmed for user applications before assembly.

The imp004m's SPI flash chip **must** support both 4KB erases (Command 0x20) and 64KB erases (command 0xD8) and Page Program (command 0x02). You must also ensure that the SPI flash you use is able to run down to the **minimum operational voltage** of your product to ensure that the SPI flash is operational at all times that the imp is operational. This is critical during upgrades in low battery states. If you are running from a single LiMnO₂ cell (eg. CR123), you should use a wide voltage range SPI flash that is operational from 1.7-3.6V such as the [Macronix MX25R8035FM2IH0](#).

Minimum Size	8 Mbit (1024 kByte)
Reserved for OS (do not pre-program)	0x000000 to 0xC2000 (776 kByte)

Summary of required SPI flash commands

Required Command	Command in Hex
4KB Sector Erase	0x20
64KB Block Erase	0xD8
Page Program	0x02

8. Required wiring for Bluetooth operation

If Bluetooth is not used in the application, leave all Bluetooth pins (3, 71-74, 77, 82) unconnected.

To use Bluetooth in an application, you must connect the MCU pins to the Bluetooth device:

- BT_UART_TXD should be connected to an MCU UART RX pin (pinC, pinG or pinJ)
- BT_UART_RXD should be connected to the same UART's TX pin (pinB, pinF or pinH)
- pinE MUST be connected to the LPO in pin, to supply a 32kHz clock to the Bluetooth radio
- BT_REG_ON should be connected to any free MCU pin, to control Bluetooth power
- BT_UART_CTS should be grounded (The imp Bluetooth stack uses 2 wire UART)

Aside from pinE, which cannot be reassigned, choice of UART and control pin for BT_REG_ON is determined by the application – this allows flexibility in complex IO configurations.

Please refer to the Electric Imp dev center for more information on how to configure the Bluetooth stack, which is present from impOS release 40.

Note that though use of Bluetooth is free for developers, commercial use incurs an additional licensing fee for the stack. Please contact sales@electricimp.com for more details.

9. Absolute Maximum Rating

		min.	max.	unit
Storage Temperature		-40	85	deg.C
Supply Voltage	VBAT_MCU	-0.3	4	V
	VDDA_MCU	-0.3	4	
	VDD_WLAN	-0.5	6	
	VDD_IO_MCU	-0.3	3.63	

Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability. No damage assuming only one parameter is set at limit at a time with all other parameters is set within operating condition.

10. Operating Condition

		min.	typ.	max.	unit
Operating Temperature Range		-30	25	70	deg.C
Specification Temperature Range		-20	25	55	deg.C
Supply Voltage	VBAT_MCU	1.65	3.3	3.6	V
	VDDA_MCU	1.8	3.3	3.6	
	VDD_WLAN	3.0	3.3	3.6	
	VDD_IO_MCU	1.8	3.3	3.6	

Notes :

- All RF characteristics in this datasheet are defined by Specification Temperature Range. Specifications require derating at extreme temperatures.
- VDDA_MCU and VDD_IO_MCU must be the same potential.

11. External 32.768 kHz Crystal

If the application requires the imp004m to enter deep sleep mode, a 32kHz crystal should be attached to the OSC32_IN and OSC32_OUT pins. Please refer to the STM32F412 datasheet and application note AN2867 by STMicroelectronics NV for detailed crystal requirements.

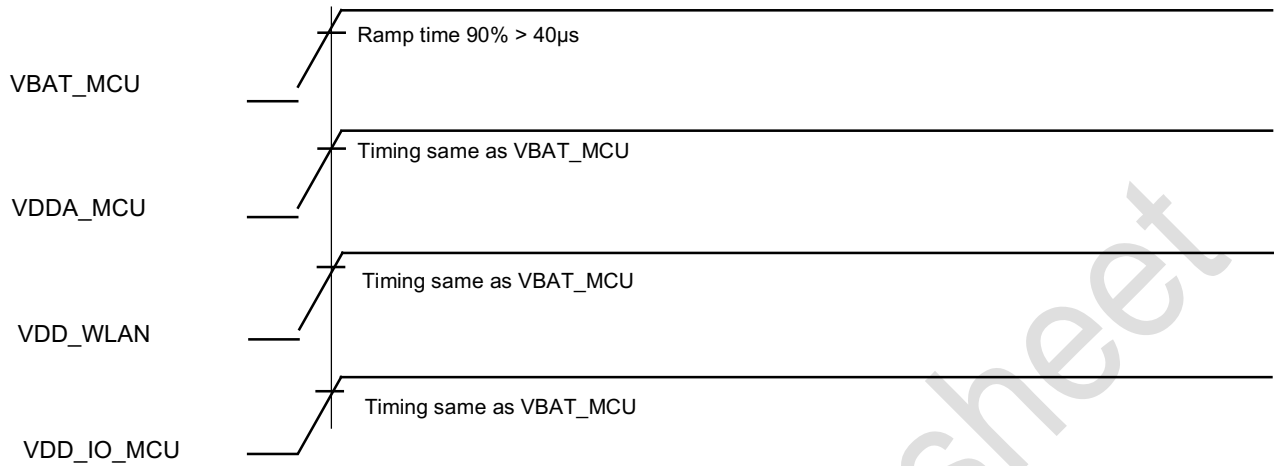
If deep sleep mode is not required, OSC32_IN should be connected to GND and OSC32_OUT left floating. The imp004m will detect this state and disable the sleep APIs.

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12. Power Up Sequence

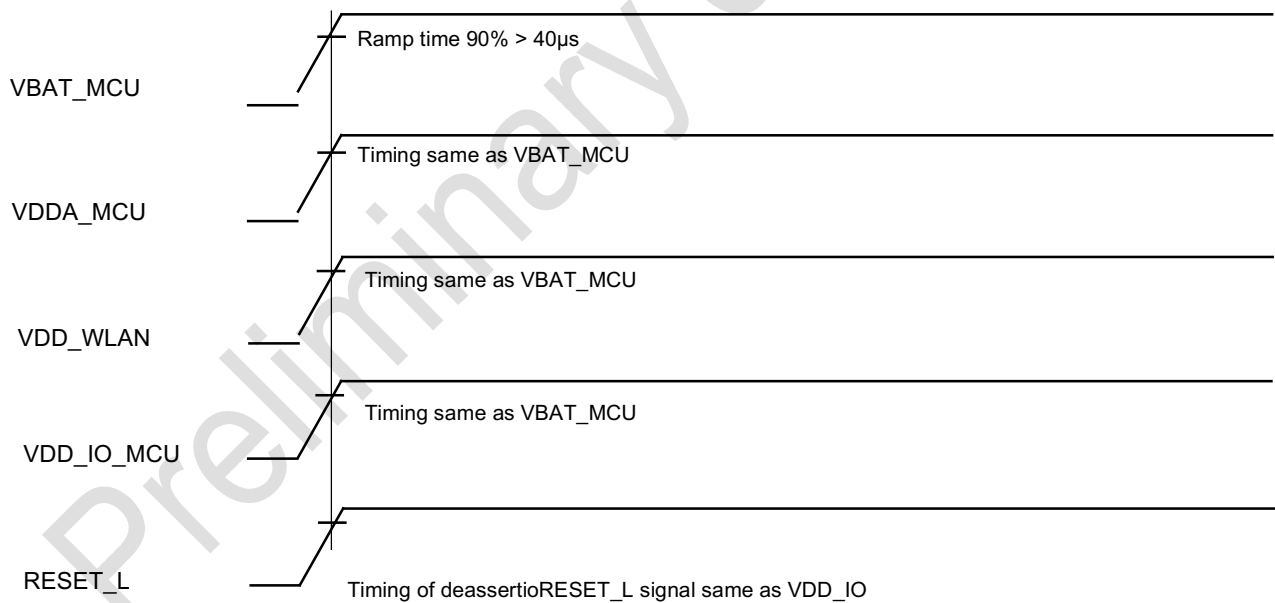
12.1. Without RESET L control

Following timing diagram explain module power up sequence.



*Power down sequence is opposite sequence of power up.

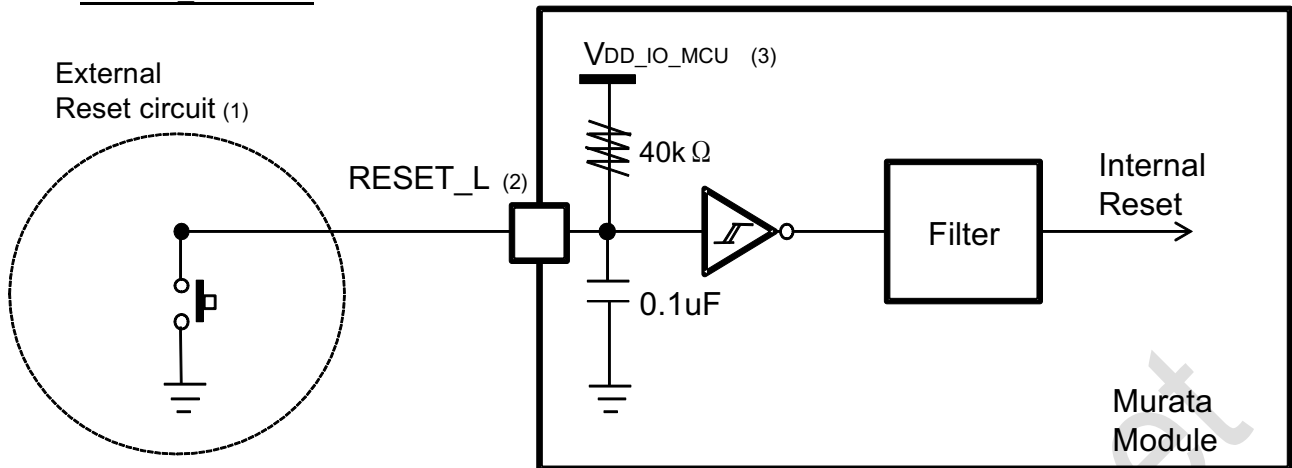
12.2. With RESET L control



*Power down sequence is opposite sequence of power up.

*RESET_L pin must be controlled by Open Drain.

12.3. RESET L Circuit



- (1) The reset network protects the device against parasitic resets.
- (2) The use must ensure that the level on the RESET_L pin can go below the $V_{IL}(NRST)$ max level specified in below table. Otherwise the reset is not taken into account by the device.
- (3) RESET_L pin must be controlled by Open Drain. High signal must not input to this pin.

Symbol	Parameter	Min	Typ	Max	Unit
VIL	RESET_L I/O input low level voltage	-	-	$0.1 \times V_{DD_IO_MCU} + 0.1$	V

13. Electrical Characteristics

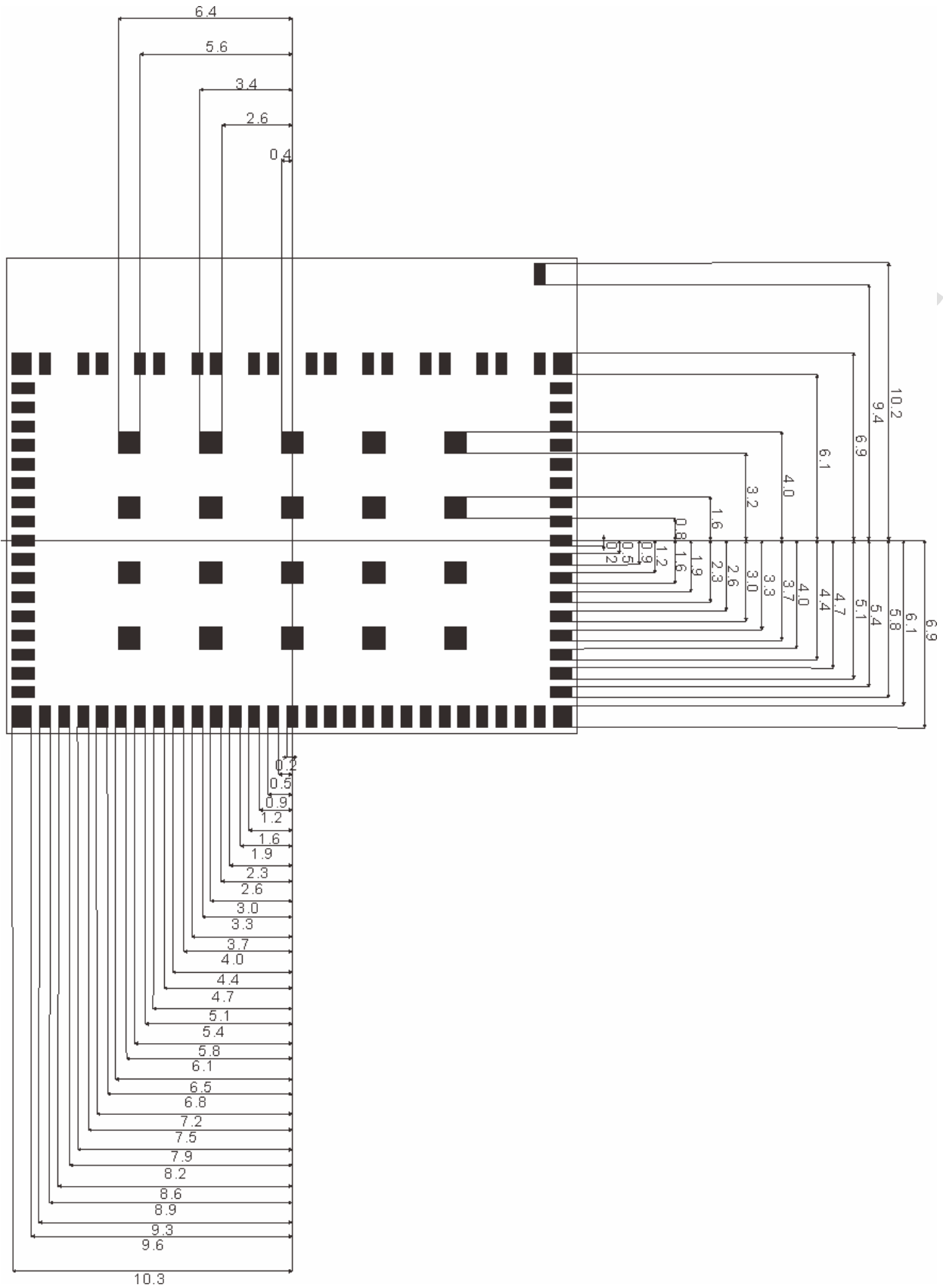
- DC Characteristics -	min.	typ.	max.	unit
1. DC current				
1) Tx mode ¹⁾		300	370	mA
2) Rx mode		45	100	mA

1) Conditions: 25deg.C, VDD_WLAN=3.3V, VDD_IO_MCU=3.3V
(1Mbps mode unless otherwise specified.)

Note: The above mentioned values have been obtained according to our own measuring methods and may very depend on the circuit, in which the component is actually incorporated. Therefore, you are kindly requested to test the performance of the component actually in your set.

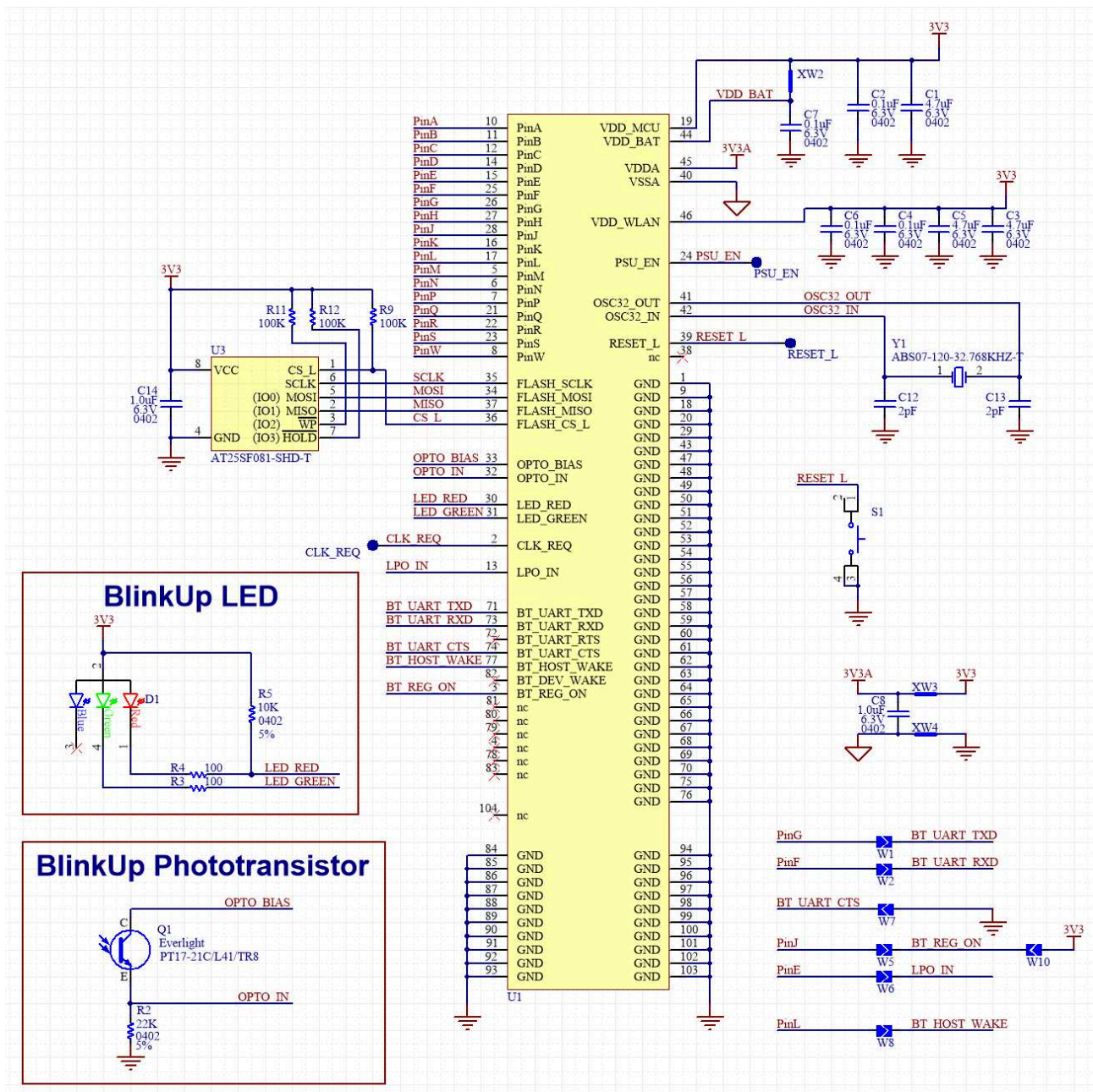
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14. Land pattern (Top View)



Unit : mm

15. Reference Circuit



16. Recommended Components

16.1. Bi-color LED

	Manufacturer	Manufacturer's part number
Surface mount	SunLED	XZMDKVG59W-1
	Liteon	LTST-C195KGJRKT
side-view	SunLED	XZMDKVG88W
	Bivar	SM1204BC
Through-hole	SunLED	XLMDKVG34M
	Liteon	LTL1BEKVJNN

16.2. Phototransistor

	Manufacturer	Manufacturer's part number
Surface mount		
top-view	Everlight	PT17-21C/L41/TR8
	Fairchild	KDT00030TR
side-view	SunLED	XZRNI56W-1
	Everlight	PT12-21C/TR8
Through-hole		
3mm	SunLED	XRNI30W-1
	LiteOn	LTR-4206

16.3. SPI Flash

Size	Manufacturer	Manufacturer's part number
8 Mbit	Adesto Technologies	AT25SF081
	Macronix International	MX25R8035F ⁽¹⁾
16 Mbit	Adesto Technologies	AT25SF161
	Cypress Semiconductor Corp	S25FL116K ⁽²⁾
32 Mbit	Adesto Technologies	AT25SF321
	Cypress Semiconductor Corp	S25FL132K ⁽²⁾
64 Mbit	Cypress Semiconductor Corp	S25FL064L
	Cypress Semiconductor Corp	S25FL164K ⁽²⁾

(1) This device offers a wide operating voltage range

(2) This part is EOL, though inventory may still be available through distributors

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