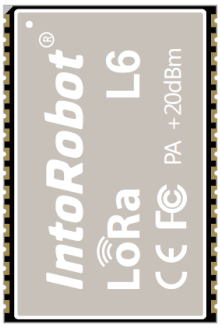
IntoRobot

L6 LoRa™ Datasheet



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Category

Chart Category

1 Overview

1.1 Product Description

IntoRobot-L6 (L6, for short), designed by Shenzhen MOLMC Technology co., Ltd., is a kind of LoRa™ communication module, with the advantages of long distance, compact package and low power consumption. The module operates at the frequency range of Sub-1GHz, including 433MHz and 470MHz.

L6 integrates the chip SX1276/1278 from Semtech, and its LoRa™ modulation mode is backward compatible with FSK and OOK. The LoRa™ spread spectrum modulation technology exhibits extremely high receive sensitivity and anti-jamming ability; the communication distance as well as the receive sensitivity is much larger than those of FSK and GFSK modulation modes. L6 integrates a high-performance data processing MCU, a 32-bit ARM Cortex-M3 chip STM32L151CB. The MCU supports 1.25DMOPS at 32MHz operating frequency, and the power consumption is lower than 0.28uA when standby.

L6 encrypts the wireless data with the AES128 technology, making the data transmission safe. The module utilizes wide-voltage power supply of range from 1.8 to 3.6V; it supports 2 working modes including continuous and power-saving modes. The module's power consumption is as low as 9uA, and can work at the power-saving mode for years or even tens of years with one-time battery power supply.

L6's development is compatible with Arduino programming and internally integrates IntoYun platform, which means the programming work can be decreased dramatically so the product development cycle can also be reduced. The most creative ideas can be achieved when L6 is combined with IntoYun and IntoYun-APP.

1.2 Key Specification

- Transmission distance up to 6000m in open space;
- Radio frequency: 433/470 MHz;
- LoRa™ Modulation mode backward compatible with FSK and OOK;
- Receive sensitivity as low as -148dBm;
- RF output power: max 100mW (+20dBm)
- Power supply: 1.8~3.6V;
- Operating temperature: -40~+85℃;
- Plenty of interfaces: UART, SPI, I2C, ADC, DAC, USB, SWD;
- Support LoRaWan Class A, C;

- Support data encryption;

1.3 Product Applications

- Smart agriculture, forestry, animal husbandry and fishery;
- Smart logistics, e.g., cargo tracking, cold chain logistics, important assets monitoring;
- Smart city, e.g., smart metering, parking, street lighting, and fire alarms;
- Environment monitor, e.g., air quality monitoring (PM2.5, CO2, CO, and formaldehyde), forest fire monitoring, and water quality monitoring;
- Smart home and building, e.g., access control systems, security systems, and smoke alarms;
- Smart industry, e.g., industrial automation;
- Robotics and UAVs.

2 Hardware Specification

2.1 Specification Table

Chart 1: Specification Table

Product	IntoRobot L6
Cloud Service	**IntoYun (www.intoyun.com)**
CPU	STM32L151CBU6A Cortex-M3 32bit，32MHz Flash: 128KB RAM: 32KB
Power Supply	1.8 ~ 3.6 V, typical 3.3V
Work Current	Transmission: Maximum current 135mA (20dBm)
	Receive: Maximum current 25mA
	Standby current 9uA
Radio Frequency	433MHz/470MHz
Modulation Mode	LoRa/FSK/OOK
Emission Power	2-20dBm
Receive Sensitivity	> -148dBm
Peripheral Interface	21 GPIO
	1 SPI
	2 UART
	1 I2C
	1 USB

	1 SWD
	1 Reset
	Power in pin 1.8 ~ 3.6 V
	Antenna interface
Antenna Type	IPX/IPEX U.FL-R-SMT Antenna interface
Temperature	Operating Temperature -40°C - 85°C
	Storage Temperature -40°C - 125°C
	Humidity 10% - 90% Non-condensing
Panel Connection	Stamp Hole
Shield	Shield
Size	17.3mm(Width), 25.4mm(Length), 2.5mm(Height)

2.2 Pin Description

Chart 2: Pin Block Diagram (Front View)

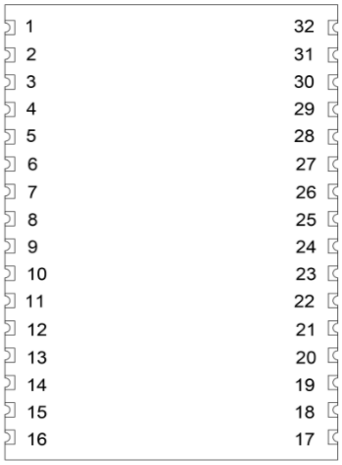


Chart 3: Pin Definition and Description

Pin	Name	Description
1	GND	Ground
2	NC	NC
3	PA0	WKUP1/ ADC_IN0
4	PA1	ADC_IN1
5	PA2	USART2_TX/TIM2_CH3/ TIM9_CH1/ADC_IN2
6	PA3	USART2_RX/TIM2_CH4/ ADC_IN3
7	PA4	ADC_IN4/ DAC_OUT1
8	PA5	ADC_IN5/ DAC_OUT2
9	PA6	TIM3_CH1/ADC_IN6

10	PA7	TIM3_CH2/ADC_IN7
11	PA14	JTCK-SWCLK
12	PA13	JTMS-SWDIO
13	NRST	NRST
14	PB2	BOOT1
15	PB10	I2C2_SCL/USART3_TX/ TIM2_CH3
16	PB11	I2C2_SDA/USART3_RX/ TIM2_CH4
17	PB12	SPI2_NSS/TIM10_CH1/ADC_IN18
18	PB13	SPI2_SCK/ADC_IN19
19	PB14	SPI2_MISO/TIM9_CH2/ADC_IN20
20	PB15	SPI2_MOSI/TIM11_CH1/ADC_IN21
21	PA9	USART1_TX
22	PA10	USART1_RX
23	PA11	USB_DM
24	PA12	USB_DP
25	3.3V	External power supply, range: +1.8V - +3.6V
26	3.3V	External power supply, range: +1.8V - +3.6V
27	GND	Ground
28	NC	NC
29	NC	NC
30	GND	Ground
31	RF	RF Out
32	GND	Ground

2.3 Electrical characteristics

2.3.1 Operating Environment

Chart 4: Recommended Operating Environment

Item	Label	Min	Typical	Max	Unit
Operating Tempererature	-	-40	20	85	°C
Storage Temperature	-	-40	20	125	°C
Power Supply	VDD	1.8	3.3	3.6	V
Operating Humidity	-	10%	-	90%	-

Test condition: IPC/JEDEC J-STD-020.

2.3.2 Digital Port Characteristics

Chart 5: Digital Port Characteristics

Label	Description	Condition	Min	Max	Unit
VIL	Input Level Logic Low	-	-	0.3VDD	V
VIH	Input Level Logic High	-	0.7VDD	-	V
VOL1	Output Level Logic Low	IIO=8mA 2.7V<VDD<3.6V	-	0.4	V
VOH1	Output Level Logic High		2.4	-	V
VOL2	Output Level Logic Low	IIO=4mA 1.65V<VDD<2.7V	-	0.45	V
VOH2	Output Level Logic High		VDD-0.45	-	V
VOL3	Output Level Logic Low	IIO=20mA 2.7V<VDD<3.6V	-	1.3	V
VOH3	Output Level Logic High		VDD-1.3	-	V

2.3.3 SPI Parameters

Chart 6: SPI Timing Parameters

Symbol	Parameter	Conditions	Min	Max(2)	Unit
f_{SCK} $1/t_{c(SCK)}$	SPI clock frequency	Master mode	-	16	MHz
		Slave mode	-	16	
		Slave transmitter	-	12(3)	
$t_{r(SCK)}$(2) $t_{f(SCK)}$(2)	SPI clock rise and fall time	Capacitive load: C = 30 pF	-	6	ns
DuCy(SCK)	SPI slave input clock duty cycle	Slave mode	30	70	%
$t_{su(NSS)}$	NSS setup time	Slave mode	$4t_{HCLK}$	-	ns
$t_{h(NSS)}$	NSS hold time	Slave mode	$2t_{HCLK}$	-	
$t_{w(SCKH)}$(2) $t_{w(SCKL)}$(2)	SCK high and low time	Master mode	$t_{SCK}/2-5$	$t_{SCK}/2+3$	
$t_{su(MI)}$(2)	Data input setup time	Master mode	5	-	
$t_{su(SI)}$(2)		Slave mode	6	-	
$t_{h(MI)}$(2)	Data input hold time	Master mode	5	-	
$t_{h(SI)}$(2)		Slave mode	5	-	
$t_{a(SO)}$(4)	Data output access time	Slave mode	0	$3t_{HCLK}$	
$t_{v(SO)}$(2)	Data output valid time	Slave mode	-	33	
$t_{v(MO)}$(2)	Data output valid time	Master mode	-	6.5	
$t_{h(SO)}$(2)	Data output hold time	Slave mode	17	-	
$t_{h(MO)}$(2)		Master mode	0.5	-	

2.3.4 I2C Interface

I2C interface is open drain, requiring external pull-up resister (4.7K Ω recommended).

Chart 7: I2C Interface Design Reference

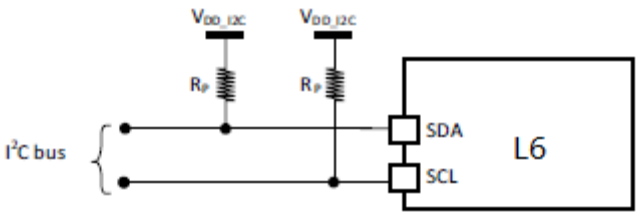
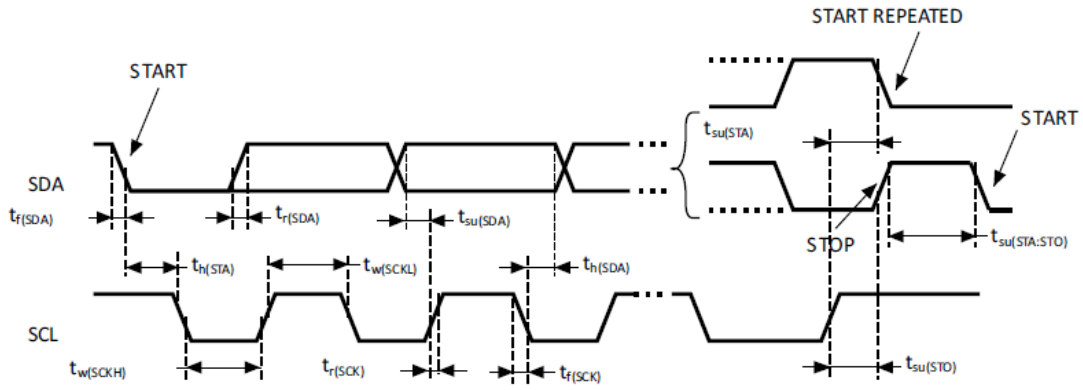


Chart 8: I2C Timing Parameters

Symbol	Parameter	Standard mode I²C(1)		Fast mode I²C(1)(2)		Unit
		Min	Max	Min	Max	
$t_{w(SCLL)}$	SCL clock low time	4.7	-	1.3	-	µs
$t_{w(SCLH)}$	SCL clock high time	4.0	-	0.6	-	
$t_{su(SDA)}$	SDA setup time	250	-	100	-	ns
$t_{h(SDA)}$	SDA data hold time	0	-	0	900(3)	
$t_{r(SDA)}$ $t_{r(SCL)}$	SDA and SCL rise time	-	1000	20 + 0.1C_b	300	
$t_{f(SDA)}$ $t_{f(SCL)}$	SDA and SCL fall time	-	300	-	300	
$t_{h(STA)}$	Start condition hold time	4.0	-	0.6	-	µs
$t_{su(STA)}$	Repeated Start condition setup time	4.7	-	0.6	-	
$t_{su(STO)}$	Stop condition setup time	4.0	-	0.6	-	µs
$t_{w(STO:STA)}$	Stop to Start condition time (bus free)	4.7	-	1.3	-	µs
C_b	Capacitive load for each bus line	-	400	-	400	pF

Chart 9: I2C Timing Chart



2.3.5 Reset

L6's pin NRST is already connected with a 0.1uF capacitor, and L6's MCU STM32L151CB is also weakly pulled-up with a resistor RPU (30-60KΩ).

Chart 10: NRST Interface Design

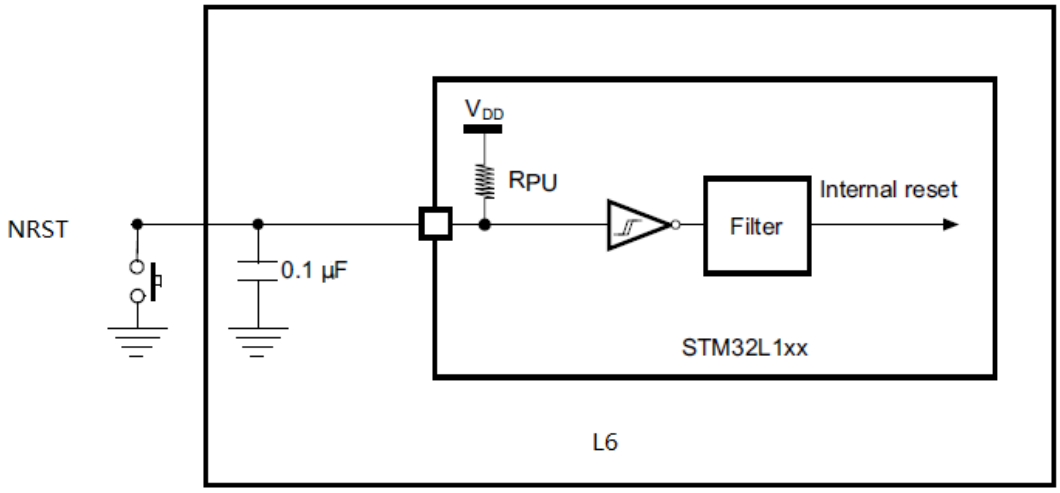


Chart 11: NRST Timing Parameters

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{IL(NRST)}$ (1)	NRST input low level voltage	-	-	-	0.8	V
$V_{IH(NRST)}$ (1)	NRST input high level voltage	-	1.4	-		
$V_{OL(NRST)}$ (1)	NRST output low level voltage	I_{OL} = 2 mA 2.7 V < V_{DD} < 3.6 V	-	-	0.4	
		I_{OL} = 1.5 mA 1.65 V < V_{DD} < 2.7 V	-	-		
$V_{hys(NRST)}$ (1)	NRST Schmitt trigger voltage hysteresis	-	-	10%V_{DD} (2)		mV
R_{PU}	Weak pull-up equivalent resistor(3)	V_{IN} = V_{SS}	30	45	60	kΩ
$V_{F(NRST)}$ (1)	NRST input filtered pulse	-	-	-	50	ns
$V_{NF(NRST)}$ (1)	NRST input not filtered pulse	-	350	-		ns

2.3.6 Clock

L6's MCU supports RTC, with crystal frequency 32.768KHz. The system clock is 12MHz.

2.4 Power Consumption

2.4.1 Operating Power Consumption

Chart 12: Operating Power Consumption

Modes	Min	Typical	Max	Unit
Sleep mode		9		uA
Normal		20		mA
Receive		25		mA

Transmission (5dBm)		65		mA
Wake-up (20dBm)		135		mA

Remark：T=25°C, VDD=3.3V.

2.5 RF Characteristics

2.5.1 RF Characteristics

Chart 13: RF Characteristics

Parameters	Min	Max	Unit
Sensitivity@433MHz	-148	—	dBm
Power Consumption@433MHz	2	20	dBm
Sensitivity@470MHz	-148	—	dBm
Power Consumption@470MHz	2	20	dBm

3 Mechanical Specification

3.1 Recommended SMT Temperature

Chart 14: Recommended RF Temperature

Temperature increases from TS to TL	Maximum value 3℃/s
Warm-up Minimum temperature (TS Min.) Typical temperature (TS Typ.) Maximum temperature (TS Max.) Time(TS)	150℃ 175℃ 200℃ 60~180 seconds
Temperature increases from TL to TP	Maximum value 3℃/s
Temperature(TL)/Duration period	217℃/60~150 seconds
Peak temperature (TP)	Maximum value 260℃， duration period 10 ″
Target temperature	260℃+0/-5℃
Real peak temperature (TP) 5℃ duration period	20~40 ″
Temperature decreases	Maximum value 6℃/s
The time that Temperature increases from 25℃ to peak value(t)	8 minutes at most

3.2 Module Weight

Chart 15: Module Weight

Module	Weight
IntoRobot-L6	2.6 g

3.3 Module Size

Chart 16: Module Size (Front View) Unit mm

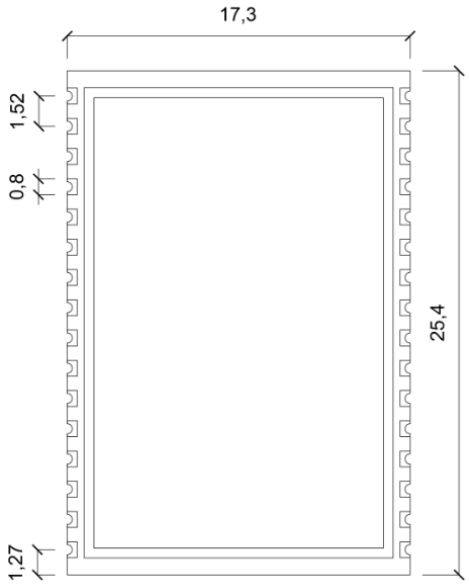
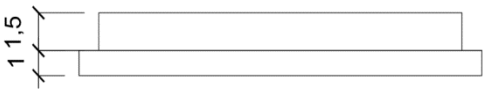
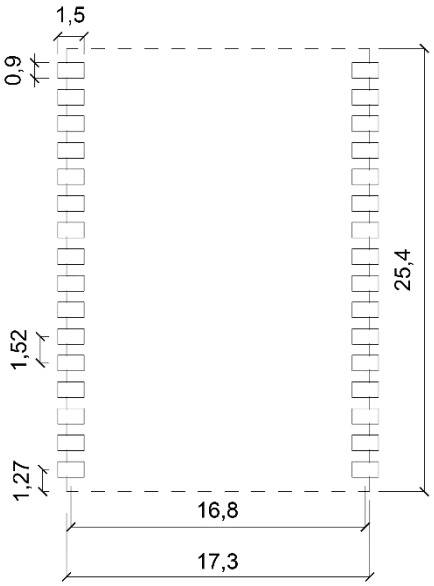


Chart 17: Module Size (Side View) Unit mm



3.4 Recommended PCB package

Chart 18: Recommended PCB Package (Front View) Unit mm



4 Schematic

4.1 Schematic

Chart 19: Schematic of L6