1. General:

The HC1276 transceivers feature the LoRa™ long range modem that provides ultra-long range spread spectrum communication and high interference immunity whilst minimising current consumption.

Using Semtech's patented LoRa™ modulation technique SX1276 can achieve a sensitivity of over -148dBm using a low cost crystal and bill of materials. The high sensitivity combined with the integrated +20 dBm power amplifier yields industry leading link budget making it optimal for any application requiring range or robustness. LoRa™ also provides significant advantages in both blocking and selectivity over conventional modulation techniques, solving the traditional design compromise between range, interference immunity and energy consumption.

These devices also support high performance (G)FSK modes for systems including WMBus, IEEE802.15.4g. The SX1276 deliver exceptional phase noise, selectivity, receiver linearity and IIP3 for significantly lower current consumption than competing devices.

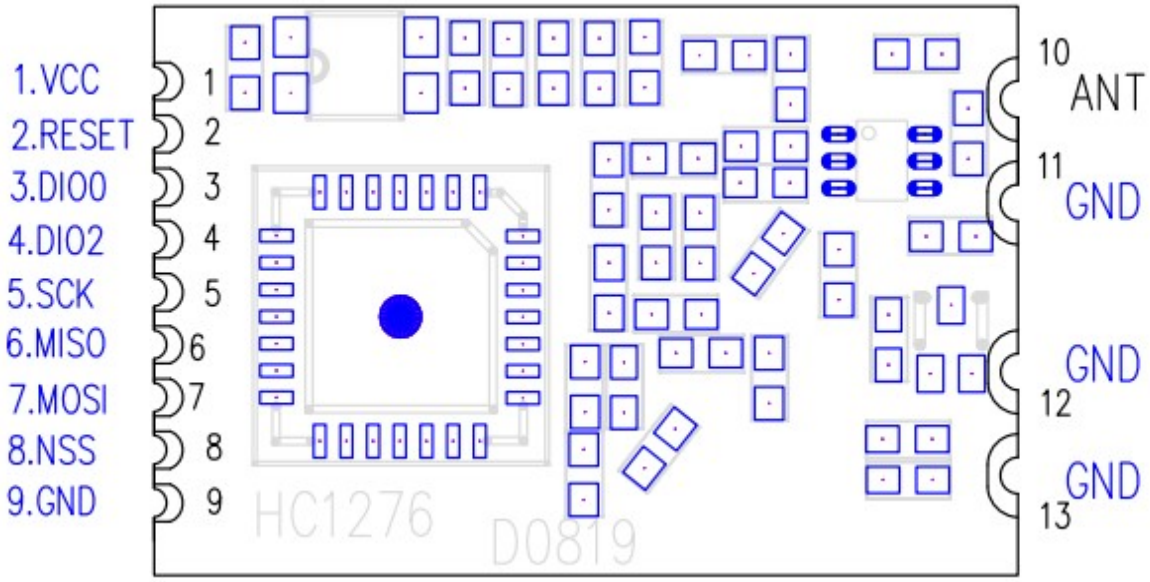
2. Applications：

- Automated Meter Reading.
- Home and Building Automation.
- Wireless Alarm and Security Systems.
- Industrial Monitoring and Control
- Long range Irrigation Systems

3. Features：

- LoRa™ Modem
- 168 dB maximum link budget
- +20 dBm - 100 mW constant RF output vs. V supply
- +14 dBm high efficiency PA
- Programmable bit rate up to 300 kbps
- High sensitivity: down to -148 dBm
- Bullet-proof front end: IIP3 = -11 dBm
- Excellent blocking immunity
- Low RX current of 9.9 mA, 200 nA register retention
- Fully integrated synthesizer with a resolution of 61 Hz
- FSK, GFSK, MSK, GMSK, LoRa™and OOK modulation
- Built-in bit synchronizer for clock recovery
- Preamble detection
- 127 dB Dynamic Range RSSI
- Automatic RF Sense and CAD with ultra-fast AFC
- Packet engine up to 256 bytes with CRC
- Built-in temperature sensor and low battery retention

4. Pin Diagram



5. Pin Description

Number	Name	Type	D
1	VCC	I	Supply voltage for moudule.
2	RESET	I	Reset trigger input.
3	DIO0	I/O	Digital I/O, software configured.
4	DIO2	I/O	Digital I/O, software configured.
5	SCK	I	SPI Clock input.
6	MISO	O	SPI Data output.
7	MOSI	I	SPI Data input.
8	NSS	I	SPI Chip select input
9,11-13	GND	I	Ground.
10	ANT	0	RF Output

6. Electrical Characteristics

6.1. ESD Notice

The HC1276 is a high performance radio frequency device. It satisfies:

- Class 2 of the JEDEC standard JESD22-A114-B (Human Body Model) on all pins.
- Class III of the JEDEC standard JESD22-C101C (Charged Device Model) on all pins

It should thus be handled with all the necessary ESD precautions to avoid any permanent damage.

6.2. Absolute Maximum Ratings

Stresses above the values listed below may cause permanent device failure. Exposure to absolute maximum ratings for extended periods may affect device reliability.

Table 3 Absolute Maximum Ratings

Symbol	Description	Min	Max	Unit
VDDmr	Supply Voltage	-0.5	3.9	V
Tmr	Temperature	-55	+115	° C
Tj	Junction temperature	-	+125	° C
Pmr	RF Input Level	-	+10	dBm

Note Specific ratings apply to +20 dBm operation (see Section 5.4.3).

6.3. Operating Range

Table 1 Operating Range

Symbol	Description	Min	Max	Unit
VDDop	Supply voltage	1.8	3.7	V
Top	Operational temperature range	-40	+85	°C
Clop	Load capacitance on digital ports	-	25	pF
ML	RF Input Level	-	+10	dBm

Note A specific supply voltage range applies to +20 dBm operation (see Section 5.4.3).

7. Power Consumption

Table 3 Power Consumption Specification

Symbol	Description	Conditions	Min	Typ	Max	Unit
IDDSL	Supply current in Sleep mode		-	0.2	1	uA
IDDIDLE	Supply current in Idle mode	RC oscillator enabled	-	1.5	-	uA
IDDST	Supply current in Standby mode	Crystal oscillator enabled	-	1.6	1.8	mA
IDDFS	Supply current in Synthesizer mode	FSRx	-	5.8	-	mA
IDDR	Supply current in Receive mode	*LnaBoost* Off, band 1 *LnaBoost* On, band 1	- -	10.8 11.5	- -	mA
IDDT	Supply current in Transmit mode with impedance	RFOP = +20 dBm, on PA_BOOST RFOP = +17 dBm, on PA_BOOST RFOP = +13 dBm, on RFO_LF/HF pin RFOP = + 7 dBm, on	- - -	120 87 29	- - -	m A

8. Frequency Synthesis

Table 4 Frequency Synthesizer Specification

Symbol	Description	Conditions	Min	Typ	Max	Unit
FR	Synthesizer frequency range	Programmable Band 1 Programmable Band 2	137 410	- -	175 525	MHz
FXOSC	Crystal oscillator frequency		-	32	-	MHz
TS_OSC	Crystal oscillator wake-up time		-	250	-	us
TS_FS	Frequency synthesizer wake-up time to PllLock	From Standby mode	-	60	-	us
TS_HOP	Frequency synthesizer hop time at most 10 kHz away from the target frequency	200 kHz step 1 MHz step 5 MHz step 7 MHz step 12 MHz step	- - - - -	20 20 50 50 50	- - - - -	us us us us us
FSTEP	Frequency synthesizer step	FSTEP = FXOSC/2^{19}	-	61.0	-	Hz
FRC	RC Oscillator frequency	After calibration	-	62.5	-	kHz
BRF	Bit rate, FSK	Programmable values (1)	1.2	-	300	kbps
BRA	Bit rate Accuracy, FSK	ABS(wanted BR - available BR)	-	-	250	ppm
BRO	Bit rate, OOK	Programmable	1.2	-	32.768	kbps
BR_L	Bit rate, LoRa Mode	From SF6, BW=500kHz to SF12, BW=7.8kHz	0.018	-	37.5	kbps
FDA	Frequency deviation, FSK (1)	Programmable FDA + BRF/2 =< 250 kHz	0.6	-	200	kHz

Note For Maximum Bit rate the maximum modulation index is 0.5.

9. FSK/OOK Mode Receiver

All receiver tests are performed with RxBw = 10 kHz (Single Side Bandwidth) as programmed in *RegRxBw*, receiving a PN15 sequence. Sensitivities are reported for a 0.1% BER (with Bit Synchronizer enabled), unless otherwise specified. Blocking tests are performed with an unmodulated interferer. The wanted signal power for the Blocking Immunity, ACR, IIP2, IIP3 and AMR tests is set 3 dB above the receiver sensitivity level.

Table5 FSK/OOK Receiver Specification

Symbol	Description	Conditions	Min	Typ	Max	Unit
RFS_F_LF	Direct tie of RFI and RFO pins, shared Rx, Tx paths FSK sensitivity, highest LNA gain. Bands 2&3	FDA = 5 kHz, BR = 1.2 kb/s	-	-121	-	dBm
		FDA = 5 kHz, BR = 4.8 kb/s	-	-117	-	dBm
		FDA = 40 kHz, BR = 38.4 kb/s*	-	-107	-	dBm
		FDA = 20 kHz, BR = 38.4 kb/s**	-	-108	-	dBm
	Split RF paths, the RF switch insertion loss is not accounted for. Bands 2&3	FDA = 5 kHz, BR = 1.2 kb/s	-	-123	-	dBm
		FDA = 5 kHz, BR = 4.8 kb/s	-	-119	-	dBm
		FDA = 40 kHz, BR = 38.4 kb/s*	-	-109	-	dBm
		FDA = 20 kHz, BR = 38.4 kb/s**	-	-110	-	dBm
RFS_F_HF	Direct tie of RFI and RFO pins, shared Rx, Tx paths FSK sensitivity, highest LNA gain. Band 1	FDA = 5 kHz, BR = 1.2 kb/s	-	-119	-	dBm
		FDA = 5 kHz, BR = 4.8 kb/s	-	-115	-	dBm
		FDA = 40 kHz, BR = 38.4 kb/s*	-	-105	-	dBm
		FDA = 20 kHz, BR = 38.4 kb/s**	-	-105	-	dBm
	Split RF paths, *LnaBoost* is turned on, the RF switch insertion loss is not accounted for. Band 1	FDA = 5 kHz, BR = 1.2 kb/s	-	-123	-	dBm
		FDA = 5 kHz, BR = 4.8 kb/s	-	-119	-	dBm
		FDA = 40 kHz, BR = 38.4 kb/s*	-	-109	-	dBm
		FDA = 20 kHz, BR = 38.4 kb/s**	-	-109	-	dBm
RFS_O	OOK sensitivity, highest LNA gain shared Rx, Tx paths	BR = 4.8 kb/s	-	-117	-	dBm
		BR = 32 kb/s	-	-108	-	dBm
CCR	Co-Channel Rejection, FSK		-	-9	-	dB
ACR	Adjacent Channel Rejection	FDA = 5 kHz, BR=4.8kb/s Offset = +/- 25 kHz or +/- 50kHz Band 3	-	60	-	dB
		Band 2	-	56	-	dB
		Band 1	-	50	-	dB
BI_HF	Blocking Immunity, Band 1	Offset = +/- 1 MHz	-	71	-	dB
		Offset = +/- 2 MHz	-	76	-	dB
		Offset = +/- 10 MHz	-	84	-	dB
BI_LF	Blocking Immunity, Bands 2&3	Offset = +/- 1 MHz	-	71	-	dB
		Offset = +/- 2 MHz	-	72	-	dB
		Offset = +/- 10 MHz	-	78	-	dB

IIP2	2nd order Input Intercept Point Unwanted tones are 20 MHz	Highest LNA gain	-	+55	-	dBm
IIP3_HF	3rd order Input Intercept point Unwanted tones are 1MHz and 1.995 MHz above the LO	Band 1 Highest LNA gain G1 LNA gain G2, 5dB sensitivity hit	- -	-11 -6	- -	dBm dBm
IIP3_LF	3rd order Input Intercept point Unwanted tones are 1MHz and 1.995 MHz above the LO	Band 2 Highest LNA gain G1 LNA gain G2, 2.5dB sensitivity hit	- -	-22 -15	- -	dBm dBm
		Band 3 Highest LNA gain G1 LNA gain G2, 2.5dB sensitivity hit	- -	-15 -11	- -	dBm dBm
BW_SSB	Single Side channel filter BW	Programmable	2.7	-	250	kHz
IMR	Image Rejection	Wanted signal 3dB over sensitivity BER=0.1%	-	50	-	dB
IMA	Image Attenuation		-	57	-	dB
DR_RSSI	RSSI Dynamic Range	AGC enabled Min Max	- -	-127 0	- -	dBm dBm

* *RxBw = 83 kHz (Single Side Bandwidth)*

** *RxBw = 50 kHz (Single Side Bandwidth)*

*** *RxBw = 250 kHz (Single Side Bandwidth)*

10. FSK/OOK Mode Transmitter

Table 6 Transmitter Specification

Symbol	Description	Conditions	Min	Typ	Max	Unit
RF_OP	RF output power in 50 ohms on RFO pin (High efficiency PA).	Programmable with steps Max Min	- -	+14 -1	- -	dBm dBm
ΔRF_OP_V	RF output power stability on RFO pin versus voltage supply.	VDD = 2.5 V to 3.3 V VDD = 1.8 V to 3.7 V	- -	3 8	- -	dB dB
RF_OPH	RF output power in 50 ohms, on PA_BOOST pin (Regulated PA).	Programmable with 1dB steps Max Min	- -	+17 +2	- -	dBm dBm
RF_OPH_MAX	Max RF output power, on PA_BOOST pin	High power mode	-	+20	-	dBm
ΔRF_OPH_V	RF output power stability on PA_-BOOST pin versus voltage supply.	VDD = 2.4 V to 3.7 V	-	+/-1	-	dB
ΔRF_T	RF output power stability versus	From T = -40 °C to +85 °C	-	+/-1	-	dB
PHN	Transmitter Phase Noise	169 MHz, Band 3 10kHz Offset 50kHz Offset 400kHz Offset	- - -	-118 -118 -128	- - -	dBc / Hz
		433 MHz, Band 2 10kHz Offset 50kHz Offset 400kHz Offset	- - - -	-110 -110 -122 -129	- - - -	dBc / Hz
		868/915 MHz, Band 1 10kHz Offset 50kHz Offset 400kHz Offset 1MHz Offset	- - - -	-103 -103 -115 -122	- - - -	dBc / Hz
ACP	Transmitter adjacent channel power (measured at 25 kHz offset)	BT=1. Measurement conditions as defined by EN 300 220-1 V2.3.1	-	-	-37	dBm
TS_TR	Transmitter wake up time, to the first rising edge of DCLK	Frequency Synthesizer enabled, *PaR-amp* = 10us, BR = 4.8 kb/s	-	120	-	us

11. Electrical Specification for LoRa™ Modulation

The table below gives the electrical specifications for the transceiver operating with LoRa™ modulation. Following conditions apply unless otherwise specified:

- Supply voltage = 3.3 V
- Temperature = 25° C
- f_{XOSC} = 32 MHz
- bandwidth (BW) = 125 kHz
- Spreading Factor (SF) = 12
- Error Correction Code (EC) = 4/6
- Packet Error Rate (PER)= 1%
- CRC on payload enabled
- Output power = 13 dBm in transmission
- Payload length = 64 bytes
- Preamble Length = 12 symbols (programmed register *PreambleLength=8*)
- With matched impedances

Table 7 LoRa Receiver Specification

Symbol	Description	Conditions	Mi	Typ	Max	Unit
IDDR_L	Supply current in receiver LoRa™ mode, *LnaBoost* off	Bands 2&3, BW=7.8 to 62.5 kHz	-	11.0	-	mA
		Bands 2&3, BW = 125 kHz	-	11.5	-	mA
		Bands 2&3, BW = 250 kHz	-	12.4	-	mA
		Band 1, BW=7.8 to 62.5 kHz	-	9.9	-	mA
		Band 1, BW = 125 kHz	-	10.3	-	mA
		Band 1, BW = 250 kHz	-	11.1	-	mA
IDDT_L	Supply current in transmitter mode	RFOP = 13 dBm	-	28	-	mA
		RFOP = 7 dBm	-	20	-	mA
IDDT_H_L	Supply current in transmitter mode with an external impedance	Using PA_BOOST pin RFOP = 17 dBm	-	90	-	mA
BI_L	Blocking immunity, CW interferer	offset = +/- 1 MHz offset	-	89	-	dB
		= +/- 2 MHz offset = +/-		94		dB
IIP2_L	2nd order Input Intercept Point Unwanted tones are 20 MHz above	Highest LNA gain	-	+55	-	dBm
IIP3_L_HF	3rd order Input Intercept point Unwanted tones are 1MHz and 1.995 MHz above the LO	Band 1 Highest LNA gain G1	-	-11	-	dBm
		LNA gain G2, 5dB sensitivity hit	-	-6	-	dBm

Symbol	Description	Conditions	Min.	Typ	Max	Unit
IIP3_L_LF	3rd order Input Intercept point Unwanted tones are 1MHz and 1.995 MHz above the LO	Band 2 Highest LNA gain G1 LNA gain G2,2.5dB sensitivity hit	- -	-22 -15	- -	dBm dBm
RFS_L10_HF	RF sensitivity, Long-Range Mode, highest LNA gain, *LnaBoost* for Band 1, using split Rx/Tx path	SF = 6 SF = 7 SF = 8	- - -	-131 -134 -138	- - -	dBm dBm dBm
RFS_L62_HF	RF sensitivity, Long-Range Mode, highest LNA gain, *LnaBoost* for Band 1, using split Rx/Tx path 62.5 kHz bandwidth	SF = 6 SF = 7 SF = 8 SF = 9 SF = 10	- - - - -	-121 -126 -129 -132 -135	- - - - -	dBm dBm dBm dBm dBm
RFS_L125_HF	RF sensitivity, Long-Range Mode, highest LNA gain, *LnaBoost* for Band 1, using split Rx/Tx path 125 kHz bandwidth	SF = 6 SF = 7 SF = 8 SF = 9 SF = 10	- - - - -	-118 -123 -126 -129 -132	- - - - -	dBm dBm dBm dBm dBm
RFS_L250_HF	RF sensitivity, Long-Range Mode, highest LNA gain, *LnaBoost* for Band 1, using split Rx/Tx path 250 kHz bandwidth	SF = 6 SF = 7 SF = 8 SF = 9 SF = 10	- - - - -	-115 -120 -123 -125 -128	- - - - -	dBm dBm dBm dBm dBm
RFS_L500_HF	RF sensitivity, Long-Range Mode, highest LNA gain, *LnaBoost* for Band 1, using split Rx/Tx path 500 kHz bandwidth	SF = 6 SF = 7 SF = 8 SF = 9 SF = 10	- - - - -	-111 -116 -119 -122 -125	- - - - -	dBm dBm dBm dBm dBm
RFS_L7.8_LF	RF sensitivity, Long-Range Mode, highest LNA gain, Band 2 or 3, using split Rx/Tx path	SF = 12 SF = 11	- -	-148 -145	- -	dBm dBm
RFS_L10_LF	RF sensitivity, Long-Range Mode, highest LNA gain, Band 3, 10.4 kHz bandwidth	SF = 6 SF = 7 SF = 8	- - -	-132 -136 -138	- - -	dBm dBm dBm
RFS_L62_LF	RF sensitivity, Long-Range Mode, highest LNA gain, Band 3, 62.5 kHz bandwidth	SF = 6 SF = 7 SF = 8 SF = 9 SF = 10	- - - - -	-123 -128 -131 -134 -135	- - - - -	dBm dBm dBm dBm dBm

Symbol	Description	Conditions	Min.	Typ	Max	Unit
RFS_L125_LF	RF sensitivity, Long-Range Mode, highest LNA gain, Band 3, 125 kHz bandwidth	SF = 6 SF = 7 SF = 8 SF = 9 SF = 10	- - - - -	-121 -125 -128 -131 -134	- - - - -	dBm dBm dBm dBm dBm
RFS_L250_LF	RF sensitivity, Long-Range Mode, highest LNA gain, Band 3 250 kHz bandwidth	SF = 6 SF = 7 SF = 8 SF = 9 SF = 10	- - - - -	-118 -122 -125 -128 -131	- - - - -	dBm dBm dBm dBm dBm
RFS_L500_LF	RF sensitivity, Long-Range Mode, highest LNA gain, Band 3 500 kHz bandwidth	SF = 6 SF = 7 SF = 8 SF = 9 SF = 10	- - - - -	-112 -118 -121 -124 -127	- - - - -	dBm dBm dBm dBm dBm
CCR_LCW	Co-channel rejection Single CW tone = Sens +6 dB 1% PER	SF = 7 SF = 8 SF = 9 SF = 10	- - - -	5 9.5 12 14.4	- - - -	dB dB dB dB
CCR_LL	Co-channel rejection	Interferer is a LoRa™ signal using same BW and same SF. Pw = Sensitivity + 3 dB		-6		dB
ACR_LCW	Adjacent channel rejection	Interferer is 1.5*BW_L from the wanted signal center frequency 1% PER, Single CW tone = Sens + 3 dB	-	60 72	-	dB dB
IMR_LCW	Image rejection after calibration.	1% PER, Single CW tone = Sens +3 dB	-	66	-	dB
FERR_L	Maximum tolerated frequency offset between transmitter and receiver, no	All BW, +/-25% of BW The tighter limit applies (see		+/-25%		BW
	Maximum tolerated frequency offset between transmitter and receiver, no	SF = 12 SF = 11	-50 -100	- -	50 100	ppm ppm

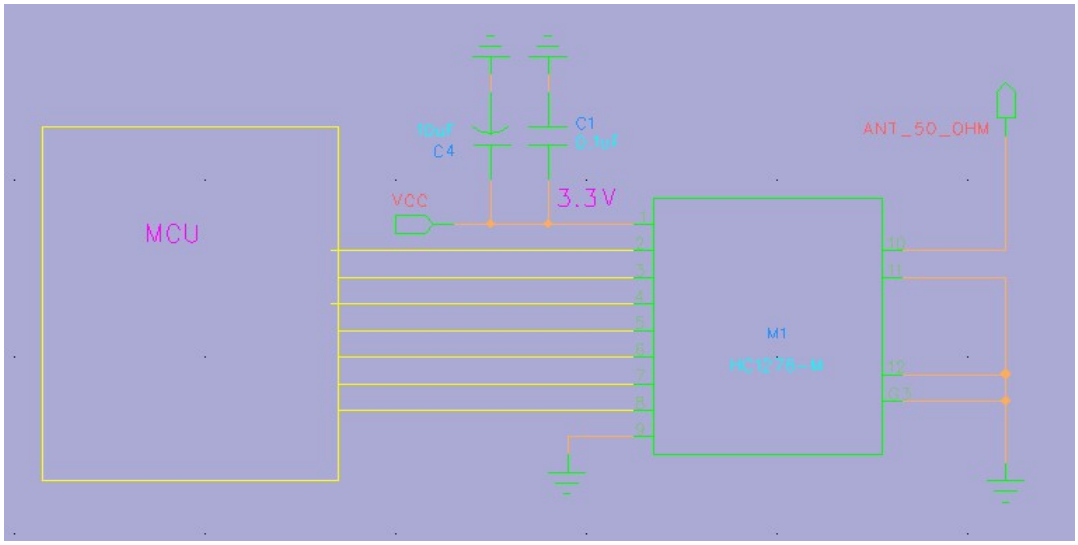
12. Digital Specification

Conditions: Temp = 25° C, VDD = 3.3 V, FXOSC = 32 MHz, unless otherwise specified.

Table 8 Digital Specification

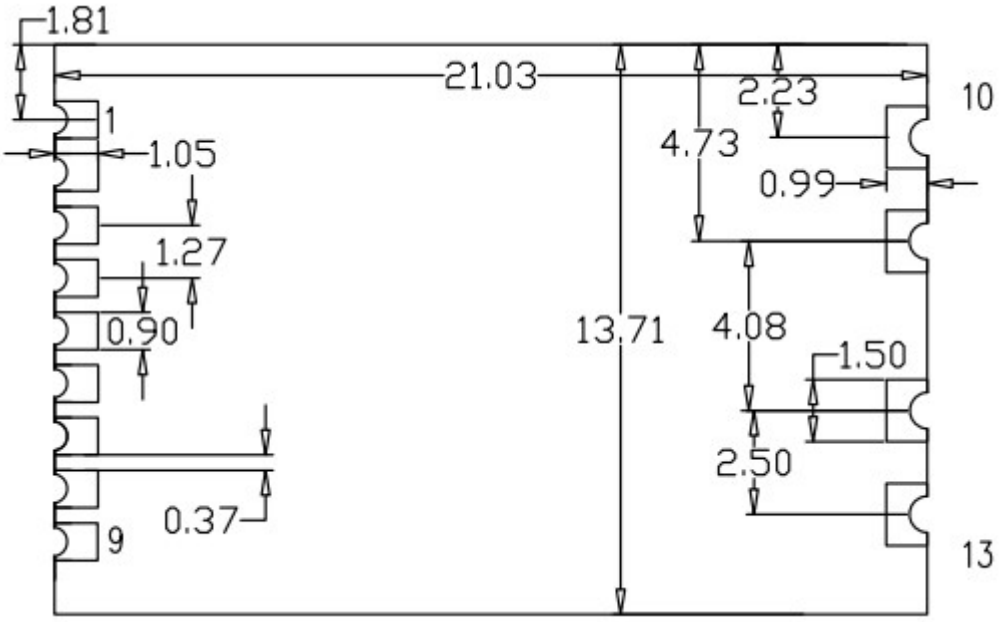
Symbol	Description	Conditions	Min	Typ	Max	Unit
V_{IH}	Digital input level high		0.8	-	-	VDD
V_{IL}	Digital input level low		-	-	0.2	VDD
V_{OH}	Digital output level high	Imax = 1 mA	0.9	-	-	VDD
V_{OL}	Digital output level low	Imax = -1 mA	-	-	0.1	VDD
F_{SCK}	SCK frequency		-	-	10	MHz
t_{ch}	SCK high time		50	-	-	ns
t_{cl}	SCK low time		50	-	-	ns
t_{rise}	SCK rise time		-	5	-	ns
t_{fall}	SCK fall time		-	5	-	ns
t_{setup}	MOSI setup time	From MOSI change to SCK rising edge.	30	-	-	ns
t_{hold}	MOSI hold time	From SCK rising edge to MOSI change.	20	-	-	ns
t_{nsetup}	NSS setup time	From NSS falling edge to SCK rising edge.	30	-	-	ns
t_{nhold}	NSS hold time	From SCK falling edge to NSS rising edge, normal mode.	100	-	-	ns
t_{nhigh}	NSS high time between SPI accesses		20	-	-	ns
T_DATA	DATA hold and setup time		250	-	-	ns

13. Appication



14. Module Package Outline Drawing

Unit: mm



15. Ordering Information

Model	Part Number	Operation Band
HC1276	HC1276-315	315MHz
HC1276	HC1276-433	433MHz
HC1276	HC1276-868	868MHz
HC1276	HC1276-915	915MHz

16. Module Revisions

Revisions	Date	Updated History
Rev1.0	March 2016	The first final release

17. Importance Notice

The HC1276 datasheet will be changed by LJ ELECTRONICS TECHNOLOGY LIMITED according to the module design.

18.Contact us

E-mail: bonnie@Ljelect.com Http://www.Ljelect.com

LJ ELECTRONICS TECHNOLOGY LIMITED

TEL: 0769-83021397 FAX: 0769- 82828646

The 2nd Floor (west side),JieAn Industrial Park, The 1st Industrial Road,

TuTang Village, ChangPing Town,DongGuan City, GuangDong, China