LT2510P Family Preliminary Manual

LT2510P Regulatory Information

Agency Identification Numbers

Family	US/FCC	CANADA/IC
LT2510P	KQL-2510100P	2268C-2510100P

LT2510P FAMILY

Part #	Description	Packaging
PRM110	125mW (+21 dBm), SMD with U.FL connector	SMD-U.FL
PRM111	125mW (+21 dBm), SMD with Chip antenna	SMD-ANT
PRM112	50mW (+17 dBm), SMD with U.FL connector	SMD-U.FL
PRM113	50mW (+17 dBm), SMD with Chip antenna	SMD-ANT
PRM120	125mW (+21 dBm), Pluggable with U.FL connector	PLG-U.FL
PRM121	125mW (+21 dBm), Pluggable with Chip antenna	PLG-ANT
PRM122	50mW (+17 dBm), Pluggable with U.FL connector	PLG-U.FL
PRM123	50mW (+17 dBm), Pluggable with Chip antenna	PLG-ANT

Approved Antenna List

LT2510P family has been designed to operate with the antennas listed below and having a maximum gain of 9dbi. The required antenna impedance is 50 ohms.

Item	Part Number	Mfg.	Type	Gain (dBi)
1	WIC2450-A	Laird Technologies	Chip	2
2	NZH2400-MMCX	Laird Technologies	Microstrip	1
3	ID2450-RS36[2]	Laird Technologies	Panel	9
3	IG2450-RS36[2]	Laird Technologies	Omni	6
4	S151FC-L-(132)PX-2450S	Nearson	Dipole	5

- The OEM is free to choose another vendor's antenna of like type and equal or lesser gain as an antenna appearing in the table and still maintain compliance.

FCC/ IC Requirements for Modular Approval

In general, there are two agency classifications of wireless applications; portable and mobile.

Portable – Portable is a classification of equipment where the user, in general, will be within 20 cm of the transmitting antenna. Portable equipment is further broken down into two classes; within 2.5 cm of human contact and beyond 2.5 cm. The LT2510P family is not agency approved for portable applications. The OEM is required to have additional testing performed to receive this classification. Contact Laird Technology for more details.

Mobile – Mobile defines equipment where the user will be 20 cm or greater from the transmitting equipment. The antenna must be mounted in such a way that it cannot be moved closer to the user with respect to the equipment, although the equipment may be moved.

This equipment has been approved for mobile applications where the equipment should be used at distances greater than 20 cm from the human body. Operation at distances of less than 20 cm would require additional RF exposure evaluation, including SAR requirement according to FCC RF Exposure guideline.

NOTE: 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 not cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user in encouraged to try to correct the interference by one or more of the following measures:

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

OEM Equipment Labeling Requirements

WARNING: The OEM must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Laird Technology FCC identifier for this product as well as the FCC notice below. The FCC identifiers are listed above.

Contains FCC ID:KQL-2510100P This enclosed 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

Label and text information should be in a size of type large enough to be readily legible, consistent with the dimensions of the equipment and the label. However, the type size for the text is not required to be larger than eight point.

Antenna Requirements

To reduce potential radio interference to other users, the antenna type and gain should be chosen so that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

WARNING: This device has been tested with an U.FL connector and the above listed antennas. When integrated into the OEM's product, these fixed antennas require professional installation preventing end-users from replacing them with non-approved antennas. Any antenna not listed in the above table must be tested to comply with FCC Section 15.203 for unique antenna connectors and Section 15.247 for emissions. Contact Laird Technology for assistance.

Caution: Any changes or modifications not expressly approved by Laird Technology could void the user's authority to operate the equipment.

Warnings Required In OEM Manuals

WARNING: This equipment has been approved for mobile applications where the equipment should be used at distances greater than 20cm from the human body. Operation at distances of less than 20cm is prohibited and requires additional SAR evaluation .

OVERVIEW AND KEY FEATURES

The LT2510 Frequency Hopping Spread Spectrum Transceiver Module from Laird Technologies is the latest in robust and easy to use radio modules. Supporting both high data rates and long ranges, the LT2510 is a great fit for any number of machine to-machine applications. The LT2510 features an easy to use serial UART with hardware flow control for fast integration into an existing serial infrastructure.

KEY FEATURES

- Retries and acknowledgements
- Configurable network parameters
- Multiple generic I/O
- 280 kbps or 500kbps RF data stream
- Idle current draw of 12mA, sleep current of 50uA
- Software selectable interface baud rates from 1200 bps to 460.8 kbps
- Upgradable FW through serial port
- Low cost, low power and small size ideal for high volume, portable and battery powered applications
- All modules are qualified for Industrial temperatures (-40°C to 85°C)
- Advanced configuration available using AT commands
- Easy to use Configuration & Test Utility software

OVERVIEW

The LT2510 is available in two main versions, one with 100mW conducted output power and approved for North American and similar markets and one with 50mW conducted output power and approved for European and similar markets. These modules are identical except for output power, max power consumption, and the number of RF Channels available. This document will call out the differences where appropriate based on the part numbers.

This document contains information about the hardware and software interface between a Laird Technologies LT2510 transceiver and an OEM Host. Information includes the theory of operation, specifications, interface definitions, configuration information and mechanical drawings.

Note: Unless mentioned specifically by name, the LT2510 modules will be referred to as "radio" or "transceiver". Individual naming is used to differentiate product specific features. The host (PC/Microcontroller/Any device to which the LT2510 module is connected) will be referred to as "OEM Host" or "Host."

SPECIFICATIONS

TABLE 1: LT2510 DETAILED SPECIFICATIONS

GENERAL		FCC: PRM110/111/120/121	CE: PRM112/113/122/123
Form Factor		SMD-ANT, SMD-U.FL, Pluggable-ANT, Pluggable-U.FL	
Antenna		Integrated chip antenna or external antenna through U.FL connector	
Serial Interface Data Rate		Baud rates from 1200 bps to 230,400 bps. Non-standard baud rates are also supported.	
Channels		42 or 78 selectable channels	42 selectable channels
Security		Channelization and System ID	
Minimum Flash (EEPROM) Memory Endurance		1000 Write/Erase Cycles	
TRANSCEIVER			
Frequency Band		2400 - 2483.5 MHz	
RF Data Rate (Raw)		280 kbps or 500kbps selectable	
Hop Bin Spacing		900kHz at 280kbps RF Data Rate 1500kHz at 500kbps RF Data Rate	
RF Technology		Frequency Hopping Spread Spectrum	
Modulation		MSK	
Output Power Conducted		+11 to +20dBm selectable	+8 to +17dBm selectable
Supply Voltage		3.3 - 3.6V ± 50mV ripple	
Current Draw	100% TX	190mA	85mA
	1/8 TX (when selected)	40mA	40mA
	100% RX	40mA	40mA
	RX average (idle current)	12mA	12mA
	Deep sleep	50uA	50uA
Receiver Sensitivity (1% PER)		-98 dBm at 280kbps RF Data Rate -94 dBm at 500kbps RF Data Rate	
Range (based on external 2.5dBi antenna at 280kbps RF Data Rate)	Outdoor (line-of-sight)	2.5miles (4km)	1.5miles (2.4km)
	Indoor (estimated)	1300ft (400m)	790ft (240m)
ENVIRONMENTAL			
Operating Temperature Range		-40°C to 85°C	
Storage Temperature Range		-50°C to 85°C	
PHYSICAL			
Dimensions	SMD-ANT	1.0" x 1.54" x 0.14" (25.4mm x 39mm x 3.6mm)	
Dimensions	SMD-U.FL	1.0" x 1.28" x 0.14" (25.4mm x 33mm x 3.6mm)	
Dimensions	Pluggable-ANT	0.96" x 1.42" x 0.406" (24.3mm x 36mm x 10.3mm)	
Dimensions	Pluggable-U.FL	0.96" x 1.185" x 0.406" (24.3mm x 30.1mm x 10.3mm)	

TABLE 2: PIN DEFINITIONS FOR THE LT2510 TRANSCEIVER

SMT PIN	PLUGGABLE PIN	TYPE	SIGNAL NAME	FUNCTIONS
1	7	O	GO_0/ Hop_Frame	Generic Output/Hop_Frame
2	6	O	GO_1	Generic Output
3	8		DNC	Do not connect.
4	17		Reserved	Reserved for future use
5	19	O	PWM_Output	PWM Output
6	3	I	RXD	Asynchronous serial data input to transceiver
7	2	O	TXD	Asynchronous serial data output from transceiver
8	10	GND	GND	Signal Ground
9	1	PWR	Vcc	3.3 - 3.6 V ±50mV ripple (must be connected)
10	-	PWR	Vpa	3.3 – 3.6 V +/-50mV ripple (must be connected)
11	-	GND	GND	Signal Ground
12	9	I	$\overline{\text{Test}}$	Test Mode – When pulled logic Low and then applying power or resetting, the transceiver's serial interface is forced to a 9600, 8-N-1 rate. To exit Test Mode, the transceiver must be reset or power-cycled with Test Mode pulled logic High or left floating/disconnected. Note: Because this mode disables some modes of operation, it should not be permanently pulled Low during normal operation.
13	14	I	DI0	Digital Input 0
14	5	I	$\overline{\text{UP\_Reset}}$	RESET – Controlled by the LT2510 for power-on reset if left unconnected. After a stable power-on reset, a logic Low pulse will reset the transceiver.
15	11	I	$\overline{\text{CMD/Data}}$	When logic Low, the transceiver interprets OEM Host data as command data. When logic High, the transceiver interprets OEM Host data as transmit data.
16	15	O	$\overline{\text{In Range}}$	When logic low, the client is in range and synchronized with a server. This will always be low on a Server.
17	16	I	$\overline{\text{RTS}}$	Request to Send. Floats high if left unconnected, when enabled the module will not transmit data out the Serial UART unless the pin is low
18	12	O	$\overline{\text{CTS}}$	Clear to Send - Active Low when the transceiver is ready to accept data for transmission.
19	14	I	DI1	Digital Input 1
20	13		Reserved	Reserved for future use. Do not connect.
21	4		Reserved	Reserved for future use. Do not connect.
22	20	I	AD_In	Analog to Digital Input

ENGINEER'S TIP

- All I/O is 3.3V TTL.
- All inputs are weakly pulled High via a 20kOhm pull-up resistor and may be left floating during normal operation
- Minimum Connections: VCC, VPA, GND, TXD, & RXD
- Signal direction is with respect to the transceiver
- Unused pins should be left disconnected

TABLE 3: INPUT CHARACTERISTICS

SIGNAL NAME	MIN HIGH	HIGH MAX	LOW MIN	LOW MAX
RXD	2.31v	3.3v	0v	.99v
$\overline{\text{Test}}$	2.31v	3.3v	0v	.99v
$\overline{\text{UP\_Reset}}$	0.8v	3.3v	0v	0.6v
$\overline{\text{CMD/Data}}$	2.31v	3.3v	0v	.99v
$\overline{\text{RTS}}$	2.31v	3.3v	0v	.99v
AD_In	N/Av	3.3v	0v	N/A
DI0	2.31v	3.3v	0v	.99v
DI1	2.31v	3.3v	0v	.99v

TABLE 4: OUTPUT CHARACTERISTICS

SIGNAL NAME	MIN HIGH	HIGH MAX	LOW MIN	LOW MAX	SINK CURRENT
GO_0	2.5v	3.3v	0v	0.4v	20mA
GO_1	2.5v	3.3v	0v	0.4v	20mA
PWM_Output	N/A	3.3v	0v	N/A	4mA
TXD	2.5v	3.3v	0v	0.4v	4mA
$\overline{\text{In\_Range}}$	2.5v	3.3v	0v	0.4v	4mA
$\overline{\text{CTS}}$	2.5v	3.3v	0v	0.4v	4mA

BLOCK DIAGRAM

Figure 1 includes a functional Block Diagram of the transceiver module.

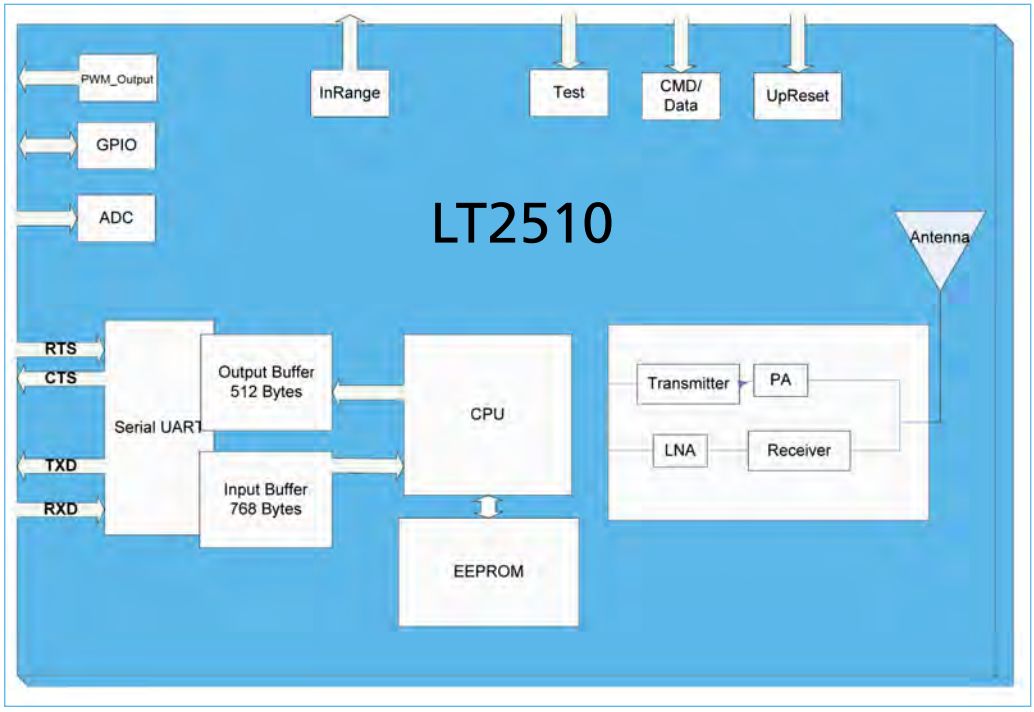
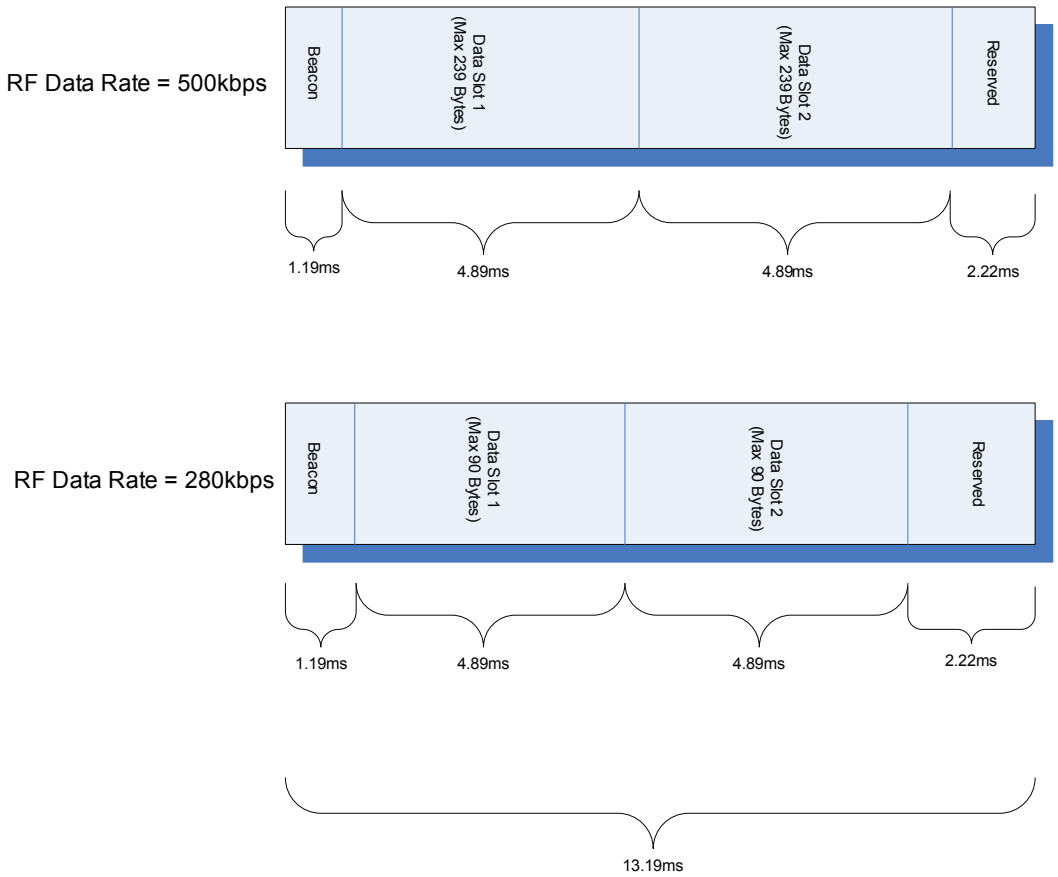


TABLE 5: TIMING SPECIFICATIONS

PARAMETER	SERVER/CLIENT	MIN	TYP	MAX	NOTES
Power on to CTS Low		5ms	10ms	N/A	
EEPROM Read		800us	1ms	2ms	Measured from last byte of command to first byte of response: 870us for 1 byte 1.1ms for 80bytes 1.4ms for 256bytes
EEPROM Write		20ms	30ms	40ms	Measured. EEPROM writes cause the radio to go out of range for up to 3 seconds
Power on to In Range	Client only, server will go in range in less than 13ms	13ms	600ms	1700ms*	*Maximum time assuming all beacons are heard, RF interference could extend the maximum time indefinitely
Hop Period In Range			13.19ms		
Hop Period Out of Range	Client only		38.4ms		
Reset Pulse		250ns			

HOP FRAME



PIN DESCRIPTIONS

RXD and TXD

The LT2510 accepts 3.3 VDC TTL level asynchronous serial data from the OEM Host via the RXD pin. Data is sent from the transceiver, at 3.3V levels, to the OEM Host via the TXD pin.

$\overline{\text{Test}}$

Test Mode - When pulled logic Low before applying power or resetting, the transceiver's serial interface is forced to 9600, 8-N-1 (8 data bits, No parity, 1 stop bit): regardless of actual EEPROM setting. The interface timeout is also set to 3 ms and the RF packet size is set to the default size for the selected RF Data Rate. To exit, the transceiver must be reset or power-cycled with Test pin logic High or disconnected.

Note: Because this pin disables some modes of operation, it should not be permanently pulled Low during normal operation.

$\overline{\text{UP\_RESET}}$

UP_Reset provides a direct connection to the reset pin on the LT2510 microprocessor and is used to force a hard reset. For a valid reset, reset must be asserted Low for an absolute minimum of 250 ns.

$\overline{\text{Command/Data}}$

When logic High, the transceiver interprets incoming serial data as transmit data to be sent to other transceivers. When logic Low, the transceiver interprets incoming serial data as command data. When logic Low, data packets from the radio will not be transmitted over the RF interface however incoming packets from other radios will still be received. RX Data Received can be disabled by enabling CMD/Data RX Disable in the EEPROM.

$\overline{\text{In\_Range}}$

The In Range pin will be driven low when a client radio is synchronized with a server. In Range will always be driven low on a server. In Range will transition low in approximately 12ms on a Server. For a Client the In Range will take an average of 500ms, this time is dependant on the server timing and the signal strength of the received beacon. It can vary from 150ms to over 1500ms.

Hop_Frame

Disabled by default and controlled by the Control 1, Bit-6 EEPROM Setting. When enabled this pin will transition logic Low at the start of a hop and transition logic High at the completion of a hop. The OEM Host is not required to monitor Hop Frame.

$\overline{\text{RTS}}$ Handshaking

With RTS mode disabled, the transceiver will send any received data to the OEM Host as soon as it is received. However, some OEM Hosts are not able to accept data from the transceiver all of the time. With RTS enabled, the OEM Host can prevent the transceiver from sending it data by de-asserting RTS (High). Once RTS is re-asserted (Low), the transceiver will send packets to the OEM Host as they are received.

Note: Leaving RTS de-asserted for too long can cause data loss once the transceiver's receive buffer reaches capacity.

$\overline{\text{CTS}}$ Handshaking

If the transceiver buffer fills up and more bytes are sent to it before the buffer can be emptied, data loss will occur. The transceiver prevents this loss by deasserting CTS High as the buffer fills up and asserting CTS Low as the buffer is emptied. CTS should be monitored by the Host device and data flow to the radio should be stopped when CTS is High.

SERVER/CLIENT ARCHITECTURE

The LT2510 utilizes a server-client network architecture to synchronize the frequency hopping. Each network must have one radio configured as a Server and all other radios configured as Clients. When a radio is configured as a Server, it will transmit a beacon at the beginning of each hop. Radios configured as Clients will default to a receive mode where they are scanning the available frequencies listening for a beacon from a Server in their network. When a Client detects the Server's beacon, the client will synchronize to it and transition the InRange pin low. When the Server and the Client are synchronized they can begin transferring data.

Each network consists of one, and only one, Server. Multiple networks can exist in the same area, provided the networks are configured on different Channels. The LT2510 utilizes an intelligent Frequency Hopping algorithm which ensures minimal interference between two networks. There is no need to synchronize the communications between the networks. The possible interference between two networks is given by the equation.

Maximum number of interfering bins = #of collocated Servers -1

The LT2510 radio can be configured to hop over 43 or 79 bins, so with two Servers present they will interfere with each other once every 43 or 79 hops. With 10 collocated Servers, they will interfere a maximum of 9 out of 43 or 79 hops (presuming they are also transmitting data during each hop).

ADJUSTABLE RF DATA RATE

The LT2510's RF data rate can be adjusted to provide a trade-off between throughput and range.

TABLE 6: RF DATA RATE

PRODUCT MODEL	RF DATA RATE	NUMBER OF HOPS	RECEIVER SENSITIVITY	THROUGHPUT[1]
PRM110, 111, 121, 122	280kpbs	79	-98dBm	120kpbs
PRM110, 111, 112, 113, 121, 122, 123, 124	500kpbs	43	-94dBm	250kpbs
PRM110, 111, 112, 113, 121, 122, 123, 124	280kpbs	43	-98dBm	120kpbs

1 Throughput is ideal, one direction, with no retransmissions. All practical RF applications should include the need to retransmit data due to interference or less than ideal RF conditions.

2 CE versions (50 mW) allow the 43 hop set ONLY.

Deciding which RF Data Rate to choose depends on the individual application. The fast RF Data Rate will deliver much faster throughput, but will have much less range. In addition, because the lower data rate solution uses more hops, it is better situated for collocated networks. In version 1.XX and above the RF Data rate is set by the appropriate RF Profile, EEPROM Address 0xXX.

A rule of thumb for RF systems is every 6dB of gain doubles the effective distance. The 4dB gain on the Receive Sensitivity for the lower data rate solution means it will be able to transmit almost 60% farther than the higher data rate solution.