APEX/APEX LT DATASHEET

ZigBee Ready Modules

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1 Product Description

The LS Research APEX and APEX LT modules are 2.4 GHz 802.15.4 data transceivers providing a cost-effective solution for data links and wireless networks.

The APEX module is based on the Ember EM250 802.15.4/Zigbee platform and supports point to point, point to multi-point, and EmberZNet applications. It provides a true Zigbee module combining an IEEE 802.15.4 compliant radio transceiver with a 16-bit microprocessor.

The APEX LT module is based on the Ember EM260 Zigbee network processor providing an IEEE 802.15.4 compliant radio transceiver with a SPI based interface to an application microprocessor, giving the flexibility to choose the external microprocessor size to best fit the application.

Both APEX and APEX LT utilize a 100mW power amplifier, providing for enhanced range performance over standard 802.15.4/Zigbee implementations. The APEX modules offer a standard integrated PCB trace antenna. Alternatively, each module has the option to be populated with a MMCX connector for use with an external cabled antenna.

The hardware design files can be licensed from LS Research or LS Research can modify the hardware to accommodate specific application requirements. The APEX modules provide a low cost, best in class performance, in a compact form factor.

2 Key Features

- 100mW output
- Specifically designed for use with EmberZNet
- Small form factor (1.00" x 1.275")
- Integrated antenna
- Supported connector for external antenna
- 16 RF channels (Channel 16 at a reduced power level)
- Long Range: over 4000 feet
- Output power software controlled 1mW – 100mW
- Integrated hardware support for Ember InSight Development Environment
- Non-intrusive debug interface (SIF)
- AES-128 encryption
- Constant RF output power over voltage range of 2.1 – 3.6V
- RoHS compliant

APEX module

- 128 kB Flash memory
- 5 kB SRAM
- 16-bit XAP2b microprocessor
- 16 GPIO connections
- Two serial controllers with DMA – SPI, I^2C, UART functionality
- Integrated ADC with 12-bit resolution

APEX LT module

- Integrated IEEE 802.15.4 PHY and MAC
- Dedicated network processor
- SPI-slave or UART interface to application microcontroller
- Handles all processing and timing intensive tasks of Zigbee protocol

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3 Absolute Maximum Ratings

Rating	Value	Unit
Power Supply Voltage	3.6	Vdc
Voltage on any digital pin	VDD + 0.3, Max 3.6	Vdc
RF Input Power	+10	dBm
Storage Temperature Range	-45 to 125	°C

Note: Under no circumstances exceeding the maximum ratings in Table can be allowed. Such a stress may cause permanent damage to the module or devices

4 Operating Conditions

Characteristic	Min	Typ	Max	Unit
Power Supply Voltage (Vdd)	2.1		3.6	V
Input Frequency	2405		2480	MHz
Ambient Temperature Range	-40	25	85	°C
Logic Input Low Voltage	0		20% Vdd	V
Logic Input High Voltage	80% Vdd		Vdd	V

5 Electrical Specifications

At 25°C, Vdd = 3.3V for both APEX and APEX LT unless stated otherwise.

5.1 General

Parameter	Min	Typ	Max	Unit
RF Frequency Range	2400		2483.5	MHz
RF Data Rate		250		kbps
Microcontroller Operating Frequency (APEX only)		12		MHz
Flash Memory (APEX only)		128		kB
RAM (APEX only)		5		kB

5.2 Power Consumption

Parameter	Min	Typ	Max	Unit
Transmit Mode (100mW output)				
APEX		170		mA
APEX LT		170		mA
Receive Mode				
APEX		37		mA
APEX LT		37		mA
Standby Mode				
10mW			5	µA
100mW			5	µA

Boost mode is an optional higher performance radio mode that is software selectable to boost receiver sensitivity.

5.3 Transmitter

Parameter	Min	Typ	Max	Unit
Nominal Output Power		20		dBm
Programmable Output Power range		32		dB
Error Vector Magnitude		15	35	%

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5.4 Receiver

Parameter	Min	Typ	Max	Unit
Receiver Sensitivity (1% PER) – normal mode	-92	-96		dBm
Receiver Sensitivity (1% PER) – boost mode	-93	-97		dBm
Saturation (Maximum Input Level) (1% PER)	0			dBm
802.15.4 Adjacent Channel Rejection				
APEX	35			dB
APEX LT	30			dB
802.15.4 Alternate Channel Rejection	40			dB
802.11g Rejection (±10 MHz)				
APEX	40			dB
APEX LT	30			dB

5.5 Control DC characteristics

Parameter	Min	Typ	Max	Unit
Logic Input Low	0		0.2VDD	V
Logic Input High	0.8VDD		VDD	V
Logic Output Low	0		0.18VDD	V
Logic Output High	0.82VDD		VDD	V
Output source current (standard pad – APEX)			4	mA
Output sink current (standard pad – APEX)			4	mA
Output source current (high current pad – APEX)			8	mA
Output sink current (high current pad – APEX)			8	mA
I/O pin pull-up and pull-down resistor (APEX)		30		kΩ

Please refer to the Ember EM250/EM260 datasheets (www.ember.com) for further information or more details regarding the functional descriptions of the system modules.

6 Pin Signals, I/O port configuration

The APEX/APEX LT modules have 28 edge I/O interfaces for connection to the user's host board. Figure 1 shows the layout of the 28 edge castellations.

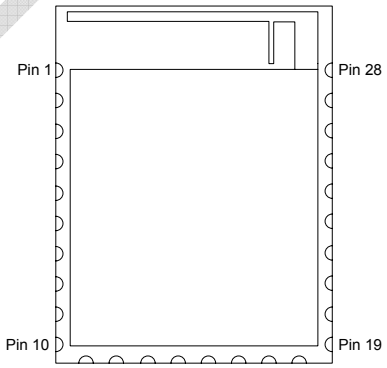

Figure 1

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6.1 The I/O pin assignments for the APEX module

Pin #	Name	Type	Description
1	GROUND	GND	Ground
2	GROUND	GND	Ground
3	GROUND	GND	Ground
4	VDD	PI	Power Supply Input
5	RSTB	DI	Reset, active low
6	GPIO11	DI/DO	General Purpose Digital I/O, SC1 UART CTS, SC1 SPI master clock, or Capture Input A of Timer 2
7	GPIO12	DI/DO	General Purpose Digital I/O, SC1 UART RTS, or Capture Input B of Timer 2
8	GPIO0	DI/DO	General Purpose Digital I/O, SC2 SPI MOSI, or Capture Input A of Timer 1
9	GPIO1	DI/DO	General Purpose Digital I/O, SC2 SPI MISO, SC2 I²C SDA, or Capture Input A of Timer 2
10	GPIO2	DI/DO	General Purpose Digital I/O, SC2 SPI master clock, SC2 I²C SCL, or Capture Input B of Timer 2
11	GPIO3	DI/DO	General Purpose Digital I/O, SC2 SPI slave select, or Capture Input B of Timer 1
12	GPIO4	DI/DO/AI	General Purpose Digital I/O, ADC Input 0, or PTI frame signal
13	GPIO5	DI/DO/AI	General Purpose Digital I/O, ADC Input 1, or PTI data signal
14	GPIO6	DI/DO/AI	General Purpose Digital I/O, ADC Input 2, Timer 2 Clock Input, or Timer 1 Enable
15	GPIO7	DO	Regulator Enable, active high (see section 8)
16	GPIO8	DI/DO/AO	General Purpose Digital I/O, ADC Reference Output, Timer 1 Clock Input, Timer 2 Enable, or Source A Interrupt
17	GPIO9	DI/DO	General Purpose Digital I/O, SC1 TXD, SC1 MO, SC1 I²C Data, or Capture Input A of Timer 1
18	GPIO10	DI/DO	General Purpose Digital I/O, SC1 RXD, SC1 MI, SC1 I²C Clock, or Capture Input B of Timer 1
19	CLK	DI	SIF Interface clock
20	MISO	DO	SIF Interface master in/slave out
21	MOSI	DI	SIF Interface master out/slave in
22	LOADB	DI/DO	SIF Interface load strobe
23	GPIO16	DI/DO	General Purpose Digital I/O, Output B of Timer 1, Capture Input B of Timer 2, or Source D Interrupt
24	GPIO15	DI/DO	General Purpose Digital I/O, Output A of Timer 1, Capture Input A of Timer 2, or Source C Interrupt
25	GPIO14	DI/DO	General Purpose Digital I/O, Output B of Timer 2, Capture Input B of Timer 1, or Source B Interrupt
26	GPIO13	DI/DO	General Purpose Digital I/O, Output A of Timer 2, or Capture Input A of Timer 1
27	GROUND	GND	Ground
28	GROUND	GND	Ground

Unused I/O pins should be left unconnected and the pin state set via the Host Protocol.

DI = Digital Input PI = Power Input AI = Analog Input
DO = Digital Output GND = Ground AO = Analog Output

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The APEX module contains 16 GPIO ports that are shared with other peripheral or alternate functions. The alternate functions can be utilized on a variety of different GPIOs as detailed in the following table of pin assignments and definitions. All the GPIO pads are selectable as input, output, or bi-directional and have an internal pull-up or pull-down.

The integrated Serial Controller SC1 can be configured for SPI (master-only), I^2C (master-only), or UART functionality. The Serial Controller SC2 can be configured for SPI (master or slave) or I^2C (master-only) operation. The integrated ADC can sample analog signals from three GPIO pins single-ended or differentially. The integrated voltage reference VREF for the ADC can be made available to a GPIO port.

Please consult the Ember EM250 datasheet for details on configuring and controlling the information flow of the APEX module interface ports to setup the following:

- GPIO Data Registers
- Alternate function routing
- External Interrupts
- Serial Controller SC1 module (UART mode, SPI Master mode, I^2C Master mode)
- Serial Controller SC2 module (SPI modes, I^2C Master mode)
- General Purpose Timers
- ADC Module
- Event Manager

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6.2 I/O pin assignments for the APEX LT module

Pin #	Name	Type	Description
1	GROUND	GND	Ground
2	GROUND	GND	Ground
3	GROUND	GND	Ground
4	GROUND	GND	Ground
5	VDD	PI	Power Supply Input
6	nRESET	DI	Reset, active low
7	MOSI	DI	SPI Data, Master Out/Slave In (from Host to APEX LT)
8	MISO	DO	SPI Data, Master In/Slave Out (from APEX LT to Host)
9	SCLK	DI	SPI Clock (from Host to APEX LT)
10	VPA_EN	DI	APEX LT Enable, active high (see section 8)
11	nRTS	DO	UART RTS
12	nSSEL_INT/nCTS	DI	SPI Slave Select (from Host to APEX LT)/UART CTS
13	PTI_EN	DO	PTI Frame signal
14	PTI_DATA	DO	PTI Data signal
15	TXD	DO	UART TXD
16	nHOST_INT/RXD	DO/DI	Host Interrupt Signal (from APEX LT to Host) or UART RXD
17	nWAKE	DI	Wake Interrupt Signal (from host to APEX LT)
18	GROUND	GND	Ground
19	SIF_CLK	DI	SIF Interface clock
20	SIF_MISO	DO	SIF Interface master in/slave out
21	SIF_MOSI	DI	SIF Interface master out/slave in
22	nSIF_LOAD	DI/DO	SIF Interface load strobe
23	SDBG	DO	Spare Debug Signal
24	LINK_ACTIVITY	DO	Link and Activity signal
25	GROUND	GND	Ground
26	GROUND	GND	Ground
27	GROUND	GND	Ground
28	GROUND	GND	Ground

Unused I/O pins should be left unconnected and the pin state set via the Host Protocol.

DI = Digital Input PI = Power Input AI = Analog Input
DO = Digital Output GND = Ground AO = Analog Output

The APEX LT module provides a connection to the Ember Serial API over the SPI allowing the application development to be completed on a host microprocessor of choice. In addition to the SPI signals, two additional signals (nHOST_INT and nWAKE) provide a handshake mechanism. The module is the slave device with all transactions initiated by the host. Please consult the EM260 datasheet (www.ember.com) for details on the SPI Protocol including:

- Physical Interface Configuration
- SPI Transactions
- SPI Protocol Timing Parameters & Waveforms
- Data Formatting
- SPI Commands & Responses
- Handling Resets and Power Cycling
- Transaction Examples

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7 SIF Interface

The APEX and APEX LT modules provide access to the SIF module programming and debug interface. Consult the EM250 and EM260 datasheets for further details on the following features it provides

- Production Testing
- Firmware Download
- Product Control and Characterization
- XAP2b Code Development (APEX only)

8 Power Amplifier Regulator Control Line

Both the APEX and APEX LT modules include a separate 1.8V regulator for the power amplifier bias to enable the consistent module output performance over the wide Vdd voltage range of 2.1 – 3.6 volts. To prevent excessive sleep currents, this regulator needs to be disabled when the module is put into sleep mode. An external pull up resistor population option is provided on each module (R6) to allow the regulator to be constantly enabled. This option will increase the sleep current of the module well above the specified values.

The following table provides the specifications for the regulator enable control line.
GPIO7 (APEX), VPA_EN (APEX LT)

Parameter	Min	Typ	Max	Unit
Regulator enable voltage	0.95			V
Regulator disable voltage			0.4	V
Enable line current (VEN = 0)			0.1	µA
Enable line current (VEN = Vdd)			10	µA
Turn on Time			250	µsec

On the APEX LT module the VPA_EN control must be provided by the host microprocessor. In normal operation, the VPA_EN line must be set high. It must be set low when the module is put into sleep mode in conjunction with putting the EM260 into deep sleep. Upon a module wake-up the Turn on time requirement of 250µsec must be met prior to any transmission to allow the module regulator to settle. The EM260 wake up time is separate from this value as this 250µsec requirement applies only to the external power amplifier.

On the APEX module, the regulator control line is brought to the module ports via GPIO7. The host can drive this port as on the APEX LT module, but alternatively, the EM250 can use the default serial digital function of GPIO7 which is as an external voltage regulator enable. Please consult the EM250 datasheet for details on the operation of this function. Note that both approaches preclude the use of the GPIO7 port for any other possible functions including the use as the ADC3 input.

If the application does not put the module to sleep or if sleep current is not an issue, the power amplifier regulator may be permanently enabled by tying the control line high. In this setup, the sleep current will increase by 80µA over the value provided in section 5.2.

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9 Antenna

The APEX and APEX LT modules include an integrated PCB trace antenna. An optional configuration with a MMCX connector is also available. This will enable connector to a 50-ohm external antenna of the user's choice.

The integrated PCB antenna topology is an F-antenna. This antenna is used because it is reasonably compact, has a fairly omni-directional radiation pattern, good efficiency, and is very simple. An adequate ground plane is necessary to provide good efficiency. The ground plane of the host board on which the module is mounted increases the effective antenna ground plane size and improves the antenna performance if done per the guidelines provided in this datasheet.

The antenna radiation patterns are dependent upon the host board the APEX/APEX LT module is mounted on. Measured radiation patterns of the module alone are available by contacting LS Research.

The environment the module is placed in will dictate the range performance. The non-ideal characteristics of the transmission channel result in the transmitted signal producing reflection, diffraction, and/or scattering. All of these factors randomly combine to create extremely complex scenarios.

It is also best to keep some clearance between the antenna and nearby objects. This includes how the module is mounted in the product enclosure. Unless the items on the following list of recommendations are met, the radiation pattern can be heavily distorted.

- Never place ground plane or copper trace routing underneath the antenna.
- Never place the antenna very close to metallic objects.
- In the final product, ensure that any wiring or other components do not get too close to the antenna.
- The antenna will need a reasonable ground plane area on the mother board area to be efficient.
- Do not use a metallic enclosure or metallized plastic for the antenna.
- Try to keep any plastic enclosure greater than 1 cm from the antenna in any orientation.

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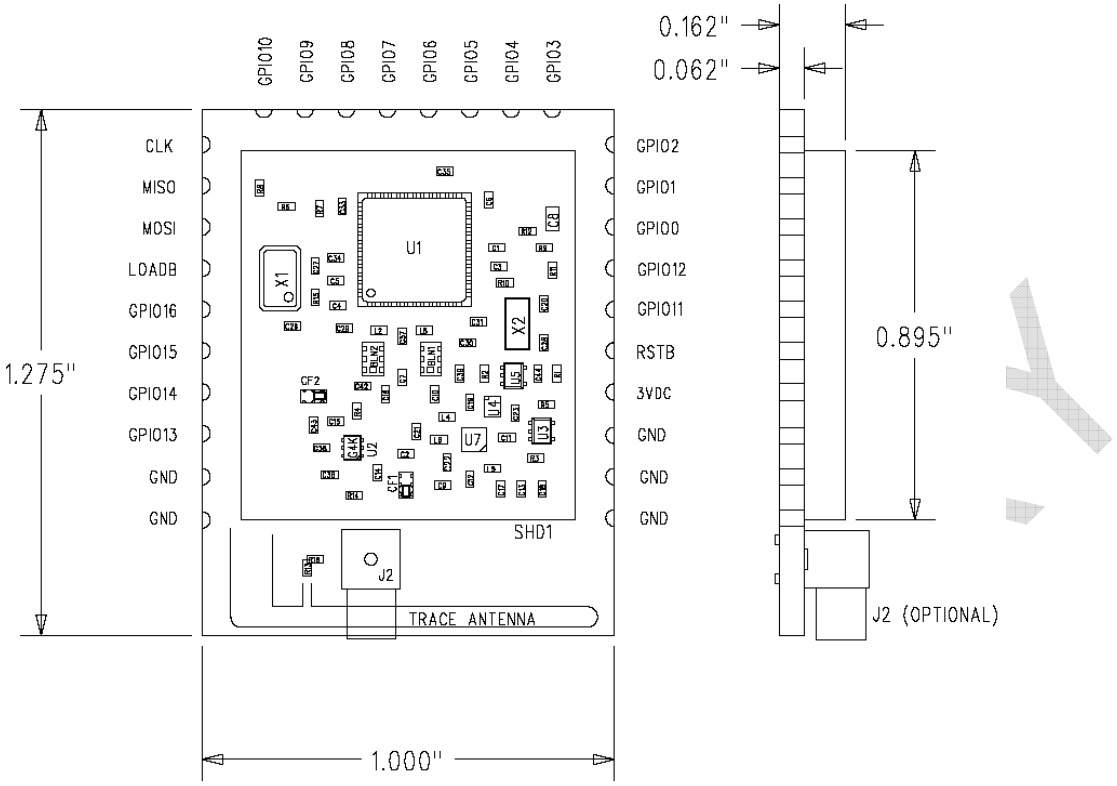
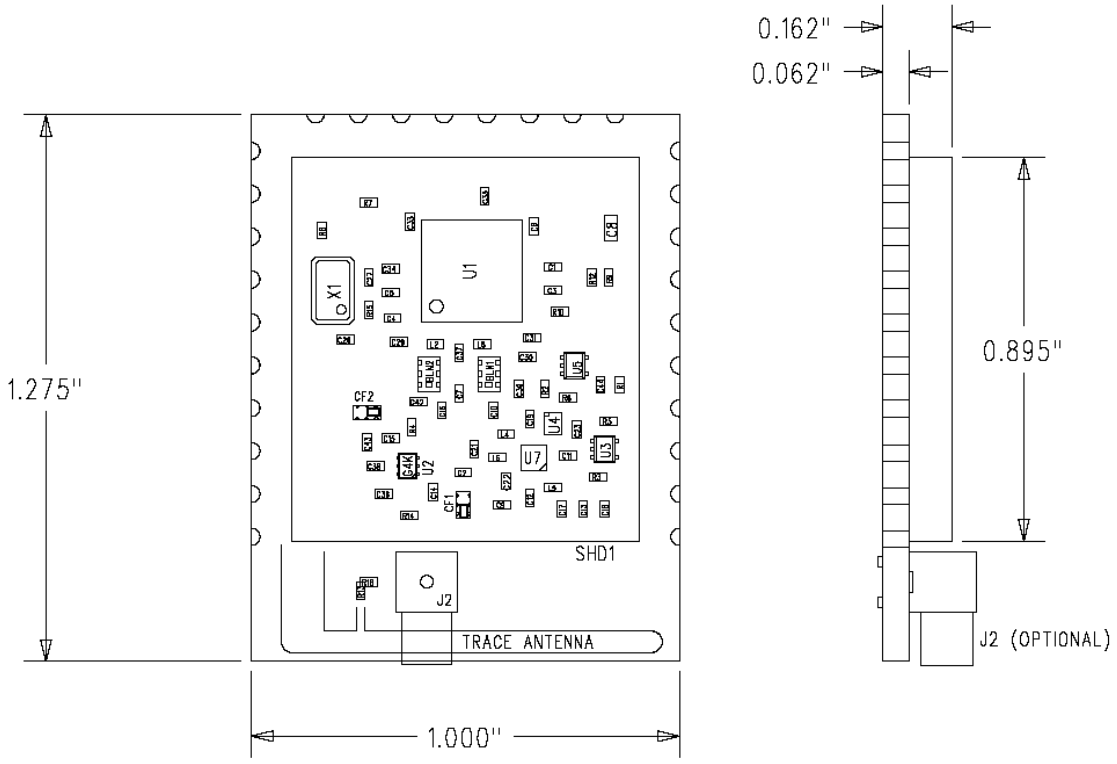
10 Mechanical Drawing – APEX



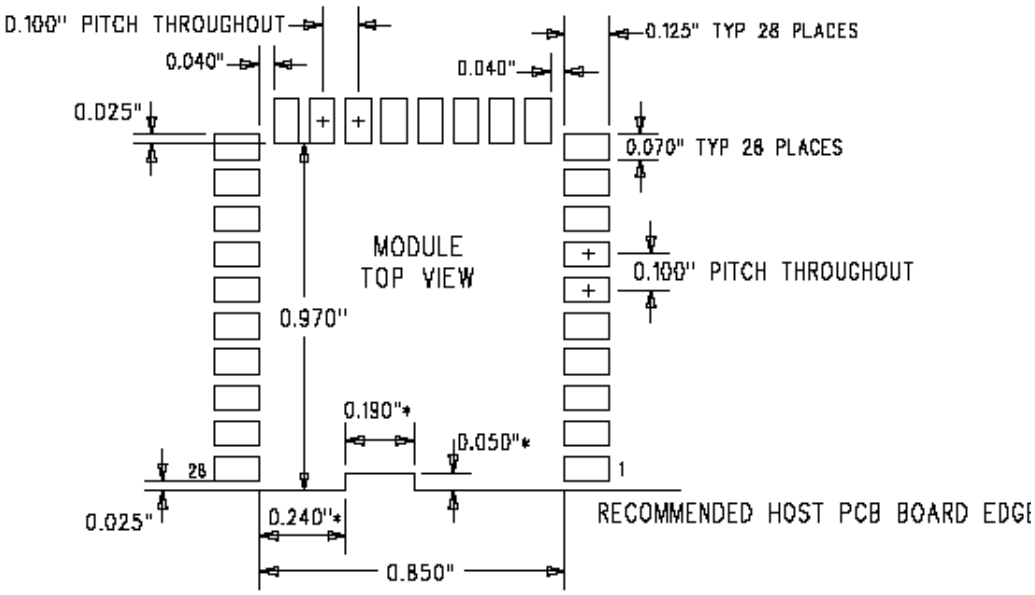
APEX LT



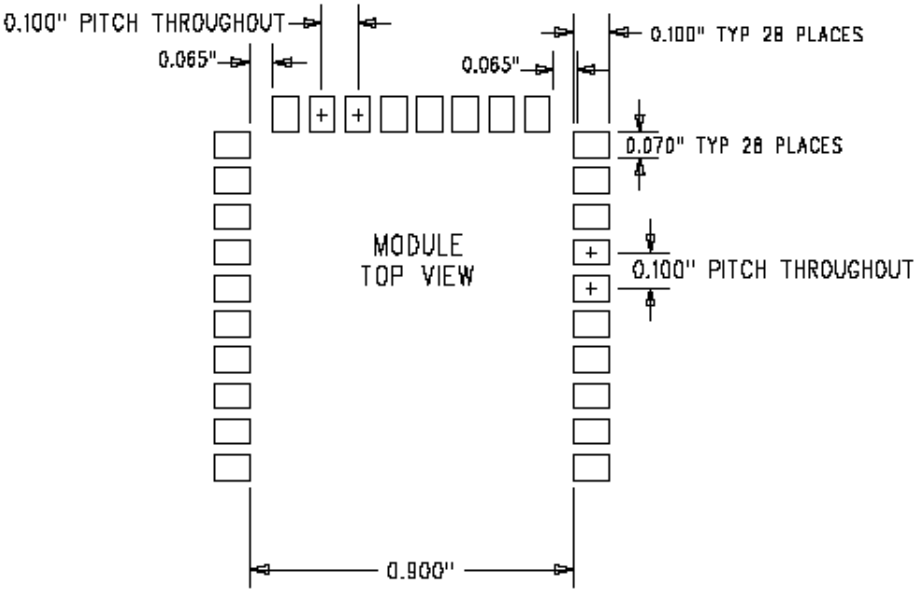
11 Mounting considerations

PCB Pattern Layout

For both APEX/APEX LT

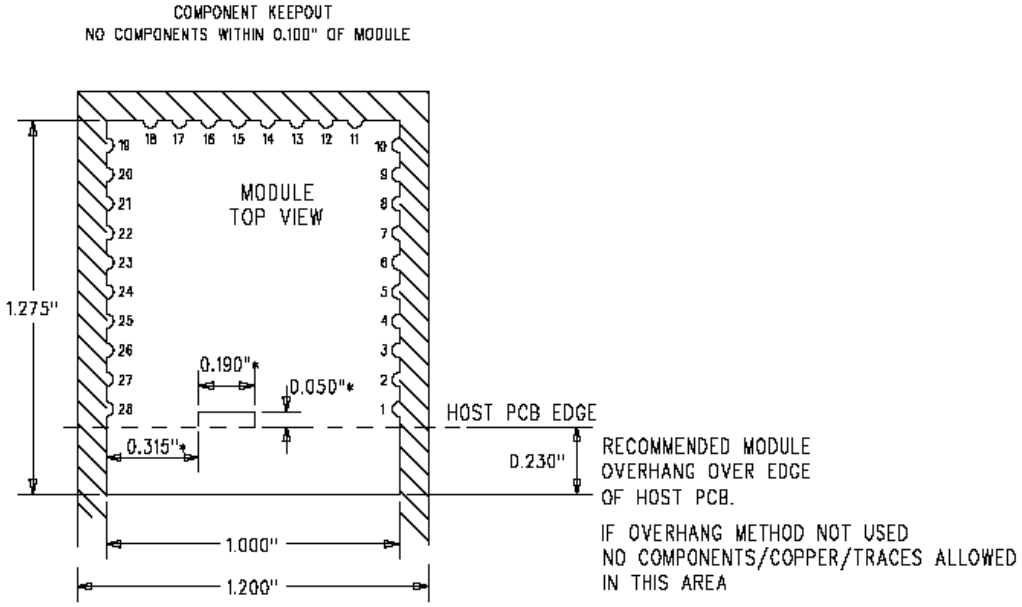


PCB COPPER PATTERN
FOR REFERENCE ONLY



PASTE STENCIL PATTERN
FOR REFERENCE ONLY

Keep out areas
APEX/APEX LT



* IF CONNECTOR J2 IS POPULATED ON MODULE, HOST BOARD EDGE MUST BE NOTCHED AS SHOWN

= NO HOST BOARD PERIPHERAL COMPONENTS ALLOWED

The footprint recommends the APEX/APEX LT module is to be mounted so the antenna is overhanging the board edge. This will provide the best antenna performance for the PCB trace antenna. It is also recommended to have a ground plane on the host board underneath the rest of the module, up to the recommended PCB edge. This will only improve the antenna performance by increasing the overall ground plane.

Traces can be run underneath the module on the host PCB as long a there is an uninterrupted ground plane on one layer as well. LS Research will provide any guidance and help with the host PCB layout.

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12 Agency Certifications

FCC Part 15.247 Module Certified (Mobile)

The APEX and APEX LT modules comply with Part 15 of the Federal Communications Commission rules and regulations. To meet the FCC Certification requirements, the user must meet these regulations.

- The text on the FCC ID label provided with the module is placed on the outside of the final product.
- The modules may only use the antennas that have been tested and approved with this module.
    - The on-board PCB trace antenna
    - Nearson S131CL-5-RMM-2450S antenna.

To meet the section 15.209 emission requirements in the restricted frequency bands of section 15.205, the maximum transceiver transmitter power setting for both the APEX (EM250) and APEX LT (EM260) modules vary depending on the channel used within the band of operation as follows:

APEX module using external antenna – maximum channel power setting

Channel 11 (2405 MHz)	-4
Channel 12 (2410 MHz) – Channel 23 (2465 MHz)	3
Channel 24 (2470 MHz)	-7
Channel 25 (2475 MHz)	-14
Channel 26 (2480 MHz)	-2b

APEX module using on board PCB trace antenna – maximum channel power setting

Channel 11 (2405 MHz) – Channel 24 (2470 MHz)	3
Channel 25 (2475 MHz)	-12
Channel 26 (2480 MHz)	-2b

APEX LT module using either external or PCB trace antenna – maximum channel power setting

Channel 11 (2405 MHz) – Channel 24 (2470 MHz)	0
Channel 25 (2475 MHz)	-10
Channel 26 (2480 MHz)	-26

Per section 2.109, the APEX and APEX LT modules have been certified by the FCC for use with other products without additional certification. Any modifications to this product may violate the rules of the Federal Communications Commission and make operation of the product unlawful.

Per sections 15.107 and 15.109, the user's end product must be tested to comply with unintentional radiators for compliance.

Per Section 47 C.F.R. Sec.15.105(b), the APEX and APEX LT modules are certified as a mobile device for the FCC radiation exposure limits set forth for an uncontrolled environment. The antenna used with this module must be installed to provide a separation distance of at least 8 inches (20cm) from all persons. If the module is to be used in a handheld application, the user

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is responsible for passing the additional FCC part 2.1093 rules (SAR) and FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, OET Bulletin and Supplement C.

The labeling requirements for Industry Canada are similar to those of the FCC. A visible label on the outside of the final product must display the IC labeling. The user is responsible for the end product to comply with IC ICES-003 (Unintentional radiators).

The APEX and APEX LT modules have been certified per EN 300-328-1 for use in European countries. The user must ensure compliance of any final product to the European harmonized EMC and safety standards. Annex II of the R&TTE Directive gives the requirements for the issuance of a Declaration of Conformity.

The CE marking must be affixed legibly and indelibly to a visible location on the user's product.

To meet the EN 300-328-1 power spectral density requirements of Clause 4.3.2.2, the maximum transceiver power setting for the APEX module and the APEX LT module are as follows:

Maximum transceiver power setting for APEX CE approval

Channel 11 (2405 MHz) - Channel 22 (2460 MHz)	-15
Channel 23 (2465 MHz) – Channel 26 (2480 MHz)	-20

Maximum transceiver power setting for APEX LT CE approval

TBD

12.1 FCC approved antennas

Integrated PCB trace antenna
Nearson S131CL-5-RMM-2450S
A 2.4GHz Dipole antenna with a 5 inch cable and a right angle MMCX connector.

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13 Shipment, Handling, and Storage

13.1 Shipment

The LS Research APEX Modules are delivered in single piece, or 50 piece cartons in individual anti-static bags.

13.2 Handling

The APEX/APEX LT Module is designed and packaged to be processed in an automated assembly line.

! Warning - The Modules contain highly sensitive electronic circuitry. Handling without proper ESD protection may destroy or damage the module permanently.

! Warning - According to JEDEC ISP, the APEX Modules are moisture sensitive devices. Appropriate handling instructions and precautions are summarized in Section 2.1. Read carefully to prevent permanent damages due to moisture intake.

13.3 Storage

Storage/Shelf life in sealed bags is 12 months at <40°C and <90% relative humidity.

14 Processing

14.1 Moisture Preconditioning

Both substrate and some components can absorb moisture. JEDEC specification J-STD-020 must be observed to prevent the delamination and cracking associated with the "popcorn" effect" during solder reflow, (the popcorn effect can be described as miniature explosions of water vapor that has been trapped in gaps).

Baking before processing is required if module is exposed to excessive humidity.

Recommended baking procedure:

Oven: Convection flow oven.
Duration: 48 hours
Temperature: 125°C
Humidity: Below 5%.

After conditioning (baking) modules should be processed within the specified floor life: for products with moisture sensitivity level 4, the floor life is three days, or precisely 72 hours, assuming factory temperature and humidity conditions of <30°C, and <60% relative humidity.

If they cannot be processed within this time period, place the modules with desiccant and a moisture indicator into a humidity proof bag and use a vacuum hot barrier sealing machine for sealing

Other Storage options such as a nitrogen cabinet or dry box are also possible.

Note: A repeated baking process will reduce the wetting effectiveness of the land contacts.

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14.2 Reflow Soldering

A convection soldering oven is recommended over the infrared radiation type oven. Convection ovens allow more precise temperature control, and more even heating of parts regardless of material composition, thickness, or color.

Consider the IPC-7530 Guidelines for temperature profiling for mass soldering processes, reflow and wave, published 2001.

14.2.1 Preheat Phase

Initial heating of component leads and solder paste balls, for removal of residual humidity.
Note: the preheat phase is not intended to replace prior baking procedures.

• Temperature rise rate: 1-4°C/sec
Note: excessive slumping can result if the temperature rise is too rapid.

• Time: 60-120 seconds
Note: If the preheat is insufficient, large solder balls tend to be generated. Conversely, if preheat is excessive, small and large balls will be generated in clusters.

• End Temperature: 150-200°C

14.2.2 Heating/Reflow Phase

The temperature rises above the liquidus temperature of the solder paste selected. Avoid a sudden rise in temperature as any slump of the solder paste could become worse.

• Limit time above liquidus temperature to 20-40 seconds.
• Peak reflow temperature: 230-250°C

14.2.3 Cooling Phase

A controlled cooling phase avoids unwanted metallurgical effects of the solder, and possible mechanical tensions in the products. Controlled cooling helps achieve the brightest possible solder fillets with a good shape and low contact angle.

• Temperature fall rate: max 3°C/sec

14.3 Pb-free Soldering Paste

Use of "No Clean" soldering paste is strongly recommended, as it does not require cleaning after the soldering process. The pastes listed in the examples below meet these criteria.

14.3.1 Soldering Paste: Indium 5.1 (Indium Corporation of America)
Alloy Specification: SAC305 - Sn Zinc 96.5%/Ag Silver 3.0%/Cu Copper 0.5%
Alloy Specification: SAC387 - Sn Zinc 95.5%/Ag Silver 3.8%/Cu Copper 0.7%
Melting Temperature: 217°C

14.3.2 Soldering Paste: LFSOLDER TLF-206-93F (Tamura Kaken [UK] Ltd.)
Alloy Specification: Sn Zinc 95.5%/Ag Silver 3.9%/Cu Copper 0.6%
Melting Temperature: 216-221°C

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The final choice of the soldering paste depends on individual factory approved manufacturing procedures.

Stencil Thickness: 150 µm for host boards

Note: The quality of the solder joints on the castellations ('half vias') where they contact the host board should meet the appropriate IPC specification. See IPC-A-610-12.2.4.

14.4 Cleaning

In general, cleaning the populated modules is strongly discouraged. Residuals under the module cannot be easily removed with any cleaning process.

• Cleaning with water can lead to capillary effects where water is absorbed into the gap between the host board and the module. The combination of soldering flux residuals and encapsulated water could lead to short circuits between neighboring pads. Water could also damage any stickers or labels.

• Cleaning with alcohol or a similar organic solvent will likely flood soldering flux residuals into the two housings, which is not accessible for post-washing inspection. The solvent could also damage any stickers or labels.

• Ultrasonic cleaning could damage the module permanently.

The best approach is to consider using a "no clean" soldering paste and eliminate the post soldering cleaning step.

14.5 Optical Inspection

After soldering the Module to the host board, consider optical inspection to check the following:

• Proper alignment and centering of the module over the pads.
• Proper solder joints on all pads.
• Excessive solder or contacts to neighboring pads, or vias.

14.6 Repeating Reflow Soldering

Only a single reflow soldering process is encouraged for host boards.

14.7 Wave Soldering

If a wave soldering process is required on the host boards due to the presents of leaded components, only a single wave soldering process is encouraged.

14.8 Hand Soldering

Hand soldering is possible. Use a soldering iron temperature setting equivalent to 350°C, follow IPC recommendations/reference document IPC-7711.

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14.9 Rework

The APEX & APEX LT Module can be unsoldered from the host board. Use of a hot air re-work tool and hot plate for pre-heating from underneath is recommended. Avoid overheating.

! Warning - Never attempt a rework on the module itself, e.g. replacing individual components. Such actions will terminate warranty coverage.

14.10 Additional grounding

Attempts to improve module or system grounding by soldering braids, wires, or cables onto the module RF shield cover is done at the customers own risk. The numerous ground pins at the module perimeter should be sufficient for optimum immunity to external RF interference.

14.11 Conformal Coating

Conformal coating may be necessary in certain applications. Please note that the RF shield and the sticker prevent optimum inflow of liquids or aerosols.

15 Contact Info

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Wireless Product Development

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www.lsr.com

For more information e-mail
sales@lsr.com

16 Document history

Revision 0.0 (1-29-2007) Preliminary release
Revision 0.1 (6-1-2007) Updated for performance, APEX LT pin out, mounting considerations.
Revision 0.2 (1-22-2008) Updated for FCC/CE power levels, added section 18

17 Disclaimer

LS Research, LLC believes the information in this document is correct and accurate at the time of release. However, LS Research, LLC reserves the right to make changes to this product without notice.

18 Statements

Compliance Statement (Part 15.19)

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,

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including interference that may cause undesired operation.

Warning (Part 15.21)

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement (Part 15.105 (b))

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.

RF Exposure (OET Bulletin 65)

To comply with FCC's RF exposure limits for general population / uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

OEM Responsibility to the FCC Rules and Regulations

The **APEX** Module has been certified per FCC Part 15 rules for integration into products without further testing or certification. To fulfill the FCC certification requirements the OEM of the **APEX** Module must ensure that the information provided on the **APEX** Label is placed on the outside of the final product.

The **APEX** Module is labeled with its own FCC ID Number. If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

"**Contains Transmitter Module FCC ID: TFB-APEX**"
or
"**Contains FCC ID: TFB-APEX**"

The OEM of the **APEX** Module must only use the approved antenna, which has been certified with this module.

The OEM of the **APEX** Module must test their final product configuration to comply with Unintentional Radiator Limits before declaring FCC compliance per Part 15 of the FCC rules.

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Industry Canada Statement per Section 4.0 of RSP-100

The term **"IC:"** before the certification / registration number only signifies that the Industry Canada technical specifications were met.

Section 7.1.5 of RSS-GEN

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.

Section 7.1.4 of RSS-GEN

This device has been designed to operate with the antenna(s) listed below, and having a maximum gain of 2.0 dB. Antennas not included in this list or having a gain greater than 2.0 dB are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

List of all Antennas Acceptable for use with the Transmitter

Integrated PCB trace antenna
Nearson S131CL-5-RMM-2450S

Section 7.1.5 of RSS-GEN

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

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