



AC4790

Hardware Integration Guide Version 2.0

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Hardware Integration Guide

REVISION HISTORY

Revision	Date	Description	Approved By
1.0		Initial Release	Chris Downey
1.1		Changes and Revisions	Chris Downey
2.0	19 Dec 2013	Separated Hardware Integration Guide (HIG) from User Guide information (created two separate documents). Add Related Documents section.	Chris Downey

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AC4790 TRANSCEIVER

The compact AC4790 900MHz transceiver replaces miles of cable in harsh industrial environments. Using field-proven FHSS technology, which needs no additional FCC licensing in the Americas, OEMs can easily make existing systems wireless with little or no RF expertise.

Overview

The AC4790 is a member of Laird's RAMP OEM transceiver family. The AC4790 is a cost effective, high performance, frequency hopping spread spectrum (FHSS) transceiver designed for integration into OEM systems operating under FCC part 15.247 regulations for the 900 MHz ISM band.

AC4790 transceivers operate in a masterless architecture. When an AC4790 has data to transmit, it enters transmit mode and starts transmitting a sync pulse intended for an individual radio or broadcasts to all transceivers within the same network and range. Intended receivers synchronize to this sync pulse, a session begins, and data is transmitted. This instinctive dynamic peer-to-peer networking architecture enables several transceiver pairs to carry on simultaneous conversations on the same network.

To boost data integrity and security, the AC4790 uses Laird's FHSS technology featuring optional Data Encryption Standards (DES). Fully transparent, these transceivers operate seamlessly in serial cable replacement applications. Communications include both system and configuration data via an asynchronous TTL serial interface for OEM host communications. Configuration data is stored in an on-board EEPROM and most parameters can be changed on the fly. All frequency hopping, synchronization, and RF system data transmission/reception is performed by the transceiver, transparent to the OEM host.

This document contains information about the hardware interface between a Laird AC4790 transceiver and an OEM host. Refer to the [AC4790 User Guide](#) for software and configuration information.

The OEM is responsible for ensuring the final product meets all appropriate regulatory agency requirements listed herein before selling any product.

Note: Unless mentioned specifically by name, the AC4790 modules are referred to as the *radio* or *transceiver*. Individual naming is used to differentiate product-specific features. The host (any device to which the AC4790 is connected, such as a PC) are referred to as *OEM host*.

Features

Networking and Security

- Masterless: True peer-to-peer, point-to-multipoint, point-to-point
- Retries and acknowledgements
- API commands to control packet routing and acknowledgement on a packet-by-packet basis
- FHSS for security and interference rejection
- Customizable RF Channel number and system ID
- Hardware Protocol Status monitoring
- Two generic input and output digital lines and integrated ADC functions

Easy to Use

- Continuous 76.8 kbps RF stream rate
- Software selectable interface baud rates from 1200 bps to 115.2 kbps
- 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 80 °C)
- Advanced configuration available using AT commands

DETAILED SPECIFICATIONS

Table 1: AC4790 Specification table

GENERAL					
20-Pin Interface Connector	Molex 87759-0030, mates with Samtec SMM-110-02-S-D				
MMCX RF Connector	Johnson Components 135-3711-822				
Antenna	AC4790-1x1: Customer must provide AC4790-200: MMCX Connector AC4790-1000: MMCX Connector See Approved Antenna List				
Serial Interface Data Rate	Baud rates from 1200 bps to 115200 bps				
	Duty Cycle (TX = Transmit; Rx = Receive)				
		10% TX	50% TX	100% TX	100% RX
Power Consumption (typical)	AC4790-1x1:	33mA	54mA	80mA	28mA
	AC4790-200:	38mA	68mA	106mA	30mA
	AC4790-1000:	130mA	650mA	1300mA	30mA
Channels	AC4790-1x1/-200: 16 channels, US/Canada AC4790-1x1/-1000: 32 channels, US/Canada AC4790-1x1/-200/-1000: 8 channels, Australia/US/Canada				
Security	One byte System ID. 56-bit DES encryption key.				
Interface Buffer Size	Input/Output: 256 bytes each				
TRANSCIVER					
Frequency Band	902 – 928 MHz US/Canada 915 – 928 MHz Australia, US/Canada (optional)				
RF Rate	76.8 kbps fixed				
RF User Data Rate	~25 kbps average				
RF Technology	Frequency Hopping Spread Spectrum (FHSS)				
		Conducted (no antenna)		EIRP (3dBi gain antenna)	
Output Power	AC4790-1x1:	10 mW typical		20 mW typical	
	AC4790-200:	100 mW typical		200 mW typical	
	AC4790-1000:	743 mW typical		1486 mW typical	
Supply Voltage	AC4790-1x1:	3.3V, ±50 mV ripple			
	AC4790-200:	3.3 – 5.5V, ±50 mV ripple			
	AC4790-1000*:	Pin 10: 3.3 – 5.5V ±50 mV ripple Pin 11: 3.3 ±3%, ±100 mV ripple			
	* Pins 10 and 11 may be tied together, provided the supply voltage never falls below 3.3V, is capable of supplying 1.5A of current, and has a +/-50mV ripple spec.				
Sensitivity	-100 dBm typical @ 76.8 kbps RF Data Rate -110 dBm typical @ 76.8 kbps RF Data Rate (AC4490LR-200/AC4490LR-1000)				
EEPROM write cycles	20000				
Initial Transceiver Sync time/Hop period	25 ms/50 ms				

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Range, Line of Sight (based on 3 dBi gain antenna)	AC4790-1x1:	Up to 1 mile
	AC4790-200:	Up to 4 miles
	AC4790LR-200:	Up to 8 miles
	AC4790-1000:	Up to 20 miles
	AC4790LR-1000:	Up to 40 miles

ENVIRONMENTAL

Temperature (Operational)	-40°C to 80°C
Temperature (Storage)	-50°C to 85°C
Humidity (non-condensing)	10% to 90%

PHYSICAL

Dimensions	Transceiver with MMCX Connector:	1.65" x 1.9" x 0.20"
	AC4790-1x1:	1.00" x 1.00" x 0.162"

CERTIFICATIONS

	AC4490-200/ AC4490LR-200	AC4790-1000
FCC Part 15.247	KQL4x90-200	KQLAC4490
Industry Canada (IC)	2268C-4x90200	2268C-AC44901000



Caution! ESD Sensitive Component. Proper ESD precautions should be used when handling this device to prevent permanent damage.

External ESD protection is required to protect this device from damage as required to pass IEC 61000-4-2 or ISO 10605 based on end system application.

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ELECTRICAL SPECIFICATIONS

Table 2: Input Voltage Characteristics

Signal Name	AC47901x1 / AC4790-1000M				AC4790-200X				Unit
	High Min.	High Max.	Low Min.	Low Max.	High Min.	High Max.	Low Min.	Low Max.	
RS485A/B	N/A	12	-7	N/A	N/A	12	-7	N/A	V
RXD	2.31	3.3	0	0.99	2	5.5	0	0.8	V
GIO	2.31	3.3	0	0.99	2	5.5	0	0.8	V
RTS	2.31	3.3	0	0.99	2	5.5	0	0.8	V
Test	2.31	3.3	0	0.99	2	5.5	0	0.8	V
GI1	2.31	3.3	0	0.99	2	5.5	0	0.8	V
UP_RESET	0.8	3.3	0	0.6	0.8	5	0	0.8	V
Command/Data	2.31	3.3	0	0.99	2	5.5	0	0.8	V
AD In	N/A	3.3	0	N/A	N/A	3.3	0	N/A	V

Table 3: Output Voltage Characteristics

Signal Name	Module Pin	1x1 Pin	Type	High Min.	Low Max.	Unit
Go0	1	19	O	2.5 @ 8 mA	0.4 @ 8 mA	V
TXD	2	6	O	2.5 @ 2 mA	0.4 @ 2 mA	V
RS485A/B	2, 3	N/A	I/O	3.3 @ 1/8 Unit Load	N/A	V
CTS	7	9	O	2.5 @ 2 mA	0.4 @ 2 mA	V
GO1	9	19	O	2.5 @ 2 mA	0.4 @ 2 mA	V
RSSI	13	12	O	See RSSI	See RSSI	V
Session Status	20	18	O	2.5 @ 2 mA	0.4 @ 2 mA	V
GO0	1	19	O	2.5 @ 8 mA	0.4 @ 8 mA	V

HARDWARE

AC4790 Pinout

The AC4790 has a simple interface that allows OEM host communications with the transceiver. Table 4 shows the connector pin numbers and associated functions. The I/O direction is with respect to the transceiver. All outputs are 3.3 VDC levels and inputs are 5 VDC TTL (with the exception of AC4790-1x1 and AC4790-1000 transceivers, which have 3.3 V inputs). All inputs are weakly pulled High and may be left floating during normal operation (with the exceptions listed for the AC4790-1x1).

Table 4: AC4790 Pinout

Pin #	1x1 Pin	Type	Signal Name	Function
1	4	O	GO0	Session status if Protocol Status is enabled. Otherwise, generic output.
2	6	O	TXD	Transmitted data out of the transceiver
		I/O	RS485A (True) ¹	Non-inverted RS485 representation of serial data
3	7	I	RXD	Data input to the transceiver
		I/O	RS485B(Invert) ¹	Mirror image of RS485A
4	5 ²		GI0	Generic Input pin
5	3	GND	GND	Signal Ground
6		O	Do Not Connect	Has internal connection, for Laird use only .
7	9	O	CTS	Clear-to-Send – Active Low when the transceiver is ready to accept data for transmission.
8	10 ²	I	RTS	Request-to-Send – When enabled in EEPROM, the OEM host can take this High when it is not ready to accept data from the transceiver. Note: Keeping RTS High for too long can cause data loss.
9	19	O	GO1	Received Acknowledge status pin if Protocol Status is enabled. Otherwise, generic output.
10	2	PWR	VCC1	AC4790-1x1: 3.3V, ±50mV ripple AC4790-200: 3.3 – 5.5V, ±50mV ripple (Pin 10 is internally connected to Pin 11) AC4790-1000: 3.3 – 5.5V, ±50mV ripple
11	11	PWR	VCC2	AC4790-1x1: 3.3V, ±50mV ripple AC4790-200: 3.3 – 5.5V, ±50mV ripple (Pin 11 is internally connected to Pin 10) AC4790-1000: 3.3V ±3%, ±100mV ripple
12	23	I	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, the transceiver must be reset or power-cycled with Test Mode logic High.
13	12	O	RSSI	Received Signal Strength - An analog output giving an instantaneous indication of received signal strength. Only valid while in Receive Mode.
14	21 ²	I	GI1	Generic Input pin
15	16	I	UP_RESET	RESET – Controlled by the AC4790 for power-on reset if left unconnected. After a stable power-on reset, a logic High pulse will reset the transceiver.
16	13	GND	GND	Signal Ground

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Pin #	1x1 Pin	Type	Signal Name	Function
17	17	I	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.
18	15 ³	I	AD In	10 bit Analog Data Input
19	1,8,20 24-28	N/C	Do Not Connect	Has internal connection, for Laird use only .
20	18	O	Session Status	When logic Low, the transceiver is in session
N/A	14	RF	RF Port	RF Interface
N/A	22	I	Reset	Active Low version of UP_RESET. If RESET is used, UP_RESET should be left floating and if UP_RESET is used, RESET should be left floating.

1. When ordered with a RS485 interface (not available on the AC4790-1x1).
2. Must be tied to VCC or GND if not used. Should never be permitted to float.
3. If used, requires a shunt 0.1µF capacitor at pin 15 followed by a series 1k resistor.

Detailed Pin Definitions

Generic I/O

Both GIn pins serve as generic input pins. When Protocol Status (byte 0xC2 of EEPROM) is disabled, GO0 & GO1 serve as generic outputs. When Protocol Status is enabled, pins GO0 and GO1 alternatively serve as the Session Status and Receive Acknowledge Status pins, respectively. Reading and writing of these pins can be performed using CC Commands.

Hardware Protocol Status

When the GO0 pin is configured as the Session Status pin, GO0 is normally Low. GO0 will go High when a session is initiated and remain High until the end of the session. When the GO1 pin is configured as the Receive Acknowledge Status pin, GO1 is normally Low and GO1 will go High upon receiving a valid RF Acknowledgement and will remain High until the end (rising edge) of the next hop.

TXD & RXD

Serial TTL	The AC4790-200 accepts 3.3 or 5VDC TTL level asynchronous serial data on the RXD pin and interprets that data as either Command Data or Transmit Data. Data is sent from the transceiver, at 3.3V levels, to the OEM host via the TXD pin. Note: The AC4790-1000 & AC4790-1x1 transceivers only accept 3.3V level signals.
RS485	When equipped with an onboard RS485 interface chip, TXD and RXD become the Half Duplex RS485 pins. The transceiver interface will be in Receive mode except when it has data to send to the OEM host. TXD is the non-inverted representation of the data (RS485A) and RXD is a mirror image of TXD (RS485B). The transceiver will still use RTS (if enabled).

CTS

The AC4790 has an interface buffer size of 256 bytes. If the buffer fills up and more bytes are sent to the transceiver before the buffer can be emptied, data is lost. The transceiver prevents this loss by asserting CTS High as the buffer fills up and taking CTS Low as the buffer is emptied. CTS On and CTS Off control the operation of CTS. CTS On specifies the amount of bytes that must be in the buffer for CTS to be disabled (logic High). Even while CTS is disabled, the OEM host can send data to the transceiver, but it should do so carefully.

Note: The CTS On/Off bytes of the EEPROM can be set to 1, in which case CTS will go High as data is sent in and Low when buffer is empty.

RTS

With RTS 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 disabling RTS (logic High). Once RTS is enabled (logic Low), the transceiver can send packets to the OEM host as they are received.

Note: Leaving RTS disabled for too long can cause data loss once the transceiver's 256 byte receive buffer fills up.

Test / 9600 Baud

When pulled logic Low before applying power or resetting, the transceiver's serial interface is forced to a 9600, 8-N-1 (8 data bits, No parity, 1 stop bit). To exit, the transceiver must be reset or power-cycled with Test pin logic High. This pin is used to recover transceivers from unknown baud rates only. It should not be used in normal operation. Instead the transceiver Interface Baud Rate should be programmed to 9600 baud if that rate is desired for normal operation. The Test/9600 pin should be used for recovery purposes only as some functionality is disabled in this mode.

RSSI

Instantaneous RSSI Received Signal Strength Indicator is used by the OEM host as an indication of instantaneous signal strength at the receiver. The OEM host must calibrate RSSI without an RF signal being presented to the receiver. Calibration is accomplished by following these steps:

1. Power up only one transceiver in the coverage area.
2. Measure the RSSI signal to obtain the minimum value with no other signal present.
3. Power up another transceiver and begin sending data from that transceiver to the transceiver being measured.
4. Separate the transceivers by approximately ten feet.
5. Measure the peak RSSI, while the transceiver is in session, to obtain a maximum value at full signal strength.

Validated RSSI As RSSI is only valid when the local transceiver is receiving an RF packet from a remote transceiver, instantaneous RSSI can be very tricky to use. Therefore, the transceiver stores the most recent valid RSSI value. The OEM host issues the Report Last Good RSSI command to request that value. Additionally, validated RSSI can be obtained from Receive Packet and Send Data Complete API commands and from the Probe command. Validated RSSI is not available at the RSSI pin. The following equation approximates the RSSI curve, which is illustrated in [Figure 1](#).

$$\text{Signal Strength (dBm)} = (-46.9 \times \text{VRSSI}) - 53.9$$

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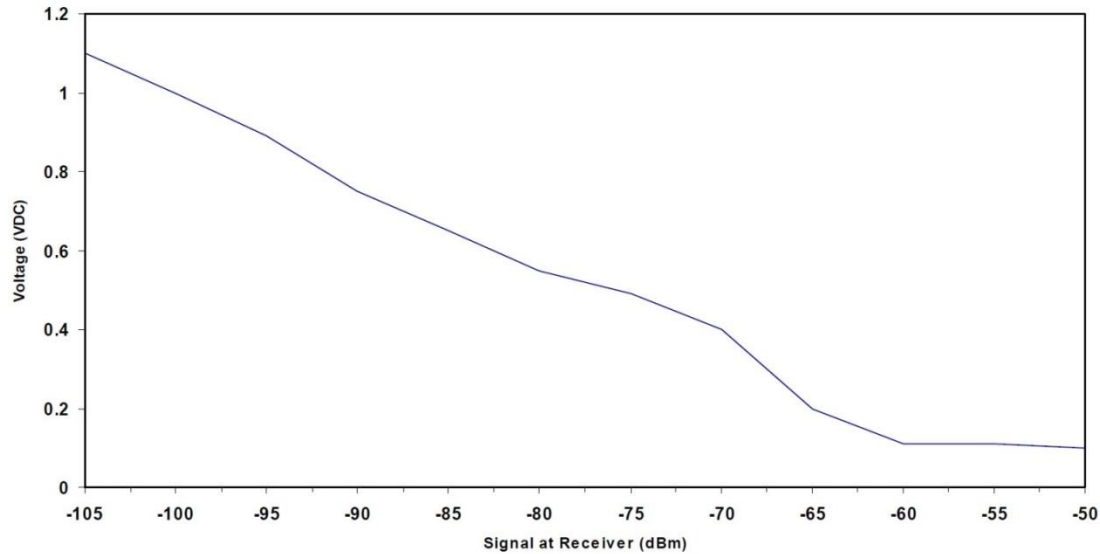


Figure 1: RSSI Voltage vs. Received Signal Strength

UP_Reset

UP_Reset provides a direct connection to the reset pin on the AC4790 microprocessor and is used to force a soft reset. For a valid reset, reset must be asserted High for a minimum of 10 ms.

CMD /Data

When logic High, the transceiver interprets incoming OEM host data as transmit data to be sent to other transceivers and their OEM hosts. When logic Low, the transceiver interprets OEM host data as command data.

AD In

AD In can be used as a cost savings to replace Analog-to-Digital converter hardware. Reading of this pin can be performed locally using the Read ADC command found in the On-the-Fly Control Command Reference.

Session Status

Session Status reports logic Low during a session and logic High when not in session. The inverse of this pin can be obtained from pin GO0 when Protocol Status is enabled.

SERIAL INTERFACE

In order for the OEM host and a transceiver to communicate over the serial interface they must be set to the same serial data rate. Refer to the following sections to ensure that the OEM host data rate matches the serial interface baud rate.

Serial Communications

The AC4790 is a TTL device which can be interfaced to a compatible UART (microcontroller) or level translator to allow connection to serial devices. UART stands for Universal Asynchronous Receiver Transmitter and its main function is to transmit or receive serial data.

Asynchronous Operation

Since there is no separate clock in asynchronous operation, the receiver needs a method of synchronizing with the transmitter. This is achieved by having a fixed baud rate and by using START and STOP bits. A typical asynchronous mode signal is shown in [Figure 2: Asynchronous Mode Signal](#).

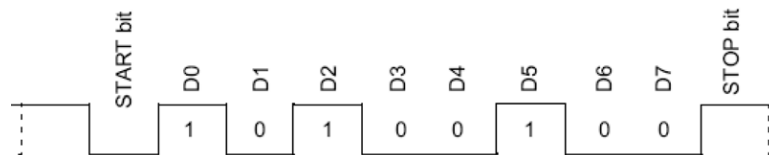


Figure 2: Asynchronous Mode Signal

The UART outputs and inputs logic-level signals on the Tx and Rx pins. The signal is High when no data is being transmitted and goes Low when transmission begins.

The signal stays Low for the duration of the START bit and is followed by the data bits, LSB first. The STOP bit follows the last data bit and is always High. After the STOP bit has completed, the START bit of the next transmission can occur.

Parity

A parity bit is used to provide error checking for a single bit error. When a single bit is used, parity can be either even or odd. Even parity means that the number of ones (1) in the data and parity add up to an even number and vice-versa. The ninth data bit can be used as a parity bit if the data format requires eight data bits and a parity bit as shown in [Figure 3](#). See [Table 5](#) for supported serial data formats.

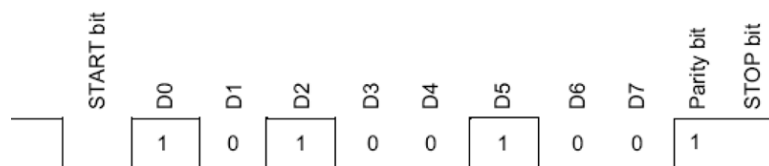


Figure 3: Even Parity Bit

Note: Enabling parity cuts throughput and the interface buffer in half.

OEM Host Data Rate

The OEM Host Data Rate is the rate with which the OEM host and transceiver communicate over the serial interface. This rate is independent of the RF rate, which is fixed at 76.8 kbps. Possible values range from 1200 bps to 115200 bps.

Note: Enabling Parity cuts throughput in half and the Interface Buffer size in half.

Table 5 lists supported asynchronous serial data formats.

Table 5: Supported Serial Formats

Data Bits	Parity	Stop Bits	Transceiver Programming Requirements
8	N	1	Parity Disabled
7	N	2	Parity Disabled
7	E, O, M, S	1	Parity Disabled
9	N	1	Parity Enabled
8	N	2	Parity Enabled
8	E, O, M, S	1	Parity Enabled
7	E, O, M, S	2	Parity Enabled

Mark (M) corresponds to 1 & Space (S) corresponds to 0

Serial Interface Baud Rate

This two-byte value determines the baud rate used for communicating over the serial interface to a transceiver. Table 6 lists values for some common baud rates. Baud rates below 1200 baud are not supported. For a baud rate to be valid, the calculated baud rate must be within $\pm 3\%$ of the OEM host baud rate. If the Test pin (Pin 12) is pulled logic Low at reset, the baud rate will be forced to 9600. The RF rate is fixed at 76.8kbps and is independent of the interface baud rate. For baud rate values other than those shown in Table 6, the following equations can be used:

$$BAUD = \frac{14.7456 \times 10^6}{64 \times \text{Desired Baud}}$$

$$\text{BaudH} = \text{Always } 0$$

$$\text{BaudL} = \text{Low 8 bits of BAUD (base 16)}$$

Table 6: Baud Rate / Interface Timeout

Baud Rate	BaudL (0x42)	BaudH (0x43)	Minimum Interface Timeout (0x58)	Stop Bit Delay (0x3F)
115200	0xFE	0x00	0x02	0xFF
57600 ¹	0xFC	0x00	0x02	0x03
38400	0xFA	0x00	0x02	0x08
28800	0xF8	0x00	0x02	0x0E
19200	0xF4	0x00	0x03	0x19
14400	0xF0	0x00	0x04	0x23
9600	0xE8	0x00	0x05	0x39
4800	0xD0	0x00	0x09	0x7A
2400	0xA0	0x21	0x11	0xFC
1200	0x40	0x21	0x21	0x00 ²

1. 57600 is the default baud rate
2. 0x00 will yield a stop bit of 421 μ S. The stop bit at 1200 baud should actually be 833 μ S.

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AC4790 MECHANICAL AND LAYOUT

Mechanical Drawings

Interface Connector	20 pin OEM Interface connector (Molex 87759-0030, mates with Samtec SMM-110-02-S-D)
MMCX Jack	Antenna Connector (Johnson Components 135-3711-822) AC4790 (with MMCX connector) Mechanical

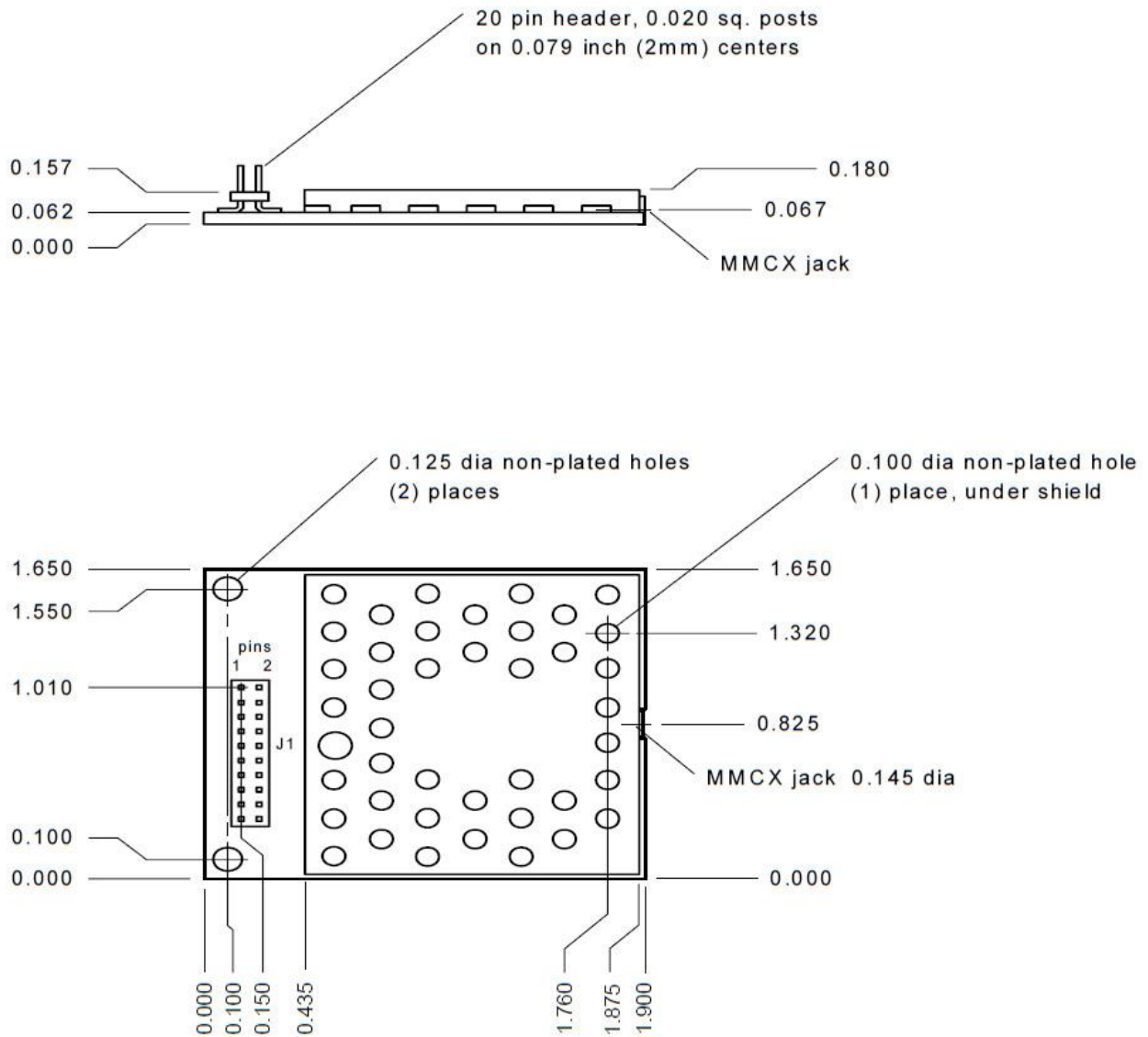


Figure 4: AC4790 (with MMCX connector) Mechanical

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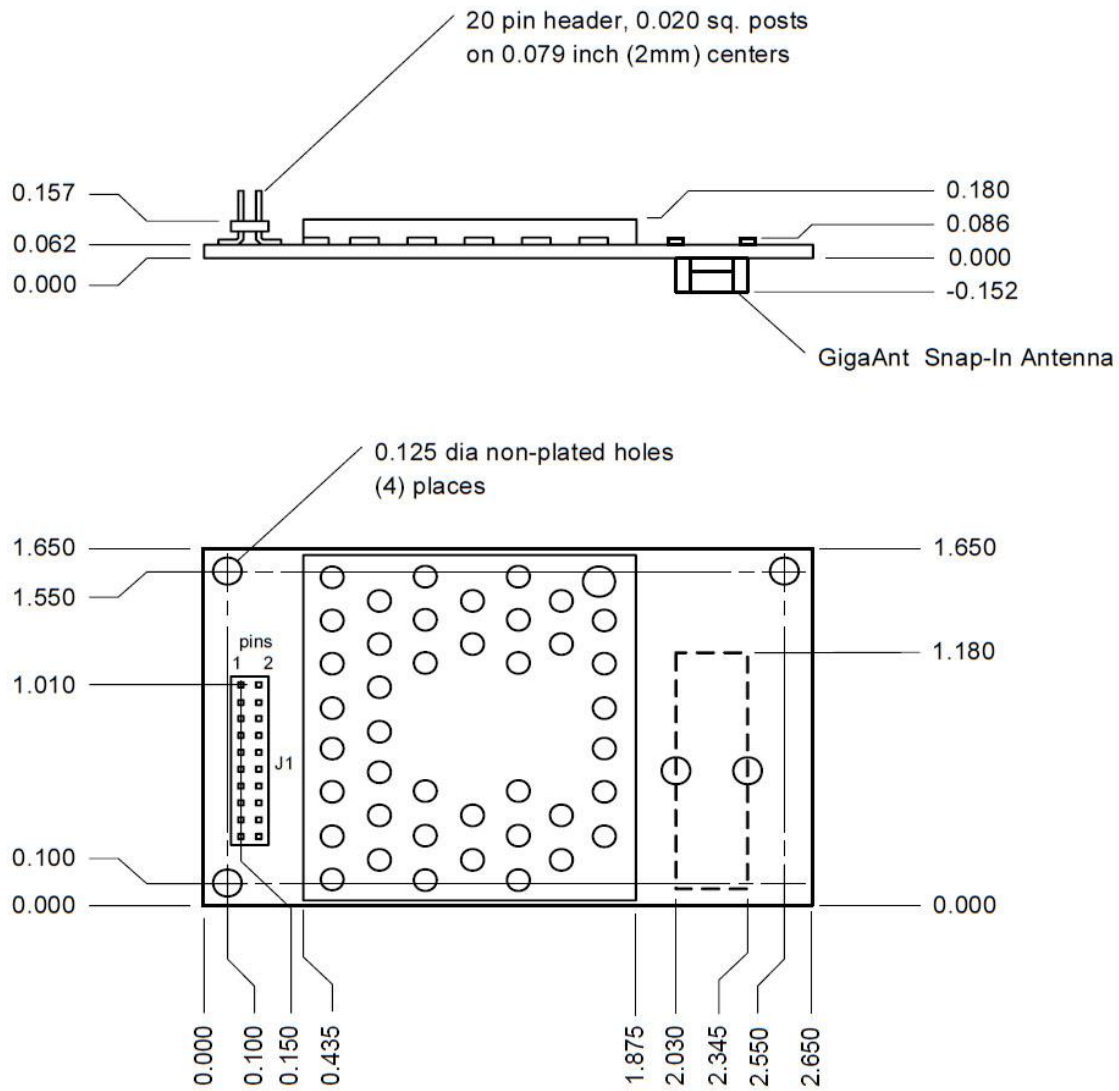


Figure 5: AC4790 with integral gigaAnt Antenna (on bottom) Mechanical

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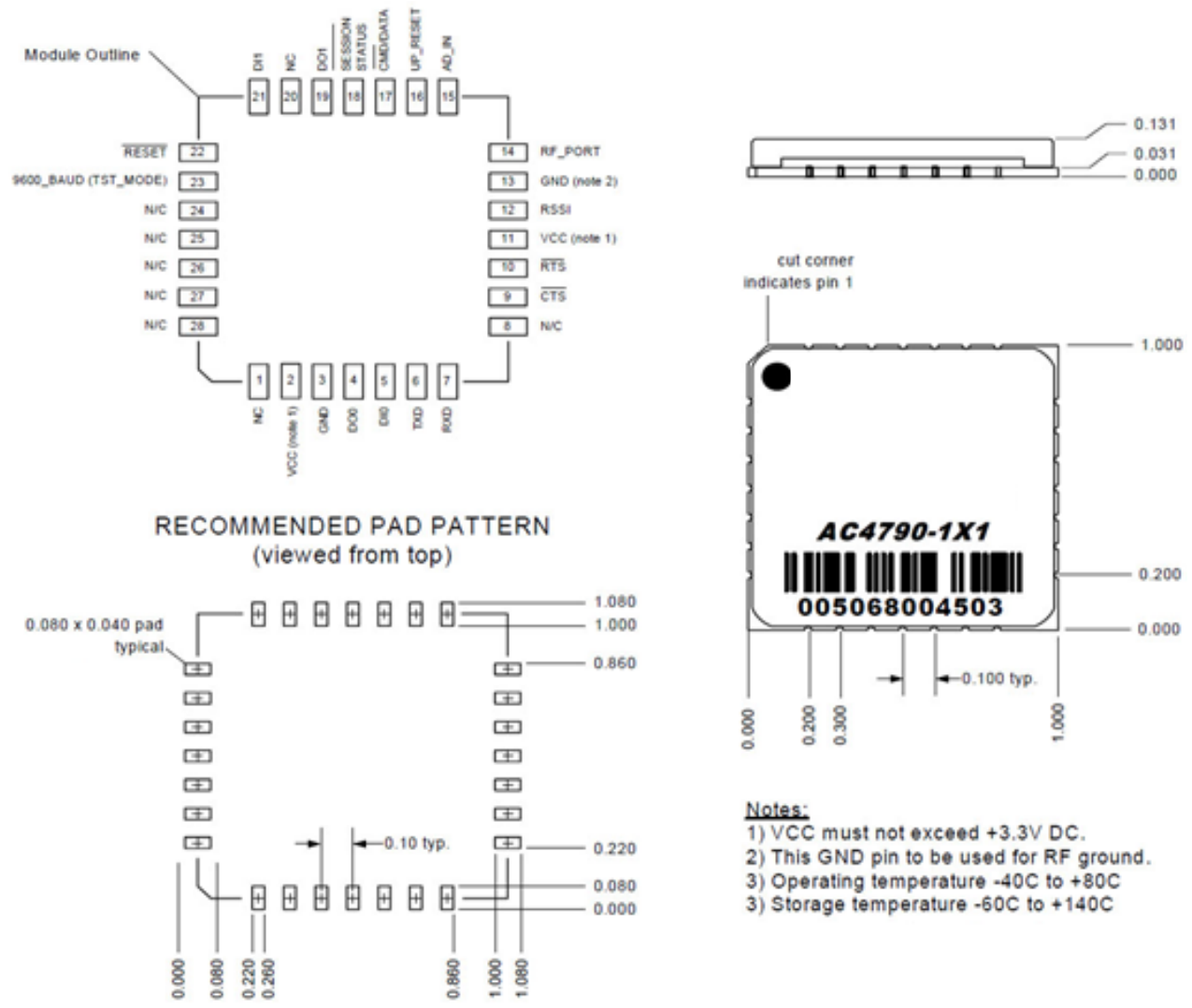
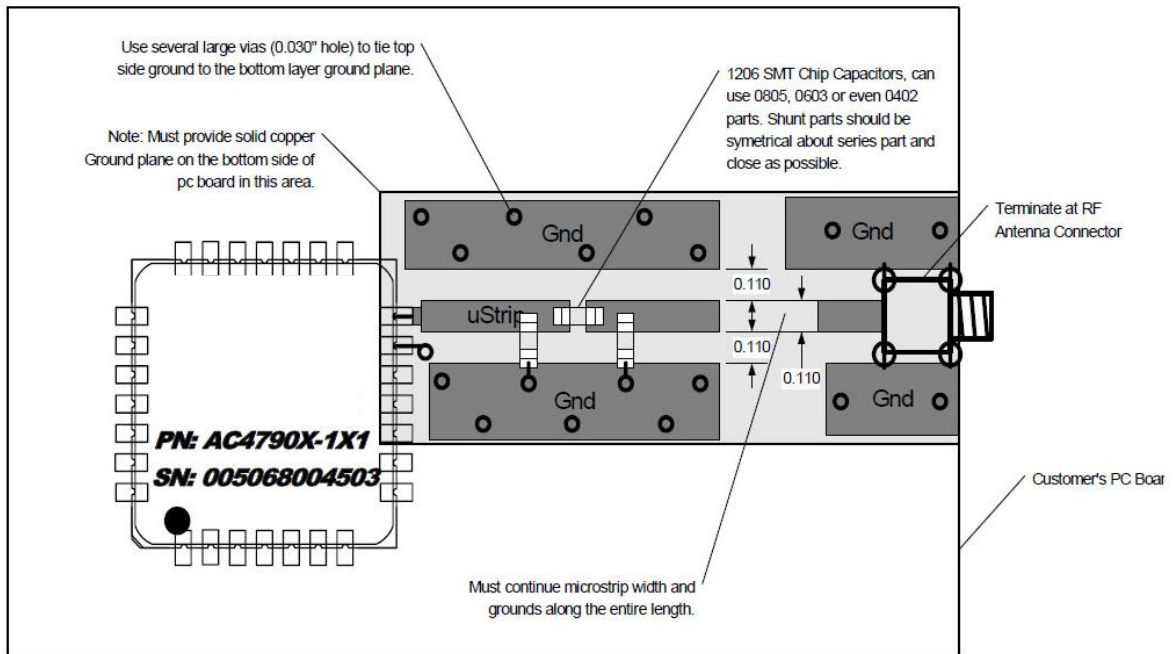


Figure 6: AC4790 1x1 Mechanical

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Note: Keep distance between 1x1 Module and antenna connector as short as possible for better performance.



PCB Thickness Notes:

For 0.062 thick PC board microstrip width and spacing is 0.110 inches.

For 0.031 thick PC board microstrip width and spacing is 0.055 inches.

Figure 7: AC4790 - 1x1 PCB Considerations

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OUTPUT POWER

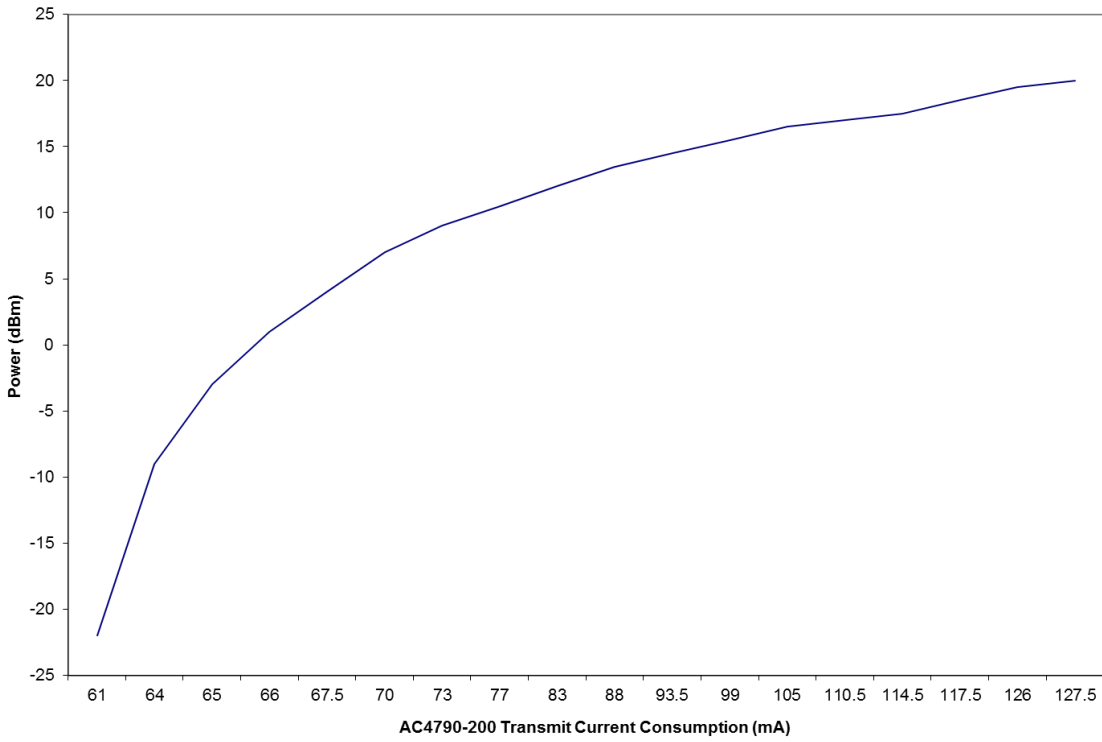


Figure 8: 4790-200M

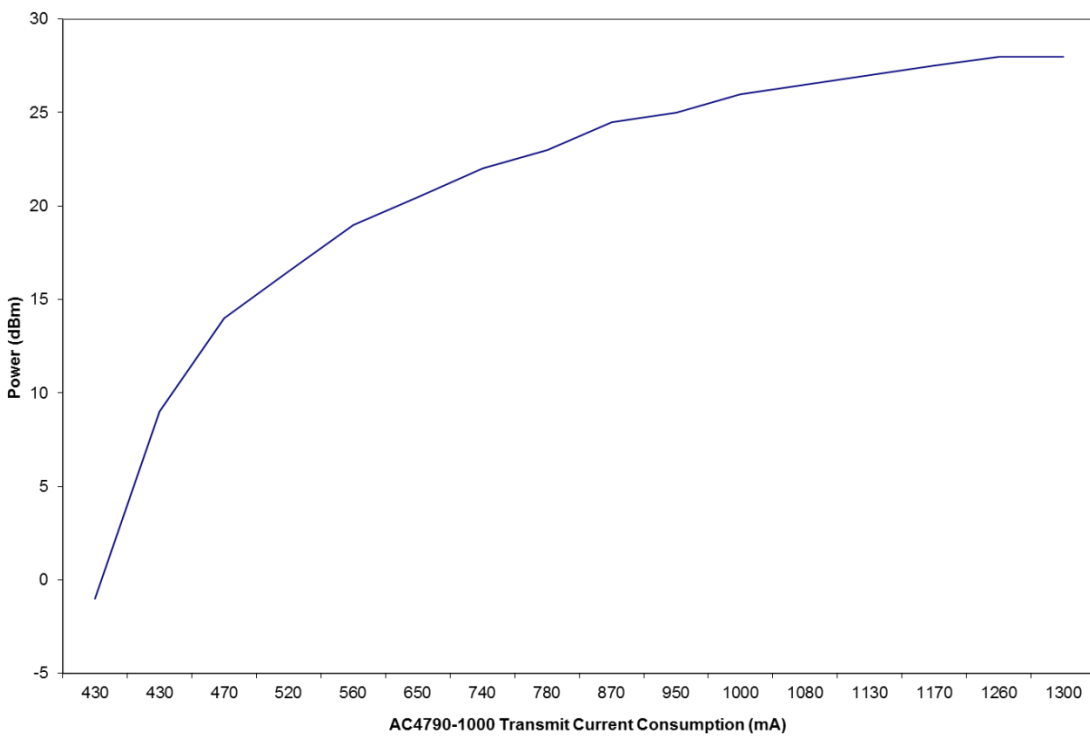


Figure 9: 47909-1000

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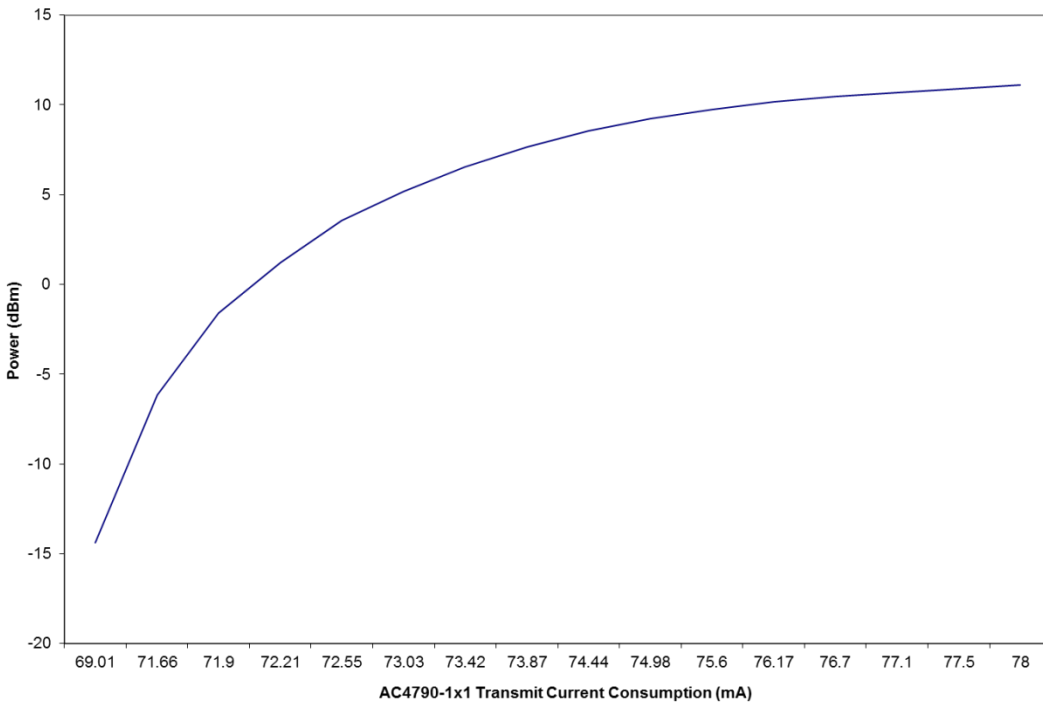
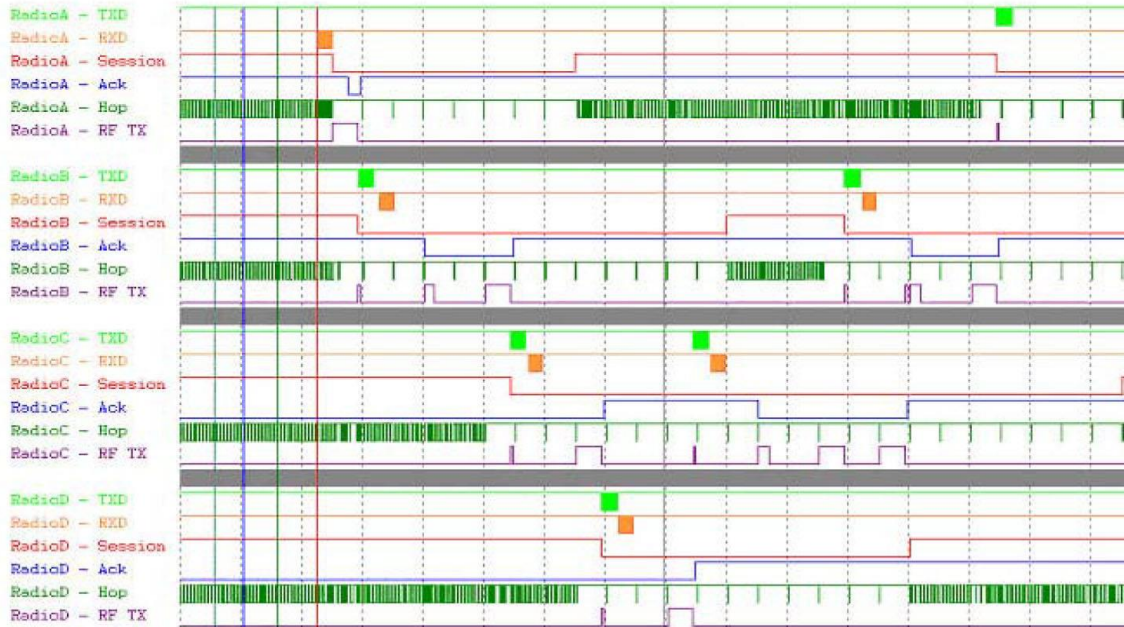
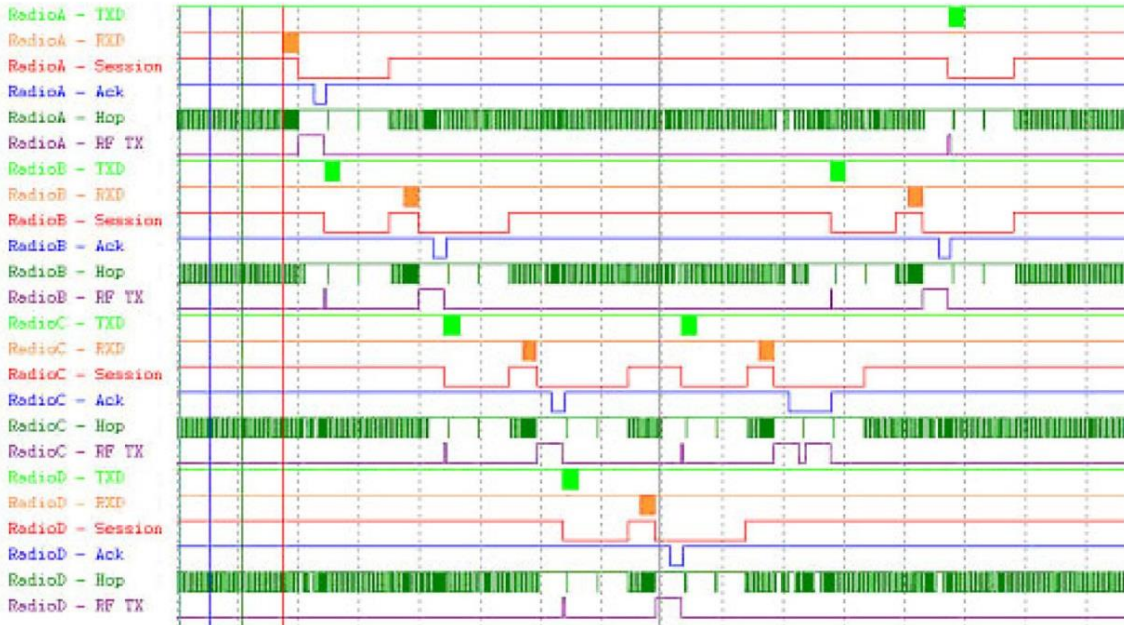


Figure 10: 4790-1x1

TIMING DIAGRAMS



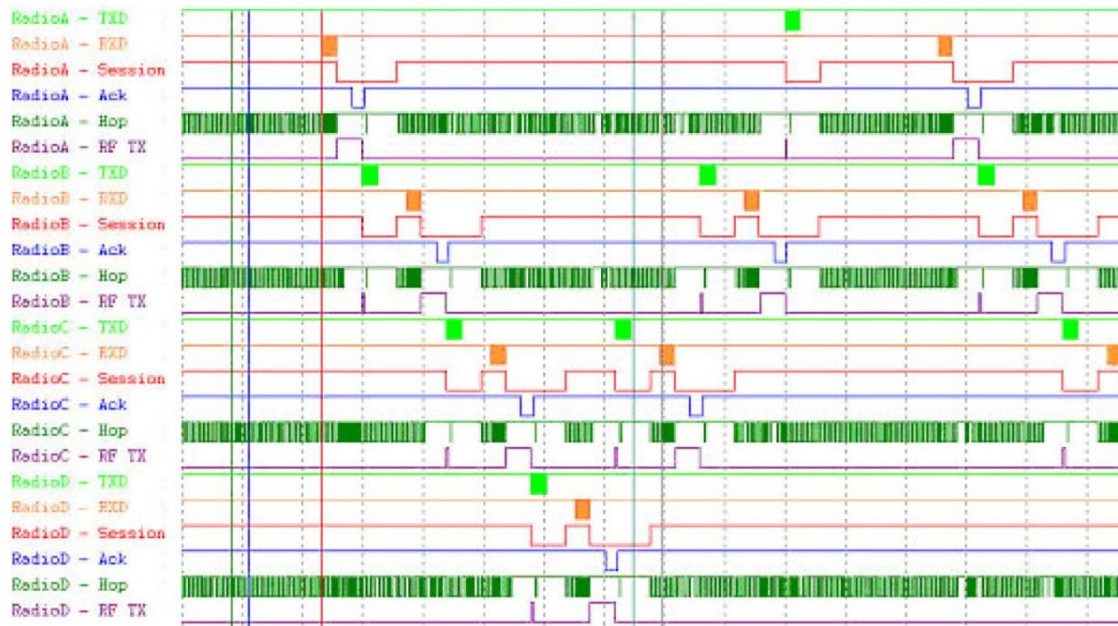
Session Count = 8, Retries = 3



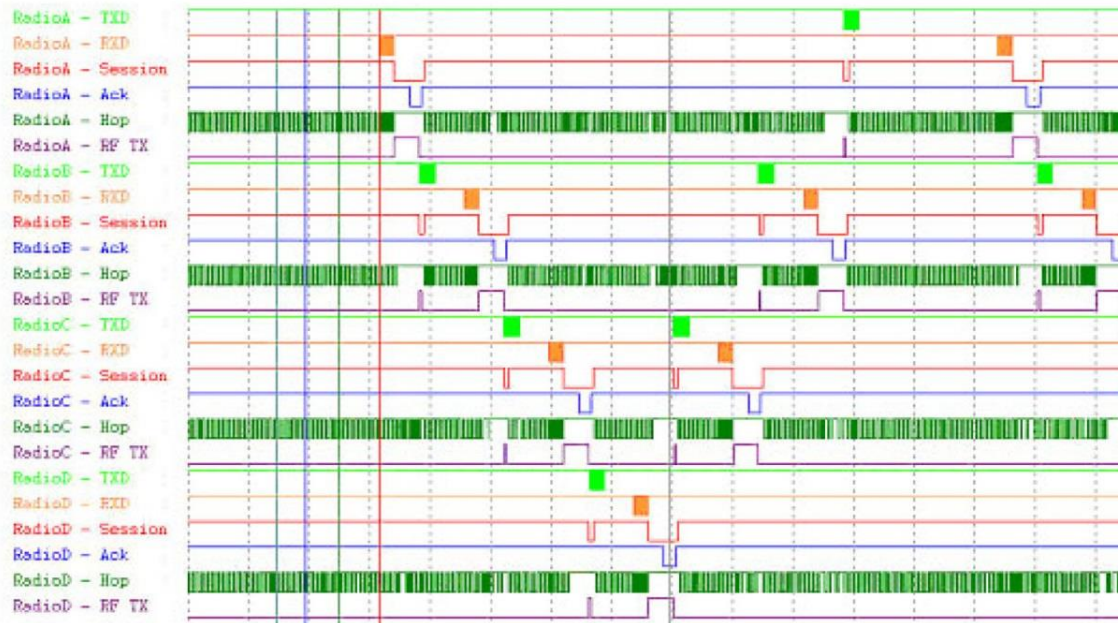
Session Count = 3, Retries = 3

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Session Count = 2, Retries = 2



Session Count = 1, Retries = 1

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ORDERING INFORMATION

Product Part Number Tree

AC4790-XXXXX-XXX

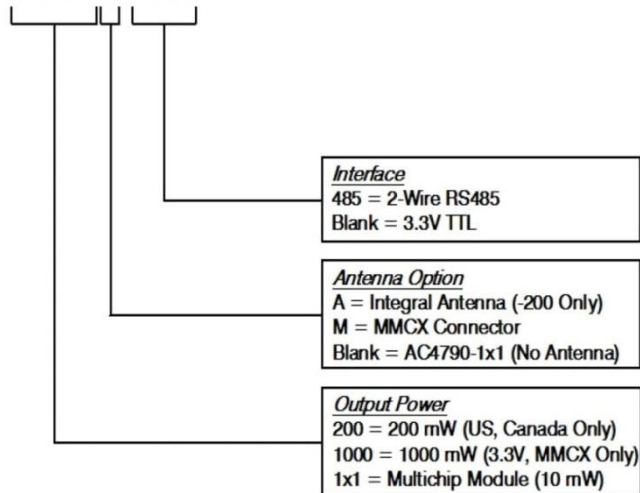


Figure 11: Product part number tree

Developer Kit Part Numbers

All of the above part numbers can be ordered as a development kit by prefacing the part number with “SDK-”. As an example, part number AC4790-200A can be ordered as a development kit using the part number: SDK-AC4790-200A.

All developer’s kits include (2) transceivers, (2) development boards, (2) 7.5V DC unregulated power supplies, (2) serial cables, (2) USB cables, (2) antennas, configuration/testing software and integration engineering support

COMPLIANCE INFORMATION

AC4790 – 1X1

Since the RF antenna trace resides on the OEM host PCB, the FCC will not grant modular approval for the AC4790- 1x1 and requires the OEM to submit their completed design for approval. Contact Laird for the approval procedure.

Agency Identification Numbers

Agency compliancy is a very important requirement for any product development. Laird has obtained modular approval for its products so the OEM only has to meet a few requirements to be eligible to use that approval. The corresponding agency identification numbers and approved antennas are listed in [Table 7](#).

Table 7: Agency Identification Numbers

Part Number	US/FCC	Canada/IC
C4790-200A	KQLAC4490-100	2268C-AC4490
AC4490-200/AC4490LR-200	KQL-4x90-200	2268C-4x90200
AC4790-1000	KQL-AC4490	2268C-AC44901000

Approved Antenna List

The following antennas are approved for use with the AC4790 as identified. The OEM may choose another vendor's antenna of like type and equal or lesser gain as a listed antenna and still maintain compliance.

Table 8: AC4790 Approved Antennas

Laird Part #	Manufacturer Part #	Manufacturer	Type	Gain (dBi)	200M	200LR	1000M
0600-00019	S467FL-5-RMM-915S	Nearson	1/2 Wave Dipole	2	X	X	X
0600-00025	S467FL-5-RMM-915	Nearson	1/2 Wave Dipole	2	X	X	X
0600-00024	S467AH-915	Nearson	1/2 Wave Dipole	2	X	X	X
0600-00027	S467AH-915R	Nearson	1/2 Wave Dipole	2	X	X	X
0600-00028	S161AH-915R	Nearson	1/2 Wave Dipole	2.5	X	X	X
0600-00029	S161AH-915	Nearson	1/2 Wave Dipole	2.5	X	X	X
0600-00030	S331AH-915	Nearson	1/4 Wave Dipole	1	X	X	X
-	1020B5812-04 Flavus	gigaAnt	Microstrip	-0.5	-	-	-
-	Y2283 ¹	Comtelco	Yagi	6dBd	X	X	X
-	Y2283A0915-10RP	Comtelco	Yagi	6dBd	X	X	X
-	SG101N915 ¹	Nearson	Omni	5	X	X	X
-	SG101NT-915	Nearson	Omni	5	X	X	X
-	GM113	V.Torch	Omni	3.5	X	X	-
-	PC8910NRTN	Cushcraft	Yagi	11dBd	-	X	-
-	ANT-DB1-RMS	Antenna Factor	Monopole	3	X	X	-

1. Strictly requires professional installation.

FCC / IC Requirements for Modular Approval

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

Portable	<p>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.</p> <p>Note: Ankles, feet, wrists, and hands may be within 2.5 cm of the antenna even if the equipment is designated as being greater than 2.5 cm.</p> <p>The AC4790 is not agency approved for portable applications. The OEM is required to have additional testing performed to receive this classification. Contact Laird for more details.</p>
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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.
Note: Ankles, feet, wrists, and hands are permitted to be within 20 cm of mobile equipment.

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 FCC identifier for this product as well as the following FCC notice. The FCC identifiers are listed in Table 13.

Contains FCC ID: KQLAC4490-100 / KQLAC4490 / KQL-4x90-200

The 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 large enough to be readily legible, consistent with the equipment dimensions and the label. However, the type size for the text is not required to be larger than eight points.

Antenna Requirements

WARNING: This device has been tested with an MMCX connector with 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. Antenna Y2283 & SG101N915 strictly require professional installation. Any antenna not in the previous table must be tested to comply with FCC Section 15.203 for unique antenna connectors and Section 15.247 for emissions. Contact Laird for assistance.

Caution: Any change or modification not expressly approved by Laird 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 20 cm from the human body (with the exception of hands, feet, wrists, and ankles). Operation at distances of fewer than 20 cm is strictly prohibited and requires additional SAR testing.

Channel Warning

The OEM must prevent the end-user from selecting a channel not approved for use by the FCC.

APPENDIX I: 5V TO 3.3V LEVELS

All inputs on the AC4790-200 & AC4790-1000 are weakly pulled high via 10k ohm resistors. The AC4790-200 has 5 V inputs while the AC4790-1000 & AC4790-1x1 have 3.3 V inputs. The AC4790-200 uses an octal buffer to drop the 5 V to the required 3.3 V level; the -1000 and -1x1 leave this to the OEM.

Some of the most common voltage conversion methods are described in the following sections.

Voltage Level Conversion IC's

This is the easiest and most efficient method. Laird recommends the TI SN74LVC244A Octal Buffer/Driver. Inputs can be driven from 3.3 or 5 V systems, allowing the device to be used in a mixed 3.3/5 V system.

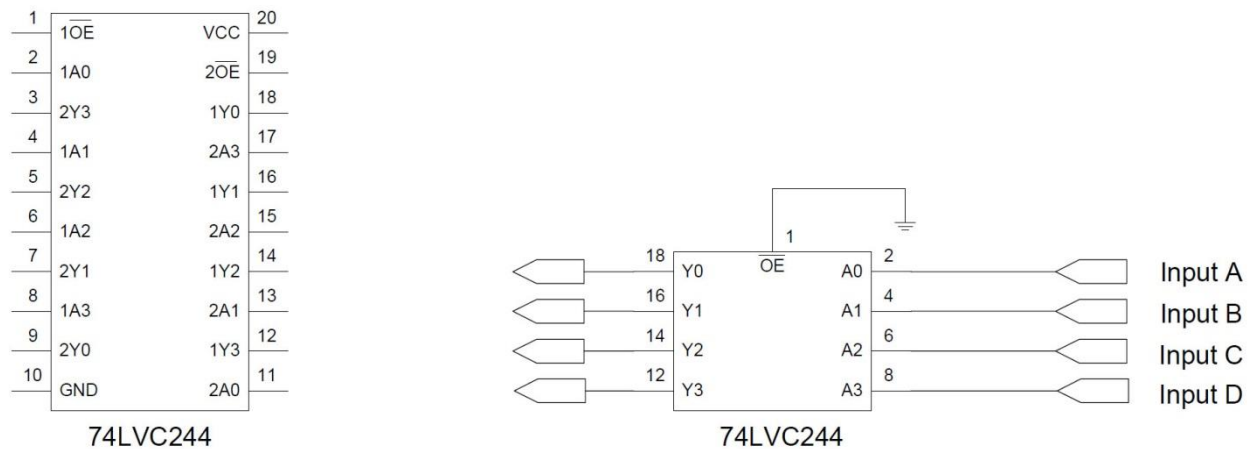


Figure 12: 74LVC255 Integrated Circuits

Passive Resistor Voltage Divider

While a resistor voltage divider can successfully drop the 5 V to the required 3.3 V, it will draw static current all of the time. Typically this method is only suitable for one-way 5 V to 3.3 V conversion. When choosing the resistor values, one needs to include the radio's internal 10kohm resistors on the input signals.

APPENDIX II: SAMPLE POWER SUPPLY

This appendix describes a simple switching power supply that provides enough current to easily power any Laird OEM module. It utilizes low cost, off-the-shelf components that fit into a small area. This supply has an input voltage range of +6 volts to +18 volts and outputs +3.4 volts at 1.5 amps.

Included is a schematic, bill of materials with manufacture's name and part numbers, and a sample PCB layout. It is important to follow the layout suggestions and use large areas of copper to connect the devices as shown in the layout. It is also important to hook up the ground traces as shown and use multiple vias to connect input and output capacitors to the bottom side ground plane.

If the input voltage is fewer than 12 volts then C1 and C2 can be replaced with a single 100 uF 20 volt capacitor (same part number as C7). This reduces board space and lowers costs further. If you are powering an AC5124 module, R1 can be changed to a 373 ohm 1% resistor. This changes the output to +5 volts at 1.0 amps.

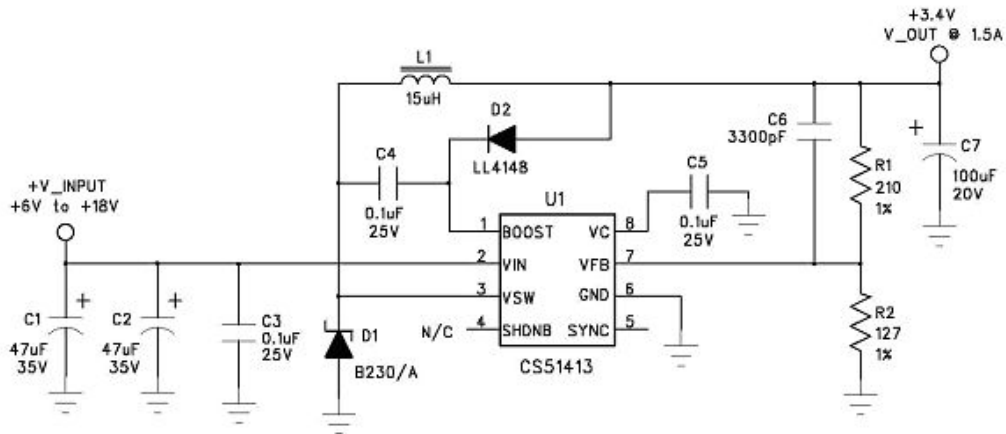
Bill of Materials

Table 9: Power Supply Bill of Materials

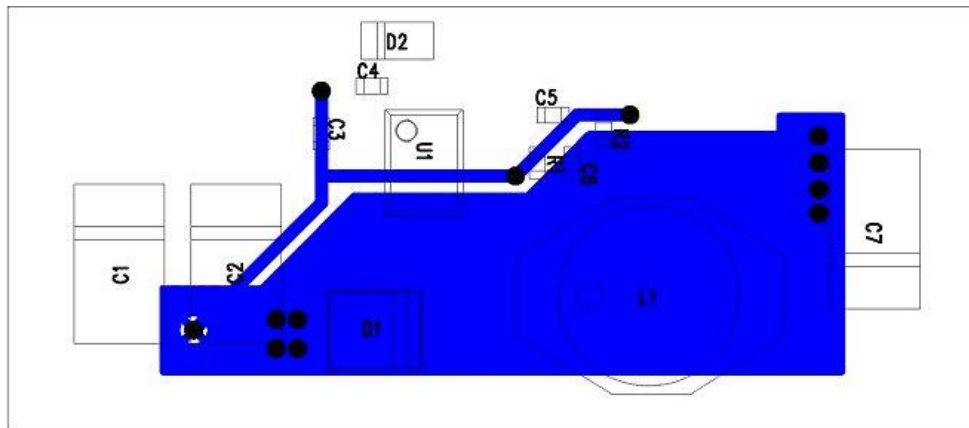
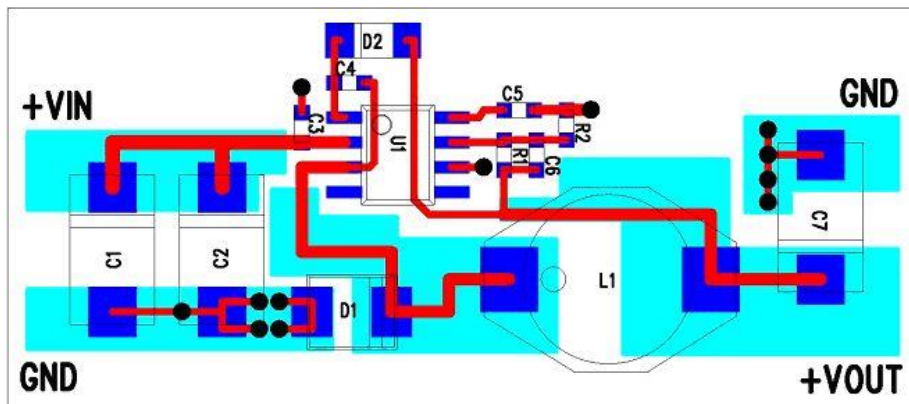
Qty	Reference	Value	Description	Mfg.	Mfg. part number
1	R1	210	Res, 0603, 210, 1/16W, 1%	KOA	RK73H1JT2100F
1	R2	127	Res, 0603, 127, 1/16W, 1%	KOA	RK73H1JT1270F
2	C1 C2	47uF	Cap, Tant, 7343, 47uF, 35V	AVX	TPSE476M035R0200
3	C3 C4 C5	0.1 uF	Cap, Cer, 0603, 0.1uF, Y5V, 25V	Murata	GRM39Y5V104Z025AD
1	C6	3300 pF	Cap, Cer, 0603, 3300pF, X7R, 50V	Murata	GRM39X7R332K050AD
1	C7	100 uF	Cap, Tant, 7343, 100uF, 20V	Kemet	T491X107K020A5
1	D1	B230/A	Diode, SMB, B230/A, 2A, Schottkey	Diodes, Inc.	B230/A
1	D2	LL4148	Diode, MELF, LL4148, Switch Diode	Diodes, Inc.	LL4148
1	L1	15 uH	Xfmr, 2P, SMT, 15uH, 2A	Coiltronics	UP2.8B150
1	U1	CS51413	IC, CS51413, 8P, SO, Switch Reg Ctrl	On- Semicond	CS51413

Schematic

Switching Power Supply



PCB Layout



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APPENDIX III: PRODUCT THROUGHPUT

Table 10: Product Matrix

Part Number	AC 4790- 1x1	AC4790- 200	AC4790-1000
Cost	< \$40	< \$50	< \$60
Size	1.0" x 1.0" x 0.125"	1.9" x 1.65" x 0.20"	1.9" x 1.65" x 0.20"
Range	Up to 1 mile	Up to 4 miles	Up to 20 miles
Throughput	32kbps	20kbps	20kbps
Current Draw RX	28mA	30mA	30mA
Current Draw TX	80mA	106mA	1300mA
Current Draw in Sleep Mode	N/A	N/A	N/A
Chan	48	48	32
Band	900MHz	900MHz	900MHz
3.3V	Yes	Yes	Yes
Unit	Module	Module	Module
Approvals	None; requires end approval by OEM	FCC/IC	FCC/IC
API	Yes	Yes	Yes
Integrated Antenna Available	No	Yes	No
RS485 Output Available	Yes	Yes	Yes

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RELATED DOCUMENTS AND FILES

The following additional AC4790 technical documents are also available from the Laird AC4790 product page under the Documentation tab:

- [AC4790 Product Brief](#)
- [AC4790 User Guide](#)
- [Statement of Compliance to EU WEEE Directive and RoHS Directive](#)

The following downloads are also available from the software downloads tab of the AC4790 product page:

- [Configuration Utility](#)
- [USB Drivers](#)