Laird TECHNOLOGIES

WIRELESS SYSTEMS

global solutions :
local support™

AC4868
868MHz Transceiver

VERSION 1.4

This material is preliminary

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For a period of one (1) year from the date of purchase by the OEM customer, Laird Technologies warrants the OEM transceiver against defects in materials and workmanship. Laird Technologies will not honor this warranty (and this warranty will be automatically void) if there has been any (1) tampering, signs of tampering; 2) repair or attempt to repair by anyone other than an Laird Technologies authorized technician.

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If, after inspection, Laird Technologies determines that there is a defect, Laird Technologies will repair or replace the OEM transceiver at their discretion. If the product is replaced, it may be a new or refurbished product.

Revision	Description
Version 1.0	8/29/05 - Initial Release Version
Version 1.1	10/7/05 - Added Declaration of Conformity
Version 1.2	5/29/07 - Updated serial interface section. Corrected EEPROM write command response.
Version 1.3	9/18/07 - Internal Release.
Version 1.4	9/5/08- Updated to Laird Technologies branding. Clarified Duty Cycle calculations. Updated information on client to client communications. Corrected Read Temperature Command to a max of 0x50. Updated Minimum Baud Rate

Table of Contents

AC4868-250 TRANSCEIVER MODULE

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The compact AC4868-250 868MHz transceiver can replace miles of cable in harsh industrial environments. Using field-proven technology which needs no additional CE licensing in Europe, OEMs can easily make existing systems wireless with little or no RF expertise.

AC4868-250 FEATURES

NETWORKING AND SECURITY

- Drop-in replacement for AC4490 900 MHz & AC4424 2.4 GHz product families
- Generic I/O digital lines and integrated DAC/ADC functions
- Retries and Acknowledgements
- Low latency and high throughput

EASY TO USE

- Software selectable interface baud rates from 1200 bps to 57.6 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
- Server/Client or peer-to-peer communication

OVERVIEW

The AC4868-250 is a member of Laird Technologies's ConnexRF OEM transceiver family. The AC4868-250 is designed for integration into OEM systems operating under European ETSI regulations for the 868 - 870 MHz band.

AC4868-250 transceivers provide an asynchronous TTL/RS-485 level serial interface for OEM Host communications. Communications include both system and configuration data. The Host supplies system data for transmission to other Host(s). Configuration data is stored in the on-board EEPROM. All synchronization and RF system data transmission/reception is performed by the transceiver.

AC4868-250 transceivers can operate in a Point-to-Point, Point-to-Multipoint, or Peer-to-Peer architecture. The AC4868-250 utilizes a single channel synchronization allowing all radios to communicate with any radio in range. Optionally any radio can be configured as a Server to provide a synchronization beacon. This beacon is used be the Client radios to determine In Range status and for Auto Destination addressing.

This document contains information about the hardware and software interface between an Laird Technologies AC4868-250 transceiver and an OEM Host. Information includes the theory of operation, specifications, interface definition, configuration information and mechanical drawings. 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 AC4868-250 modules will be referred to as the "radio" or "transceiver". Individual naming is used to differentiate product specific features. The host (PC/Microcontroller/Any device to which the AC4868-250 module is connected) will be referred to as "OEM Host".

SPECIFICATIONS

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Table 1: AC4868-250 Specifications

General	
20 Pin Interface Connector	Molex 87759-0030, mates with Samtec SMM-110-02-S-D
RF Connector	Telegartner J01341C0081, mates with any manufacturer's MMCX style plug
Antenna	AC4868-250: MMCX Connector
Serial Interface Data Rate	Baud rates from 1200 bps to 57.6 kbps
Power Consumption (typical)	10%TX 50%TX 100%TX 100%RX Pwr-Down Deep Sleep 54mA 138mA 240mA 36mA TBD 24mA
Channels	Single Channel
Security	One byte System ID. 56-bit DES encryption key.
Interface Buffer Size	Input/Output:256 bytes each
Transceiver	
Frequency Band	Europe 500 mW: 869.4 - 869.65 MHz
RF Data Rate	19.2 kbps or 28.8 kbps dependent on interface baud rate
RF Technology	Single Frequency FSK
Output Power	Conducted (no antenna) EIRP (2.5dBi gain antenna) 186mW typical 250mW typical
Supply Voltage	Pin 10 (uP power): 3.3 – 5.5V ±50mV ripple; draws ~30-50mA. Must be connected. Pin 11 (PA power): 3.3 ±3%, ±100mV ripple; draws most current. Must be connected.
Sensitivity	-103dBm typical @ 28.8kbps RF Data Rate
EEPROM write cycles	20000
Hop period	53 ms
Range, Line of Site (based on 2.5dBi gain antenna)	Up to 15 km (9.3 miles)
Environmental	
Temperature (Operating)	-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"

PIN DEFINITIONS

The AC4868-250 has a simple interface that allows OEM Host communications with the transceiver. The table below shows the connector pin numbers and associated functions. The I/O direction is with respect to the transceiver. All inputs/outputs are 3.3VDC. All inputs are weakly pulled High and may be left floating during normal operation.

Table 2: AC4868-250 Pin Definitions

Module Pin	Type	Signal Name	Function
1	O	GO0	Generic Output pin
2	O	TXD	Transmitted data out of the transceiver
	I/O	RS485 A (True)	Non-inverted RS-485 representation of serial data
3	I	RXD	Data input to the transceiver
	I/O	RS485 B (Invert)	Mirror image of RS-485 A
4	I	GI0	Generic Input pin
5, 16	GND	GND	Signal Ground
6		N/C	This pin has an internal connection and should be left disconnected.
7	O	CTS	Clear to Send – Active Low when the transceiver is ready to accept data for transmission.
8	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	O	GO1	Generic Output pin
10	PWR	VCC1	3.3 – 5.5V, ±50mV ripple. Powers the radio's uP. Draws ~30-50mA.
11	PWR	VCC2	3.3V, ±50mV ripple. Powers the radio's power amplifier. Current draw depends on duty cycle and output power.
12	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		N/C	This pin has an internal connection and should be left disconnected.
14	I	GI1	Generic Input pin
15	I	UP_RESET	RESET – Controlled by the AC4868-250 for power-on reset if left unconnected. After a stable power-on reset, a logic High pulse will reset the transceiver.
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	I	AD In	10 bit Analog Data Input
19	O	DA_Out	10 bit Analog Data Output
20	O	In_Range	When logic Low, a Client is in range of a Server on same Channel and System ID. Always low on a Server.

ELECTRICAL SPECIFICATIONS

Table 3: Input Voltage Characteristics

Signal Name	High Min.	High Max.	Low Min.	Low Max.	Unit
RS485A/B	N/A	12	-7	N/A	V
RXD	2.31	3.3	0	0.99	V
GI0	2.31	3.3	0	0.99	V
RTS	2.31	3.3	0	0.99	V
$\overline{\text{Test}}$	2.31	3.3	0	0.99	V
GI1	2.31	3.3	0	0.99	V
UP_RESET	0.8	3.3	0	0.6	V
Command/Data	2.31	3.3	0	0.99	V
AD In	N/A	3.3	0	N/A	V

Table 4: Output Voltage Characteristics

Signal Name	Module Pin	Type	High Min.	Low Max.	Unit
GO0	1	O	2.5 @ 8mA	0.4 @ 8mA	V
TXD	2	O	2.5 @ 2mA	0.4 @ 2mA	V
RS485A/B	2,3	I/O	3.3 @ 1/8 Unit Load	N/A	V
CTS	7	O	2.5 @ 2mA	0.4 @ 2mA	V
GO1	9	O	2.5 @ 2mA	0.4 @ 2mA	V
DA_Out	19	O	N/A	N/A	V[1]
In Range	20	O	2.5 @ 2mA	0.4 @ 2mA	V

1. DA_Out is an unbuffered, high impedance output and must be buffered by the OEM Host when used.

3 THEORY OF OPERATION

RF ARCHITECTURE

The AC4868-250 is a single channel radio transceiver. Each unit can be configured as a Server or as a Client. Servers are responsible for sending out beacons and for allow for radios to be configured very simply in a point-to-multipoint network. Servers are not required for operation, but if they are used, there should only be one Server per network. All other radios in the network should be configured as Clients. Clients can communicate point-to-point or in a mesh with or without a Server.

MODES OF OPERATION

The AC4868-250 has three different operating modes; Receive, Transmit, & Command Mode. If the transceiver is not communicating with another radio, it will be in Receive Mode actively listening for a beacon from the Server. If the Client determines that the beacon is from a server operating on the same RF Channel and System ID, it will respond by asserting In_Range Low. A transceiver will enter Transmit or Command mode when the OEM Host sends data over the serial interface. The state of the Command/Data pin (Pin 17) or the data contents determine which of the two modes will be entered.

Transmit Mode

All packets sent over the RF are either Addressed or Broadcast packets. Broadcast and Addressed delivery can be controlled dynamically with the API Control byte and corresponding on-the-fly commands. To prohibit transceivers from receiving broadcast packets, Unicast only can be enabled.

ADDRESSED PACKETS

When sending an addressed packet, the RF packet is sent only to the receiver specified in destination address. To increase the odds of successful delivery, Transmit retries are utilized. transparent to the OEM Host; the sending radio will send the RF packet to the intended receiver. If the receiver receives the packet free of errors, it will return an RF acknowledge within the same 53 ms hop. If a receive acknowledgement is not received, the radio will use a transmit retry to resend the packet. The radio will continue sending the packet until either (1) an acknowledgement is received or (2) all transmit retries have been used. The received packet will only be sent to the OEM Host if and when it is received free of errors.

BROADCAST PACKETS

When sending a broadcast packet, the RF packet is sent out to every eligible transceiver on the network. To increase the odds of successful delivery, Broadcast attempts are utilized. Transparent to the OEM Host, the sending radio will send the RF packet to the intended receiver(s). Unlike transmit retries, all broadcast attempts are used; regardless of when the RF packet is actually received and without RF acknowledgements. If the packet is received on the first attempt, the receiver will ignore the remaining broadcast attempts. The received packet will only be sent to the OEM Host if and when it is received free of errors.

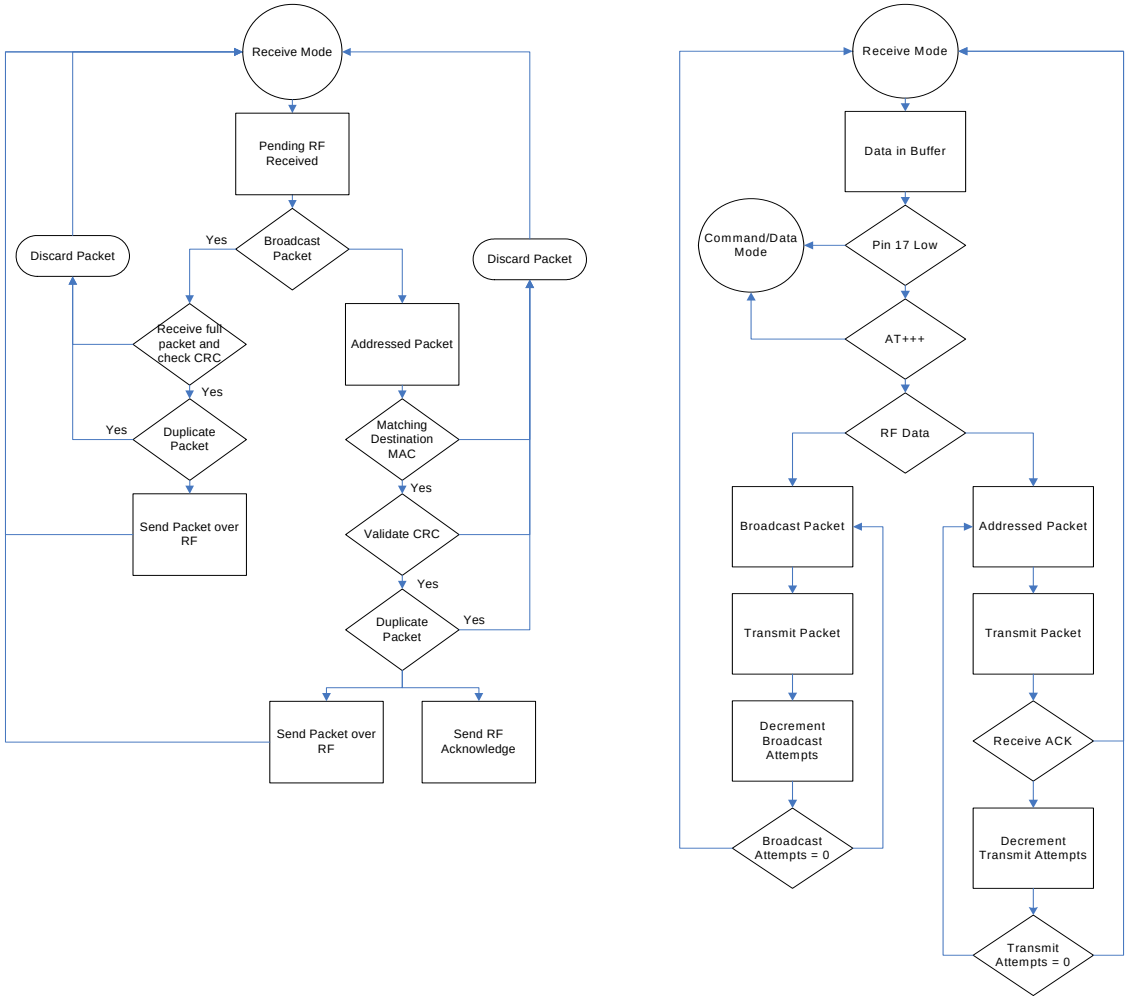
Receive Mode

When a transceiver is not in Transmit or Command mode, it will be in Receive Mode listening for data. While in Receive Mode, subsequent data of up to 80 bytes can be received every hop (53 ms).

Command Mode

A radio will enter Command Mode when data is received over the serial interface from the OEM Host and either the Command/Data pin (pin 17) is logic Low or the received data contains the “AT+++” (Enter AT Command Mode) command. Once in Command Mode, all data received by the radio is interpreted as command data. Command Data can be either EEPROM Configuration or On-The-Fly commands.

Figure 1: Pending RF and Data in Buffer Flow



4 DUTY CYCLE LIMITATIONS

EUROPEAN REGULATIONS

ETSI requirements as specified in the ETSI EN 300 220-1 define the requirements for the 868-870MHz bands. For a conducted output of 180mW and radiated outputs up to 500mW, the maximum allowed duty cycle is <10%. This duty cycle is measured as the amount of TX time on, monitored over one hour and relative to a one hour period. Thus for the AC4868-250, the maximum "on" time in an hour cannot exceed six minutes.

RADIO OPERATION

The AC4868 will transmit data whenever data is present on the serial UART. Data will be transmitted for Broadcast packets according to the value of the Broadcast Attempts. For Addressed Packets data will be transmitted until a successful acknowledgement is received. The OEM is responsible for limiting the Transmitter's "on" time to less than the duty cycle regulations.

Transmit Calculations

For a rough estimate the TX Time on is 53ms * the number of retries or attempts. By default this is 212ms. For servers you need to a 5ms beacon.

The interval time is based on an increment of data equal to or less than the packet size given in the following table.

Table 5: RF Packet Size

RF Baud Rate	Addressed Mode	RF Packet Size
19200	Addressed	0x24
28800	Addressed	0x50
19200	Broadcast	0x40
28880	Broadcast	0x60

So the total TX On Time is 5ms (For Servers) + Data Size/RF Packet Size * Number of Retries/Attempts.

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SERIAL INTERFACE

In order for the OEM Host and a transceiver to communicate over the serial interface they need to have the same serial data rate. Refer to the following sections to ensure that the OEM Host data rate matches the serial interface baud rate.

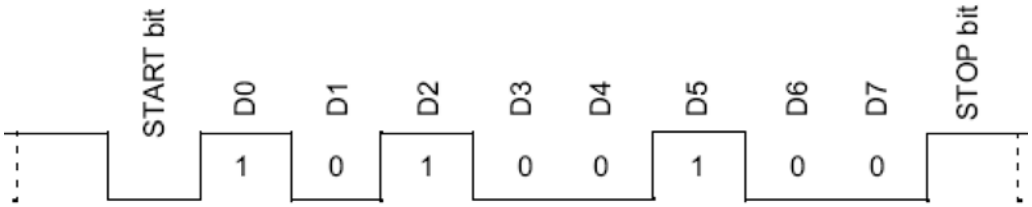
SERIAL COMMUNICATIONS

The AC4868-250 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 below.

Figure 2: Asynchronous Mode Signal



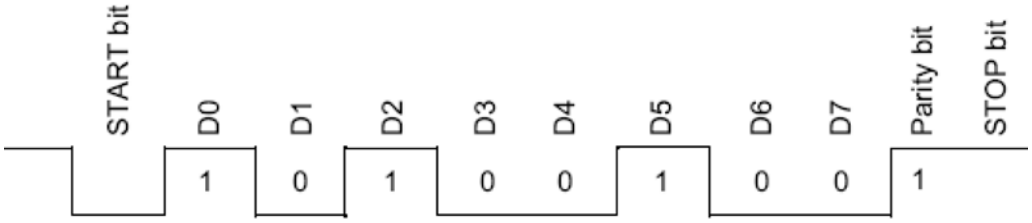
The UART outputs and inputs logic level signals on the TX and RX pins. The signal is high when no data is being transmitted and goes low when transmission begins.

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 in the data and parity sum 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 below.

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. Possible values range from 1200 bps to 57,600 bps. Note: Enabling Parity cuts throughput in half and the Interface Buffer size in half. The following asynchronous serial data formats are supported:

Table 6: 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. The Table below lists values for some common baud rates. Baud rates below 1200 and above 57,600 baud are not

supported. For a baud rate to be valid, the calculated baud rate must be within ±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 9,600.

Table 7: Baud Rate / Interface Timeout

Baud Rate	BaudL (0x42)	BaudH (0x43)	RF Baud (not adjustable)	Minimum Interface Timeout (0x58)	Stop Bit Delay (0x3F)
57,600[1]	0xFC	0x00	28,800	0x02	0x03
38,400	0xFA	0x00	19,200	0x02	0x08
28,800	0xF8	0x00	28,800	0x02	0x0E
19,200	0xF4	0x00	19,200	0x03	0x19
14,400	0xF0	0x00	28,800	0x04	0x23
9,600	0xE8	0x00	19,200	0x05	0x39

1. 57,600 is the default baud rate

INTERFACE TIMEOUT / RF PACKET SIZE

Interface Timeout (EEPROM address 0x58), in conjunction with **RF Packet Size** (EEPROM address 0x5B), determines when a buffer of data will be sent out over the RF as a complete RF packet, based on whichever condition occurs first.

Interface Timeout – Interface Timeout specifies a maximum byte gap between consecutive bytes. When that byte gap is exceeded, the bytes in the transmit buffer are sent out over the RF as a complete packet. Interface Timeout is adjustable in 0.5ms increments and has a tolerance of ±0.5ms. Therefore, the Interface Timeout should be set to a minimum of 2. The default value for Interface Timeout is 0x04 (2ms) and should be adjusted accordingly when changing the transceiver baud rate.

RF Packet Size – When the number of bytes in the transceiver transmit buffer equals RF Packet Size, those bytes are sent out as a complete RF packet. It is much more efficient to send a few large packets rather than several short packets as every packet the transceiver sends over the RF contains extra header bytes which are not included in the RF Packet Size. However, if the RF Packet Size is set too large, the transceiver will not be able to send any packets because the AC4868 requires the entire RF packet to be sent in the same hop period (53 ms). The RF packet size if programmed in EEPROM automatically when Auto Config is enabled. It is strongly recommended that Auto Config be left enabled to maximize the efficiency of the transceiver. RF Packet Size must be set to a minimum of 6 in order to send the Enter AT command.

FLOW CONTROL

Flow control refers to the control of data flow between transceivers. It is the method used to handle data in the transmit/receive buffer and determines how data flow between the transceivers is started and stopped. Often, one transceiver is capable of sending data much faster than the other can receive and flow control allows the slower device to tell the faster device when to pause and resume data transmission.

ENGINEER'S TIP

Can I implement a design using just Txd, Rxd and Gnd (Three-wire Interface)?

Yes. However, it is strongly recommended that your hardware monitor the CTS pin of the radio. CTS is taken High by the radio when its interface buffer is getting full. Your hardware should stop sending at this point to avoid a buffer overrun (and subsequent loss of data).

You can perform a successful design without monitoring CTS. However, you need to take into account the amount of latency the radio adds to the system, any additional latency caused by Transmit Retries or Broadcast Attempts, how often you send data, non-delivery network timeouts and interface data rate. Polled type networks, where the Server host requests data from the Client host and the Client host responds, are good candidates for avoiding the use of CTS. This is because no one transceiver can monopolize the RF link. Asynchronous type networks, where any radio can send to another radio at any point in time, are much more difficult to implement without the use of CTS.

HALF DUPLEX / FULL DUPLEX

When Half Duplex communication is chosen, the AC4868-250 will send a packet out over the RF whenever it can. This can cause packets sent by multiple transceivers at the same time to collide with each other over the RF. To prevent this, Full Duplex communication can be chosen. Full Duplex shares the bandwidth intelligently to enable two-way collision-free communication without any collision. This is done by calculating the amount of time until the next hop to ensure that it has time to send the packet; if there is enough time, it will send the packet and if not, it will wait until its next appropriate hop. The Server transmits during the even hops while the Client(s) will transmit during the odd hops. Although there is technically only one frequency bin, the Server still maintains a bin count for the purpose of handling Full Duplex mode. While the RF hardware is still technically half duplex, the bandwidth sharing it makes the transceiver seem full duplex. Enabling Full Duplex can cause overall throughputs to be cut in half.

SYSTEM TIMING & LATENCY

Care should be taken when selecting transceiver architecture, as it can have serious effects on data rates, latency, and overall system throughput. The importance of these three characteristics will vary from system to system and

should be a strong consideration when designing the system.

ENGINEER'S TIP

In High-density applications, what amount of latency should be expected?

It is not easy to predict the exact amount of latency in high-density applications. There are many variables that affect system latency. The three variables that most affect the latency are the network load, the distance between transceivers, and whether the transceivers are operating in a broadcast or addressed mode. There is no fixed answer as to how much latency will be introduced in the system when considering high-density applications. In these cases we can just offer qualitative analysis of the latency in high-density applications. As the network load increases, then the number of collisions that will occur increases. As the number of collisions increase, then the system latency increases. As the distance between the transceivers increases, so to does the system latency. Finally, when transceivers operate in addressed mode they will retry sending a packet up to the number of time specified in the transmit retry parameter specified in the EEPROM. As the number of retries increases, the system latency will increase also.

SYSTEM THROUGHPUT

When operating as shown below, an AC4868-250 transceiver is capable of achieving the listed throughput. However, in the presence of interference or at longer ranges, the transceiver may be unable to meet the specified throughput.

Table 8: Maximum System Throughput

RF Mode	RF Baud (determined by Interface Baud)	Half Duplex Throughput (bps)	Full Duplex Throughput (bps) each way
Addressed	28,800	15k	7.5k
Addressed	19,200	6.8k	3.4k
Broadcast	28,800	18k	9k
Broadcast	19,200	12k	6k

SOFTWARE INTERFACE

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NETWORKING

System ID - System ID (EEPROM address 0x76) is similar to a password character or network number and makes network eavesdropping more difficult. A transceiver will not establish a Session or communicate with a transceiver operating on a different System ID or Channel Number.

RF Channel Number -

Table 9: RF Channel Number Settings

RF Channel Number Range (0x40)	Frequency Details & Regulatory requirements	Countries
0x38	869.4 - 869.65 MHz (Single Frequency. Up to 500 mW EIRP @ 10% maximum transmit vs. receive duty cycle	Europe

DES (Data Encryption Standard) - DES (Data Encryption Standard) – Encryption is the process of encoding an information bit stream to secure the data content. The DES algorithm is a common, simple and well-established encryption routine. An encryption key of 56 bits is used to encrypt the packet. The receiver must use the exact same key to decrypt the packet; otherwise garbled data will be produced.

To enable DES, EEPROM Byte 0x45, bit 6 must be set to a value of 1. To disable DES, set bit 6 to a value of 0. The 7 byte (56 bits) Encryption/Decryption Key is located in EEPROM Bytes 0xD0 – 0xD6. **It is highly recommended that this Key be changed from the default.**

RANGE REFRESH

Range Refresh - Range Refresh specifies the maximum amount of time a Client reports in range without having heard a beacon from the Server. Each time the Client hears a beacon, it resets its Range Refresh timer. If the timer reaches zero, the Client will go out of range, take its In_Range pin High and enter acquisition mode attempting to find the Server once again. The range refresh is equal to the hop period (53 ms) x Range refresh value.

Note: Range Refresh should not be set to 0x00.

AUTO CONFIG PARAMETERS

The AC4868-250 has several variables that vary by RF mode and architecture. By default, Auto Config is enabled and bypasses the values stored in EEPROM and uses predetermined values for the given operating mode. Below is a list

of the variables controlled by Auto Config and their respective predetermined values. If Auto Config is disabled, these values **must** be programmed in the transceiver EEPROM for the corresponding mode of operation.

Table 10: Auto Config Parameters

Parameter	EEPROM Address	Default	RF Baud = 19,200		RF Baud = 28,800	
			Addressed	Broadcast	Addressed	Broadcast
RF Packet Size	0x5B	0x24	0x24	0x40	0x50	0x60

MAX POWER

Max Power provides a means for controlling the RF output power of the AC4868. Output power and current consumption can vary by as much as ±10% per transceiver for a particular Max Power setting. Contact Laird Technologies for assistance in adjusting Max Power.

ENGINEER'S TIP

The max power is set during Production and may vary slightly from one transceiver to another. The max power can be set as low as desired but should not be set higher than the original factory setting. A backup of the original power setting is stored in EEPROM address 0x8E.

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TIMING DIAGRAMS

AC4868-250 TIMING DIAGRAMS

Figure 4: Addressed Mode with Timeout

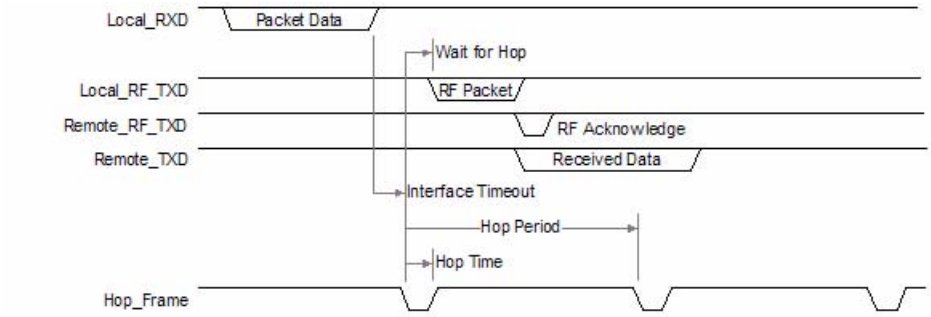


Figure 5: Addressed Mode with Fixed Packet Length

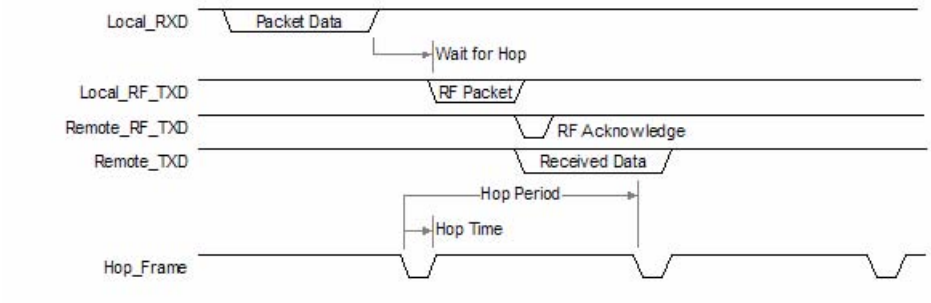


Figure 6: Broadcast Mode with Timeout

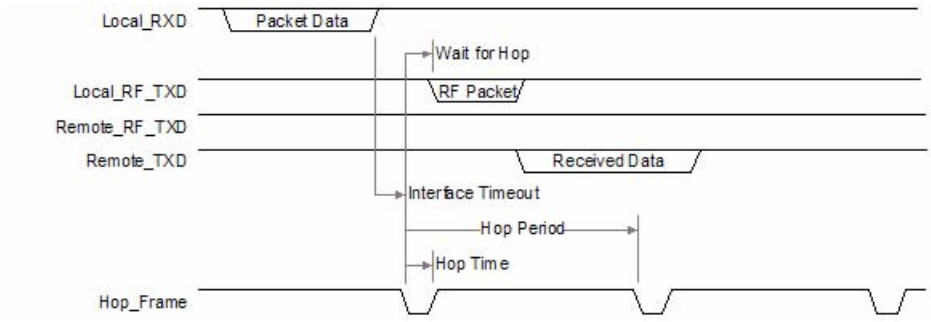
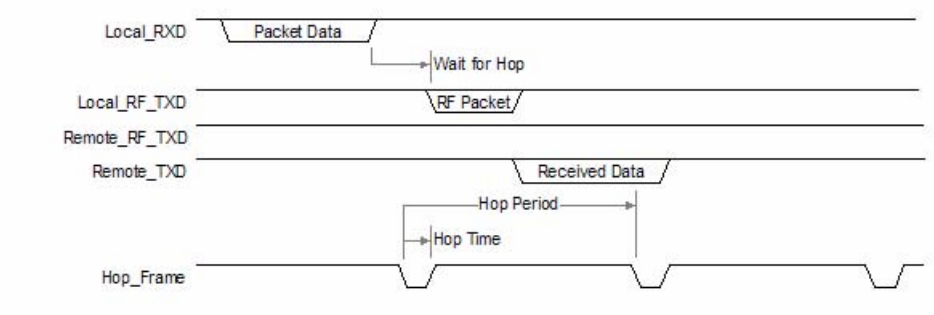


Figure 7: Broadcast Mode with Fixed Packet Length



HARDWARE INTERFACE

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Below is a description of all hardware pins used to control the AC4868-250.

PIN DEFINITIONS

Generic I/O

Both GIn pins serve as generic input pins and both GOn pins server as generic output pins. Reading and writing of these pins can be performed using CC Commands.

TXD & RXD

SERIAL TTL

The AC4868-250 accepts 3.3VDC 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.

RS-485

When equipped with an onboard RS-485 interface chip, TXD and RXD become the half duplex RS-485 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).

Hop Frame

Transitions logic Low at the start of a hop and transitions logic High at the completion of a hop. The OEM Host is not required to monitor Hop Frame. The AC4868 is a single frequency radio that uses fictitious hops, though it generates a Hop Frame signal every time it transmits a timing beacon.

CTS

The AC4868-250 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 loss will occur. 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 still 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.

GND

Signal Ground. Pins are internally connected.

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.

ENGINEER'S TIP

Laird Technologies does not recommend permanently grounding the Forced_9600 pin. This mode was intended for recovering transceivers from unknown settings and was not intended to be used in real-time communications.

UP_Reset

UP_Reset provides a direct connection to the reset pin on the AC4868-250 microprocessor and is used to force a soft reset. For a valid reset, reset must be asserted High for a minimum of 11ms.

Command/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 & DA Out

AD In & DA Out can be used as a cost savings to replace Analog-to-Digital and Digital-to-Analog converter hardware. Reading of this pin can be performed locally using the Read ADC command found in the On-the-Fly Control Command Reference. DA Out is an unbuffered, high impedance output and MUST be buffered by the OEM Host when used.

In Range

Reports logic Low when a Client transceiver is in range of a Server radio operating on the same RF Channel and system ID. If a Client cannot hear a Server for the amount of time defined by Range Refresh, it will drive In_Range High and enter search mode looking for a Server. When a server is detected, In_Range will be asserted Low. In_Range will always report Low on Server transceivers.

CONFIGURING THE AC4868-250

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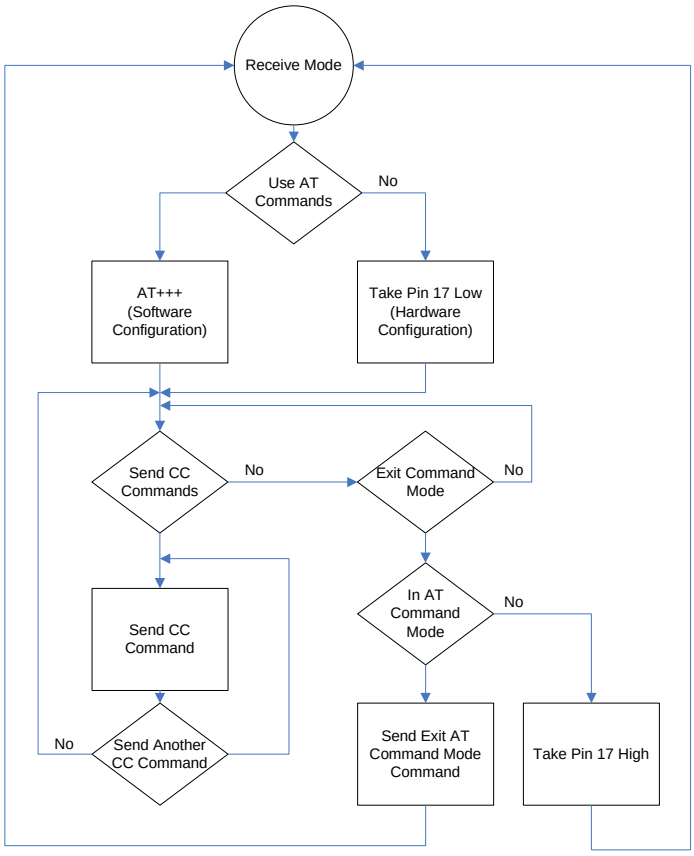
The AC4868-250 can be configured using the CC Configuration Commands. The CC Commands can be issued using either Hardware or Software Configuration. To use Hardware Configuration, pin 17 of a transceiver must be asserted Low. Software Configuration can be used by entering AT Command Mode before issuing the CC Commands.

Figure 8: AC4868-250 Configuration Flow



AT COMMANDS

The AT Command mode implemented in the AC4868-250 creates a virtual version of the Command/Data pin. The “Enter AT Command Mode” Command asserts this virtual pin Low (to signify Command Mode) and the “Exit AT Command Mode” Command asserts this virtual pin High (to signify Data). Once this pin has been asserted Low, all On-the-Fly CC Commands documented in the manual are supported.

On-the-Fly Control Commands

The AC4868-250 transceiver contains static memory that holds many of the parameters that control the transceiver operation. Using the “CC” command set allows many of these parameters to be changed during system operation. Because the memory these commands affect is static, when the transceiver is reset, these parameters will revert back to the settings stored in the EEPROM. While in CC Command mode using pin 17 (Command/Data), the RF interface of the transceiver is still active. Therefore, it can receive packets from remote transceivers while in CC Command mode and forward these to the OEM Host.

While in CC Command mode using AT Commands, the RF interface of the transceiver is active, but packets sent from other transceivers will not be received. The transceiver uses Interface Timeout/RF Packet Size to determine when a CC Command is complete. Therefore, there should be no delay between each character as it is sent from the OEM Host to the transceiver or the transceiver will not recognize the command. If the OEM Host has sent a CC Command to the transceiver and an RF packet is received by the transceiver, the transceiver will send the CC Command response to the OEM Host before sending the packet. However, if an RF packet is received before the Interface Timeout expires on a CC Command, the transceiver will send the packet to the OEM Host before sending the CC Command response.

When an invalid command is sent, the radio scans the command to see if it has a valid command followed by bytes not associated with the command, in which case the radio discards the invalid bytes and accepts the command. In all other cases, the radio returns the first byte of the invalid command back to the user and discards the rest.

Table 11: Command Quick Reference

Command Name	Command (All Bytes in Hex)						Return (All Bytes in Hex)			
AT Enter Command Mode	0x41	0x54	0x2B	0x2B	0x2B	0x0D	0xCC	0x43	0x4F	0x4D
Exit AT Command Mode	0xCC	0x41	0x54	0x4F	0x0D	-	0xCC	0x44	0x41	0x54
Status Request	0xCC	0x00	0x00	-	-	-	0xCC	Firmware Version	0x00: Server 0x01: Client in range 0x03: Client out of range	
Change Server/Client	0xCC	0x03	0x00: Server 0x03: Client		-	-	0xCC	Firmware Version	0x00: Server 0x03: Client	
Sleep Walk Power Down	0xCC	0x06	-	-	-	-	0xCC	Channel	-	-
Sleep Walk Wake Up	0xCC	0x07	-	-	-	-	0xCC	Channel	-	
Broadcast Packets	0xCC	0x08	0x00: Broadcast 0x01: Addressed			-	0xCC	0x00 or 0x01	-	-
Write Destination Address	0xCC	0x10	Byte 4 of Dest. MAC		Byte 5	Byte 6	0xCC	Byte 4 of Dest. MAC	Byte 5	Byte 6
Read Destination Address	0xCC	0x11	-	-	-	-	0xCC	Byte 4 of Dest. MAC	Byte 5	Byte 6
Auto Destination	0xCC	0x15	bit-0: Auto Destination bit-4: Enable Auto Destination				0xCC	bit-0: Auto Destination bits-1-7: 0		
Read Digital Inputs	0xCC	0x20	-	-	-	-	0xCC	bit-0: GI0 bit-1: GI1	-	-
Read ADC	0xCC	0x21	0x01: AD In 0x02: Temp		-	-	0xCC	MSB of 10 bit ADC	LSB of 10 bit ADC	
Write Digital Outputs	0xCC	0x23	bit-0: GO0 bit-1: GO1		-	-	0xCC	bit-0: GO0 bit-1: GO1	-	-
Write DAC	0xCC	0x24	Update Period	Duty Cycle	-	-	0xCC	Update Period	Duty Cycle	-
Set Max Power	0xCC	0x25	New Max Power			-	0xCC	Max Power	-	-
Transmit Buffer Empty	0xCC	0x30	-	-	-	-	0xCC	0x00	-	-
Deep Sleep Mode	0xCC	0x86	-	-	-	-	0xCC	Channel	-	-
Read Temperature	0xCC	0xA4	-	-	-	-	0xCC	Temp (C)	-	-
EEPROM Byte Read	0xCC	0xC0	Start Address		Length		0xCC	Starting Address	Length	Data
EEPROM Byte Write	0xCC	0xC1	Start Address		Length	Data	Starting Address		Length	Data written
Soft Reset	0xCC	0xFF	-	-	-	-	-	-	-	-

COMMAND DESCRIPTIONS

Enter AT Command Mode

Prior to sending this command, the OEM Host must ensure that the transceiver's RF transmit buffer is empty. If the buffer is not empty, the radio will interpret the command as data and it will be sent over the RF. This can be accomplished by waiting up to one second between the last packet and the AT command. RF packet size must be set to minimum of 6 in order to send this command.

Command: 0x41 0x54 0x2B 0x2B 0x2B 0x0D

Number of Bytes Returned: 4

Response: 0xCC 0x43 0x4F 0x4D

Exit AT Command Mode

The OEM Host should send this command to exit AT Command mode and resume normal operation.

Command: 0xCC 0x41 0x54 0x4F 0x0D

Number of Bytes Returned: 4

Response: 0xCC 0x44 0x41 0x54

Status Request

The OEM Host issues this command to request the status of the transceiver.

Command: 0xCC 0x00 0x00

Number of Bytes Returned: 3

Response: 0xCC Version Data1

Parameter Range: Data1 = 0x00 for Server, 0x01 for Client in Range, 0x03 for Client out of Range

Change Server/Client

The OEM Host issues this command to change the mode of the transceiver from Server to Client and vice versa.

Command: 0xCC 0x03 Data1

Number of Bytes Returned: 3

Response: 0xCC Firmware Version Data1

Parameter Range: Data1 = 0x00 for Server, 0x03 for Client

Sleep Walk Power-Down

After the Host issues this command, the transceiver will de-assert its In_Range line after entering power down. A Client in power down will remain in sync with a Server for a minimum of 2 minutes. To maintain synchronization with the Server, the Client should re-sync at least once every 2 minutes. This is done by sending the Power Down wake up command and waiting for the In_Range line to go active. Once this occurs, the Client is in sync with the server and can be put back into power-down mode.

This command is valid only for Client transceivers.

Command: 0xCC 0x06

Number of Bytes Returned: 2

Response: 0xCC Channel

Sleep Walk Power-Down Wake Up

The OEM Host issues this command to bring the transceiver out of Power Down mode.

Command: 0xCC 0x07

Number of Bytes Returned: 2

Response: 0xCC Channel

Broadcast Packets

The OEM Host issues this command to change the transceiver operation between Addressed Packets and Broadcast Packets. If Addressed Packets are selected, the transceiver will send all packets to the transceiver designated by the Destination Address programmed in the transceiver. If Broadcast Packets are selected, the transceiver will send its packets to all transceivers on that network. Setting bit-7 of API Control to 1 can also enable Broadcast Packets.

Command: 0xCC 0x08 Data1

Number of Bytes Returned: 2

Response: 0xCC Data1

Parameter Range: Data1 = 0x00 for Addressed, 0x01 for Broadcast

Write Destination Address

The OEM Host issues this command to the transceiver to change the Destination Address.

Note: Only the three Least Significant Bytes of the MAC Address are used for packet delivery.

Command: 0xCC 0x10 MAC3 MAC2 MAC1

Number of Bytes Returned: 4

Response: 0xCC MAC3 MAC2 MAC1

Parameter Range: 0x00 - 0xFF corresponding to 3 LSB's of destination MAC Address

Read Destination Address

The OEM Host issues this command to the transceiver to read the destination address.

Note: Only the three Least Significant Bytes of the MAC Address are used for packet delivery.

Command: 0xCC 0x11

Number of Bytes Returned: 4

Response: 0xCC MAC3 MAC2 MAC1

Parameter Range: 0x00 - 0xFF corresponding to 3 LSB's of destination MAC Address

Auto Destination

The Host issues this command to change the Auto Destination setting. When issuing this command, the Auto Destination setting will only be changed if the corresponding enable bit is set (Control1 Parameter, EEPROM address 0x56, bits-4,5)

Command: 0xCC 0x15 Data1

Number of Bytes Returned: 2

Response: 0xCC Data2

Parameter Range: Data1 = bit-0: Auto Destination, bit-4: Enable Auto Destination modification; Data2 = bit-0: New Auto Destination setting, bits 1 - 7:0

Read Digital Inputs

The OEM Host issues this command to read the state of both digital input lines.

Command: 0xCC 0x20

Number of Bytes Returned: 2

Response: 0xCC Data1

Parameter Range: Data1 = bit-0: GI0, bit-1: GI1

Read ADC

The OEM Host issues this command to read any of the three onboard 10-bit A/D converters. Because the RF is still active in On-the-Fly Command Mode, the transceiver will not process the command until there is no activity on the network.

Analog Voltage = (10 bits / 0x3FF) * 3.3V
Temperature (°C) = ((Analog Voltage - 0.3) / 0.01) - 30

Command: 0xCC 0x21 Data1

Number of Bytes Returned: 3

Response: 0xCC Data2 Data3

Parameter Range: Data1 = 0x00: AD In, 0x01: Temperature; Data2 = MSB of requested 10-bit ADC value; Data3 = LSB of requested 10-bit ADC value

Write Digital Outputs

The OEM Host issues this command to write both digital output lines to particular states.

Note: This command should only be used when Protocol Status (0xC2) is not set to 0xE3.

Command: 0xCC 0x23 Data1

Number of Bytes Returned: 2

Response: 0xCC Data1

Parameter Range: Data1 = bit-0: GO0, bit-1: GO1

Write DAC

The OEM Host issues this command to write DA_Out to a particular voltage. The transceiver uses a PWM (Pulse Width Modulator) to generate the analog voltage. The theory behind a PWM is that a binary pulse is generated with a fixed duty cycle and rate. As such, this pin toggles between High & Low. This signal is filtered via an on-board R-C circuit and an analog voltage is generated. Duty cycle specifies the ratio of time in one cycle that the pulse spends High proportionate to the amount of time it spends Low. So, with a duty cycle of 50% (0x80), the pulse is High 50% of the time and Low 50% of the time; therefore the analog voltage would be half of 3.3V or 1.15V. A broad filter has been implemented on the transceiver and there is no advantage to using a slower update period. Generally, a faster update period is preferred.

Command: 0xCC 0x24 Data1 Data2

Number of Bytes Returned: 3

Response: 0xCC Data1 Data2

Parameter Range: Data1 = Update Period; Data2 = Duty cycle

$$T_{update} = \frac{(255 \times (Data1 + 1))}{14.7456^{6}}$$

$$V_{out} = \frac{Data2}{0xFF} \times 3.3V$$

Set Max Power

The OEM Host issues this command to limit the maximum transmit power emitted by the transceiver. This can be useful to minimize current consumption and satisfy certain regulatory requirements. The radios are shipped at maximum allowable power.

Command: 0xCC 0x25 Max Power

Number of Bytes Returned: 2

Response: 0xCC Max Power

Transmit Buffer Empty

The OEM Host issues this command to determine when the RF transmit buffer is empty. The Host will not receive the transceiver response until that time.

Command: 0xCC 0x30

Number of Bytes Returned: 2

Response: 0xCC 0x00

Deep Sleep Mode

The OEM Host issues this command to put the transceiver into Deep Sleep mode. Once in Deep Sleep mode, the transceiver disables all RF communications and will not respond to any further commands until being reset or power-cycled.

This command is valid for both Servers and Clients.

Command: 0xCC 0x86

Number of Bytes Returned: 2

Response: 0xCC Channel

Read Temperature

The OEM Host issues this command to read the onboard temperature sensor. The transceiver reports the temperature in ^{o}C where 0x00 - 0x50 corresponds to 0 - 80 ^{o}C and where 0xD8 - 0x00 corresponds to -40 - 0 ^{o}C.

Command: 0xCC 0xA4

Number of Bytes Returned: 2

Response: 0xCC Temperature

Parameter Range: Temperature = 0xD8 - 0x80

EEPROM Byte Read

Upon receiving this command, a transceiver will respond with the desired data from the addresses requested by the OEM Host.

Command: 0xCC 0xC0 Data1 Data2

Number of Bytes Returned: 4+

Response: 0xCC Data1 Data2 Data3

Parameter Range: Data1 = EEPROM address; Data2 = Length (0x00 - 0x80); Data3 = Requested data

EEPROM Byte Write

Upon receiving this command, a transceiver will write the data byte to the specified address but will not echo it back to the OEM Host until the EEPROM write cycle is complete (up to 10 ms).

Multiple byte writes of up to 128 bytes are allowed. An EEPROM boundary exists between addresses 0x7F and 0x80. No single EEPROM write command shall write to addresses on both sides of that EEPROM boundary.

Command: 0xCC 0xC1 Data1 Data2

Number of Bytes Returned: 4+

Response: Data1 Data2 Data

Parameter Range: Data1 = EEPROM address; Data2 = Length (0x00 - 0x80); Data3 = Last byte of Data written

Reset

The OEM Host issues this command to perform a soft reset of the transceiver. Any transceiver settings modified by CC commands will revert to the values stored in the EEPROM.

Command: 0xCC 0xFF

Number of Bytes Returned: None

Response: None

EEPROM PARAMETERS

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The OEM Host can program various parameters that are stored in EEPROM which become active after a power-on reset. The table below gives the locations and descriptions of the parameters that can be read/written by the OEM Host. Factory default values are also shown. Do not write to any EEPROM addresses other than those listed below. Do not copy one transceiver's EEPROM to another transceiver as doing so may cause the transceiver to malfunction.

Table 12: EEPROM Parameters

Parameter	EEPROM Address	Length (Bytes)	Range	Default	Description
Product ID	0x00	40			40 bytes - Product identifier string. Includes revision information for software and hardware.
Beacon Period	0x3C	2	0x01 - 0xFF	0x14	Specifies the number of hop periods between Server beacon transmissions (equal to 53ms * value). Note that each transceiver should only transmit 10% of the time and beacons count as transmissions.
Range Refresh	0x3D	1	0x01 - 0xFF	0x18	Specifies the maximum amount of time a transceiver will report In Range without having heard a Server's beacon (equal to hop period * value). **Do not set to 0x00.**
Stop Bit Delay	0x3F	1	0x00 - 0xFF	0xFF	For systems employing the RS-485 interface or Parity, the serial stop bit might come too early. Stop bit delay controls the width of the last bit before the stop bit occurs. 0xFF = Disable Stop Bit Delay (12 us) 0x00 = (256 * 1.6 us) + 12 us 0x01 - 0xFE = (value * 1.6 us) + 12 us
Channel Number	0x40	1	0x38	0x38	
Server/Client Mode	0x41	1	0x01 - 0x02	0x02	0x01 = Server 0x02 = Client
Baud Rate Low	0x42	1	0x00 - 0xFF	0xFC	Low byte of the interface baud rate. Default baud rate is 57,600.
Baud Rate High	0x43	1	0x00	0x00	High byte of interface baud. Always 0x00
Control 0	0x45	1	0x00 - 0xFF	0x14	Settings are: bit-7: Laird Technologies Use Only bit-6: DES Enable bit-5: Laird Technologies Use Only bit-4: Laird Technologies Use Only bit-3: Laird Technologies Use Only bit-2: Laird Technologies Use Only bit-1: RF Delivery 0 = Addressed packets 1 = Broadcast packets bit-0: Laird Technologies Use Only
Transmit Retries	0x4C	1	0x01 - 0xFF	0x10	Maximum number of times a packet is sent out when Addressed packets are selected.

Table 12: EEPROM Parameters

Parameter	EEPROM Address	Length (Bytes)	Range	Default	Description
Broadcast Attempts	0x4D	1	0x01 - 0xFF	0x04	Maximum number of times a packet is sent out when Broadcast packets are selected.
API Control	0x56	1	0x00 - 0xFF	0x43	Settings are: bit-7: Laird Technologies Use Only bit-6: Laird Technologies Use Only bit-5: Unicast Only 0 = Disabled 1 = Enabled bit-4: Auto Destination 0 = Use destination address 1 = Use auto destination bit-3: Laird Technologies Use Only bit-2: RTS Enable 0 = Ignore RTS 1 = Transceiver obeys RTS bit-1: Duplex 0 = Half Duplex 1 = Full Duplex bit-0: Auto Config 0 = Use EEPROM values 1 = Auto Configure values
Interface Timeout	0x58	1	0x02 - 0xFF	0x04	Specifies a byte gap timeout, used in conjunction with RF Packet Size to determine when a packet coming over the interface is complete (0.5 ms per increment).
RF Packet Size	0x5B	1	0x01 - 0xFF	0x24	Used in conjunction with Interface Timeout; specifies the maximum size of an RF packet. When Auto Config is enabled, this value is overridden based on the Interface Baud Rate and RF Delivery mode. Must be set to a minimum of 6 in order to send the Enter AT command.
CTS On	0x5C	1	0x01 - 0xFF	0xC0	CTS will be deasserted (High) when the transmit buffer contains at least this many characters.
CTS Off	0x5D	1	0x00 - 0xFE	0xB0	Once CTS has been deasserted, CTS will be reasserted (Low) when the transmit buffer is contains this many or less characters.
Max Power	0x63	1	0x00 - 0x60	Set in Production & can vary	Used to increase/decrease the output power. The transceivers are shipped at maximum allowable power.
Parity	0x6F	1	0xE3, 0xFF	0xFF	0xE3 = Enable Parity 0xFF = Disable Parity **Note:** Enabling parity cuts throughput and the interface buffer size in half.
Destination ID	0x70	6	0x00 - 0xFF	0xFF	Specifies destination for RF packets
System ID	0x76	1	0x00 - 0xFF	0x01	Similar to network password. Radios must have the same system ID to communicate with each other.
RS-485 DE	0x7F	1	0xE3, 0xFF	0xFF	0xE3 = GO0 is active Low DE for control of external RS-485 hardware 0xFF = Disable RS-485 DE

Table 12: EEPROM Parameters

Parameter	EEPROM Address	Length (Bytes)	Range	Default	Description
MAC ID	0x80	6	0x00 - 0xFF		Factory programmed unique IEEE MAC address.
Original Max Power	0x8E	1		Set in Production and can vary	Copy of original max power EEPROM setting. This address may be referenced but should not be modified.
Product ID	0x90	15			0x90 - 0x93: Product ID 0x94 - 0x95: Prefix (AC) 0x96 - 0x99: Power (250M) 0x9A - 0x9C: Interface (485, TTL) 0x9D - 0x9E: Setup script (01 is stock) 0x9F: Reserved for future use; always 0xFF
DES Key	0xD0	7	0x00 - 0xFF		56-bit Data Encryption key

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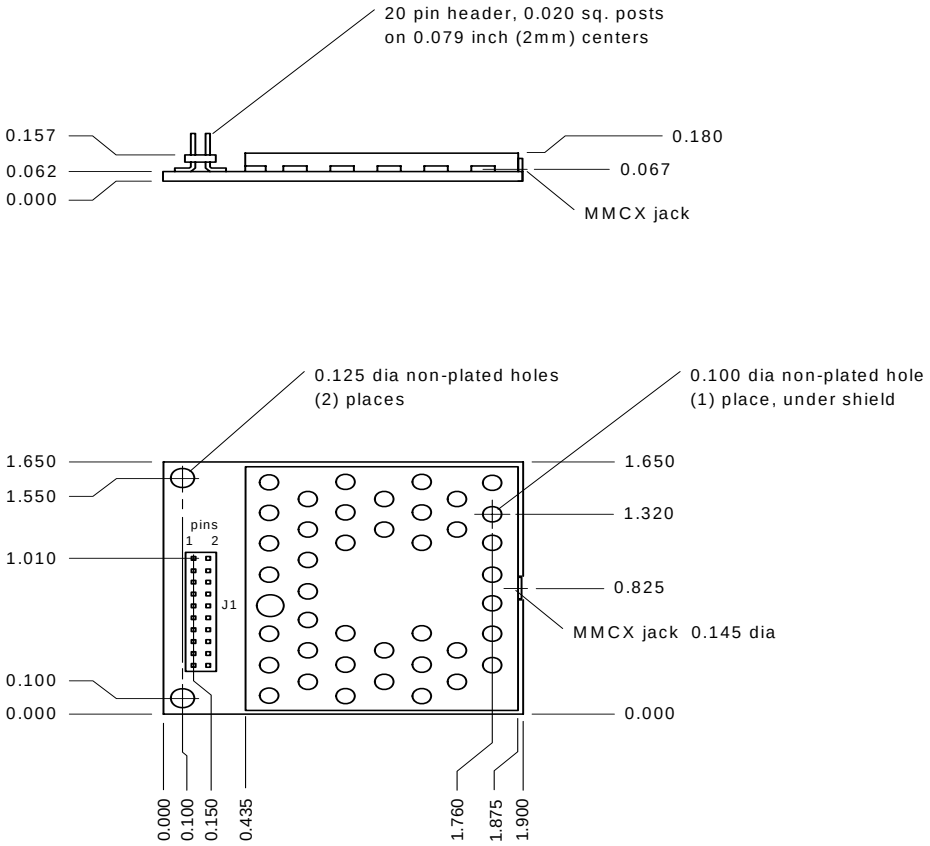
DIMENSIONS

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)

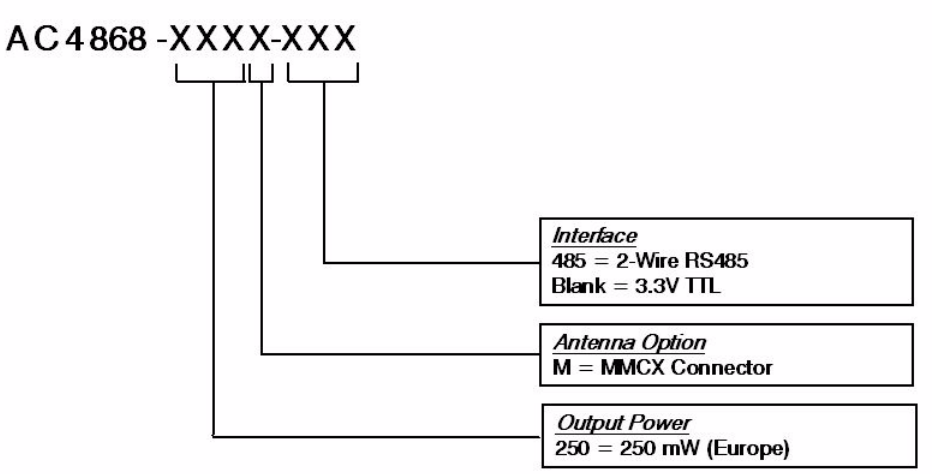
Figure 9: AC4868-250 (with MMCX connector) Mechanical



12

ORDERING INFORMATION

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 AC4868-250M can be ordered as a development kit using the part number: SDK-AC4868-250M.

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

COMPLIANCY INFORMATION

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AGENCY IDENTIFICATION NUMBERS

Agency compliancy is a very important requirement for any product development. Laird Technologies 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 below.

Table 13: Agency Identification Numbers

Part Number	EUR/EN
AC4868-250M	Approved

APPROVED ANTENNA LIST

The following antennas are approved for use with the AC4868-250 as identified. The OEM is free to choose another vendor's antenna of like type and equal or lesser gain as a listed antenna and still maintain compliance.

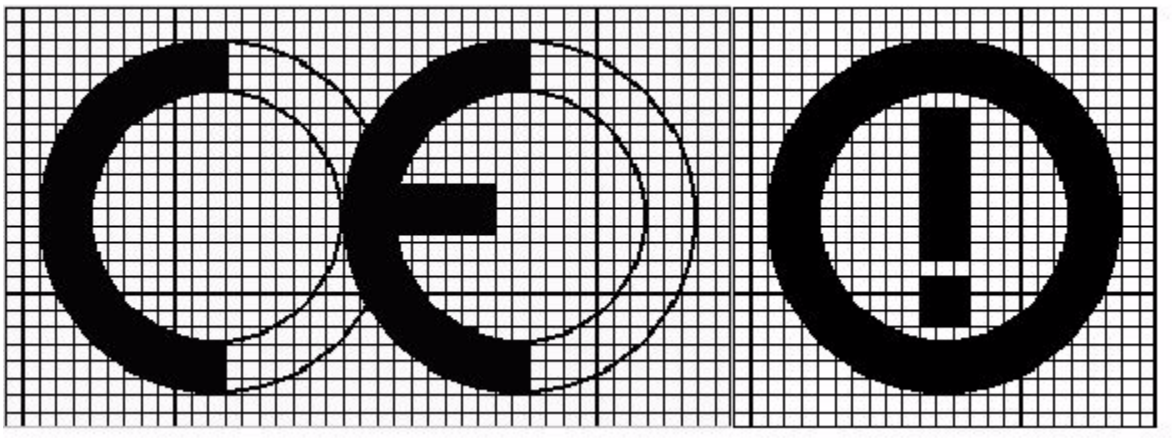
Table 14: AC4868-250 Approved Antennas

Laird Technologies Part Number	Manufacturer Part Number	Manufacturer	Type	Gain (dBi)	200A	200M	1000M
0600-00020	S467-FL-6-RMM-868S	Nearson	1/2 Wave Dipole	2	-	X	X

OEM EQUIPMENT LABELING REQUIREMENTS

WARNING: The OEM must ensure that the appropriate labeling requirements are met. Following are the requirements for labeling equipment:

1. If the CE marking is reduced or enlarged, the proportions given in the following graduated drawing must be respected.
2. The CE marking must have a height of at least 5 mm except where this is not possible on account of the nature of the apparatus.
3. The CE marking must be affixed to the product or to its data plate. Additionally, it must be affixed to the packaging, if any, and to the accompanying documents.
4. The CE marking must be affixed visibly, legibly, and indelibly.
5. The exclamation point must be included with the CE mark (as shown below) to alert the user to the fact that there are restrictions placed on usage in certain countries. It must have the same height as the CE mark.



COUNTRY RESTRICTIONS

The exclamation point included with the CE mark denotes that the equipment has restrictions in certain countries. Following is a list of countries having restrictions on the AC4868 and a description of those restrictions. The OEM is responsible for ensuring that these restrictions are met.

Table 15: AC4868 Country Restrictions

RF Channel	Country	Restriction	Reason/Remarks
0x38	All countries (unless otherwise noted)	Maximum ERP of 500 mW and maximum transmit duty cycle of 10% (amortized over one hour)	
0x38	Bulgaria	Not implemented	
0x38	Finland	Audio and voice are not permitted	
0x38	Germany	Audio and voice are not permitted	
0x38	Italy	Maximum ERP of 25 mW	Military applications
0x38	Slovak Republic	Not implemented	Military

COUNTRY NOTIFICATION

The OEM is responsible for notifying ANY country of the intent to ship product to that country containing the AC4868 four weeks prior to shipping.

DECLARATION OF CONFORMITY

Laird Technologies has issued a Declaration of Conformity for the AC4868-250M transceiver module concerning emissions, EMC, and safety. The Declaration of Conformity is a document that lists the product name and band of use and must appear in the OEM user's manual.

DECLARATION OF CONFORMITY

APPPLICATION OF COUNCIL DIRECTIVE(S):	**R&TTE Directive 1999/5/EC** **EMC Directive 89/336/EEC**
MANUFACTURER'S NAME:	**Aerocomm Inc.** 11160 Thompson Ave. Lenexa, Kansas USA, 66219
EUROPEAN REPRESENTATIVE'S NAME/ADDRESS:	
PRODUCT UNDER TEST:	**868 MHz OEM Transceiver**
MODEL NO.:	**AC4868-250M**
RF OUTPUT POWER:	**186mW Peak**
FREQUENCY RANGE:	**869.4 – 869.65 MHz**
TEST LABORATORIES:	Senton GmBH Test Center Aeussere Fruehlingstrasse 45 D-94315 Straubing Germany

STANDARD(S) TO WHICH CONFORMITY IS DECLARED:

Protection requirements concerning electromagnetic compatibility (EMC) pursuant to Article 3.1.b of the EMC directive:
Standards applied: **EN 301 489-1 V1.4.1 (2002-08), EN 301 489-3 V1.4.1 (2002-08)**

Standards (Harmonized) applied: EN 300 220-1 V1.3.1 (2000-09), EN 300 220-3 V1.1.1 (2000-09)

I, the undersigned, hereby declare that the equipment as tested is representative within manufacturing tolerance to units.

Manufacturer	Legal Representative in Europe
Signature	**Signature**
John Eckart	**Michael Schröttle**
Full Name	Full Name
Vice President, Sales	Geschäftsführer
Position	Position
11160 Thompson Ave., Lenexa, KS	Kirchstrasse 28, 8574 Lengwil-Oberhofen
Place	Place
Aug 25, 2005	**30. Aug. 2005**
Date	Date

APPENDIX I - SAMPLE POWER SUPPLY

Below is a simple switching power supply that provides enough current to easily power any Laird Technologies 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 will output +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.

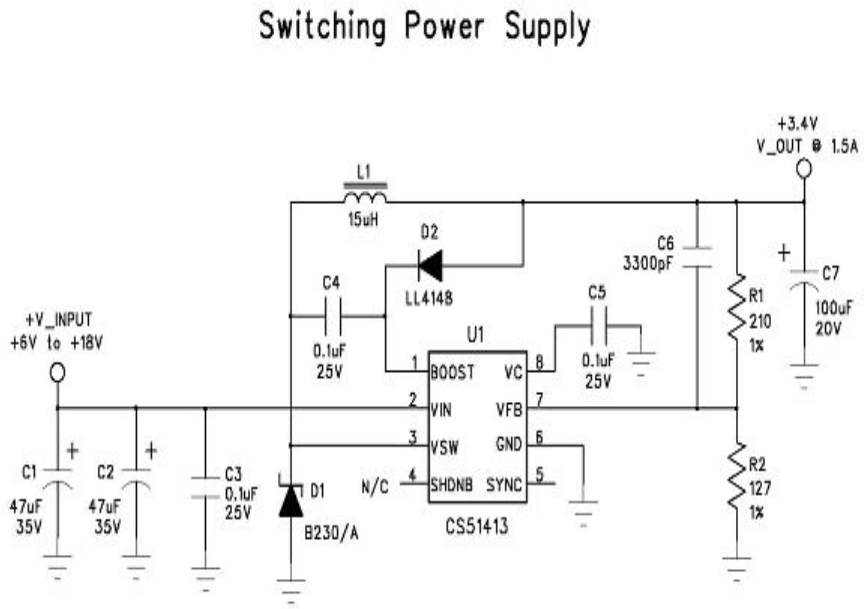
If the input voltage will be less than 12 volts then C1 and C2 can be replaced with a single 100uF 20 volt capacitor (same part number as C7). This will reduce board space and lower costs further. If you are powering an AC5124 module, R1 can be changed to a 373 ohm 1% resistor. This will change the output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

BILL OF MATERIALS

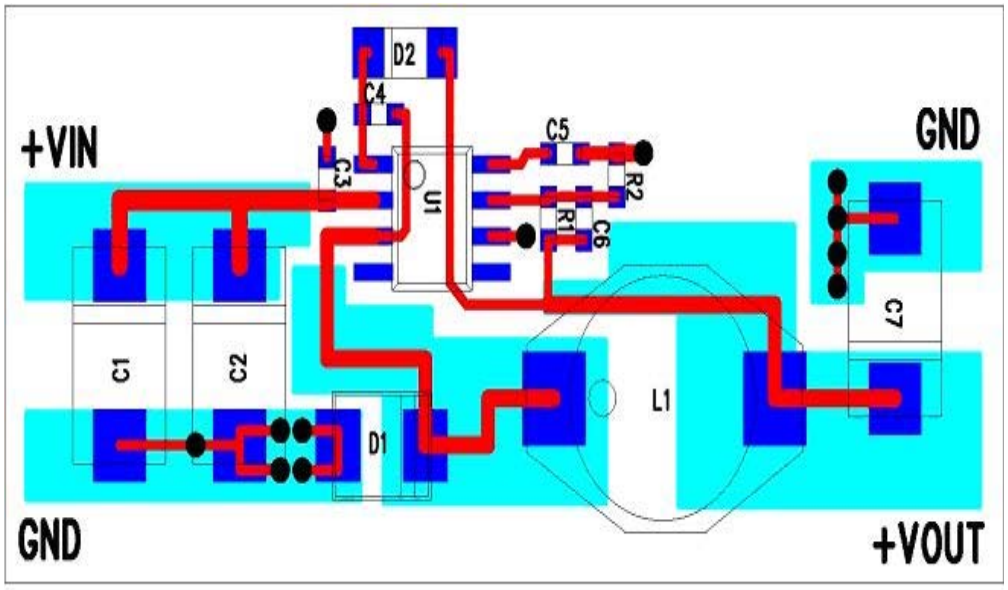
Table 16: Power Supply Bill of Materials

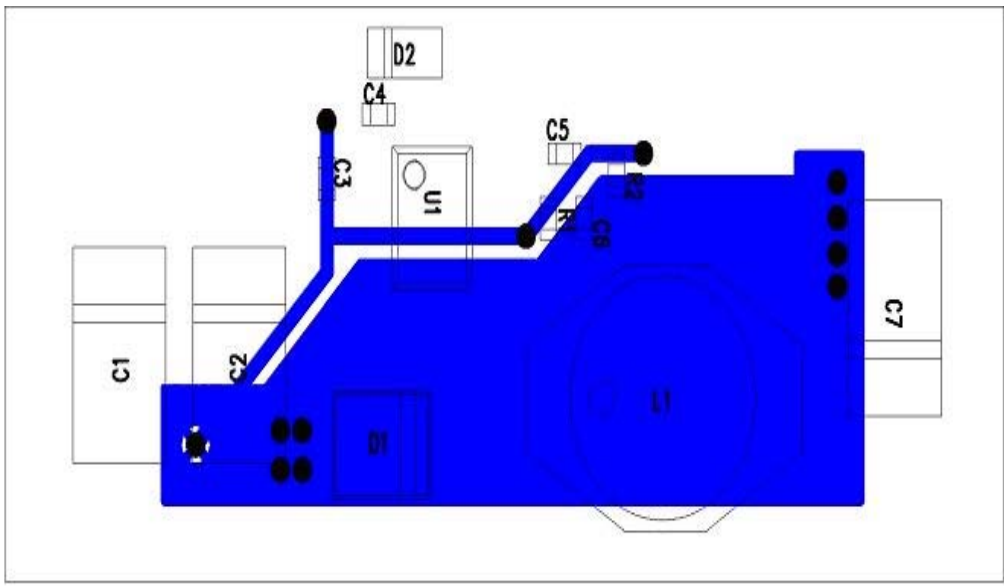
Qty	Reference	Value	Description	Mfg.	Mfg. part number
1	R1	210	Res, 0603, 210, 1/16W, 1%	KOA	RK73H1JT2100F
1	R2	127	Res, 0603, 127, 1/16W, 1%	KOA	RK73H1JT1270F
2	C1 C2	47uF	Cap, Tant, 7343, 47uF, 35V	AVX	TPSE476M035R0200
3	C3 C4 C5	0.1uF	Cap, Cer, 0603, 0.1uF, Y5V, 25V	Murata	GRM39Y5V104Z025AD
1	C6	3300pF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

SCHEMATIC



PCB LAYOUT




D2
C4
C5
C3
U1
C8
C7
C1
C2
L1
D1

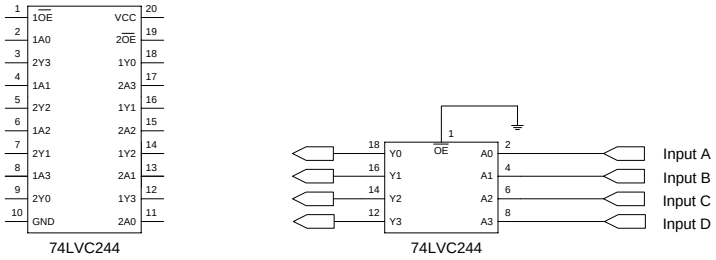
APPENDIX II - 5V TO 3.3V LEVELS

All inputs on the AC4868-250 are weakly pulled high via 10 kohm resistors. The AC4868-250 has 3.3V only inputs.

Some of the most common voltage conversion methods are described below.

Voltage Level Conversion IC's

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



Passive Resistor Voltage Divider

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