



PACIFIC CREST

ADL Foundation

Radio Modem Integrator's Guide



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Introduction

This guide provides information concerning the integration of the Advanced Data Link (ADL) Foundation radio modem transceivers - Model numbers ADLF-1 (390 to 430 MHz) and ADLF-2 (430 to 470 MHz) - into your product. This guide should be used in conjunction with the ADLCONF User's Guide – Dealer Version that should be referenced for general information concerning the configuration of ADL radio modems, and also for detailed programming information.

The ADL Foundation is a general-purpose radio modem transceiver that is compatible with both the ADL and the Positioning Data Link (PDL) product families of radio modems. The ADL Foundation transceiver is designed specifically for integration into existing or new products. Its small size, light weight and power efficient operation provide superior performance in embedded systems.

A variety of configurations are available to ease the integration task, including CMOS or RS-232 data interface, a variety of I/O connectors and two frequency bands covering the 390-430 and 430-470 MHz ranges. The ADL RXO, a receive-only radio module, is described in a separate Integrator's Guide available from Pacific Crest.

Main Components

There are two ADL Foundation Developer's Kit s: P/N 82264 (CMOS) and P/N K01096 (RS232). They comprise the following:

ADL Foundation transceiver (430-470MHz)	A02777 (CMOS) or A02652 (RS232)
Test and Demo Board	A02599
2 screws to attach transceiver to test board	C02982
Power Supply	C03047
Universal power cord adapter set	C02316
DB9 Male to DB9 Female Modem Cable	C02592
Flexible ¼ Wavelength Antennas (2)	
420-450 MHz, 2.4 dB Gain	C02107
450-470 MHz, 2.4 dB Gain	C02108
Antenna Cable	A02650
Data/power test interface cable	A02720
ADL Foundation Getting Started Guide	M00809
ADL Foundation Integrator's Guide	M00790
ADLCONF User Guide - Dealer Version	M00800
ADLCONF Software	S00039
ADL TEST Software	S00047
ADLCONF (Dealer Version) USB Key	A02672

Getting Started



Caution: ADL Foundation transceiver must be handled with care during installation. Remove the transceiver from its protective bag only in an ESD safe area.

To set up the hardware components, follow these steps:

1. Plug the ADL Foundation transceiver into the I/O-test board's 20-pin connector
2. Secure the module to the I/O-test board using the provided screws
3. Attach the antenna cable to the ADL Foundation transceiver
4. Attach one of the two antennas (whichever matches your licensed frequency) to the antenna cable
5. Attach the PC interface cable to the I/O-test board's 9-pin UART connector (see diagram below)
6. Attach the PC interface cable to a serial port on your PC
7. Attach the wall cable to the AC/DC adapter and select the proper plug from the adapter kit
8. Attach the AD/DC adapter's tubular plug to the power jack on the I/O-test board
9. Plug in the ADLCONF (Dealer's Version) USB key on your PC
10. Install ADLCONF (<http://www.pacificcrest.com/support.php?page=updates>) on your PC, but do not launch the program yet
11. Download and install the latest Sentinel driver for the USB driver from <http://www.safenet-inc.com/support-downloads/sentinel-drivers>
12. Launch ADLCONF and refer to its user guide for instructions on connecting to the ADL Foundation transceiver

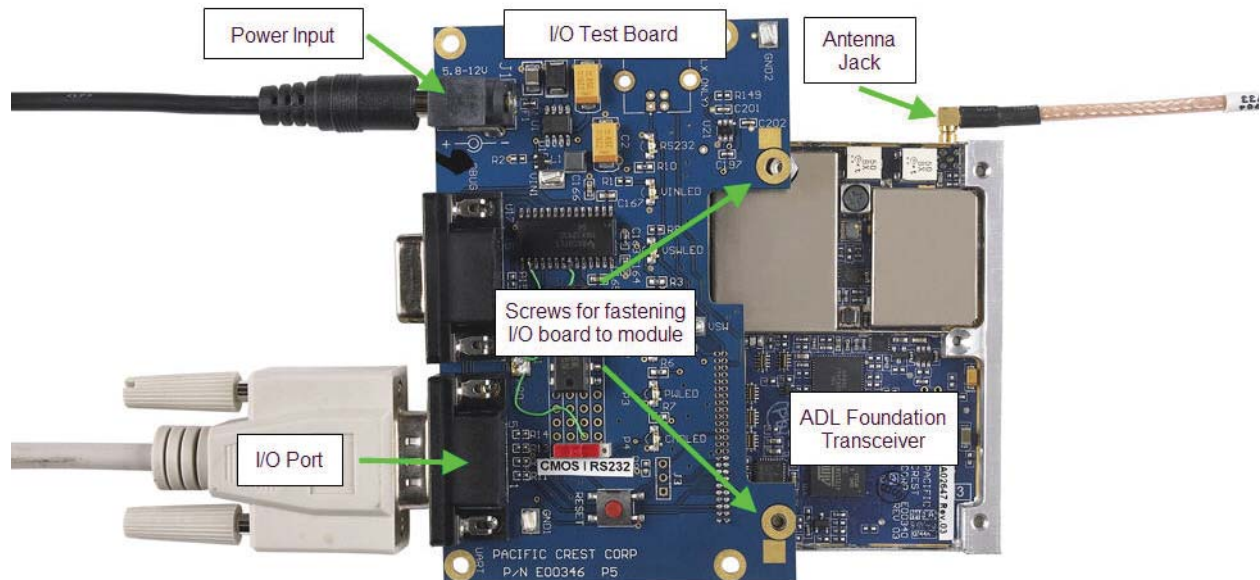


Figure 1 - ADL Foundation Developer's Kit

Interface Port Pin Out

The standard ADL Foundation transceiver comprises a 20-pin port for power, data and interfacing with other electronic devices.

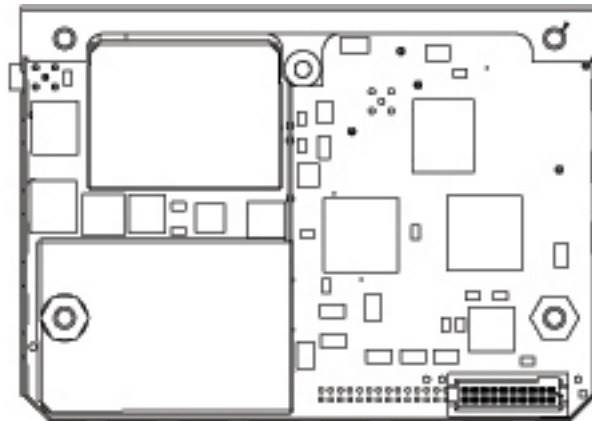


Figure 2 - 20 Pin Foundation Board

The following signals are available on the 20-pin connector:

Pin	Name	Description
1	GND	GROUND FOR SIGNAL AND POWER
2	GND	GROUND FOR SIGNAL AND POWER
3	PWR IN	DC POWER INPUT, +6V to +30V
4	PWR IN	DC POWER INPUT, +6V to +30V
5	TX1	TX DATA, DTE SERIAL PORT 1, RS232 OR 3V CMOS (3.3V COMPATIBLE)
6	RX1	RX DATA, DTE SERIAL PORT 1, RS232 OR 3V CMOS (3.3V COMPATIBLE)
7	PWRON	POWER ENABLE, ACTIVE LOW, WITH PULL DOWN RESISTOR
8	GND	GROUND FOR SIGNAL AND POWER
9	PWRLED	POWER LED DRIVER, 3V CMOS OUTPUT W/ 470 RESISTOR IN SERIES
10	--	FACTORY USE ONLY, PLEASE LEAVE NO CONNECTION
11	RXLED	RADIO RECEIVE LED DRIVER, 3V CMOS OUTPUT W/ 470 RESISTOR IN SERIES
12	--	FACTORY USE ONLY, PLEASE LEAVE NO CONNECTION
13	TXLED	RADIO TRANSMIT LED DRIVER, 3V CMOS OUTPUT W/ 470 RESISTOR IN SERIES
14	--	FACTORY USE ONLY, PLEASE LEAVE NO CONNECTION
15	CMDLED	PROGRAMMABLE LED DRIVER, 3V CMOS OUTPUT W/ 470 RESISTOR IN \ SERIES
16	--	FACTORY USE ONLY, PLEASE LEAVE NO CONNECTION
17	NC	FACTORY USE ONLY, PLEASE LEAVE NO CONNECTION
18	TEST1	FACTORY USE ONLY, PLEASE LEAVE NO CONNECTION
19	TEST2	FACTORY USE ONLY, PLEASE LEAVE NO CONNECTION
20	GND	GROUND FOR SIGNAL AND POWER

TX and RX Pins

Pin 5 is used to receive data into the radio from an external device (a PC, GPS receiver, weather sensor, etc). Pin 6 is used to send data out of the radio to the external device. The external device is transmitting data to the ADL Foundation on Pin 5, so according to the DTE naming convention, Pin 5 is called the TX pin. The external device receives data from the ADL Foundation's Pin 6 so this is called the RX pin.

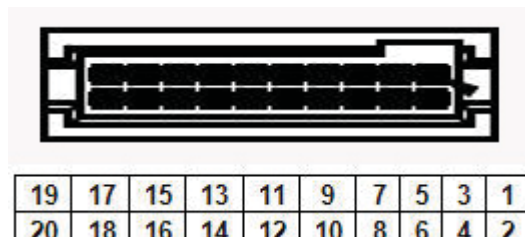


Figure 3 - Pin Orientation

Antenna Port

A coaxial antenna port is provided for connecting the antenna system to the ADL Foundation transceiver. The antenna connector is a 50-Ohm MMCX type. Appendix B provides part numbers and manufacturer information for compatible interface and RF connectors. Pacific Crest Corporation also provides custom manufactured cables designed to your specific needs. Contact us for a quotation for your specific cabling requirements.



Warning: Don't transmit without first connecting an antenna.

Compliance

The ADL Foundation transceiver radio modem is designed to be compliant with worldwide regulatory requirements, including FCC part 90, ETS 300-113-2, IC RSS 119 and others.



Warning: The ADL Foundation transceiver is classified as an intentional radiator of type radio transceiver. Conducted and radiated emissions of the standard ADL Foundation transceiver do not exceed the requirements of FCC part 90 and ETS 300-113-2. OEM is responsible for full compliance of final product.

Compatibility

The ADL Foundation transceiver is compatible with most modes of operation supported by the ADL and PDL product families of radio modems. See the Protocols and Modes of Operation section for an overview of the protocols and modes that are supported with the ADL Foundation transceiver radio modem. The compatibility also extends to ADLCONF software configuration program and the ADL Test application that are supplied as part of the ADL Foundation Developer's Kit.

Protocols and Modes of Operation

The ADL Foundation transceiver radio modem is completely configurable using ADLCONF software. Configuration parameters define the DTE interface and the over-the-air protocol. Depending on the application you may need to change the factory default settings. The following table shows the factory default configuration of the ADL Foundation transceiver.

Parameter	Default
Channel	0
Baud Rate	38400
Parity	None
Soft Break Disable	On
Mode	Transparent EOT Timeout
EOT	50 ms
Repeater Delay	0
TX ACK Timeout	10 ms
Link Rate	9600 bps GMSK
Retries	10
CSMA	On*
FEC	On
Scrambling	On
Sensitivity	High
Local Address	0
Destination Address	255

*CSMA is required to be on only inside the United States.
You should turn CSMA off in EU countries.

Table 1 - ADL Foundation Factory Default Settings

Up to 32 frequencies are stored in the configuration memory called the channel table. The selection of channel is subject to proper licensing of the corresponding frequencies by the appropriate governmental agency. Please refer to the ADLCONF User's Guide for instructions in creating and uploading channel tables into the ADL Foundation transceiver modem.

The ADL Foundation transceiver modem supports multiple protocols and modes of operation including:

- Transparent with EOT Timeout
- Transparent with EOT Character
- Transparent FST
- Packet Switched
- TRIMTALK™ 450S
- TRIMTALK II/IIIE
- TT450S HW
- TRIMMARK™ 3
- SATEL®

Refer to the ADLCONF User's Guide for a detailed description.

Electrical Considerations

Power Supply

The ADL Foundation transceiver has a power supply connection on both Pin 3 and Pin 4 of the interface connector. Pins 1, 2, 8 and 20 are connections to both power ground and RS-232 interface signal grounds. Note that these pins are tied to a common point on the ADL Foundation transceiver. If there is a potential for a ground path current loop due to improper power application, we recommend a fusible link be inserted in the signal ground to protect the ADL Foundation transceiver.

ADL Foundation transceiver modems are designed to operate with unregulated DC voltage levels between 6 and 30 VDC. The power supply must be capable of sourcing 1.6A.

Note: The ADL Foundation Developer Kit includes a 5 V DC power supply. This provides sufficient power for development and testing purposes. ADLCONF software allows you to configure an ADL radio modem to warn the user when input voltage falls below a certain level. The default level is 9 V DC. Because the Developer Kit power supply provides only 5 V DC, you should not enable this feature in ADLCONF and then configure your test module.

Data Interface

ADL Foundation transceiver provides two serial ports. One is a data port, which has a simple 3-wire CMOS or RS-232 electrical interface with signals for transmitting data to and receiving data from the ADL Foundation transceiver, and for providing a reference ground for the TX (Pin 5) and RX (Pin 6) signals. The other is a debug port (TX is Pin 14 and RX is Pin 12). ADL Foundation transceiver uses this port to send out debug information for trouble shooting purpose. The CMOS/RS-232 option is set by Pacific Crest prior to shipping.

Note: We define TX and RX as a DTE port. In other words, an external device transmits data to the radio modem's TX pin (Pin 5) and receives data from the radio modem's RX pin (Pin 6).

CMOS Input/Output Protection Circuitry

The TX signal terminates into a CMOS input port on the ADL Foundation transceiver and should be driven externally or pulled to ground through a 10 kΩ resistor. The absolute maximum voltage applied to the TX signal is -0.3 V to 3.3 V.

The RX and DCD signals are CMOS outputs. Note that loading the RX and DCD signals increases the power consumption of the ADL Foundation transceiver and these should be limited to no more than 2.5 mA each to maintain performance across the temperature range.



Caution: Internal circuitry protects the inputs and outputs against damage caused by high static voltages or electric fields; however, normal precautions are necessary to avoid application of any voltage higher than the maximum-rated voltages.

LED Drivers

The ADL Foundation transceiver provides access to four function-specific LED drivers. Figure 2 shows the product with a 20 pin connector. Table 4 shows the pin-out and function of the four LED drivers.

Pin	Function	Description
9	PWR LED	Power LED Driver
11	RX LED	Radio Receive LED driver
13	TX LED	Radio transmit LED driver
15	CMD LED	Programmable LED driver

Table 2 - Pin-outs for the LED driver port

The LED drivers are designed to provide approximately 2 mA. This drive level requires that only high-efficiency LEDs be used with the drivers.

Error Codes

The ADL Foundation transceiver performs a variety of power-up and run-time tests to assure optimal operation. Tests include environmental as well as electrical measurements designed to avoid damage to the unit while maintaining adequate operation. In the event of an error condition, an error code is flashed on the ADL RXO's LED lines, but only if they are connected to LED drivers. The number of times the LED(s) flash equals the number of the error code. Table3 lists the possible error conditions.

Code	Description
01	External voltage too high
02	External voltage too low
08	Unit temperature is too high for transmit
11	Config memory C/S error during initialization
12	RAM error during initialization
15	TX Synthesizer Lock Error
16	RX Synthesizer Lock Error
99	Unknown error

Table 3 - ADL Error Codes

A 50Ω impedance coaxial MMCX style RF connector is provided for attachment to an external antenna system. The MMCX connector offers a positive friction locking mechanism that is very reliable. In some circumstances, it may be required to provide a physical stop to prevent the MMCX plug from becoming disconnected due to extreme shock or vibration.

The ADL Foundation transceiver requires an antenna and feed cable system that is impedance-matched to 50Ω. We recommend that high quality RG-178 or equivalent coaxial cable be used for internal wiring of the RF signal from the MMCX to the panel connector. We also suggest the selection of an antenna that has a low VSWR (less than 1.5:1) and that has been tuned for operation in the band of the ADL Foundation transceiver.



Caution: Improper impedance matching of the antenna, connectors or cable will degrade the performance of the ADL Foundation transceiver.

Shielding Considerations

The ADL Foundation transceiver is designed to operate in proximity to noise generating circuitry. However, certain radiated or conducted frequencies may degrade the performance of the ADL Foundation transceiver or render it inoperable. When possible, provide well-grounded shielding between circuits that radiate, such as power supplies, voltage-controlled oscillators, crystal oscillators and the ADL Foundation transceiver.

Frequency Planning

The ADL Foundation transceiver contains a very sensitive, dual-conversion super-heterodyne receiver.



Caution: Radiated and conducted signals to and from the ADL Foundation transceiver may cause problems due to interference. Proper attention to frequency planning may reduce interference from radiated or conducted frequencies that fall within the pass-bands of the filters at the IF frequencies.

We recommend the use of upfront analysis of the product frequency plan (including harmonics) and then the use of a spectrum analyzer to determine the potential for interference within the pass-bands of the various front-end and band pass filters.

The following table indicates the frequencies and band pass filter characteristics that are areas of potential interference.

Circuit	Center Frequency (MHz)	Bandwidth (MHz)
RF front-end	410 or 450 (depending on model)	40
First IF	54.45	0.015
Second IF	0.450	0.010

Table 4 - ADL Foundation Frequency Plan

Mechanical Considerations

EMI interferers

The ADL Foundation transceiver is easily mounted inside new and existing products. The ADL Foundation transceiver is specifically designed for operation in harsh environments. For best performance, mount the radio away from potential EMI radiators and route RF signals apart from digital signals.



Caution: We do not recommend the bundling of the antenna interface cable with other signal cables internal to your product.

Shock and Vibration

Sensitive radio transceivers, such as the ADL Foundation transceiver, are susceptible to interference due to mechanical shock and vibration. To reduce the potential for electromechanical interference, a robust mounting scheme must be used when being integrated into other systems. A thin damping pad between the mounting surface and the ADL Foundation transceiver may be required. We recommend the use of damping pads made of PORON(R) or a similar material.

Thermal Transfer

The ADL Foundation transceiver requires additional thermal heat dissipation in order to supply maximum power out at elevated ambient temperatures and high duty cycles. The ADL Foundation transceiver has a thermal sensor and a firmware controlled limit switch. The ADLF will shut down when the PCB temperature reaches 85°C to prevent permanent damage to transmitter. The integrated heat sink is adequate for most bench top testing but when the ADL Foundation transceiver is integrated into other systems additional thermal heat sinking must be considered. The ADLF will produce approximately 6 Watts of heat at full RF power out.

Refer to Appendix A for mounting diagrams and specification.

Materials

The ADL Foundation transceiver is housed in a metal shield that is a conductor and is electrically connected to the ground and signal ground pins.

Service and Support

Philosophy

Pacific Crest is dedicated to providing the very best service and support possible. We recognize that the success of our business is directly related to the success our customers have in using our products. For this reason, we provide easy access with our toll free number, which we encourage our customers to use if they are experiencing difficulties or problems with the products we supply.

Let us know what you think. A cornerstone of our business philosophy is to evolve our product lines to match the needs of our customers. Your input allows us to better determine what we need to do to keep our product and support offerings in alignment with your needs.

Phone/Internet Support

Phone support is available during our business hours, Monday through Friday (7 a.m. to 4 p.m. Pacific Standard Time). Call 1-800-795-1001 (U.S. and Canada), +1-408-481-8070 (International), +1-408-481-8984 (Fax). You can contact the support group via our web site, www.PacificCrest.com or send an e-mail to support@pacificcrest.com

Warranty

One-Year Limited Warranty

This warranty gives you specific legal rights. You may also have other rights which vary from state to state or province to province.

Pacific Crest warrants its ADL Foundation transceiver radio modem products against defects in materials and workmanship for a period of one year from receipt by the end user. During the warranty period, Pacific Crest will, at its option, either repair or replace products that prove to be defective.

Exclusions

Should Pacific Crest be unable to repair or replace the product within a reasonable amount of time, a refund of purchase price may be given upon return of the product.

The warranty on your ADL Foundation transceiver radio modem shall not apply to defects resulting from:

- Improper or inadequate maintenance by the customer
- Unauthorized modification or misuse
- Operation outside of the environmental specifications for the product
- Negligence or misuse

Warranty Limitations

The warranty set forth above is exclusive and no other warranty, whether written or oral, is expressed or implied. Pacific Crest specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

Appendix A - Mounting Guide

Standard Enclosure

Figure A1 below shows mounting holes locations and overall dimensions for the ADL Foundation transceiver.



Caution: Screws used to mount the ADL Foundation transceiver to a mounting plate must not penetrate the mounting surface of the ADL Foundation transceiver by more than 0.20 inches. Screws that penetrate beyond this distance may cause damage.

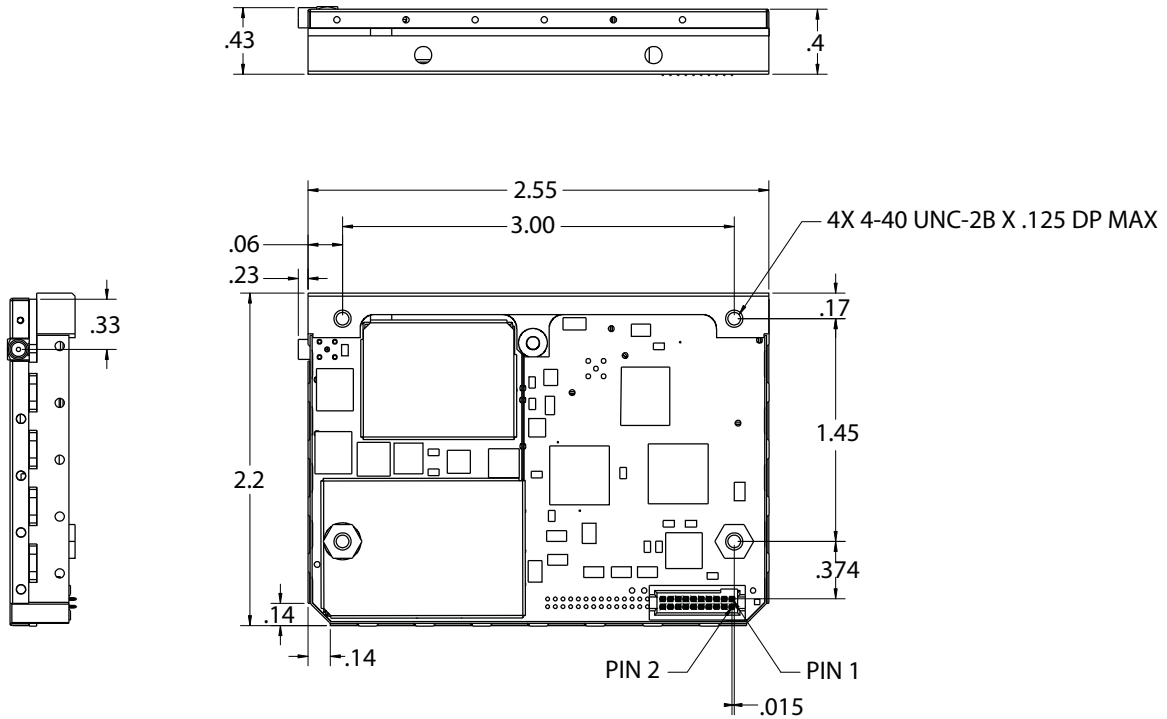
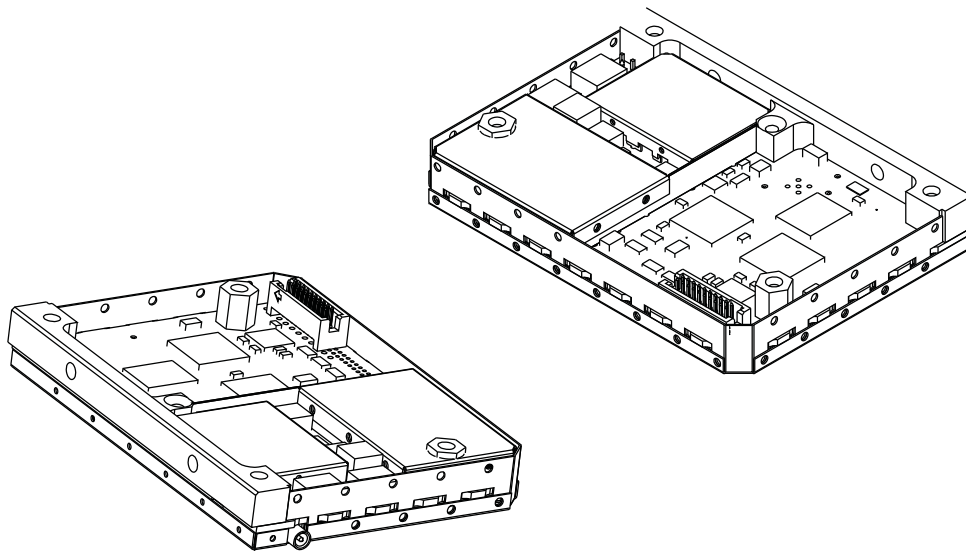


Figure A1 - ADL Foundation Mounting Template



Appendix B - Cables and Connectors

Value-Added Cable Products

Pacific Crest manufactures a wide variety of high-quality custom cables in support of its OEM customers. Contact your Pacific Crest sales representative to discuss your custom cable requirements.

Interface Connector

The 20-pin data/power header is a Samtec TFM series housing a standard-configuration connector, Samtec part number TFM-110-11-S-D. The mating Samtec connector is part number SFM-110-01-S-D for a board-to-board interface that is coincident with the mounting hardware and heat sink (.25" mating height). See Samtec website www.samtec.com for other mating connector options.

RF Connector

The RF connector is compatible with an MMCX-style coaxial plug. Plugs are available from many sources and in many configurations. We use plugs manufactured by Radiall. Radiall MMCX right-angle plug for use with RG-178 cable is part number R110 172 100. Radiall MMCX straight plug for use with RG-178 cable is part number R110 083 120.

Appendix C - Technical Specifications

General

Interface

DTE - DCE Interface RS-232 or CMOS, 115.2 kbps maximum

Power Requirements

External 6.0 – 30.0 VDC, +/- 0.50 VDC
During RX 0.6 Watts nominal @ 7.4 VDC
During TX 7 Watts nominal @ 7.4 VDC, 1W RF output

Radio Specifications

Frequency Bands

390-430 MHz
430-450 MHz

Frequency Control

Synthesized 12.5 kHz tuning resolution
Frequency stability +/- 1PPM

Channel Spacing

Channel spacing 12.5/25 kHz (user-selectable)

RF Transmitter Output

0.1 – 1 Watt (Programmable)

Sensitivity

-110 dBm BER = 1×10^{-5}

Adjacent Channel Selectivity

>55dB

Type Certification

All models are type accepted and certified for operation in the U.S., Europe, Australia, New Zealand, and Canada FCC, IC, EU, NZ, Australia ETS300-113-2



Figure C-1 – ADL Foundation Label

Modem

Link Rate/Modulation

4-Level FSK: 9600, 19,200 bps

GMSK: 4800, 8000, 9600, 16,000, 19,200 bps

Link Protocols

Transparent FST/EOT/EOC, Packet-switched, SATEL, TRIMMARK™, TRIMTALK™, OEM-specific

Forward Error Correction (FEC) and Detection

Yes

Environmental

Shock and Vibration

Per MIL-STD-810F

Temperature Range

Operating Temperature (Receiver): -40° to +85° C (-40° to +185° F)

Operating Temperature (Transmitter): -40° to +65° C (-22° to +149° F)

Storage Temperature (Receiver/Transmitter): -55° to +85° C (-67° to +185° F)

Mechanical

Dimensions

7.6 cm W x 5.4 cm D x 1.1 cm H (3.0"W x 2.2"D x 0.4"H)

Weight

70 grams (2.5 oz.)

Appendix D – API Commands
A description of the ADL Foundation transceiver Application Programmer Interface is available to qualified Pacific Crest development partners. Please contact sales@PacificCrest.com.

Appendix E – ADL Test

Description

The ADL Test application is used to perform functional radio tests on Pacific Crest ADL radios.

Usage

Set radio to command mode:

- Start application

- Select Serial Port + Data Rate to connect to radio

- Select Soft Break (Put radio into command mode, default behavior for ADL radio is that it is in data mode.)

Run Test

- Select Link Rate

- Select Modulation

- Select Channel

- Select Transmit Test

- Select Adjust Frequency Error



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