

PKLR2400S-200
200mW OEM Transceiver

Hardware and Software
Interface Specification
Version 1.1



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AGENCY APPROVAL OVERVIEW

	US/FCC	CAN/IC	EUR/EN	Portable	Mobile	Fixed
PKLR2400-200	X	X	Not Approved	Not Approved	X-32cm	X-32cm

Note: The product approval above is with antennas specified below.

FCC NOTICE



WARNING: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

ANTENNA WARNING



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

APPROVED ANTENNA LIST

Manufacturer	Part Number	Type	Gain	Application*
Centurion	WCP-2400-MMCX	¼ Wave Dipole	2dBi	M/F
Maxrad	Z986	Patch	2.5dBi	M/F
AeroComm	NZH2400-MMCX (External)	Microstrip	1dBi	M/F
Nearson	S131CL-5-RMM-2450S	¼ Wave Dipole	2dBi	M/F
Nearson	S181FL-5-RMM-2450S	¼ Wave Dipole	2dBi	M/F
Nearson	S191FL-5-RMM-2450S	¾ Wave Dipole	3dBi	M/F

*M=Mobile, F=Fixed/Basestation

LABELING REQUIREMENTS



WARNING: The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the AeroComm FCC identifier, KQL-PKLR2400-200, for this product as well as the FCC Notice above.

RF EXPOSURE



WARNING: To satisfy FCC RF exposure requirements for mobile and base station transmitting devices, a separation distance of 32cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operations at closer than this distance is not recommended.

The preceding statement must be included as a CAUTION statement in manuals for OEM products to alert users on FCC RF Exposure compliance.

Revision

Version 1.0

Version 1.1

Description

Initial Release Version – 8/18/00

Updated FCC requirements – 9/16/00

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This material is preliminary.

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1. Overview

This document contains information about the hardware and software interface between an AeroComm PKLR2400 transceiver and an OEM Host. Information includes the theory of operation, system issues, and a basic command set for operational control of the system and transceiver.

The Transceiver is designed to allow flexibility at the hardware interface level with a minimum number of actual hardware pins connecting the transceiver and the OEM Product. The transceiver is controlled by a Dallas 87C520 microcontroller providing program storage. A separate EEPROM provides user definable parameter storage.

The RF system is Server/Client (Master/Slave) architecture. Data can be transmitted from Client to Server or Server to Client, but not from Client to Client, or Server to Server.

The Serial Interface Modes provide four different serial interfaces. This protocol provides significant flexibility to the OEM allowing them to provide data in many forms including packet, end character and fixed-length with and without timeouts.

2. PKLR2400 Specifications

GENERAL

Interface	Serial (TTL Level Asynchronous) 40 pin mini connector. Amp P/N 177986-1
Interface Data Rate	
Serial	Programmable to 882Kbps. PC rates to 57.6 Kbps
Power Consumption	
TX/RX Active (All Modes)	400mA/115mA typical
Interface ON/RX OFF (API Mode Only)	45mA typical
Sleep Walk (All Modes)	25mA typical
Standby (API Mode Only)	20mA typical
Channels	Supports 77 non-interfering channels
Security	User assigned System ID. Unique IEEE addresses on each transceiver.

RADIO

Frequency Band	2.402 – 2.478 GHz
Transceiver Type	Spread Spectrum Frequency Hopping
Output Power (Conducted, no antenna)	199.5mW
Effective Radiated Isotropic Power (EIRP with Highest Gain Antenna)	363.1mW
Input Voltage	5V nominal $\pm 2\%$, $\pm 50\text{mV}$ ripple
Sensitivity	-90dBm
Data Rate	882Kbps
Range	Indoors up to 1000 ft., Outdoors up to 10,000 ft.

ENVIRONMENTAL

Temperature (Operating)	0 °C to +70 °C
Temperature (Storage)	-50 °C to +85 °C
Humidity (non-condensing)	10% to 90%

PHYSICAL

Dimensions	1.65" x 2.65" x 0.20"
Antenna Connector	Standard MMCX jack
Weight	Less than 0.5 ounce

SOFTWARE

User Configurable Options	
Host Interface Data Rate	Up to 882Kbps
Variable Packet Length	Up to 2Kbyte
Serial Interface Modes	(3) Transparent and (1) API
Diagnostic Error Counters	API mode
User Programmable Attempts	Up to 255

3. Theory of Operation

The PKLR2400 has a serial interface that allows the OEM Host to send and receive communications to and from the transceiver. All I/O is 5Vdc TTL level signals except for RSSI. All outputs are weakly pulled logic high (20k – 50k ohms) when left unconnected and are driven logic high at reset.

3.1 Definitions

Server Host: The Server Host is the OEM device controlling the Server transceiver

Client Host: The Client Host is the OEM device controlling the Client transceiver

Host: Host refers to both the Server Host and the Client Host

Server Transceiver: The Server transceiver is the “master” transceiver. It is the hub of communications

Client Transceiver: The Client transceiver is a “slave” transceiver. It is controlled by it’s own Host, but is a slave to the Server transceiver

Authentication: The acquisition of the IEEE 802.3 address of the Server transceiver by the Client transceiver and the subsequent issuance of an ***In-Range**** command by the Client transceiver to the Client Host.

Unicast Address: A frame that is directed to a single recipient as specified in IEEE 802.3.

Broadcast Address: A frame that is directed to a multiple recipients as specified in IEEE 802.3.

3.2 Interface Signal Definitions

The following pinout is for the 40-pin mini-connector J1 (Amp P/N 177986-1). I/O direction is with regard to the transceiver.

Table 1. Transceiver Interface Signal Definitions

Pin	Type	Signal Name	Function
1	GND	GND	Signal Ground
2	I	PKTMODE	Packet Mode - When active (Active Low), the transceiver is forced into API Mode 3
3	VCC	VCC	5V \pm 2%
4	NC	NC	No Connect
5	VCC	VCC	5V \pm 2%
6	NC	NC	No Connect
7	NC	NC	No Connect
8	NC	NC	No Connect
9	NC	NC	No Connect
10	NC	NC	No Connect
11	O	RSSI	Received Signal Strength - An analog output giving a relative indication of received signal strength while in receive mode.
12	NC	NC	No Connect
13	NC	NC	No Connect/Data 7
14	O	TXD	Transmitted data out of the transceiver
15	O	In-Range	In-Range - Provides a logic low signal when the Client detects a master with the same System ID and Channel. This pin is active only in Transparent Serial Interface Modes 1, 2 and 4.
16	I	RXD	Data input to the transceiver
17	I	RI_IN	Ring Indicator to communicate to modem
18	NC	NC	No Connect
19	O	RI_OUT	Ring Indicator to communicate to computer
20	GND	GND	Ground
21	GND	GND	Ground
22	I	DCD_IN	Data Carrier Detect to communicate to modem
23	O	CTS	Clear to Send - Active Low when the transceiver is ready to accept data for transmission.
24	Reserved	Reserved	Reserved
25	Reserved	Reserved	Reserved
26	I	BDSEL	Baud Select - Take this pin active (Active Low) to force the transceiver into a known serial interface baud rate (9600 8-N-1)
27	I	RTS	RTS - MUST BE LOW TO ALLOW THE HOST TO RECEIVE DATA FROM THE PKLR2400.
28	NC	NC	No Connect
29	NC	NC	No Connect
30	NC	NC	No Connect
31	NC	NC	No Connect
32	O	DSR	Data Set Ready
33	NC	NC	No Connect
34	I	DTR	Data Terminal
35	NC	NC	No Connect
36	O	DCD_OUT	Data Carrier Detect to communicate to computer
37	I	WR_ENA	EEPROM Write Enable - Enabled when pin 37 is logic low. Pin 37 must be logic low to Write to the EEPROM. NOTE: The transceiver should NOT be write enabled during the initial power up or upon a hardware reset to ensure the integrity of the EEPROM data.
38	I	uP_RESET	Microprocessor Reset - The transceiver is reset by holding pin 38 logic high for a minimum of 2ms. If a reset is performed after power has been applied to the transceiver and is stable, the reset time will be significantly less. At all other times, pin 38 should be logic low. If pin 38 is not connected, the microprocessor will hold pin 38 at logic low.
39	VCC	VCC	5V \pm 2%
40	GND	GND	Signal Ground

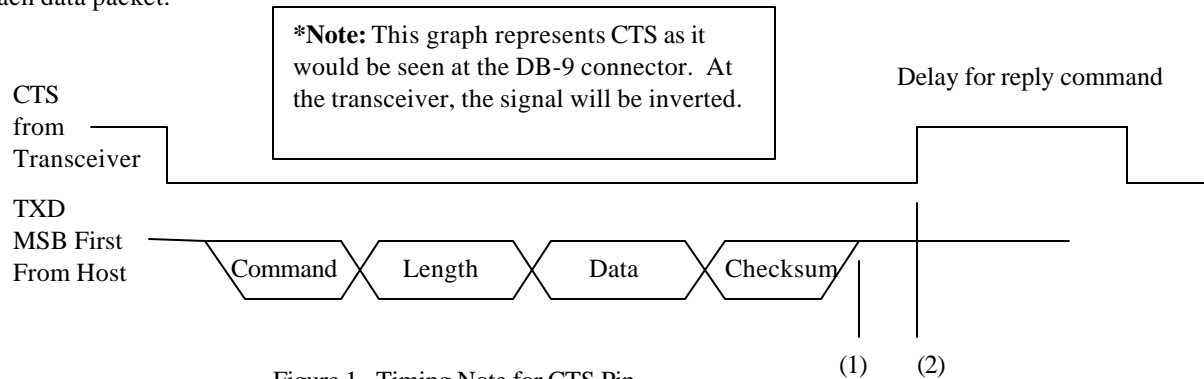
I = Input to the transceiver

O = Output from the transceiver

3.3 Host Software/Hardware Interface Definition

3.3.1 Clear To Send (CTS)

Clear To Send (CTS), pin 23, requires a minimum delay of 40 μ s between (1) and (2) after the end of each data packet.



3.3.2 Reserved

AeroComm uses the reserved pins 24 and 25 for internal testing and/or future transceiver enhancements. These pins should be treated as No Connect pins and must not be connected to logic high or low, but must be left floating.

3.3.3 Baud Rate Selector (BDSEL)

The Baud Rate Selector (BDSEL), pin 26, provides the user a default method of communicating with the transceiver in the event the EEPROM baud rate parameters become corrupted. If pin 26 is logic high or not connected, the baud rate will default to that specified in EEPROM. If pin 26 is logic low at RESET, the baud rate will default to 9600 baud.

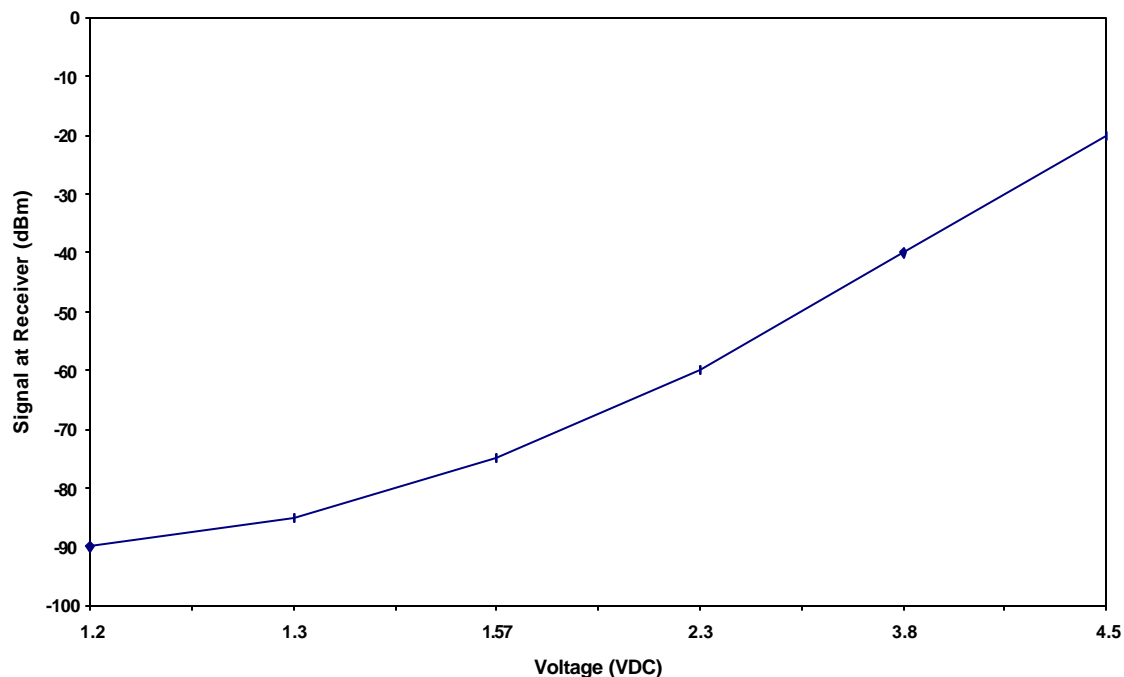
3.3.4 In Range

The IN_RANGE pin at the connector will be driven logic low when a Client is in range of a Server on the same channel and system ID. If the Client cannot hear a PKLR2400 Server for an amount of time that is programmable (Range refresh time) in the EEPROM, the PKLR2400 Client drives the IN_RANGE pin logic high and enters a search mode looking for a PKLR2400 Server. As soon as it detects a Server, the IN_RANGE pin will be driven logic low.

3.3.5 Received Signal Strength Indicator

Received Signal Strength Indicator is used by the Host as an indication of instantaneous signal strength at the receiver. The Host must calibrate RSSI without a signal being presented to the receiver. Figure 1 shows approximate RSSI performance. The RSSI pin requires the Host to provide a 27k Ω pull-down to ground. Output is 1.20V to 5.0V.

Figure 1 - RSSI Voltage vs. Received Signal Strength



3.3.6 Request To Send (RTS)

When the RTS bit is enabled in the PKLR2400 EEPROM, pin 27 (RTS) must be logic low to allow the Host to receive data from the PKLR2400.

3.3.7 Microprocessor Reset (uP_RESET)

Microprocessor Reset (uP_RESET) is achieved by holding pin 38 at logic high for a minimum of 2ms. If uP_RESET is performed after power has been applied to the transceiver and is stable, the reset time will be significantly less. At all other times, pin 38 should be logic low. If pin 38 is not connected, the microprocessor will hold pin 38 at logic low.

3.3.8 EEPROM Write Enable (WR_ENA)

EEPROM Write Enable (WR_ENA) is enabled when pin 37 is logic low. Pin 37 must be logic low to write to the EEPROM.

NOTE: The OEM must ensure that the transceiver is **NOT** write-enabled during initial power up and during a hardware RESET. Failure to do so may result in corruption of important EEPROM data.

4. Serial Interface Modes

The PKLR2400 provides four different Serial Interface Modes with programmability in each mode allowing maximum system flexibility. These four Serial Interface Modes include three transparent modes and one API mode. The transceiver-to-transceiver protocol is identical for all three Transparent Serial Interface Modes. This allows all three Transparent Serial Interface Modes to coexist within the same network. The API Serial Interface Mode 03 is not interoperable with Transparent Serial Interface Modes 01, 02 and 04.

4.1 Serial Interface Mode 01 – Transparent, Fixed Length, with Timeout

Mode 01 specifies transparent mode with fixed length packets and active timeout. Packets will be transmitted over the RF interface when one of the following conditions occurs:

- The number of data bytes received over the interface is equal to the buffer specified by the user in EEPROM address locations 43H and 44H.
- A byte gap larger than the timeout specified by the user in EEPROM location 4DH occurs.

4.2 Serial Interface Mode 02 – Transparent, End Character

Mode 02 specifies transparent mode with an End Character. Packets will be transmitted over the RF interface when the user-defined End Character is received by the transceiver over the interface. The End Character is defined by the user at EEPROM location 3EH.

4.3 Serial Interface Mode 03 – API

Mode 03 specifies API Mode. In this mode, the OEM has control of the transceiver command set detailed in Section 6.2. Packets are transmitted upon completion of the *Send_Data* command.

In API Serial Interface Mode 03, the OEM Host may utilize a set of basic commands to control the transceiver and system. These commands allow the customer to establish system parameters through the programming of variables in EEPROM as well as monitoring system performance. **These commands can only be exercised when the transceiver is in API Serial Interface Mode 03.** It is important to understand two aspects of the software commands.

1. There are only three commands that are issued *from* the Client *to* the Client Host. These three commands are *Out_of_range**, *In_range** and *Receive_data**. The *Receive_data** command is the only command issued from the Server to the Server Host. It is important to note that these commands will **NOT** get an acknowledgement, they are signals to the Host to alert it to incoming data, or a change of status.
2. All remaining commands initiated by the Host **MUST** receive an acknowledge from the transceiver to signal completion of the assigned task. This works as flow control for the information going to the transceiver.

Since more than one Client can transmit to the Server, it is possible that there will be multiple *Receive_data** commands at the same time. Since there is no reply command at the completion of *Receive_data**, the Host must be capable of handling multiple *Receive_data** commands at one time.

Note: This means that whenever a command is initiated by the transceiver to the Host, the Host must be ready to accept the command and any data following the command.

Note: A full list of commands, definitions, and implementation can be found in Section 6.

4.4 Serial Interface Mode 04 – Transparent, Fixed Length, No Timeout

Mode 04 specifies transparent mode with fixed length packets and no timeout. Packets will be transmitted over the RF interface when the number of data bytes received over the interface is equal to the buffer specified by the user in EEPROM address locations 43H and 44H.

4.5 Serial Interface Buffer

The serial interface buffer provides 8Kbytes of memory broken into four dynamic regions. In API Serial Interface Mode 03, only one region is utilized. In Transparent Serial Interface Modes 01, 02 and 04, a buffer region is used each time a packet release condition is met. As an example, in End Character Mode 02, if 500 bytes are transmitted followed by the specified end character, 500 bytes will be stored in the first region and the remaining 7.5Kbytes will be dynamically allocated for the next three packets. It is strongly recommended that CTS or upper layer protocol with acknowledgements be used by the OEM when operating in any of the Transparent Serial Interface Modes to eliminate the following system issues:

Note: If all four buffers are filled and the OEM Host continues to send data over the interface, it will be discarded by the transceiver. This can be eliminated if the OEM utilizes CTS.

4.6 Initialization Sequence

Upon reset or power-up, the PKLR2400 requires a minimum of 400ms for hardware initialization prior to receiving any data or commands. When operating in the three Transparent Serial Interface Modes, the initialization sequence is managed by the AeroComm protocol. In-Range commands are not issued and there is no acknowledge from the transceiver on data delivery unless the OEM protocol has built-in acknowledgement. An In-Range hardware pin, 15, provides In-Range information for Transparent Serial Interface Modes.

When operating in the API Serial Interface Mode 03, the following initialization sequence occurs. During the power up sequence or upon a *Reset** command, the Clear to Send (CTS) line is driven logic high (5V TTL logic levels). While CTS is logic high, initialization occurs, and when finished, CTS is driven logic low indicating successful initialization is complete.

Note: At this point, the only command that can not be issued is the *Send_data** command. This command can only be issued after the *RF_enable** and *In_range** commands have been issued.

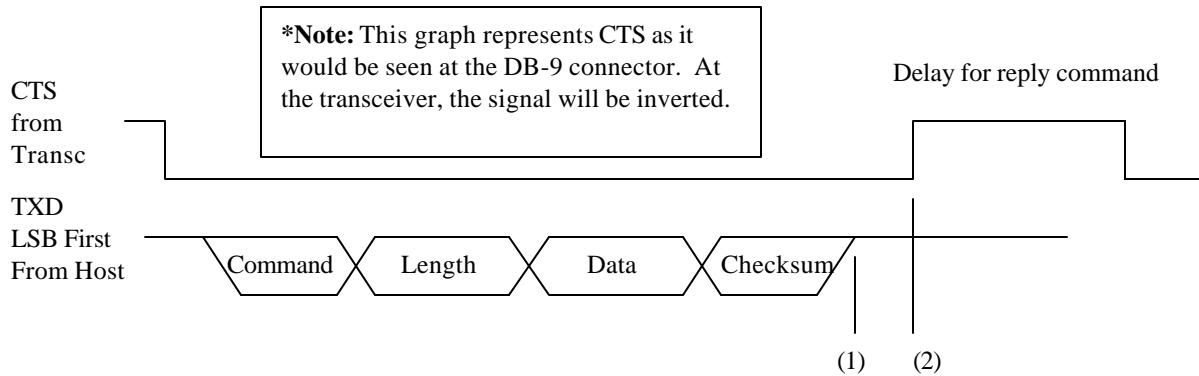
Before data communications can begin, a Client needs to be authenticated. The Client Host must issue an *RF_enable** command to activate the Client and receive an acknowledgement from the Client. The Server transmits a beacon containing its IEEE 802.3 address. Once the Client has been activated by use of the *RF_enable** command, it will receive the Server IEEE 802.3 address once it is in range. Upon receiving the IEEE 802.3 Server address, the Client will issue an *In_range** command to the Client Host containing the IEEE 802.3 Server address.

The Client Host must receive the *In_range** command from the Client before the *Send_data** command is invoked. Broadcast mode, as defined by IEEE 802.3, is supported and can be used to send data

Configuring the PKLR2400

to all transceivers that are within range but its use should be limited because reception of the message is not guaranteed.

When the last bit of data is transferred from the Host to the transceiver, the Host must wait for the CTS line to transition logic high (meaning that the transceiver has found the end of the data packet) and then transition back to logic low (meaning that the transceiver is ready for the next command).



Clear To Send minimum delay of 40ms between (1) and (2) after end of data packet

Note: All serial data must be transmitted LSB first.

Note: These transceivers are designed to be single threaded, meaning that for every command issued, there is a reply command that signifies the completion of the command issued. There can be no command interleaving.

5. Configuring the PKLR2400

The various configurable parameters are stored in the EEPROM in the transceiver. These parameters are read by the AeroComm firmware on power-up or when a reset is executed. These parameters can be configured by AeroComm or by the customer using a PC and a serial adapter board included in the Developer Kit. If the customer is writing to the EEPROM, they must use the Write EEPROM Command and enable pin 37 (WR_ENA), or switch 2 on the serial adapter board. The different configurable parameters and their respective EEPROM locations are highlighted in this chapter.

NOTE: WRITING TO ANY OTHER LOCATIONS IN EEPROM CAN CAUSE THE RADIO TO MALFUNCTION

5.1 System EEPROM Parameters

The system EEPROM parameters provide general system configuration information for the transceiver. These parameters can be monitored and changed independent of the serial interface protocol. **These parameters can only be changed when the API Serial Interface Mode 03 is active. See Section 7.1 for details.**

EEPROM Address	Size	Description
0H	40 bytes	Product identifier string/Version Info
28H	6 bytes	IEEE assigned MAC Address
2EH	1 byte	Channel number – Range = 00-4C; Default = 00;
33H	1 byte	Client/Server mode 01 – Server mode 02 – Client mode (default)
34H	8 bytes	System ID – Used to demarcate RF networks (default=00 00 00 00 00 00 00 01)
40H	1 byte	Baud High (BH) – Range = 00-FF; Default = FF
41H	1 byte	Baud Low (BL) – Range = 00-FF; Default = F1

5.1.1 Product Identifier String/Version Information

EEPROM Address: 0H

Size: 40 bytes

Useful for OEM to read AeroComm version information. This information should not be overwritten by the OEM. Original information is restored when a **RESET EEPROM** command is issued.

5.1.2 IEEE assigned MAC Address

EEPROM Address: 28H

Size: 6 bytes

This is the unique, 6-byte, IEEE 802.3 Ethernet address assigned by AeroComm to each transceiver. This unique address should not be changed.

5.1.3 Channel Number

EEPROM Address: 2EH

Size: 1 byte

Default: 00

Range: 00-4C

This provides 77 unique and non-interfering pseudorandom hopping sequences or channels. This allows for up-to 77 independent, co-located data networks. Default shipped at 00. It is highly recommended that this be changed to a channel number other than 00.

Note: Channel Number AND System ID between Clients and Server must be identical for transceivers to communicate.

5.1.4 Client/Server Mode

EEPROM Address: 33H

Size: 1 byte

Default: 02

Range: 01-02

Specifies whether the transceiver is operating in the Client Mode (02) or Server Mode (01)

5.1.5 System ID

EEPROM Address: 34H

Size: 8 bytes

Default: 00 00 00 00 00 00 00 01

Range: 00 00 00 00 00 00 00 00 to FF FF FF FF FF FF FF FF

Note: Channel Number AND System ID between Clients and Server must be identical for transceivers to communicate.

5.1.6 Baud High (BH) and Baud Low (BL)

EEPROM Address: 40H and 41H respectively

Size: 1 byte

Default: FF for BH and F1 for BL

Range: 00-FF for BH and BL

Baud High (BH) along with Baud Low (BL) is used to establish the data rate over the interface between the OEM transceiver and Host as follows:

Sample BHBL selections for common Baud Rates

(Using a 28.224 MHz Crystal)

Baud Rate	BH	BL
300	F4	84
2,400	FE	91
4,800	FF	48
9,600	FF	A4
19,200	FF	D2
28,800	FF	E1
38,400	FF	E9
57,600 (default)	FF	F1
115,200	Not Supported	Not Supported

Custom baud rates can be obtained through the use of the following formula:

$$\text{Baud Rate} = \frac{28.224 * 106}{32.0 * (65,536 - B_{BH} - B_{BL})}$$

Note: The calculated value must be within 3% of the actual value.

5.2 Protocol EEPROM Parameters

The protocol EEPROM parameters are related to the Serial Mode interface selection. A summary of the required EEPROM settings is illustrated in Section 7.3.

Note: These parameters can only be changed when the API Serial Interface Mode 03 is active. When in Transparent Serial Interface Modes, this can be accomplished by holding pin 2, PKTMODE, logic low and resetting.

Note: When writing to EEPROM using the developer kit, remember to hold the EEPROM write enable switch during the write command.

EEPROM Address	Size	Description
2FH	1 byte	Transmit data link attempts; Range = 01 - FF; Default = 10H;
31H	1 byte	Receive mode - determines what type of data frames are received by the OEM Product, based on MAC address of received frame 01 - unicast/broadcast data (default) 02 - unicast only 03 - all (promiscuous mode)
32H	1 byte	In-Range, Out-of-Range Refresh. This byte specifies the number of 250 ms ticks between range indications. This gives a range of .05 seconds to 12.5 seconds.
3EH	1 byte	End Character Definition. This byte specifies the character that will be used to signify the end of a packet.
43H	1 byte	Fixed Packet Length HIGH BYTE
44H	1 byte	Fixed Packet Length LOW BYTE
4AH	1 byte	Serial Interface/Power Down Modes 01 – Transparent, Fixed Length, with Timeout 02 – Transparent, End Character 03 – API 04 – Transparent, Fixed Length, No Timeout
4BH	1 byte	Destination Address Control 00 – Addressed Mode: Destination address is the IEEE 6 bytes at 50H. This mode utilized RF-Layer acknowledges to guarantee delivery of the packet. 01 – Broadcast Mode: No RF-Layer acknowledge, must set Transmit Attempts (2FH) to 01.
4DH	1 byte	Interface Timeout Control 00 – 4 mS 40 – 40 mS 80 – 300 mS C0 – 2.6 S
4EH	1 byte	Broadcast Attempts; Range 01-FF; Default 04
4FH	1 byte	RF Mode Byte 01 – Turbo Bit disabled 03 – Turbo Bit enabled

5.2.1 Transmit Data Link Attempts

EEPROM Address: 2FH

Size: 1 byte

Default: 10H

Range: 01-FF

This parameter specifies the maximum number of attempts over the RF interface. Serial Interface mode 03 will respond with a Send Data Failure when maximum Data Link attempts is achieved. All other modes will not receive an acknowledge.

Note: Transmit Data Link Attempts must be set to 01 when operating in the Broadcast Mode of the Address Transparent Control.

5.2.2 Receive mode

EEPROM Address: 31H

Size: 1 byte

Default: 03

Range: 01-03

This parameter applies only to API Serial Interface Mode 03. The default, 01, specifies Unicast/Broadcast. Unicast will receive all packets that match the receiving unit IEEE assigned address. Broadcast is achieved by placing FF in all six bytes of the IEEE assigned destination address sent from sender. In Broadcast mode, the receiver will accept all data with a destination address that has FF in all six bytes. It is important to note that there is no RF acknowledge on Broadcast packets. Mode 01 will accept Unicast and Broadcast data packets and discard all others. In Unicast only mode, 02, The receiving transceiver will receive only Unicast packets and discard all others. In Promiscuous mode, 03, the receiving transceiver will accept all packets with the same System ID.

Note: The Receive Mode must be set to 03 in all Transparent Serial Interface Modes including 01, 02 and 04 specified by EEPROM address 4AH.

5.2.3 In-Range, Out-of-Range Refresh

EEPROM Address: 32H

Size: 1 byte

Default: 14H

Range: 01-FF

This parameter is used only when the transceiver is operating in API Serial Interface Mode 03. The In-Range, Out-of-Range Refresh parameter allows the user to select the interval between which the Client searches for Server beacon that includes the Server IEEE source address. This parameter is very useful when operating in a fringe condition to minimize the In-Range and Out-of-Range commands that may flood the Host. AeroComm has established a default value of 5 seconds through extensive testing.

5.2.4 End Character Definition

EEPROM Address: 3EH

Size: 1 byte

Default: FF

Range: 00-FF

This parameter is used only when the transceiver is operated in Serial Interface Mode 02 specified by EEPROM address 4AH. Otherwise, this parameter is ignored by the system. The parameter specified by the user will indicate the last character in a data packet. When this end character is seen by the transceiver, the packet will be transmitted. The packet length including the end character can not exceed 2Kbytes.

5.2.5 Fixed Packet Length High Byte/Low Byte

EEPROM Address: 43H/44H

Size: 1 byte each

Default: 01/00

Range: 00/01 to 07/FFH

THIS PARAMETER IS ACTIVE ONLY WHEN THE TRANSCEIVER IS IN SERIAL INTERFACE MODES 01 OR 04 SPECIFIED BY EEPROM ADDRESS 4AH. THIS PARAMETER IS IGNORED IN ALL OTHER MODES. THE FIXED PACKET LENGTH CAN NOT EXCEED 2KBYTES OR IT WILL NOT BE RECEIVED.

5.2.6 Serial Interface/Power Down Modes

EEPROM Address: 4AH

Size: 1 byte

Default: 01

Range: 01-04

THERE ARE FOUR SERIAL INTERFACE MODES FOR THE OEM TRANSCEIVER INCLUDING ONE PACKET MODE AND THREE TRANSPARENT MODES. ALL MODES ARE DIFFERENTIATED BY THE DEFINITION OF WHEN DATA WILL BE TRANSMITTED BY THE TRANSCEIVER.

MODE 01 SPECIFIES TRANSPARENT MODE WITH FIXED LENGTH PACKETS AND ACTIVE TIMEOUT. PACKETS WILL BE TRANSMITTED OVER THE RF INTERFACE WHEN ONE OF THE FOLLOWING CONDITIONS OCCURS:

- **THE NUMBER OF DATA BYTES RECEIVED OVER THE INTERFACE IS EQUAL TO THE BUFFER SPECIFIED BY THE USER IN EEPROM ADDRESS LOCATIONS 43H AND 44H.**
- **A BYTE GAP LARGER THE TIMEOUT SPECIFIED BY THE USER IN EEPROM LOCATION 4DH OCCURS.**

Mode 02 specifies transparent mode with End Character. Packets will be transmitted over the RF interface when the user-defined End Character is received by the transceiver over the interface. The End Character is defined by the user at EEPROM location 3EH.

Mode 03 specifies API Mode. In this mode, the OEM has control of the transceiver command set detailed in Section 6.2. Packets are buffered and transmitted at the direction of the OEM.

Mode 04 specifies transparent mode with fixed length packets and no timeout. Packets will be transmitted over the RF interface when the number of data bytes received over the interface is equal to the buffer specified by the user in EEPROM address locations 43H and 44H.

Note: EEPROM parameters cannot be read or written once the transceivers are programmed and reset in any of the Transparent modes 01, 02 or 04. The transceiver must be forced to API mode 03 to access EEPROM parameters. This can only be accomplished by holding pin 2 logic low during and after reset.

5.2.6.1 Power Down Modes

The PKLR2400S Power Down Modes include a Sleep Walk and Deep Sleep mode. Sleep Walk is for Clients only and Deep Sleep is for Servers only.

If bit 7 of the Serial Interface/Power down Mode Byte is set, the Client enters into Sleep Walk mode. This applies to ALL modes (01-04).

In API mode 3, the user can issue commands to place the transceiver into the power down modes. The commands are as follows: (CS is checksum)

API mode commands.

- | | |
|----------------|--|
| 88 01 00 00 CS | This is to command the transceiver into Sleep Walk |
| 88 01 00 01 CS | This is to command the transceiver into Deep Sleep mode. |
| 88 01 00 04 CS | This will cancel the power down functions. |

*Note: it is necessary to enable the RF before commanding the transceiver into a power down mode in API Mode 03.

5.2.6.1.1 Power Down Wake-up event

A power down wake-up event occurs when data is sent to the transceiver over the serial interface or over the RF channel causing the transceivers to leave power down.

Deep Sleep mode: (Servers only)

In Deep Sleep mode the Server completely shuts down and remains in a powered down mode until a byte is received over the serial interface. This is the only wake-up event that is valid in Deep Sleep mode. The Server will not wake up if a Client tries to transmit data to the Server. Therefore, this mode is intended for use on Servers that do not need to monitor the RF for incoming packets because it initiates all communications.

Sleep Walk mode: (Clients only)

In Sleep Walk mode, the Client will shut down after a certain amount of inactivity, this is called the Wait Time. In Sleep Walk mode, the Client will wake up when it receives either a RF packet or a byte over the serial interface. The amount of time is user programmable and can be programmed in EEPROM location 7D. The user can also program how long the Client is asleep (Sleep Time) in location 7A. After the amount of time programmed in 7A has elapsed, the Client will wake up and listen to the RF for any incoming traffic. If the Client hears the Server beacon and there is no pending RF data to be received, then the Client will return to sleep 2mS later. If the Client does not hear the Server's beacon, it will stay awake for 50mS to try and find the beacon. If a Client does not hear a beacon after 50ms, it will go back to sleep and repeat the cycle.

7AH Sleep Time (3 Byte number) – This is loaded in 200mS increments and is how long the Client is asleep when it is in Sleep Walk mode.

7DH Wait Time (3 Byte number) – This is also in 200mS increments and is how long the Client waits, before going to sleep.

5.2.6.2 Modem

If bit 6 of the serial control byte is set, then the transceiver uses all of the modem lines (DCD, DSR, DTR, RI, RTS, and CTS). If bit 3 is set, then the transceiver will listen to and respect RTS.

*Note: If bit 6 is set, enabling modem control lines, then bit 3 must be set for the transceivers to operate properly.

5.2.7 Destination Address Control

EEPROM Address: 4BH

Size: 1 byte

Default: 00

Range: 00-01

THIS PARAMETER SETS THE DESTINATION ADDRESS FOR TRANSPARENT SERIAL INTERFACE MODES ONLY. THE API SERIAL INTERFACE MODE 03 UTILIZES THE RECEIVE MODE AT EEPROM ADDRESS 31H TO SPECIFY ADDRESS MODES. WITH DESTINATION ADDRESS CONTROL SET AT THE DEFAULT, 00, THE TRANSCEIVER WILL DETERMINE IF THE SIX BYTE IEEE ADDRESS AT 50H MATCHES. IF THE DESTINATION ADDRESS MATCHES, THE DATA PACKET IS FORWARDED TO THE OEM HOST. OTHERWISE THE DATA IS DISCARDED. THIS ADDRESSED MODE GUARANTEES DELIVERY OF THE DATA PACKET OVER THE TRANSCEIVER LINK BY USING ACKNOWLEDGEMENTS.

WITH DESTINATION ADDRESS CONTROL SET TO BROADCAST MODE, 01, CLIENTS WILL RECEIVE ALL DATA PACKETS. THERE ARE NO ACKNOWLEDGEMENTS AND NO DATA PACKET RETRIES IN THIS MODE.

Clients can operate in Destination Address Control Mode 00, providing more reliable delivery of data to the Server. At the same time, the Server can operate in Destination Control Mode 01, acting as a broadcasting Server without guaranteed delivery. This provides a unique method of implementing a data network of many-to-one or one-to-many.

5.2.8 Interface Timeout Control

EEPROM Address: 4DH

Size: 1 byte

Default: 00H

Range: 00, 40, 80 or C0

THE TIMEOUT PARAMETER APPLIES ONLY TO THE TRANSPARENT SERIAL INTERFACE MODE 01 WITH FIXED LENGTH PACKETS AND TIMEOUT. THIS PARAMETER SPECIFIES THE AMOUNT OF TIME BETWEEN BYTES THAT THE TRANSCEIVER WILL WAIT BEFORE TRANSMITTING THE DATA PACKET.

5.2.9 Broadcast Attempts

EEPROM Address: 4EH

Size: 1 byte

Default: 04H

Range: 01-FF

THE BROADCAST ATTEMPT PARAMETER APPLIES ONLY TO THE BROADCAST MODES FOR ALL FOUR SERIAL PACKET MODES AND SPECIFIES THE NUMBER OF TIMES THAT THE RF WILL BROADCAST EVERY PACKET. THE RECEIVING TRANSCEIVER WILL DISCARD DUPLICATE PACKETS.

5.2.10 RF Mode

EEPROM Address: 4FH

Size: 1 byte

Default: 01H

Range: 01 or 03

01 = CSMA mode. CSMA mode allows random back off for collision avoidance. The amount of randomness is controlled by the byte in 45h in the EEPROM as follows:

- 00 – wait 1 packet time then retry,
- 01 – wait 1 or 2 packet times, then retry
- 03 – wait 1-4 packet times, then retry
- 07 – wait 1-8 packet times, then retry
- 0F – wait 1-16 packet times, then retry

***Note: The number of packet times waited is random except in the case of 00.**

03 = Turbo Mode. If RF Mode Byte is set to 03, then CSMA Turbo mode is enabled. This is useful for a one-to-one connection as it has no back off between errors. In normal CSMA mode, the transceiver will wait one packet time between successful packets. Turbo CSMA mode eliminates the wait time between successful packets and will transmit packets immediately, one after the other. If the packet is not successfully received then the transceiver will just re-send the packet until a successful receipt is acknowledged.

5.3 EEPROM Parameter Summary

EEPROM PARAMETERS
BY
SERIAL INTERFACE MODES

Address	Description	A	B	C	D	E	F	G	H	I
4AH	Serial Interface Mode	01	01	02	02	03	03	03	04	04
2FH	Transmit Attempts	01-FF	01	01-FF	01	01-FF	01-FF	01-FF	01-FF	01
31H	Receive Mode	03	03	03	03	01	02	03	03	03
32H	Range Refresh	NA	NA	NA	NA	01-FF	01-FF	NA	NA	NA
3EH	End Char Definition	NA	NA	00-FF	00-FF	NA	NA	NA	NA	NA
43H	Fixed Pkt Length-HB	01-07	01-07	NA	NA	NA	NA	NA	01-07	01-07
44H	Fixed Pkt Length-LB	00-FF	00-FF	NA	NA	NA	NA	NA	00-FF	00-FF
4BH	Dest Address Control	00	01	00	01	NA	NA	NA	00	01
4DH	Interface Timeout	Table	Table	NA	NA	NA	NA	NA	NA	NA

MODE DEFINITIONS

- A. **MODE 01 – TRANSPARENT, FIXED LENGTH PACKET, TIMEOUT, ADDRESSED**
- B. **MODE 01 – TRANSPARENT, FIXED LENGTH PACKET, TIMEOUT, BROADCAST**
- C. Mode 02 – Transparent, End Character, Addressed
- D. Mode 02 – Transparent, End Character, Broadcast
- E. Mode 03 – API, Unicast/Broadcast
- F. Mode 03 – API, Unicast Only
- G. Mode 03 – Packet, Promiscuous
- H. Mode 04 – Transparent, Fixed Length, No Timeout, Addressed
- I. Mode 04 – Transparent, Fixed Length, No Timeout, **Broadcast**

6. API Command Set (Serial Interface Mode 03 Only)

The basic command set consists of several commands from the Host and Transceiver. **The command set can be used ONLY when the transceiver is in Serial Interface API Mode 03 determined by EEPROM address 4AH (See Section 3.7, Configuring the PKLR2400).** The command set is designed as follows:

Command	Length	Data	Checksum
---------	--------	------	----------

Command – 1 Byte. This is the actual command from the appropriate processor.

Length – 2 Bytes. This is the total size of the remaining data for this command. The length field is in little endian format.(i.e. low byte/high byte). This length does not include the checksum.

Data – N Bytes. The actual data associated with the command or sub-command.

Checksum – 1 Byte. The checksum is a byte-by-byte, bitwise “EXCLUSIVE OR” of the COMMAND, LENGTH, and DATA block.

6.1 System Command Set Summary

The System Commands allow the user to initialize the system and perform general system analysis when operating in API Serial Interface Mode 03.

Name	Command	Length	Data	Checksum
Reset*	AAH	0H	0H	AAH
Control*	86H	1 to 5 (depends on sub-command)	As Required	As Required
Diagnostic Result*	87H	As Required	As Required	As Required
Standby*	88H	No yet supported		
Reset EEPROM*	89H	0H	0H	89H
Status Request*	8AH	1H	0-reset error counter 1-don't do anything	8AH
Status Reply*	8BH	14H-116H	See 6.1.7	
Update EEPROM Checksum*	8CH	0H	0H	8CH
Check EEPROM Checksum*	8DH	0H	0H	8DH
EEPROM Checksum Status*	8EH	1H	0-Checksum invalid 1-Checksum valid	8EH
Acknowledge*	As Required	0H		As Required

6.1.1 Reset*

This command is issued from the Host processor to the Transceiver. This command provides a software reset to the PKLR2400 Transceiver initializing the code at the same location as a hardware reset. This must be followed by an RF Enable.

Example: AA/00/00/AA (There are no Data bytes for this command)

6.1.2 Control*

The Host processor will issue this command to Write and Read EEPROM as well as for NOP.

<i>Sub-command (Counts as one byte in the Length)</i>	<i>Description</i>
2H*	Read EEPROM. Additional data: first two bytes specify starting address. Second two bytes specify ending address.
8H*	NOP.
9H*	Write EEPROM. Additional data: first two bytes specify starting address. Second two bytes specify ending address. Remaining bytes specify data to be written. (Range 00 to 7F)

Data Frame:

86H	Length Low	0H	Sub-command	Data	Checksum
-----	------------	----	-------------	------	----------

Example: 86/05/00/02/04/00/09/00/8C (There are no Data bytes for this command)

Note: Any additional sub-commands are reserved by the system and if used may cause system operation problems.

Note: Following and *EEPROM Write** Command, the user should invoke the *Update EEPROM Checksum** command. If this command is not executed, the checksum will not be updated with the newly written data. Pin 37 (WR_ENA) must be low for this command to execute successfully.

Note: Following the *EEPROM Write** Command, the user **MUST** invoke the *Reset** command before any EEPROM changes will become active. Pin 37 (WR_ENA) must be high for this command to execute successfully.

6.1.3 Diagnostic result*

This command will be sent by the Transceiver to the OEM Host in response to a Control command.

<i>Sub result (Counts as one byte in the Length)</i>	<i>Description</i>
2H*	Read EEPROM. Additional data: first two bytes specify starting address. Second two bytes specify ending address.
8H*	NOP. Returns 6 bytes (87 02 00 08 00 8D)
9H*	Write EEPROM status. 0 - Write successful. 1- Write failed.

Data Frame:

87H	Length Low	Length High	Sub-result	Data	Checksum
-----	------------	-------------	------------	------	----------

6.1.4 Reset EEPROM*

This command is sent by the OEM Host to the Transceiver, the result of which sets the various locations/parameters in the EEPROM to their default values. The execution of this command does NOT affect the IEEE Address and Operation Mode parameters in the EEPROM. This command returns a generic positive acknowledgment.

Example: 89/00/00/89 (The are no Data bytes for this command)

6.1.5 Status Request*

This command is sent by the OEM Host to the Transceiver to find out the various statistics associated with the RF Data Link Layer. The Transceiver sends back the values of the various parameters/statistics as part of the Status Reply command. 1 byte of data is supplied along with the command that determines whether the Transceiver resets the various Error Counters or not.

Example: 8A/01/00/01/8A

6.1.6 Status Reply*

This command will be sent by the Transceiver to the OEM Host in response to a Status Request command. All the different parameters pertain to the data link layer and are cumulative totals. Once this command has been sent back to the OEM Product, depending on whether the OEM Product desired an error counter variable reset, the reset operation is carried out. The different statistics and their sizes are shown below:

Name	Type	Description	Size
Transceiver Time	Time Counter	Incremented by 1 every 250ms. Initialized to 0 at power on or reset.	Unsigned Byte – 3 bytes, Low Byte first
Tx Failures	Error Counter	Number of times the Transceiver was not able to deliver a data frame to the destination	Unsigned Long - 4 bytes
Tx Retries	Error Counter	Number of times the Transceiver had to retry before delivering a data frame to the destination	Unsigned Long - 4 bytes
Rx Failures	Error Counter	Number of times the Transceiver had to throw away a received data frame because of bad CRC/checksum	Unsigned Long - 4 bytes
Rx Retries	Error Counter	Number of times data frames had to be retransmitted before a valid data frame was received	Unsigned Long - 4 bytes
Num Active Transceivers	Data Counter	Number of Clients registered to a Server. If the Transceiver under consideration is a Client, just return 0	Unsigned Byte - 1 Byte
List of Registered Transceivers	Identity	A list of 6 byte IEEE Addresses of all the transceiver devices + 3 byte time stamp + 3 byte packet count. Time stamp and packet counter are reset at power on or RESET.	12 bytes * Num Reg Clients

Status Reply Example

Name	Type	0 Active Transceivers	2 Active Transceivers
Transceiver Time	Time Counter	1 Byte – TL 1 Byte – TM 1 Byte – TH	1 Byte – TL 1 Byte – TM 1 Byte – TH
Tx Failures	Error Counter	4 Bytes	4 Bytes
Tx Retries	Error Counter	4 Bytes	4 Bytes
Rx Failures	Error Counter	4 Bytes	4 Bytes
Rx Retries	Error Counter	4 Bytes	4 Bytes
Num Active Transceivers	Data Counter	0	2
List of Registered Transceivers	Identity		6 bytes IEEE Address 3 bytes time stamp 3 bytes packet count 6 bytes IEEE Address 3 bytes time stamp 3 bytes packet count
Checksum		Actual	Actual

Data Frame:

8BH	17H	00H	Data	Checksum
-----	-----	-----	------	----------

6.1.7 Update EEPROM Checksum*

This command is sent by the Host to the AeroComm module to tell it to recalculate the checksum. The Host CPU typically does this after it has completed writing data to the EEPROM on the AeroComm module. The response to this command is an acknowledge.

Example: 8C/00/00/8C (There are no Data bytes for this command)

6.1.8 Check EEPROM Checksum*

This command is sent by the Host CPU to the AeroComm module to validate the EEPROM checksum. This is typically done after bringing up the AeroComm module out of reset. The AeroComm module reports either a good or a bad checksum, by sending back a response called **EEPROM Checksum Status**

Example: 8D/00/00/8D (There are no Data bytes for this command)

6.1.9 EEPROM Checksum Status*

This command will be sent by the Transceiver to the OEM Host in response to a **Check EEPROM Checksum** command. The data portion of the command indicates whether the checksum is good or bad, based on which the Host CPU takes the appropriate action.

6.1.10 Acknowledge*

Some commands in the above set have an implied positive response. The generic positive response is defined as the command sequence just received retransmitted back with a zero length.

6.2 Transceiver Command Set Summary

The Transceiver Commands allow the user to control the flow of data into and out of the transceiver as well as initialization of the transceiver in API Serial Interface Mode 03.

Name	Command	Length	Data	Checksum
RF enable*	80H	0H	0H	80H
Send Data*	81H	1 to 7f0h (includes 802.3 Header)	As required	As Required
Send Data Complete*	82H	1H	0 or 1 (see 5.1.4)	As Required
Received Data*	83H	1 to 7f0h (includes 802.3 Header)	As Required	As Required
In range*	84H	06H	IEEE address of Server	As Required
Out of Range*	85H	0H	0H	85H

6.2.1 RF enable*

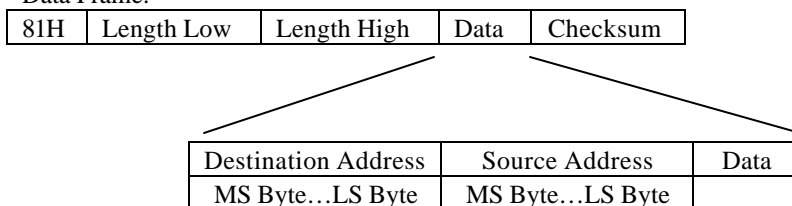
This command is issued from the Host processor to the Transceiver. The Transceiver must have this command issued to it prior to any RF data transfers. This is a command with no data. Typically, this command is issued to the Transceiver just after it has been brought out of reset. This enables the RF portion of the Transceiver and turns the transmitter/receiver ON. This command requires an acknowledge.

NOTE: ENSURE THAT ONLY ONE RF ENABLE COMMAND IS ISSUED FOLLOWING RESET.

6.2.2 Send data*

This command is issued by the Host to the Transceiver to send a data frame. The data frame here is the actual frame that the transport/network protocol wants to send out. The data portion will be delivered to the appropriate RF device. Broadcast frames will be delivered to all registered Clients without a RF data link ACK. Broadcast frames are not required to reach all destinations. They are typically sent to everyone at once.

Data Frame:



Note: The Data must include header information as follows:

(6)Bytes for the IEEE 802.3 standard destination address and

(6)Bytes for the IEEE 802.3 standard source address.

These unique IEEE addresses are provided by AeroComm. See Section 4 for EEPROM location

Note: The Length must include the IEEE 802.3 Header

6.2.3 Send data complete*

The Transceiver will issue this command upon completion of the data transmission process, as indicated by a RF-layer Acknowledgment from the destination RF-device. An additional byte of data indicates a success or a failure code. This command must be returned for every send data command unless the device power fails.

Command: 82H
Length: 01
Data: 0 - indicates success. 1 - Can't send packet.
Checksum: As required

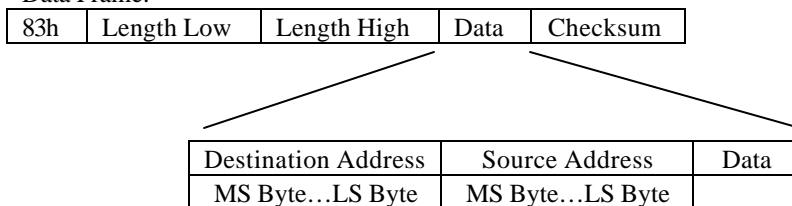
Data Frame:

82H	01H	00H	Data	Checksum
-----	-----	-----	------	----------

6.2.4 Received data*

The Transceiver will issue this command upon reception of data from the RF link. The information in the data frame is the received data.

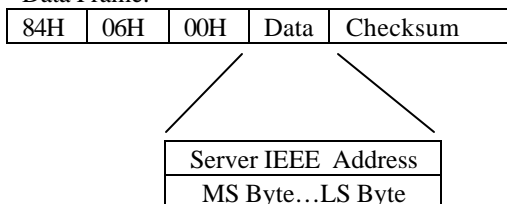
Data Frame:



6.2.5 In range*

The Client will issue this command upon detecting that it is in range of a Server. This command is only valid after reset or after an out of range command has been issued. This command should have some hysteresis so that the Host processor isn't flooded with these commands in a fringe coverage area. The state of the RF link should be **updated with the frequency specified in the Protocol EEPROM Parameters, Chapter 7.2**, to provide the needed hysteresis. This command includes the Server IEEE802 Address.

Data Frame:



Note: This is only valid from the viewpoint of Client.

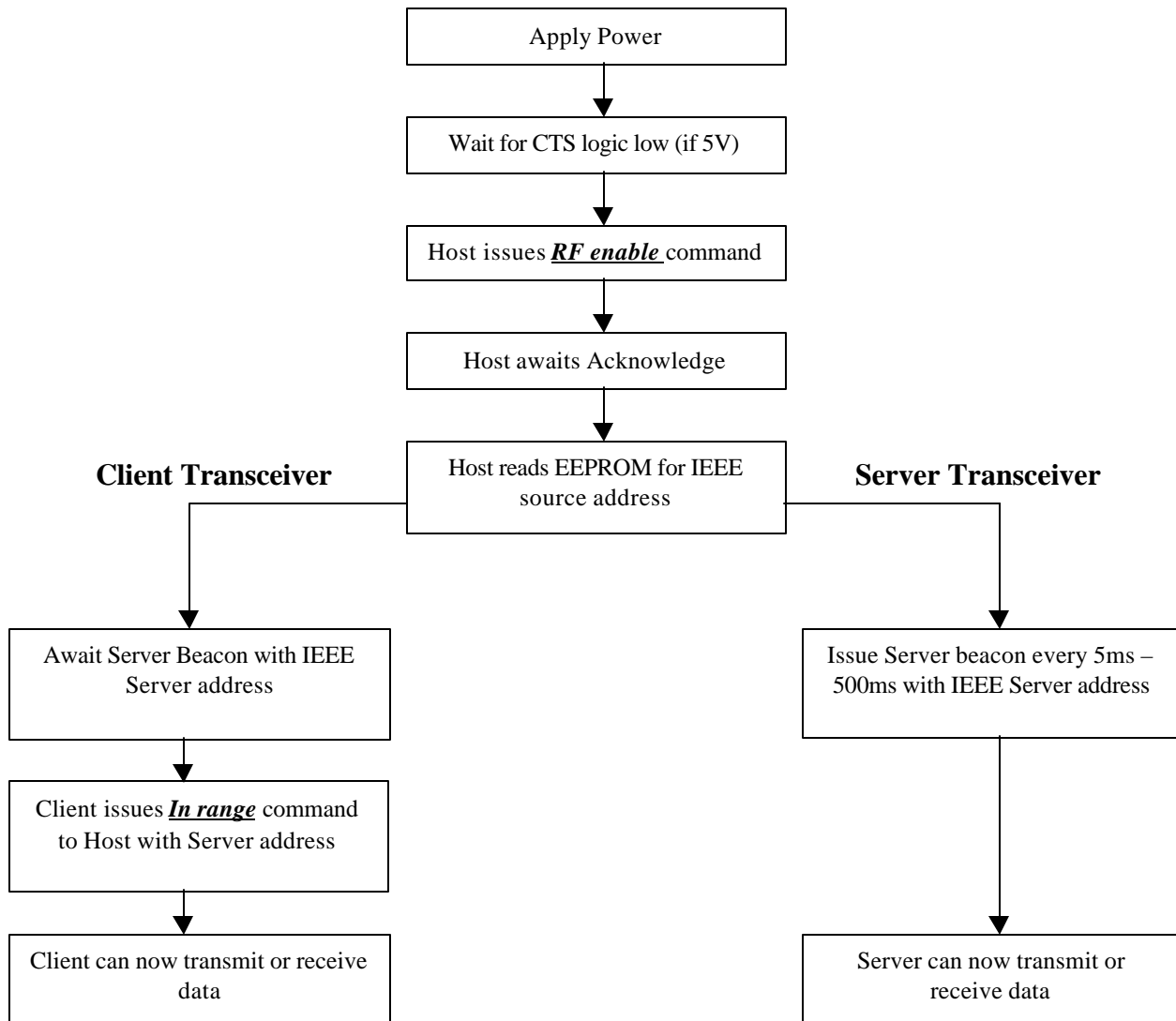
6.2.6 Out of range*

The Transceiver will issue this command upon detecting that it is out of range of a Server. This command is only valid after reset or after an in range command has been issued to the Host processor. This command should have some hysteresis so that the Host processor isn't flooded with these commands in a fringe coverage area. The state of the RF link should be **updated with the frequency specified in the configuration command** to provide the needed hysteresis.

Note: This is only valid from the viewpoint of a Client.

6.3 Initializing the PKLR2400 Transceiver

Following is an example of the initialization sequence for both the Clients and Servers following AeroComm or customer configuration of the EEPROM configuration parameters. This occurs only in the API Serial Interface Mode 03.

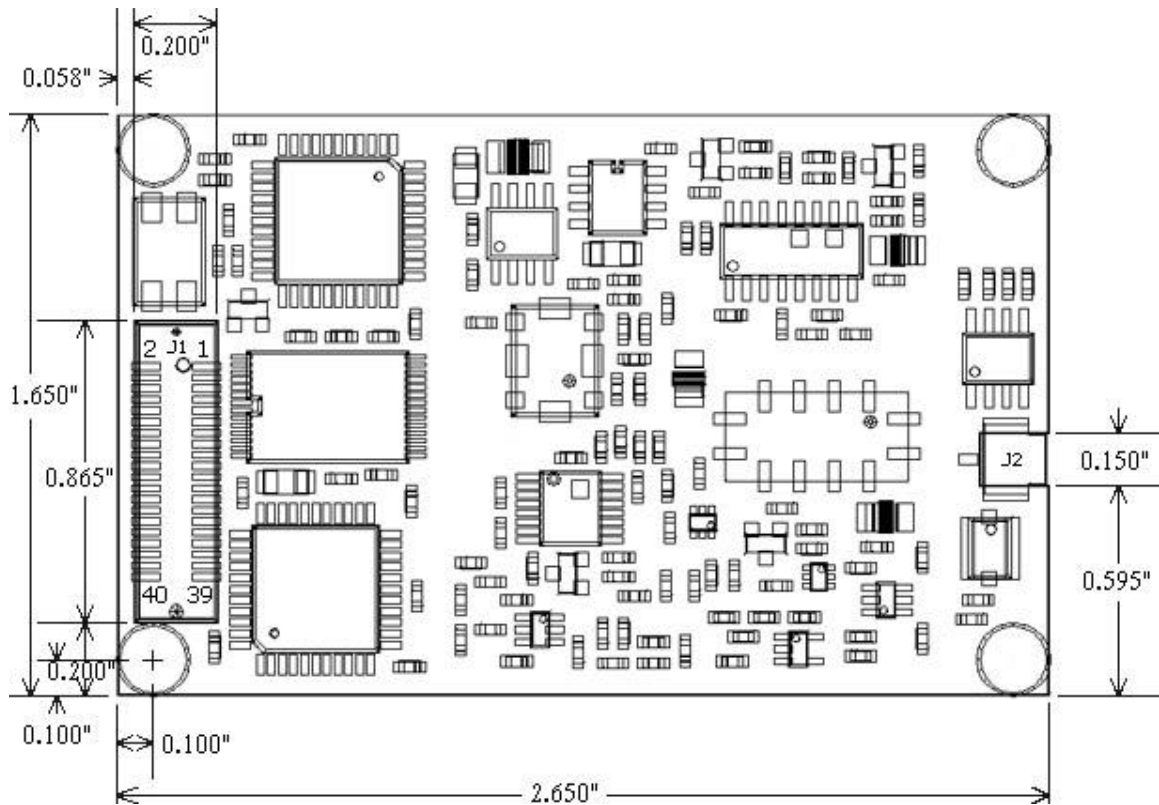


7. Mechanical Overview

The PKLR2400 measures 1.65" x 2.65". Critical parameters are as follows:

- J1 – 40 pin OEM interface connector (Amp P/N 177986-1) mates with Amp P/N 177985-1
- J2 – High frequency MMCX style antenna connector (Telegartner P/N J0134A0081) mates with any manufacturer MMCX plug
- (4) Mounting holes are 0.100" diameter.

Figure 1. Mechanical Overview of PKLR2400



8. Ordering Information

8.1 *Product Part Numbers*

PKLR2400S-100, PKLR2400S with 100mW output power, interface data rates to 882Kbps, MMCX antenna connector

8.2 *Developer Kit Part Numbers*

SDK-PKLR2400S-100, Includes (2) PKLR2400S-100 transceivers, (2) RS232 Serial Adapter Boards, (2) 6Vdc unregulated power supplies, (2) Serial cables, (2) WXE2400 dipole antennas with 2" pigtail and MMCX connector, configuration/testing software, Integration engineering support