Alligator Model 2888
895 – 960 MHz
4800 Baud Data Transport Radio

MANUAL

Version 1.10

Alligator Communications, Inc.
317 Brokaw Road
Santa Clara, California 95050
Telephone: (408) 327-0800
Fax: (408) 327-0808

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1.0 General Information

1.1 GENERAL DESCRIPTION

The Alligator Communications Model 2888 is a microprocessor-controlled data radio transceiver designed to operate in accordance with FCC rules Part 101. The 2888 data radio is frequency synthesized and programmable to individual transmitter and receiver frequencies in the 900 MHz frequency band. The transceiver is a fixed channel, half-duplex radio available with channel bandwidths of 12.5 kHz and 25.0 kHz.

1.2 APPLICATIONS

The 2888 data radio is designed for point-to-multipoint or point-to-point licensed operations in the 900 MHz band. Some of the most common applications are:

Electric Utility Substation SCADA
Pipeline Flow Monitors
Energy Distribution & Metering Applications
Gas or Petroleum Production Well Head Control and Monitoring
Water Distribution and Waste Water Collection Control and Monitoring
Petroleum Production, Transmission, Storage and Distribution

1.3 TECHNICAL SPECIFICATIONS

GENERAL

Frequency Agility:	895.00 – 960.00 MHz, 6.25 kHz per Step
Channel Spacing:	Available in 12.5, 25.0 KHz Bandwidths
Data Rates:	300 to 4800 bps
Input Voltage:	13.2 Vdc Nominal (11-16 Vdc)
Current Consumption:	
* Receive Mode:	100 mA
* Transmit Mode (5.00 Watts):	< 1.75 A
Connectors:	
* Antenna:	Type “N” Female
* Data:	DB-9F, Subminiature
* Power:	2 Pin Captive Rectangular

*Diagnostics:	RJ-45 Jack
Environment:	
* Temperature:	-30°C to +60°C
* Humidity:	95% @ +40°C
Dimensions:	6.5”W x 1.35”H x 5.5”D
Weight:	1.5 Pounds

TRANSMITTER

RF Power:	5.0 Watt (+ 37 dBm)
Impedance:	50 Ohms
Duty Cycle:	Continuous
Transmitter Attack Time:	Less than 1msec
Frequency Stability:	+/-0.00015%, -30°C to +60°C
Modulation Deviation:	
* 12.5 kHz Band:	+/- 2.2 kHz
* 25.0 kHz Band:	+/- 3.5 kHz
Spurious and Harmonic Emissions:	-60 dB
Tx Timeout Timer (Programmable)	1-255 Seconds, or 0 for no Timeout

RECEIVER

Type:	Double Conversion Super heterodyne
Frequency Stability:	+/-0.00015%, -30°C to +60°C
Sensitivity:	-117 dBm minimum discernable signal
10E6 BER Threshold:	-97 dBm
Selectivity:	-100 dB Minimum at Adjacent Channel
Desensitization:	
* at 12.5 kHz Spacing:	-60 dB
* at 25.0 kHz Spacing:	-70 dB
Intermodulation:	-70 dB (EIA)
Spurious/Image Rejection:	-80 dB
Desensitization:	
* at 12.5 kHz Spacing:	-60 dB
* at 25.0 kHz Spacing:	-70 dB
Intermodulation:	-70 dB (EIA)
Spurious/Image Rejection:	-80 dB

Note: If other frequencies or power levels are required but are not listed, please contact factory.

OPTIONS

INTERNAL MODEM: Emission Type: FSK

300-4800 BPS, Direct Interface, Asynchronous: RS-232

FCC INFORMATION

FCC Rules:	Part 101	
FCC Identifier:	2888	
FCC Emission Designators:	12.5 KHz	9K50F1D
	25.0 KHz	19K50F1D

1.4 WARRANTY

Alligator Communications, Inc., warrants each of the instruments of its manufacture to meet the specifications when delivered to the BUYER; and to be free from defects in material and workmanship. Alligator Communications will repair or replace, at its expense, for a period of one year from the date of delivery of equipment, any parts that are defective from faulty material or poor workmanship.

Instruments found to be defective during the warranty period shall be returned to the factory with transportation charges prepaid by the BUYER. It is expressly agreed that replacement and repair shall be the sole remedy of the SELLER with respect to any defective equipment and parts hereof and shall be in lieu of any other remedy available by applicable law. All returns to the factory must be authorized by the SELLER, prior to such returns. Upon examination by the factory, if any instrument is found to be defective, the unit will be repaired and returned to the BUYER, with transportation charges prepaid by the SELLER.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. ALLIGATOR COMMUNICATIONS IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

1.5 CLAIMS FOR DAMAGE IN SHIPMENT

The instrument should be inspected and tested as soon as it is received. If the instrument is damaged in any way, or fails to operate properly, a claim should immediately be filed with the freight carrier, or if insured separately, with the insurance company.

WE PLEDGE OUR IMMEDIATE AND FULLEST COOPERATION TO ALL USERS OF OUR ELECTRONIC EQUIPMENT.

PLEASE ADVISE US IF WE CAN ASSIST IN ANY MANNER:

Alligator Communications, Inc.
317 Brokaw Road
Santa Clara, CA 95050
Phone: (408) 327-0800
FAX: (408) 327-0808
E-mail: sales@alligatorcom.com
Website: www.alligatorcom.com

1.6 INFORMATION TO USER

Changes or modifications not expressly approved in writing by Alligator Communications, Inc. may void the user's authority to operate this equipment.

In accordance with FCC Rules, the user of this equipment is advised that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

2.0 Radio Configuration and Operational Check

2.1 GENERAL DISCUSSION

Prior to customer installation and electrical connection of the customer's terminal equipment to the 2888 radio, it is recommended that the installing technician conduct a brief operational checkout of the 2888 radio and confirm that all operating parameters are set as desired.

This initial checkout and possible reprogramming is generally performed on the maintenance shop test bench before the radio is installed and commissioned in a link application.

The following parts of this section provide guidance in this checkout process, and illustrate alternate configurations and paths to perform the initial checkout. Please refer to Figure 2.2 (*DB-9 Locator*), Table 2.3 (DB-9 *Pin Functions*), Figure 2.3 (*Locations of Adjustment Components on Main P.C. Board*

For a definition of all 2888 radio functions and possible configurations, see Section 4.3.

2.2 OPERATIONAL BENCH TEST

To ensure that the 2888 radio is functional prior to installation at the desired site, it is highly recommended that the following tests be performed in sequence (please refer to Figure 3.1, *Model 2888 External Connectors*, Page 3-2):

2.2.1 ANTENNA CONNECTOR

The 2888 radio antenna port (RF Connector) is a coaxial, female, type N connector. This connector mates with a cable connector male, type N such as Amphenol 3900, Andrew L44N, or MIL Type UG-21. Under most circumstances, bench tests are conducted with a service monitor (manufactured by IFR Inc., Marconi Instruments Ltd., Hewlett-Packard, Motorola, etc.).

CAUTION
The transmitter should not be keyed on or placed in the transmit mode without a load on the antenna port to prevent damage to the 2888 radio Power Amplifier due to long periods (more than 10 minutes) of severely high SWR. An antenna, service monitor, or dummy load should be attached to the antenna port. The 2888 radio power output is approximately 5.0 watt maximum, so if a service monitor is connected to the antenna port, ensure that the service monitor's input port can handle at least 10 watt input to avoid damaging the service monitor.

2.2.2 POWER CONNECTOR

The dc power input connector to the 2888 radio is a rectangular two-pin locking connector. The radio unit is normally powered upon connection to a DC power source delivering +11 to +16 Vdc, +13.8 Vdc nominal. The red conductor is positive; the black conductor is negative and is internally grounded to the chassis.

2.2.3 INITIAL CHECKOUT

Alligator wireless data transport products are factory configured according to customer configuration information received prior to shipment from the factory, thereby minimizing customer field configuration requirements.

To verify that 2888 radio parameters are correct, we recommend the following minimal tests be conducted with regards to the transmitter and receiver settings of the 2888 radio.

With the service monitor connected to the antenna port, proceed to conduct the following preliminary tests:

A. Power Checkout

With DC power applied to the PWR IN connector, the power LED should illuminate and remain on. Pin 6 of the DATA connector should measure +10.0 Vdc nominal which is the output from the voltage regulator (Note: Pin 5 is dc ground, signal ground and is also grounded to the chassis).

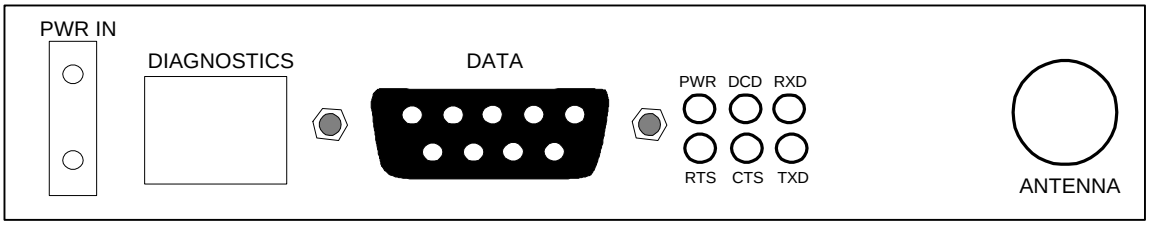


Figure 2.1 LED Display

B. 2888 LED Checkout

Briefly observe the behavior of each of the 6 LED indicators with reference to the following table:

LED	Description
TXD (Transmit Data)	Indicates the 2888 radio is receiving incoming data from the customer's interconnected terminal to be transferred to the destination.
RXD (Receive Data)	Indicates the 2888 radio is receiving data over the air from an associated radio or communications test set.
DCD (Data Carrier Detect)	Indicates the 2888 radio is receiving a sufficient level of RF carrier signal to open the receiver's squelch gate.
RTS (Request To Send)	Indicates the customer's interconnected terminal is requesting to send data.
CTS (Clear To Send)	Indicates the 2888 radio is ready to receive data from the customer's interconnected terminal.
PWR (Power)	Lights up whenever the radio is powered up. Off when radio is powered down.

Table 2.2 LED Description

C. Transmitter Test

CAUTION
To avoid possible damage to your service monitor, be sure that the input port can handle at least 5.0 watt.

Key the Tx by pulling RTS pin 7 of the DB9 data interface port high. This can be accomplished by shorting RTS pin 7 with DSR pin 6. At this time, the RTS & CTS LEDs should light up. As long as the keying signal is on, both LEDs will remain on until the time exceeds the time out timer value, which is factory set at 30 seconds or at a customer programmed timing interval.

Measure the RF power level as inputted to a calibrated communications test set or to a RF power level meter to measure the 2888 transmitter power output. Note: The output power should be about 5.0 watts (when +13.8 Vdc is the power supply voltage), which is the factory setting.

Note the transmitted frequency on a calibrated Communications Test set and compare this reading to the desired Transmitter frequency setting of the 2888 radio.

Note: The Transmitter time out operating parameter can be set for 0 to 255 seconds, with 0 meaning that the transmitter will not time out and will follow the keying signal no matter how long it lasts. Use the Alligator Advanced Diagnostics Software to change the value of this parameter. This can be found under the *Change Operating Parameters* option under the Remote sub-menu.

D. Receiver Test

With the service monitor connected to the antenna port (Figure 3.1, ①, Page 3-2), turn on the service monitor's RF signal generator. Set the frequency of the service monitor's RF signal generator to the programmed receive frequency of the 2888 radio.

The 2888's DCD LED should turn on for an input level which is higher than the receiver squelch level.

With the squelch level set at 0.7 uV (-110 dBm), an RF signal level of 0.5 uV or lower will turn squelch on (DCD LED off). For an RF input of 10 uV, 2.4 kHz modulation frequency, and +/- 2.2 kHz deviation from the service monitor, you should see the RXD LED light up. The DCD LED should light up, and the RXD LED should light up for a square wave 20 volts peak-to-peak with frequency of approximately 2.4 kHz going through Pin 2 (RXD) of the DB-9 connector. This output is RS-232 compatible.

The receiver squelch level is factory set at 0.7 uV (-110 dBm). Other squelch levels can be set by the user (see Section 2.2.5). The RSSI level can be measured at Pin 21 of the DB-9 connector. Approximately +1.2 Vdc = 1 uV (-107 dBm) RF, +2.3 Vdc = 10 uV (-87 dBm) RF, and +3.2 Vdc = 100 uV (-67 dBm) RF. The RSSI will become saturated at approximately +4 Vdc with a 1 mV (-47 dBm) or higher RF input.

E. Deviation Test

Check the deviation level of the 2888 Radio by keying on the transmitter using RTS, and presenting an alternating square wave to the TXD input utilizing a test data frequency of 600 Hz to 3000 Hz. The amplitude of this wave should be at least 10 volts peak-to-peak and the low level of the square wave must be less than 0.5 volts.

Since the IF bandwidth of a service monitor determines how much signal goes through, a narrow bandwidth will create overshoot in the square wave, resulting in a deviation reading which is higher than the actual deviation. Choose the highest bandwidth setting possible for the service monitor.

A bandwidth of 50 kHz or more will be needed to present a square wave without overshoot (distortion). For example, the modulation for a 2.4 kHz square wave through a 15 kHz bandwidth will result in a deviation reading which is approximately 20 percent higher than the actual deviation.

Read the deviation of the Remote Radio from the service monitor. If it reads around +/- 2.2 kHz (+/- 3.5 kHz for wide band), no further adjustment is necessary. The RTS, CTS, and TXD LEDs should all light up. If for any reason a lower deviation than that set by the factory is desired, refer to Section 2.2.7 for adjusting the deviation level.

CAUTION
For a Remote Radio with a 4800 BPS data rate, any deviation exceeding +/- 2.2 kHz (+/- 3.5 kHz for wide band) will violate FCC Rules Part 101. Never adjust the deviation

for more than this value. For a data rate lower than 4800 BPS, a higher deviation may be used, but +/- 2.2 kHz (+/- 3.5 kHz for wide band) deviation is still the recommended maximum value.

2.2.5 SQUELCH ADJUSTMENT

By default, the factory sets the squelch level to 0.7 micro volts (-110 dBm). If a different squelch level is required for the 2888 Radio, you can adjust the mechanical potentiometer located at R131 on the 2888 Radio P.C. Board (see Figure 2.3, ④). The squelch level can be adjusted from 0 to 5 micro volts.

A. Determining the Squelch Level

To properly adjust the squelch level, the squelch level should be set according to the site where the Remote Radio is to be installed. If the squelch level is set too low (less than 0.5 uV or -113 dBm), it will be likely that environmental interference or other various noise to initiate the triggering of the squelch. This may create invalid data from noise to be sent to the RTU and may result in invalid received data packets.

For any squelch level below 0.5 uV (-113 dBm), note invalid data can be generated due to outside interference. A low squelch level setting is not recommended for an RF link with a strong signal level (due to close proximity or a good antenna setup); a higher squelch level is recommended for these kinds of situations. A good squelch level setting is always a compromise between interference from the environment, the receive RF level, background noise, and the fade margin.

In order to calculate the recommended squelch level, you must first calculate or measure the receive level. For a fairly strong receive level (greater than 100 uV or -67 dBm), subtract 20 to 30 dB away from the receive level (to account for the fade margin), then set the squelch level 3 to 4 dB below that point. For example, a typical situation follows:

Receive level in RF path: -67 dBm (typically 10 miles separation)

Lowest possible receive level: -67 dBm - 20 dB (fade margin) = -87 dBm

Recommended squelch level: -87 dBm - 3 dB = -90 dBm

If the receiver level is under 5 uV for a weak RF path under ideal environmental conditions, the squelch level should be set to 0.5 uV (-113 dBm).

The level to turn squelch on and the level to turn squelch off is approximately 3dB difference. For example, if the level to turn squelch off (Rx LED on) is 0.7 uV, the level to turn squelch on (Rx LED off) has to be approximately 0.4 uV. The purpose of this is to prevent squelch noise when the receive level is at this threshold point. This is the 3 dB hysteresis gap between squelching and unsquelching the receiver.

B. Adjusting the squelch level

After determining the appropriate squelch level, set the RF signal generator to that level. Connect the output port of the service monitor to the antenna port of the 2888 Radio (Figure 3.1, ①, Page 3-2). Turn the Squelch Adjustment Potentiometer located at R57 (Figure 2.3, ④) counterclockwise to the turn limit. Then, rotate the potentiometer clockwise slowly until you see the Rx LED solidly on, then stop turning immediately. To verify proper adjustment, reduce the RF input to the 2888 Radio by approximately 4 dB. The Rx LED should turn off solidly. If this is not the case, a minor counterclockwise adjustment may be required to insure squelch to be off at the required receive level, and turned on 4 dB below the required receive level.

2.2.7 DEVIATION ADJUSTMENT

If the factory setting for the deviation is not what is desired, you can use the Alligator Advanced Diagnostics Software to set the digital potentiometer on the P.C. Board (if the deviation adjustment option is installed), or manually adjust the mechanical deviation potentiometer R104 (Figure 2.3,⑧) after removing the top cover. The factory presets both potentiometers for a deviation of +/- 2.2 kHz for 12.5 KHz channels (+/- 3.5 kHz for 25 KHz channels; the digital deviation potentiometer is set at position 27), which is the maximum deviation allowed to avoid violating FCC emissions rules.

To properly receive the transmitted data at the destination, deviation settings of less than +/- 1.5 kHz are not recommended.

If for any reason a lower deviation than that set by the factory is desired, you may change the position of the digital potentiometer by accessing the *FM Deviation Adjustment* option under the Remote sub-menu. Use the <+> and <-> keys to raise and lower the deviation, respectively.

Whenever the digital potentiometer position is changed, you must first unplug the DB-25 connector from the radio (when doing a local adjustment) and transmit a square wave 10 volts peak-to-peak, low level lower than +0.5 Vdc, between 600 Hz and 3000 Hz through the TXD line, with RTS high, to see the results of the deviation adjustment on the service monitor.

The deviation digital potentiometer is already at the maximum position of 31. If the potentiometer position is at 31 and a higher deviation is required, you must first set the position to 27, and then adjust the mechanical deviation potentiometer R309 (Figure 2.3,①) while inputing the square wave as described above, until the desired level is achieved. Turning the mechanical potentiometer counterclockwise will result in a lower deviation. Repeat this process until the desired deviation is achieved.

CAUTION
For a Remote Radio with a 4800 BPS data rate, any deviation exceeding +/- 2.2 kHz (+/- 3.5 kHz for wide band) will violate the FCC rules. Never adjust the deviation for more than this value. For a data rate lower than 4800 BPS, a higher deviation may be used, but +/- 2.2 kHz (+/- 3.5 kHz for wide band) deviation is still the recommended maximum value.

2.2.10 FIELD SIMULATION TEST

When the 2888 Radio has passed the initial series of tests, it is now ready for field simulation testing.

NOTE: A second 2888 Radio or a Model 1800G Master Station Radio configured to link with the 2888 Radio under test is required to perform this test.

(1) Connect a 50 Ohm Dry load to the antenna port of the Model 2888 Radio.

(2) Connect a 50 Ohm Dry load to the antenna port of the 2888 Radio or Model 1800G Master Station Radio that is configured to communicate with the 2888 Radio under test

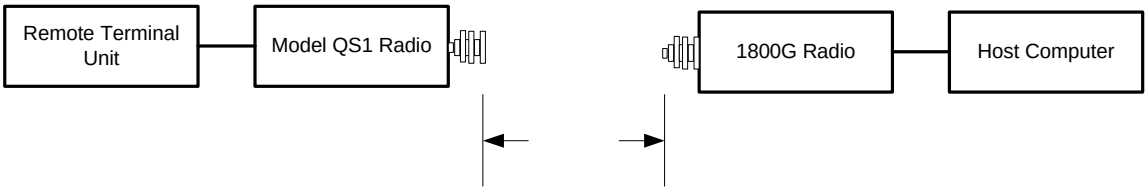
(3) Place the 2888 Radio 5 to 20 feet away from the 1800A Master Radio.

(4) Be sure that the transmit frequency of the 2888 Radio under test matches the receive frequency of the opposite link end 2888 Radio or Model 1800G Master Station Radio being utilized for the test , and that the receive frequency of the 2888 Radio under test matches the transmit frequency of the opposite link end test radio. Utilize the Alligator Advanced Diagnostics Software or a service monitor to verify the complementary frequency configuration information.

(5) Key the transmitter of the 2888 Radio under test by applying a high logic to the RTS input pin. Observe that the SQUELCH LEDs on the Master Radio turn on and off solidly whenever the 2888 Radio under test is keyed off and on, respectively.

(6) Observe that the DCD LED on the Remote Radio is lit when it is not being keyed, whenever the TX ON AIR LED on the 1800A Master Station is lit.

(7) Repeat Steps 1 through 6, except connect the Remote and Master Radios together using an attenuator (80 to 100 dB gain). If one is not available, you may connect the two radios together using a series of smaller gain attenuators to achieve 80 to 100 dB signal attenuation. Ensure the attenuator(s) are rated 1.0 to 5.0 watts.


Remote Terminal Unit
Model QS1 Radio
1800G Radio
Host Computer
5 to 20 Ft. Separation

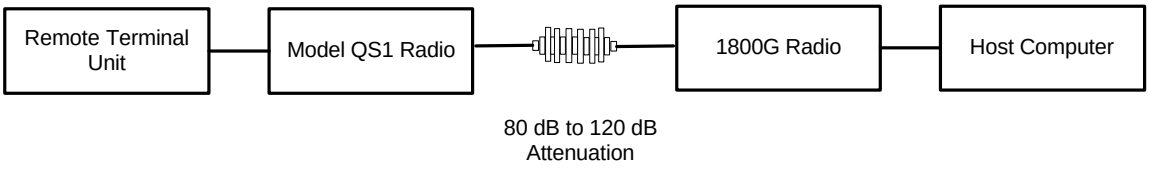

Remote Terminal Unit
Model QS1 Radio
1800G Radio
Host Computer
80 dB to 120 dB Attenuation

Figure 2.3 DB-9 DESCRIPTION AND PIN LOCATOR

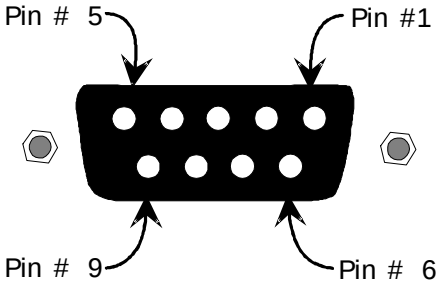


Figure 2.3 DB-9 connector; Model 1888A

View of the DB-9 connector from outside of the radio enclosure (same as the rear view of the mating connector).

Table 2.4 DB-9 PIN FUNCTIONS

Pin	Function/Comment
1	DCD (Data Carrier Detect) from Radio to RTU
2	RXD (Receive Data Output) -Data from Radio Receiver to Field Device
3	TXD (Transmit Data Input) - Data from Field Device to Radio Transmitter
4	Not Connected
5	Signal Ground
6	DSR (Data Set Ready) from Radio to RTU
7	RTS (Request to Send) from RTU to Radio
8	CTS (Clear to Send) from Radio to RTU
9	Not Connected

Table 2.3 Pin Assignments for DB-9 Data Interface Port

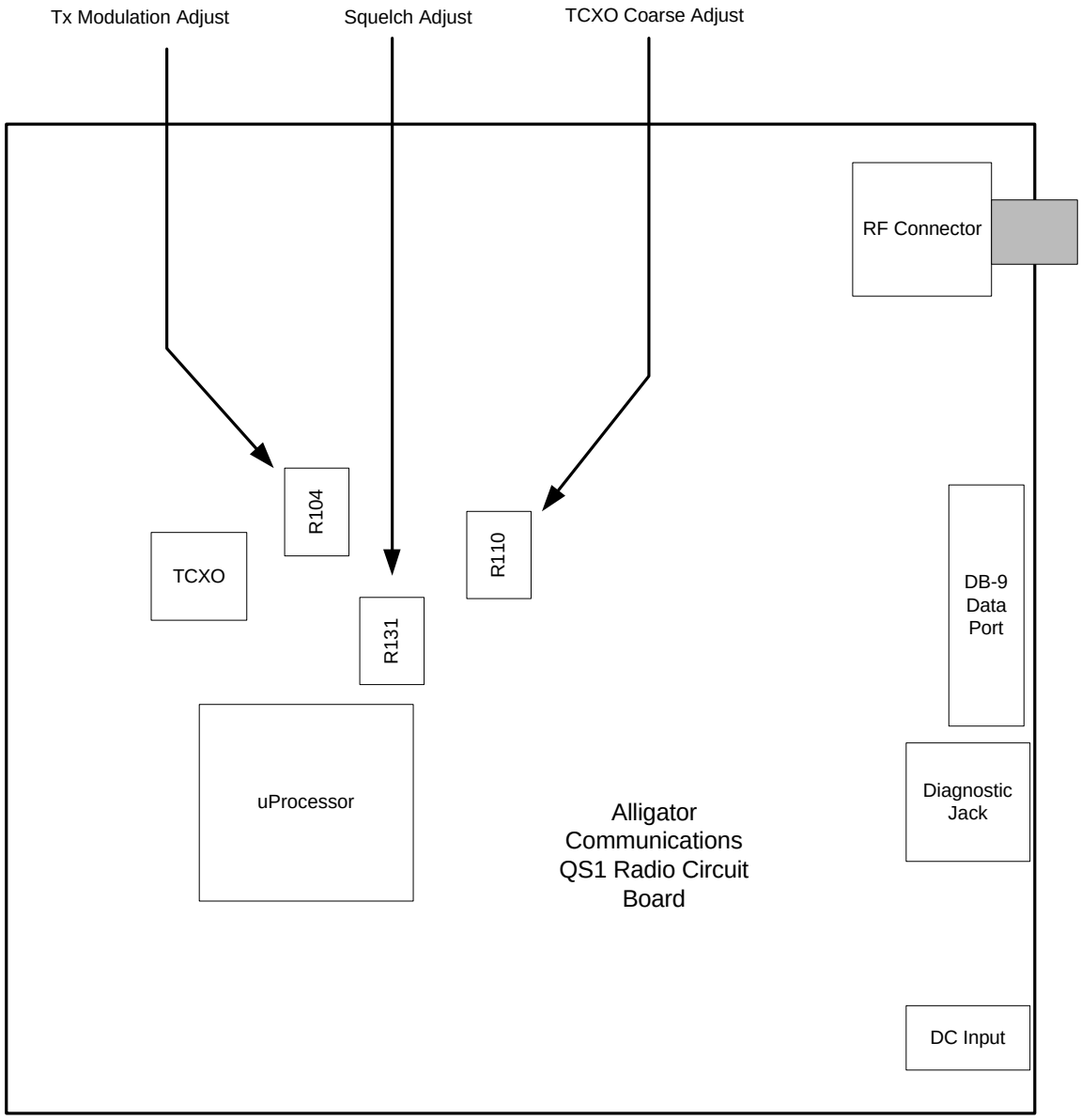
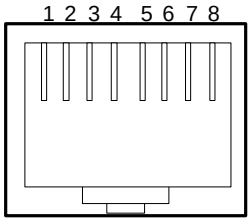


Figure **2**.4, Model 2888 Internal Circuit Board

Figure 2.6 RJ-45 Diagnostic Port



View of the RJ-45 diagnostic port connector from outside of the radio enclosure

Table 2.6 RJ-45 PORT PIN FUNCTIONS

Pin	Function/Comment
1	10 VDC (High)
2	Signal and DC Ground
3	PTT/ (Keys Tx when Grounded)
4	DTMF Tones Out
5	DTMF Tones In
6	RSSI Ramp Voltage (0.2 to 4.0 VDC)
7	RXMute (Mutes RX during Diagnostics)
8	Alarm Logic Output Pin

2.6 DIAGNOSTIC PC INTERFACE

A diagnostic computer running the Alligator Advanced Diagnostic Software can interface with a Model 2888 Radio in a number of ways. The following sections diagram the most common system configurations.

2.6.1 Model 2888 Radio Local Diagnostic Connect

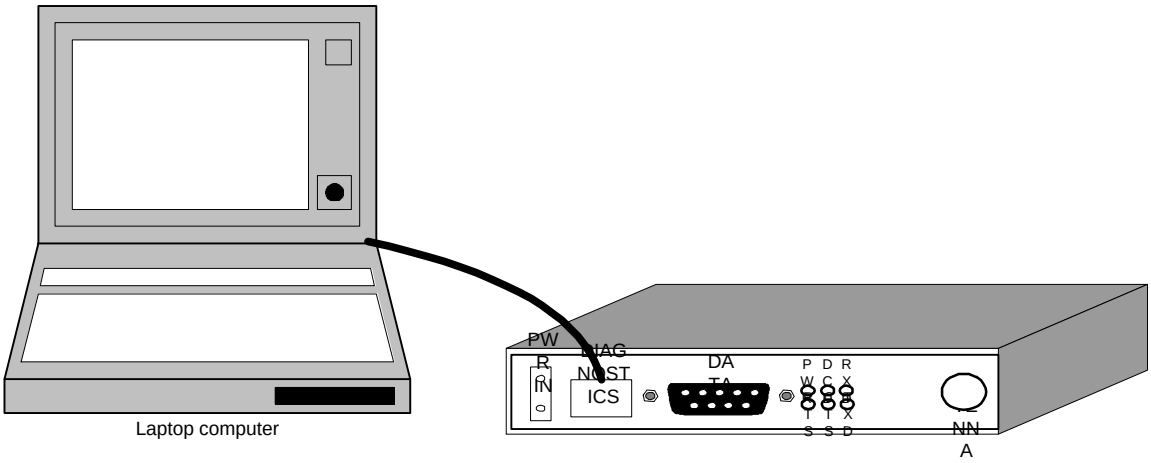


Figure 2.5 - Remote Radio Local Link

In this configuration the sub-menus of the diagnostic software are fully functional. To link the computer to the Model 2888 Remote Radio: first, connect the male DB-25 connector of the **DTMF Converter Cable** to the female DB-25 parallel port of the diagnostic computer. Then connect the male RJ48 connector of the DTMF cable to the female RJ45 connector on the 2888 Radio.

Required Hardware: 1ea PC to DTMF converter (Part No. 4000-0002)

2.6.2 Model 1800A Master Station Local Connect

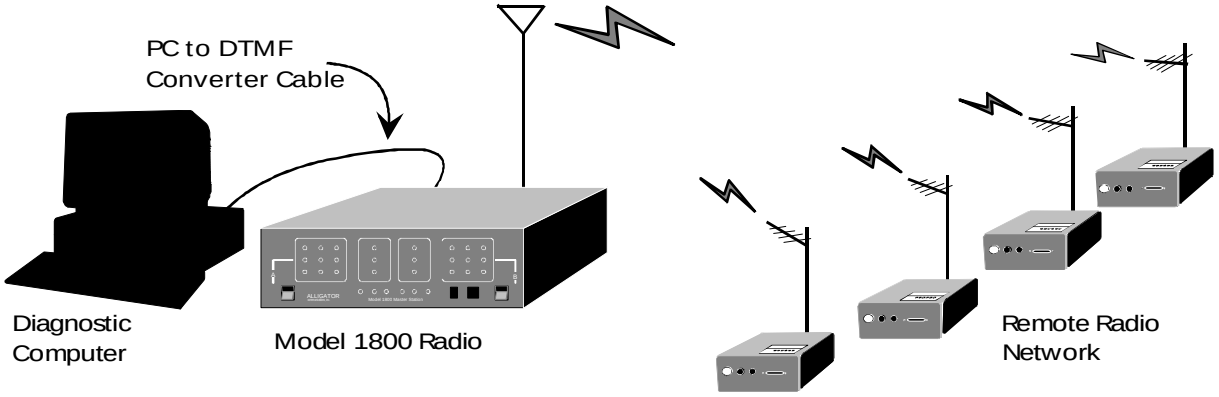


Figure 2.6 Model 1800A Master Station Local Link

In this configuration the Alligator diagnostics software is fully functional. To link the computer to the Model 1800A Master Station: first, connect the male DB-25 connector of the **DTMF converter cable** to the female DB-25 parallel port of the diagnostic computer. Then connect the male RJ48 connector of the DTMF cable to the female RJ48 port on the back of the master station (See Figure 2.6, above). The RJ48 port on the master station is labeled **PC(DTMF)** (See Figure 2.7, below).

Required Hardware: 1 - PC to DTMF converter (Part No. 4000-0002)

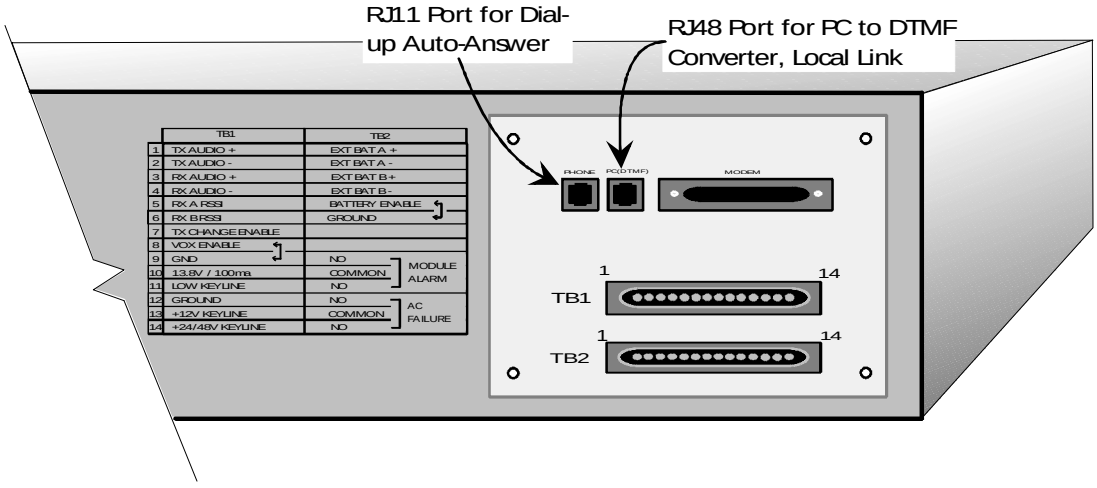


Figure 2.7 Model 1800A Master Station Rear Panel

2.6.3 Model 1800A Master Station Phone Dial-up Connect

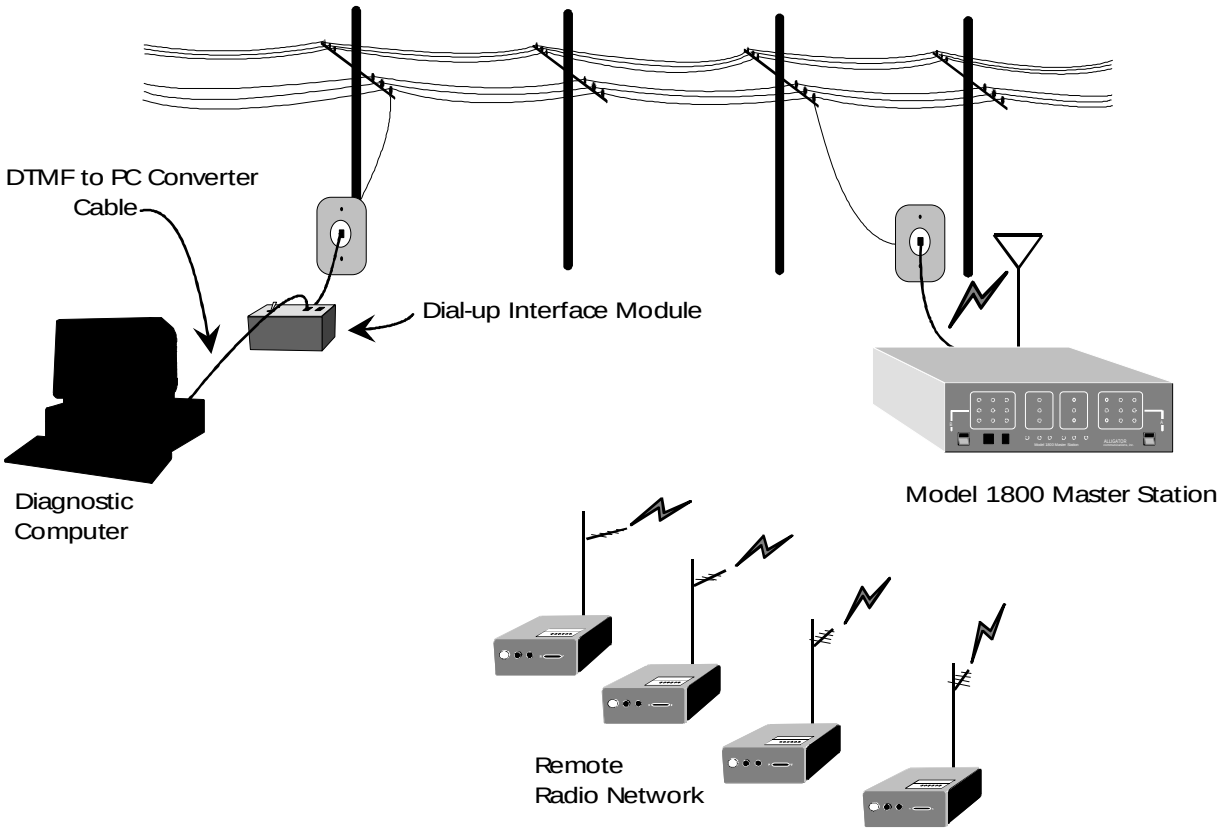


Figure 2.8 Phone Dial-up Master Link

In this configuration, the Alligator diagnostics software is fully functional. This configuration requires the **Dial-up Auto-Answer** option be installed on the connected Model 1800A.

To link the computer to the Model 1800A via telephone: first, connect the male DB-25 connector of the **DTMF Converter Cable** to the female DB-25 parallel port on the back of the diagnostic computer. Then, connect the male RJ45 connector of the DTMF cable to the female RJ48 connector on the **Dial-up Interface Module**. Then use a standard RJ11 phone cord to connect the interface module to an operational phone jack. At the master station location, connect the Model 1800G to an operational phone jack also using a standard RJ11 phone cord (See Figure 2.8, above). The RJ11 phone port is located on the rear panel of the Model 1800G and is labeled **PHONE** (See Figure 2.7, previous page).

Required Hardware:
1 -- PC to DTMF converter (Part No. 4000-0002)
1 -- Dial-up Interface Module (Part No. 4000-0004)
1 -- Dial-up Auto-Answer option installed on Model 1800A

3.0 Installation

3.1 MECHANICAL INSTALLATION

The Model 2888 radio is shipped with a universal mounting bracket which can be attached to the radio enclosure and allow mounting the radio on a wall or other flat surface (6-32 X 5/16" round head screws are provided to secure the bracket to the enclosure). The bracket will accommodate four 1/4" fasteners.

CAUTION
If substitute screws are necessary for the 6-32 X 5/16" round head screws, do not use screws which extend into the chassis more than 5/16". Doing so might contact and damage the P.C. Board in the radio.

Note: In the event of an uneven mounting plane, consider using two (diagonally opposite) or three fasteners rather than four, which might distort the bracket and radio enclosure, resulting in physical damage.

3.2 LOCATION

Monitoring the diagnostics and/or changing the parameters of the 2888 radio is possible by using a local computer connected to the RF-45 connector of the 2888 radio. If this is desired, attempt to locate the radio with convenient access to the 2888 connector.

Note: Attempt to position the transceiver away from main power lines and hydraulic or pneumatic lines. A catastrophic failure of any of these lines in close proximity to the radio transceiver could damage the radio and disrupt communications at a time when specific alarms are most needed. Also, service technicians repairing these types of failures require space to work and might inadvertently damage the radio or cables.

3.3 ELECTRICAL INTERCONNECTION

The Model 2888 radio has four external connectors. These connectors provide access to the antenna, power supply, associated RTU and diagnostic computer

Figure 3.1 illustrates the connector locations and their usage.

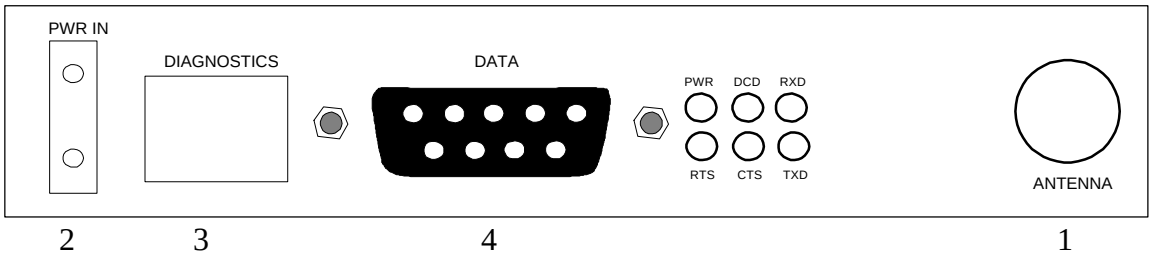


Figure 3.1 Model 2888 External Connectors

① **Antenna Feedline:** RF signals are transmitted and received via a coaxial cable (not supplied) connected to a type "N" connector.
Note: Most feedlines are substantial in size and relative rigidity. It is suggested that a flexible "coaxial pigtail" be used between the feedline and the radio to preclude the application of mechanical stress to the connector and/or radio.

② **Power Cable:** Power is supplied to the radio transceiver via a two-conductor cable and a power connector (supplied). Red wire to + 13.8 Vdc and black wire to Ground If a power supply voltage other than 13.8Vdc is required, an external DC-DC converter will result in the red wire reading the desired power supply voltage.

③ **Diagnotics Port:** RJ45 connection for the DTMF diagnostic cable(P/N 4000-0002)

④ **Interconnecting Cable:** The RTU connects to the radio transceiver via a multiconductor cable (not supplied) and a DB-9 connector. Section 2.4 includes a pin-by-pin commentary on the function of each pin in the DB-9 connector. The connector should be tightened using two 4-40 X 1/4” long screws to avoid losing contact between the cable and connector before the radio is in service.

4.0 Theory of Operation

4.1 GENERAL DISCUSSION

The 2888 radio is a half duplex transceiver intended for use as either a Master or a Remote Station Radio unit in a Wireless SCADA data transmission system.

4.2 MICROPROCESSOR OPERATION

The microprocessor, U-203 is the "brain" of the 2888 radio. It enables a computer to communicate with the 2888 radio and enables the operator to "see" everything that the Remote "sees", such as diagnostics. The microprocessor also allows the operator to observe the operating parameters, frequency, power output, reverse power, PLL voltages, the power output level and the frequency offset. These and other operations may be performed locally or through the RF link.

4.3 FUNCTIONS OF THE 2888 RADIO

The Alligator Model 2888 offers diagnostic parameters which aid the user in troubleshooting potential problems in the SCADA network. The Model 2888 also offers options which enable the radio to be a “smart” radio. It may also be configured for use in a variety of different configurations. The Alligator Advanced Diagnostics Software can read and/or modify all of the following parameters for each responding Model 2888 Radio.

4.3.1 Diagnostic Parameters

Parameter	Description
Alarm Status	Alerts the user that one or more of the diagnostic parameters are not within the safety limits.
Received Signal Strength Indicator (RSSI)	An indicator of a Remote’s signal strength.
Forward Power	The amount of power the carrier frequency is being transmitted.
Reverse Power	An indicator of the quality of the Remote Radio’s antenna. A reverse power reading greater than one-third of the forward power reading indicates that the antenna is degrading, or that cables and connectors are not properly connected to the radio.

Parameter	Description
Supply Voltage	The recommended power supply to the Remote Radio should be no less than 11 V and no more than 16V, with 13.8V the nominal voltage. A power supply capable of supplying at least 2 amps is required for proper operation of the radio.
PLL Voltages	The voltage readings of the two Phase-Locked-Loops (PLL1 & PLL2). For safe radio operation, this voltage should be between 0.1 to 4 Volts.
Internal Temperature	Serves as a "thermometer" for the environment surrounding the radio. Also serves as a sign if something is wrong with the Remote Radio.

Table 4.2 Diagnostic Parameters Descriptions

4.3.2 Alarm Limits and Conditions

The Alligator Advanced Diagnostics Software provides the user with the capability to set the desired safety limits for each diagnostic parameter. The user can set high and low limits for Supply Voltage, PLL1 Voltage, PLL2 Voltage, Internal Temperature, Forward Power, and event (squelch, PTT, Time-out) counters. Should any of these parameters fall outside its safety limits, an alarm condition will be generated and displayed by the Remote Radio.

An alarm condition will also exist if the Reverse Power (reflected power) reading exceeds 30% of the Forward Power reading, or if the VSWR (Voltage Standing Wave Ratio) reaches an unsafe value.

4.3.3 Operating Parameters

The Alligator Advanced Diagnostics Software enables the user to configure each Remote Radio to operate in a certain configuration. Each Remote Radio can be configured to operate under any of the following configurations:

Parameter	Description
PTT Dekey Time (0-255 msec)	Whenever the 2888 Radio turns on its transmitter, the dekey time is the number of milliseconds the transmitter stays on after the radio is dekeyed. Some applications require squelch-tail elimination, and other applications may require that the master station is never squelched. By keeping each of the Remote's transmitters on for an extra few milliseconds, the Remotes will overlap each other during polling cycles, thus the master station's receiver modules will always be receiving something. For applications where a dekey time is not required, this

Parameter	Description
	parameter should always be programmed to 0 milliseconds. The factory automatically sets this value to 0 milliseconds unless the customer specifies otherwise.
Tx On Delay Time (0-255 msec)	For some applications, especially when one or more repeater stations involved in a SCADA system, the 2888 Radio may need to delay turning on its transmitter whenever it is keyed.
Time-out Duration (0-255 sec)	To prevent lockup of the transmitter, each 2888 Radio can be individually programmed to shut off its transmitter if it is keyed on for a certain number of seconds. If this value is zero, the transmitter will never time out. When setting this parameter, be sure that this duration is longer than the longest possible transmit time for each data transmission.
RTS/CTS Delay for Internal Modem (0-255 msec)	Each Radio needs a certain amount of time to get ready for data to be transmitted over the air. The RTS (Request To Send) signal is the command from the RTU to key on the 2888 Radio. The CTS (Clear To Send) signal is the indicator from the Remote Radio to the RTU that it is ready to send the data supplied by the RTU. This delay time is simply the minimum amount of time that the data must be delayed starting from the RTS signal. The Alligator Model 2888 Radio can handle a delay of 1 millisecond, but the most effective value is anywhere from 10 to 20 milliseconds. The factory default setting is 10 milliseconds.
PTT Limit (per 10-second interval) (0-255)	This parameter is used mainly to detect problems with external keying circuits. Each Remote Radio is capable of counting the number of external keys within every 10-second interval of operation. If the number of external keys exceeds the PTT Limit, the PTT operating parameter will automatically become disabled. Using the Alligator Advanced Diagnostics Software, the Remote Radio will alert the user that PTT had been disabled due to erratic keying. Once the user investigates the problem and fixes it, the user can then enable PTT. The factory preset this value to 255. A value of 255 means that there is no limit to the number of external keys that can occur within each 10-second time frame.

Table 4.3 Description of Operating Parameters

4.3.4 Communication Parameters

The Alligator Advanced Diagnostics Software enables the user to configure each Remote Radio to operate in a certain configuration. Each Remote can be configured to operate under any of the following configurations:

Parameter	Description
Transmitter Frequency	Each 2888 Radio's transmitter can be individually programmed to frequencies in the FCC designated 895.0 - 960.0 MHz Band.
Radio Address	Each 2888 Radio's identification address can be changed at any time. Each address consists of a unique 4-digit number.
Mechanical Frequency Potentiometer for Manual Frequency Adjustment	For users who do not like to deal with digital potentiometers or automatic frequency adjustment schemes, it is possible to disable the frequency digital potentiometer on the 2888 Radio and use the mechanical potentiometer R110 to tune the Remote Radio's reference standard frequency at the site. This mechanical potentiometer has 25 turns and has an adjustment range of approximately +/- 7 kHz, with an accuracy of 100 Hz. This frequency adjustment scheme can only be enabled if the technician is at the Remote site, since changing from the digital potentiometer to the mechanical potentiometer can be dangerous if done over-the-air.
Digital Frequency Potentiometer for Manual Frequency Adjustment	By enabling this parameter, the user can manually adjust any 2888 Radio's frequency, remotely or locally, using the Alligator Advanced Diagnostics Software. The software allows the user to move the frequency digital potentiometer one step at a time. Each step of the digital potentiometer will adjust the Remote Radio's frequency by approximately 200 Hz each step. The adjustment range for this digital potentiometer is approximately +/- 3 kHz.
Automatic Global Frequency Calibration (AGFC) (Optional Feature) (YES/NO)	By enabling AGFC, each 2888 Radio will continuously and automatically adjust its own TCXO frequency to match that of its received carrier frequency whenever it has finished transmitting data, without using any special hardware circuits to constantly track the TCXO bias voltage. All adjustments are done through the on-board microprocessor to insure that the Remote Radio does not lock onto an interfering signal or environmental noise. A frequency digital potentiometer is used and controlled by the on-board microprocessor, so even if the 2888 Radio is powered down, the frequency of the Remote will remain unchanged after power up. In other

Parameter	Description
	words, after the Remote Radio is correctly adjusted, its frequency will remain unchanged, even if the master station's signal has disappeared (for Remote Radios operating under traditional AFC, the TCXO bias voltage becomes unstable if the master station's signal disappears and requires some time to follow the Master Station's signal after squelch is off). This AGFC frequency adjustment scheme will enhance the reliability and stability of the Remote Radio's frequency at all times, without the disadvantages of "traditional" AFC. The accuracy of adjustment is 200 Hz. This automatic frequency adjustment scheme cannot be enabled when either of the Tx and/or Rx AFC schemes are enabled. Whenever AGFC is enabled, Tx and Rx AFC automatically become disabled. It is always good practice to calibrate the master station's RF signal before adjusting any of the 2888 Radio's frequencies. As a safety precaution, each frequency adjustment will be by no more than 200 Hz every time the Remote Radio has just finished transmitting data.
Tx AFC (YES/NO) Rx AFC (YES/NO)	By enabling Tx or Rx AFC, each 2888 Radio will automatically adjust its own Tx or Rx frequency to match that of its received carrier frequency whenever it is receiving an RF signal. The adjustment accuracy is 400 Hz, and offers less immunity to interfering signals compared to AGFC. AGFC is also smart enough to adjust only when the Remote Radio has just finished transmitting data, while Tx and Rx AFC are not. Whenever Tx and/or Rx AFC are to be enabled, AGFC must be disabled first. Adjustments are done based on the AGFC Counter Limit (see above).

Table 4.3 Communication Parameters Descriptions

5.0 Maintenance

5.1 GENERAL DISCUSSION

While the 2888 is a reliable and relatively maintenance free radio, there are a few quick checks and adjustments that may be made to ensure continued worry-free operation. These procedures should only be performed by qualified engineers or technicians. Should any problems arise or there are any questions that would assist in maintaining the radio, we invite you to call Alligator Communications Customer Service Department at **1-408-327-0800,** 8 A.M. to 6 P.M. Pacific Standard Time.

5.2 TEST EQUIPMENT REQUIRED

① **Communications Test Set/Service Monitor.** This instrument performs the combined functions of an RF and audio signal generator, a frequency counter, a modulation analyzer, and an RF wattmeter. These units are usually equipped with an input-attenuated pad (or dummy load) that allows the full output of the radio to be transmitted directly into the instrument. If this feature is not included, a separate dummy load must be used. Suitable monitors are made by Hewlett-Packard, Motorola Inc., Marconi Instruments Ltd., and IFR Inc.

② **Multimeter.** A basic multimeter, such as a Simpson or a Fluke, will meet this requirement.

③ **Oscilloscope.** If the service monitor does not include a low frequency oscilloscope, then a basic one is needed.

6.0 Alligator Diagnostic Software

6.1 GENERAL DESCRIPTION

Alligator Communication's **Advanced Diagnostic Software (ALLI)** reads and modifies all operating parameters on the Model 2888 radios. With this software, a technician can quickly identify possible conditions that may eventually result in a non-responding remote radio. The technician may then modify the current radio's parameters to correct the condition "over-the-air". Virtually all radio maintenance no longer requires dispatching a technician to perform an on site repair, thus reducing undesirable downtime.

The software runs on a PC/AT compatible computer system (Desktop or Laptop). When connected directly to a Model 2888 the software can read and/or modify each of the following remote parameters:

Diagnostic Parameters:

Alarm Status	RSSI	RF Power Output Mode
PLL1 Voltage	PLL2 Voltage	Power Supply Voltage
FM Deviation	Frequency Offset	Internal Temperature
Forward Power	Reverse Power	

Alarm Limits and Conditions (Low/High):

Power Supply Voltage	PLL1 Voltage	PLL2 Voltage
Forward Power	Reverse Power	Internal Temperature
Squelch Counter	PTT Counter	Tx Timeout Counter

Operating Parameters:

	PTT Dekey Time	PTT Limit per 10 seconds
Timeout Duration		
RTS/CTS Delay	Tx On Delay (repeater use)	

Communication Parameters:

Transmitter Frequency	Receiver Frequency	Radio Address
Tx/Rx Spacing	Bandwidth	

Frequency Adjustment Schemes:

Tx AFC	Rx AFC	Mechanical Frequency Pot
Automatic Global Frequency Calibration (AGFC)		Digital Frequency Pot

Event Counters:

Squelch	PTT	Time-out

Sleep Mode Parameters:

Clock Time	Sleep Enable/Disable	Wake-Up Time
Sleep Time	Wake Duration	Snooze Duration
Maintenance Enable	Start Time	End Time

When connected to a Model 1800A master station, the **Alligator Advanced Diagnostics Software (ALLI)** can read and/or modify all of the previously listed parameters for each responding Model 2888 Radio. It can also switch the master transmitter, and perform a master station battery test. In addition, the software can read the following parameters from the Model 1800A:

Master Station Diagnostic Parameters (A and B)

RF Power Output	Supply Current	Power Supply Voltage
Front Panel Status	FM Deviation	Frequency Offset

Received Signal Strength and Offset (A and B):

RSSI (dBm)	Frequency Offset

Alarm Conditions:

Module Unlock	TxA Power too low	TxB Power too low
Primary TCXO failure	Power Supply A off-line	Power Supply B off-line

Communication Parameters:

TxA Frequency	TxB Frequency	Radio Address
RxA Frequency	RxB Frequency	Setup Configuration

Operating Parameters:

Repeater Operation Enable	Hot-Warm-Standby	Timeout Timer

Automatic Tx A/B Cycling Parameters:

Time of Day	Switchover Countdown	Switchover Interval
Tx A/B Cycling Enable	Time to Switch	

Dial-Up Auto Answer Parameter Settings:

Auto Answer Enable	Number of Rings

Frequency and Deviation Adjustments (from any remote location)

Digital Frequency Pot	Digital Deviation Pot

Transmitter Forward Power Reading Corrections

TxA Correction Factor	TxB Correction Factor

For a complete description of the software installation and operation refer to the Alligator Advanced Diagnostics Software Manual.

6.2 Diagnostics Feature Theory of Operation

The **ALLI** software uses a multi-address polling communications scheme to communicate with the microprocessor of each remote radio responding to the connected master station. Each time the software updates information to or from a remote or master, it must send a command string requesting the appropriate action from the specified radio. The software then waits for a response. If the remote or master does not exist or is not responding then the software will report a time-out error.

The software communicates with the radios using the DTMF protocol. It is the same protocol researched and implemented by the U.S. telephone and emergency broadcast systems for more than two decades. This protocol isolates the diagnostic capabilities of the radio system from the connected SCADA equipment. In other words the radio system's diagnostic transmissions will not trip the connected SCADA equipment and the connected SCADA equipment's data transmissions will not trip the radios' diagnostics. However, this protocol was not designed to quickly transmit large quantities of data. Therefore, a few of the software commands that require large amounts of data will respond slowly. This trade off of speed for data isolation has only a minimal effect on overall system performance. The few extra seconds spent reliably performing over-the-air calibrations is much more desirable than the few extra hours spent visiting a remote site.

By default, Alligator programs the Model 2888 to prevent the **ALLI** software from interrupting any SCADA transmission. Also by default, any SCADA transmission will interrupt the software's attempt to communicate with any remote. However, upon a customer request, the factory can program the master to operate in the reverse.