

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)	<p>This parameter is used mainly to detect problems with external keying circuits.</p> <p>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.</p> <p>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.</p> <p>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.</p>

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 - 960 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)	<p>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.</p> <p>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</p>

Parameter	Description
	<p>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.</p> <p>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.</p> <p>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.</p>
<p>Tx AFC (YES/NO) Rx AFC (YES/NO)</p>	<p>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.</p> <p>Whenever Tx and/or Rx AFC are to be enabled, AGFC must be disabled first.</p> <p>Adjustments are done based on the AGFC Counter Limit (see above).</p>

Table 4.3 Communication Parameters Descriptions

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.