1. SYSTEM DESCRIPTION

1.1. INTRODUCTION

The In-Home Display 900MHz radio card from Aztech Associates Inc. is an easy-to-use radio interface for communicating with the Energy Axis 900MHz network wirelessly. It allow end products to extract energy consumption, price and message information directly from the AMI.

The onboard microcontroller interfaces with an internal 900MHz transceiver to send and receive data to and from and near-by power meter. Communications between the microcontroller and the radio is 3.3V TTL. The 900Mhz performs all necessary DSP functions.

The antenna used is a 900MHz end fed monopole. The antenna is connected to the radio via a permanent soldered RF connection.

1.2. RADIO DESCIPTION

The Radio module is an intentional radiator and is classified as a FCC Part 15.247 device. The critical specifications of the Radio module are listed in the following table:

TX Frequency Band	902.8 – 914.8 MHz
Classification	Frequency-Hopping Spread Spectrum (Part 15.247)
Maximum Output Power	0.25W (+24 dBm)
Number of Channels	25
Channel Spacing	400 kHz
Channel 20 dB Bandwidth	325 kHz
Max channel dwell time within a 10 second period	< 0.4 seconds (MAX 0.016 sec)
Modulation	2FSK

2. ELECTRONIC ASSEMBLY DESCRIPTION

2.1. DESCRIPTION OF CIRCUIT FUNCTION

The radio module electronic assembly includes a printed circuit board with integral shields, implementing an integrated 900 MHz, frequency hopping spread spectrum transceiver. It is used with an external antenna, and integral filtering to suppress spurious emissions.

The 900 MHz Radio is designed using the CC1110 Transceiver IC from Texas Instruments as shown in figure 2. The CC1110 contains an 8051 microprocessor, 32KB flash memory, 4 KB of RAM and an RF transceiver. The 8051 CPU derives its clock from the 26.168889 MHz Xtal oscillator that is also used as the radio's frequency synthesizer reference oscillator.

The receiver portion of the CC1110 is a low-IF receiver with an IF that is programmed at the factory to 230 KHz. In receiver mode, RF signals between 902.4 and 927.6 MHz are picked up by the external 50-ohm antenna and routed through a low pass filter to a T/R switch that directs its output to a low noise amplifier. Received signals output from the LNA are routed to another T/R switch that passes them to a SAW bandpass filter, to a balun circuit, then to the RF input/output of the CC1110. The CC1110 has an internal LNA whose output is routed to mixer where it is down-converted in Quadrature to a low IF frequency of 230 KHz. At IF, the I/Q signals are digitized by ADCs and then demodulated.

In transmit mode, the RF carrier is generated by direct synthesis from the 26.168889 MHz Xtal reference

oscillator, FSK modulation is applied and the signal is routed to an on-chip power amplifier before being output from the IC. The TX output and RX input are the same bidirectional pins on the CC1110. The transmit signal passes from the IC through the balun circuit and the SAW bandpass filter to the T/R switch. The output of the T/R switch is directed to an RF2172 power amp IC which provides approximately 20 dB of gain. The PA output passes to another T/R switch, then to a low pass filter and finally to the external 50-ohm antenna. The output level of the CC1110 is set by the factory to ensure that the RF power delivered to the antenna is less than 250 Milliwatts (24dBm).

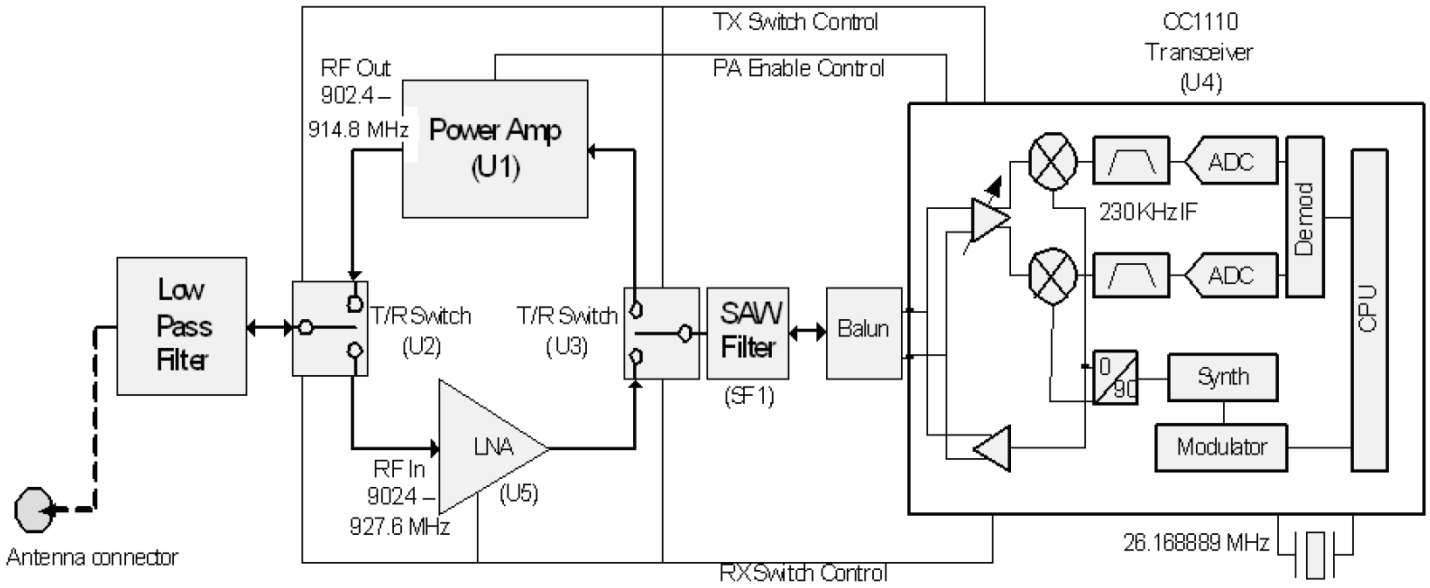

Figure 1: Module block diagram

CC1110Fx Microcontroller & Transceiver	"System-on-a-chip" radio transceiver with built-in industry standard "8051" architecture microprocessor. All frequency determining circuitry is built into this integrated circuit with the exception of quartz crystals. As configured, it can transmit on 902.8 – 914.8 MHz and receive on 902.8 – 927.6 MHz.
5.0V/3.3V Battery	Power source for the Radio module. The CC1110Fx has a built-in 1.8V internal regulator for powering its radio (including frequency-determining circuitry) and microprocessor.
EEPROM	The serial EEPROM provides storage for radio and gas metering configuration information. All radio parameters are programmed at the factory.
Power Amplifier (PA)	A 2-stage Class-C RF amplifier that runs directly from the 3.3V Battery. Since factory power calibration is performed at maximum possible battery voltage (3.67), maximum RF power output cannot be exceeded.
Antenna	External 50-ohm antenna. power calibration

2.2. RF CHANNEL PLAN

The Radio module is a frequency-hopping spread spectrum device using 25 hopping frequencies between 902.8 MHz and 914.8 MHz for the transmit channel.

The 20 dB bandwidth of the hopping channel is approximately 325 kHz and the average time of occupancy on any frequency is less than 0.4 seconds within a 10 second period per FCC part 15.247(a)(1)(i).

In the worst case burst transmit mode, the module would send sixteen 100msec packets with approximately 10 msec delay between packets, followed by 1,750 msec of off time to yield a 50% duty cycle. Thus, in any 10 second interval, a maximum of packets sent will be 48 with 23 channels being used twice and 2 channels only being used once. The maximum dwell time on any one channel is approximately 200 msec which is less than the 400 msec occupancy requirement.

There are no channel avoidance techniques.

The Radio module uses the 25 channels in the following pseudorandom order as the transmit channel set. The transmitter is a slow hopping frequency system where the entire data packet is sent on a single channel. After sending, the transmitter will move to the next channel in the pseudo-random hop table. Each frequency is used before the transmitter will hop to a frequency that has already been used. The receiver is a single IF system whose bandwidth is 330 kHz. When not synchronized. The receiver is constantly hopping across the 25 channels, scanning for a valid preamble. Once a valid preamble is detected, the receiver is synchronized to the transmitter and receives the data packet. After transmission, the receiver returns to the scanning mode

Index	Channel	Center Frequency (MHz)
1	12	907.2
2	29	914.0
3	5	904.4
4	19	910.0
5	11	906.8
6	23	911.6
7	26	912.8
8	13	907.6
9	22	911.2
10	15	908.4
11	1	902.8
12	25	912.4
13	4	904.0
14	21	910.8
15	14	908.0
16	27	913.2
17	8	905.6
18	31	914.8
19	18	909.6
20	16	908.8
21	7	905.2
22	20	910.4
23	3	903.6
24	28	913.6
25	6	904.8