# RE1 Operational Description

The RE1 circuit is realized as a small PCB with castellations (pads), which will be soldered to a host PCB. With reference to the block diagram, a quartz crystal of 16.00 MHz provides an oscillator that is used by the ARM M0 micro-controller and the radio transceiver for controlling modulation, and determining and stabilizing frequency. A second quartz crystal of 32.768 kHz may be used by the micro-controller.

Spurious emissions are suppressed by: (1) a soldered-down metal shield, and ground-fill on the PCB, that enclose the oscillators and active components, and (2) the antenna impedance-matching network. An external DC voltage source of 1.8 to 3.6 V provides power. Transmitted power and current consumption is limited internally within the nRF51822 integrated circuit. The RE1 circuit has a factory-installed surface-mount IC antenna. The transmitted power level is variable in software between -30 dBm and +4 dBm conducted from the nRF51822.

The RE1 is a hybrid, frequency hopping / spread spectrum device. It uses GFSK wide-band modulation with frequency deviation. The 6 dB bandwidth is at least 500 kHz and the 20 dB bandwidth is at least 1 MHz. The modulation index is 0.32. The over-the-air data rate is 1 Mbps. Frequency hopping is performed on 5 factory-set hopping channels in a pseudo-random sequence: 2472, 2402, 2422, 2446, and 2480 MHz.

The modulation and channel bandwidth characteristics described above are identical for a receiving RE1 device and a corresponding transmitting RE1 device. A transmitting device will transmit data continuously for a maximum of 2.75 ms. A receiving device will occupy (dwell on) a given frequency channel for a maximum duration of 0.4 seconds in any 2-second period. The RE1 communicates only with other RE1 modules. It does not recognize any data that might be received from other FHSS systems. The RE1 therefore is incapable of coordinating its hopping activity with other FHSS systems.

Two RE1 devices communicate using a simple protocol that defines one device as a *Sensor* and the other device as a *Base,* which is normally listening. Communication is always initiated by the Sensor, which will send a message on a frequency channel then listen for a Base response. If no Base response is received, the Sensor will send the message again, listening in turn, on each of the remaining 4 frequency channels in the pseudo-random sequence. This process is termed *Beaconing*. If the Sensor receives a Base response on any channel, then both the Sensor and the Base will hop to the next frequency channel and the Sensor may send another message and subsequently may receive another Base response. After each message-response exchange, both the Sensor and the Base will hop to the next frequency channel. This process continues until either the Sensor or the Base ceases to transmit. At the end of the dwell period, the Base will hop to the next frequency channel and resume listening. The Sensor may subsequently restart communication by beaconing. Consideration of the protocol shows that the Sensor and Base expect to have equal time of occupancy on all frequency channels. The beaconing process synchronizes the Sensor frequency channel with that of the Base; thereafter channel synchronization is maintained by the hopping activity.