

## **VQ2020 Q-Bot Operational Description**

The VQ2020 Q-Bot is a portable hand-held device that is the customer interface to the Lo-Q VQ2020 virtual queuing system. It is capable of bi-directional communication using the 2.4GHz unlicensed ISM radio band or via Infrared. The user interface consists of an LCD display, two, two-way push buttons, a vibratory motor and a sounder.

The Q-Bot contains a single printed circuit board and a battery pack. The exterior case is made from a high-grade polycarbonate and provides a rigid housing that is both shock proof and waterproof.

The microprocessor used is from the Texas MSP430 family of very low power 16 bit Risc microprocessors and provides extended operational life from a single battery pack. The battery pack is constructed using 4 non-rechargeable CR2477 Lithium Manganese Dioxide Coin cells, which is simply replaced when depleted. The cells are connected in series and provide a nominal voltage of 12.8v from a fresh set of cells. A current monitoring device measures the battery current and feeds the microprocessor with an analogue voltage proportional to the current drawn. The 12v supply is fed into a DC-DC converter that steps this down to 3v that is used by all the onboard devices.

The RF sub-system is based around the Texas Instruments CC2420 chip. This is a complete RF system in a chip; it includes a digital direct sequence spread spectrum baseband modem and requires very little additional support circuitry. The chip is designed to work in the 2.4GHz band and supports the IEEE 802.15.4 standards including Zigbee and offers an effective data rate of 250Kbps.

The CC2420 has internal Transmit/Receive switch circuitry simplifying the connection to the antenna. A passive balun is used to connect the differential RF signal to a single-ended Planar Inverted-F Antenna.

A 16MHz crystal provides the reference frequency for the synthesizer. The built in digital baseband processing includes support for frame handling, address recognition, data buffering and MAC security. Connection to the MSP430 is via a 4-wire SPI serial interface that is used for configuration and data transfer.

The Q-Bot supports operation in IEEE 802.15.4 channels 11 through 25, channel 26 is internally disabled and cannot be selected. The actual channels used are determined by the system configuration and downloaded over the Infrared to the Q-Bot by a control program running on a server computer. The RF power output is set by the microprocessor to 0dBm and is not user or system selectable.

The infrared transceiver operates with asynchronous data at 9,600 bps. The modulation method used is standard 3/16 pulse shaping.

The microprocessor receives incoming messages from either the Infrared the RF channels and drives the user interface as required. It also generates responses when necessary, which are transmitted over either the Infrared or RF channels.

The sounder and vibro provide user alerts and the 128 x 128 pixel FSTN LCD and two two-way tactile switches provide the man machine interface. An ambient light sensor allows the intensity of the LCD backlight to be controlled automatically.

The embedded software uses a multitasking operating system that directly supports the IEEE 802.15.4 protocol stack.