Qualifier Transmitter
Theory of Operation

Please refer to the Qualifier Block Diagram (imt-block.pdf) and Qualifier Schematics (imt-sch1.pdf through imt-sch8.pdf)

R.F. Generation and Amplification - Signal Path Description

RF energy is produced by a voltage controlled oscillator circuit at Q8. Correction voltage is supplied by PLL at U4 for tuning the tank circuit varactor. The PLL reference signal is produced by VCXO1, a voltage controlled crystal oscillator operating at 15.36 MHz. The PLL is programmed to provide one of three frequencies by the microcontroller at U11. 27.45 MHz, 27.47 MHz, and 27.49 MHz, therefore providing a channel spacing of 20KHz.

The RF energy from oscillator Q8 is amplified by buffer stage Q21. There is a 'PI' type attenuator pad providing -10dB of gain, used to limit the amount of RF energy between the VCO buffer at Q21 and the next gain stage in the series at A1. A1 is a MMIC providing about +20dB of gain. From there, the RF energy is passed through a variable attenuator, comprised of PIN diodes D8 and D9. This variable attenuator provides -1dB to -55dB of gain, giving ample control range over the output signal. The RF energy is then passed into the driver stage at Q20, which provides a +13dB gain. The final stage in the chain at Q1 provides +13dB worth of gain. The RF signal is then low pass filtered and finally band pass filtered before connecting to the external antenna connector. The band pass filter serves another purpose, that is to provide a high impedence at the antenna connector at 433 MHz, the frequency at which the ASH receiver at IC9 operates.

R.F. Power Control

The RF energy is sampled near the antenna connector by an AD8307 at U9. This device produces a voltage output that is proportional to the RF input signal level. The voltage output is gain and D.C. offset corrected by an op-amp at U10A. It is then compared to a reference voltage by an op-amp at U15A. The reference voltage is produced by a resistor network, controlled by the microcontroller through a 1 of 8 decoder at U16. The output from this comparison at U15A is fed into the variable PIN diode attenuator at D8 and D9, providing a gain control range of -1dB to -55dB.

GMSK Signal Generation and Two Point Modulation System

The GMSK signal is produced by an MX-589 at U5. This signal is filtered by an op-amp network comprised of U6B, U6A, U8B, U8A, U7A, and U7B. The signal path splits at U7A and U7B, with the output from U7A going to the VXCO at VXCO1, providing a reference offset for the PLL and the output from U7B going to the varactor diode in the oscillator's tank circuit at D5. By applying the modulating signal to both the oscillator and the PLL reference source simultaneously, you minimize the distorting characteristics caused by the PLL's normal operation. The modulating frequency range runs from D.C. through 7.2 KHz, deviating the output frequency by 15 KHz.

Temperature Sensor - Thermal Shutdown

The sensor at IC6 is used to monitor the temperature of the final amplifier. The voltage from the sensor is compared to a reference voltage by an op-amp at IC5B. When the temperature sensor's voltage exceeds that of the reference voltage, an input pin on the microcontroller is pulled low. The controlling software will monitor this pin every 10mS and when an over temperature condition is met, the microcontroller software will prevent the unit from further transmissions. There is an LED on the front panel that will notify a user of this condition.

VSWR Sensor

There is a VSWR monitoring circuit, comprised of detectors DX1, and DX2, and an op-amp at IC5A. When this detector circuit detects a VSWR level that is above a preset level, the op-amp will pull a pin on the microcontroller low. The controlling software will then prevent any further transmissions until the power is cycled OFF and back ON. This is intended to prevent the use of the transmitter with an improperly matched antenna. There is an LED on the front panel that will notify a user of this condition.

NOTE: The units sent to your facility for testing will not require a power off-on sequence to reset from a mismatch at the antenna connector.

PLL Lock Monitoring

The microcontroller monitors the state of the PLL device and will prevent transmissions when an "out of lock" condition is detected.

ASH Receiver (Command Link)

There is an ASH receiver at IC9 tuned to 433.92 MHz. This receiver is used for data reception from the Qualifier hand held unit. The data output from this device is delivered to both the main microcontroller at U11 and to an additional microcontroller at U1000. The device at U1000 is used to detect a start of transmission sequence from the data stream and notify the microcontroller at U11 of this. The main microcontroller at U11 will then parse the data stream and extract the control message from it. This data stream is used to control the operating characteristics of the IMT unit, such as when to transmit, what power level to use, how many transmissions, the frequency to use, etc.

Output Frequency Selection

The operating frequency is controlled by the microcontroller at U11 with inputs either from the command link data stream or from an external computer. The frequency selection is one of three possible frequencies, 27.45 MHz, 27.47 MHz, or 27.49 MHz.

Safety Shutdown

In case of microcontroller failure, the unit will cease transmitting within 240 mS. There is an R-C circuit in the transmitter's control line that will shut power off to the driver and final amplifier stages.
NOTE: This feature has been disabled in the two units your facility has for testing.

Modes of Operation

The transmitter will operate in one of two modes.

Mode one is an on/off cycling of the transmission signal with a low duty cycle. The transmitter will be ON for 100mS then OFF for 900mS, repeating.

Mode two, the transmitter will transmit three short bursts, followed by a period of inactivity, then may transmit this three burst pattern again, up to two additional times. Timing for mode two follows this form: ON for 100mS, OFF for 20mS, ON for 100mS, OFF for 20mS, ON for 100mS, OFF.
If the sequence is repeated, there will be approximately 2.5 to 3 seconds from the last OFF period to the next ON period. The minimum time between repeated transmission cycles is five seconds.