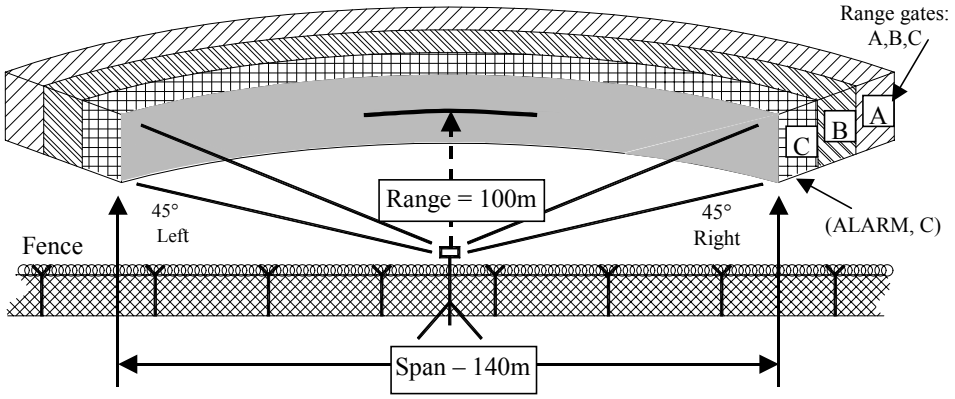
QUPID OVERVIEW

The QUPID sensor is a rapidly deployable, easily transportable and quickly relocatable security sensor for a variety of applications. This sensor utilizes Ultra-Wideband (UWB) radar technology operating in the "S" band (2.0 to 2.4 GHz), with a very low average transmit power output of less than 3 milliwatts. The sensor is used to detect intrusion into a protected asset area. In general, the sensor is applied as a "beyond the fence" perimeter intrusion detection device as illustrated in Figure 1.

The basic sensor detection pattern is a 90^{o} circular arc. Three distinct detection zones, A, B and C, are employed by the QUPID to mitigate false alarms. The inner radius of zone C can be operator set at 30, 70 or 100 meters. The Figure 1 illustration is shown at 100 meters. QUPID will indicate an alarm by detection of an intruder sequentially passing through range gates A, B and then C (the alarm range setting).

The QUPID sensor concept of operation and system implementation are described in the following section.

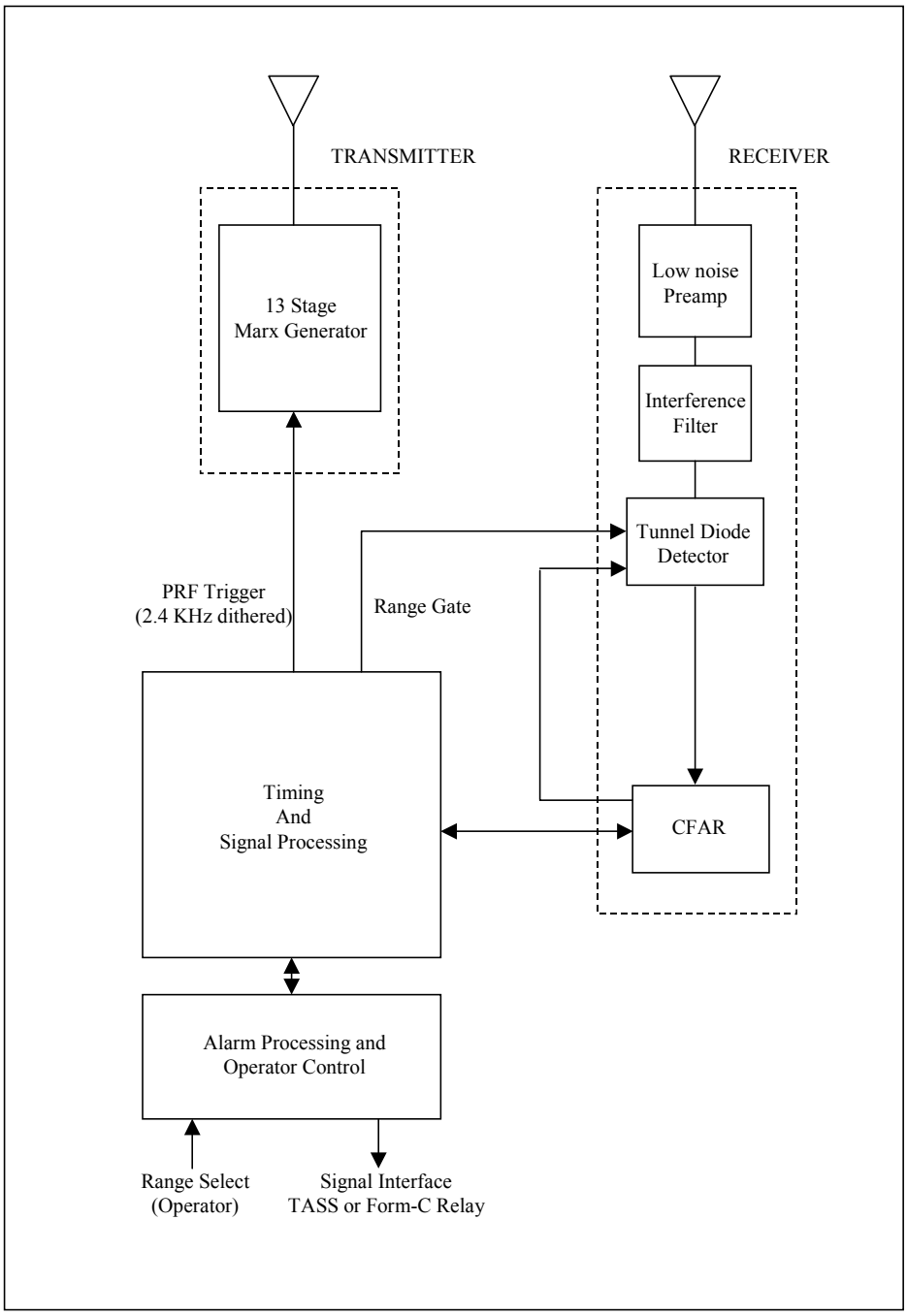


Example: 100 meter range and 90^{o} azimuth shown.
Drawing is not to scale and is for illustrative purposes only.

Figure 1 QUPID Range Gate Detection Pattern (100-Meter Example)

Operational Concept

The basic operation of the QUPID sensor is described herein with the aid of the following block diagram.



QUPID BLOCK DIAGRAM

The QUPID transmitter operates at a pulse repetition frequency (PRF) of about 2.4 kHz that is dithered to permit operation of several of these sensors in close proximity without causing self-interference. QUPID transmits a microwave pulse packet which is about 1.5 nanoseconds in duration, and has a nominal center frequency of 2.3 GHz. QUPID generates its UWB output signal by, essentially, impulse exciting an antenna (filter) with a kilovolt baseband pulse several nanoseconds in duration. The resulting radiated output signal has been theoretically and experimentally evaluated both in the frequency and time domains and is shown to comply with the FCC specifications for UWB Emission Limits for Thru-Wall Imaging & Surveillance System Guidelines as described in its February 14 and again in its April 22, 2002 First Report and Order.

A system clock establishes the PRF of the sensor. As stated above, the clock is dithered to prevent one QUPID sensor from possibly interfering with another. In the process of dithering the PRF, the spectral lines produced by the transmitted pulses are "smeared" so that the radiated signal begins to resemble "white noise". The system clock triggers a 13 stage Marx generator (the Transmitter) that produces about a 1000-volt baseband pulse having about a one-nanosecond risetime and 3-nanosecond duration. This pulse is incident on an avalanche diode that breaks down and sharpens the rise time of the Marx generator pulse to about 100 ps. The avalanche diode is, literally, located at the mouth of a dipole antenna that is tuned to 2.3 GHz and located within a corner reflector.

A range- gated tunnel diode Constant False Alarm Rate (CFAR) threshold detector is used to determine the presence of a target. The range gate width is selected to be consistent with the slowest speed expected by a intruding "crawler". The range gate is about 24 nanoseconds in duration corresponding to approximately 12 feet in space. The tunnel diode is a negative resistance detection device, which is capable of switching stable states very quickly with the incidence of very small amounts of energy. Once the state is changed by the presence of a signal, the bistable tunnel diode threshold detector must be reset. The CFAR circuit shown in the accompanying block diagram sets the tunnel diode bias. It is a binary integrator circuit that always requires that 16/32 hits of the peak of the clutter pattern exceed the receiver threshold. This is accomplished by setting the dc bias on the tunnel diode. Maintaining this ratio of 16/32 hits is accomplished by a closed feedback loop. It is the peak of the clutter signal present anywhere within the range gate that sets this tunnel diode bias.

The range gate normally sits at position "A", the outermost range gate , and is sensitive to a disturbance in the peak of it's clutter pattern due to the presence of a target. *Note that QUPID does not detect a target per se!* QUPID only announces a possible detection when there is a change in the peak of the clutter pattern due to the constructive or destructive interference of the returned signal in the presence of a target. When the peak of the clutter pattern changes by +/- 4 hits in range gate position "A", and within a prescribed period of time, then a possible "target" is noted, and the range gate is shifted closer to the radar (called gate "B"), and the test is then repeated. The timing and signal-processing network shown in the block diagram accomplishes this shift in range gate

position. Note that the peak of the clutter pattern is likely to be different in the new range gate position "B", and the dc bias on the tunnel diode as shown in the block diagram will automatically be readjusted by the CFAR to once again stabilize on 16/32 hits. The presence of a target entering range gate "B" at a time corresponding to the anticipated velocity of a crawler, walker, etc. shifts the range gate to its final contiguous position, "C". If a target is again detected in range gate "C" within the correct time period for the third time in a row, then an alarm state is indicated and the sensor is reset to range gate "A". The alarm processor shown in the block diagram provides the output function that is an analog voltage for the TASS interface and a Form-C relay output for commercial use.

The Receiver antenna is of similar design to that of the transmitting antenna except for the absence of an avalanche diode at the mouth of its dipole. The output from the receive antenna is fed to a preamplifier and then post amplifier to establish a favorable noise figure. A band-pass filter precedes the tunnel diode threshold detector to eliminate signals outside QUPIDs operating frequency band of 2.3 GHz +/-150 MHz. An interference reduction filter is also included to attenuate certain in-band interference signals. That is, eliminating narrow band interfering signals located within QUPID's 300 MHz reception band. The preamplifier, post amplifier, interference filter, and range gated tunnel diode CFAR threshold detector constitute the Receiver.