# The Micromet Model CF-5 Precision X-Band Doppler Radar

## 1.0 Basic Operating Principles

The Model CF-5 Doppler Radar is a straightforward, well known, type of X-Band Transceiver based radar; however, there is an important exception. The X-Band Microwave Generator is very stable. It has low phase noise and an extremely stable frequency. The low noise and frequency stability are obtained by phase locking a 10.525 GHhz Microwave Generator to a Rubidium Frequency Standard having a frequency stability of one part in 10-E10. This degree of stability makes it possible, using external specialize signal processing equipment, to accurately measure extremely small changes in Doppler frequency. This type of measurement is often desired at automobile proving grounds to measure very small changes in vehicle speed.

## 2.0 Block Diagram

A block diagram of the CF-5 System is shown in Figure 1. The process of generating a very stable microwave signal starts at Block One, a Rubidium Frequency Standard. This device generates an extremely stable 5MHz signal that is fed to Block 2, a Microwave Generator. The Generator phase locks to the 5MHz signal, and produces a 10.525 microwave signal having the same degree of stability as the Rubidium Standard.

The output from the Microwave Signal Generator is fed through a Directional Coupler to a Horn Antenna. The Antenna has a gain of 14 db and a beam-width of 30 degrees in each plane. The microwave beam emanating from the antenna is directed at a moving target, usually and automobile undergoing a performance test. Signal reflected from the target automobile is returned to the antenna and is directed by the Coupler to a Microwave diode. A portion of the signal generated by the Microwave Generator, that was not directed to the Antenna, is also present at the Microwave Generator. The two signals present at the Microwave Diode are mixed by the diode, and a signal equal to the difference between the two frequencies, is an output from the diode. This output is generally called the Doppler Signal, and it has a frequency proportional to the targeted vehicles velocity. This frequency is precisely 31.3949 Hertz, for each mile per hour, of the targeted vehicles velocity.

The Doppler Signal emanating from the Microwave Diode is passed to a Signal Processor where it is amplified and converted into a TTL square wave. This square wave signal is the output from the CF-5 X-Band Doppler Radar. It is generally processed further with external specialized signal processing equipment.

## 3.0 Schematic Diagram

A schematic diagram showing the Signal Processing Circuit is given in Figure 2. A 12 volt DC source, must be provided by the user, as the basic power source. The current drawn during warmup, which generally takes about five minutes, is about one ampere. After warm up, the current drops to about one half ampere. Most of the initial current is consumed by a heating element present in the Rubidium Frequency Standard.

The input to the circuit is taken from a Mixer Diode connected to the Directional Coupler. The input is passed through C1, a 33uf capacitor ,to IC1, a LM351 Operational Amplifier. The maximum desired gain of the Operational Amplifier is factory adjusted using R2, a 200K potentiometer.

The output of IC1 is processed by the combination, R7 and C4, that comprise a 6DB per octave, HI pass filter that eliminates unwanted higher frequencies, moistly noise, generated by the Mixer Diode. After the filter, output from IC1 passes through C5 to the input to IC2, an LM148 Operational Amplifier configured as a sensitive Voltage Comparator, that converts its sine wave input, into a square wave output.

Gain potentiometer R1 is factory set so that Comparator IC2 will not react to noise, when there is no real target present.

The square wave generated by IC2 is the output of the CF-5 Radar. It is generally processed further by external frequency and phase measuring systems, to determine very small changes in speed of a targeted vehicle or test sled.

## 4.0 Operating Instructions

### 4.1 Power Requirements

A voltage of at lease 12 volts is required to operate the CF-5 Radar. During warmup, when power is first applied, a surge current of 4.4 amps will be drawn. After warmup, which normally takes approximately five minutes, the current drops to about 2.6 amps.

### 4.2 Positioning and Mounting

A rigid mounting arrangement is required. Mounting on a sturdy tripod permits position flexibility. Maximum accuracy cannot generally be attained if the CF-5 is hand held during tests.

The CF-5 is generally positioned at the center, and at the end, of a vehicle test straightaway. The height above ground should be adjusted to be about the average height of the vehicle under test. If data is required when the test vehicle is operating within about the first 200 feet from the CF-5, its height should be about one foot above ground to avoid dropout errors due to transmission multipath.