

Doppler Sensor Heads

2004

FEATURES

- ❖ High sensitivity
- ❖ Low 1/f noise
- ❖ Circular polarized waveform
- ❖ Low harmonic and spurious emission
- ❖ Temperature and vibration qualified
- ❖ Compact size
- ❖ Low cost and volume production

APPLICATIONS

- ❖ Automotive Radar
- ❖ Doppler Radar
- ❖ Directional sensor
- ❖ Long range motion detector



SRF Series

DESCRIPTION

SRF series Single and Dual Channel Doppler Sensor Heads are designed for **long range** motion/speed/directional detection where the sensitivity is essential. The sensors are constructed with a high performance horn antenna or horn-lens antenna, a linear to circular polarizer and T/R diplexer, a balanced mixer (I/Q mixer for dual channel version) and a high performance Gunn diode oscillator or dielectric resonator oscillator/multiplier chain. The low 1/f noise mixer diodes and high performance oscillator enhance Doppler detection at low IF frequency and circular polarization waveform improves reception ability for various Radar targets. The sensors are offered with single or dual channel version. The dual channel version provides target moving direction (approaching or receding) information of the target while detecting speed.

Standard products are offered at 24.15 GHz, 35 GHz and 76.5 GHz, while other frequency bands are available upon request.

SPECIFICATIONS

Typical Specifications (Single Channel)			
Parameters / Model #	SRF-24120610-01	SRF-35120610-01	SRF-77120910-01
RF frequency	24.150 GHz	35.500 GHz	76.500 GHz
Transmitter output power	+10 dBm (typical)	+10 dBm (typical)	+10 dBm (typical)
Receiver conversion loss	6 dB (typical)	6 dB (typical)	9 dB (typical)
IF bandwidth	DC to 100 MHz (minimum)	DC to 100 MHz (minimum)	DC to 100 MHz (minimum)
Antenna 3 dB beamwidth	12 degrees (typical)	12 degrees (typical)	12 degrees (typical)
Antenna side lobe level	-20 dB (maximum)	-20 dB (maximum)	-20 dB (maximum)
Polarization	right hand circular	right hand circular	right hand circular
Spurious and harmonics	-16 dBc (maximum)	-16 dBc (maximum)	-16 dBc (maximum)
$\Delta F/\Delta T$	-0.20 MHz/°C (maximum)	-0.40 MHz/°C (maximum)	-4.0 MHz/°C (typical)
$\Delta P/\Delta T$	-0.03 dB/°C (maximum)	-0.04 dB/°C (maximum)	-0.04 dB/°C (typical)
DC bias	+5.5 V / 250 mA (typical)	+5.5 V / 350 mA (typical)	+5.5 V / 650 mA (typical)
Operation temperature	-40 to +85 °C	-40 to +85 °C	-40 to +85 °C
Outline drawing	WT-C-A1	WT-C-A2	Consult factory

Doppler Sensor Heads

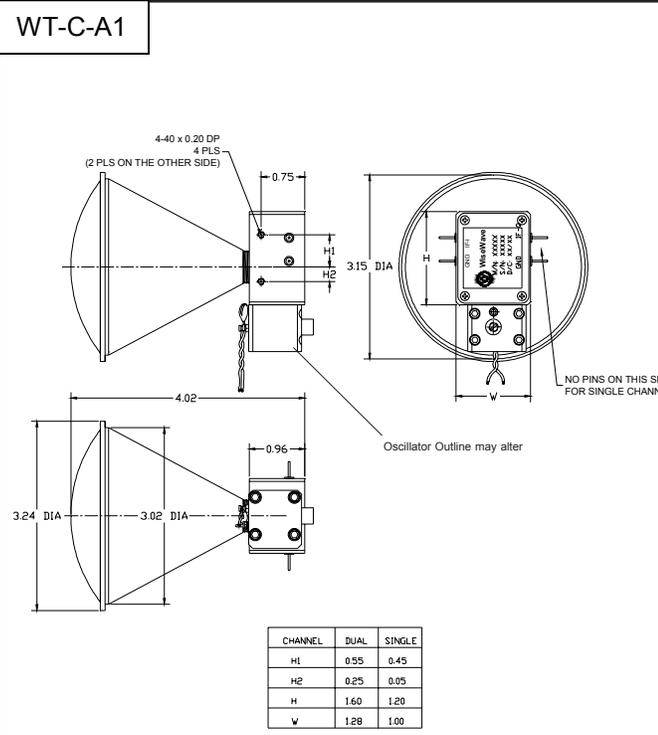
2004

Typical Specifications (Dual Channel)

Parameters / Model #	SRF-24120910-D1	SRF-35121010-D1	SRF-77121210-D1
RF frequency	24.150 GHz	35.500 GHz	76.500 GHz
Transmitter output power	+10 dBm (typical)	+10 dBm (typical)	+10 dBm (typical)
Receiver conversion loss	9 dB (typical)	10 dB (typical)	12 dB (typical)
IF bandwidth	DC to 100 MHz (minimum)	DC to 100 MHz (minimum)	DC to 100 MHz (minimum)
I/Q Channel Phase	90 °± 10 °	90 °± 10 °	90 °± 20 °
Antenna 3 dB beamwidth	12 degrees (typical)	12 degrees (typical)	12 degrees (typical)
Antenna side lobe level	-20 dB (maximum)	-20 dB (maximum)	-20 dB (typical)
Polarization	right hand circular	right hand circular	right hand circular
Spurious and harmonics	-16 dBc (maximum)	-16 dBc (maximum)	-16 dBc (maximum)
$\Delta F/\Delta T$	-0.20 MHz/°C (maximum)	-0.40 MHz/°C (maximum)	-4.0 MHz/°C (typical)
$\Delta P/\Delta T$	-0.03 dB/°C (maximum)	-0.04 dB/°C (maximum)	-0.04 dB/°C (typical)
DC bias	+5.5 V / 250 mA (typical)	+5.5 V / 350 mA (typical)	+5.5 V / 650 mA (typical)
Operation temperature	-40 to +85 °C	-40 to +85 °C	-40 to +85 °C
Outline drawing	WT-C-A1	WT-C-A2	Consult factory

OUTLINES

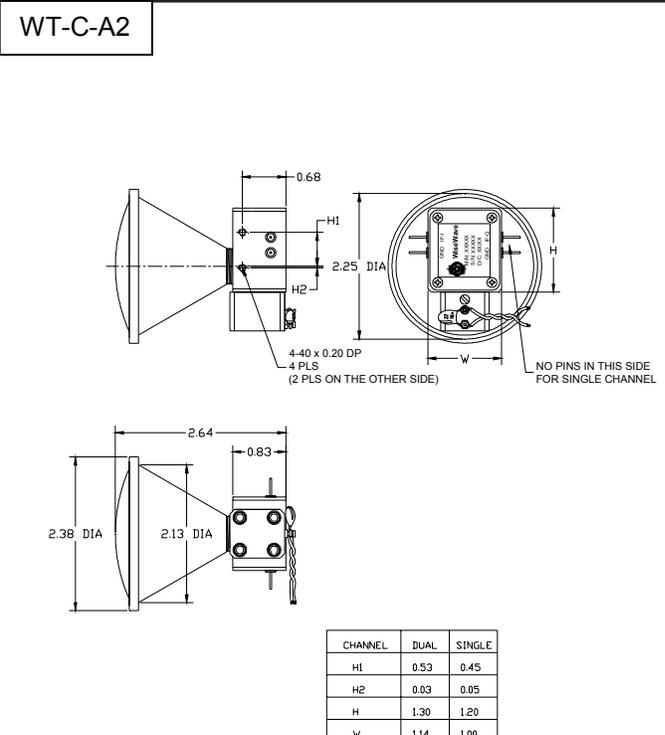
WT-C-A1



CHANNEL	DUAL	SINGLE
H1	0.55	0.45
H2	0.25	0.05
H	1.60	1.20
W	1.28	1.00

K Band Doppler Sensor Heads

WT-C-A2



CHANNEL	DUAL	SINGLE
H1	0.53	0.45
H2	0.83	0.05
H	1.30	1.20
W	1.14	1.00

Ka Band Doppler Sensor Heads

Sensor Heads Application Notes

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WiseWave Technologies offers three types of microwave and millimeterwave sensor heads. They are **Doppler Sensor Heads**, **Directional Doppler Sensor Heads (SRF Series)** and **Ranging Sensor Heads (SRR Series)**. The main objectives of the application notes are to explain the basic principles of Doppler Radar and Ranging (Distance) Radar and how WiseWave Technologies' sensor heads should be implemented to configure such Radar systems.

Doppler Radar

It is well known that **Doppler Radar** is widely used for speed measurement. The principle behind the Doppler Radar is the frequency shift of a microwave signal bounced back by a moving object. The resultant frequency shift is known as **Doppler Frequency Shift**, which is given by the following equation

$$F_d = 2V (F_o/C) \text{ Cos } (\theta)$$

Where:

F_o is the transmitter frequency (Hertz).

C is the speed of light, which is 3×10^8 (meter/sec).

V is the speed of the target (meter/sec).

θ is the angle between the radar beam and the moving target (in degrees) as shown in Fig. 1.

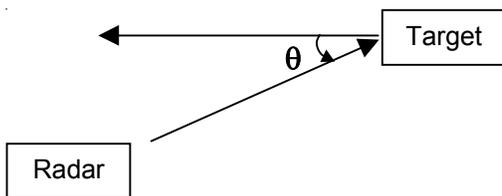


Figure 1. Doppler Shift

When moving target moves perpendicular to the radar beam, the F_d equals 0, which indicates no Doppler shift. On the other hand, the F_d is equal to $2V(F_o/C)$ when the target moves parallel to the radar beam or if θ is real small (0 to 10 degrees).

SRF series single channel Doppler sensor heads offered by WiseWave Technologies, Inc. are designed for **long range** Doppler Radar application where detection sensitivity is essential.

The simplified block diagram of a Doppler Radar formed by using WiseWave's single channel sensor head is shown in Fig. 2. A high quality DC power supply for Gunn oscillator bias, a low noise IF amplifier and DSP circuitry are the minimum requirements for a system designer to realize such a radar system. In addition, the moving target radar cross section, detection distance and target speed are the main factors in consideration when specifying the transmitting power, antenna gain and IF frequency bandwidth of the sensor head. The example of the IF frequency range of a 24.15 GHz and 76.5 GHz Doppler radar at various speeds is shown in the following table.

Transmitting Freq. (GHz)	24.15		
Speed (Km/Hr.)	10	80	200
IF (Hz)	224	1,790	4,475
Transmitting Freq. (GHz)	76.50		
Speed (Km/Hr.)	10	80	200
IF (Hz)	709	5,670	14,176

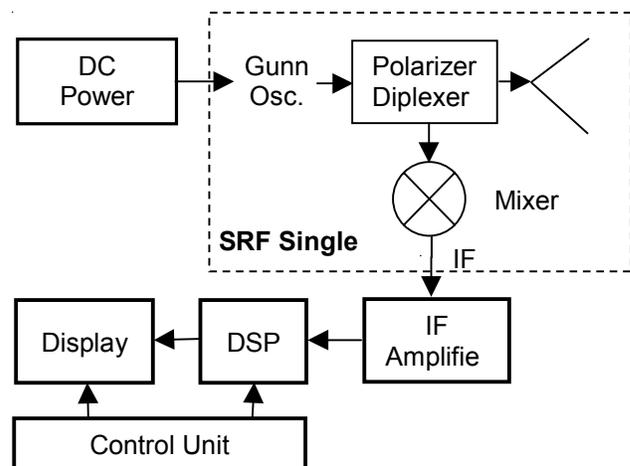


Figure 2. Simplified Doppler Radar

Doppler Directional Radar

In certain applications, one not only has to know the target speed, but also the target moving directions, i.e., whether the target is approaching to the radar or receding from the Radar. The examples for such applications are the law enforcement radar systems used by police officer or door openers in the building entrance. Also, such radar systems are often used for distinguishing vibrating targets, fan rotations or curtain movements caused by the wind from a real intrusion in the security system.

The implement of the directional information is realized by adding an additional mixer to the single channel sensor head with a 90 degrees phase difference. The mixer used in the directional sensor is sometimes known as phase detector or I/Q mixer. The phase relationship between two mixers is that the first mixer will lead the second, or the phase shift is positive if the target is approaching the radar, while the phase will lag if the target is receding from the radar.

SRF series dual channel Doppler sensor heads offered by WiseWave Technologies, Inc. are designed for **long range** Directional Doppler Radar applications where detection sensitivity is essential.

The simplified block diagram of a Directional Doppler Radar achieved by using WiseWave's dual channel sensor head is shown in the Fig. 3. In a similar manner, a high quality DC power supply for Gunn oscillator bias, a low noise IF amplifier and DSP circuitry are the minimum requirements for a system designer to realize such a radar system.

Ranging (Distance) Radar

In many applications, one has to know not only the speed of a moving target, but also the range or distance between the moving or stationary target and the radar. In this case, a Frequency Modulation Continuous Waveform (FMCW) technique may be used in the sensor head to realize the ranging radar.

Implementing the FMCW technique in the sensor head is to replace the fixed tuned oscillator with a Varactor or voltage tuned one.

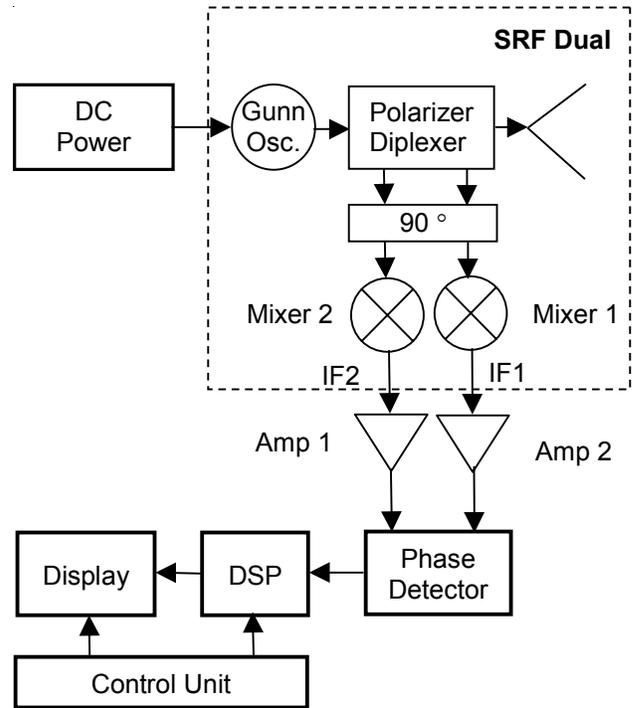


Figure 3. Simplified Directional Doppler Radar

SRR series dual channel Doppler sensor heads offered by WiseWave Technologies, Inc. are designed for **long range** FMCW Radar application.

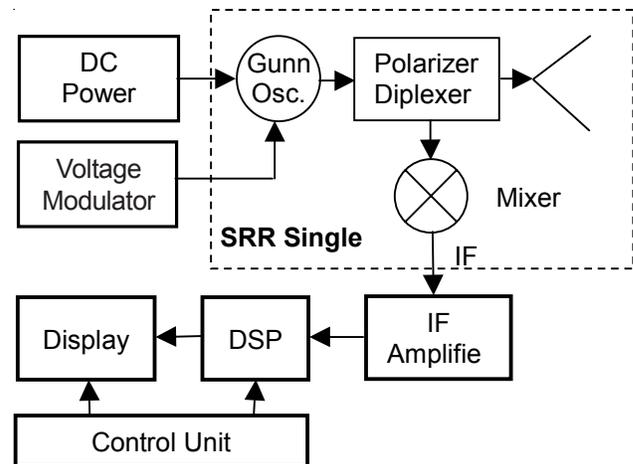


Figure 4. Simplified FMCW Ranging Radar

The simplified block diagram of an FMCW Radar formed by using WiseWave's single channel sensor head is shown in the Fig. 4. In a similar manner, a high quality DC power supply for Gunn oscillator bias, a voltage modulator, a low noise IF amplifier and DSP circuitry are the minimum requirements for a system designer to realize such a radar system.

The range information can be extracted from the frequency difference between the transmitted and returned signal at distance R, the signal transit time (ΔT) and the frequency modulation rate (N). The idea is briefly illustrated in the Fig. 5. The detail is explained as follow. At time T1, the signal is transmitted and fed to the mixer at frequency F1. The F1 returned from the target at distance R is received at T2, while the transmitting and LO frequency is F2. With known ramping rate (N), one can find the transit time by using

$$\Delta T = (F_t - F_r) / N,$$

where F_t and F_r are the IF frequency at mixer IF port in Hz and N is Hz/sec.

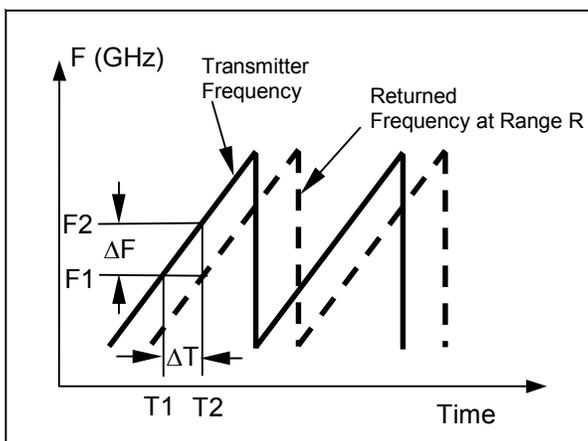


Figure 5. FMCW Radar Frequency vs. Time

Therefore, the range (distance) is given by

$$R = (\Delta T \times C) / 2$$

Where C is the speed of light, which is 3×10^8 (meter/sec).

The range accuracy is governed by the ramp linearity.

From the description above, an FMCW ranging radar can detect not only the stationary target, but also the moving target. Therefore, an FMCW radar is a Doppler Ranging Radar.

Ranging (Distance) Radar with Directional Doppler Feature

With a similar idea, WiseWave Technologies' **SRR series** Dual channel sensor head offers ranging capacity with directional features. The simplified block diagram is shown in Figure 6.

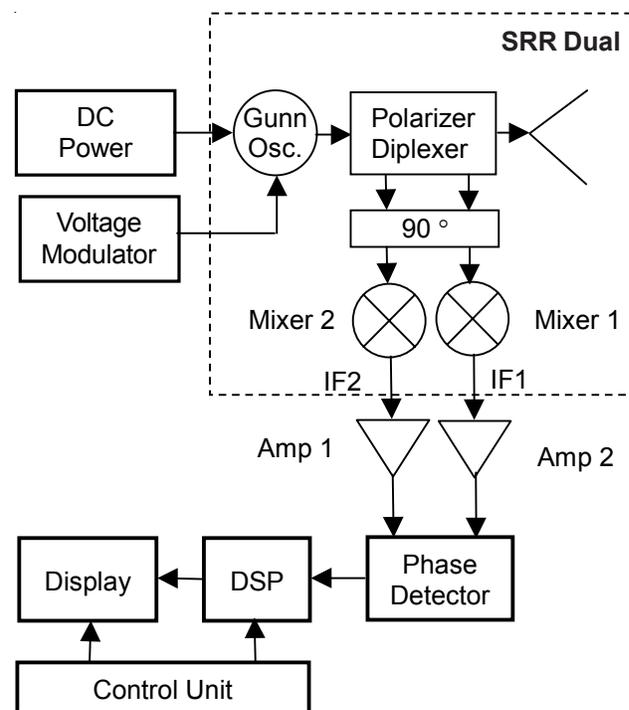


Figure 6. Simplified FMCW Ranging Radar with Directional Doppler Feature

Conclusions

1. WiseWave Technologies' **SRF and SRR series** sensor heads offer total solutions for **Long Range** Radar system requirements.
2. WiseWave Technologies' **SRF and SRR series** sensor heads can be tailored to various transmitting power levels and antenna gains.