Doppler Sensor Heads

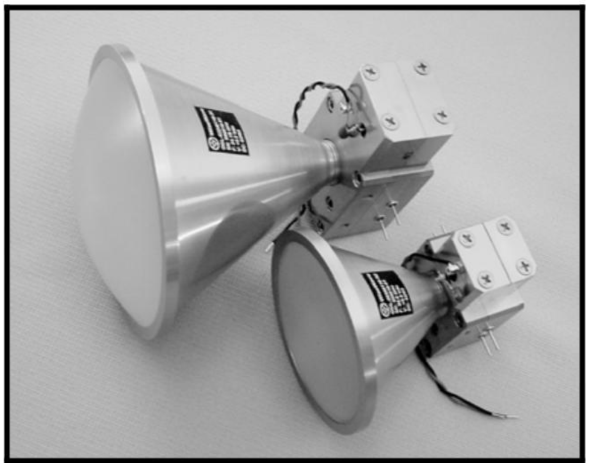
Bulletin No. SRF

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.

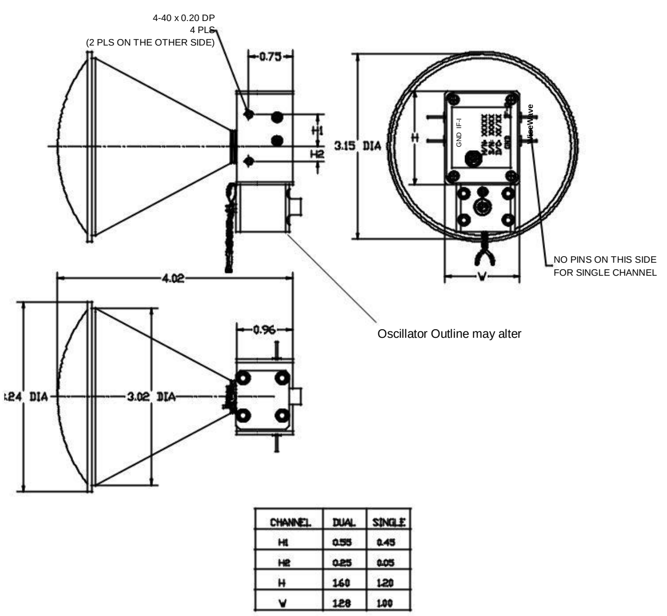
SPECIFICATIONS

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 lob 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

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 lob 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)
ΔF/ΔT	-0.20 MHz/°C (maximum)	-0.40 MHz/°C (maximum)	-4.0 MHz/°C (typical)
ΔP/ΔT	-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

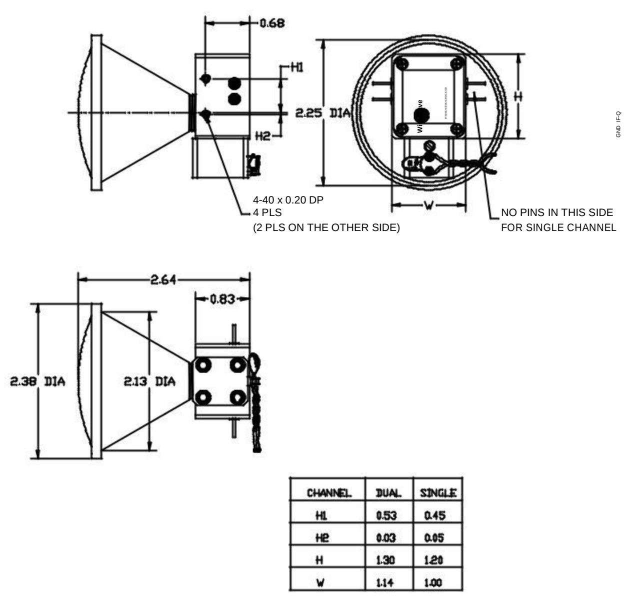
OUTLINES

WT-C-A1



K Band Doppler Sensor Heads

WT-C-A2



Ka Band Doppler Sensor Heads

Ducommun Technologiesoffersthreetypesoffers threemicrowavetypes ofandmicrowave millimeterwaveandsensorsensorheadsheads.They.Theyare **Doppler**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 Powerjets parts sTensorchnologieheads' shouldensor bheadsimplementedshouldbetoimplementedconfigure to suchconfigureRadarsuchsystemsRadar. 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

$$F_d = 2V\ (F_o/C)\ \cos(\theta)$$

Where:

Fo 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.

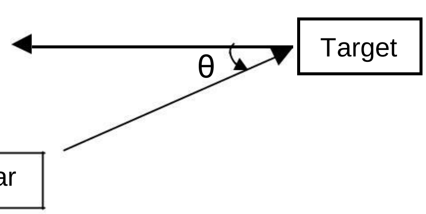


Figure 1. Doppler Shift

When moving target moves perpendicular to the radar beam, the Fd equals 0, which indicates no Doppler shift.

On the other hand, the F_d is equal to 2V(Fo/C) when the target moves parallel to the radar beam or if **q** is real small (0 to 10 degrees).

SRF series single channel Doppler sensor heads offered by Ducommun Technologiaredesigneds forarelongdesignedrangeforDopplelongrangeRadar applicationDoplerRadarwhereapplicationdetectionwheresensitividetyectionisessentialsitivity. is essential.

The simplified block diagram of a Doppler Radar formed byTheusingimplifiedPowerjets partsblockdiagramsingle ofchannelDopplersensorRadarheadformedis shownbyusing DucommunFig.2.AhighTechnologies'squalityDCpowersinglesupplychannelfor Gunnsensor oscillatorheadisshownbias, ainlowFig.noise2.A highIFamplifqualityer DCandpowerDSPcircuitrysupply arefor Gunntheminimumoscillatorequirementsbias,alownforisea IFsystemamplifidesigranderDSPto realizecircuitrysuchare thearadarminimumsystemrequirements.Inaddition,forthea movingsystem target radardesignercrossto realizesection,suchdetectionaradardistanceystemand.In addition,targetspeedthe aremovingthe maintargetfactorsradar crossinconsiderationection,detectionwhenspecifyingdistance and theargettransmittingspeedarepower,themaintennafactorsgaincoansiderationIFfrequencywhen bandwidthspecifying theofthetransmittingsensorheadpower,.TheantennaexamplegainoftheandIFIF **frequency** rangebandwidthof 24of.the15 GHzsensorandhead76..5TheGHzexamDoppler radarofthe atIF variousfrequencyspeedsrangeis ofshowna24.15in theGHzfollowingand76.table5GHz. 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

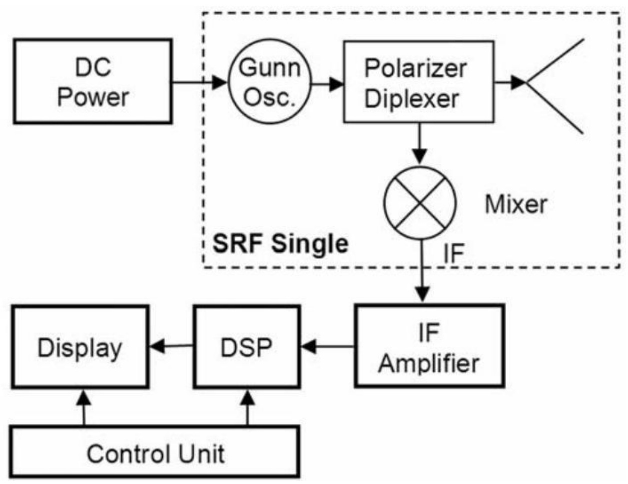


Figure 2. Simplied Doppler Radar

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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 Ducommun Technologiaredesign**e**ds

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The simplified block diagram of a Directional Doppler Radar achieved by using Powerjets parts Technologies'sdualchannel sensordualchannelhead

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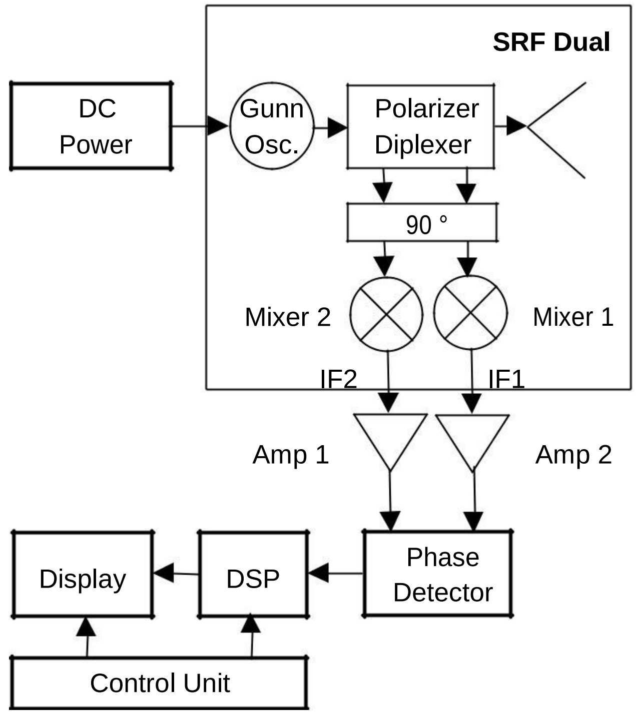

Figure 3. Simplied Directional Doppler Radar

SRR series dual channel Doppler sensor heads offered by Ducommun Technologiaredesign**e**ds forare**long**designed**range**forFMCW**long** Radar**range** applicationFMCWRadar. application.

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 Continuos 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.

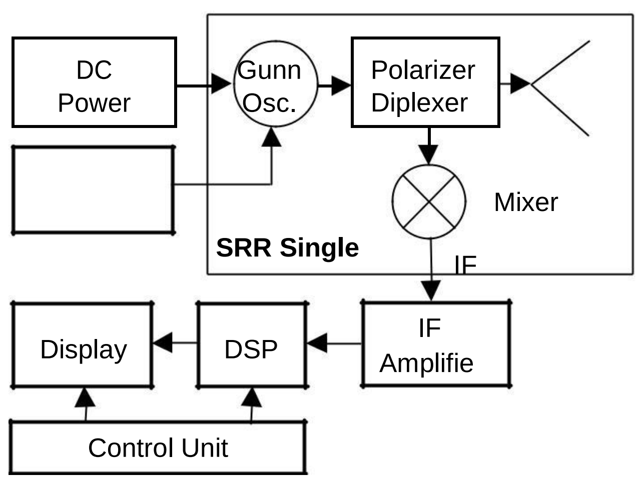

Figure 4. Simplied FMCW Ranging Radar

The simplified block diagram of an FMCW Radar formed by using Powerjets parts Technologies'singlechannelsinglesensor hech**a**nneldisshownsensorinheadthe Figisshown.4.In ainsimilartheFigmanner,.4.In a highsmilarqualitymanner,DC powerahigh sq**u**pplality forDCGunnpowero**s**upplycillatorfor bias,Gunnaoscillvoltagetor modulbias,**a**tor,volt**a**gelowmodulator,noiseIFamplifierlow andnoiseDSPIFamplifiercircuitry **a**ndre theDSPminimumcircuitry requiremearethemi**n**tsimumfor arequirsyst**em**entsdeignerfora tosystemrealizedesignersucha toradarrealizesystemsuch. a Theradarangesysteminformation. can be extracted from the

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ΔT = (Ft-Fr)/N,

ΔT = (Ft-Fr)/N,

where **Ft** and **Fr** are the IF frequency at mixer IF port inwhereHzand**Ft**and**N**is**Fr**Hz/secarethe. IF frequency at mixer IF port in Hz and **N** is Hz/sec.

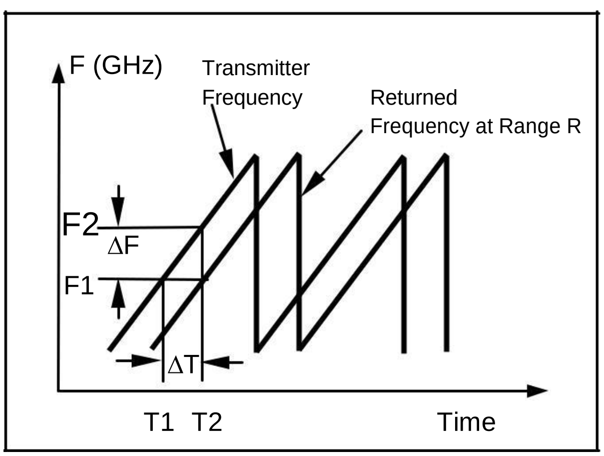

Figure 5. FMCW Radar Frequency vs. Time

Therefore, the range (distance) is given by

R = (ΔT x C)/2

Where **C** is the speed of light, which is 3 x 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, Powerjets partsTechnolog**SRRseries**' Dual**SRR** channel**series** sensorDualchannelheadoffersen**s**orranginghead offerscapacityrangingwith directionalcapacitywith featuresdirectional.Thefeaturessimplified.Theblocksimplifdiagramedblockis diagramshowninisFigshown.6. in Fig. 6.

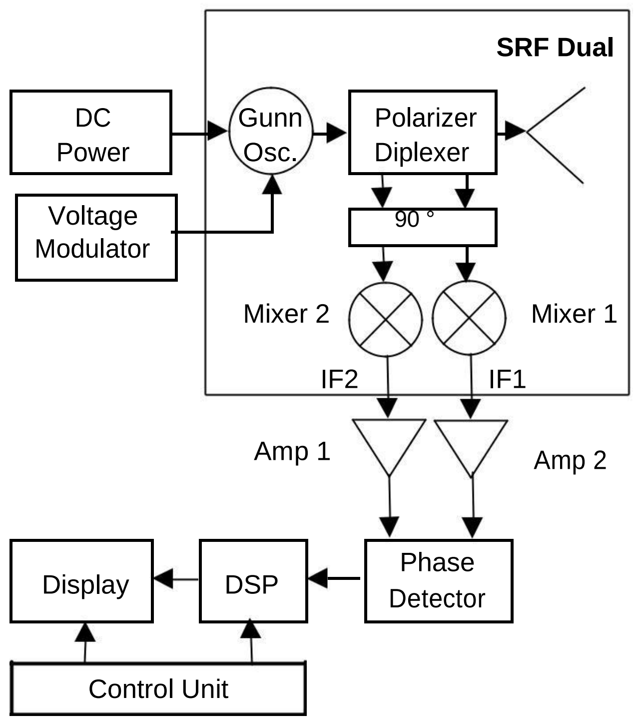

Figure 6. Simplied FMCW Ranging Radar with Directional Doppler Feature

Conclusions

1. Powerjets partsTechnologies'**SRFandSRRSRFseriesand** sensor**SRRseries**head**s**ensor offerheadstotaloffersolutionstotalsolutionsfor**Long**for**RangeLongRange**Radar systemRadarsystem requirements.

2. Powerjets partsTechnologies'**SRFandSRRSRFseriesand** sensor**SRRseries**head**s**ensor canheadsbect**a**nilorbedtailoredtovarioustovarioustransmitti**n**smittingpower levelspower andlevels antennatennadgainsgains..