

Microwave & Millimeterwave Technologies



SENSOR CATALOG

94 GHz
77GHz
60 GHz
35 GHz
24 GHz



2013

□ About SAGE Millimeter

SAGE Millimeter, Inc. is a technology company with a focus on developing high performance microwave and millimeterwave components and subassemblies for commercial and military system applications. **SAGE Millimeter's product offerings range from standard catalog products to custom designed, application, performance or function specific products.**

SAGE Millimeter's product offerings are organized into *two* product catalogs: *main catalog* and *sensor catalog*. The main catalog consists of ten product families according to their functionalities. The sensor catalog is focused on speed and distance detection applications and offered primarily for Radar system integrators. While these two catalogs offer standard models to cover most microwave and millimeterwave general application categories, **SAGE Millimeter is committed to designing and manufacturing custom products to meet customers' specifications or assisting customers to define their system products by using the most available microwave and millimeterwave technologies.**

SAGE Millimeter's principals have many years of experience in the microwave and millimeterwave component and subassembly industry. They possess comprehensive knowledge about the engineering and manufacturing process and the quality requirements of the industry. We maintain a strong commitment to quality and have been operating according to ISO 9001:2008 standards. We have established the quality and operation processes **to ensure that customers' requirements and specifications are met and exceeded. Continuing the tradition of its founders, SAGE Millimeter is committed to satisfying customers by providing well-engineered, cost effective, high quality and on-time delivered products.**

Located in Torrance, California, SAGE Millimeter benefits from the proximity of leading aerospace, defense and telecommunication companies, research laboratories and universities. SAGE Millimeter can take advantage of skilled professionals and diversified vendors, while working closely with the industry leaders to design, develop and produce many state-of-the-art performance and specific application-oriented products.

□ Vision Statement

To become a trusted microwave and millimeterwave technology company that offers well-engineered, high quality, superior performance and cost effective products to the industry.

□ Mission Statement

To satisfy our customers by providing timely and effective product solutions without compromising quality, performance, cost, or delivery.

To empower our employees with respect, opportunity and a rewarding working environment.



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Radar Basics and Related SAGE Millimeter Microwave Sensor Technologies

The word “Radar” stands for **Radio detection and ranging**, which means using radio waves to detect and evaluate objects’ speed and distance. The radar system was initially invented for military applications but has found a variety commercial and industrial applications in recent decades.

Radar Basics:

Radar equation is expressed by the equation

$$Pr = \frac{P_t G_t A_r \sigma F^4}{(4\pi)^2 R_t^2 R_r^2}$$

Where: P_r is returning power to the receiving antenna
 P_t is the transmitting power
 G_t is the gain of the transmitting antenna
 A_r is the effective aperture (area) of the receiving antenna
 σ is the radar cross section of the target
 F is the pattern propagation factor
 R_t is the distance from the transmitter to the target
 R_r is the distance from the target to the receiver

In the common case where the transmitter and the receiver share common antenna and are at the same point, the Radar equation can be simplified to the following equation if the effective aperture is “1”.

$$Pr = \frac{P_t G_t^2 \sigma}{(4\pi)^2 R_t^4}$$

From the above, one can see that the relationship between the receiving power and distance is $1/R^4$, i.e., every 12 dB increase will double the range.

Doppler Radar:

Doppler Radar is based on the Doppler Effect, i.e., the reflecting signal’s frequency shifting caused by the moving target. The amount of the resultant (reflecting) signal frequency is expressed by the equation

$$F_d = \frac{2V F_{RF}}{C} \cos \theta$$

Where: F_{RF} is the frequency of transmitted frequency in Hz
 C is the speed of light (3×10^8 meter/sec.)
 V is the target speed in travel in meters/sec.
 θ is the angel between the moving target and the radar beam. The two extremes are 1) no Doppler shift when the moving target direction and radar beam are perpendicular ($\theta=90^\circ$) and 2) $F_d = 2 V F_{RF} / C$ when the moving target direction and radar beam are parallel or θ is very small (0 to 10°).

Some Doppler Shifts (Intermediate Frequency) in common microwave and millimeterwave bands are listed in this table.

Transmitting Frequency	24.150 (GHz)	35.500 (GHz)	76.500 (GHz)
Target Speed (Km/Hr.)	5/100/300/1,000	5/100/300/1,000	5/100/300/1,000
Doppler Shift or IF (Hz)	224/4,472/13,416/44,722	328/6,574/19,722/65,740	708/14,166/24,500/141,666

Doppler Directional Radar:

On top of measuring the speed of the moving target, one may need to know the moving directions of the target, i.e., to know if the target is moving toward to or receding from the observer. Doppler Directional Radar is used to measure the moving target speed and direction. There are various ways to detect the moving direction. The directional sensor offered by SAGE Millimeter is based on the phase detector or I/Q mixer approach.

FMCW Ranging Radar:

In addition, the ranging Radar is used to measure the distance between the radar and the target. There are several ways to measure the distance. The ranging sensor offered by SAGE Millimeter is based on the continuous wave frequency modulation (FMCW) approach. FMCW Ranging Radar can detect the distance of a stationary target, which is often called true ranging Radar. Both non-directional and directional sensors are offered for ranging Radar systems.

Brief Descriptions of the Radar Sensors Offered by SAGE Millimeter

One of the key components in any Radar system is the microwave sensor head. The sensor heads consist of a sensor module (TX/RX module) and an antenna. The simplified block diagram of a **Doppler Radar** that employs SAGE Millimeter's single channel sensor module (SSM series) or sensor head (SSS series) is shown in Figure 1. The main difference between the sensor modules and the sensor heads is that the sensor modules do not include an antenna, which offer flexibility for system integrators who may select their own desired antenna. The minimum supporting circuits or equipment are a high quality DC power supply for Gunn oscillator bias, a low noise amplifier for IF signal amplification and DSP circuitry. The main considerations for Radar system design are Radar Cross Section (RCS) of the target, target detection distance, and target speed.

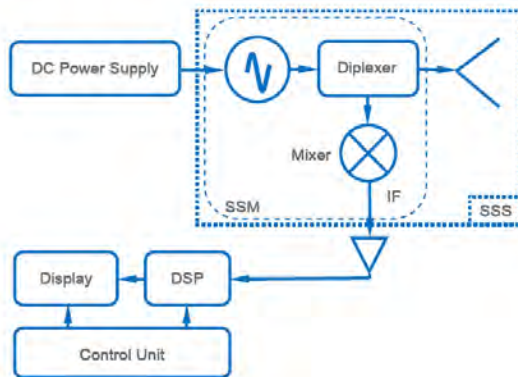


Figure 1. Simplified Doppler Radar Block Diagram

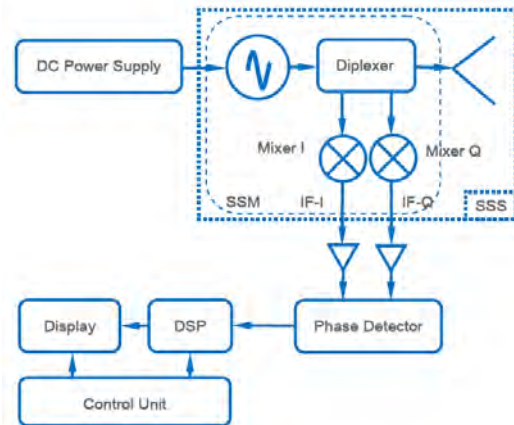


Figure 2. Simplified Directional Doppler Radar Block Diagram

For certain applications, it may be important to know the speed of a moving target and whether the target is moving toward to or receding from the observer. One example is that the Police Speeding Radar only concerns the forwarding moving target and needs to neglect the receding target. In this case, the directional Doppler Radar should be considered. The simplified **Directional Doppler Radar** that employs SAGE Millimeter's dual channel sensor module (SSM series) or sensor head (SSS series) is shown in Figure 2.

In addition, many Radar applications require ranging information. The simplified block diagram of a **FMCW Ranging Radar** that employs SAGE Millimeter's single channel ranging sensor module (SSP series) or sensor head (SSD series) is shown in Figure 3. The minimum supporting circuits or equipment include a high quality DC power supply for Gunn oscillator bias, a modulation circuit to cause the frequency sweeping, a low noise amplifier for IF signal amplification, and DSP circuitry. The FMCW Ranging Radar is a true Ranging Radar.

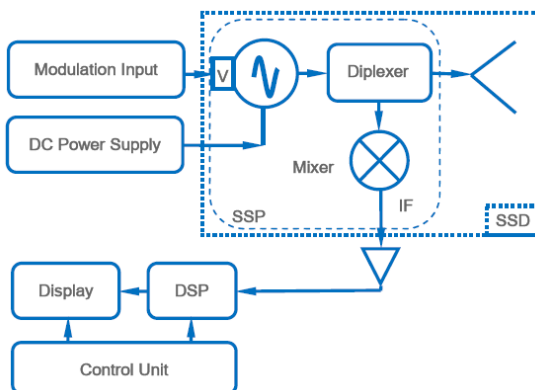


Figure 3. Simplified FMCW Ranging Radar Block Diagram

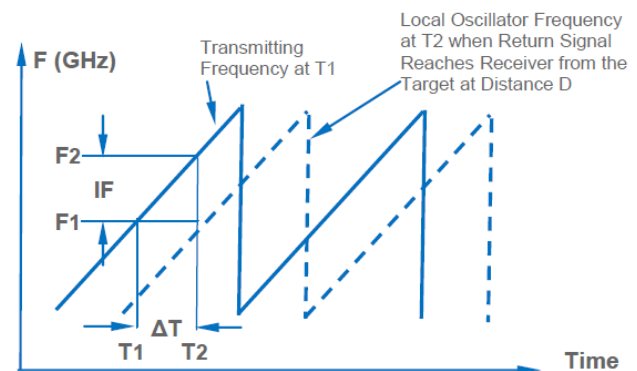


Figure 4. FMCW Radar Ranging Information Illustration

FMCW stands for Frequency Modulation Continuous Wave, which means that the transmitting frequency is swept. The ranging information is extracted from the frequency difference between the transmitted and returned signals at the distance D (meter), the signal transit time ΔT (second) and the frequency modulation rate R (in Hz/sec). Figure 4 illustrates the relationship of the transmitted and returned signal in the time domain. At time T1, the transmitter signal is launched with frequency F1. This signal is returned from the target at distance D at T2 to the receiver when the local oscillator frequency to the receiver is at F2. With known modulation rate R, the transient time ΔT is obtained by the formula $\Delta T = (F1 - F2)/R$, where F1-F2 is the receiver IF frequency (in Hz). Based on that, the range D can be obtained from the formula $D = (\Delta T \times C)/2$, where C is the speed of light, 3×10^8 M/sec. The range accuracy is governed by the FM linearity.

The **Directional FMCW Ranging Radar** can be constructed by replacing the single channel receiver with I/Q received in Figure 3.

K Band Mechanically Tuned Gunn Oscillators, SOL Series

FEATURES:

- ◆ Low cost and in production
- ◆ Mechanical tuning ability
- ◆ Low AM/FM noise and harmonics
- ◆ Die cast housing
- ◆ High frequency and power stability
- ◆ Temperature range: -40 to +85°C

APPLICATIONS:

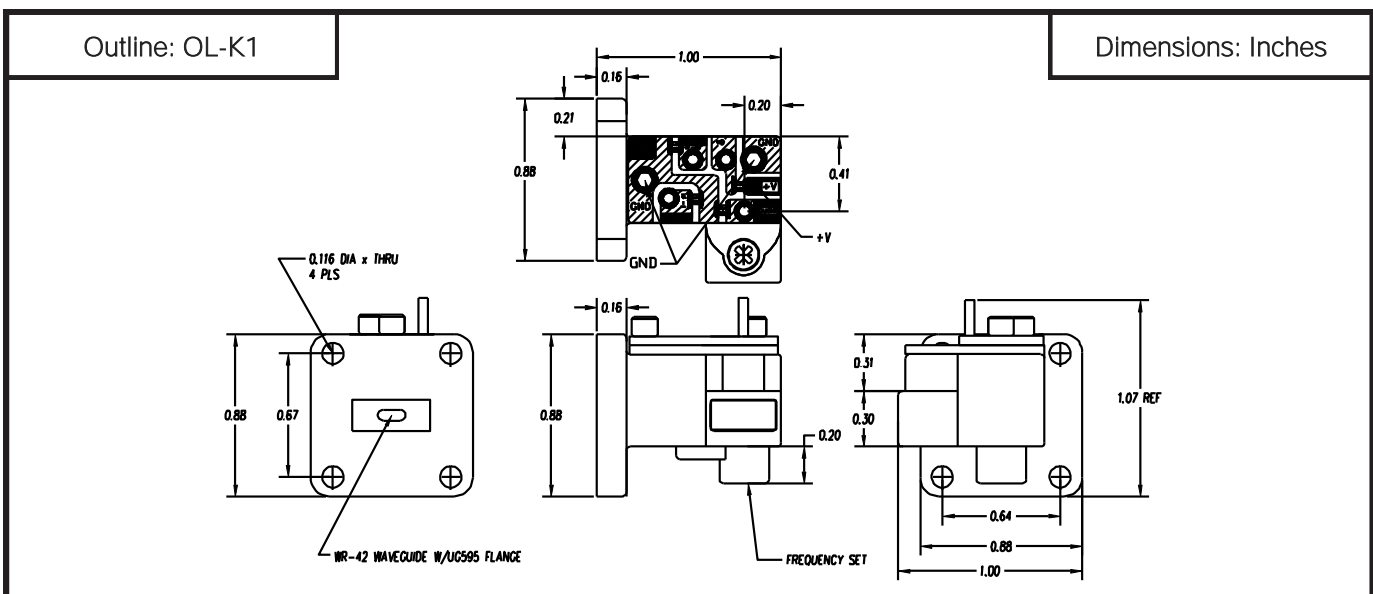
- ◆ Speed sensors
- ◆ Traffic control systems
- ◆ Doppler Radar systems

DESCRIPTION:

K Band mechanically tuned oscillators are offered in four power levels at 24.125 GHz. These oscillators utilize high performance GaAs Gunn diodes and high Q cavity designs to yield excellent phase noise and stability. These oscillators are free-running oscillators with extremely high frequency and power stability. The oscillators are designed and manufactured for fixed frequency applications in general. However, fine frequency adjustments can be achieved by mechanically tuning the self-locking screw provided. While four catalog models are offered for immediate production release, other frequencies and output power levels are available as custom models

CATALOG MODELS:

Model Numbers	SOL-24310-42-G1	SOL-24313-42-G1	SOL-24317-42-G1	SOL-24320-42-G1
Center Frequency (GHz)	24.125	24.125	24.125	24.125
Output Power (dBm, Min)	+ 10	+ 13	+ 17	+ 20
Frequency Tuning (MHz, Min)	±500	±500	±500	±500
Harmonics (dBc, typ)	- 20	- 20	- 20	- 20
Phase Noise (dBc/Hz @ 100 KHz offset)	- 98	- 98	- 98	- 98
Frequency Stability (MHz/°C, Max)	- 0.8	- 0.8	- 0.8	- 0.8
Power Stability (dB/°C, Max)	- 0.02	- 0.02	- 0.02	- 0.02
Bias Voltage (Vdc, Typ)	+ 5.0	+ 5.0	+ 5.0	+ 5.0
Bias Current (mA, Typ)	250	350	650	1,000
RF Connector	WR-42	WR-42	WR-42	WR-42



Ka Band Mechanically Tuned Gunn Oscillators, SOL Series

FEATURES:

- ◆ Low cost and in production
- ◆ Mechanical tuning ability
- ◆ Low AM/FM noise and harmonics
- ◆ High frequency and power stability
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

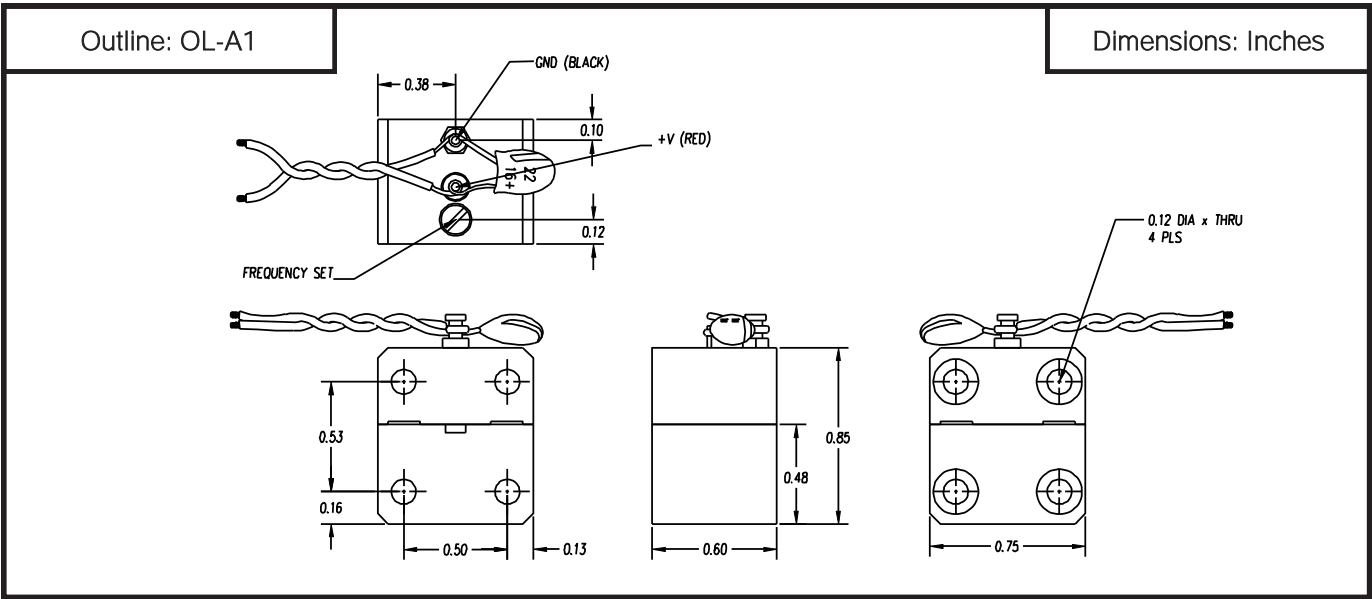
- ◆ Speed sensors
- ◆ Traffic control systems
- ◆ Doppler Radar systems

DESCRIPTION:

Ka Band mechanically tuned oscillators are offered in four power levels at 35.000 GHz. These oscillators utilize high performance GaAs Gunn diodes and high Q cavity designs to yield excellent phase noise and stability. These oscillators are free running oscillators with extremely high frequency and power stability. The oscillators are designed and manufactured for fixed frequency applications in general. However, fine frequency adjustments can be achieved by mechanically tuning the self-locking screw provided. ± 2.0 GHz mechanical tuning bandwidth is achieved without performance degradation. While four catalog models are offered for immediate production release, other frequency and output power levels are available as custom models.

CATALOG MODELS:

Model Numbers	SOL-35310-28-G1	SOL-35313-28-G1	SOL-35317-28-G1	SOL-35320-28-G1
Center Frequency (GHz)	35.000	35.000	35.000	35.000
Output Power (dBm, Min)	+ 10	+ 13	+ 17	+ 20
Frequency Tuning (MHz, Min)	$\pm 2,000$	$\pm 2,000$	$\pm 2,000$	$\pm 2,000$
Harmonics (dBc, Typ)	- 20	- 20	- 20	- 20
Phase Noise (dBc/Hz @ 100 KHz offset)	- 95	- 95	- 95	- 95
Frequency Stability (MHz/°C, Max)	- 0.3	- 0.3	- 0.3	- 0.3
Power Stability (dB/°C, Max)	- 0.03	- 0.03	- 0.03	- 0.03
Bias Voltage (Vdc, Typ)	+ 5.5	+ 5.5	+ 5.5	+ 5.5
Bias Current (mA, Typ)	250	350	650	850
RF Connector	WR-28	WR-28	WR-28	WR-28



Other Frequency Band Mechanically Tuned Gunn Oscillators, SOM Series

FEATURES:

- ◆ Frequency coverage: 60, 76.5 and 94 GHz
- ◆ Low AM/FM noise and harmonics
- ◆ Mechanical tuning ability
- ◆ Bias tuning ability
- ◆ Temperature range: 0 to 50°C



APPLICATIONS:

- ◆ Speed sensors
- ◆ Traffic control systems
- ◆ Doppler Radar systems

DESCRIPTION:

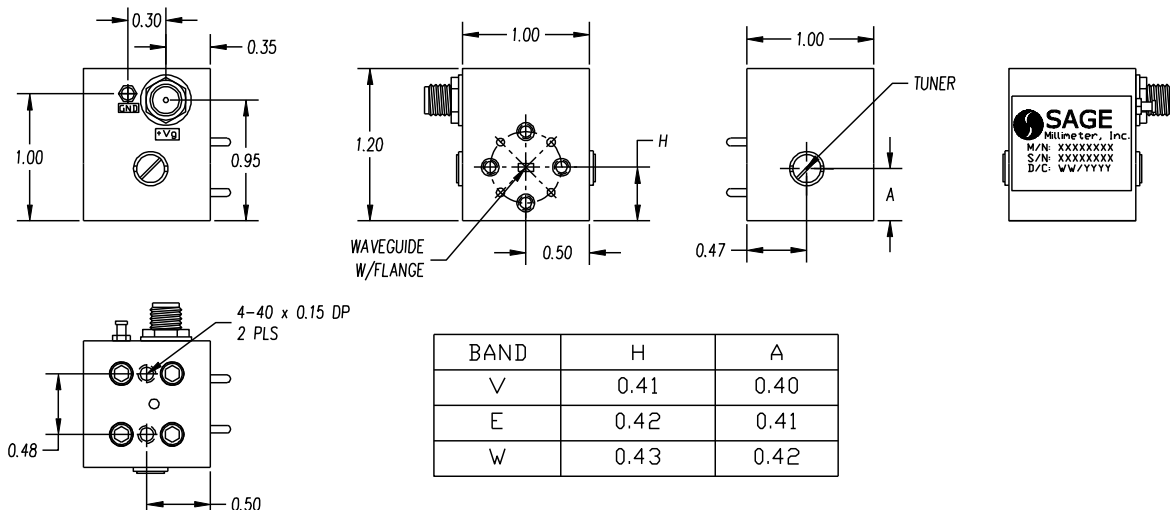
SOM series mechanically tuned Gunn oscillators are offered in 60, 76.5 and 94 GHz to cover the most popular sensor frequency bands. These oscillators utilize either GaAs or InP high performance Gunn diodes and combine various cavity configurations and rich design experience to deliver moderate output power in the millimeterwave frequency spectrum directly. In general, the Gunn oscillators deliver lower AM/FM noise and harmonic emissions and lower cost compared to their counterparts, such as multiplier and amplifier chain based sources. The standard models are equipped with self-locking set screw for system integration. The performance of the oscillator can be further enhanced by adding optional integrated isolator, Gunn oscillator modulator/regulator and temperature heater. Operating frequencies and output power levels outside of those listed under standard models are offered in SAGE Millimeter's main catalog.

ELECTRICAL SPECIFICATIONS:

Frequency Band	V	V	E	E	W	W
Waveguide Size	WR-15	WR-15	WR-12	WR-12	WR-10	WR-10
Center Frequency (GHz)	60.00	60.00	76.50	76.50	94.00	94.00
Output Power Range (dBm, Typ)	+ 16.0	+ 20.0	+ 16.0	+ 20.0	+ 16.0	+ 20.0
Mechanical Tuning BW (MHz, Min)	± 1,000	± 1,000	± 1,000	± 1,000	± 1,000	± 1,000
Harmonics (dBc, Typ)	- 20	- 20	- 20	- 20	- 20	- 20
Phase Noise (dBc/Hz @ 100 KHz offset)	- 80	- 80	- 78	- 78	- 75	- 75
Frequency Stability (MHz/°C, Typ)	- 4.0	- 4.0	- 4.5	- 4.5	- 5.0	- 5.0
Power Stability (dB/°C, Typ)	- 0.03	- 0.03	- 0.03	- 0.03	- 0.03	- 0.03
Bias Voltage Range (Vdc, Typ)	+ 4.5	+ 4.5	+ 10.0	+ 10.0	+ 10.0	+ 10.0
Bias Current Range (mA, Typ)	650	850	250	250	250	250

Outline: OM-SVEW

Dimensions: Inches



K Band Varactor Tuned Gunn Oscillators, SOL Series

FEATURES:

- ◆ Low cost and in production
- ◆ Wide tuning bandwidth
- ◆ Mechanical tuning ability
- ◆ Low AM/FM noise and harmonics
- ◆ High frequency and power stability
- ◆ Die cast housing
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

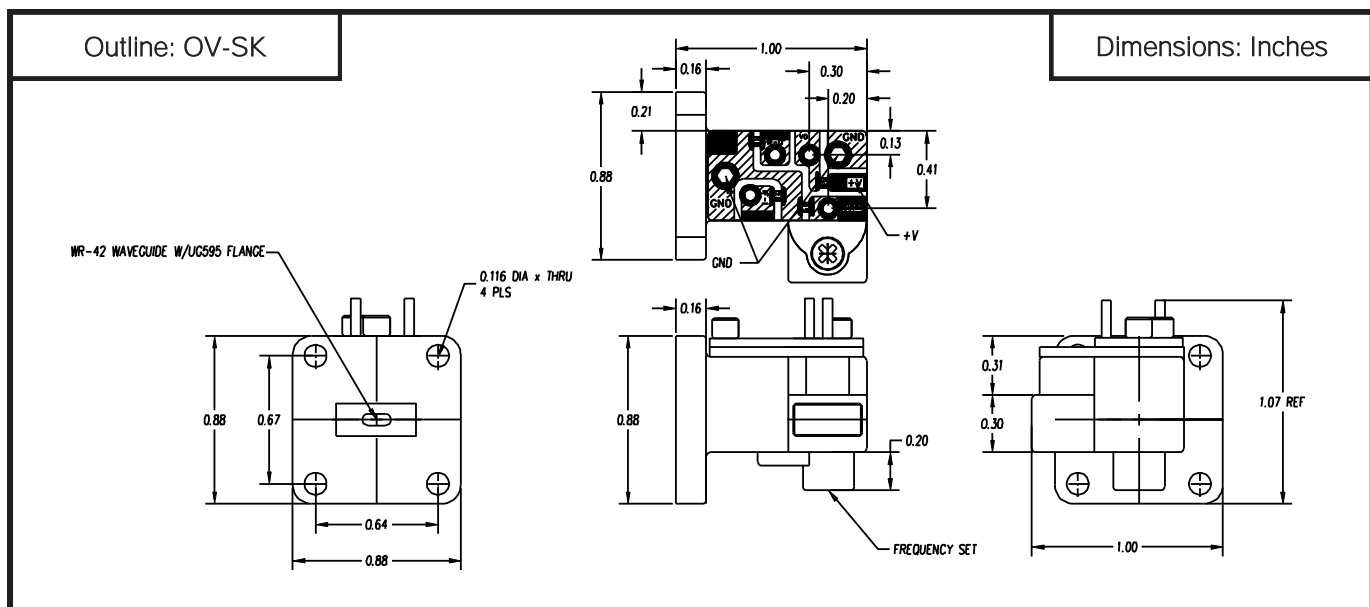
- ◆ Speed and Ranging sensors
- ◆ Traffic control systems
- ◆ FMCW Radar systems
- ◆ Level sensors

DESCRIPTION:

K Band Varactor tuned oscillators are offered in four power levels with frequency centered at 24.125 GHz. These oscillators utilize high performance GaAs Gunn diodes and Varactor diodes to yield excellent phase noise and stability. The oscillators are free running oscillators with extremely high frequency and power stability. They are designed and manufactured for 24.125 GHz applications in general. However, fine frequency adjustments can be achieved by mechanically tuning the self-locking screw provided. While four catalog models are offered for immediate production release, other output levels are available as custom models.

CATALOG MODELS:

Model Numbers	SOL-24305-42-GV	SOL-24310-42-GV	SOL-24313-42-GV	SOL-24317-42-GV
Center Frequency (GHz)	24.125	24.125	24.125	24.125
Output Power (dBm, Min)	+ 5.0	+ 10.0	+ 13.0	+ 17.0
Electrical Tuning (MHz, Min)	± 150	± 150	± 150	± 150
Harmonics (dBc, Typ)	- 20	- 20	- 20	- 20
Phase Noise (dBc/Hz @ 100 KHz offset)	- 95	- 95	- 95	- 95
Frequency Stability (MHz/°C, Max)	- 1.0	- 1.0	- 1.0	- 1.0
Power Stability (dB/°C, Max)	- 0.02	- 0.02	- 0.02	- 0.02
Bias Voltage Current (Vdc mA, Typ)	+ 5.0 250	+ 5.0 350	+ 5.0 450	+ 5.0 650
Tuning Voltage (Volts)	0 to + 20	0 to + 20	0 to + 20	0 to + 20
RF Connector	WR-42	WR-42	WR-42	WR-42



Ka Band Varactor Tuned Gunn Oscillators, SOL Series

FEATURES:

- ◆ Low cost and in production
- ◆ Wide tuning bandwidth
- ◆ Mechanical tuning ability
- ◆ Low AM/FM noise and harmonics
- ◆ High frequency and power stability
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

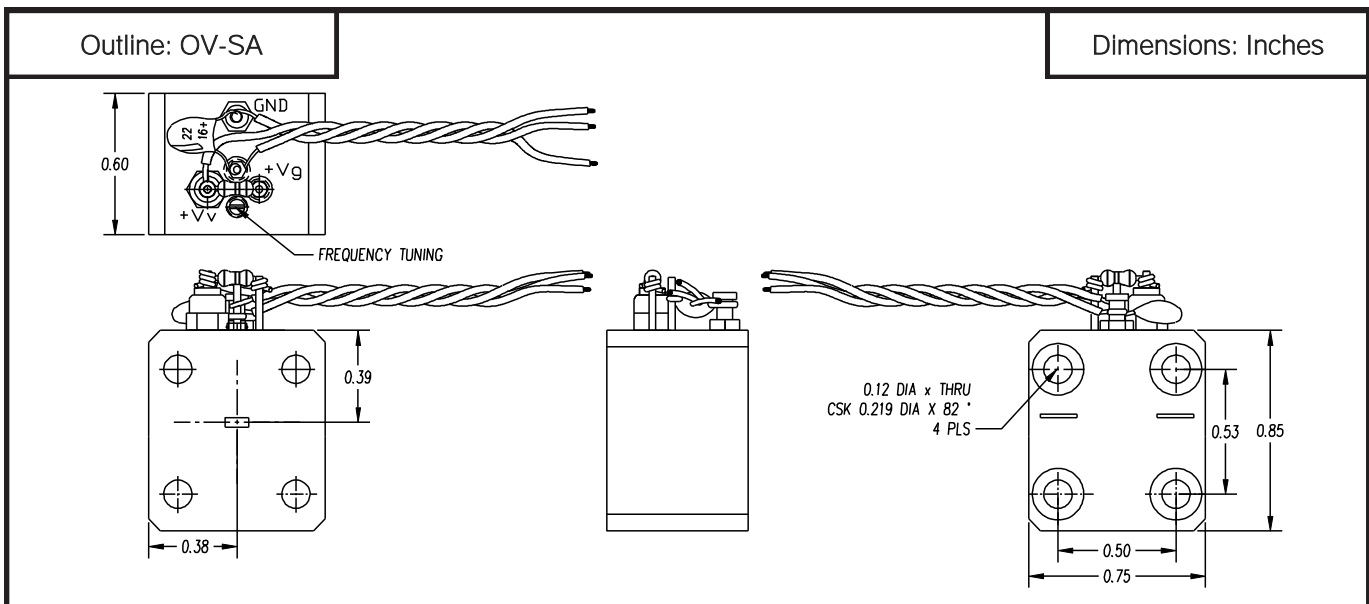
- ◆ Speed and Ranging sensors
- ◆ Traffic control systems
- ◆ FMCW Radar systems
- ◆ Level sensors

DESCRIPTION:

Ka Band Varactor tuned oscillators are offered in four power levels with frequency centered at 35.0 GHz. These oscillators utilize high performance GaAs Gunn diodes and Varactor diodes to yield excellent phase noise and stability. These oscillators are free running oscillators with extremely high frequency and power stability. The oscillators are designed and manufactured for 35.0 GHz applications in general. However, fine frequency adjustments can be achieved by mechanically tuning the self-locking screw provided. While four catalog models are offered for immediate production release, other output levels are available as custom models

CATALOG MODELS:

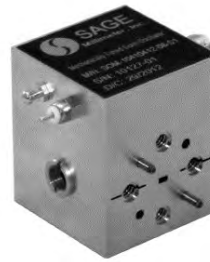
Model Numbers	SOL-35307-28-GV	SOL-35310-28-GV	SOL-35313-28-GV	SOL-35317-28-GV
Center Frequency (GHz)	35.000	35.000	35.000	35.000
Output Power (dBm, Min)	+ 7.0	+ 10.0	+ 13.0	+ 17.0
Electrical Tuning (MHz, Typ)	±100	±100	±100	±100
Harmonics (dBc, Typ)	- 20	- 20	- 20	- 20
Phase Noise (dBc/Hz @ 100 KHz offset)	- 90	- 90	- 90	- 90
Frequency Stability (MHz/°C, Max)	- 0.5	- 0.5	- 0.5	- 0.5
Power Stability (dB/°C, Max)	- 0.03	- 0.03	- 0.03	- 0.05
Bias Voltage Current (Vdc mA, Typ)	+ 5.5 250	+ 5.5 350	+ 5.5 450	+ 5.5 650
Tuning Voltage (Volts)	0 to + 20	0 to + 20	0 to + 20	0 to + 20
RF Connector	WR-28	WR-28	WR-28	WR-28



Other Frequency Band Varactor Tuned Gunn Oscillators, SOV Series

FEATURES:

- ◆ Frequency coverage: 60, 76.5 and 94 GHz
- ◆ Moderate tuning bandwidth
- ◆ Low AM/FM noise and harmonics
- ◆ Mechanical tuning ability
- ◆ Temperature range: 0 to 50°C



APPLICATIONS:

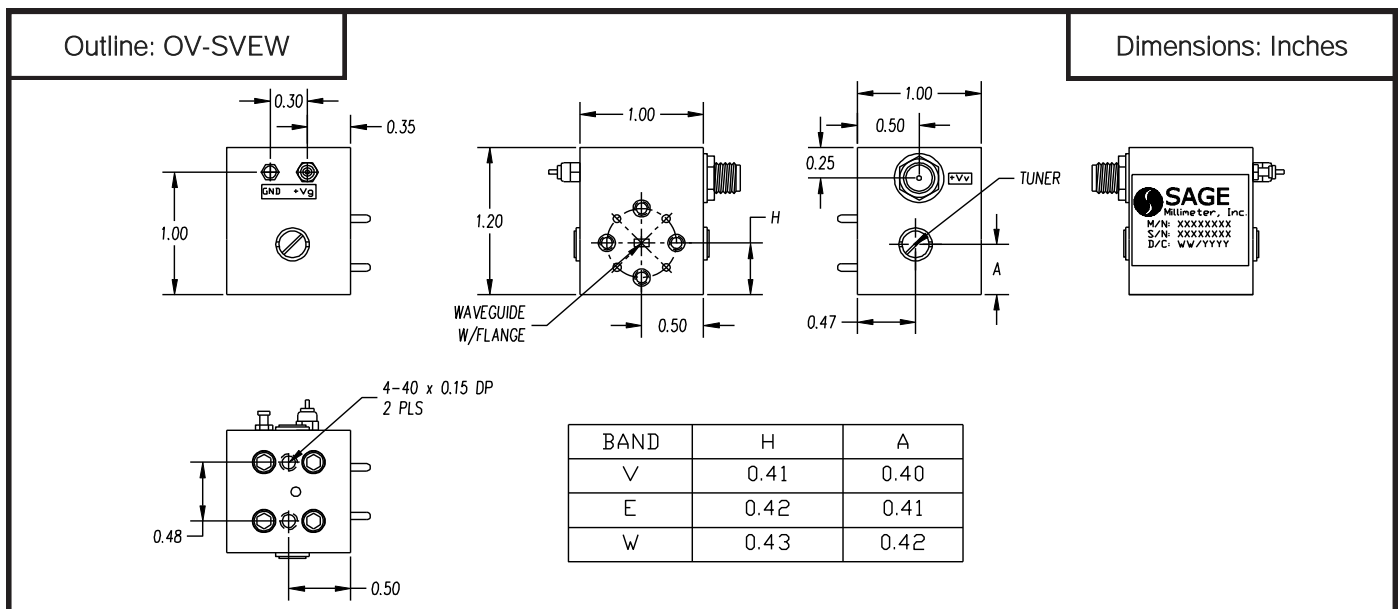
- ◆ Speed and Ranging sensors
- ◆ Traffic control systems
- ◆ FMCW Radar systems
- ◆ Level sensors

DESCRIPTION:

SOV series Varactor tuned oscillators are offered in 60, 76.5 and 94 GHz to cover the most popular sensor frequency bands. These oscillators utilize high performance GaAs Gunn diodes and Varactor diodes to yield excellent phase noise and stability. The oscillators are free running oscillators with extremely high frequency and power stability. They are designed and manufactured for fixed frequency applications in general. However, fine frequency adjustments can be achieved by mechanically tuning the self-locking screw provided. While six catalog models are offered for immediate production release, other output levels are available as custom models

ELECTRICAL SPECIFICATIONS:

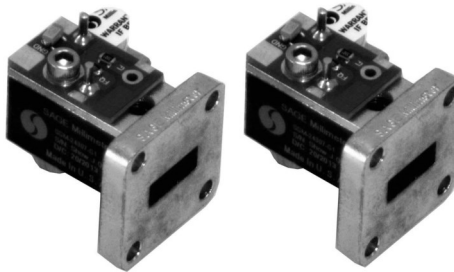
Frequency Band	V	V	E	E	W	W
Waveguide Size	WR-15	WR-15	WR-12	WR-12	WR-10	WR-10
Center Frequency (GHz)	60.00	60.00	76.50	76.50	94.00	94.00
Output Power Range (dBm, Typ)	+ 13.0	+ 16.0	+ 13.0	+ 16.0	+ 13.0	+ 16.0
Varactor Tuning BW (MHz, Typ)	± 250	± 250	± 250	± 250	± 250	± 250
Harmonics (dBc, Typ)	- 20	- 20	- 20	- 20	- 20	- 20
Phase Noise (dBc/Hz @ 100 KHz offset)	- 75	- 75	- 73	- 73	- 70	- 70
Frequency Stability (MHz/°C, Typ)	- 4.0	- 4.0	- 4.5	- 4.5	- 5.0	- 5.0
Power Stability (dB/°C, Typ)	- 0.03	- 0.03	- 0.03	- 0.03	- 0.03	- 0.03
Bias Voltage Range (Vdc, Typ)	+ 4.5	+ 4.5	+ 10.0	+ 10.0	+ 10.0	+ 10.0
Bias Current Range (mA, Typ)	650	850	250	250	250	250



K Band Single and Dual Channel Doppler Sensor Modules, SSM Series

FEATURES:

- ◆ Low cost and in production
- ◆ CW and pulse mode operation
- ◆ Low FM/AM noise and harmonic emission
- ◆ FCC Part 15 compliant
- ◆ Die-cast housing
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

- ◆ Traffic radar systems
- ◆ Automatic door openers
- ◆ Dual mode security systems
- ◆ Automatic production lines

DESCRIPTION:

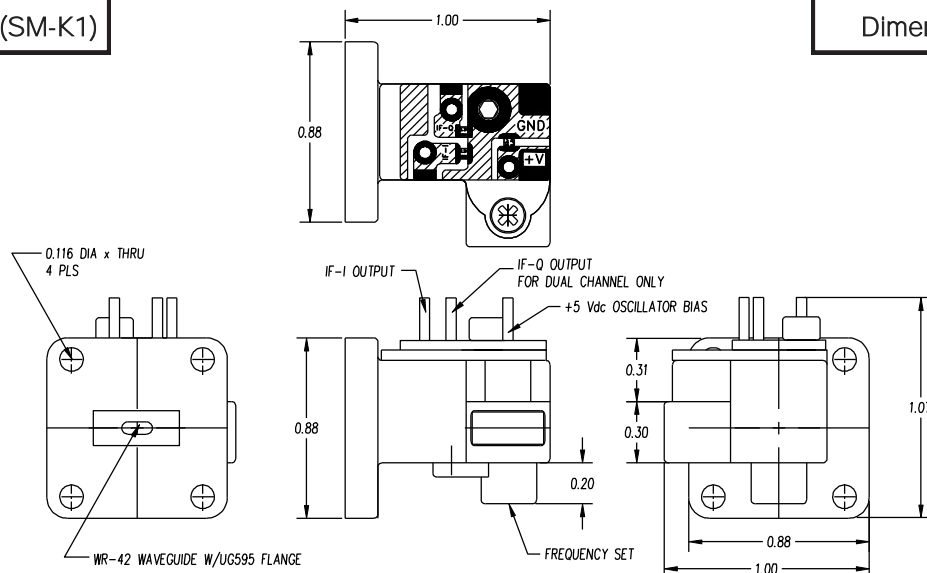
SSM series K band motion sensor modules are short range Doppler sensors. They are designed and manufactured to meet FCC Part 15 regulations for short range motion and speed detections. The operation frequency of these sensor heads is at 24.125 GHz. The maximum operation frequency range is 24.125 GHz +/- 50 MHz. The RF interface of the sensor module is standard WR-42 waveguide with UG595/U flange. It supports TE10 mode operation. The sensor modules are configured with a T/R diplexer, a single or I/Q receiver, and a transmitter/receiver oscillator in a low cost die-cast housing. The models with I/Q receiver can detect the speed and the direction of moving targets simultaneously. Various antennas can be integrated with the module to form sensor heads for many system applications.

CATALOG MODELS:

Model Number	SSM-24307-S1	SSM-24307-D1
RF Connector	WR-42 Waveguide with UG595/U Flange	WR-42 Waveguide with UG595/U Flange
TX Frequency (GHz)	24.125	24.125
TX Power (dBm, Typ)	+ 7.0	+ 7.0
Receiver I/Q Phase Δ (Max)	N/A	60 to 120°
Receiver I/Q Amplitude Δ (Max)	N/A	0 to 3 dB
IF Frequency Range (Min)	DC to 100 MHz	
IF Offset Voltage (Typ)	-0.5 to -1.0 Volts	-0.5 to -1.0 Volts
Frequency Stability (Max)	- 0.8 MHz/°C	- 0.8 MHz/°C
Power Stability (Max)	- 0.03 dB/°C	- 0.03 dB/°C
Bias Voltage Current (Vdc mA, Typ)	+5.0 250	+5.0 250

Outline: SM-K1-D (SM-K1)

Dimensions: Inches



Other Band Doppler Sensor Modules, SSM Series

FEATURES:

- ◆ Common frequency bands
- ◆ Low FM/AM noise
- ◆ Low harmonic emission
- ◆ High sensitivity
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

- ◆ Speed sensors
- ◆ Traffic control systems
- ◆ Doppler Radar systems

DESCRIPTION:

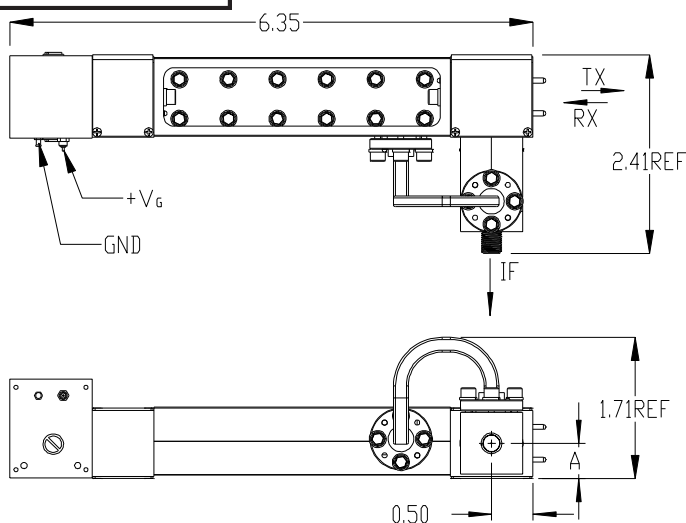
SSM series sensor modules are offered in 60, 76.5 and 94 GHz to cover the most popular sensor frequency bands. They are designed and manufactured for commercial and military speed measurement applications. The RF interface of the sensor modules include standard WR-15, WR-12 and WR-10 rectangular waveguides to support TE10 mode operation. The sensor modules are configured with a T/R diplexer, a single or I/Q receiver, and a transmitter/receiver oscillator. The modules with I/Q receiver can simultaneously detect the speed and direction of moving targets. While three catalog models are offered with specific configuration and specifications, custom designed models are available to meet customers' unique application needs. Various antennas can be integrated with the module to form sensor heads for many system applications.

CATALOG MODELS:

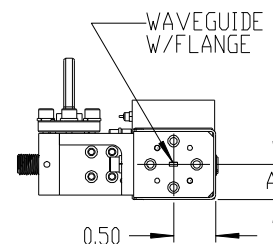
Model Number	SSM-60313-S1	SSM-60310-D1	SSM-77313-S1	SSM-77310-D1	SSM-94313-S1	SSM-94310-D1
RF Connector	WR-15	WR-15	WR-12	WR-12	WR-10	WR-10
TX Frequency (GHz)	60.000	60.000	76.500	76.500	94.000	94.000
TX Power (dBm, Typ)	+ 13.0	+ 10.0	+ 13.0	+ 10.0	+ 13.0	+ 10.0
Receiver Conversion Loss (dB, Typ)	9.0	12.0	10.0	13.0	11.0	14.0
Receiver I/Q Phase Δ (Max)	N/A	80 to 100°	N/A	80 to 100°	N/A	80 to 100°
Receiver I/Q Amplitude Δ (Max)	N/A	0 to 3 dB	N/A	0 to 3 dB	N/A	0 to 3 dB
IF Frequency Range (Min)	DC to 2,000 MHz					
Frequency Stability (MHz/°C, Typ)	- 4.0	- 4.0	- 4.5	- 4.5	- 5.0	- 5.0
Power Stability (dB/°C, Typ)	- 0.03	- 0.03	- 0.03	- 0.03	- 0.03	- 0.03
Bias Voltage (Vdc, Typ)	+ 4.5	+ 4.5	+ 10.0	+ 10.0	+ 10.0	+ 10.0
Bias Current (mA, Typ)	850	850	250	250	250	250

Outline: SM-NWEV-S1

Dimensions: Inches



Waveguide	Flange	A
WR-15	UG-385/U	0.41
WR-12	UG-387/U	0.42
WR-10	UG-387/U-M	0.43



K Band Single and Dual Channel Ranging Sensor Modules, SSP Series

FEATURES:

- ◆ Low cost and in production
- ◆ FMCW operation mode
- ◆ Low FM/AM noise and harmonic emission
- ◆ Die-cast housing
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

- ◆ Traffic radar systems
- ◆ True ranging systems
- ◆ Level sensing systems
- ◆ Automotive radar systems
- ◆ Automatic production lines

DESCRIPTION:

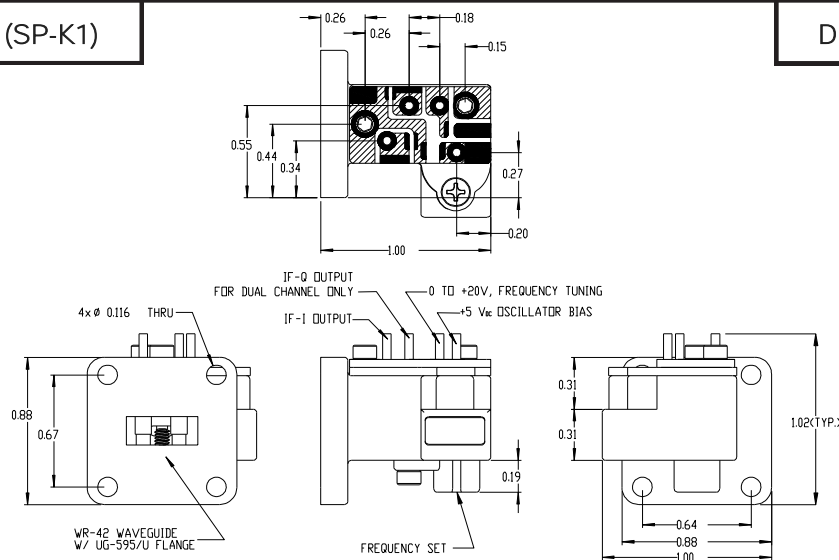
SSP series K band ranging sensor modules are based on FMCW radar principles. These sensor modules are designed and manufactured for short distance moving or stationary target measurement. The operation frequency of these sensor modules is at 24.125 GHz. The sensor modules take +5.0 Vdc/250 mA nominal bias and the frequency modulation bandwidth of +/-150 MHz minimum is realized via tuning voltage from 0 to +20 volts. The RF interface of the sensor module is standard WR-42 waveguide with UG595/U flange. It supports TE10 mode operation. The sensor modules are configured with a T/R diplexer, a single or dual (I/Q) receiver and a transmitter/receiver oscillator in an integrated die-cast housing. The modules with I/Q receiver can simultaneously detect the speed and direction of moving targets. Various antennas can be integrated with the module to form sensor heads for many system applications.

CATALOG MODELS:

Model Number	SSP-24305-S1	SSP-24303-D1
TX Frequency (GHz)	24.125	24.125
TX Power (dBm, Typ)	+ 5.0	+ 3.0
Frequency Modulation (MHz, Typ)	±150	±150
Receiver I/Q Phase Δ (Max)	N/A	60 to 120°
Receiver I/Q Amplitude Δ (Max)	N/A	0 to 3 dB
IF Frequency Range (Min)	DC to 100 MHz	DC to 100 MHz
IF Offset Voltage (Typ)	-0.5 to -1.0 Volts	-0.5 to -1.0 Volts
Frequency Stability (Max)	- 0.8 MHz/°C	- 0.8 MHz/°C
Power Stability (Max)	- 0.03 dB/°C	- 0.03 dB/°C
Bias Voltage (Vdc, Typ)	+5.0	+5.0
Bias Current (mA, Typ)	250	250
Tuning Voltage (Volts)	0 to + 20	0 to + 20

Outline: SP-K1-D (SP-K1)

Dimensions: Inches



Other Band Ranging Sensor Modules, SSP Series

FEATURES:

- ◆ Common frequency bands
- ◆ FMCW operation mode
- ◆ Low FM/AM noise
- ◆ Low harmonic emission
- ◆ High sensitivity
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

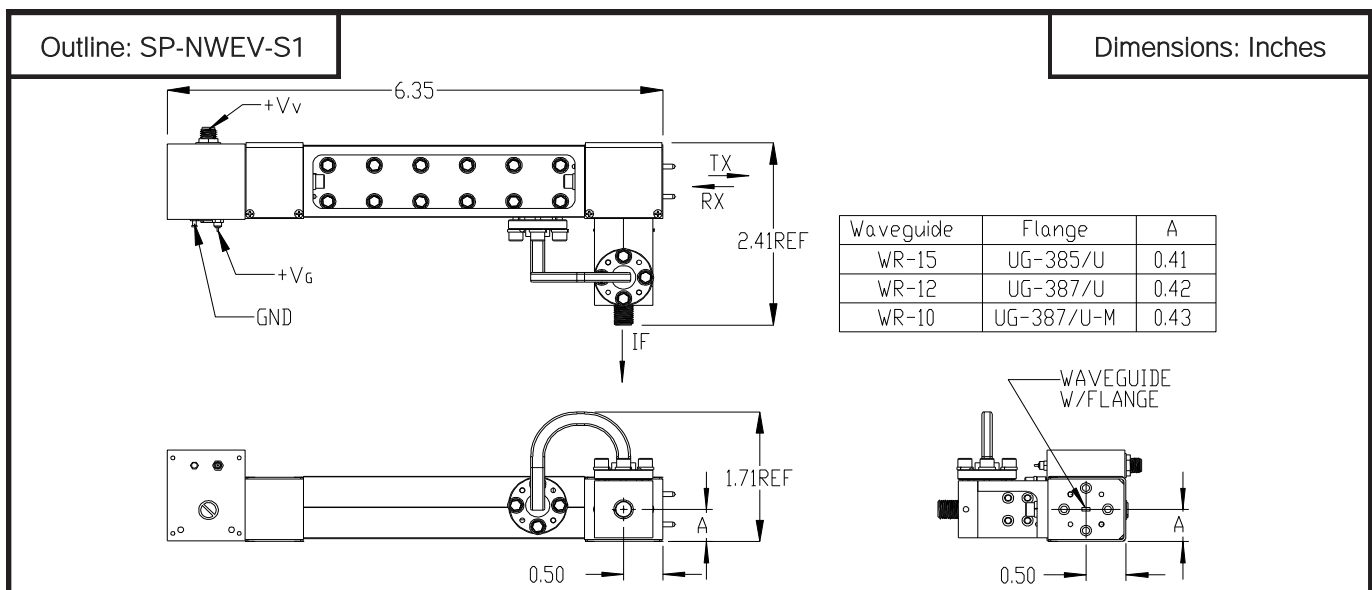
- ◆ Traffic radar systems
- ◆ True ranging system
- ◆ Automotive radar systems
- ◆ Automatic production lines

DESCRIPTION:

SSP series sensor modules are offered in 60, 76.5 and 94 GHz to cover the most popular sensor frequency bands. These ranging sensor modules are based on FMCW radar principles and are designed/manufactured for medium to long distance moving or stationary target measurement. The frequency modulation bandwidth of +/-250 MHz nominal is realized via tuning voltage from 0 to +20 volts. The RF interface of the sensor module is a standard rectangular waveguide that supports TE10 mode operation. The sensor modules are configured with a T/R diplexer, a single or dual (I/Q) receiver, and a transmitter/receiver oscillator in an integrated assembly. The modules with I/Q receiver can simultaneously detect the speed and direction of moving targets. Various antennas can be integrated with the module to form sensor heads for many system applications.

CATALOG MODELS:

Model Number	SSP-60313-S1	SSP-60310-D1	SSP-77313-S1	SSP-77310-D1	SSP-94313-S1	SSP-94310-D1
RF Connector	WR-15	WR-15	WR-12	WR-12	WR-10	WR-10
TX Frequency (GHz)	60.000	60.000	76.500	76.500	94.000	94.000
TX Power (dBm, Typ)	+ 13.0	+ 10.0	+ 13.0	+ 10.0	+ 13.0	+ 10.0
FM Bandwidth (MHz, Typ)	± 250 MHz	± 250 MHz	± 250 MHz	± 250 MHz	± 250 MHz	± 250 MHz
Receiver Conversion Loss (dB, Typ)	9.0	12.0	10.0	13.0	11.0	14.0
Receiver I/Q Phase Δ (Max)	N/A	80 to 100°	N/A	80 to 100°	N/A	80 to 100°
Receiver I/Q Amplitude Δ (Max)	N/A	0 to 3 dB	N/A	0 to 3 dB	N/A	0 to 3 dB
IF Frequency Range (Min)	DC to 2,000 MHz					
Frequency Stability (MHz/°C, Typ)	- 5.0	- 5.0	- 5.5	- 5.5	- 6.0	- 6.0
Power Stability (dB/°C, Typ)	- 0.03	- 0.03	- 0.04	- 0.04	- 0.04	- 0.04
Bias Voltage (Vdc, Typ)	+ 4.5	+ 4.5	+ 10.0	+ 10.0	+ 10.0	+ 10.0
Bias Current (mA, Typ)	850	850	250	250	250	250



K Band Microstrip Antenna Based Low Cost Doppler Sensor Heads, SSS Series

FEATURES:

- ◆ CW and pulse mode operation
- ◆ Various beamwidth
- ◆ Low harmonic emission
- ◆ FCC Part 15 compliant
- ◆ Low cost and in production
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

- ◆ Police radar systems
- ◆ Traffic monitoring systems
- ◆ Microwave fence
- ◆ Military surveillance systems

DESCRIPTION:

SSS series K Band microstrip antenna based low cost Doppler heads are designed and manufactured for moving target short range speed and direction detection applications. The operation frequencies of the catalog models are at 24.125 GHz. The antenna and sensor module are the two major parts in a sensor head assembly. Various microstrip antennas with different beamwidth are offered to combine with sensor modules to form various configurations for different applications. The sensor modules are configured with a T/R diplexer, a single or I/Q receiver, and a transmitter/receiver oscillator in an integrated package. The models with I/Q receiver can detect the speeds and directions of moving targets simultaneously. While the catalog models are offered in three standard beamwidth, other antenna beamwidth, such as 12° x 50°, are offered as custom designed models.

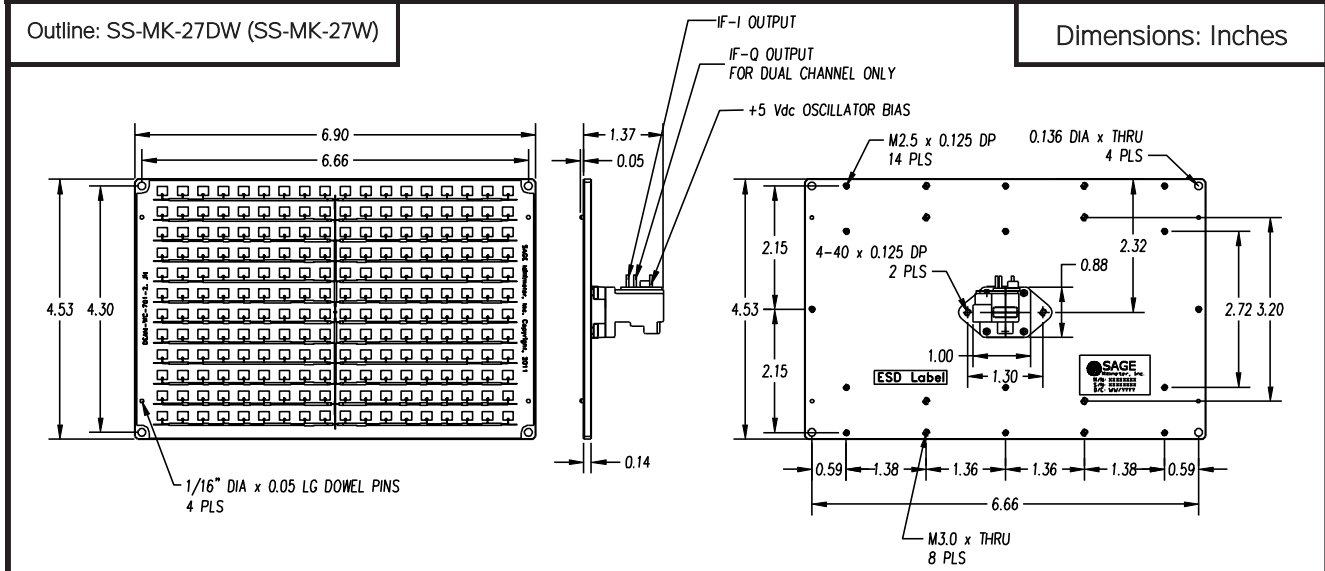
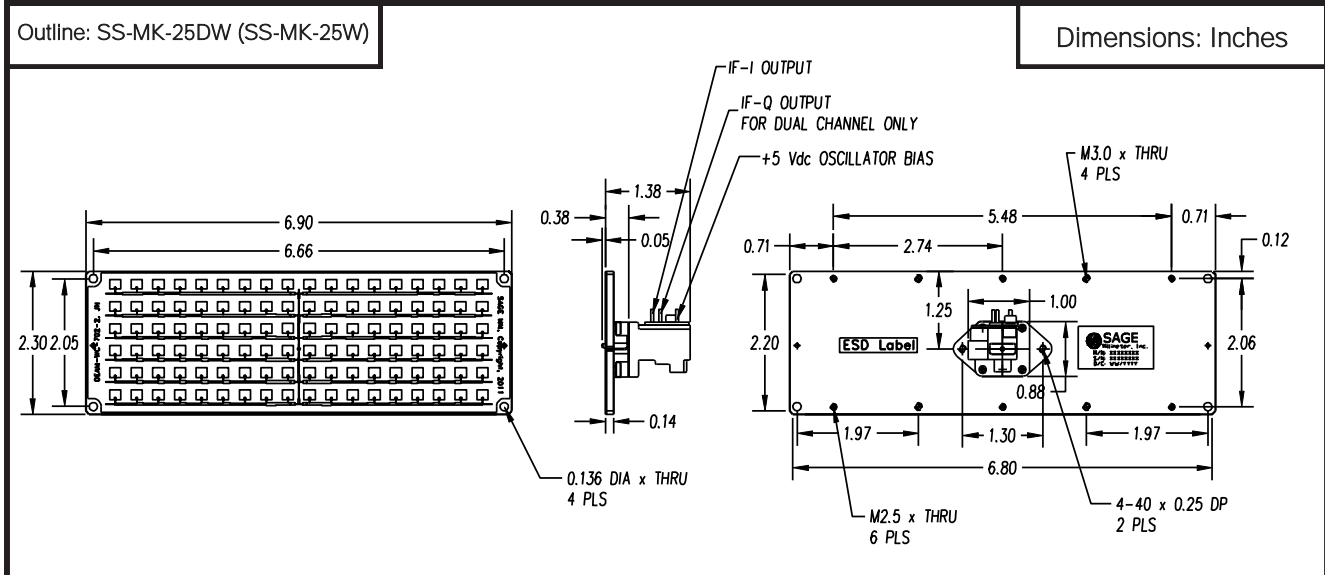
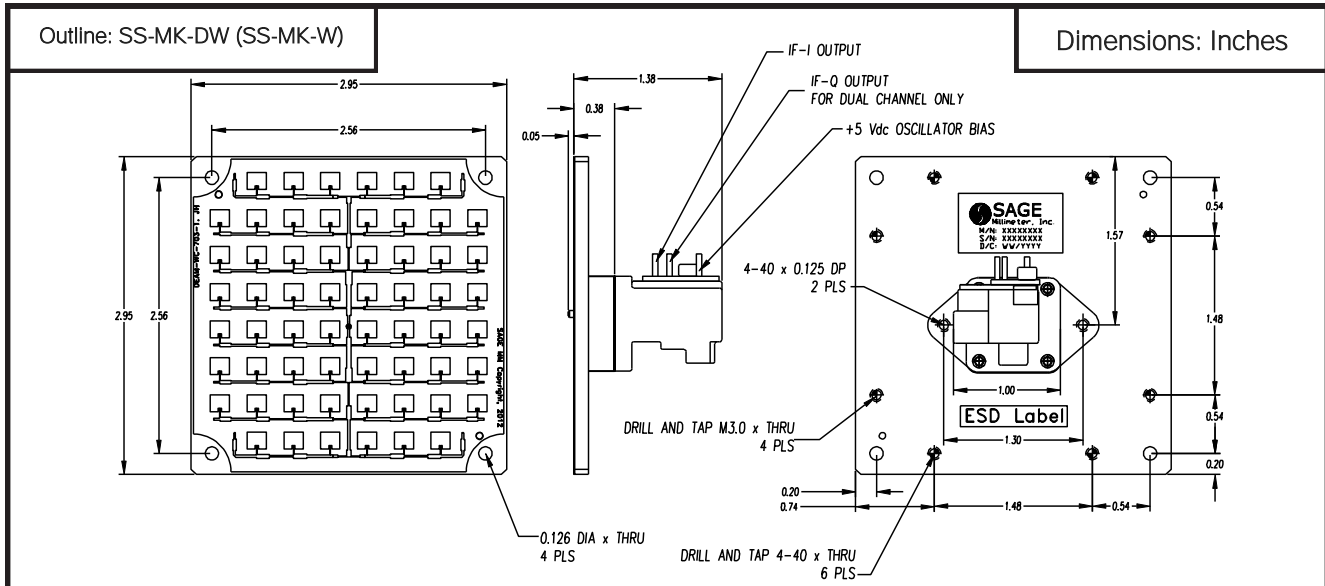
CATALOG MODELS:

Model Number	SSS-24307-20M-SW	SSS-24307-25M-SW	SSS-24307-27M-SW	SSS-24307-20M-DW	SSS-24307-25M-DW	SSS-24307-27M-DW
Antenna Type	Microstrip Array	Microstrip Array	Microstrip Array	Microstrip Array	Microstrip Array	Microstrip Array
Antenna Polarization	Linear	Linear	Linear	Linear	Linear	Linear
Antenna 3 dB Beamwidth	12°(H) x 12°(V)	4.6°(H) x 14.8°(V)	4.6°(H) x 6.8°(V)	12°(H) x 12°(V)	4.6°(H) x 14.8°(V)	4.6°(H) x 6.8°(V)
Antenna Gain (dBi, Typ)	20	25	27	20	25	27
Antenna Sidelobes (dBc)	- 20	- 20	- 20	- 20	- 20	- 20
TX Frequency (GHz)	24.125	24.125	24.125	24.125	24.125	24.125
TX Power (dBm, Typ)	+ 7.0	+ 7.0	+ 7.0	+7.0	+7.0	+7.0
Receiver I/Q Phase Δ	N/A	N/A	N/A	60 to 120°	60 to 120°	60 to 120°
Receiver I/Q Amplitude Δ	N/A	N/A	N/A	0 to 3 dB	0 to 3 dB	0 to 3 dB
Detection Range	100 to 200 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)					
IF Frequency (MHz, Min)	DC to 100 MHz	DC to 100 MHz	DC to 100 MHz	DC to 100 MHz	DC to 100 MHz	DC to 100 MHz
IF Offset Voltage (Vdc)	-0.5 to -1.0	-0.5 to -1.0	-0.5 to -1.0	-0.5 to -1.0	-0.5 to -1.0	-0.5 to -1.0
Frequency Stability	- 0.8 MHz/°C	- 0.8 MHz/°C	- 0.8 MHz/°C	- 0.8 MHz/°C	- 0.8 MHz/°C	- 0.8 MHz/°C
Power Stability	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C
Bias Voltage (Vdc, Typ)	+5.0	+5.0	+5.0	+5.0	+5.0	+5.0
Bias Current (mA, Typ)	250	250	250	250	250	250
Temperature Range (°C)	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85
Outline	SS-MK-W	SS-MK-25W	SS-MK-27W	SS-MK-DW	SS-MK-25DW	SS-MK-27DW

SAGE Millimeter's custom designed Doppler sensor head model numbers are configured per following format.

SSS - F0N PP - AGM - XY

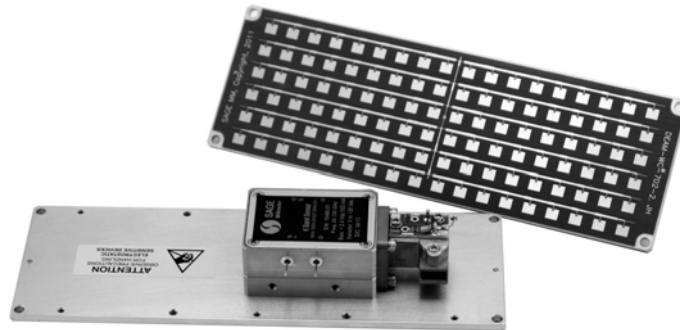
F0N is the center frequency in MHz x 10N. For example: 77.0 GHz = 773.
PP is the sensor module output power in dBm. For example: 10 dBm = 10.
AG is the antenna gain in dBi. For example: 25 dBi = 25.
X : "S" is for single channel receiver; "D" is for directional, i.e., I/Q receiver.
Y is for factory reserve.



K Band Microstrip Antenna Based High Performance Doppler Sensor Heads, SSS Series

FEATURES:

- ◆ CW and pulse mode operation
- ◆ Various beamwidth
- ◆ Low flick noise and high sensitivity
- ◆ Low harmonic emission
- ◆ FCC Part 15 compliant
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

- ◆ Police radar systems
- ◆ Traffic monitoring systems
- ◆ Microwave fence
- ◆ Military surveillance systems

DESCRIPTION:

SSS series K Band microstrip antenna based Doppler heads are designed and manufactured for moving target medium range speed and direction detection applications. The operation frequencies of the catalog models are at 24.125 GHz. The antenna and sensor module are the two major parts in a sensor head assembly. Various microstrip antennas with different beamwidth are offered to combine with sensor modules to form various configurations for different applications. The sensor modules are configured with a T/R diplexer, a single or I/Q receiver, and a transmitter/receiver oscillator in an integrated package. The models with I/Q receiver can detect the speeds and directions of moving targets simultaneously. While the catalog models are offered in two standard beamwidth, other antenna beamwidth such as 12° x 12°, are offered as custom designed models.

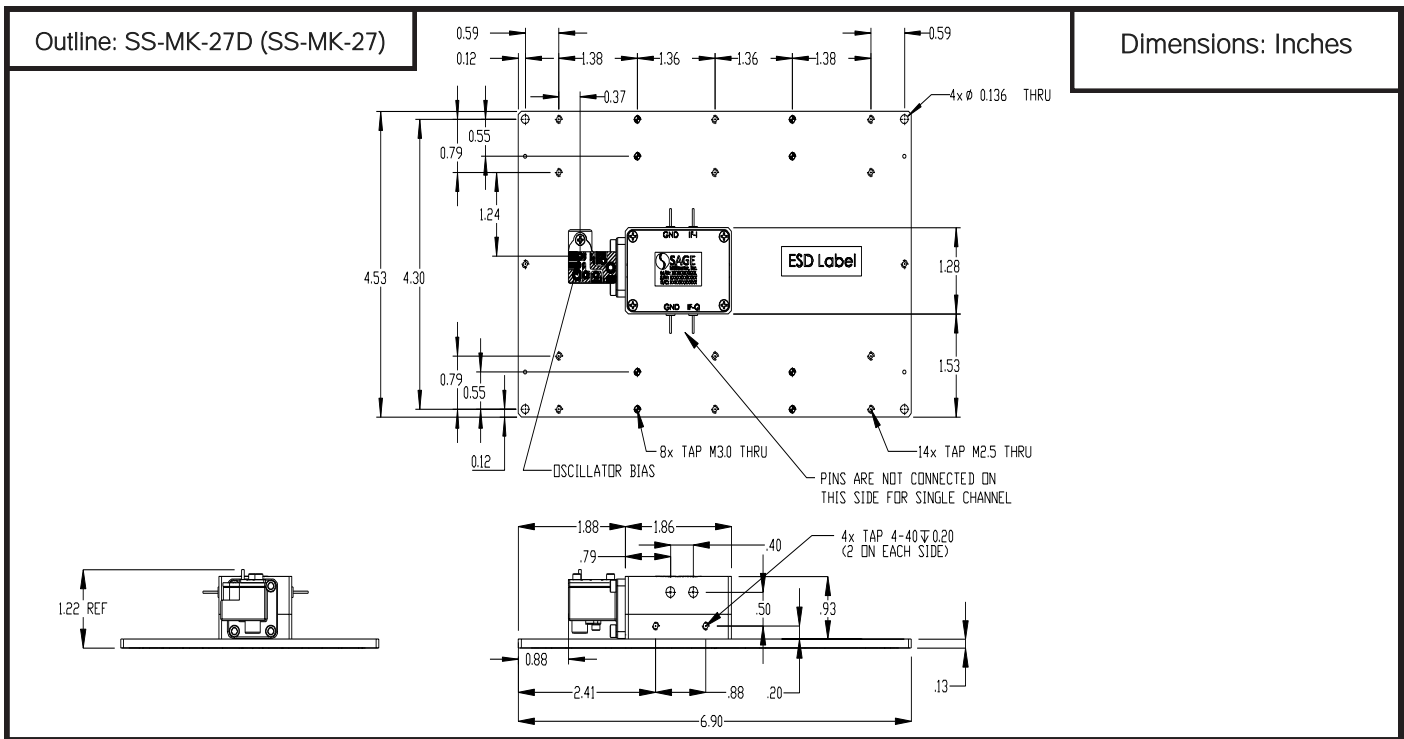
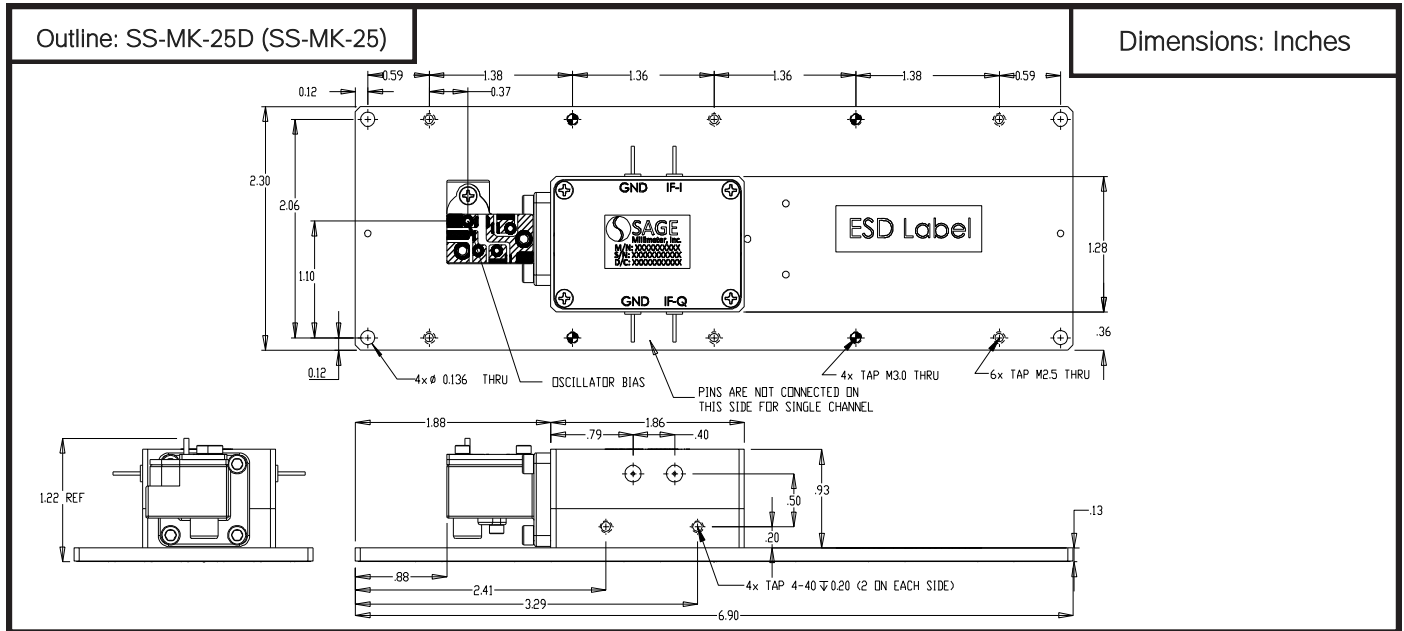
CATALOG MODELS:

Model Number	SSS-24307-25M-S1	SSS-24307-27M-S1	SSS-24307-25M-D1	SSS-24307-27M-D1
Antenna Type	Microstrip Array	Microstrip Array	Microstrip Array	Microstrip Array
Antenna Polarization	Linear	Linear	Linear	Linear
Antenna 3 dB Beamwidth	4.6°(H) x 14.8°(V)	4.6°(H) x 6.8°(V)	4.6°(H) x 14.8°(V)	4.6°(H) x 6.8°(V)
Antenna Gain (dBi, Typ)	25	27	25	27
Antenna Sidelobes (dBc)	- 20	- 20	- 20	- 20
TX Frequency (GHz)	24.125	24.125	24.125	24.125
TX Power (dBm, Typ)	+ 7.0	+ 7.0	+ 7.0	+ 7.0
Receiver I/Q Phase Δ	N/A	N/A	80 to 100°	80 to 100°
Receiver I/Q Amplitude Δ	N/A	N/A	0 to 2 dB	0 to 2 dB
Detection Range	250 to 500 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)			
IF Frequency (MHz, Min)	DC to 100	DC to 100	DC to 100	DC to 100
IF Offset Voltage (Vdc)	± 0.10	± 0.10	± 0.10	± 0.10
Frequency Stability	- 0.8 MHz/°C	- 0.8 MHz/°C	- 0.8 MHz/°C	- 0.8 MHz/°C
Power Stability	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C
Bias Voltage (Vdc, Typ)	+ 5.0	+ 5.0	+ 5.0	+ 5.0
Bias Current (mA, Typ)	250	250	250	250
Temperature Range (°C)	-40 to +80	-40 to +80	-40 to +80	-40 to +80
Outline	SS-MK-25	SS-MK-27	SS-MK-25D	SS-MK-27D

SAGE Millimeter's custom designed Doppler sensor head model numbers are configured per following format.

SSS - F0N PP - AGM - XY

F0N is the center frequency in MHz x 10N. For example: 77.0 GHz = 773.
PP is the sensor module output power in dBm. For example: 10 dBm = 10.
AG is the antenna gain in dBi. For example: 25 dBi = 25.
X : "S" is for single channel receiver; "D" is for directional, i.e., I/Q receiver.
Y is for factory reserve.



K Band Lens Corrected Antenna Based High Performance Doppler Sensor Heads, SSS Series

FEATURES:

- ◆ CW and pulse mode operation
- ◆ Various beamwidth
- ◆ Low flick noise and high sensitivity
- ◆ Low harmonic emission
- ◆ FCC Part 15 compliant
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

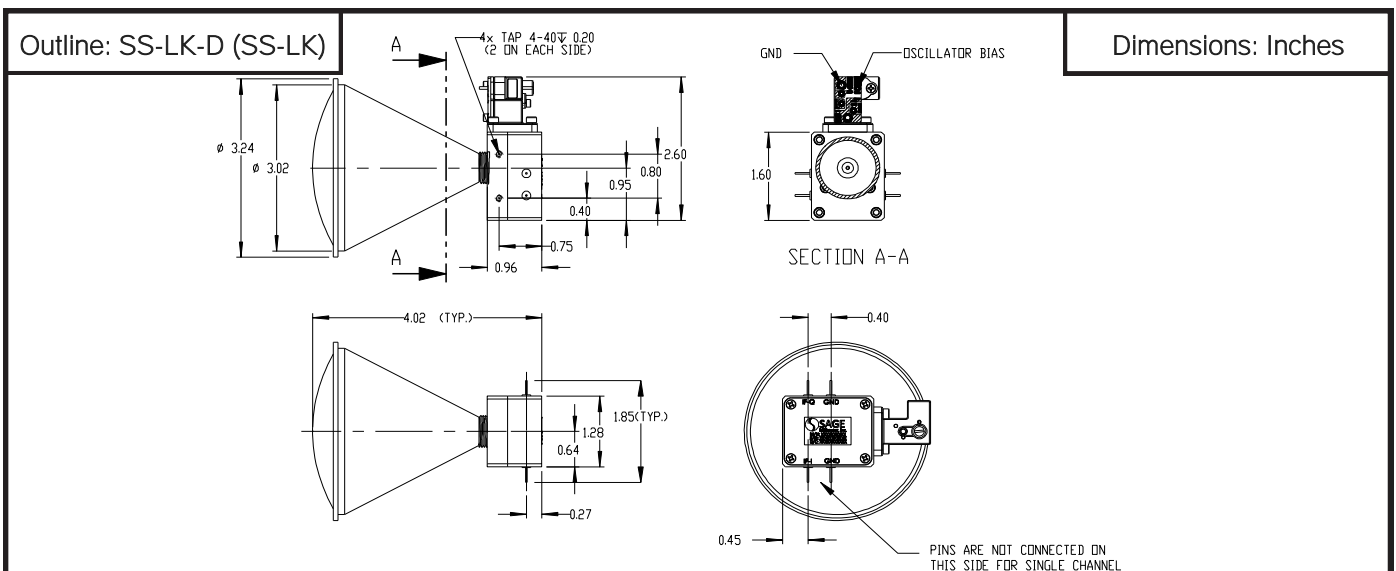
- ◆ Police radar systems
- ◆ Traffic monitoring systems
- ◆ Microwave fence
- ◆ Military surveillance systems

DESCRIPTION:

SSS series K Band lens corrected antenna based Doppler heads are designed and manufactured for moving target **long range** speed and direction detection applications. The operation frequencies of the catalog models are at 24.125 GHz. The antenna and sensor module are the two major parts in a sensor head assembly. Various lens corrected antennas with different beamwidth are offered to combine with sensor modules to form various configurations for different applications. The sensor modules are configured with a T/R diplexer, a single or I/Q receiver, and a transmitter/receiver oscillator in an integrated package. The models with I/Q receiver can detect the speeds and directions of moving targets simultaneously. The wave form transmitted from the sensor is circular polarized for optimal signal receiving. While the catalog models are offered in 12° beamwidth and two output power levels, other antenna beamwidth and output power levels are offered as custom designed models.

CATALOG MODELS:

Model Number	SSS-24310-22L-S1	SSS-24317-22L-S1	SSS-24310-22L-D1	SSS-24317-22L-D1
Antenna 3 dB Beamwidth	12°	12°	12°	12°
Antenna Gain (dBi, Typ)	22	22	22	22
Antenna Sidelobes (dBc)	- 20	- 20	- 20	- 20
TX Frequency (GHz)	24.125	24.125	24.125	24.125
TX Power (dBm, Typ)	+ 10.0	+ 17.0	+ 10.0	+ 17.0
Receiver I/Q Phase Δ	N/A	N/A	80 to 100°	80 to 100°
Receiver I/Q Amplitude Δ	N/A	N/A	0 to 2 dB	0 to 2 dB
Detection Range	1,000 to 1,500 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)			
IF Frequency (MHz, Min)	DC to 100	DC to 100	DC to 100	DC to 100
IF Offset Voltage (Vdc)	± 0.25	± 0.25	± 0.25	± 0.25
Frequency II Power Stability	-0.8 MHz/°C II -0.03 dB/°C	-0.8 MHz/°C II -0.03 dB/°C	-0.8 MHz/°C II -0.03 dB/°C	-0.8 MHz/°C II -0.03 dB/°C
Bias (Vdc II mA, Typ)	+ 5.0 II 250	+ 5.0 II 250	+ 5.0 II 250	+ 5.0 II 250



Ka Band Microstrip Antenna Based High Performance Doppler Sensor Heads, SSS Series

FEATURES:

- ◆ CW and pulse mode operation
- ◆ Various beamwidth
- ◆ Low flick noise and high sensitivity
- ◆ Low harmonic emission
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

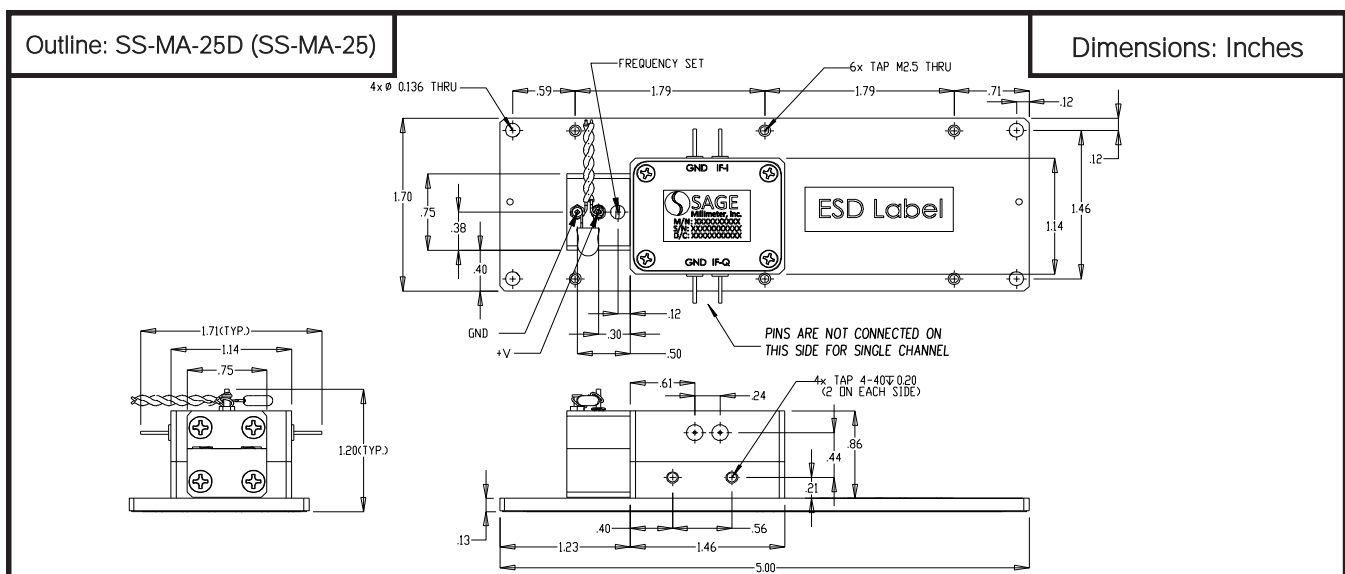
- ◆ Police radar systems
- ◆ Traffic monitoring systems
- ◆ Microwave fence
- ◆ Military surveillance systems

DESCRIPTION:

SSS series Ka Band microstrip antenna based Doppler heads are designed and manufactured for moving target **medium range** speed and direction detection applications. Although the operation frequencies of the catalog models are at 34.85 GHz, frequencies in the 34.7 to 35.0 GHz range can be selected by adjusting the self-locking screw mechanically. Various microstrip antennas with different beamwidth are offered to combine with sensor modules to form various configurations for different applications. The sensor modules are configured with a T/R diplexer, a single or I/Q receiver, and a transmitter/receiver oscillator in an integrated package. The models with I/Q receiver can detect the speeds and directions of the moving targets simultaneously. The wave form transmitted from the sensor is linear polarized. While the catalog models are offered in two models with +7 dBm output power level, other antenna beamwidth and output power levels are also available as custom designed models.

CATALOG MODELS:

Model Number	SSS-35307-19M-S1	SSS-35307-19M-D1
Antenna 3 dB Beamwidth	4.6° (H) x 15° (V)	4.6° (H) x 15° (V)
Antenna Gain (dBi, Typ)	19	19
Antenna Sidelobes (dBc)	-20	-20
TX Frequency (GHz)	34.850	34.850
TX Power (dBm, Typ)	+7.0	+7.0
Receiver I/Q Phase Δ	N/A	80 to 100°
Receiver I/Q Amplitude Δ	N/A	0 to 2 dB
Detection Range	250 to 500 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)	
IF Frequency (MHz, Min)	DC to 100	DC to 100
IF Offset Voltage (Vdc)	± 0.25	± 0.25
Frequency II Power Stability	-0.3 MHz/°C II -0.03 dB/°C	-0.3 MHz/°C II -0.03 dB/°C
Bias (Vdc II mA, Typ)	+5.5 II 250	+5.5 II 250



Ka Band Lens Corrected Antenna Based High Performance Doppler Sensor Heads, SSS Series

FEATURES:

- ◆ CW and pulse mode operation
- ◆ Various beamwidth
- ◆ Low flick noise and high sensitivity
- ◆ Low harmonic emission
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

- ◆ Police radar systems
- ◆ Traffic monitoring systems
- ◆ Microwave fence
- ◆ Military surveillance systems

DESCRIPTION:

SSS series Ka Band lens corrected antenna based Doppler heads are designed and manufactured for moving target **long range** speed and direction detection applications. Although the operation frequencies of the catalog models are at 35.00 GHz, frequencies in the 33.9 to 36.1 GHz range can be selected by adjusting the self-locking screw mechanically. Various lens corrected antennas with different beamwidth are offered to combine with sensor modules to form various configurations for different applications. The sensor modules are configured with a T/R diplexer, a single or I/Q receiver, and a transmitter/receiver oscillator in an integrated package. The models with I/Q receiver can detect the speeds and directions of the moving targets simultaneously. The wave form transmitted from the sensor is circular polarized for optimal signal receiving. While the catalog models are offered in six models, other antenna beamwidth and output power levels are also available for production quantities or as custom designed models.

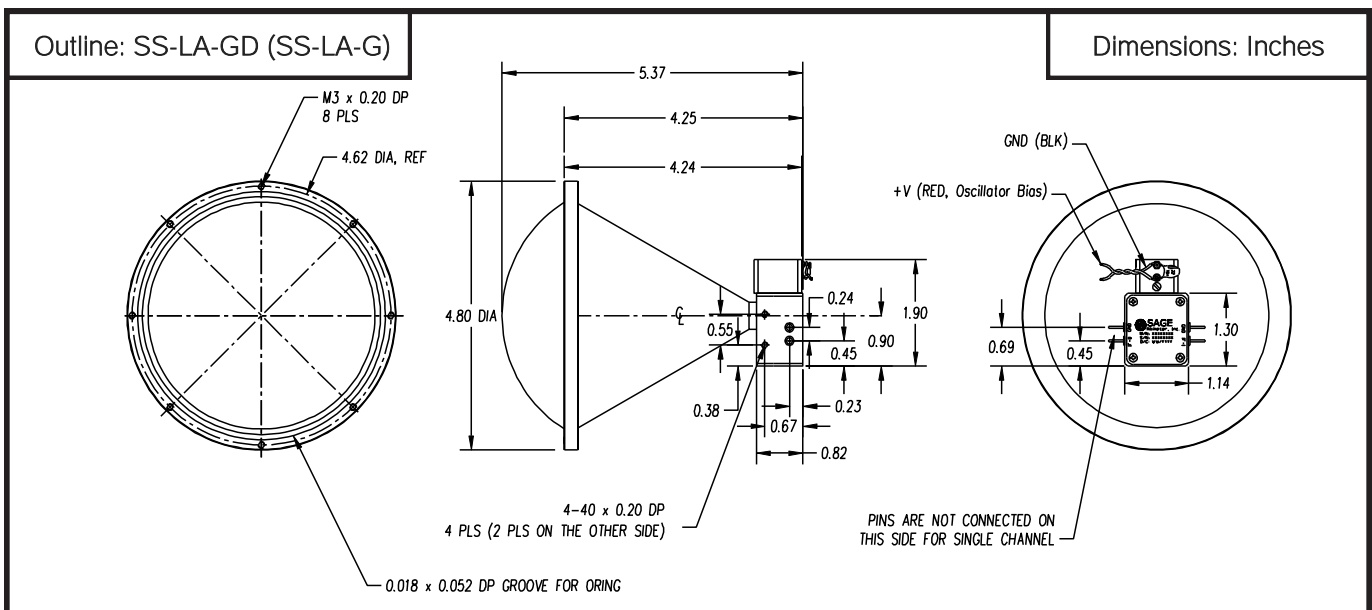
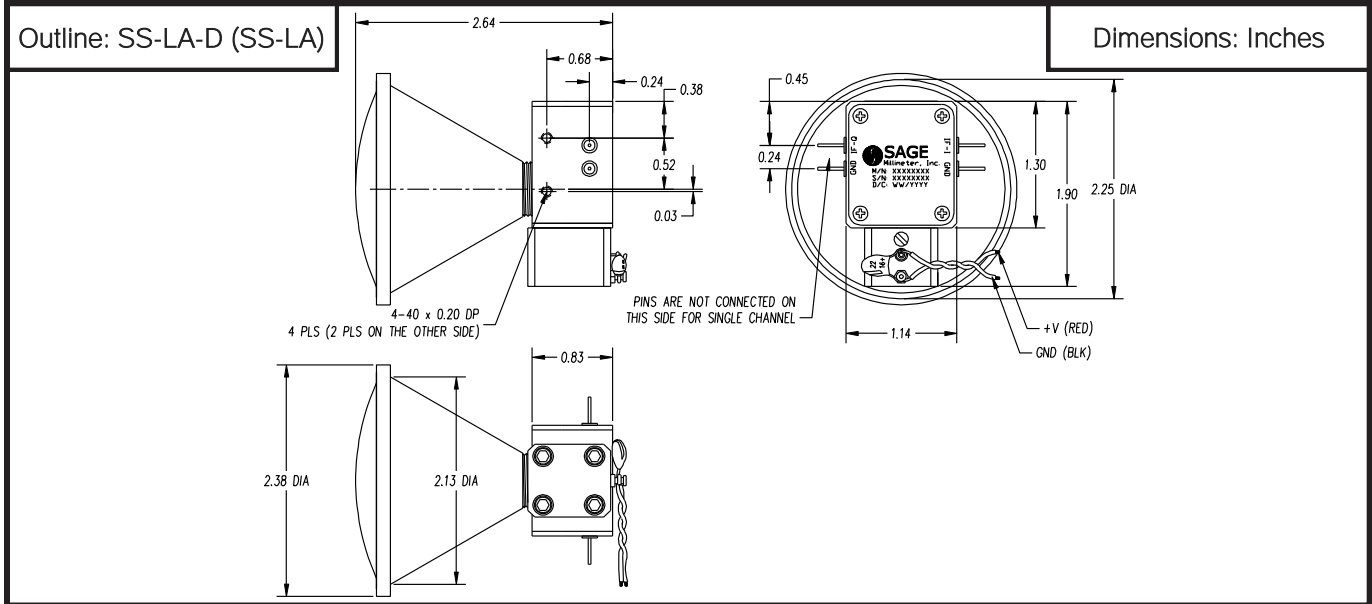
CATALOG MODELS:

Model Number	SSS-35310-22L-S1	SSS-35320-22L-S1	SSS-35300-29L-S1	SSS-35310-22L-D1	SSS-35320-22L-D1	SSS-35300-29L-D1
Antenna Type	Lens Corrected	Lens Corrected	Lens Corrected	Lens Corrected	Lens Corrected	Lens Corrected
Antenna Polarization	Circular	Circular	Circular	Circular	Circular	Circular
Antenna 3 dB Beamwidth	12°	12°	5°	12°	12°	5°
Antenna Gain (dBi, Typ)	22	22	29	22	22	29
Antenna Sidelobes (dBc)	- 20	- 20	- 20	- 20	- 20	- 20
TX Frequency (GHz)	35.00	35.00	35.00	35.00	35.00	35.00
TX Power (dBm, Typ)	+10.0	+20.0	0.0	+10.0	+20.0	0.0
Receiver I/Q Phase Δ	N/A	N/A	N/A	80 to 100°	80 to 100°	80 to 100°
Receiver I/Q Amplitude Δ	N/A	N/A	N/A	0 to 2 dB	0 to 2 dB	0 to 2 dB
Detection Range	500 to 1,500 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)					
IF Frequency (MHz, Min)	DC to 100	DC to 100	DC to 100	DC to 100	DC to 100	DC to 100
IF Offset Voltage (Vdc)	± 0.10	± 0.10	± 0.10	± 0.10	± 0.10	± 0.10
Frequency Stability	- 0.3 MHz/°C	- 0.3 MHz/°C	- 0.3 MHz/°C	- 0.3 MHz/°C	- 0.3 MHz/°C	- 0.3 MHz/°C
Power Stability	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C
Bias Voltage (Vdc, Typ)	+ 5.5	+ 5.5	+ 5.5	+ 5.5	+ 5.5	+ 5.5
Bias Current (mA, Typ)	250	650	250	250	650	250
Temperature Range (°C)	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85
Outline	SS-LA	SS-LA	SS-LA-G1	SS-LA	SS-LA	SS-LA-GD

SAGE Millimeter's custom designed Doppler sensor head model numbers are configured per following format.

SSS - F0N PP - AGL - XY

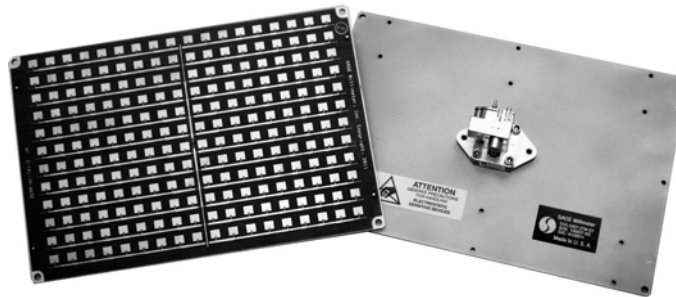
F0N is the center frequency in MHz x 10N. For example: 36.0 GHz = 363.
PP is the sensor module output power in dBm. For example: 10 dBm = 10.
AG is the antenna gain in dBi. For example: 25 dBi = 25.
X : "S" is for single channel receiver; "D" is for directional, i.e., I/Q receiver.
Y is for factory reserve.



K Band Microstrip Antenna Based Low Cost Ranging Sensor Heads, SSD Series

FEATURES:

- ◆ FMCW operation
- ◆ Various beamwidth
- ◆ Low harmonic emission
- ◆ Broad FM Bandwidth: ± 150 MHz
- ◆ Low cost and in production
- ◆ Temperature range: -40 to $+85^{\circ}\text{C}$



APPLICATIONS:

- ◆ Traffic radar systems
- ◆ True ranging systems
- ◆ Level sensing systems
- ◆ Automotive radar systems

DESCRIPTION:

SSD series K Band microstrip antenna based low cost ranging sensor heads are designed and manufactured for **short range** moving or stationary target measurement. The operation frequency of these sensor modules is at 24.125 GHz. The sensor modules take + 5.0 Vdc/250 mA nominal bias and the frequency modulation bandwidth of ± 150 MHz minimum is realized via tuning voltage from 0 to +20 Volts. The sensor heads are configured with a microstrip antenna, T/R diplexer, a single or dual (I/Q) receiver, and a transmitter/receiver oscillator in an integrated die-cast housing. Sensor heads with I/Q receivers can detect not only the speed and the range of a moving or stationary target, but also the direction of the moving target. The operation frequencies of the catalog models are at 24.125 GHz. While the catalog models are offered in standard beamwidth, other antenna beamwidth, such as $12^{\circ} \times 50^{\circ}$, are offered as custom designed models.

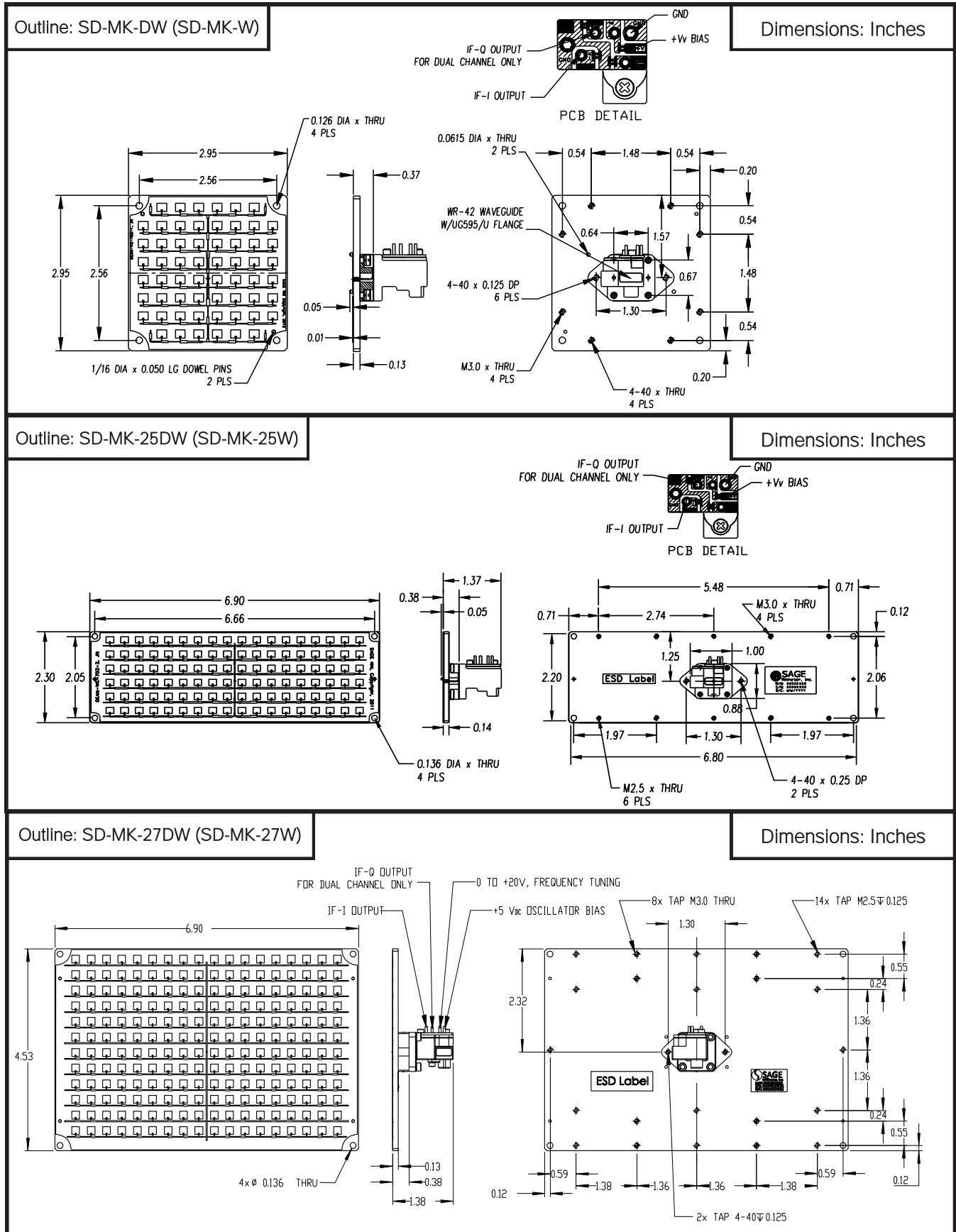
CATALOG MODELS:

Model Number	SSD-24305-20M-SW	SSD-24305-25M-SW	SSD-24305-27M-SW	SSD-24303-20M-DW	SSD-24303-25M-DW	SSD-24303-27M-DW
Antenna Type	Microstrip Array	Microstrip Array	Microstrip Array	Microstrip Array	Microstrip Array	Microstrip Array
Antenna Polarization	Linear	Linear	Linear	Linear	Linear	Linear
Antenna 3 dB Beamwidth	$12^{\circ}(\text{H}) \times 12^{\circ}(\text{V})$	$4.6^{\circ}(\text{H}) \times 14.8^{\circ}(\text{V})$	$4.6^{\circ}(\text{H}) \times 6.8^{\circ}(\text{V})$	$12^{\circ}(\text{H}) \times 12^{\circ}(\text{V})$	$4.6^{\circ}(\text{H}) \times 14.8^{\circ}(\text{V})$	$4.6^{\circ}(\text{H}) \times 6.8^{\circ}(\text{V})$
Antenna Gain (dBi, Typ)	20	25	27	20	25	27
Antenna Sidelobes (dBC)	- 20	- 20	- 20	- 20	- 20	- 20
TX Frequency (GHz)	24.125	24.125	24.125	24.125	24.125	24.125
TX Power (dBm, Typ)	+ 5.0	+ 5.0	+ 5.0	+ 3.0	+ 3.0	+ 3.0
Receiver I/Q Phase Δ	N/A	N/A	N/A	60 to 120°	60 to 120°	60 to 120°
Receiver I/Q Amplitude Δ	N/A	N/A	N/A	0 to 3 dB	0 to 3 dB	0 to 3 dB
Detection Range	50 to 150 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)					
IF Frequency (MHz, Min)	DC to 100 MHz	DC to 100 MHz	DC to 100 MHz	DC to 100 MHz	DC to 100 MHz	DC to 100 MHz
IF Offset Voltage (Vdc)	-0.5 to -1.0	-0.5 to -1.0	-0.5 to -1.0	-0.5 to -1.0	-0.5 to -1.0	-0.5 to -1.0
Frequency Stability	- 0.8 MHz/ $^{\circ}\text{C}$	- 0.8 MHz/ $^{\circ}\text{C}$	- 0.8 MHz/ $^{\circ}\text{C}$	- 0.8 MHz/ $^{\circ}\text{C}$	- 0.8 MHz/ $^{\circ}\text{C}$	- 0.8 MHz/ $^{\circ}\text{C}$
Power Stability	- 0.03 dB/ $^{\circ}\text{C}$	- 0.03 dB/ $^{\circ}\text{C}$	- 0.03 dB/ $^{\circ}\text{C}$	- 0.03 dB/ $^{\circ}\text{C}$	- 0.03 dB/ $^{\circ}\text{C}$	- 0.03 dB/ $^{\circ}\text{C}$
Blas Voltage (Vdc, Typ)	+5.0	+5.0	+5.0	+5.0	+5.0	+5.0
Bias Current (mA, Typ)	250	250	250	250	250	250
Temperature Range ($^{\circ}\text{C}$)	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85
Outline	SD-MK-W	SD-MK-25W	SD-MK-27W	SD-MK-DW	SD-MK-25DW	SD-MK-27DW

SAGE Millimeter's custom designed microstrip antenna based ranging sensor head model numbers are configured per following format.

SSD - F0N PP - AGM - XY

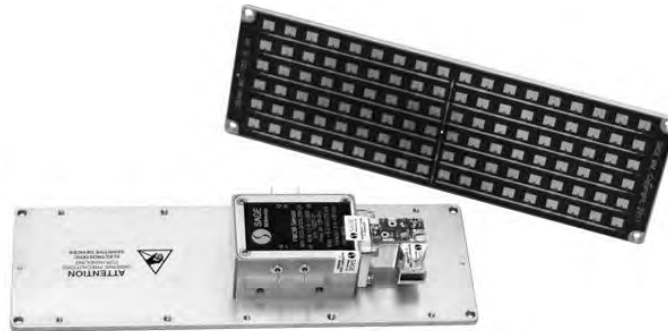
F0N is the center frequency in MHz x 10N. For example: 77.0 GHz = 773.
PP is the sensor module output power in dBm. For example: 10 dBm = 10.
AG is the antenna gain in dBi. For example: 25 dBi = 25.
X : "S" is for single channel receiver; "D" is for directional, i.e., I/Q receiver.
Y: "W" is for waveguide version and factory reserve.



K Band Microstrip Antenna Based High Performance Ranging Sensor Heads, SSD Series

FEATURES:

- ◆ FMCW operation
- ◆ Various beamwidth
- ◆ Low harmonic emission
- ◆ Low flick noise and high sensitivity
- ◆ Broad FM Bandwidth: ± 150 MHz
- ◆ Temperature range: -40 to $+85^{\circ}\text{C}$



APPLICATIONS:

- ◆ Traffic Radar systems
- ◆ True ranging systems
- ◆ Level sensing systems
- ◆ Automotive radar systems
- ◆ Military surveillance systems

DESCRIPTION:

SSD series K Band microstrip antenna based ranging sensor heads are designed and manufactured for **medium range** moving or stationary target measurement. The operation frequency of these sensor modules is at 24.125 GHz. The sensor modules take $+5.0$ Vdc/250 mA nominal bias and the frequency modulation bandwidth of ± 150 MHz minimum is realized via tuning voltage from 0 to +20 Volts. The sensor heads are configured with a microstrip antenna, a T/R diplexer, a single or dual (I/Q) receiver, and a transmitter/receiver oscillator in an integrated package. Sensor heads with I/Q receivers can detect not only the speed and the range of a moving or stationary target, but also the direction of the moving target. The operation frequencies of the catalog models are at 24.125 GHz. While the catalog models are offered in standard beamwidth, other antenna beamwidth, such as $12^{\circ} \times 12^{\circ}$, are offered as production ready or as custom designed models.

CATALOG MODELS:

Model Number	SSD-24303-25M-S1	SSD-24303-27M-S1	SSD-24303-25M-D1	SSD-24303-27M-D1
Antenna Type	Microstrip Array	Microstrip Array	Microstrip Array	Microstrip Array
Antenna Polarization	Linear	Linear	Linear	Linear
Antenna 3 dB Beamwidth	$4.6^{\circ}(\text{H}) \times 14.8^{\circ}(\text{V})$	$4.6^{\circ}(\text{H}) \times 6.8^{\circ}(\text{V})$	$4.6^{\circ}(\text{H}) \times 14.8^{\circ}(\text{V})$	$4.6^{\circ}(\text{H}) \times 6.8^{\circ}(\text{V})$
Antenna Gain (dBi, Typ)	25	27	25	27
Antenna Sidelobes (dBc)	-20	-20	-20	-20
TX Frequency (GHz)	24.125	24.125	24.125	24.125
TX Power (dBm, Typ)	+3.0	+3.0	+3.0	+3.0
Receiver I/Q Phase Δ	N/A	N/A	80 to 100°	80 to 100°
Receiver I/Q Amplitude Δ	N/A	N/A	0 to 2 dB	0 to 2 dB
Detection Range	250 to 500 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)			
IF Frequency (MHz, Min)	DC to 100	DC to 100	DC to 100	DC to 100
IF Offset Voltage (Vdc)	± 0.10	± 0.10	± 0.10	± 0.10
Frequency Stability	-0.8 MHz/ $^{\circ}\text{C}$	-0.8 MHz/ $^{\circ}\text{C}$	-0.8 MHz/ $^{\circ}\text{C}$	-0.8 MHz/ $^{\circ}\text{C}$
Power Stability	-0.03 dB/ $^{\circ}\text{C}$	-0.03 dB/ $^{\circ}\text{C}$	-0.03 dB/ $^{\circ}\text{C}$	-0.03 dB/ $^{\circ}\text{C}$
Bias Voltage (Vdc, Typ)	+5.0	+5.0	+5.0	+5.0
Bias Current (mA, Typ)	250	250	250	250
Temperature Range ($^{\circ}\text{C}$)	-40 to +80	-40 to +80	-40 to +80	-40 to +80
Outline	SD-MK-25	SD-MK-27	SD-MK-25D	SD-MK-27D

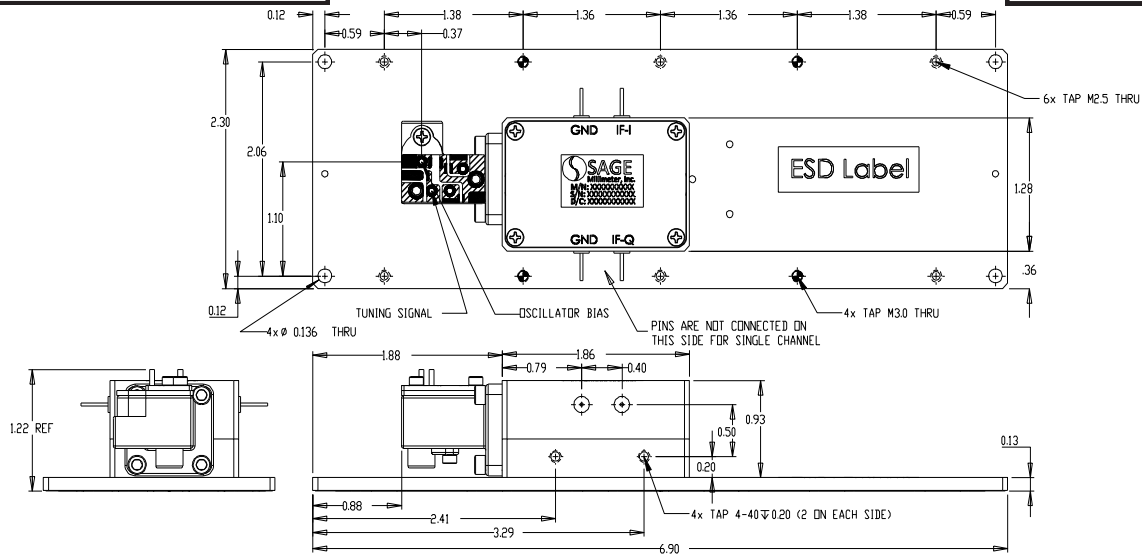
SAGE Millimeter's custom designed Doppler sensor head model numbers are configured per following format.

SSD - F0N PP - AGM - XY

F0N is the center frequency in MHz x 10N. For example: 77.0 GHz = 773.
PP is the sensor module output power in dBm. For example: 10 dBm = 10.
AG is the antenna gain in dBi. For example: 25 dBi = 25.
X : "S" is for single channel receiver; "D" is for directional, i.e., I/Q receiver.
Y is for factory reserve.

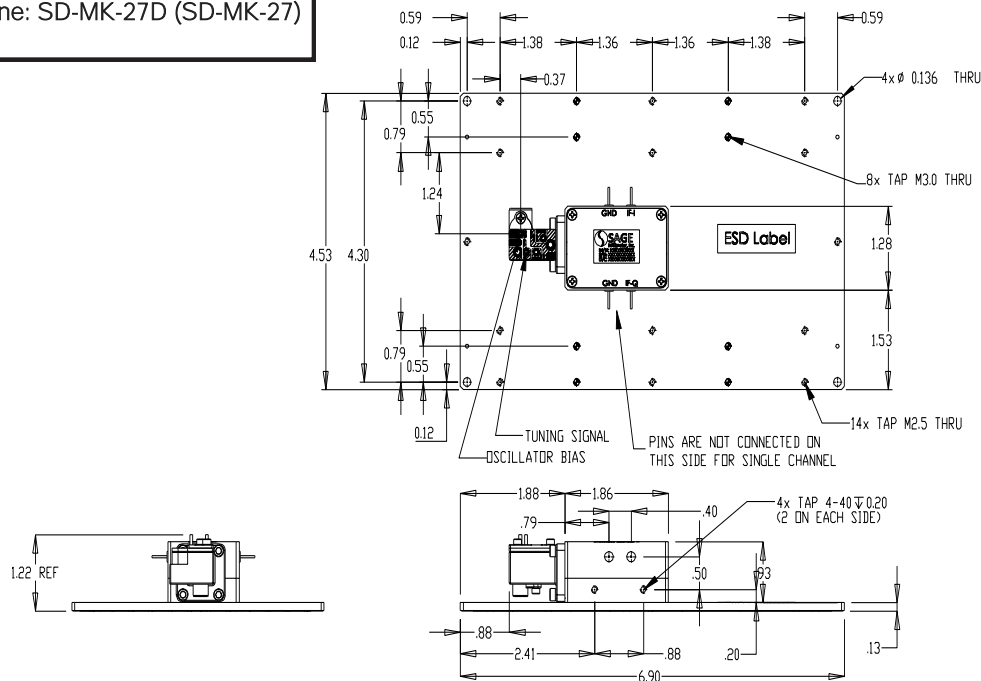
Outline: SD-MK-25D (SD-MK-25)

Dimensions: Inches



Outline: SD-MK-27D (SD-MK-27)

Dimensions: Inches



K Band Lens Corrected Antenna Based High Performance Ranging Sensor Heads, SSD Series

FEATURES:

- ◆ FMCW operation
- ◆ Various beamwidth
- ◆ Low harmonic emission
- ◆ Low flick noise and high sensitivity
- ◆ Broad FM Bandwidth: ± 150 MHz
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

- ◆ Traffic Radar systems
- ◆ True ranging systems
- ◆ Level sensing systems
- ◆ Automotive radar systems
- ◆ Military surveillance systems

DESCRIPTION:

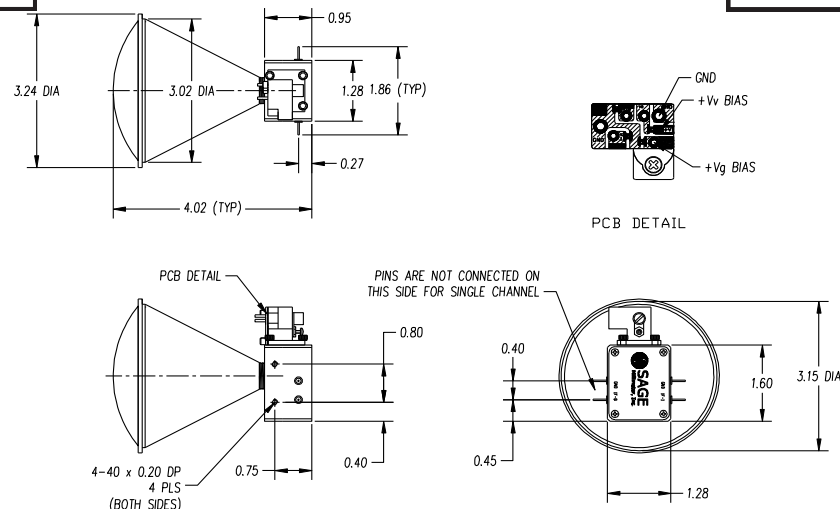
SSD series K Band lens corrected antenna based ranging sensor heads are designed and manufactured for **long range** moving or stationary target measurement. The operation frequency of these sensor modules is at 24.125 GHz. The sensor modules take + 5.0 Vdc/250 mA nominal bias and the frequency modulation bandwidth of ± 150 MHz minimum is realized via tuning voltage from 0 to +20 Volts. The sensor heads are configured with a lens corrected antenna, a T/R diplexer, a single or dual (I/Q) receiver, and a transmitter/receiver oscillator in an integrated package. Sensor heads with I/Q receivers can detect not only the speed and the range of a moving or stationary target, but also the direction of the moving target. The operation frequency of the catalog models is at 24.125 GHz. While the catalog models are offered in standard beamwidth, other antenna beamwidth, such as $5^\circ \times 5^\circ$, are offered as custom designed models.

CATALOG MODELS:

Model Number	SSD-24307-22L-S1	SSD-24313-22L-S1	SSD-24307-22L-D1	SSD-24313-22L-D1
Antenna 3 dB Beamwidth	12°	12°	12°	12°
Antenna Gain (dBi, Typ)	22	22	22	22
Antenna Sidelobes (dBc)	- 20	- 20	- 20	- 20
TX Frequency (GHz)	24.125	24.125	24.125	24.125
TX Power (dBm, Typ)	+ 7.0	+ 13.0	+ 7.0	+ 13.0
Receiver I/Q Phase Δ	N/A	N/A	80 to 100°	80 to 100°
Receiver I/Q Amplitude Δ	N/A	N/A	0 to 2 dB	0 to 2 dB
Detection Range	1,000 to 1,500 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)			
IF Frequency (MHz, Min)	DC to 100	DC to 100	DC to 100	DC to 100
IF Offset Voltage (Vdc)	± 0.25	± 0.25	± 0.25	± 0.25
Frequency II Power Stability	-0.8 MHz/°C II -0.03 dB/°C	-0.8 MHz/°C II -0.03 dB/°C	-0.8 MHz/°C II -0.03 dB/°C	-0.8 MHz/°C II -0.03 dB/°C
Bias (Vdc II mA, Typ)	+ 5.0 II 250	+ 5.0 II 450	+ 5.0 II 250	+ 5.0 II 450

Outline: SD-LK-D (SD-LK)

Dimensions: Inches



Ka Band Microstrip Antenna Based High Performance Ranging Sensor Heads, SSD Series

FEATURES:

- ◆ FMCW operation
- ◆ Various beamwidth
- ◆ Low harmonic emission
- ◆ Low flick noise and high sensitivity
- ◆ Broad FM Bandwidth: ± 100 MHz
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

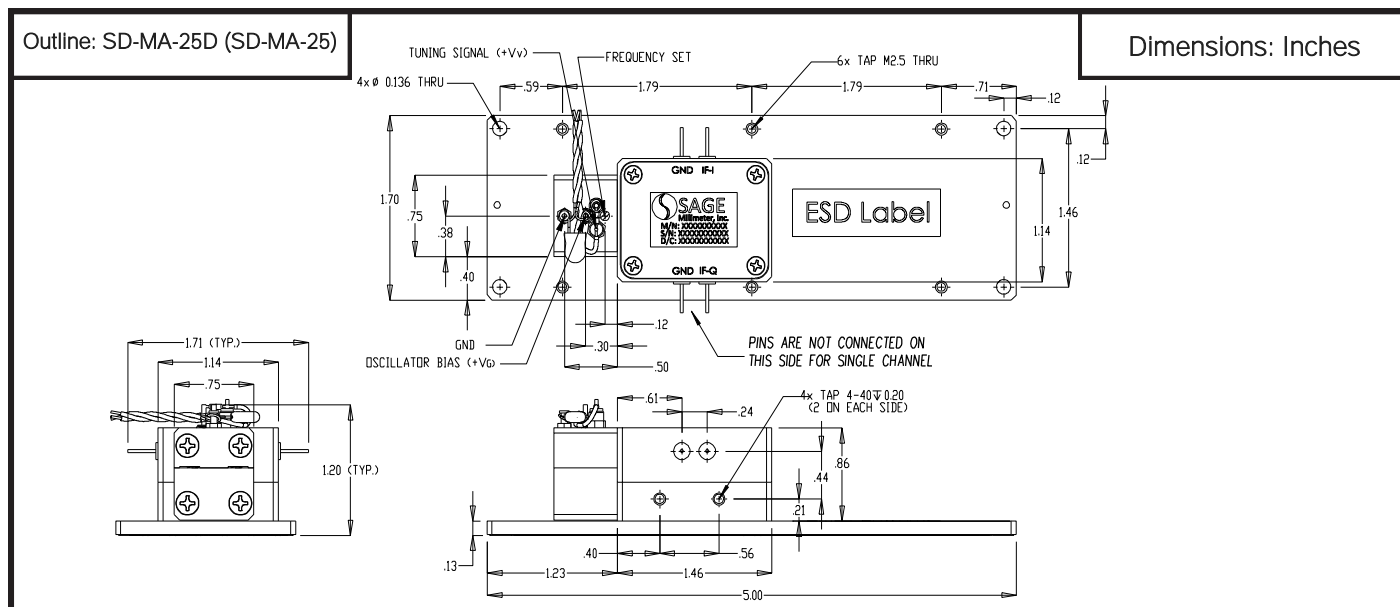
- ◆ Traffic radar systems
- ◆ True ranging systems
- ◆ Level sensing systems
- ◆ Automotive radar systems
- ◆ Military surveillance systems

DESCRIPTION:

SSD series Ka Band microstrip antenna based ranging sensor heads are designed and manufactured for **medium range** moving or stationary target measurement. The operation frequency of these sensor modules is at 34.850 GHz. The sensor modules take + 5.5 Vdc/250 mA nominal bias and the frequency modulation bandwidth of +/-100 MHz minimum is realized via tuning voltage from 0 to +20 Volts. The sensor heads are configured with a microstrip antenna, a T/R diplexer, a single or dual (I/Q) receiver, and a transmitter/receiver oscillator in an integrated package. Sensor heads with I/Q receivers can detect not only the speed and the range of a moving or stationary target, but also the direction of the moving target. While the catalog models are offered in standard beamwidth, other antenna beamwidth, such as 12° x 12°, are offered as custom designed models.

CATALOG MODELS:

Model Number	SSD-35307-19M-S1	SSD-35307-19M-D1
Antenna 3 dB Beamwidth	4.6° (H) x 15° (V)	4.6° (H) x 15° (V)
Antenna Gain (dBi, Typ)	19	19
Antenna Sidelobes (dBc)	- 20	- 20
TX Frequency (GHz)	34.850	34.850
TX Power (dBm, Typ)	+ 7.0	+ 7.0
Receiver I/Q Phase Δ	N/A	80 to 100°
Receiver I/Q Amplitude Δ	N/A	0 to 2 dB
Detection Range	250 to 500 meters for radar cross section 3 meter² (IF amplifier performance and radar DSP scheme dependent)	
IF Frequency (MHz, Min)	DC to 100	DC to 100
IF Offset Voltage (Vdc)	± 0.25	± 0.25
Frequency II Power Stability	-0.3 MHz/°C II -0.03 dB/°C	-0.3 MHz/°C II -0.03 dB/°C
Bias (Vdc II mA, Typ)	+ 5.5 II 250	+ 5.5 II 250



Ka Band Lens Corrected Antenna Based High Performance Ranging Sensor Heads, SSD Series

FEATURES:

- ◆ FMCW operation
- ◆ Various beamwidth
- ◆ Low harmonic emission
- ◆ Low flick noise and high sensitivity
- ◆ Broad FM Bandwidth: ± 100 MHz
- ◆ Temperature range: -40 to +85°C



APPLICATIONS:

- ◆ Traffic radar systems
- ◆ True ranging systems
- ◆ Level sensing systems
- ◆ Automotive radar systems
- ◆ Military surveillance systems

DESCRIPTION:

SSD series Ka Band lens corrected antenna based ranging sensor heads are designed and manufactured for **long range** moving or stationary target measurement. The operation frequency of these sensor modules is at 35.000 GHz, and frequencies in the 33.9 to 36.1 GHz range can be selected by adjusting the self-locking screw mechanically. Various lens corrected antennas with different beamwidth are offered to combine with sensor modules to form various configurations for different applications. The sensor modules take + 5.5 Vdc/250 mA nominal bias and the frequency modulation bandwidth of ± 100 MHz minimum is realized via tuning voltage from 0 to +20 Volts. Sensor heads with I/Q receivers can detect not only the speed and the range of a moving or stationary target, but also the direction of the moving target. While the catalog models are offered in standard beamwidth, other antenna beamwidth and output power levels are offered as custom designed models.

CATALOG MODELS:

Model Number	SSD-35310-22L-S1	SSD-35320-22L-S1	SSD-35310-29L-S1	SSD-35310-22L-D1	SSD-35320-22L-D1	SSD-35310-29L-D1
Antenna Type	Lens Corrected	Lens Corrected	Lens Corrected	Lens Corrected	Lens Corrected	Lens Corrected
Antenna Polarization	Circular	Circular	Circular	Circular	Circular	Circular
Antenna 3 dB Beamwidth	12°	12°	5°	12°	12°	5°
Antenna Gain (dBi, Typ)	22	22	29	22	22	29
Antenna Sidelobes (dBc)	- 20	- 20	- 20	- 20	- 20	- 20
TX Frequency (GHz)	35.00	35.00	35.00	35.00	35.00	35.00
TX Power (dBm, Typ)	+10.0	+20.0	+10.0	+10.0	+20.0	+10.0
Receiver I/Q Phase Δ	N/A	N/A	N/A	80 to 100°	80 to 100°	80 to 100°
Receiver I/Q Amplitude Δ	N/A	N/A	N/A	0 to 2 dB	0 to 2 dB	0 to 2 dB
Detection Range	500 to 1,500 meters for radar cross section 3 meter ² (IF amplifier performance and radar DSP scheme dependent)					
IF Frequency (MHz, min)	DC to 100	DC to 100	DC to 100	DC to 100	DC to 100	DC to 100
IF Offset Voltage (Vdc)	± 0.10	± 0.10	± 0.10	± 0.10	± 0.10	± 0.10
Frequency Stability	- 0.3 MHz/°C	- 0.3 MHz/°C	- 0.3 MHz/°C	- 0.3 MHz/°C	- 0.3 MHz/°C	- 0.3 MHz/°C
Power Stability	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C	- 0.03 dB/°C
Blas Voltage (Vdc, Typ)	+ 5.5	+ 5.5	+ 5.5	+ 5.5	+ 5.5	+ 5.5
Blas Current (mA, Typ)	250	650	250	250	650	250
Temperature Range (°C)	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85
Outline	SD-LA	SD-LA	SD-LA-G	SD-LA-D	SD-LA-D	SD-LA-GD

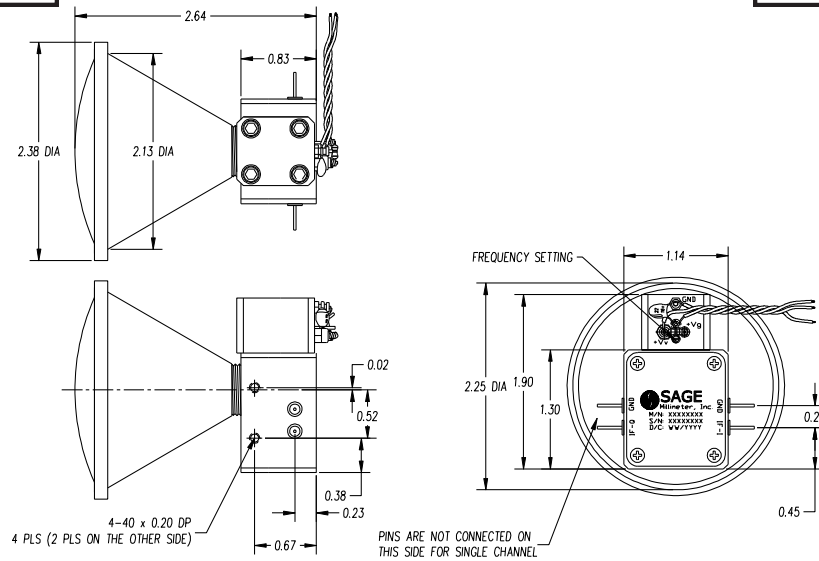
SAGE Millimeter's custom designed ranging sensor head model numbers are configured per following format.

SSD - F0N PP - AGL - XY

F0N is the center frequency in MHz x 10N. For example: 36.0 GHz = 363.
PP is the sensor module output power in dBm. For example: 10 dBm = 10.
AG is the antenna gain in dBi. For example: 25 dBi = 25.
X : "S" is for single channel receiver; "D" is for directional, i.e., I/Q receiver.
Y is for factory reserve.

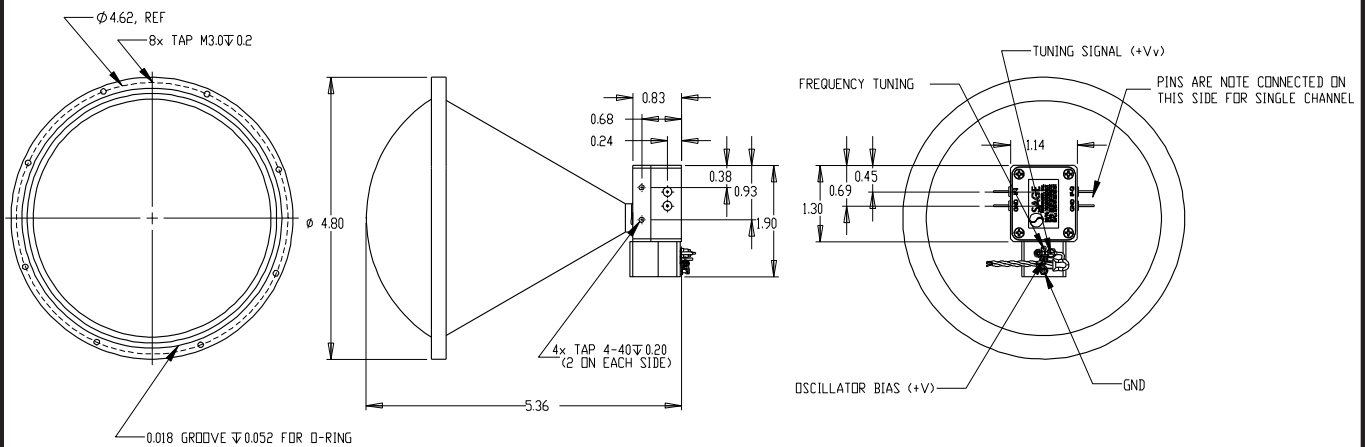
Outline: SD-LA-D (SD-LA)

Dimensions: Inches



Outline: SD-LA-GD (SD-LA-G)

Dimensions: Inches



Doppler Radar Target Simulators, STR Series

FEATURES:

- ◆ Frequencies: 24, 35, 60, 76.5 and 94 GHz
- ◆ Single sideband output
- ◆ Simulated target speed and size adjustable
- ◆ Simulated target moving direction switchable
- ◆ Instrumentation grade



APPLICATIONS:

- ◆ Doppler target simulation

DESCRIPTION:

STR series Doppler radar simulators are single sideband modulator based radar simulators with the following working mechanisms. The radar signal emitted by the under testing radar is received through the antenna port and fed into the single sideband modulator through a diplexer. The single sideband modulator modulates the incoming signal and sends either upper or low band signal back to the diplexer. The frequency shifted signal is transmitted back to the antenna as a Doppler signal for the under testing Doppler radar to receive. The amount of frequency shifting equals the input modulation frequency, i.e., the intermediate frequency (IF). By adjusting the intermediate frequency (IF), the phase of the IF's "I" / "Q" channels and the routing attenuation, the speed, direction, and radar cross-section of the target can be simulated.

STR series Doppler radar simulator offers an economic means to allow Doppler radar manufacturers to evaluate their products without expensive and time consuming field tests. Five of each standard models with level setting (as shown in the photo) and direct reading attenuators are offered at common Doppler radar frequency bands. Models at different frequencies are available upon request.

CATALOG MODELS: (Level Setting Version)

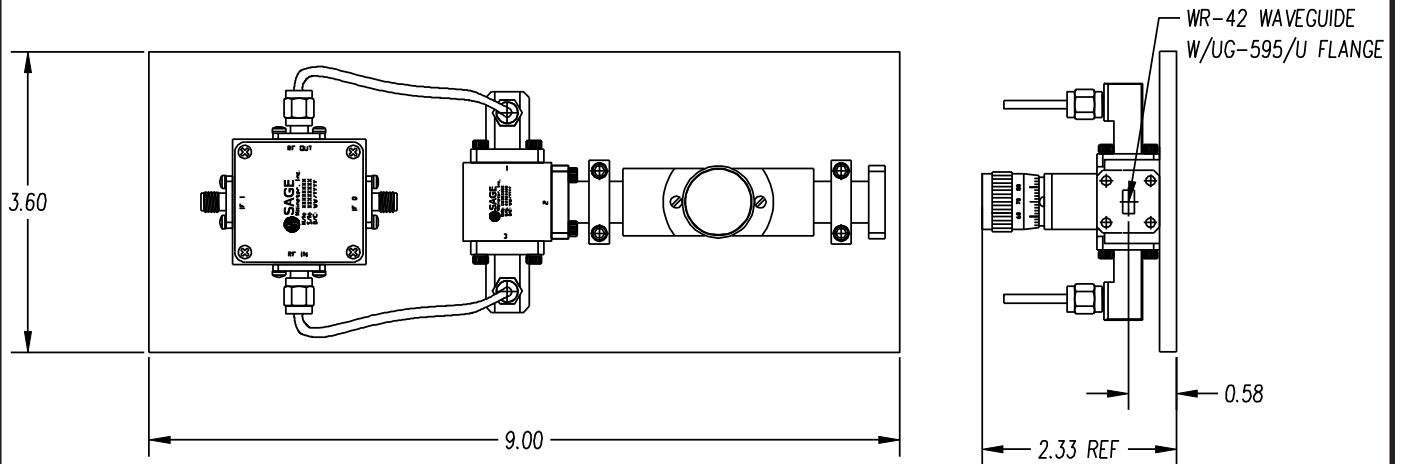
Model Number	STR-243-42-L1	STR-353-28-L1	STR-603-12-L1	STR-773-12-L1	STR-943-10-L1
Waveguide Size	WR-42	WR-28	WR-15	WR-12	WR-10
Frequency (GHz)	24.125	35.000	60.000	76.500	94.000
Operating Bandwidth (MHz)	±100	±150	±250	±250	±250
Carrier Rejection (dB, Min)	30	30	30	30	30
Image Suppression (dB, Min)	20	20	20	20	20
Routing Loss (dB, Typ)	25 to 75	28 to 75	30 to 80	30 to 80	30 to 80
I/Q Band Width (MHz, Min)	0 to 100	0 to 150	0 to 250	0 to 250	0 to 250
I/Q Driving Level (mA, Max)	±10	±10	±10	±10	±10
I/Q Phase Error (Degrees)	±5	±5	±5	±5	±5
IF Port Connectors	SMA (F)	SMA (F)	SMA (F)	SMA (F)	SMA (F)

CATALOG MODELS: (Direct Reading Version)

Model Number	STR-243-42-D1	STR-353-28-D1	STR-603-12-D1	STR-773-12-D1	STR-943-10-D1
Waveguide Size	WR-42	WR-28	WR-15	WR-12	WR-10
Frequency (GHz)	24.125	35.000	60.000	76.500	94.000
Operating Bandwidth (MHz)	±100	±150	±250	±250	±250
Carrier Rejection (dB, Min)	30	30	30	30	30
Image Suppression (dB, Min)	20	20	20	20	20
Routing Loss (dB, Typ)	25 to 125	28 to 125	30 to 130	30 to 130	30 to 130
I/Q Band Width (MHz, Min)	0 to 100	0 to 150	0 to 250	0 to 250	0 to 250
I/Q Driving Level (Vp-p Max)	±10	±10	±10	±10	±10
I/Q Phase Error (Degrees)	±5	±5	±5	±5	±5
IF Port Connectors	SMA (F)	SMA (F)	SMA (F)	SMA (F)	SMA (F)

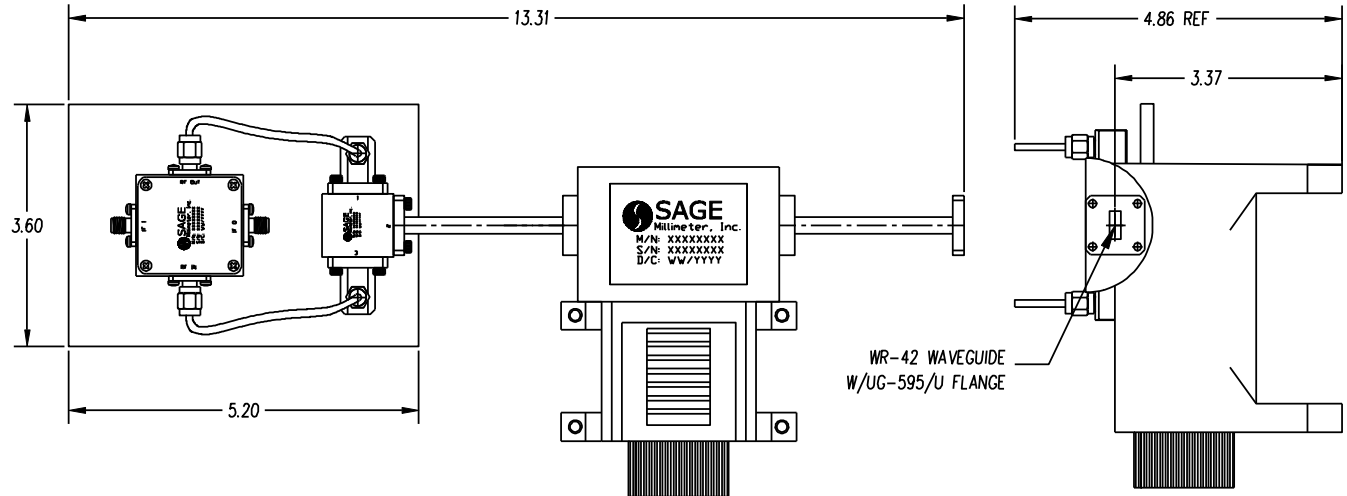
Outline: TR-KL

Dimensions: Inches

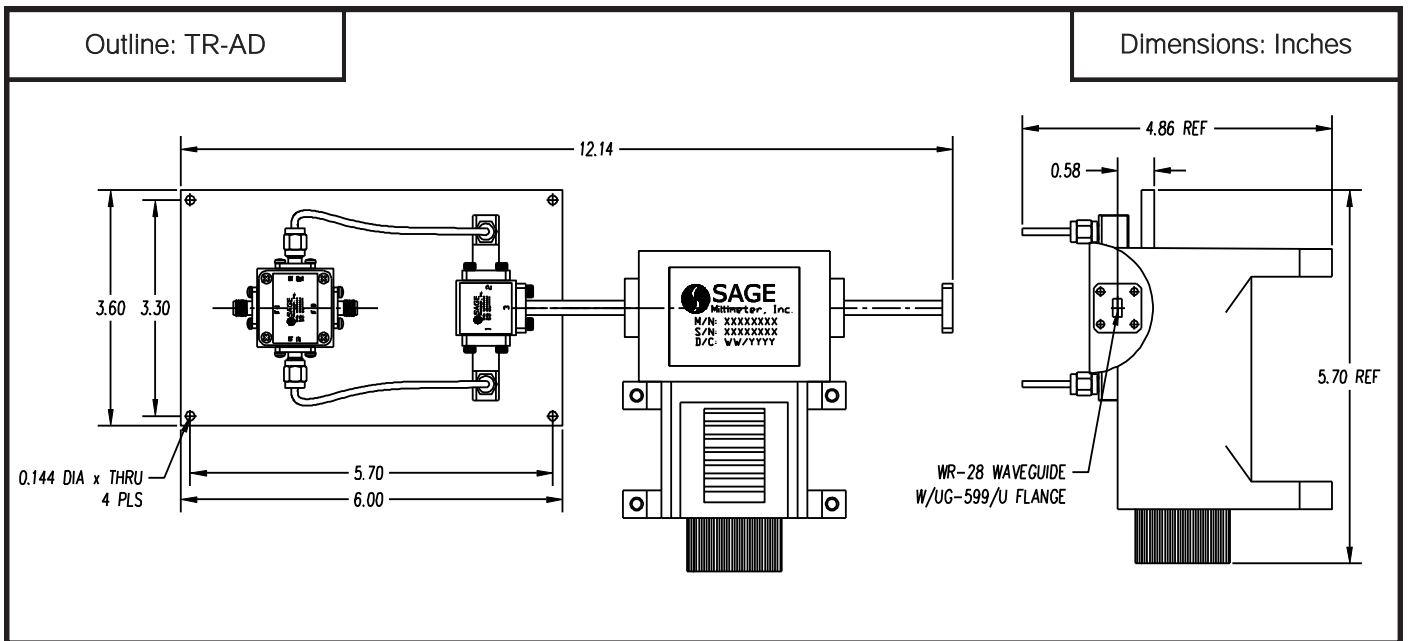
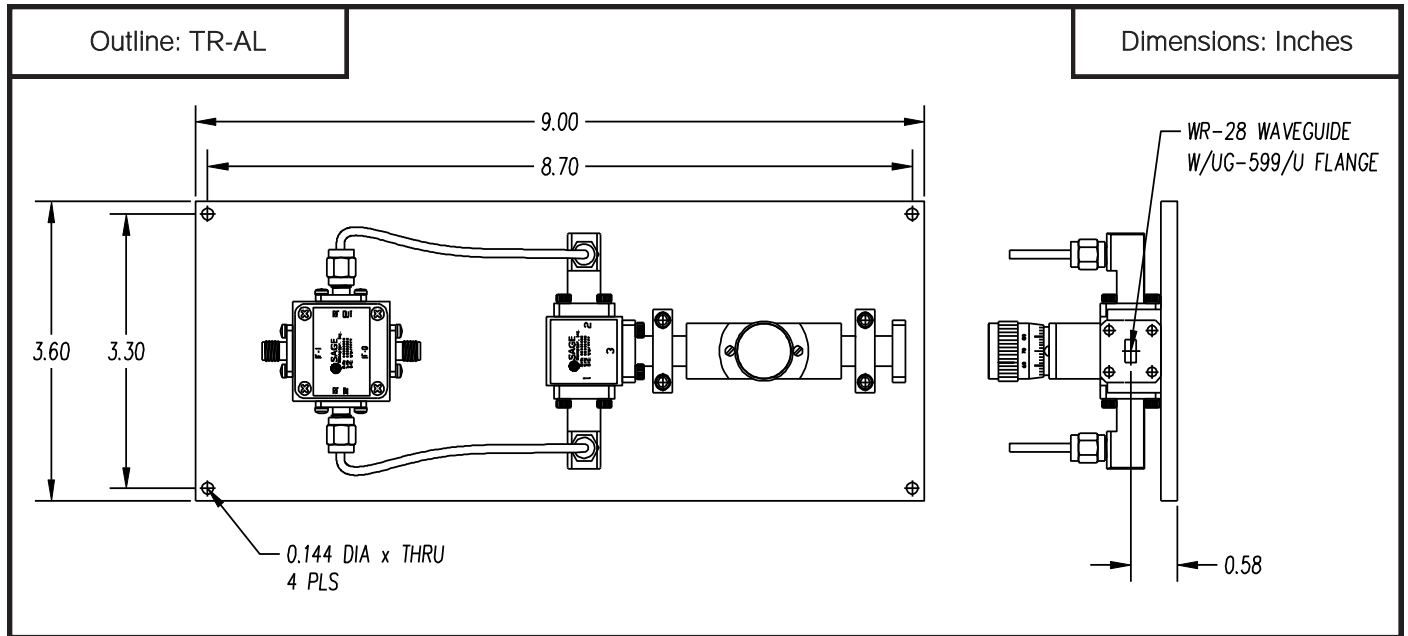


Outline: TR-KD

Dimensions: Inches



Note: Contact factory for V, E and W Band simulator outlines.



Note: Contact factory for V, E and W Band simulator outlines.

Doppler Radar Target Simulators Application Notes, STR Series



LEVEL SETTING VERSION



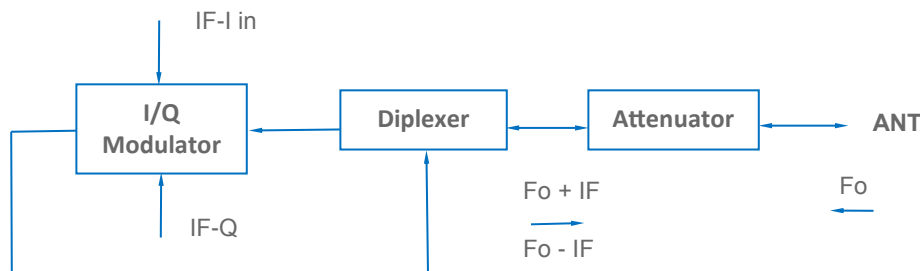
DIRECT READING VERSION

DESCRIPTION:

STR series Doppler radar simulators are single sideband modulator based radar simulators with the following working mechanisms. The radar signal emitted by the under testing radar is received through the antenna port and fed into a single sideband modulator through a diplexer. The single sideband modulator modulates the incoming signal and sends either upper or low band signal back to the diplexer. The frequency shifted signal is transmitted back to the antenna as Doppler signal for the under testing Doppler radar to receive. The amount of frequency shifting equals the input modulation frequency, i.e., the intermediate frequency (IF). By adjusting the intermediate frequency (IF), the phase of the IF's "I" / "Q" channels and the routing attenuation, the speed, direction, and radar cross-section of the target can be simulated.

BLOCK DIAGRAM:

The block diagram of the simulator is shown in the figure. If accurate distance simulation is required, a direct reading attenuator, such as SAGE Model STA-60-WG-D1, is recommended.



OPERATION:

1. Use a function generator that is capable of delivering two orthogonal output signals (IF-I and IF-Q) in the frequency range of the TBD target speed and ± 10 Vp-p amplitude level. For example, if the interested target speed is at 80 KM per hour and your radar under testing is at 24.125 GHz (F_o), the IF-I and IF-Q shall set at 3,575 Hz (Doppler Shift).
2. Connect the outputs of the function generator to the IF inputs of the simulator.
3. Emit the radar signal from the under testing radar system toward the simulator antenna port (ANT). The returned Doppler shifted frequency $F_o + IF$ or $F_o - IF$ is received by the Radar, and Radar displays the Doppler shift, which is the speed of the target.
4. Vary the frequency of the function generator to simulate various speeds of the target.
5. Vary the phase of the function generator (the phase difference of the IF-I and IF-Q signal, 90° or -90°) to simulate the direction of the moving target, i. e., approaching or receding target.
6. Vary the path attenuation by adjusting the attenuator value to simulate the target radar cross section or the distance. While the level setting attenuator can only give relative ranging (distance) information, the direct reading attenuator can give the exact ranging information directly.

Sensor Module and Sensor Head Selection Guide

SAGE Millimeter offers many sensor models based on their cost, package styles, functionalities, and application focuses. The following selection guide provides general guidelines to help the customers select proper models for its applications. Contact factory for more information.

Series	Model Number	Band	Antenna	Speed	Direction	Ranging	Sensitivity	Package	Cost	Page
SSM	SSM-24307-S1	K	None	Yes	No	No	Low	Compact	Low	11
	SSM-24307-D1	K	None	Yes	Yes	No	Low	Compact	Low	11
	SSM-60313-S1	V	None	Yes	No	No	High	Bulky	High	12
	SSM-60310-D1	V	None	Yes	Yes	No	High	Bulky	High	12
	SSM-77313-S1	E	None	Yes	No	No	High	Bulky	High	12
	SSM-77310-D1	E	None	Yes	Yes	No	High	Bulky	High	12
	SSM-94313-S1	W	None	Yes	No	No	High	Bulky	High	12
	SSM-94310-D1	W	None	Yes	Yes	No	High	Bulky	High	12
SSP	SSP-24307-S1	K	None	Yes	No	Yes	Low	Compact	Low	13
	SSP-24303-D1	K	None	Yes	Yes	Yes	Low	Compact	Low	13
	SSP-60313-S1	V	None	Yes	No	Yes	High	Bulky	High	14
	SSP-60310-D1	V	None	Yes	Yes	Yes	High	Bulky	High	14
	SSP-77313-S1	E	None	Yes	No	Yes	High	Bulky	High	14
	SSP-77310-D1	E	None	Yes	Yes	Yes	High	Bulky	High	14
	SSP-94313-S1	W	None	Yes	No	Yes	High	Bulky	High	14
	SSP-94310-D1	W	None	Yes	Yes	Yes	High	Bulky	High	14
SSS	SSS-24307-20M-SW	K	Microstrip	Yes	No	No	Low	Compact	Low	15
	SSS-24307-20M-DW	K	Microstrip	Yes	Yes	No	Low	Compact	Low	15
	SSS-24307-25M-SW	K	Microstrip	Yes	No	No	Low	Compact	Low	15
	SSS-24307-25M-DW	K	Microstrip	Yes	Yes	No	Low	Compact	Low	15
	SSS-24307-27M-SW	K	Microstrip	Yes	No	No	Low	Compact	Low	15
	SSS-24307-27M-DW	K	Microstrip	Yes	Yes	No	Low	Compact	Low	15
	SSS-24307-25M-S1	K	Microstrip	Yes	No	No	Medium	Compact	Medium	17
	SSS-24307-25M-D1	K	Microstrip	Yes	Yes	No	Medium	Compact	Medium	17
	SSS-24307-27M-S1	K	Microstrip	Yes	No	No	Medium	Compact	Medium	17
	SSS-24307-27M-D1	K	Microstrip	Yes	Yes	No	Medium	Compact	Medium	17
	SSS-24310-22L-S1	K	Lens	Yes	No	No	High	Bulky	Medium	19
	SSS-24310-22L-D1	K	Lens	Yes	Yes	No	High	Bulky	Medium	19
	SSS-24320-22L-S1	K	Lens	Yes	No	No	High	Bulky	Medium	19
	SSS-24320-22L-D1	K	Lens	Yes	Yes	No	High	Bulky	Medium	19
	SSS-35307-25M-S1	Ka	Microstrip	Yes	No	No	Medium	Compact	Medium	20
	SSS-35307-25M-D1	Ka	Microstrip	Yes	Yes	No	Medium	Compact	Medium	20
	SSS-35310-22L-S1	Ka	Lens	Yes	No	No	High	Bulky	Medium	21
	SSS-35310-22L-D1	Ka	Lens	Yes	Yes	No	High	Bulky	Medium	21
	SSS-35320-22L-S1	Ka	Lens	Yes	No	No	High	Bulky	High	21
	SSS-35320-22L-D1	Ka	Lens	Yes	Yes	No	High	Bulky	High	21
	SSS-35300-22L-S1	Ka	Lens	Yes	No	No	High	Bulky	Medium	21
	SSS-35300-22L-D1	Ka	Lens	Yes	Yes	No	High	Bulky	Medium	21

Sensor Module and Sensor Head Selection Guide (Continued)

SAGE Millimeter offers many sensor models based on their cost, package styles, functionalities and application focuses. The following selection guide provides general guidelines to help the customers to select proper models for its applications. Contact factory for more information.

Series	Model Number	Band	Antenna	Speed	Direction	Ranging	Sensitivity	Package	Cost	Page
SSD	SSD-24305-20M-SW	K	Microstrip	Yes	No	Yes	Low	Compact	Low	23
	SSD-24303-20M-DW	K	Microstrip	Yes	Yes	Yes	Low	Compact	Low	23
	SSD-24305-25M-SW	K	Microstrip	Yes	No	Yes	Low	Compact	Low	23
	SSD-24303-25M-DW	K	Microstrip	Yes	Yes	Yes	Low	Compact	Low	23
	SSD-24305-27M-SW	K	Microstrip	Yes	No	Yes	Low	Compact	Low	23
	SSD-24303-27M-DW	K	Microstrip	Yes	Yes	Yes	Low	Compact	Low	23
	SSD-24303-25M-S1	K	Microstrip	Yes	No	Yes	Medium	Compact	Medium	25
	SSD-24303-25M-D1	K	Microstrip	Yes	Yes	Yes	Medium	Compact	Medium	25
	SSD-24303-27M-S1	K	Microstrip	Yes	No	Yes	Medium	Compact	Medium	25
	SSD-24303-27M-D1	K	Microstrip	Yes	Yes	Yes	Medium	Compact	Medium	25
	SSD-24307-22L-S1	K	Lens	Yes	No	Yes	High	Bulky	Medium	27
	SSD-24313-22L-D1	K	Lens	Yes	Yes	Yes	High	Bulky	Medium	27
	SSD-35307-25M-S1	Ka	Microstrip	Yes	No	Yes	Medium	Compact	Medium	28
	SSD-35307-25M-D1	Ka	Microstrip	Yes	Yes	Yes	Medium	Compact	Medium	28
	SSD-35310-22L-S1	Ka	Lens	Yes	No	Yes	High	Bulky	Medium	29
	SSD-35310-22L-D1	Ka	Lens	Yes	Yes	Yes	High	Bulky	Medium	29
	SSD-35320-22L-S1	Ka	Lens	Yes	No	Yes	High	Bulky	High	29
	SSD-35320-22L-D1	Ka	Lens	Yes	Yes	Yes	High	Bulky	High	29
	SSD-35300-29L-S1	Ka	Lens	Yes	No	Yes	High	Bulky	Medium	29
	SSD-35300-29L-D1	Ka	Lens	Yes	Yes	Yes	High	Bulky	Medium	29

NOTE:

1. The **SSM** Doppler sensor modules and **SSP** ranging sensor modules are the building blocks for many sensor heads by selecting various antenna types or specifications. Refer to SAGE Millimeter's main catalog for your antenna selections.
2. The sensor modules and sensor heads included in this catalog are focused on single antenna (Monostatic) applications. Contact factory for dual antenna sensors and sensor heads for dual antenna (Bistatic) applications.

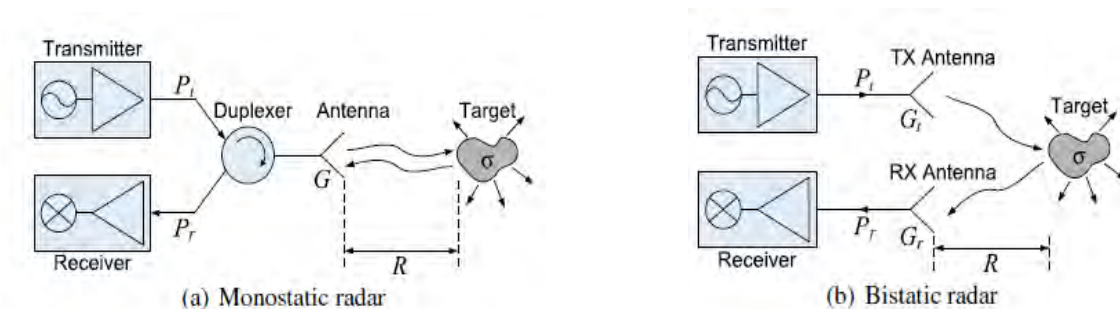


Figure 5. Monostatic and Bistatic Radar Systems

Appendix

μ W, mW and Watt to dBm Conversion

μ W and dBm

μ W	dBm
1.0	-30.0
2.0	-27.0
3.0	-25.2
4.0	-24.0
5.0	-23.0
6.0	-22.2
7.0	-21.5
8.0	-21.0
9.0	-20.5
10.0	-20.0
20.0	-17.0
30.0	-15.2
40.0	-14.0
50.0	-13.0
60.0	-12.2
70.0	-11.5
80.0	-11.0
90.0	-10.5
100	-10.0
200	-7.0
300	-5.2
400	-4.0
500	-3.0
600	-2.2
700	-1.5
800	-1.0
900	-0.5
1000	0.0

mW and dBm

mW	dBm
1.0	0.0
2.0	3.0
3.0	4.8
4.0	6.0
5.0	7.0
6.0	7.8
7.0	8.5
8.0	9.0
9.0	9.5
10.0	10.0
20.0	13.0
30.0	14.8
40.0	16.0
50.0	17.0
60.0	17.8
70.0	18.5
80.0	19.0
90.0	19.5
100	20.0
200	23.0
300	24.8
400	26.0
500	27.0
600	27.8
700	28.5
800	29.0
900	29.5
1000	30.0

Watt and dBm

Watt	dBm
1.0	30.0
2.0	33.0
3.0	34.8
4.0	36.0
5.0	37.0
6.0	37.8
7.0	38.5
8.0	39.0
9.0	39.5
10.0	40.0
20.0	43.0
30.0	44.8
40.0	46.0
50.0	47.0
60.0	47.8
70.0	48.5
80.0	49.0
90.0	49.5
100	50.0
200	53.0
300	54.8
400	56.0
500	57.0
600	57.8
700	58.5
800	59.0
900	59.5
1000	60.0

TERMS AND CONDITIONS

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Customer may place orders through sales representatives, distributors, or directly to SAGE Millimeter's sales department. **An order acknowledgement will be emailed, mailed, or faxed from SAGE Millimeter, Inc. to acknowledge the acceptance of the order.**

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Warranty repairs will be made at no cost to the customer by paid incoming freight by the customer. Out-of-warranty repairs require a purchase order from the customer before the repairs can be accomplished. SAGE Millimeter, Inc. will provide an estimate for the cost and delivery of the repair once such request is received from the customer. An estimation fee may apply for products that are deemed to be out-of-warranty.

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