Microwave & Millimeterwave Technologies

SAGE Millimeter, Inc.


# SENSOR CATALOG

2013

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A

## □ 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 to ***two*** product catalogues: main catalogue and sensor catalogue. The main catalogue consists of ten product families according to their functionalities. The sensor catalogue is focused on speed and distance detection applications and offered primary for Radar system integrators. While these two catalogues offer the standard models to cover the most microwave and millimeterwave general application categories, SAGE Millimeter is committed to design and manufacture 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' experience in microwave and millimeterwave component and subassembly industry. We possess comprehensive knowledge about the engineering and manufacturing process and 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 the customers by providing well engineered, cost effective, high quality and on time delivered products.

Located in Torrance, California with 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 enviornment.

# Radar Basics and Related SAGE Millimeter Microwave Sensor Technologies

The word "Radar" stands for **Ra**dio **d**etection **a**nd **r**anging, which means using radio wave to detect and evaluate the objects. 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 following:

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

Where: **Pr** is returning power to the receiving antenna
**Pt** is the transmitting power
**Gt** is the gain of the transmitting antenna
**Ar** is the effective aperture (area) of the receiving antenna
**σ** is the radar cross section of the target
**F** is the pattern propagation factor
**Rt** is the distance from the transmitter to the target
**Rr** 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 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,

$$F_d = \frac{2VF_{RF}}{C} \cos\Theta$$

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

Some Doppler Shifts (Intermediate Frequency) in common microwave and millimeterwave bands are listed in the 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 s to or receding from the observer. Doppler Directional Radar is used to measure the moving target and speed and direction. There are various ways to detect the moving direction. The directional sensor offered by SAGE Millimeter is based on 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 frequency modulation (FMCW) approach. 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 sensor module (TX/RX module) and antenna. The simplified block diagram of a **Doppler Radar** employs SAGE Millimeter's single channel sensor module (SSM series) or sensor head (SSS series) are shown in Figure 1. 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 of Radar system design are target Radar Cross Section (RCS), target detection distance and target speed.

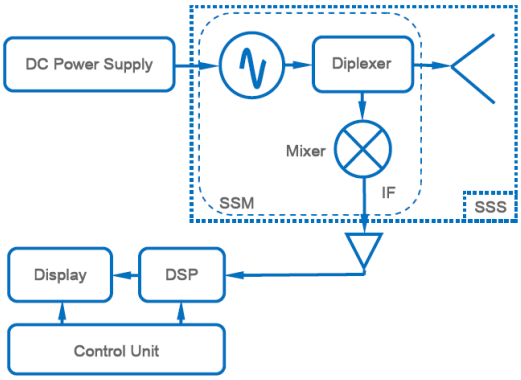



Figure 1. Simplified Doppler Radar Block Diagram

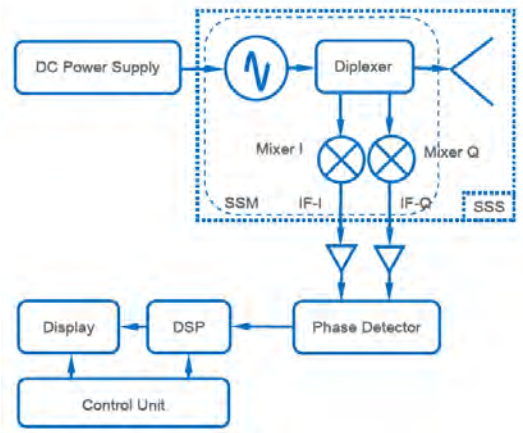



Figure 2. Simplified Directional Doppler Radar Block Diagram

For certain applications, one not only need measure the speed of moving target, but also need know if the direction of the moving target is towards the observer or receding the observer. One example is that the speeding Radar only concerns the forwarding moving target, but need to neglect the receding target. The simplified **Directional Doppler Radar** employs SAGE Millimeter's dual channel sensor module (SSM series) or sensor head (SSS series) is shown in Figure 2.

In addition, many applications requires ranging information. The simplified block diagram of a **FMCW Ranging Radar** employs SAGE Millimeter's single channel ranging sensor module (SSP series) or sensor head (SSD series) are shown in Figure 3. The minimum supporting circuits or equipment are 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.

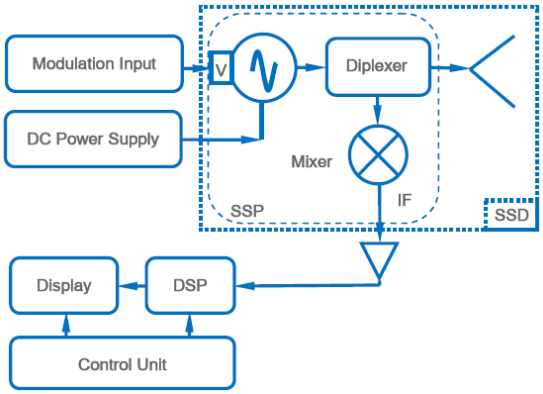



Figure 3. Simplified FMCW Ranging Radar Block Diagram

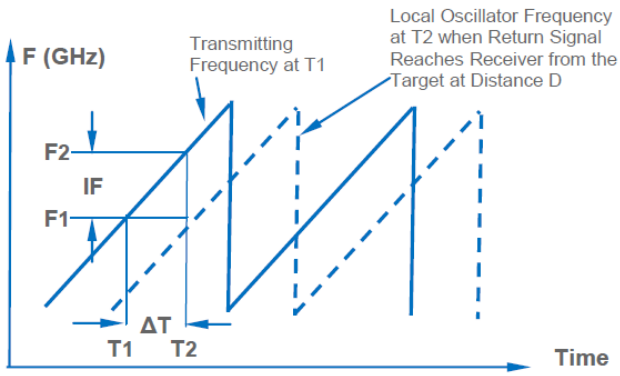



Figure 4. FMCW Radar Ranging Information Illustration

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). The Figure 4 illustrates the relationship of the transmitted and returned signal in the time domain. At time $T_1$, the transmitter signal is launched with frequency $F_1$. This signal is returned from the target at distance D at $T_2$ to the receiver when the local oscillator frequency to the receiver is at $F_2$. With known modulation rate R, the transient time ΔT is obtained by formula **$\Delta T = (F1-F2)/R$**, where $F_1$-$F_2$ is the receiver IF frequency (in Hz). Based on that, the range D can be obtained from formula **$D = (\Delta T \times C)/2$**, where C is the speed of light, $3X10^8$ 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 4.

# K Band Mechanically Tuned Gunn Oscillators, SOL Series

## FEATURES:

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

## APPLICATIONS:

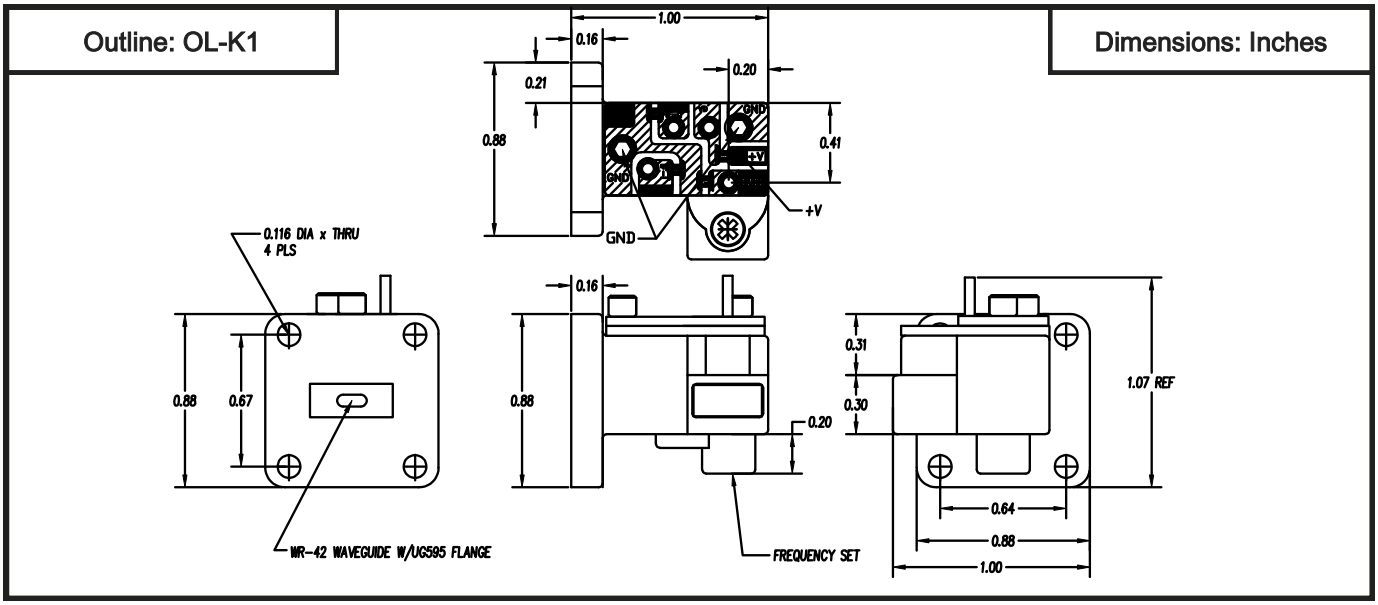
- Speed sensors
- Traffic control systems
- Doppler Radar systems

## DESCRIPTION:

**K Band** mechanically tuned oscillators are offered in 4 power levels at 24.150 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 adjustment 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-24310-42-G1 | SOL-24313-42-G1 | SOL-24317-42-G1 | SOL-24320-42-G1 |
|---|---|---|---|---|
| Center Frequency (GHz) | 24.150 | 24.150 | 24.150 | 24.150 |
| 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) | - 0.8 | - 0.8 | - 0.8 | - 0.8 |
| Power Stability (dB/°C) | - 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

B

## FEATURES:

- Low cost and production ready
- 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

B

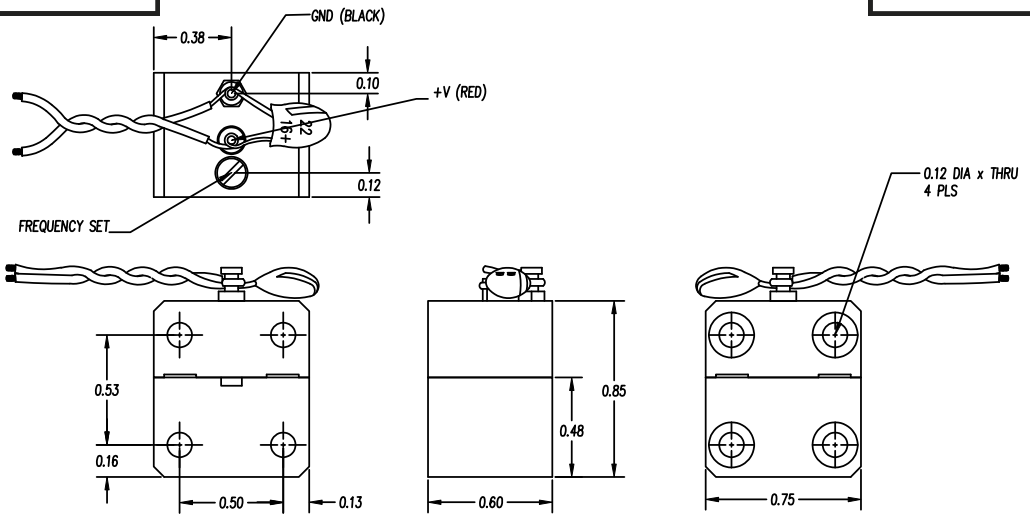
## DESCRIPTION:

**Ka Band** mechanically tuned oscillators are offered in 4 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 adjustment 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-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) | ±2,000 | ±2,000 | ±2,000 | ±2,000 |
| Harmonics (dBc, typ) | - 20 | - 20 | - 20 | - 20 |
| Phase Noise (dBc/Hz @ 100 KHz offset) | - 95 | - 95 | - 95 | - 95 |
| Frequency Stability (MHz/°C) | - 0.3 | - 0.3 | - 0.3 | - 0.3 |
| Power Stability (dB/°C) | - 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 |

**Outline: OL-A1** | **Dimensions: Inches**



# Other Frequency Band Mechanically Tuned Gunn Oscillators, SOM Series

B

## FEATURES:

- Frequency coverage: 60, 76.5 and 94 GHz
- Tuning bandwidth up to full waveguide band
- Low AM/FM noise and harmonics
- Bias tunable
- Temperature range: 0 to 50°C

## APPLICATIONS:

- Speed sensors
- Traffic control systems
- Doppler Radar systems

B

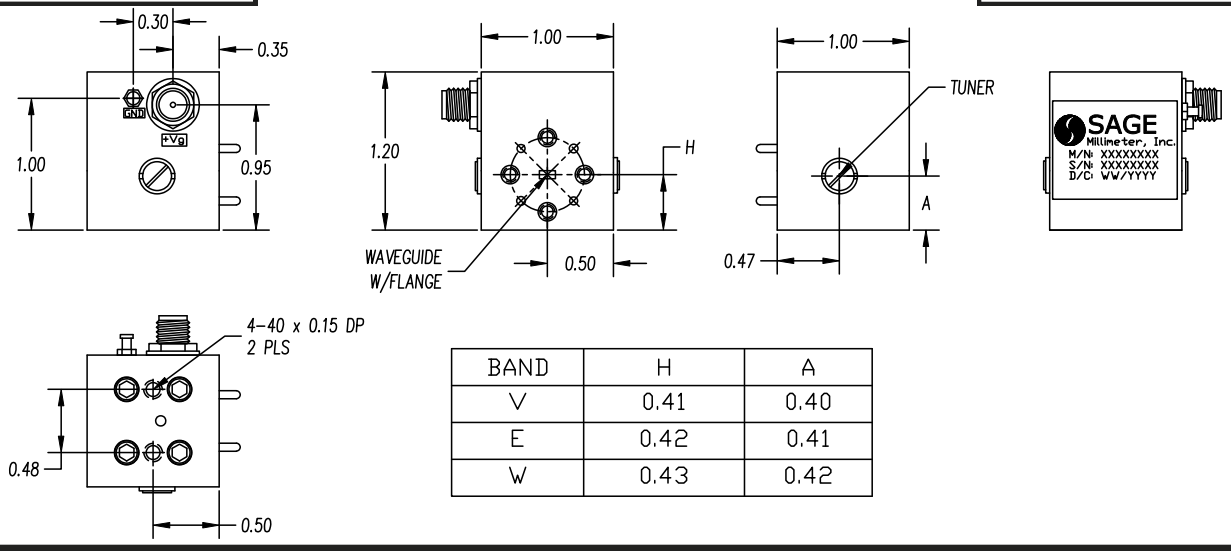
## DESCRIPTION:

**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. The operating frequencies and output power other than listed under standard models are offered in SAGE Millimeter standard catalogue.

## 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**




| BAND | H | A |
|---|---|---|
| V | 0.41 | 0.40 |
| E | 0.42 | 0.41 |
| W | 0.43 | 0.42 |

# K Band Varactor Tuned Gunn Oscillators, SOL Series

## FEATURES:

- Low cost and production ready
- 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

## DESCRIPTION:

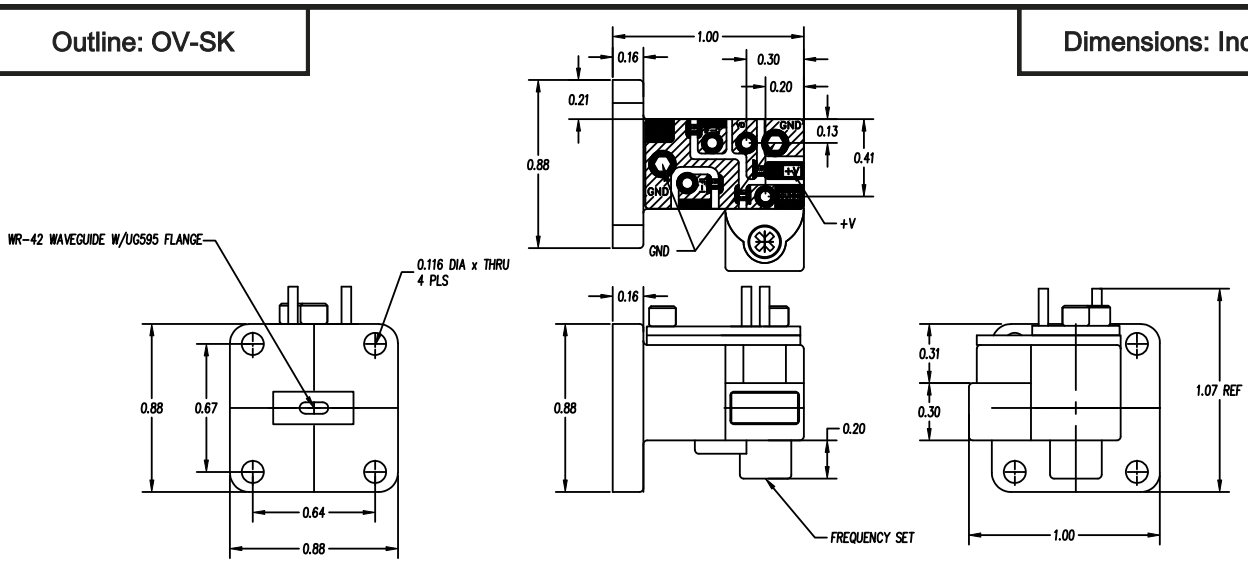
**K Band** Varactor tuned oscillators are offered in 4 power levels with frequency centered at 24.150 GHz. These oscillators utilize high performance GaAs Gunn diodes and Varactor diodes to yield excellent phase noise and stability. These oscillators are free running oscillators with extremely high frequency and power stability. The oscillators are designed and manufactured for fixed frequency applications in general, however, fine frequency adjustment 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-24307-42-GV | SOL-24310-42-GV | SOL-24313-42-GV | SOL-24317-42-GV |
|---|---|---|---|---|
| Center Frequency (GHz) | 24.150 | 24.150 | 24.150 | 24.150 |
| Output Power (dBm, min) | + 7.0 | + 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) | - 1.0 | - 1.0 | - 1.0 | - 1.0 |
| Power Stability (dB/°C) | - 0.02 | - 0.02 | - 0.02 | - 0.02 |
| Bias Voltage II Current (Vdc II mA, typ) | + 5.0 II 250 | + 5.0 II 350 | + 5.0 II 450 | + 5.0 II 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 |

**Outline: OV-SK**

**Dimensions: Inches**



# Ka Band Varactor Tuned Gunn Oscillators, SOL Series

B

## FEATURES:

- Low cost and production ready
- 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

B

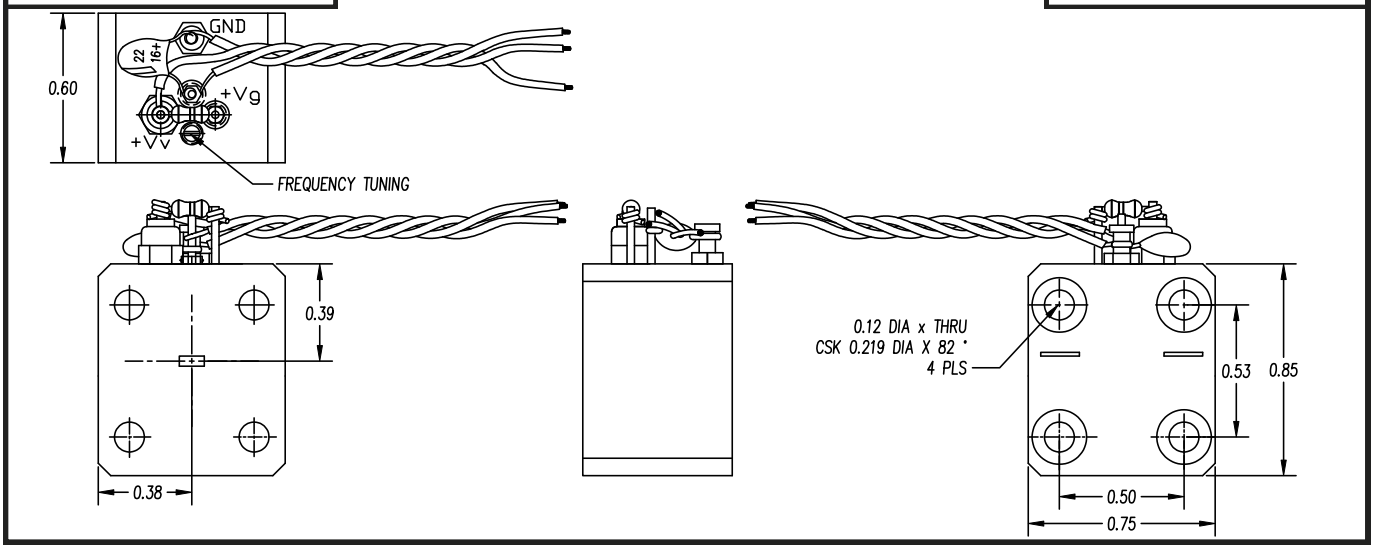
## DESCRIPTION:

**Ka Band** Varactor tuned oscillators are offered in 4 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 fixed frequency applications in general, however, fine frequency adjustment 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), min) | ±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) | - 0.5 | - 0.5 | - 0.5 | - 0.5 |
| Power Stability (dB/°C) | - 0.03 | - 0.03 | - 0.03 | - 0.05 |
| Bias Voltage II Current (Vdc II mA, typ) | + 5.5 II 250 | + 5.5 II 350 | + 5.5 II 450 | + 5.5 II 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 |

**Outline: OV-SA** **Dimensions: Inches**



# 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 tunable
- Temperature range: 0 to 50°C

## APPLICATIONS:

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

B

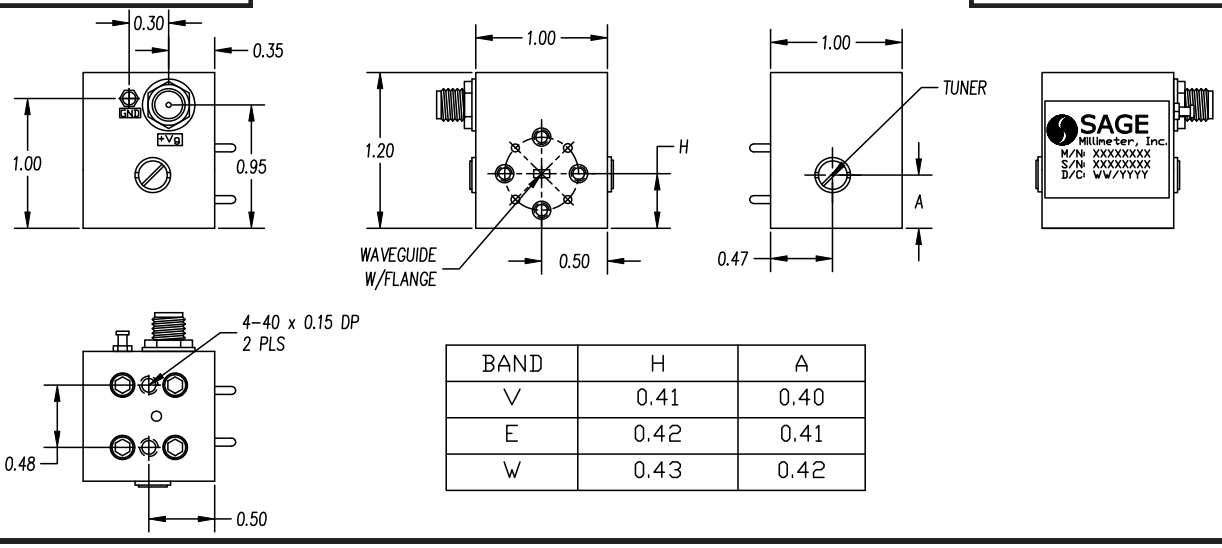
## DESCRIPTION:

**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. 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 adjustment 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, min) | ± 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 |

**Outline: OM-SVEW** | **Dimensions: Inches**




| BAND | H | A |
|---|---|---|
| V | 0.41 | 0.40 |
| E | 0.42 | 0.41 |
| W | 0.43 | 0.42 |

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

## FEATURES:

- CW and pulse mode operation
- Low harmonic emission
- FCC Part 15 compliant
- Die-cast housing for low cost
- Temperature range: -40 to +85°C

## APPLICATIONS:

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

C

## 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 24.15 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 speeds and the directions of moving targets simultaneously.

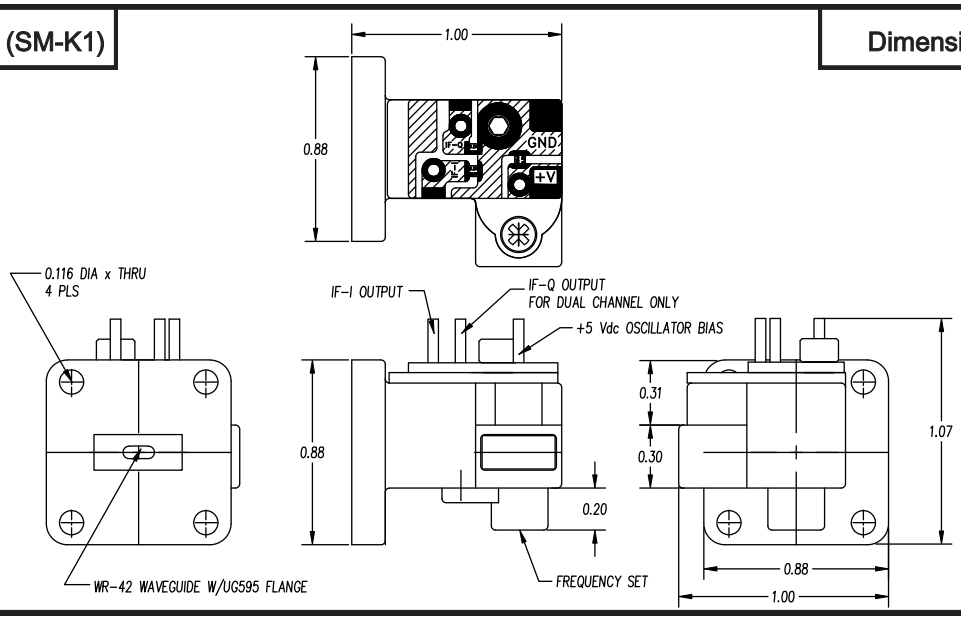
C

## 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 II Current ( Vdc II mA, Typ) | +5.0 II 250 | +5.0 II 250 |

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

Dimensions: Inches



# Other Band Doppler Sensor Modules, SSM Series

## FEATURES:

- Common frequency bands
- Low phase noise
- Low harmonic emission
- High sensitivity
- Temperature range: -40 to +85°C

## APPLICATIONS:

- Speed sensors
- Traffic control systems
- Doppler Radar systems

C

## 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 are 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 models with I/Q receiver can not only detect the speed of the moving targets, but also the direction simultaneously. While three catalog models are offered with specific configuration and specifications, custom designed models are available to meet customers' unique application needs.

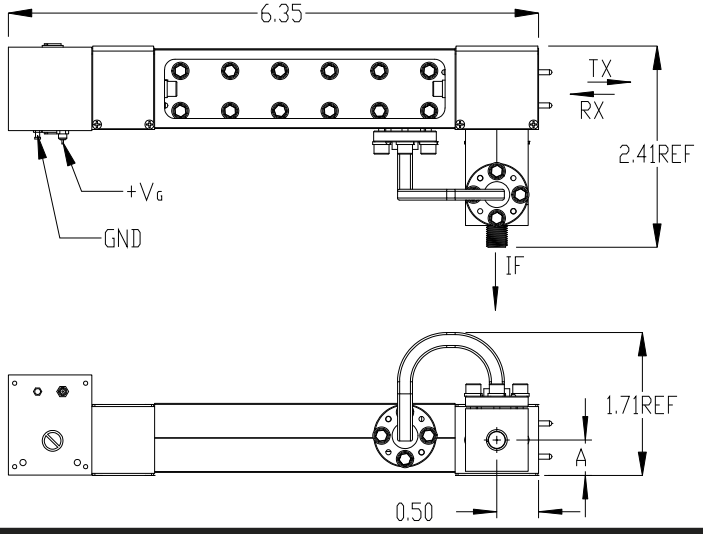
C

## 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 (Max) | - 4.0 | - 4.0 | - 4.5 | - 4.5 | - 5.0 | - 5.0 |
| Power Stability (Max) | - 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:

- FMCW operation mode
- Low harmonic emission
- Low flick noise and high sensitivity
- Die-cast housing for low cost
- 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 principle. 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 module with I/Q receiver can not only detect the speed and the range of a moving or stationary target, but also the direction of the moving target.

D

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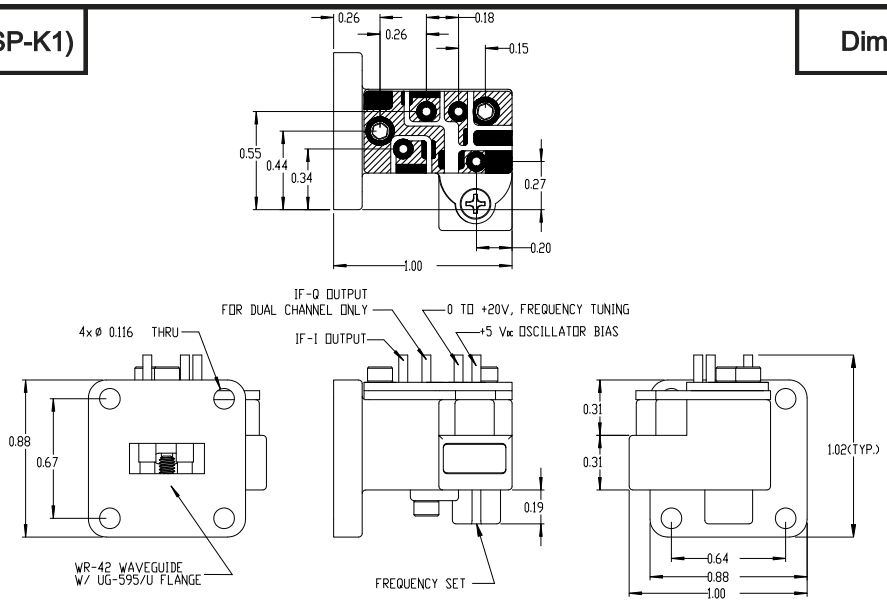
## CATALOG MODELS:

| Model Number | SSP-24307-S1 | SSP-24303-D1 |
|---|---|---|
| TX Frequency (GHz) | 24.125 | 24.125 |
| TX Power (dBm, Typ) | + 7.0 | + 3.0 |
| Frequency Modulation (MHz, Min) | ±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 phase 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 principle 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 standard rectangular waveguides that support 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 module with I/Q receiver can not only detect the speed and the range of a moving or stationary target, but also the direction of the moving target.

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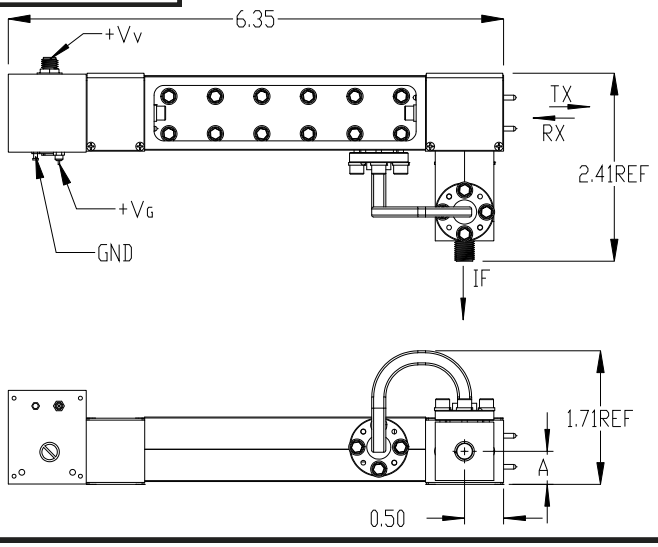
## CATALOG MODELS:

| 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 (Max) | - 5.0 | - 5.0 | - 5.5 | - 5.5 | - 6.0 | - 6.0 |
| Power Stability (Max) | - 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 |

**Outline: SP-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 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
- 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.

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## 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 | v | 10.0 | 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 |

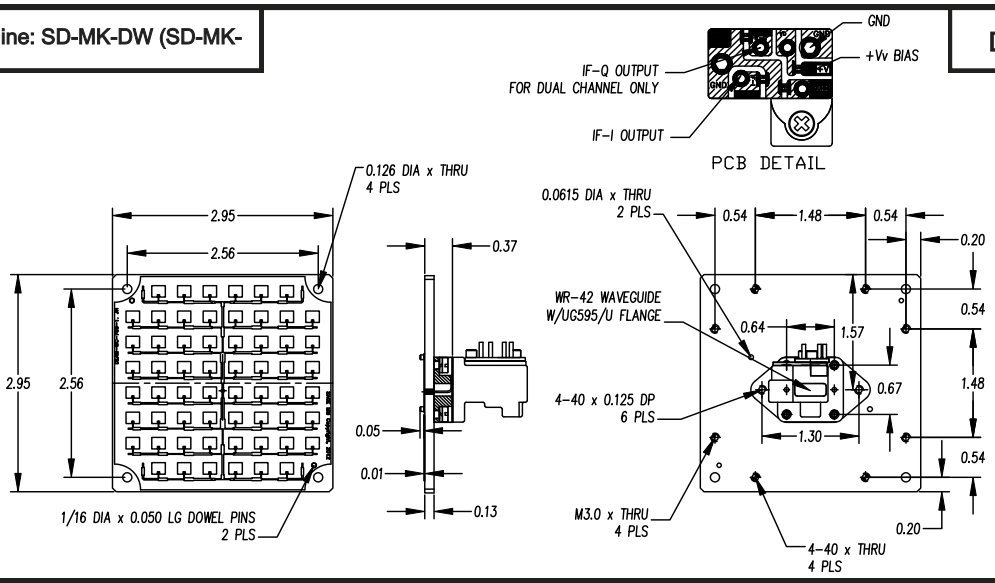
**SAGE Millimeter**'s custom designed Doppler sensor head model numbers are configured per following format.

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.

## Outline: SD-MK-DW (SD-MK-

Dimensions: Inches

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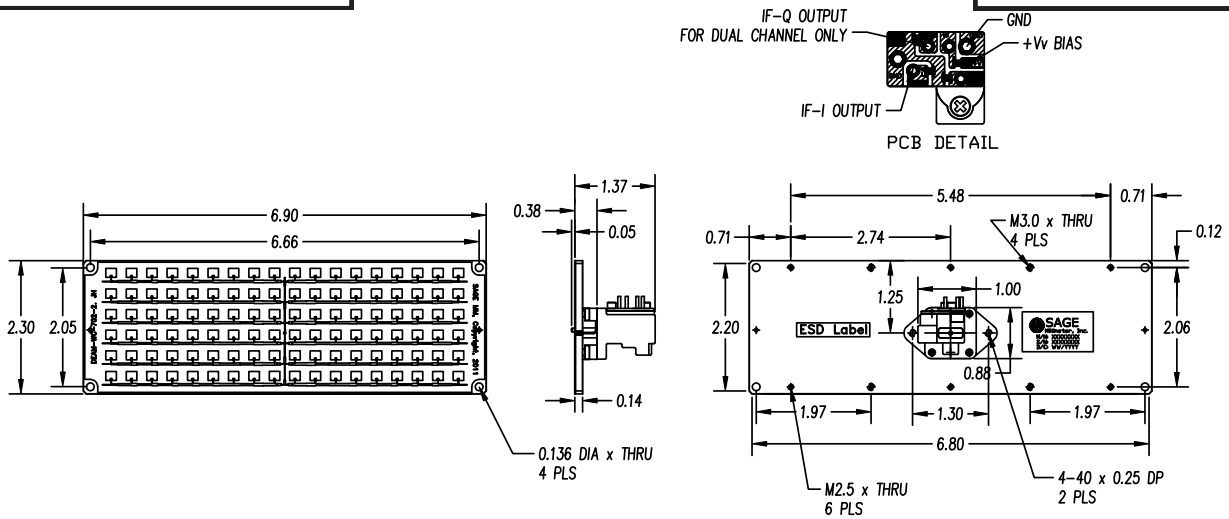
## Outline: SD-MK-25DW (SD-MK-25W)

Dimensions: Inches

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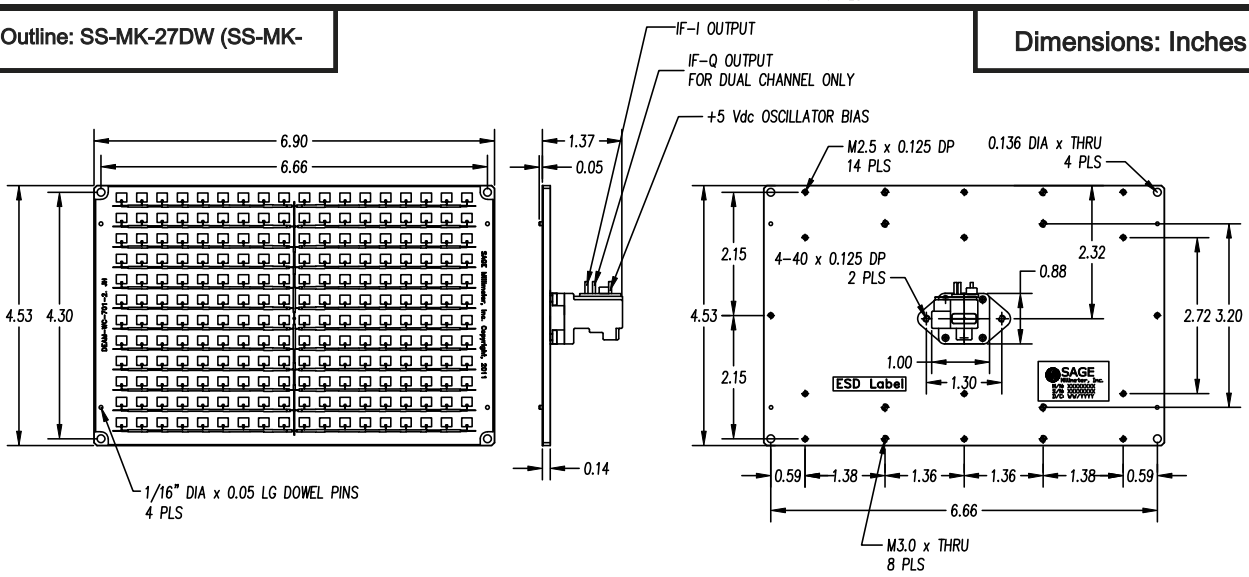
## Outline: SS-MK-27DW (SS-MK-

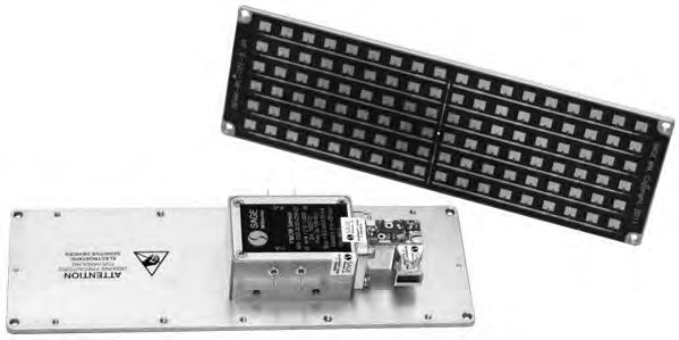
Dimensions: Inches



# 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.

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## 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 meter² (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-25W | SS-MK-27W | SS-MK-25DW | SS-MK-27DW |

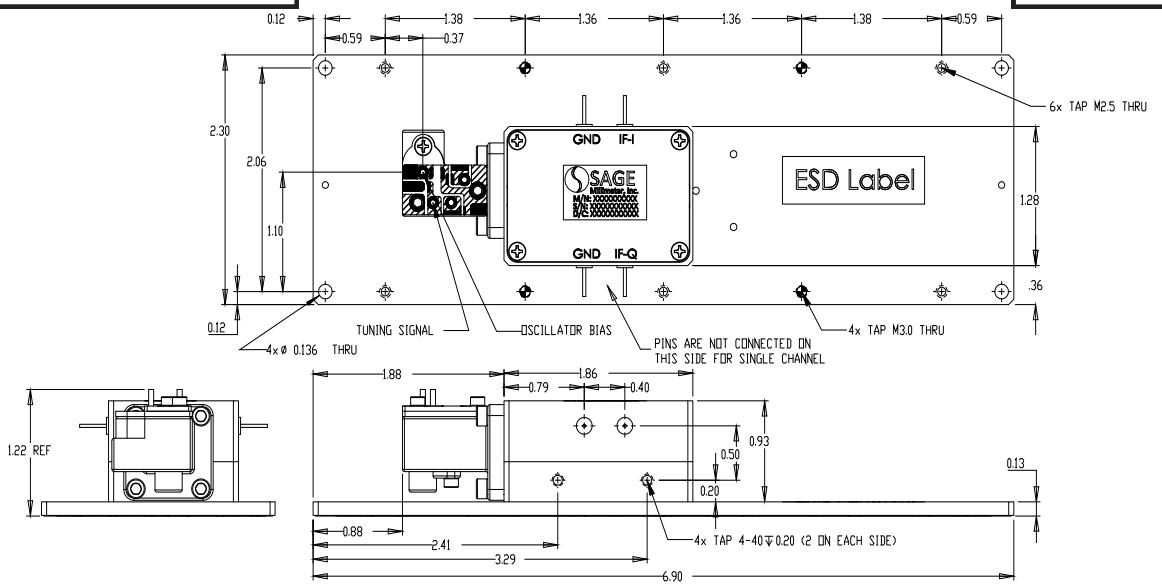
**SAGE Millimeter**'s custom designed Doppler sensor head model numbers are configured per following format.

**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.

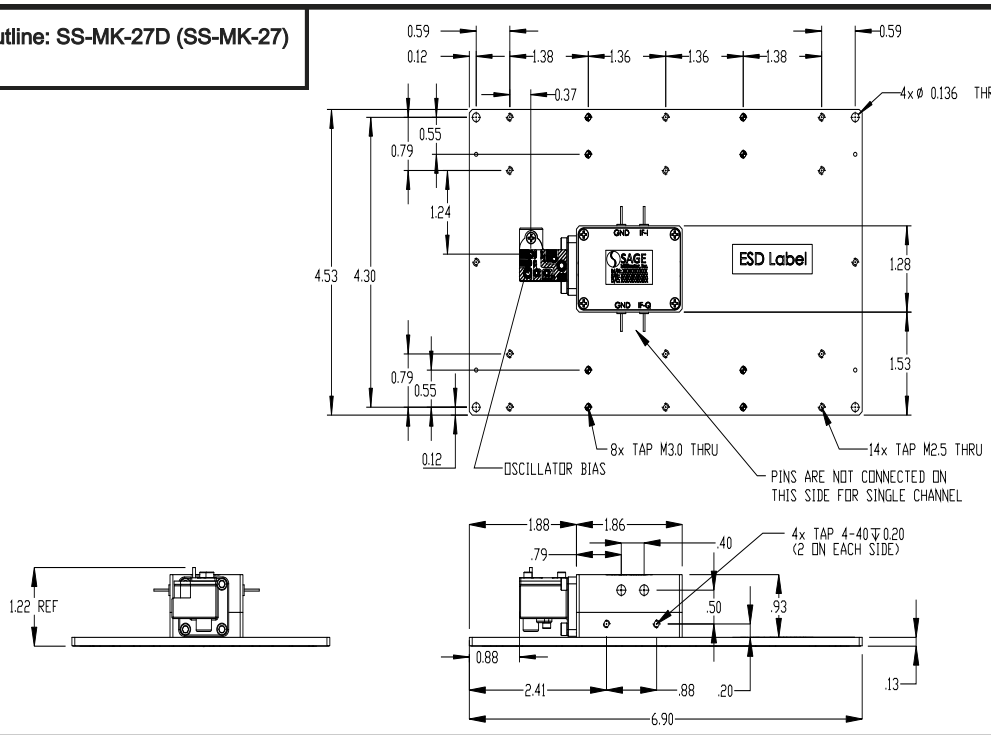
## Outline: SD-MK-25D (SD-MK-25)

Dimensions: Inches




## Outline: SS-MK-27D (SS-MK-27)

Dimensions: Inches



# 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 the best 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.

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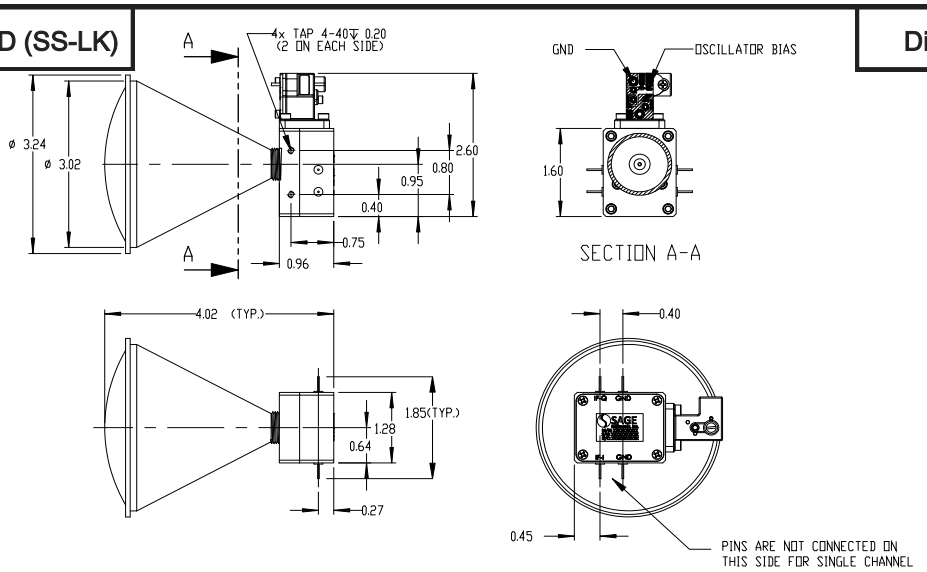
## CATALOG MODELS:

| 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 meter² (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 |

E

**Outline: SS-LK-D (SS-LK)**

**Dimensions: Inches**



# 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, the frequency 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.

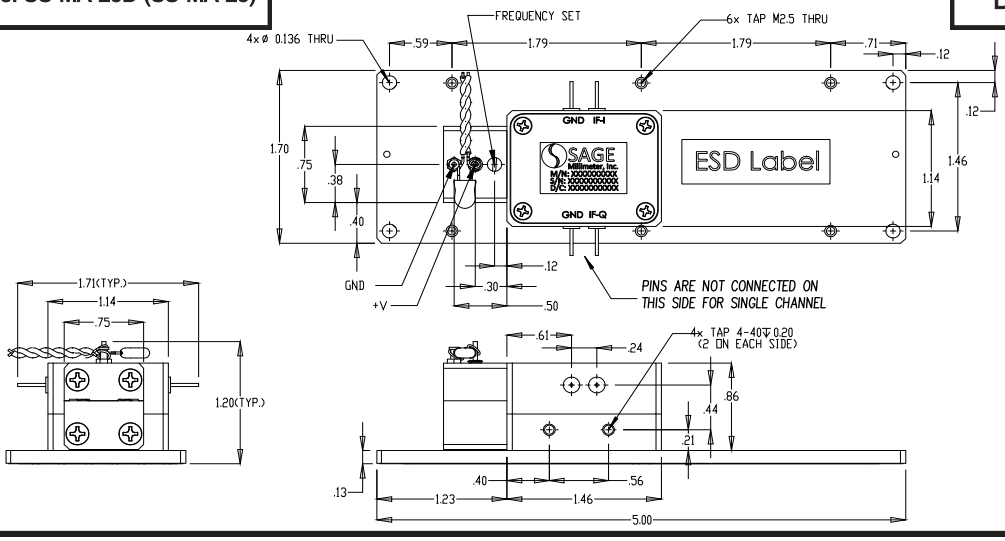
E

## CATALOG MODELS:

| Model Number | SSS-35307-25M-S1 | SSS-35307-25M-D1 |
|---|---|---|
| Antenna 3 dB Beamwidth | 4.6° (H) x 15° (V) | 4.6° (H) x 15° (V) |
| Antenna Gain (dBi, Typ) | 25 | 25 |
| 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 |

**Outline: SS-MA-25D (SS-MA-25)**

**Dimensions: Inches**



# 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, the frequency 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 best 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.

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E

## 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 |

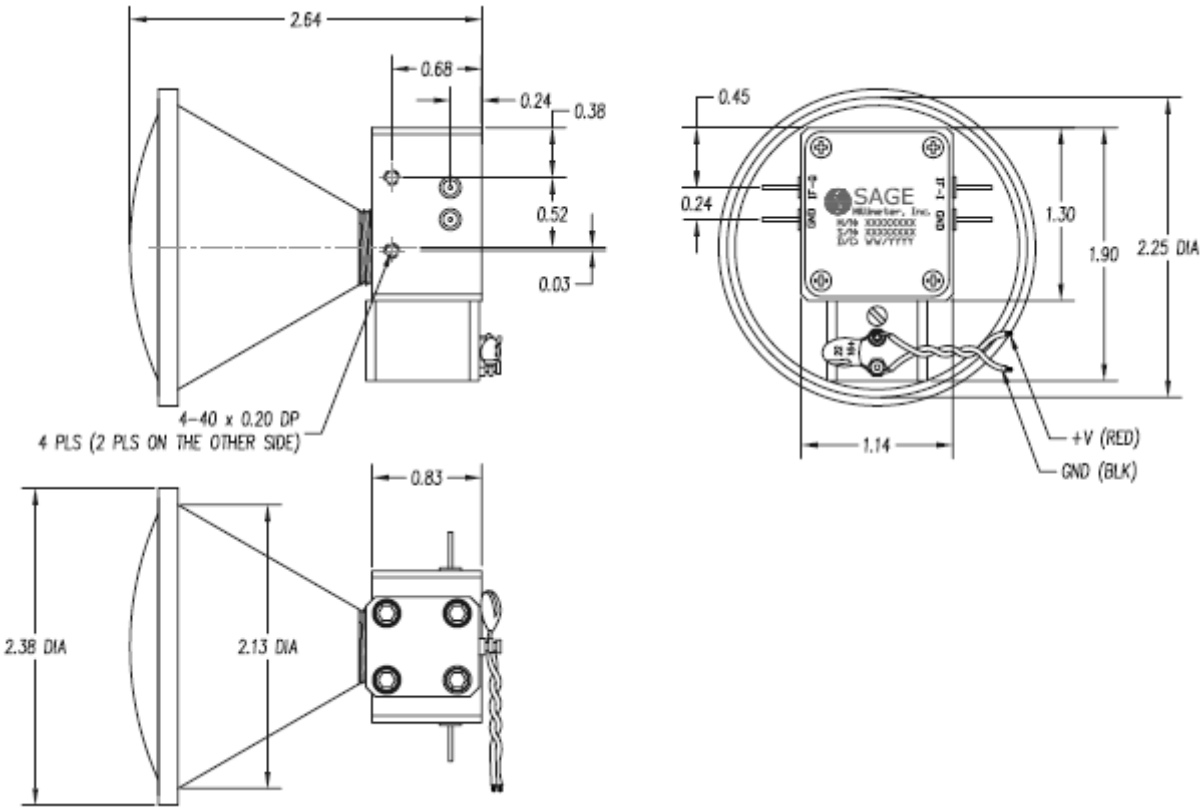
**SAGE Millimeter**'s custom designed Doppler sensor head model numbers are configured per following format.

**SSS - F0N PP - AGL- XY**

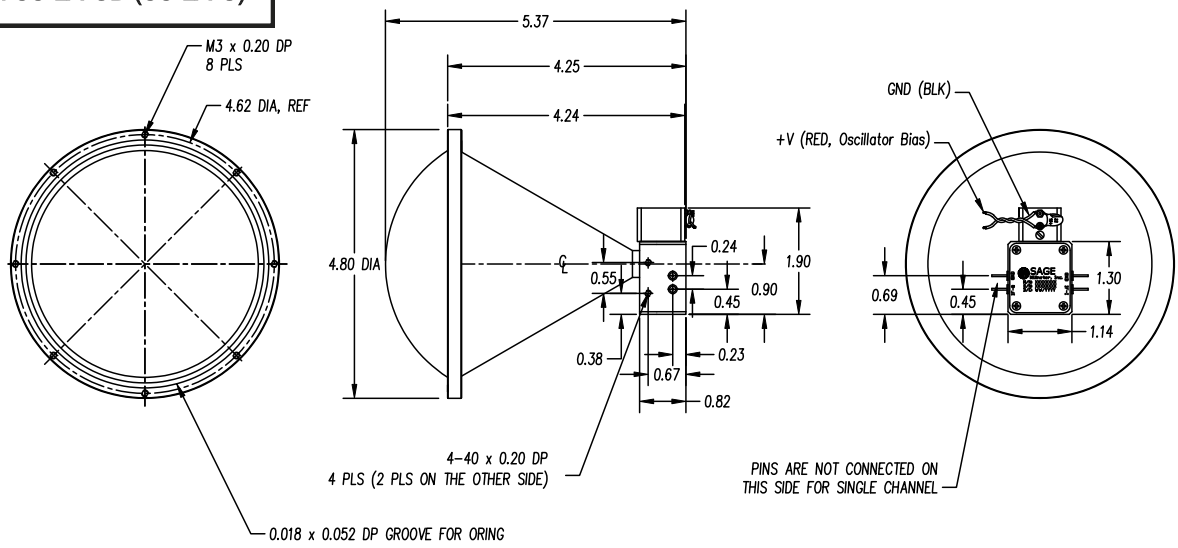
**F0N** is the center frequency in MHz x 10N. For example: 36.0 GHz = 363.
**PP** is the sensor module output power in dBm. For example: 10 dBm = 10.
**AG** is the antenna gain in dBi. For example: 25 dBi = 25.
**X :** "S" is for single channel receiver; "D" is for directional, i.e., I/Q receiver.
**Y**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

## Outline: SS-LA-D (SS-LA)

Dimensions: Inches




## Outline: SS-LA-GD (SS-LA-G)



# 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
- Temperature range: -40 to +85°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. The sensor head with I/Q receiver can not only detect 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° x 50°, are offered as custom designed models.

F

## CATALOG MODELS:

F

| 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°(H) x 12°(V) | 4.6°(H) x 4.8°(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) | + 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/°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 | SD-MK-W | SP-MK-25W | SP-MK-27W | SP-MK-DW | SP-MK-25DW | SP-MK-27DW |

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

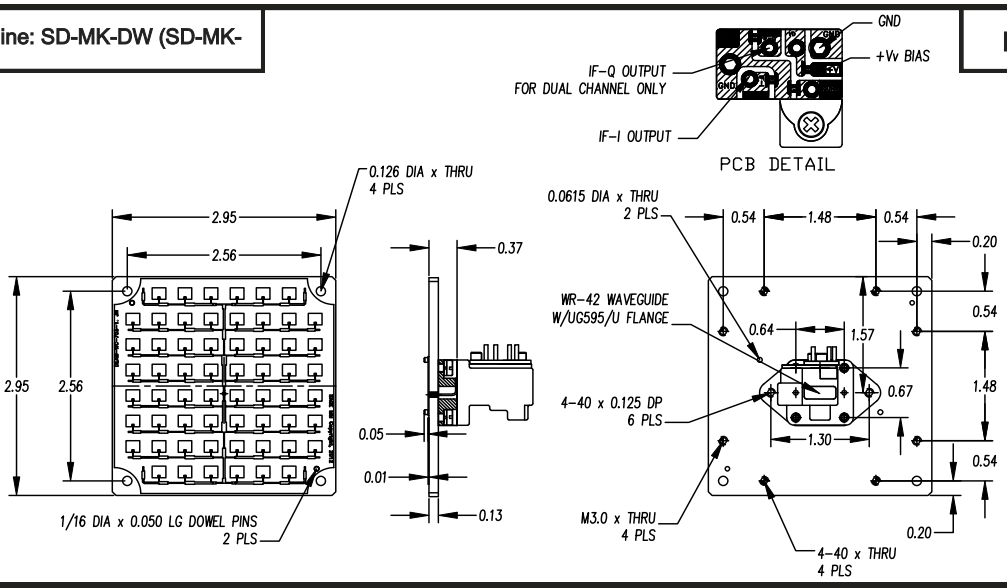
SSD - F0N PP - AGM - XY

**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.

SAGEMillimeter.com ■ 3043 Kashiwa Street, Torrance, CA 90505 ■ Ph (424)-757-0168 ■ Fax (424)-757-0188 ■ Email: Sales@SAGEMillimeter.com

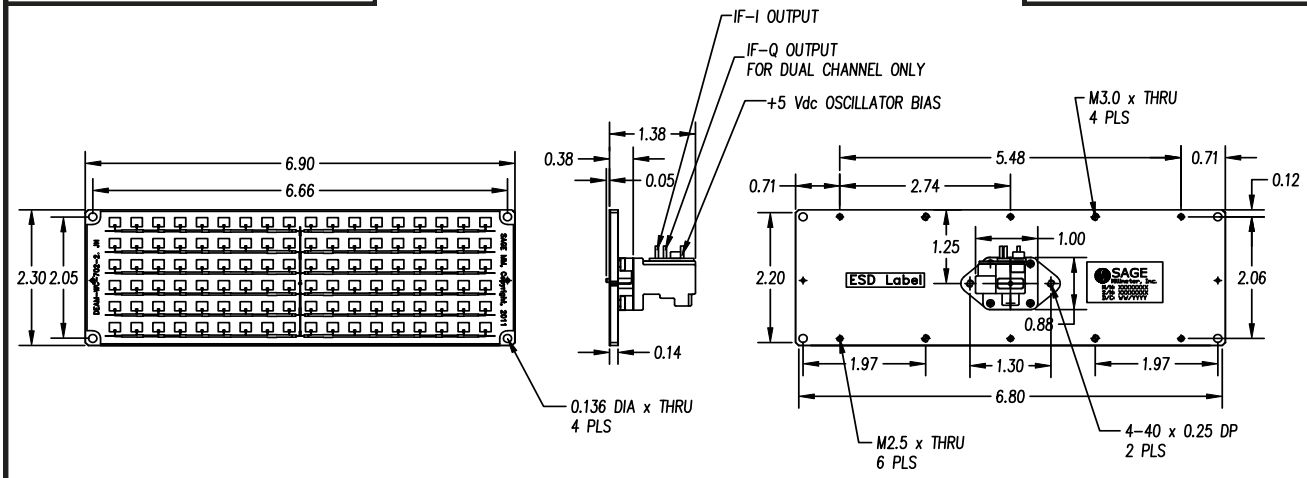
## Outline: SD-MK-DW (SD-MK-

Dimensions: Inches



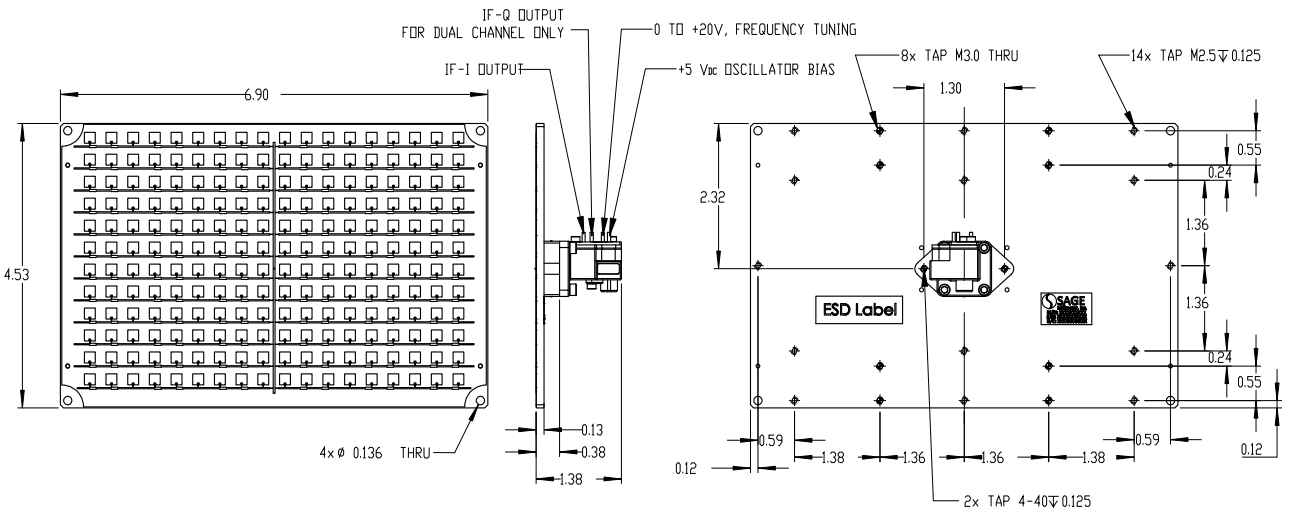

## Outline: SS-MK-25DW (SS-MK-

Dimensions: Inches

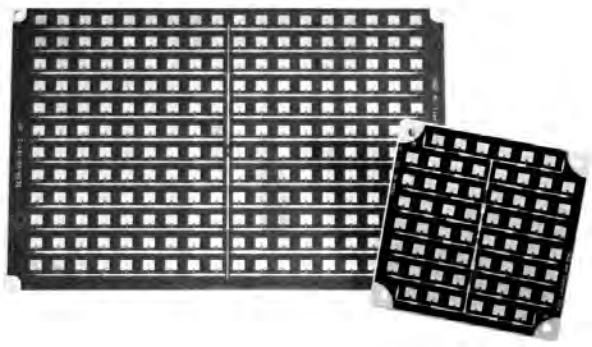



## Outline: SD-MK-27DW (SD-MK-

Dimensions: Inches



# 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°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. The sensor head with I/Q receiver can not only detect 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° x 12°, are offered as production ready or as custom designed models.

F

## CATALOG MODELS:

| Model Number | SSD-24303-25M-S1 | SSS-24303-27M-S1 | SSS-24303-25M-D1 | SSS-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°(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) | + 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 meter² (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 | SD-MK-25 | SD-MK-27 | SD-MK-25D | SD-MK-27D |

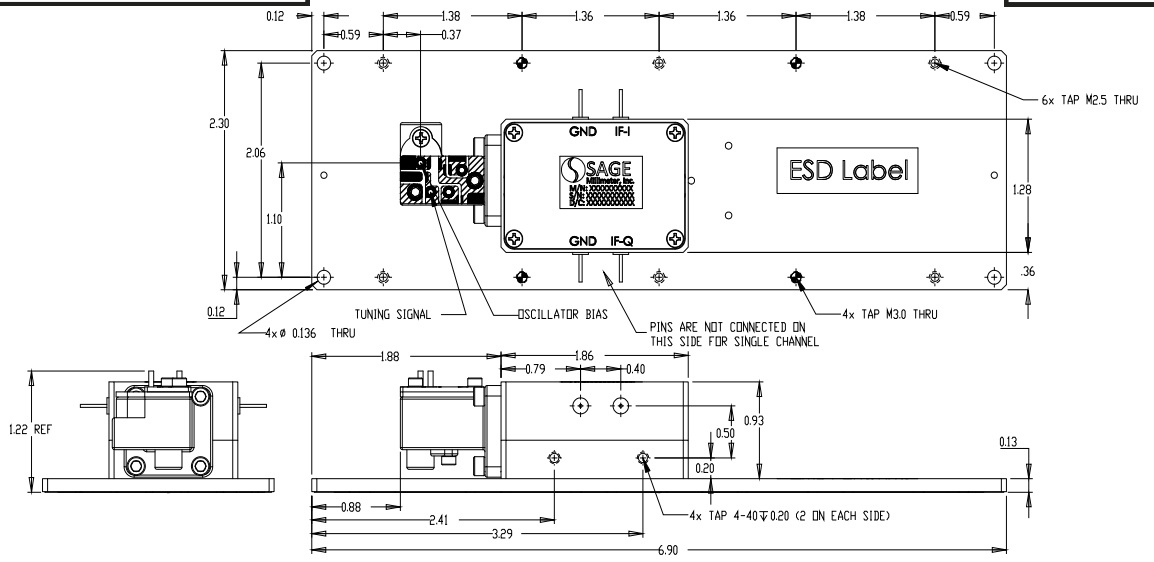
**SAGE Millimeter**'s custom designed Doppler sensor head model numbers are configured per following format.

**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**

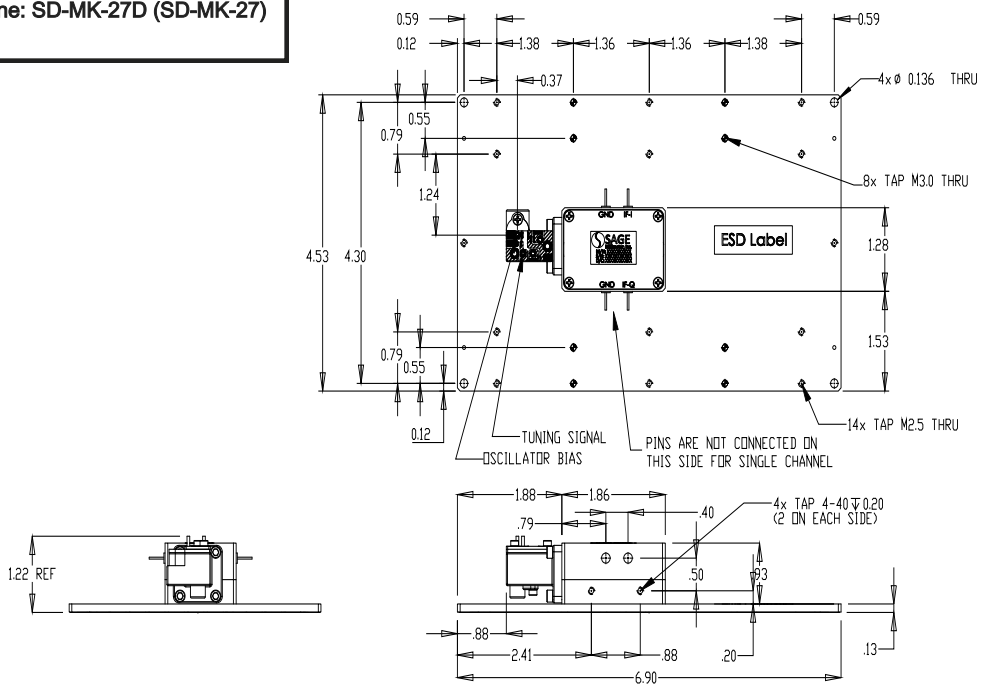



F

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

**Dimensions: Inches**

F



# K Band Lens Corrected Antenna Based High Performance Doppler Sensor Heads (SSS 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. The sensor head with I/Q receiver can not only detect 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 5° x 5°, are offered as custom designed models.

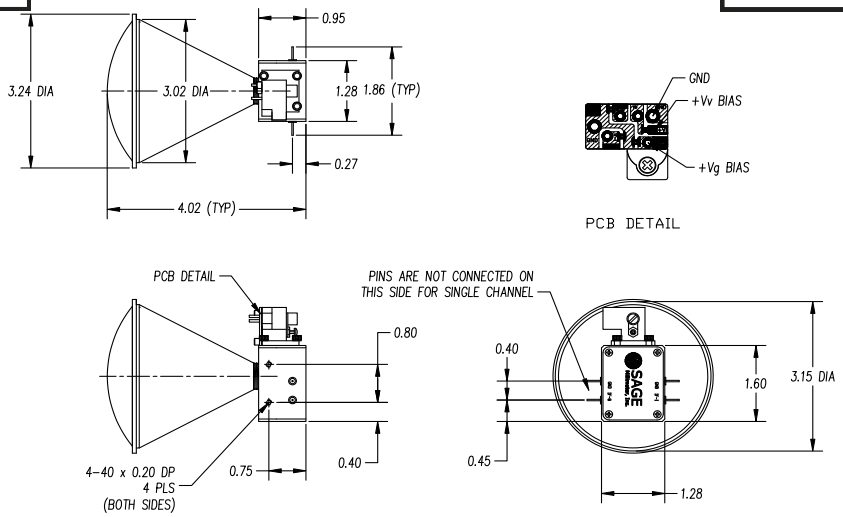
E

## 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) | + 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 meter² (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 |

E

**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. The sensor head with I/Q receiver can not only detect 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:

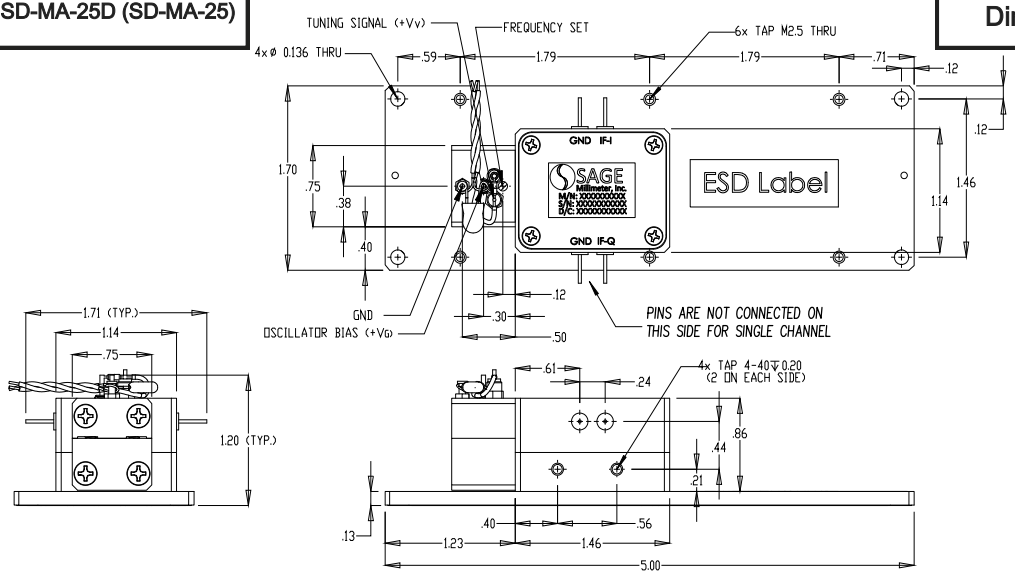
F

| Model Number | SSD-35307-25M-S1 | SSD-35307-25M-D1 |
|---|---|---|
| Antenna 3 dB Beamwidth | 4.6° (H) x 15° (V) | 4.6° (H) x 15° (V) |
| Antenna Gain (dBi, Typ) | 25 | 25 |
| 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 |

F

**Outline: SD-MA-25D (SD-MA-25)**

**Dimensions: Inches**



# 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, the frequency 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. The sensor head with I/Q receiver can not only detect 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.

F

## CATALOG MODELS:

F

| Model Number | SSD-35310-22L-S1 | SSD-35320-22L-S1 | SSD-35300-29L-S1 | SSD-35310-22L-D1 | SSD-35320-22L-D1 | SSD-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 | SD-LA | SD-LA | SD-LA-G1 | SD-LA | S-LSA | SD-LA-GD |

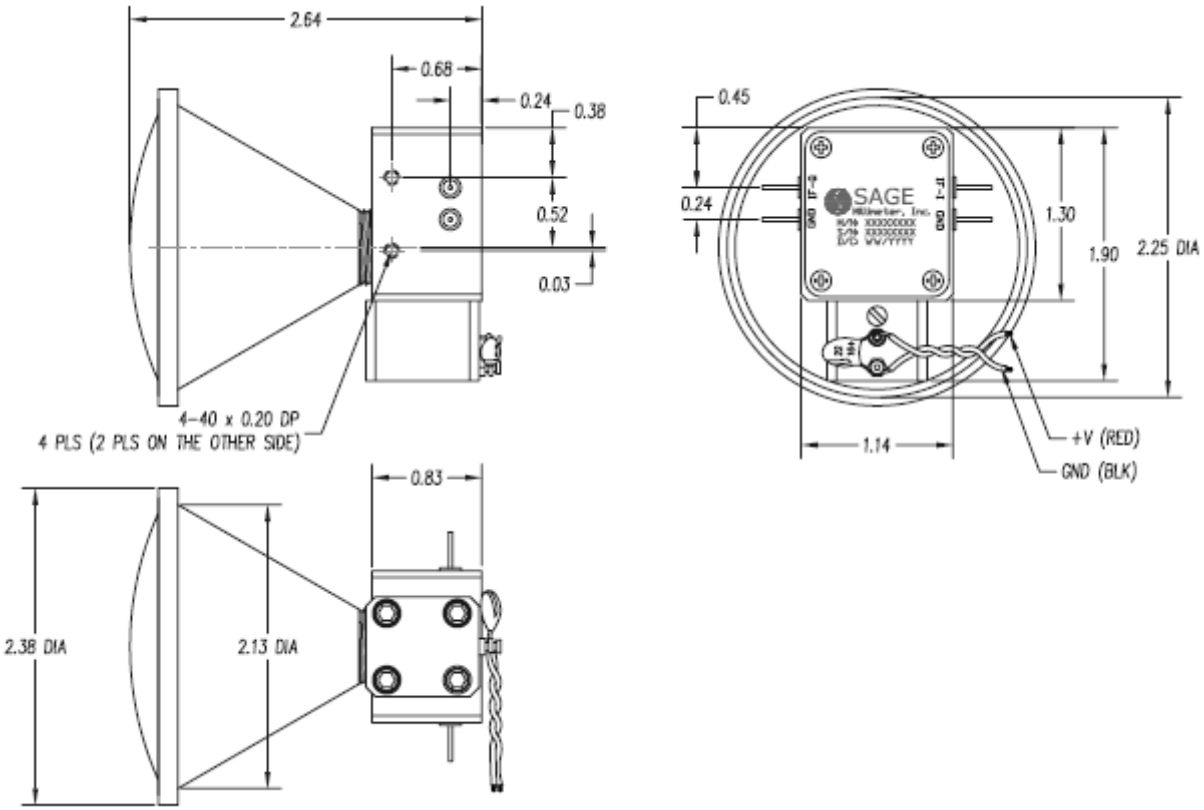
**SAGE Millimeter**'s custom designed ranging sensor head model numbers are configured per following format.

**SSD - F0N PP - AGL- XY**

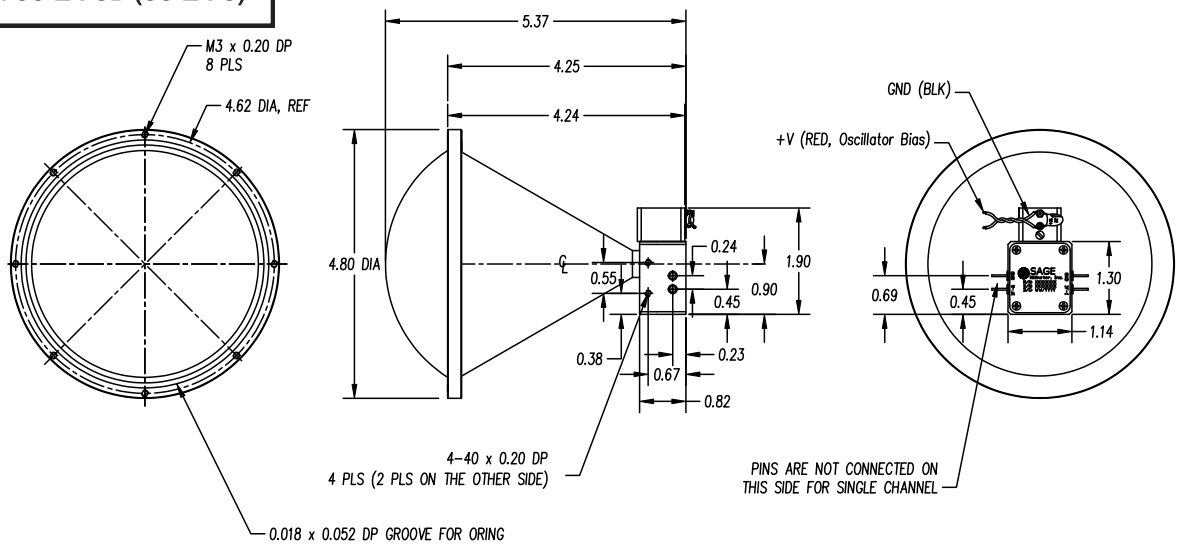
**F0N** is the center frequency in MHz x 10N. For example: 36.0 GHz = 363.
**PP** is the sensor module output power in dBm. For example: 10 dBm = 10.
**AG** is the antenna gain in dBi. For example: 25 dBi = 25.
**X :** "S" is for single channel receiver; "D" is for directional, i.e., I/Q receiver.
**Y**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

## Outline: SS-LA-D (SS-LA)

Dimensions: Inches




## Outline: SS-LA-GD (SS-LA-G)



# 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 mechanism. The radar signal emitted by the under testing radar is received through the antenna port and fed to 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.

**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. Four 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)

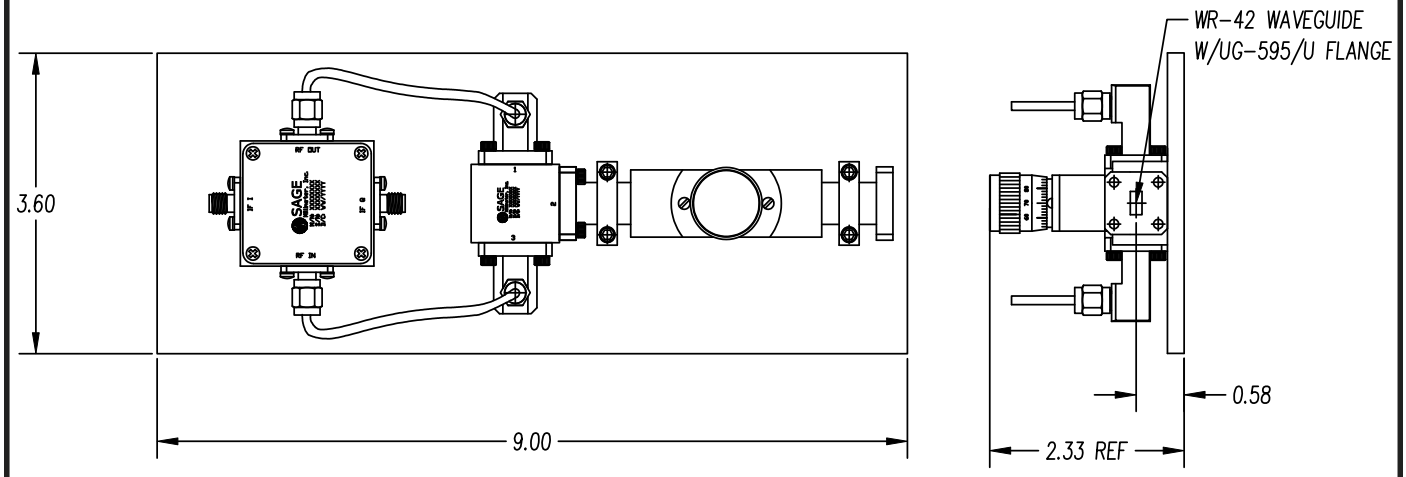
| Model Number | STR-243-42-L1 | STR-353-28-L1 | STR-603-12-L1 | STR-773-12-L1 | STR-943-10-L1 |
|---|---|---|---|---|---|
| Waveguide Size | WR-42 | WR-28 | WR-15 | WR-12 | WR-10 |
| Frequency (GHz) | 24.125 | 35.000 | 60.000 | 76.500 | 94.000 |
| Operating Bandwidth (MHz) | ±100 | ±150 | ±250 | ±250 | ±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) |

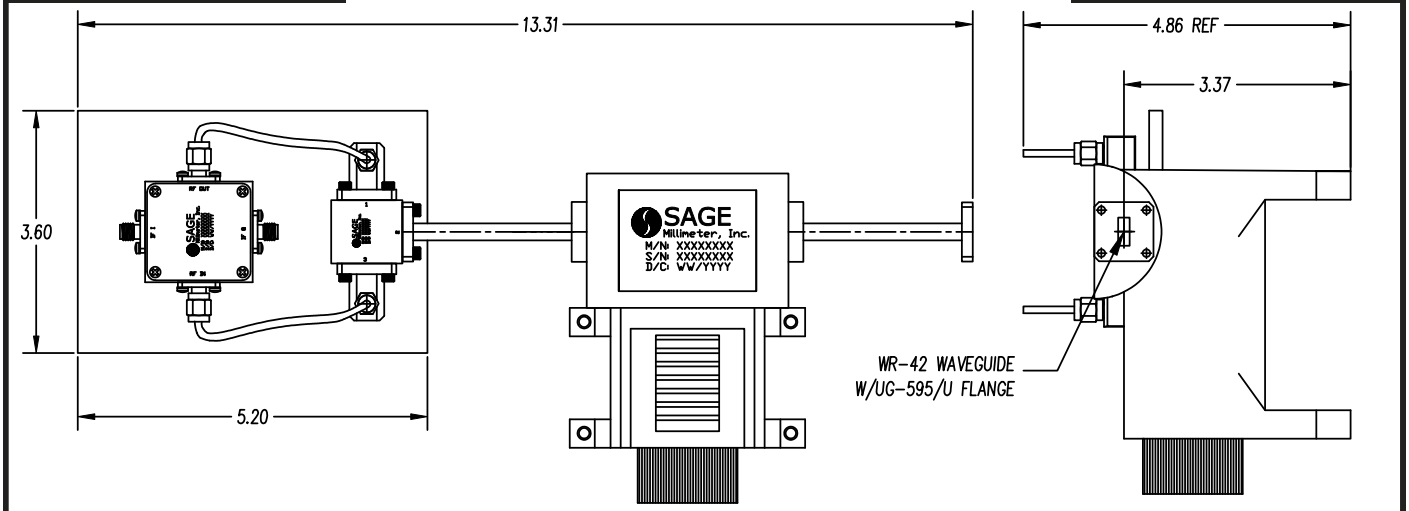
## Outline: TR-KL

Dimensions: Inches




## Outline: TR-KD

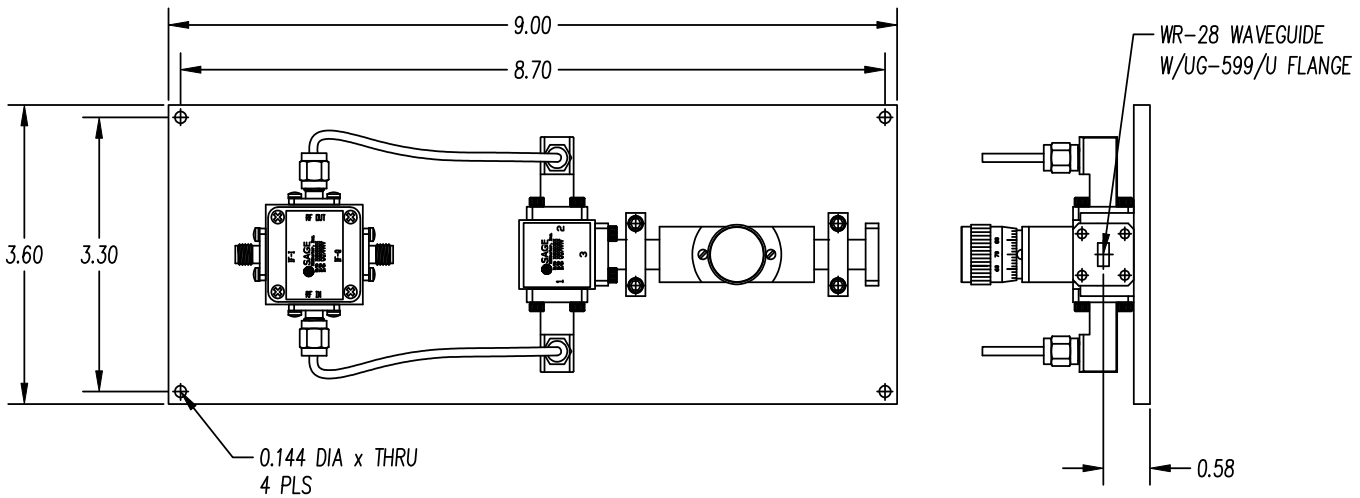
Dimensions: Inches




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

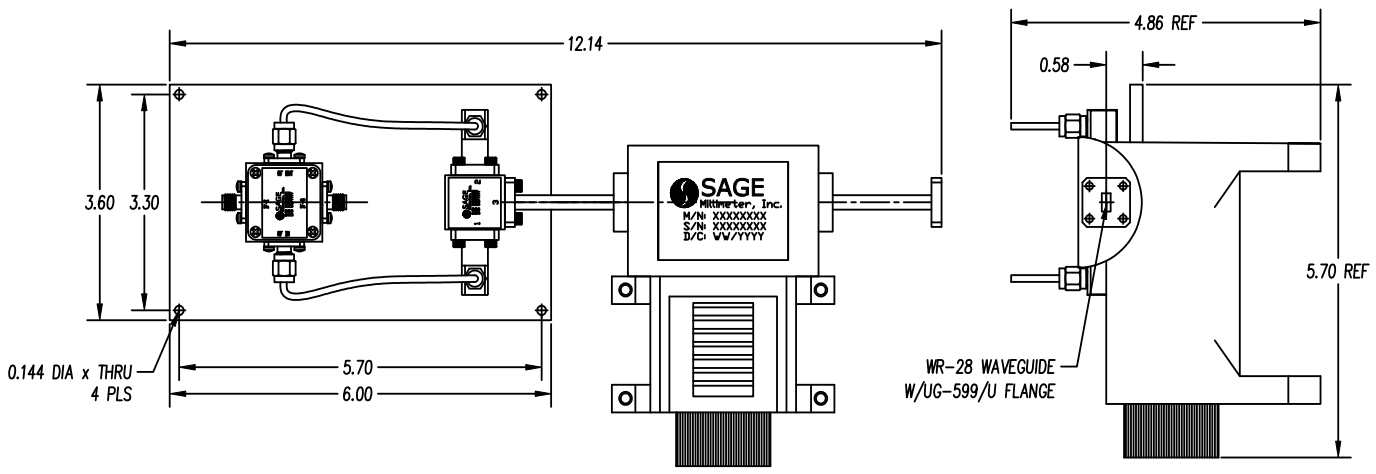
## Outline: TR-AL

Dimensions: Inches




## Outline: TR-AD

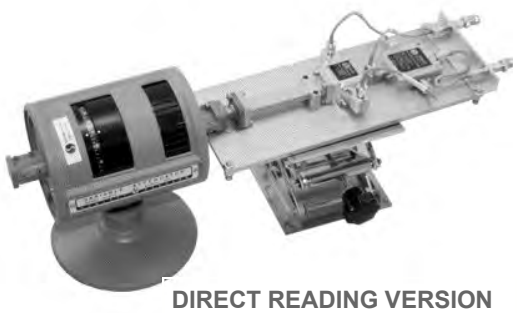
Dimensions: Inches




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

# Doppler Radar Target Simulators Application Notes, STR Series

LEVEL SETTING VERSION



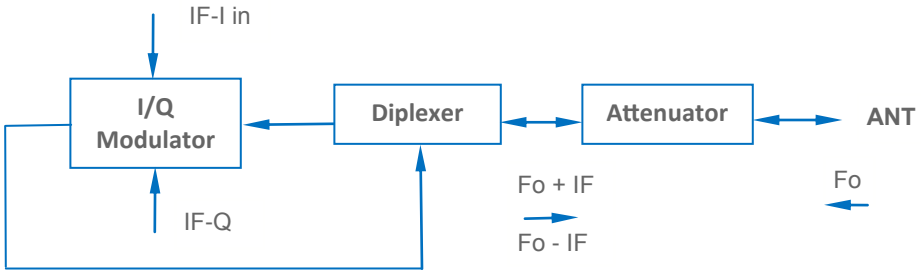
DIRECT READING VERSION

## DESCRIPTION:

**STR series** Doppler radar simulators are single sideband modulator based radar simulators with the following working mechanism. The radar signal emitted by the under testing radar is received through the antenna port and fed to 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 which 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 (Fo), the IF-I and IF-Q is 3,575 Hz.
2. Connect the output of the function generator to the IF inputs of the simulator.
3. Emit the radar signal from the under testing radar system towards the simulator antenna port (ANT). The returned Doppler shifted frequency Fo+IF or Fo-IF is received by the Radar and Radar display the speed of the target.
4. Vary the frequency of the function generator to simulate the speed of the target.
5. Vary the phase of the function generator (the phase difference of the IF-I and IF-Q signal, 90 of –90 degrees) to simulate the direction of the moving target, i.e., approaching and 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 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 to 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 |
| | SSM-77313-S1 | E | None | Yes | No | Yes | High | Bulky | High | 14 |
| | SSM-77310-D1 | E | None | Yes | Yes | Yes | High | Bulky | High | 14 |
| | SSM-94313-S1 | W | None | Yes | No | Yes | High | Bulky | High | 14 |
| | SSM-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 |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# Sensor Module 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-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 |


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## 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 is focused on single antenna (Monostatic) applications. Contact factory for dual antenna sensors and sensor heads for dual antenna (Bistatic) applications.

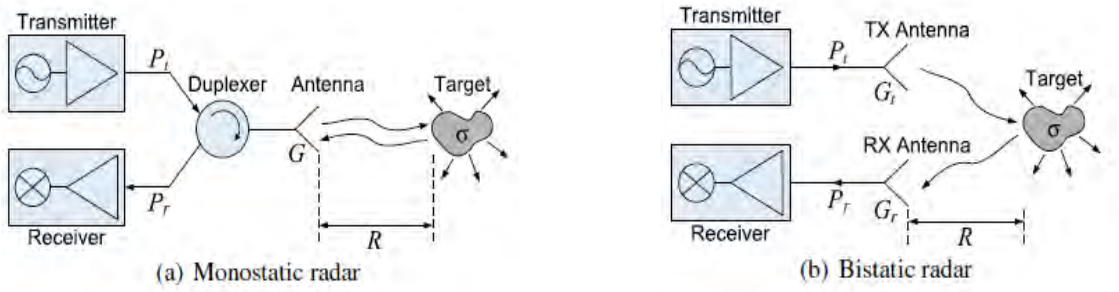


Figure 5. Monostatic and Bistatic Radar Systems

# Appendix

## µW, mW and Watt to dBm Conversion

### µW and dBm

| µW | 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

## Terms

All sales are at the factory unless specified by **SAGE Millimeter, Inc.**. The standard terms of payment are NET 30 to the customer having credit accounts with **SAGE Millimeter, Inc.**. To establish a credit account, credit references (bank account and 3 trade references) are required.

## Order Placing

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

For low value products or accessories listed on www.sagemillimeter.com, customer may order on line directly. There will be no order acknowledgement issued, instead, an email confirmation of shipment will be sent.

## Pricing and Minimum Order

Due to the continuing changes in technology, prices and specifications are subject to change without notice. Always confirm the price and specifications before placing order. The minimum combined order amount is US Dollars 250.00. There is no minimum order requirement if an order is placed on line.

## Technical Support

**SAGE Millimeter, Inc.** maintains an experienced technical team to offer an optimized solution for your application. Always contact the application department of **SAGE Millimeter, Inc.** for any technical questions or assistance.

## Warranty and Non-Warranty

**SAGE Millimeter, Inc.** warrants its products to be free from defects in materials and workmanship for a period of **twelve** months from the date of delivery. This warranty obligates **SAGE Millimeter, Inc.** to perform repair or replacement after the product is returned freight prepaid to **SAGE Millimeter, Inc.**. **SAGE Millimeter, Inc.** will not accept or repair any returned material without a Return Material Authorization (RMA) number. The RMA number can be obtained by contacting the customer service department of **SAGE Millimeter, Inc.**.

**This warranty policy does not cover the low value products or accessories, such as waveguide hardware - waveguide screws, dowel pins etc.. The warranty period for these products is limited to three months from the date of delivery.**

Warranty repairs will be made at no cost to the customer by paid incoming freight by the customer. Out of warranty repair requires 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 from the customer is received. An estimation fee may apply for products, which are deemed to be out of warranty.

## Limited Liability

In no event shall **SAGE Millimeter, Inc.** be liable neither for incidental, indirect or consequential damages or for an amount in excess of the net price of the products found to be defective or not in conformance with applicable specifications.