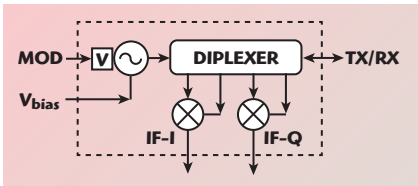
K-Band FMCW Ranging Sensor Modules

Microwave sensor modules are key components in any radar system. Today, the industry is continuously seeking low cost and high performance sensors for target speed, direction and ranging (distance) measurement for both commercial and military applications. Some of the applications include collision avoidance detection, liquid level sensing, traffic control, missile guidance and object profiling.

SAGE Millimeter has introduced a K-Band low cost FMCW sensor module with model number SSP-24303-D1 for speed, direction and ranging measurement. The FMCW based sensor is a true ranging sensor, meaning it can detect both still and moving target distance. The operation frequency of the featured sensor is at 24.125 GHz. The sensor is based on traditional TE10 waveguide cavity mode and packaged Gunn/varactor device technology, which offers low phase noise, high frequency stability and high sensitivity. Compared to its MMIC device/planar circuit based counterpart, model SSP-24303-D1 delivers lower harmonic and spurious emission and improved false signal detection due to the instinct waveguide cut-off nature. The entire sensor module is configured within a single die-cased aluminum housing, which allows low cost production.



▲ *Fig. 1 FMCW sensor module block diagram.*

Figure 1 is the function block diagram of the featured FMCW sensor module. From the function block diagram, one can see that three main function components are indicated: 1) Varactor tuned oscillator (VTO), 2) I/Q dual channel mixer and 3) diplexer. Due to its flexible design, the FMCW sensor module can be easily transformed into various function modules without redesigning, new circuits or additional tooling implementations. For example, if the VTO is replaced by a fixed tuned oscillator by extracting the varactor diode from the oscillator circuit, the module is transformed into a Doppler speed sensor with directional detector capacity. Furthermore, the sensor can be downgraded to a single channel Doppler sensor by extracting one Schottky diode from its I or Q channel to form speed detection only modules for simple speed measurement applications.

Table 1 shows the main electrical and mechanical specifications of the featured sensor

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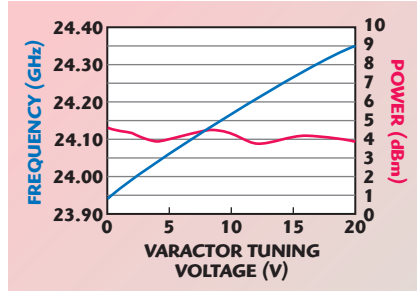
TABLE I

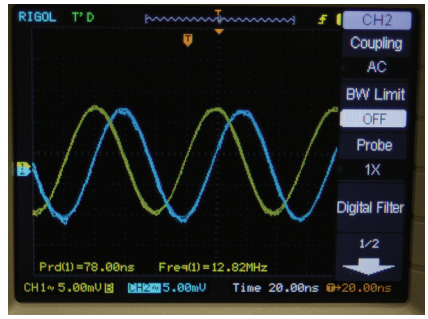
SPECIFICATIONS OF SSP-24303-D1 MODULE

TX Frequency (GHz)	24.125
TX Power (dBm, Min)	+3.0
Frequency Modulation Bandwidth (MHz, Min)	±150
Frequency Modulation Rate (kHz, Typ)	250
Frequency Modulation Voltage (Volts, Typ)	0 to +20
Mechanical Tuning Bandwidth (MHz, Min)	±250
Receiver I/Q Phase Δ (Degree, Max)	90°±30°
Receiver I/Q Amplitude Δ (dB, Max)	0 dB ±3 dB
IF Frequency Range (MHz, Min)	DC to 100
IF Offset Voltage (Volts, Typ)	-0.5 to -1.0
Frequency Stability (MHz/°C, Max)	-0.80
Phase Noise (dBc/Hz @ 100 kHz Offset, Typ)	-95
Power Stability (dB/°C, Max)	-0.03
Oscillator Bias Voltage/Current (VDC/mA, Typ)	+5.0/250
RF Connector	WR-42 Waveguide, UG595/U Flange
Oscillator Bias Connector	Solder Pin
Frequency Modulation Connector	Solder Pin
IF Connectors	Solder Pins
Dimension/Weight (Typ)	0.8" W × 0.8" H × 1.0" D / 1.2 oz

module. The typical output power and frequency versus tuning voltage is shown in ***Figure 2***. From the tuning curve, very flat power output and near linear tuning characteristics are observed. The flat power output level and high linear tuning performance are highly desirable features for system integrators to configure and develop their system hardware and software algorithms. The featured sensor module is also equipped with a mechanical self-locking tuning structure for easy frequency setting/trimming and simple frequency mechanical adjustment. ***Figure 3*** shows the I/Q channel output, which displays well-balanced and near 90 degree phase difference between the two signals.



▲ *Fig. 2 K-Band FMCW ranging sensor tuning characteristic.*



▲ *Fig. 3 Sensor module I/Q channel output.*

Waveguide

The RF interface of the sensor module is a standard WR-42, which allows quick interface with various antenna structures. SAGE Millimeter offers a variety of antennas to interface with the featured sensor module directly. These standard antennas include microstrip antennas (5° × 7°, 5° × 15°, and 12° × 12° half power beamwidth) and lens corrected antenna (12° × 12° half power beamwidth) models. All antennas have at least 20 dB sidelobe rejections to allow for proper applications. Custom designed antennas are also available on request.

As mentioned previously, many sensor modules can be transformed from the featured module's existing design and housing hardware. SAGE Millimeter offers many model numbers to cover sensor modules with various function capacities, such as single channel FMCW ranging sensor, single and dual channel Doppler sensors, and sensor heads with various integrated antenna options.

VENDORVIEW

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