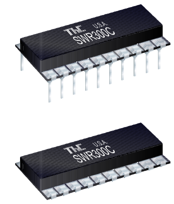
# SWR300
# Precision
# Sine \ Cosine Reference



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## FEATURES

- **SINE AND COSINE OUTPUT**
- **PROGRAMMABLE FREQUENCY: 10Hz - 100kHz**
- **DRIVE CAPABILITY: 10mA**
- **HIGH ACCURACY: 7.071 Vrms ±0.10%**
- **LOW DRIFT: 5 ppm/°C (-40°C to +85°C)**
- **EXCELLENT STABILITY: 10 ppm/1000 Hrs.**
- **LOW DISTORTION: 0.2% THD @ f = 3300 Hz**
- **20 PIN DIP OR 20 TERMINAL SURFACE MOUNT**

## PIN CONFIGURATION

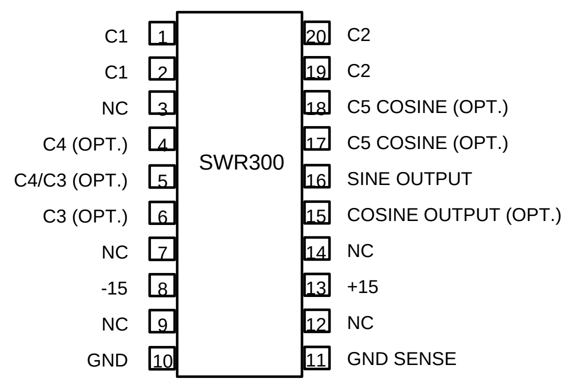



**FIGURE 1**

## DESCRIPTION

The SWR300 is a precision AC reference that provides both sine and cosine output. The outputs are 7.071V rms with an initial accuracy of ±0.10% and a temperature coefficient of 5 ppm/°C over the full industrial temperature range. The accuracy is made possible by a chopper-based AGC circuit. The temperature characteristic of the chopper circuit compensates the typical nonlinearity of the internal DC zener reference, resulting in a nearly linear amplitude-temperature characteristic. The frequency of the SWR300 is programmable with two external capacitors. The normal range is 10Hz to 100kHz. Below 1500Hz, external capacitors for the AGC circuit can be added to minimize distortion.

The SWR300 is well suited for any application requiring an amplitude stable sine wave source. High precision test and measurement equipment and transducer excitation are several examples.

The SWR300 can also be used as a reference source in precision sensing systems based on LVDT or RVDT position sensors. This includes syncro and resolver systems. A programmable AC voltage standard can be constructed using the SWR300 as a reference for a high accuracy multiplying Digital to Analog Converter.

### SELECTION GUIDE

| Type | Output (Typ.) | Temperature Operating Range | Package |
|---|---|---|---|
| SWR300C | 7.071V | 0°C to +70°C | DIP,SMT |
| SWR300L | 7.071V | -40°C to +85°C | DIP,SMT |

For package option add D for DIP or S for Surface Mount to end of model number.

## ELECTRICAL SPECIFICATIONS

**SWR300**

Vps =±15V, T = 25°C, RL = 10KΩ f=3300Hz, C1=C2 unless otherwise noted.

| MODEL | C | | | | | | L | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PARAMETERS** | **MIN** | **TYP** | **MAX** | **MIN** | **TYP** | **MAX** | **MIN** | **TYP** | **MAX** | **MIN** | **TYP** | **MAX** | **UNITS** |
| **ABSOLUTE MAXIMUM RATINGS** | | | | | | | | | | | | | |
| Power Supply | ±13.5 | 15 | ±22 | | | | * | * | * | | | | V |
| Operating Temperature | 0 | | 70 | | | | -40 | | 85 | | | | °C |
| Storage Temperature | -65 | | 150 | | | | * | | * | | | | °C |
| Short Circuit Protection | Continuous | | | | | | | * | | | | | |
| **OUTPUT VOLTAGE** | | 7.071 | | | | | | * | | | | | Vrms |
| **OUTPUT VOLTAGE ERRORS** | | | | | | | | | | | | | |
| Initial Error | | | 0.10 | | | | | | * | | | | % |
| Warmup Drift | | 100 | | | | | | * | | | | | µV |
| DC Offset | | 3 | 10 | | | | | * | * | | | | mV |
| DC Offset Over Temp. | | 3 | 18 | | | | | * | * | | | | µV/°C |
| Tmin - Tmax (1) | | 2 | 5 | | | | | 2 | 5 | | | | ppm/°C |
| Long-Term Stability | | 10 | | | | | | * | | | | | ppm/1000 hrs |
| **OUTPUT CURRENT** | | | | | | | | | | | | | |
| Range | | | ±10 | | | | | | * | | | | mA |
| **REGULATION** | | | | | | | | | | | | | |
| Line | | 10 | | | | | | * | | | | | ppm/V |
| Load | | 3 | | | | | | * | | | | | ppm/mA |
| **POWER SUPPLY CURRENTS** (2) | | | | | | | | | | | | | |
| +PS | | 10.5 | 13 | | | | | * | * | | | | mA |
| -PS | | 9.5 | 13 | | | | | * | * | | | | mA |
| **DISTORTION** | | 0.05 | 0.2 | | | | | * | * | | | | % |
| **FREQUENCY** | | | | | | | | | | | | | |
| $f = \frac{10^{-5}}{\sqrt{C1xC2}}$ (3) | .98 | 1 | 1.02 | | | | * | * | * | | | | Hz |
| Range (f) (4) | 10 | | 100k | | | | * | | * | | | | Hz |
| $\frac{\Delta f}{f}$ vs. Temperature | | | 15 | | | | | | * | | | | ppm/°C |
| Phase Shift - Sine/Cosine | 88 | 90 | 92 | | | | * | * | * | | | | Degrees |

NOTES:

*Same as C Model.

1. The temperature coefficient is determined by the box method using the following formula:

$$T.C. = \frac{V_{max} - V_{min}}{V_{nominal} \times (T_{max} - T_{min})} \times 10^6$$

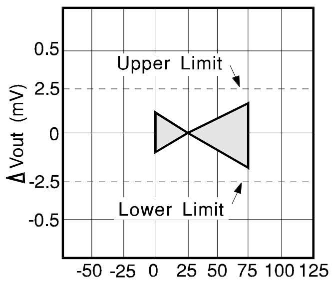
2. The specified values are unloaded.

3. Capacitance in farads.

4. The frequency range can be extended to any desired lower value by using 2 external AGC capacitors

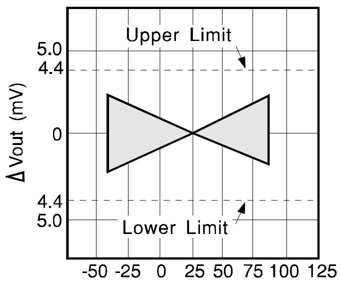
# TYPICAL PERFORMANCE CURVES

**$V_{OUT}$ vs. TEMPERATURE**



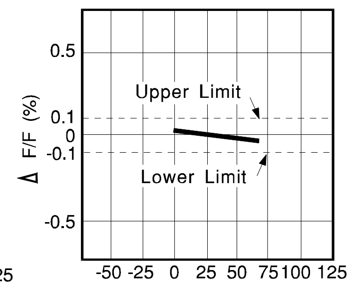

**Temperature °C**
**SWR300C**

**$V_{OUT}$ vs. TEMPERATURE**



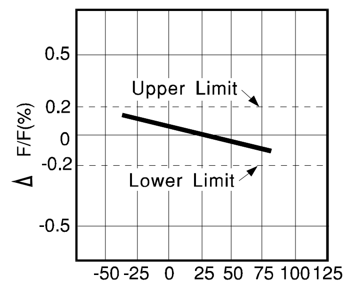

**Temperature °C**
**SWR300L**

**% ? FREQ. vs. TEMP.**



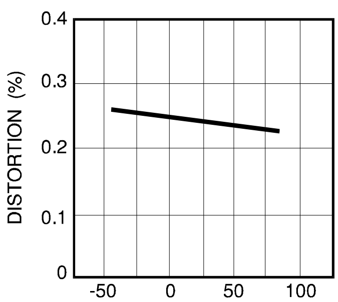

**Temperature °C**
**SWR300C**

**% ? FREQ. vs. TEMP.**



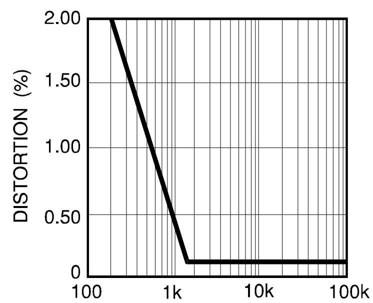

**Temperature °C**
**SWR300L**

**DISTORTION VS. TEMP**



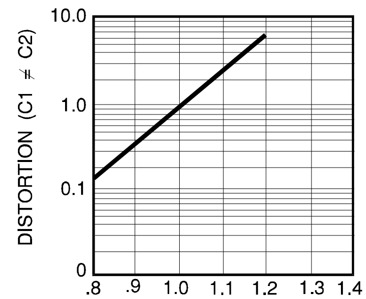

**Temperature °C**

**DISTORTION vs. FREQUENCY [1]**



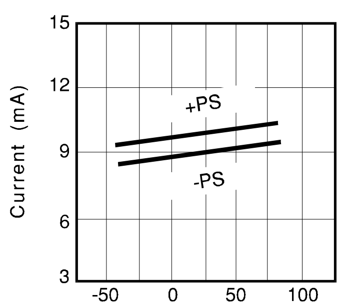

**Frequency (Hz)**

**NORMALIZED DISTORTION vs. C2/C1**



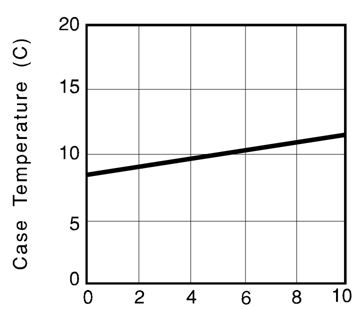

**C2/C1**

**POWER SUPPLY CURRENT vs. TEMP.**



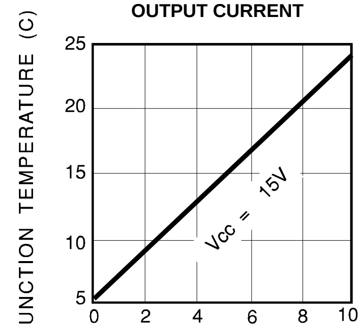

**Temperature °C**

**CASE TEMP. RISE ABOVE AMBIENT vs. OUTPUT CURRENT**




**Output Current (mA)**

**JUNCTION TEMP. RISE ABOVE CASE TEMP. vs OUTPUT CURRENT**




**Output Current (mA)**

**1) Distortion vs. Frequency graph is without the external AGC capacitors.**

# DISCUSSION OF PERFORMANCE

### THEORY OF OPERATION

The following refers to the functional diagram in Figure 2. A1 and A2 are connected as a phase-shift oscillator circuit with the frequency set by the external capacitors C1 and C2 (C1=C2). Q4 is included in the feedback loop of A1 as a gain control element.

The oscillator output is fed to the chopper amplifier which develops an absolute value representation of the oscillator output. The chopper output is compared to a precision DC reference in integrator amplifier A3. This DC error signal is used to control the gain setting FET Q4.

As in all precision zener based DC references, the drift of the zener becomes nonlinear at temperature extremes. The chopper amplifier drift characteristic is complementary to this nonlinearity and compensates for the reference drift.

### APPLICATION INFORMATION

Figure 2 shows the connections for the SWR300 including the two frequency setting capacitors C1 and C2 (capacitance in farads) for operation from 10Hz to 100kHz. The frequency is defined as:

$$f = \frac{10^{-5}}{\sqrt{C_1 \times C_2}}$$

Assuming C1 = C2 = C Then $C = 1/10^5 \times f$

For f = 10kHz C = 1nF

If the cosine output is required, C5 must be in place. The value is identical to C1 and C2. If the cosine is not required, then pins 17 and 18 must be open.

At lower frequencies, a limitation occurs in the AGC circuit that provides the high amplitude stability of the SWR300. As the frequency decreases, there is a slight increase in distortion from 1500Hz down to 10Hz. By adding external AGC capacitors (C3 and C4) , the time constant of the circuit is increased and the added distortion is eliminated. This increase in time constant comes with the tradeoff of longer settling times from power on.

The value for the lower frequency AGC capacitors is given by the following: C3 = 2 x C1, C4 = 20 x C1. To predict the AGC settling requirements, use the following formula: T = 300 / F. (T is time in seconds, F is frequency in Hertz.)

The frequency stability is directly related to the stability of the capacitors, therefore stable capacitors like NPO ceramic, polycarbonate, or polystyrene film should be used.

Two separate ground pins are provided for accurate ground sensing. This minimizes errors due to drops in the ground pin which can become a significant source of error in sockets.

The offset of the SWR300 is fully specified for initial offset and drift and is low enough that it can normally be neglected. In applications which are especially sensitive to offset the output can be AC coupled. Proper capacitor sizing and high impedance sensing will minimize errors due to capacitive coupling.

### FUNCTIONAL DIAGRAM

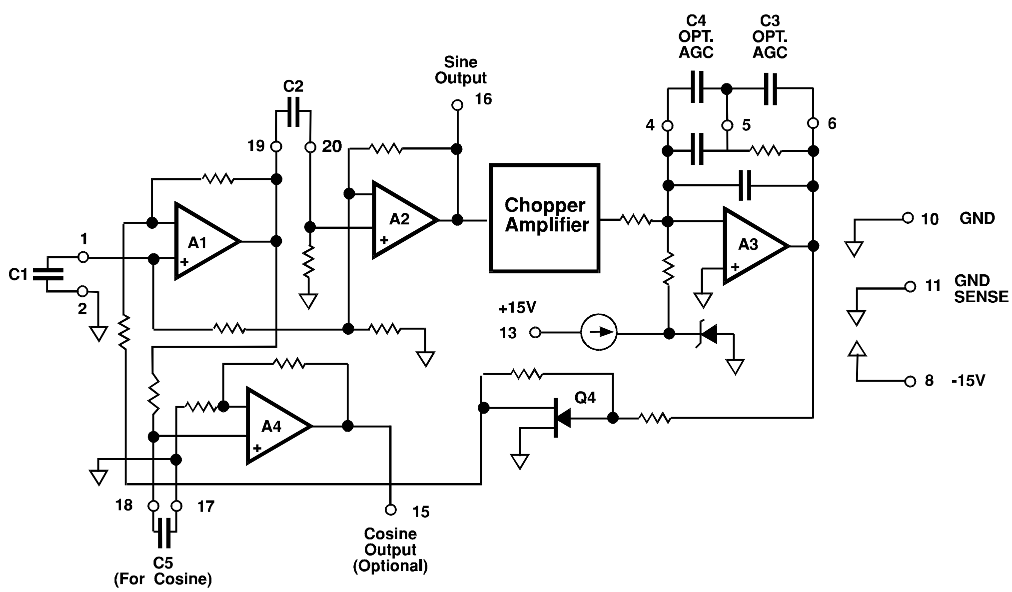
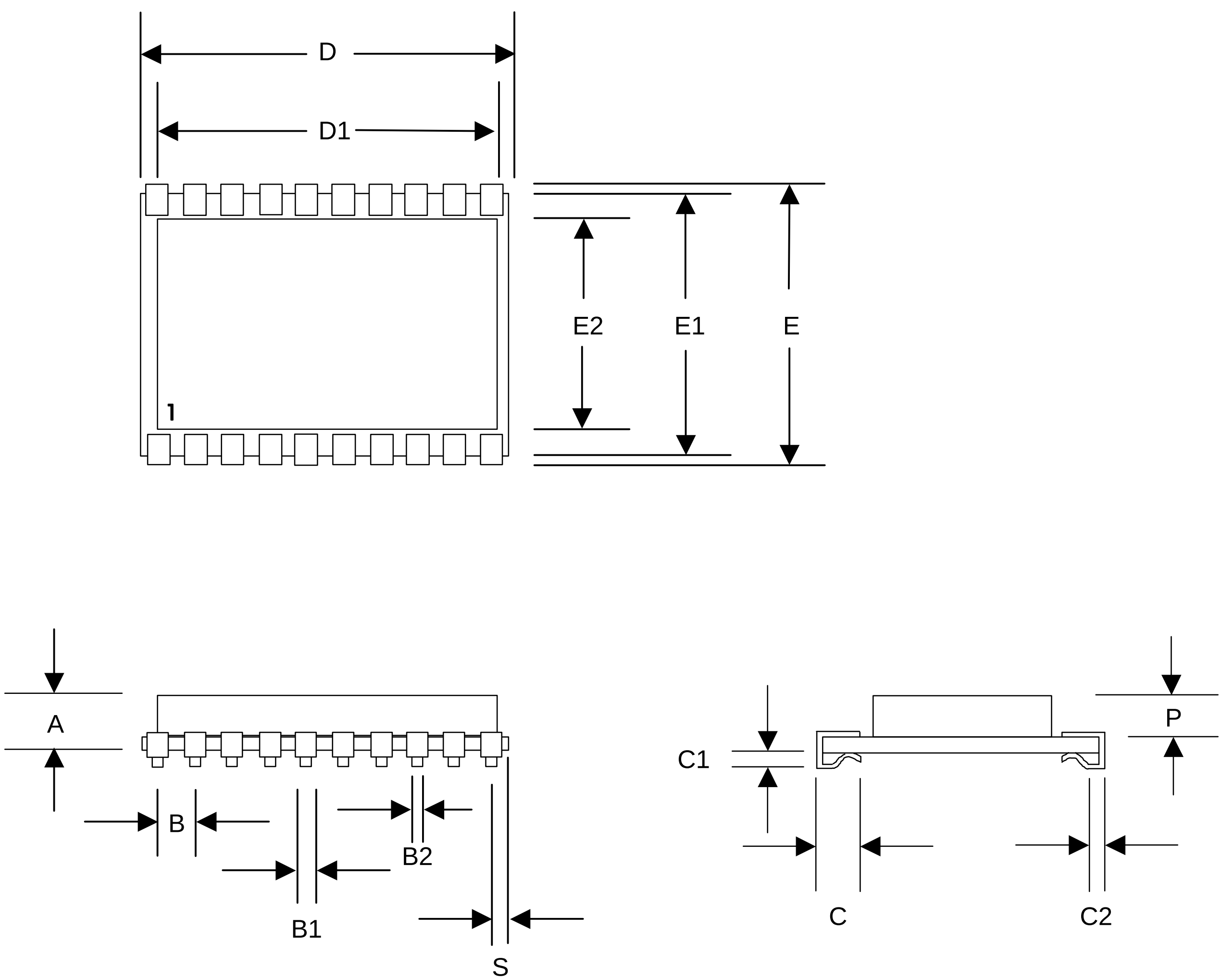



FIGURE 2

# MECHANICAL

**FIGURE 3**

| | INCHES | | MILLIMETER | | | INCHES | | MILLIMETER | |
|---|---|---|---|---|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX | DIM | MIN | MAX | MIN | MAX |
| A | .110 | .120 | 2.79 | 3.05 | D1 | .962 | .982 | 24.43 | 24.94 |
| B | .098 | .102 | 2.48 | 2.59 | E | .718 | .725 | 18.20 | 18.70 |
| B1 | .047 | .051 | 1.19 | 1.30 | E1 | .690 | .710 | 17.50 | 18.00 |
| B2 | .017 | .023 | 0.43 | 0.58 | E2 | .559 | .570 | 14.20 | 14.50 |
| C | .055 | .065 | 1.39 | 1.65 | P | .112 | .118 | 2.84 | 3.00 |
| C1 | .012 | .020 | 0.31 | 0.51 | S | .044 | .056 | 1.12 | 1.42 |
| C2 | .020 | .040 | 0.51 | 1.02 | | | | | |
| D | .998 | 1.00 | 25.34 | 25.53 | | | | | |



# MECHANICAL

**FIGURE 4**

| | INCHES | | MILLIMETER | | | INCHES | | MILLIMETER | |
|---|---|---|---|---|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX | DIM | MIN | MAX | MIN | MAX |
| A | .110 | .120 | 2.79 | 3.05 | E | .718 | .725 | 18.23 | 18.41 |
| B | .098 | .102 | 2.49 | 2.59 | E1 | .690 | .710 | 17.52 | 18.03 |
| B1 | .047 | .051 | 1.19 | 1.30 | E2 | .559 | .570 | 14.20 | 14.50 |
| B2 | .017 | .023 | 0.43 | 0.58 | G | .595 | .605 | 15.11 | 15.36 |
| C | .009 | .020 | 0.23 | 0.51 | L | .195 | .215 | 4.95 | 5.46 |
| C1 | .055 | .065 | 1.39 | 1.65 | P | .112 | .118 | 2.84 | 3.00 |
| D | .998 | 1.00 | 25.34 | 25.52 | S | .044 | .056 | 1.12 | 1.42 |
| D1 | .962 | .982 | 24.43 | 24.94 | | | | | |