

**HMIC™ Silicon PIN Diode Switches  
 with Integrated Bias Network**

Rev. V5

**Features**

- Broad Bandwidth Specified up to 18 GHz
- Usable up to 26 GHz
- Integrated Bias Network
- Low Insertion Loss / High Isolation
- Rugged
- Fully Monolithic
- Glass Encapsulate Construction
- RoHS Compliant\* and 260°C Reflow Compatible

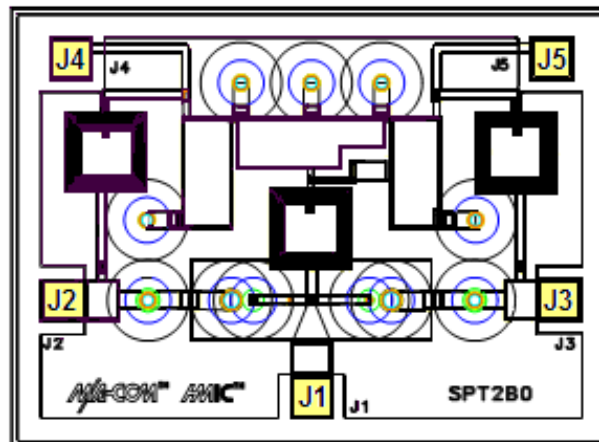
**Description**

The MASW-002102-13580 and MASW-003102-13590 devices are SP2T and SP3T broad band switches with integrated bias networks utilizing M/A-COM Technology Solutions HMIC™ (Heterolithic Microwave Integrated Circuit) process, US Patent 5,268,310. This process allows the incorporation of silicon pedestals that form series and shunt diodes or vias by imbedding them in low loss, low dispersion glass. By using small spacing between elements, this combination of silicon and glass gives HMIC devices low loss and high isolation performance with exceptional repeatability through low millimeter frequencies. Large bond pads facilitate the use of low inductance ribbon bonds, while gold back-side metallization allows for manual or automatic chip bonding via 80/20 - Au/Sn, 62/36/2 - Sn/Pb/Ag solders or electrically conductive silver epoxy.

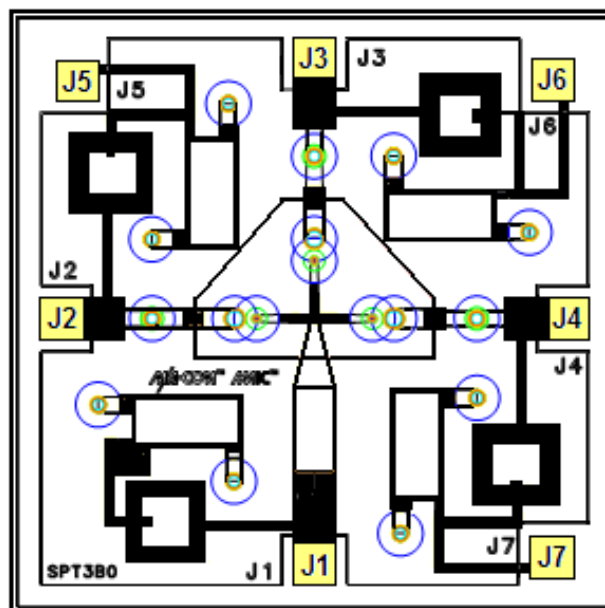
| Parameter               | Absolute Maximum |
|-------------------------|------------------|
| Operating Temperature   | -65°C to +125°C  |
| Storage Temperature     | -65°C to +150°C  |
| Junction Temperature    | +175°C           |
| Applied Reverse Voltage | 50V              |
| RF Incident Power       | +33dBm C.W.      |
| Bias Current +25°C      | ±20mA            |

**Max. operating conditions for a combination  
 of RF power, D.C. bias and temperature:  
 +33dBm CW @ 15mA (per diode) @+85°C**

**MASW-002102-13580**



**MASW-003102-13590**



**Yellow areas denote wire bond pads**

\* Restrictions on Hazardous Substances, European Union Directive 2002/95/EC.

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**MASW-002102-13580 (SPDT)  
 Electrical Specifications @ T<sub>AMB</sub> = +25°C, 20mA Bias current**

| Parameter                    | Frequency | Minimum | Nominal | Maximum | Units |
|------------------------------|-----------|---------|---------|---------|-------|
| Insertion Loss               | 2 GHz     |         | 1.5     | 1.8     | dB    |
|                              | 6 GHz     |         | 0.70    | 1.0     | dB    |
|                              | 12 GHz    |         | 0.90    | 1.2     | dB    |
|                              | 18 GHz    |         | 1.2     | 1.8     | dB    |
| Isolation                    | 2 GHz     | 55      | 60      |         | dB    |
|                              | 6 GHz     | 47      | 50      |         | dB    |
|                              | 12 GHz    | 40      | 45      |         | dB    |
|                              | 18 GHz    | 36      | 40      |         | dB    |
| Input Return Loss            | 2 GHz     |         | 14      |         | dB    |
|                              | 6 GHz     |         | 15      |         | dB    |
|                              | 12 GHz    |         | 15      |         | dB    |
|                              | 18 GHz    |         | 13.0    |         | dB    |
| Switching Speed <sup>1</sup> | -         |         | 50      |         | ns    |

**MASW-003102-13590 (SP3T)  
 Electrical Specifications @ T<sub>AMB</sub> = +25°C, 20mA Bias current**

| Parameter                    | Frequency | Minimum | Nominal | Maximum | Units |
|------------------------------|-----------|---------|---------|---------|-------|
| Insertion Loss               | 2 GHz     |         | 1.6     | 2.0     | dB    |
|                              | 6 GHz     |         | 0.8     | 1.1     | dB    |
|                              | 12 GHz    |         | 1.0     | 1.3     | dB    |
|                              | 18 GHz    |         | 1.3     | 1.9     | dB    |
| Isolation                    | 2 GHz     | 54      | 59      |         | dB    |
|                              | 6 GHz     | 47      | 50      |         | dB    |
|                              | 12 GHz    | 40      | 45      |         | dB    |
|                              | 18 GHz    | 36      | 40      |         | dB    |
| Input Return Loss            | 2 GHz     |         | 14      |         | dB    |
|                              | 6 GHz     |         | 15      |         | dB    |
|                              | 12 GHz    |         | 16      |         | dB    |
|                              | 18 GHz    |         | 14      |         | dB    |
| Switching Speed <sup>1</sup> | -         |         | 50      |         | ns    |

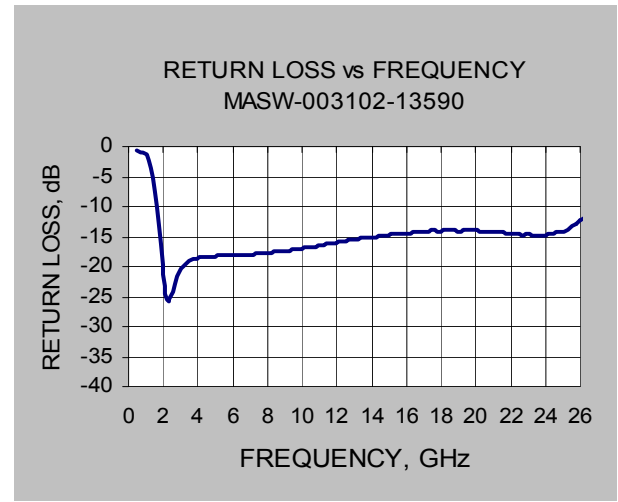
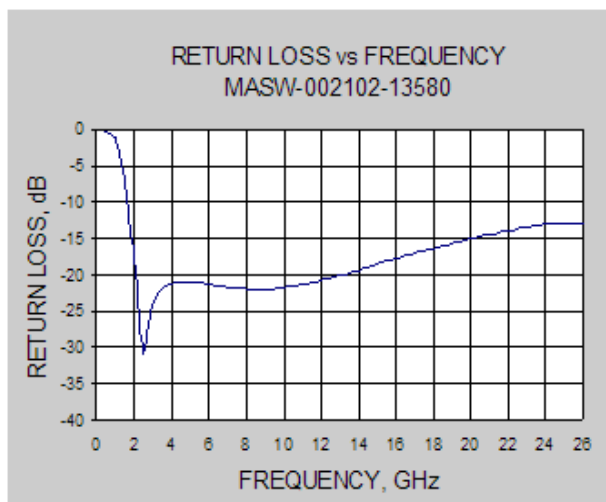
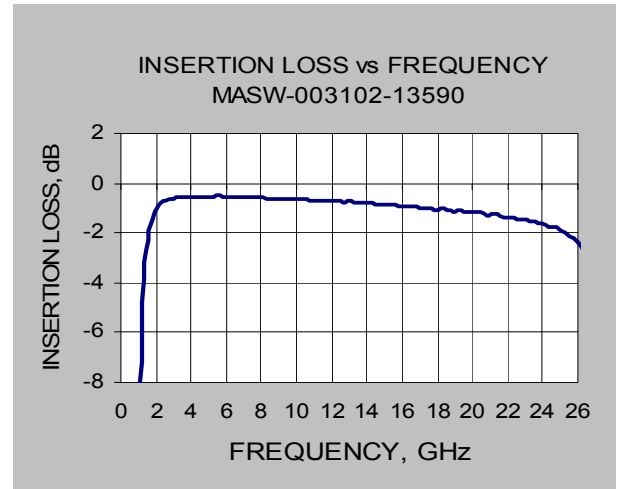
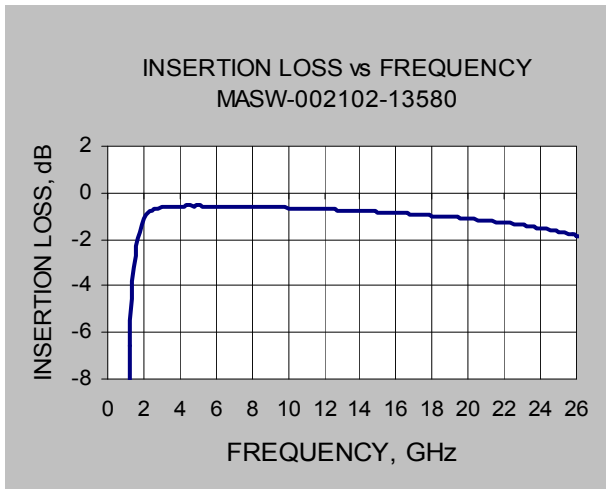
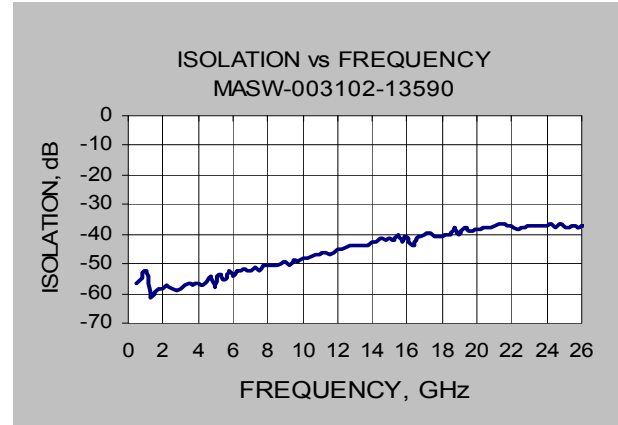
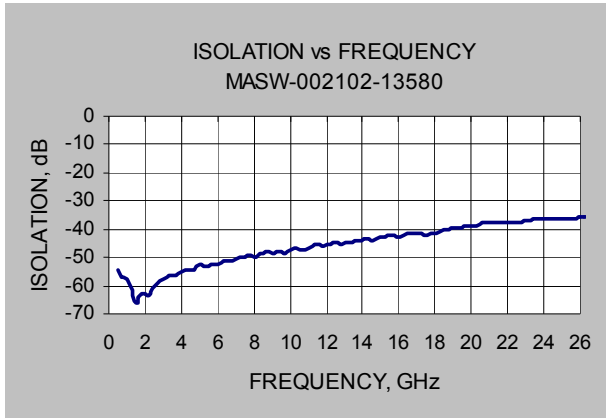
**Note:**

1. Typical switching speed measured from 10% to 90% of detected RF signal driven by TTL compatible drivers using RC output spiking network, R = 50 – 200Ω , C = 390 – 560pF.

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**Typical RF Performance at  $T_A = +25^\circ\text{C}$ , 20mA Bias Current**



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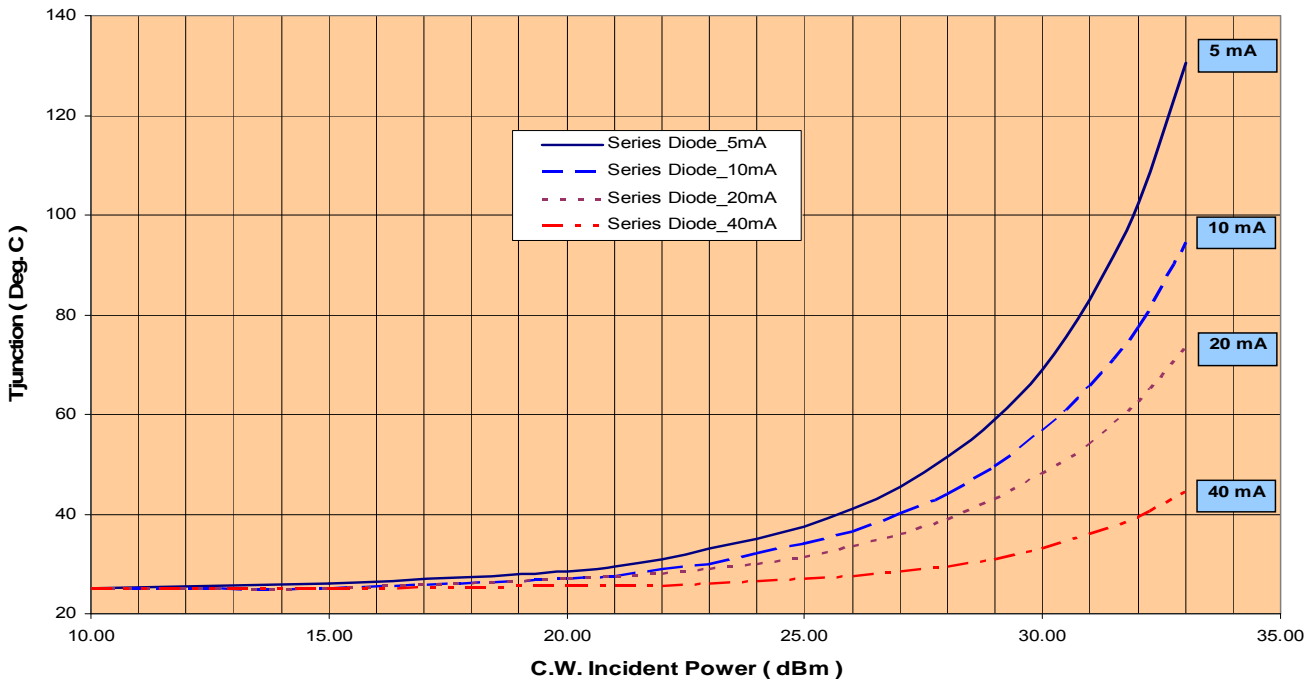
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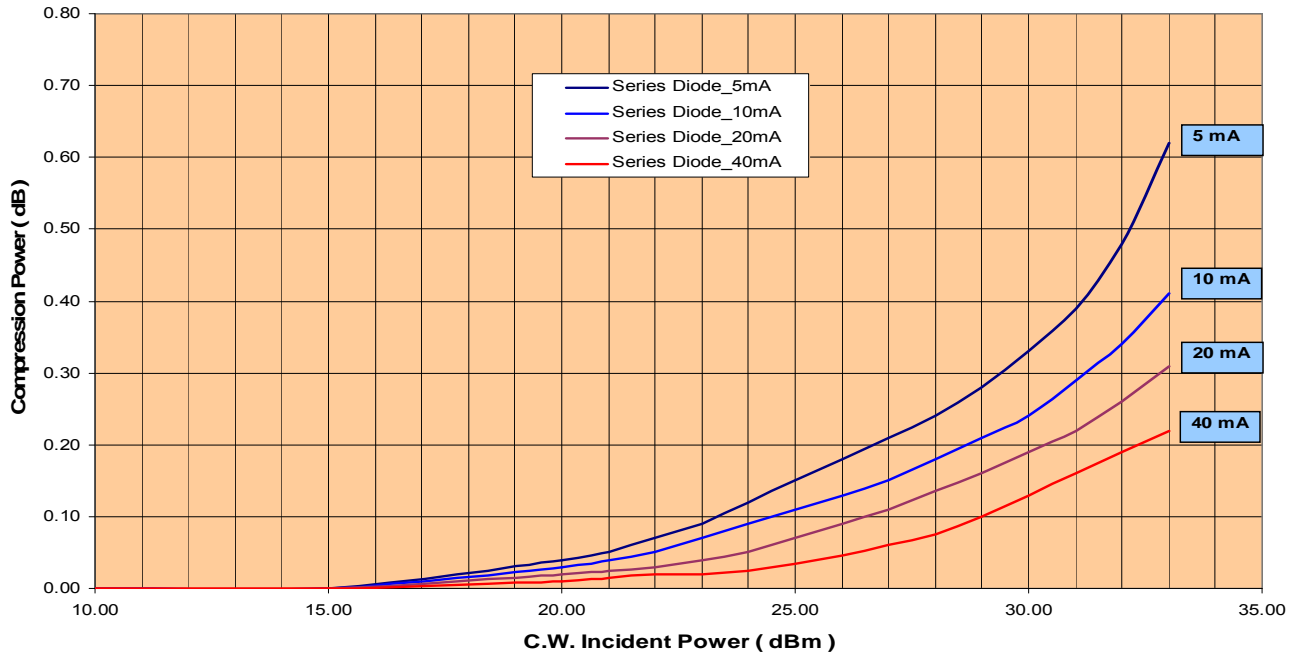
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**MASW-002102-13580 Junction Temperature vs. Incident Power at 8 GHz**



**MASW-002102-13580 Compression Power vs. Incident Power at 8 GHz**



**Note:**

The PIN diodes in the MASW-002102-13580 and the MASW-003102-13590 have the same electrical characteristics and will have similar performance.

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## Operation of the MASW-002102-13580 and MASW-003102-13590

Operation of the MASW-002102-13580 and MASW-003102-13590 PIN diode switches is achieved by simultaneous application of DC currents to the bias pads. The required levels for the different states are shown in the tables below. The on-chip pull-up resistor @ J1, shown in the schematic below, has a value of 40Ω - 60Ω and must be taken into consideration when defining drive circuitry.

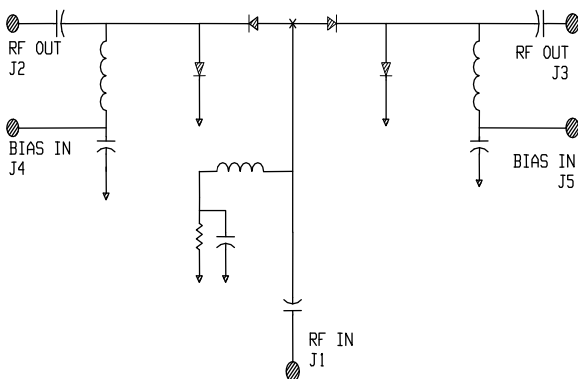
### Driver Connections MASW-002102-13580

| Control Level<br>$I_{DC}$ @ |       | Condition of<br>RF Output | Condition of<br>RF Output |
|-----------------------------|-------|---------------------------|---------------------------|
| J4                          | J5    | J1 - J2                   | J1 - J3                   |
| -20mA                       | +20mA | Low Loss                  | Isolation                 |
| +20mA                       | -20mA | Isolation                 | Low Loss                  |

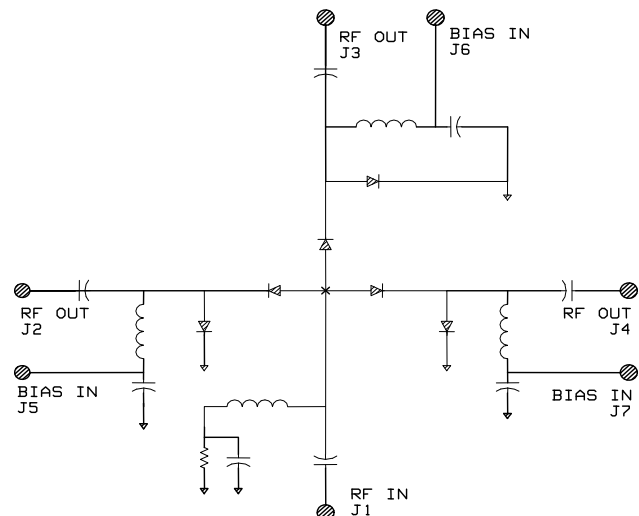
### Driver Connections MASW-003102-13590

| Control Level<br>$I_{DC}$ @ |       |       | Condition of<br>RF Output | Condition of<br>RF Output | Condition of<br>RF Output |
|-----------------------------|-------|-------|---------------------------|---------------------------|---------------------------|
| J5                          | J6    | J7    | J1 - J2                   | J1 - J3                   | J1 - J4                   |
| -20mA                       | +20mA | +20mA | Low Loss                  | Isolation                 | Isolation                 |
| +20 mA                      | -20mA | +20mA | Isolation                 | Low Loss                  | Isolation                 |
| +20mA                       | +20mA | -20mA | Isolation                 | Isolation                 | Low Loss                  |

### Equivalent Circuit MASW-002102-13580



### Equivalent Circuit MASW-003102-13590



## Wire/Ribbon and Die Attachment Recommendations

### Wire Bonding

Thermosonic wedge wire bonding using 0.00025" x 0.003" ribbon or 0.001" diameter gold wire is recommended. A heat stage temperature of 150°C and a force of 18 to 22 grams should be used. Ultrasonic energy should be adjusted to the minimum required to achieve a good bond. RF bond wires should be kept as short and straight as possible.

### Chip Mounting

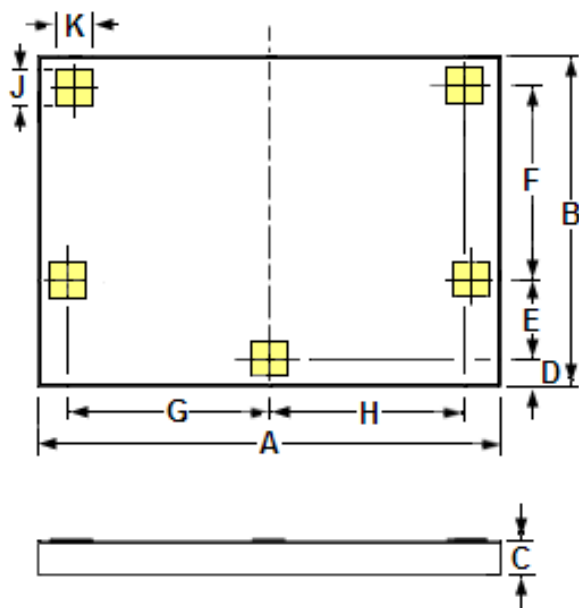
The HMIC switches have Ti-Pt-Au back metal. They can be die mounted with a gold-tin eutectic solder preform or conductive epoxy. Mounting surface must be clean and flat.

\*Note: This device utilizes a process step designed to have minimal to non-existent burring around the perimeter of the die.

**Eutectic Die Attachment:** An 80/20, gold-tin, eutectic solder preform is recommended with a work surface temperature of 255°C and a tool tip temperature of 265°C. When hot gas is applied, the tool tip temperature should be 290°C. The chip should not be exposed to temperatures greater than 320°C for more than 20 seconds. No more than three seconds should be required for attachment. Solders containing tin should not be used.

**Epoxy Die Attachment:** A minimum amount of epoxy should be used. A thin epoxy fillet should be visible around the perimeter of the chip after placement. Cure epoxy per manufacturer's schedule (typically 125-150°C).

## MASW-002102-13580 Chip Outline Drawing<sup>1,2</sup>

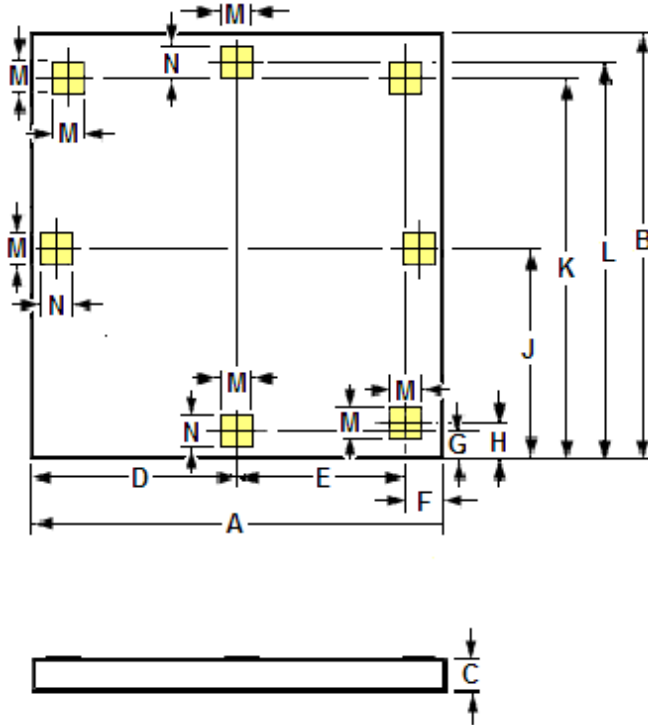


| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.066  | 0.070 | 1.680       | 1.780 |
| B   | 0.048  | 0.052 | 1.230       | 1.330 |
| C   | 0.004  | 0.006 | 0.100       | 0.150 |
| D   | 0.004  | 0.006 | 0.090       | 0.140 |
| E   | 0.012  | 0.013 | 0.292       | 0.317 |
| F   | 0.029  | 0.030 | 0.735       | 0.760 |
| G   | 0.030  | 0.031 | 0.766       | 0.791 |
| H   | 0.029  | 0.030 | 0.732       | 0.757 |
| J   | 0.005  | REF.  | 0.129       | REF.  |
| K   | 0.005  | REF.  | 0.129       | REF.  |

### Notes:

1. Topside and backside metallization is gold, 2.5um thick typical.
2. Yellow areas indicate wire bonding pads

### MASW-003102-13590 Chip Outline Drawing<sup>1,2</sup>



| DIM | INCHES |        | MILLIMETERS |       |
|-----|--------|--------|-------------|-------|
|     | MIN    | MAX    | MIN         | MAX   |
| A   | 0.0697 | 0.0736 | 1.770       | 1.870 |
| B   | 0.0693 | 0.0732 | 1.760       | 1.860 |
| C   | 0.0039 | 0.0059 | 0.100       | 0.150 |
| D   | 0.0310 | 0.0319 | 0.787       | 0.812 |
| E   | 0.0289 | 0.0299 | 0.734       | 0.759 |
| F   | 0.0055 | 0.0075 | 0.140       | 0.190 |
| G   | 0.0035 | 0.0055 | 0.089       | 0.139 |
| H   | 0.0044 | 0.0064 | 0.113       | 0.163 |
| J   | 0.0338 | 0.0358 | 0.859       | 0.909 |
| K   | 0.0632 | 0.0652 | 1.610       | 1.660 |
| L   | 0.0660 | 0.0680 | 1.680       | 1.730 |
| M   | 0.0051 | REF.   | 0.1290      | REF.  |
| N   | 0.0046 | REF.   | 0.1180      | REF.  |

**Notes:**

1. Topside and backside metallization is gold , 2.5um thick typical.
2. Yellow areas indicate wire bonding pads

### Ordering Information

| Part Number        | Package              |
|--------------------|----------------------|
| MASW-002102-13580G | Gel Pack (25 per)    |
| MASW-002102-13590W | Waffle Pack (25 per) |
| MASW-003102-13590G | Gel Pack (25 Per)    |
| MASW-003102-13590W | Waffle Pack (25 Per) |