

# MA4SW210B-1 MA4SW310B-1



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

RoHS Compliant

Rev. V4

### Features

- ◆ Broad Bandwidth Specified 2 to 18 GHz
- ◆ Usable up to 26 GHz
- ◆ Integrated Bias Network
- ◆ Low Insertion Loss / High Isolation
- ◆ Rugged,
- ◆ Fully Monolithic
- ◆ Glass Encapsulate Construction
- ◆ Polymer Protective Coating

### Description

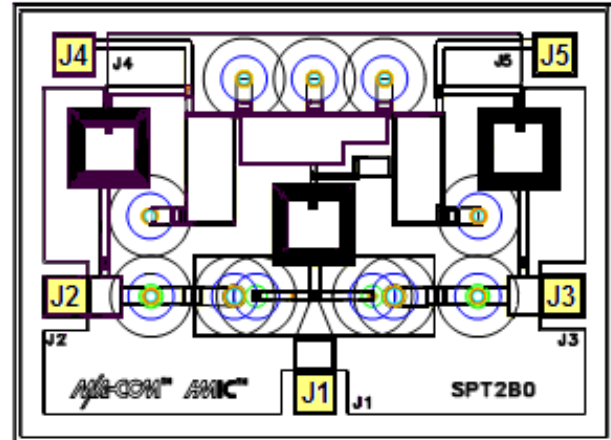
The MA4SW210B-1 and MA4SW310B-1 devices are SP2T and SP3T broad band switches with integrated bias networks utilizing M/A-COM's HMIC™ (Heterolithic Microwave Integrated Circuit) Process, US Patent 5,268,310. This process allows the incorporation of silicon pedestals that form series and shunt diodes 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 backside metallization allows for manual or automatic chip bonding via 80Au/20Sn, Sn62/Pb36/Ag2 solders or electrically conductive silver epoxy.

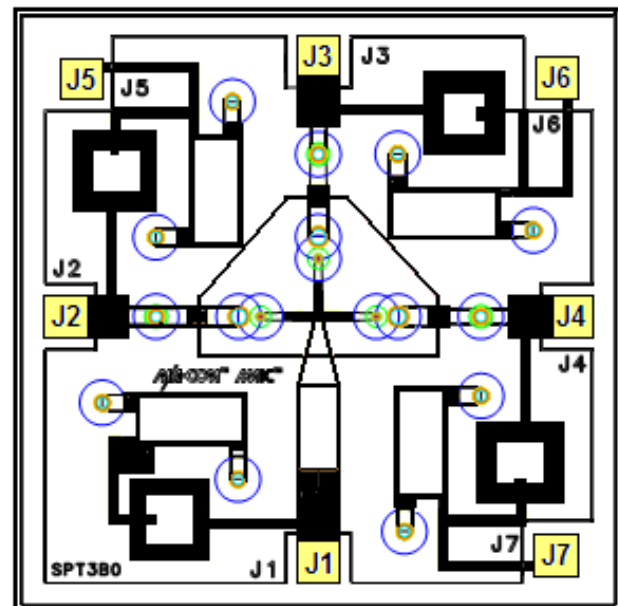
| Parameter               | Absolute Maximum |
|-------------------------|------------------|
| Operating Temperature   | -65°C to +125°C  |
| Storage Temperature     | -65°C to +150°C  |
| Junction Temperature    | +175°C           |
| Applied Reverse Voltage | - 50V            |
| RF C.W. Incident Power  | +30dBm C.W.      |
| Bias Current +25°C      | ± 20mA           |

**Max. operating conditions for a combination of RF power, D.C. bias and temperature:  
+30dBm CW @ 15mA (per diode) @+85°C**

MA4SW210B-1



MA4SW310B-1



Yellow areas indicate bond pads

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**MA4SW210B-1 (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    |

**MA4SW310B-1 (SP3T)**  
**Electrical Specifications @ T<sub>AMB</sub> = +25°C, 20mA Bias current**

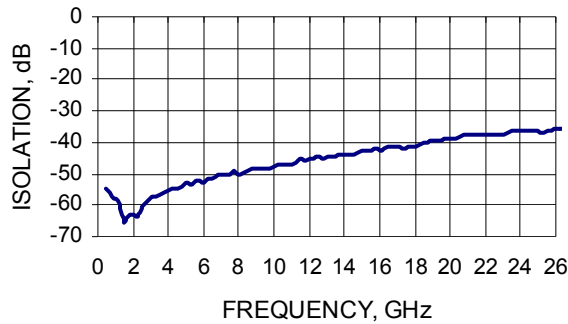
| Parameter                    | Frequency | Minimum | Nominal | Maximum | Units |
|------------------------------|-----------|---------|---------|---------|-------|
| Insertion Loss               | 2 GHz     |         | 1.6     | 2.0     | dB    |
|                              | 6 GHz     |         | 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:**

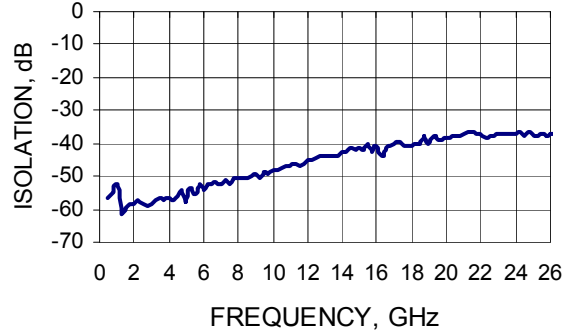
1. Typical switching speed measured from 10% to 90% of detected RF signal driven by TTL compatible drivers using RC output spiking network, R = 50 – 200Ω , C = 390 – 560pF.

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

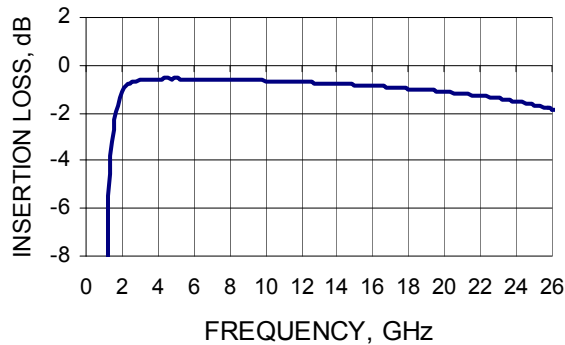
ISOLATION vs FREQUENCY  
 MA4SW210B-1



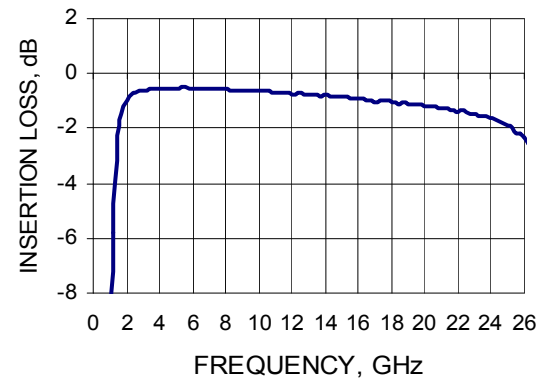
ISOLATION vs FREQUENCY  
 MA4SW310B-1



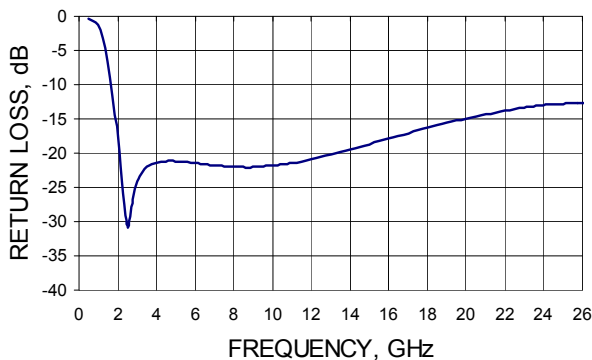
INSERTION LOSS vs FREQUENCY  
 MA4SW210B-1



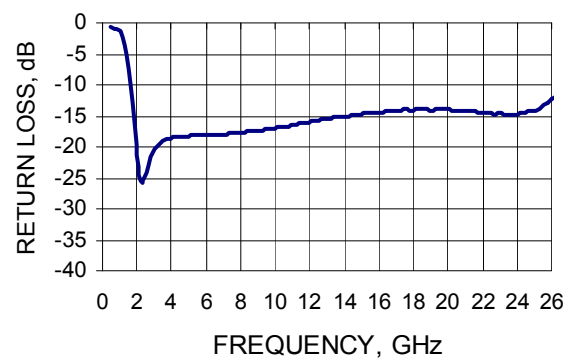
INSERTION LOSS vs FREQUENCY  
 MA4SW310B-1



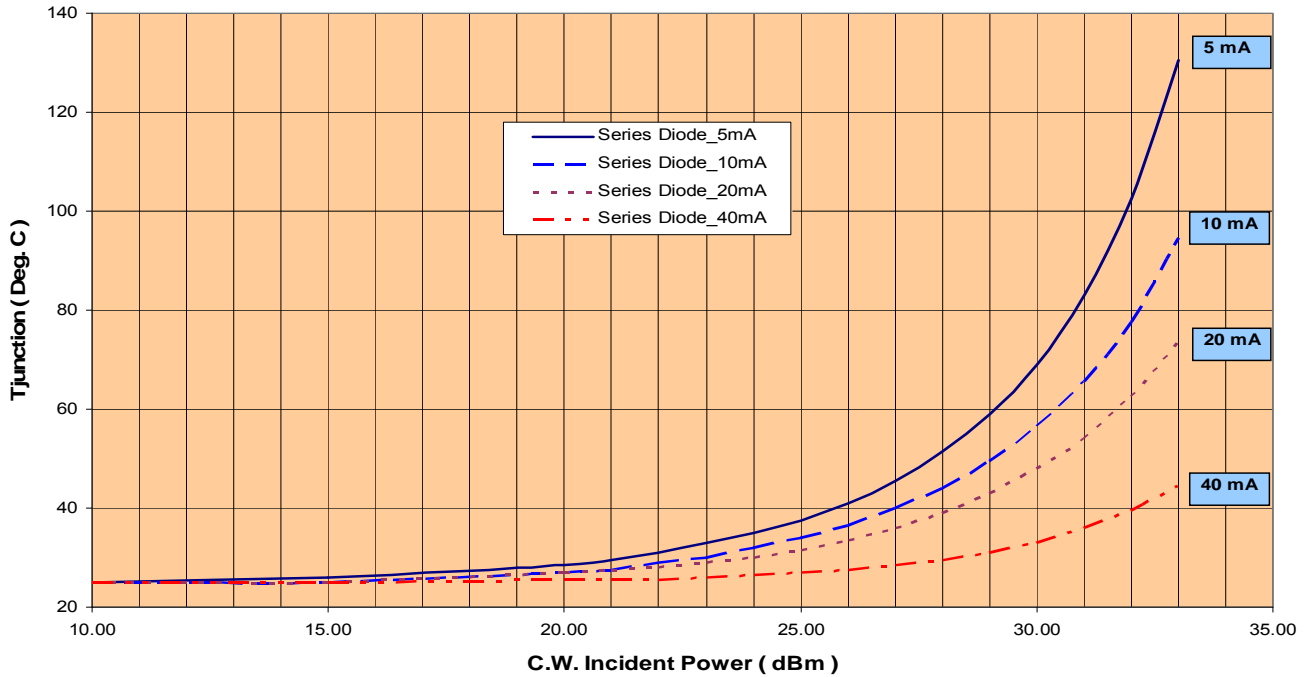
RETURN LOSS vs FREQUENCY  
 MA4SW210B-1



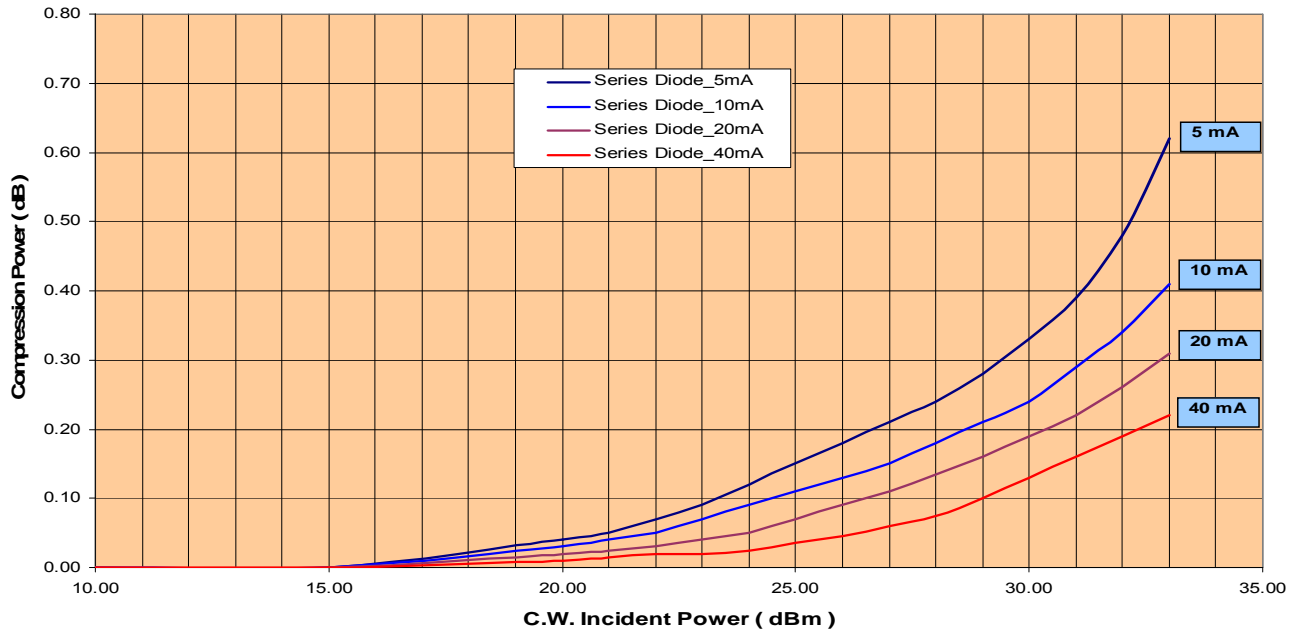
RETURN LOSS vs FREQUENCY  
 MA4SW310B-1



MA4SW210B-1 Series Diode Junction Temperature vs. Incident Power at 8 GHz



MA4SW210B-1 Compression Power vs. Incident Power at 8 GHz



**Note:**

The MA4SW310B-1 contains the same PIN diodes and will have similar performance.

**Operation of the MA4SW 210B-1 and MA4SW310B-1**

Operation of the MA4SW210B-1 and MA4SW310B-1 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 control currents should be supplied by constant current sources. The nominal 40Ω - 60Ω pull-up resistor voltage @ J4 and J5 is usually -1V for -20mA and +20mA for +1V.

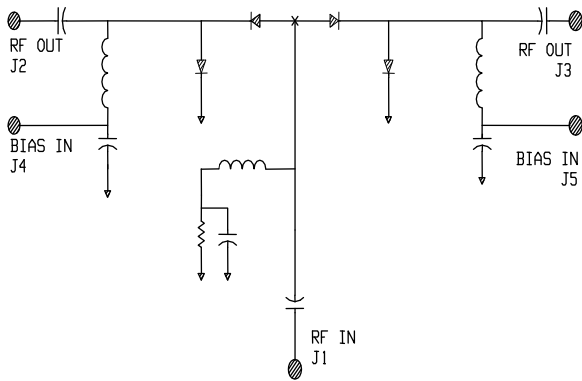
**Driver Connections MA4SW210B-1**

| 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                  |

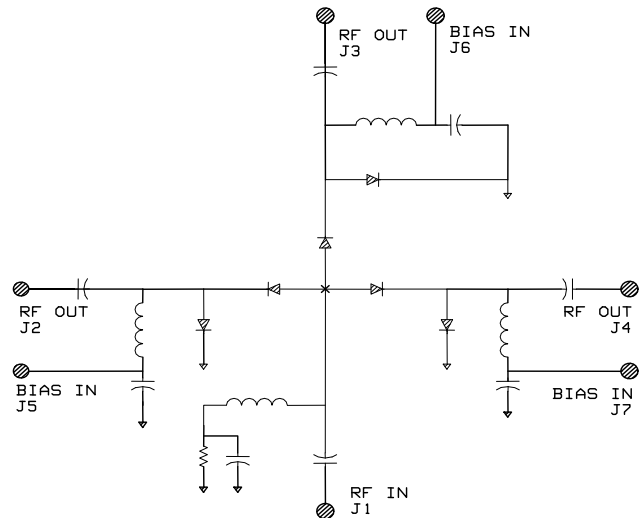
**Driver Connections MA4SW310B-1**

| 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 MA4SW210B-1**



**Equivalent Circuit MA4SW310B-1**



**Wire Bonding**

Thermosonic wedge bonding using 0.003" x 0.00025" 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. If ultrasonic energy is necessary, it should be adjusted to the minimum level required to achieve a good bond. RF bond wires should be kept as short as possible.

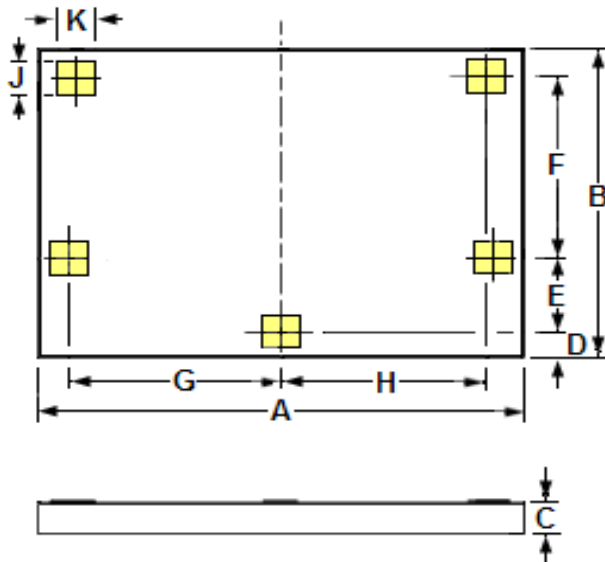
**Chip Mounting**

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.

**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 temperature at the chip 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 rich in tin should not be used.

**Epoxy Die Attachment:** A minimum amount of epoxy, 1-2 mils thick, should be used to attach chip. A thin epoxy fillet should be visible around the outer perimeter of the chip after placement. Cure epoxy per product instructions. Typically 150°C for 1 hour.

**MA4SW210B-1  
Chip Outline<sup>1,2</sup> & Dimensions**



| 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 , 2.5µm thick typical.
2. Yellow areas indicate wire bonding pads

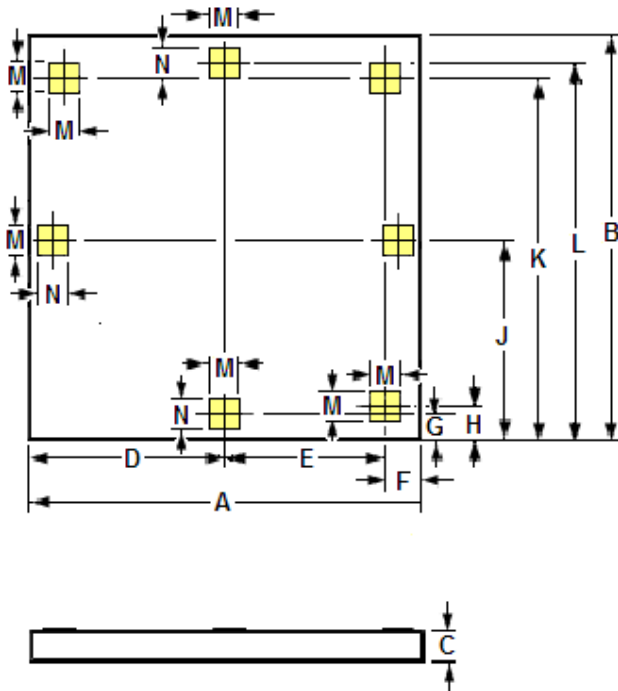
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**MA4SW310B-1  
Chip Outline<sup>1,2</sup> & Dimensions**



| 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 , 2.5µm thick typical.
2. Yellow areas indicate wire bonding pads

**Ordering Information**

| Part Number        | Package         |
|--------------------|-----------------|
| <b>MA4SW210B-1</b> | <b>Gel Pack</b> |
| <b>MA4SW310B-1</b> | <b>Gel Pack</b> |

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