

**HMIC™ Silicon PIN Diode Switches**

V6

**Features**

- ◆ Broad Bandwidth
- ◆ Specified from 50MHz to 20GHz
- ◆ Usable from 50MHz to 26.5GHz
- ◆ Lower Insertion Loss / Higher Isolation than pHempt
- ◆ Rugged
- ◆ Fully Monolithic,
- ◆ Glass Encapsulated Construction
- ◆ Up to +33dBm C.W. Power Handling
- ◆ RoHS Compliant

**Description**

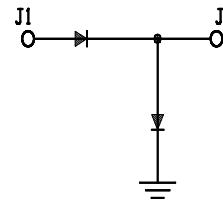
The MASW-001100-1190, MASW-002100-1191 and MASW-003100-1192 are broadband monolithic switches using series and shunt connected silicon PIN diodes. They are designed for use as 2W, high performance switches in applications up to 26.5GHz. They provide performance levels superior to those realized by hybrid MIC designs incorporating beamlead and PIN chip diodes that require chip and wire assembly.

These switches are fabricated using M/A-COM's patented 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 through low millimeter frequencies.

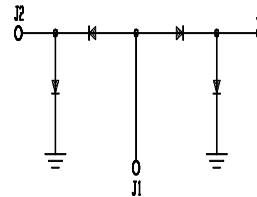
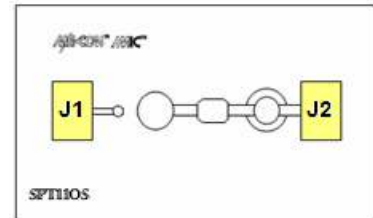
Large bond pads facilitate the use of low inductance ribbon leads, while gold backside metallization allows for manual or automatic chip bonding via 80/20, AuSn solder or conductive Ag epoxy.

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	+33dBm C.W.
Bias Current +25°C	±20mA

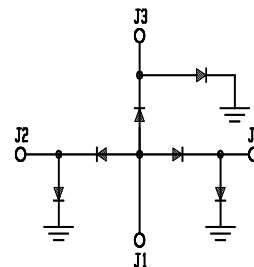
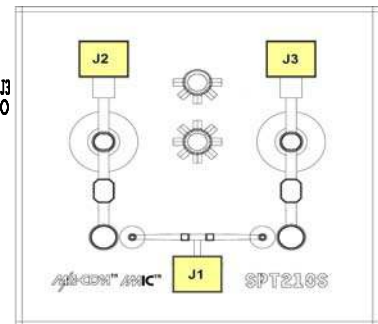
**Max operating Conditions for a Combination of RF Power, D.C. Bias and Temperature:  
 +33dBm CW @ 15mA (per diode) @+85°C**



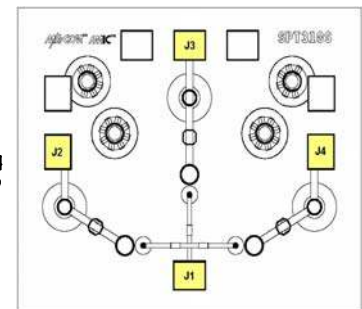
**MASW-001100-1190**



**MASW-002100-1191**



**MASW-003100-1192**



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V6

**MASW-001100-1190 (SPST)**  
**Electrical Specifications @ T<sub>A</sub> = +25°C, 20mA Bias**

Parameter	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss	6GHz	-	0.4	0.7	dB
	13GHz	-	0.5	0.9	dB
	20GHz	-	0.7	1.2	dB
Isolation	6GHz	46	55	-	dB
	13GHz	39	47	-	dB
	20GHz	34	42	-	dB
Input Return Loss	6GHz	22	31	-	dB
	13GHz	15	33	-	dB
	20GHz	14	27	-	dB
Switching Speed <sup>1</sup>	-	-	20	-	ns
Voltage Rating <sup>2</sup>	-	-	-	50	V
Signal Compression (500mW)	1GHz	-	0.2	-	dB

1.) Typical Switching Speed measured from 10 % to 90 % of detected RF signal driven by TTL compatible drivers.  
 2.) Maximum reverse leakage current in either the shunt or series PIN diodes shall be 10mA maximum at -50 volts.

**MASW-002100-1191 (SPDT)**  
**Electrical Specifications @ T<sub>A</sub> = +25°C, 20mA Bias**

Parameter	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss	6GHz	-	0.4	0.7	dB
	13GHz	-	0.5	1.0	dB
	20GHz	-	0.7	1.2	dB
Isolation	6GHz	48	63	-	dB
	13GHz	40	50	-	dB
	20GHz	34	42	-	dB
Input Return Loss	6GHz	20	27	-	dB
	13GHz	18	25	-	dB
	20GHz	15	25	-	dB
Switching Speed <sup>1</sup>	-	-	20	-	ns
Voltage Rating <sup>2</sup>	-	-	-	50	V
Signal Compression (500mW)	1GHz	-	0.2	-	dB

1.) Typical Switching Speed measured from 10 % to 90 % of detected RF signal driven by TTL compatible drivers.  
 2.) Maximum reverse leakage current in either the shunt or series PIN diodes shall be 10mA maximum at -50 volts.

**MASW-003100-1192 (SP3T)**  
**Electrical Specifications @ T<sub>A</sub> = +25°C, 20mA Bias**

Parameter	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss	6GHz	-	0.5	0.8	dB
	13GHz	-	0.7	1.1	dB
	20GHz	-	0.9	1.5	dB
Isolation	6GHz	49	57	-	dB
	13GHz	42	48	-	dB
	20GHz	33	42	-	dB
Input Return Loss	6GHz	20	24	-	dB
	13GHz	14	22	-	dB
	20GHz	11	21	-	dB
Switching Speed <sup>1</sup>	-	-	20	-	ns
Voltage Rating <sup>2</sup>	-	-	-	50	V
Signal Compression (500mW)	1GHz	-	0.2	-	dB

2

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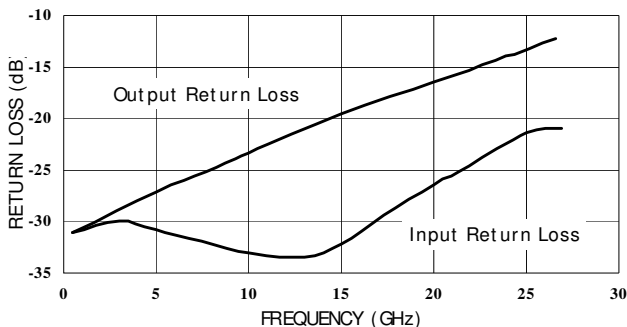
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**HMIC™ Silicon PIN Diode Switches**

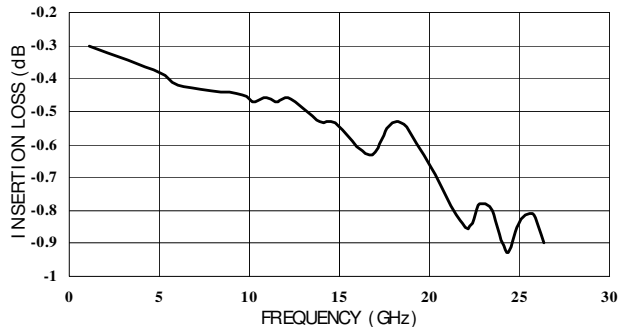
V6

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

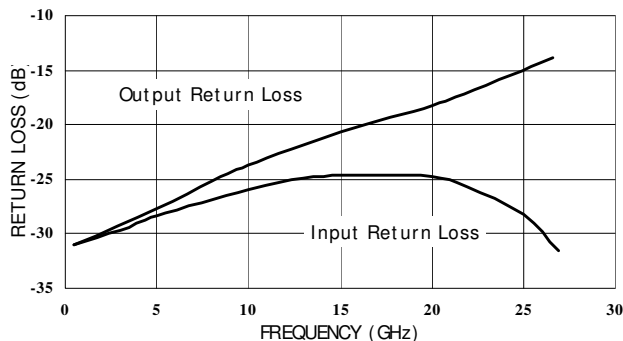
**MASW-001100-1190  
 RETURN LOSS vs. FREQUENCY**



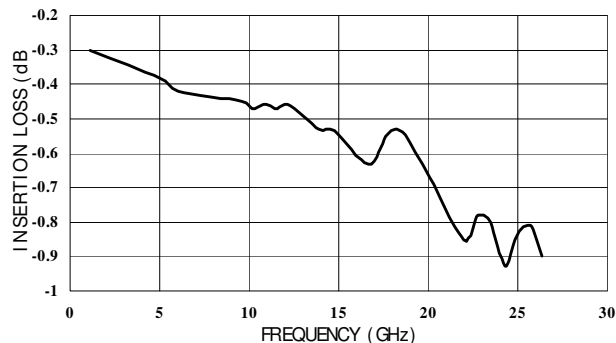
**MASW-001100-1190  
 INSERTION LOSS vs. FREQUENCY**



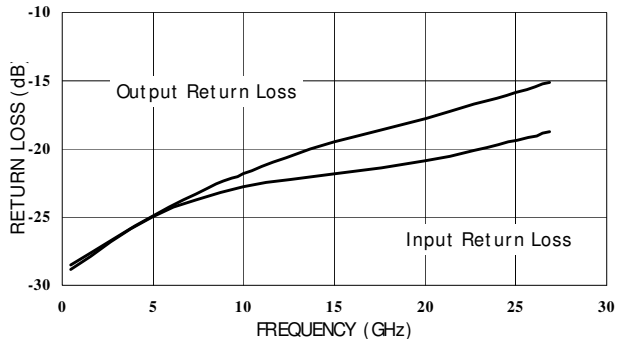
**MASW-002100-1191  
 RETURN LOSS vs. FREQUENCY**



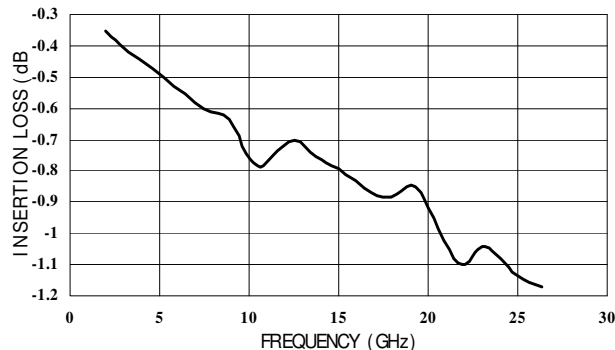
**MASW-002100-1191  
 INSERTION LOSS vs. FREQUENCY**



**MASW-003100-1192  
 RETURN LOSS vs. FREQUENCY**



**MASW-003100-1192  
 INSERTION LOSS vs. FREQUENCY**



**S-Parameters:** S-Parameter data for these devices are available upon request.

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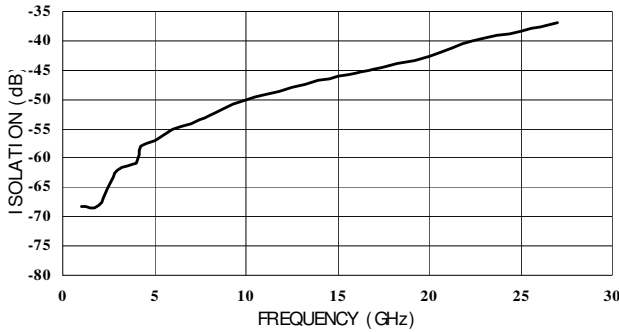
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**HMIC™ Silicon PIN Diode Switches**

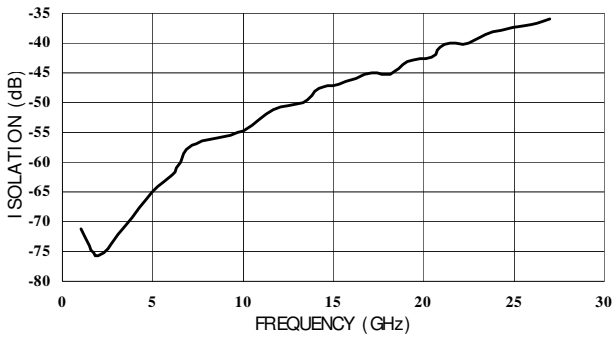
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**Typical Performance Curves @ TA = +25°C, 20mA Bias Current**

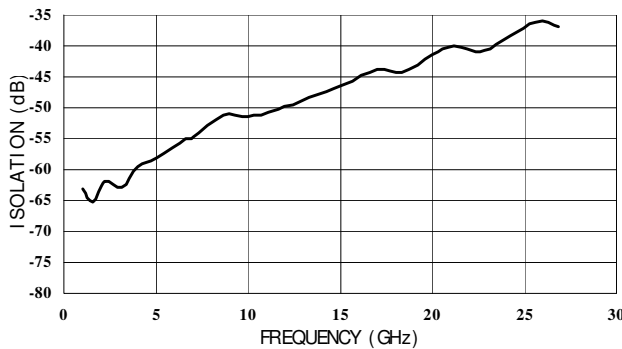
**MASW-001100-1190  
 ISOLATION vs. FREQUENCY**



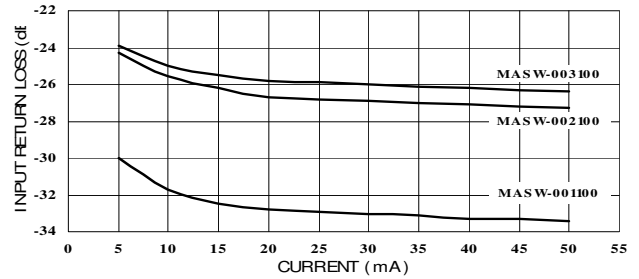
**MASW-002100-1191  
 ISOLATION vs. FREQUENCY**



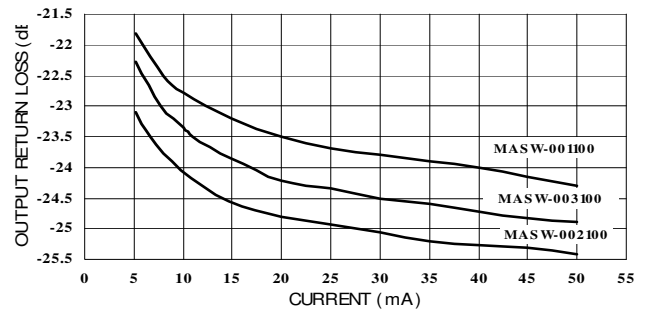
**MASW-003100-1192  
 ISOLATION vs. FREQUENCY**



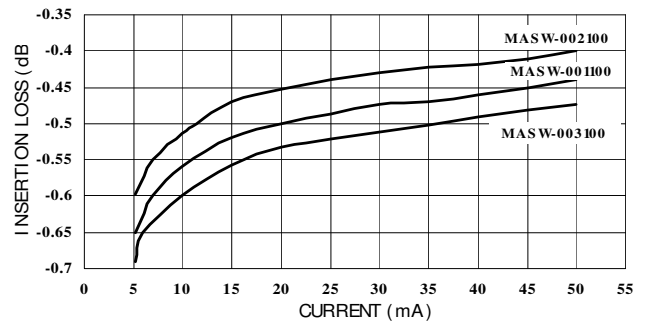
**INPUT RETURN LOSS vs. BIAS CURRENT @ 10 GHz**



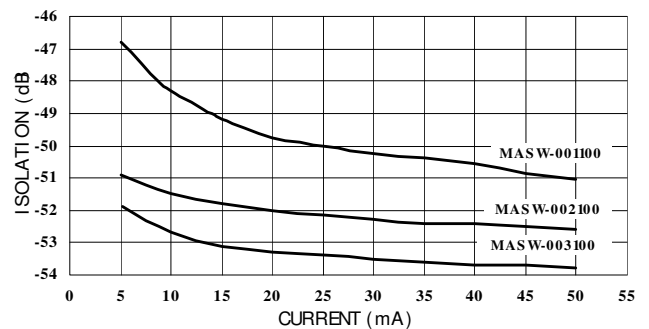
**OUTPUT RETURN LOSS vs. BIAS CURRENT @ 10 GHz**



**INSERTION LOSS vs. BIAS CURRENT @ 10 GHz**



**ISOLATION vs. BIAS CURRENT @ 10 GHz**



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### Operation of the MASW Series Switches

Operation of the MASW series of PIN switches is achieved by simultaneous application of negative DC current to the low loss switching arm J1, J2, or J3, and positive DC current to the remaining switching arms as shown in the bias connection circuits. DC return is achieved via J1. The control currents should be supplied by constant current sources. The voltages at these points will not exceed  $\pm 1.5$  volts (1.2V typical) at currents up to  $\pm 20$ mA. In the low loss state, the series diode must be forward biased and the shunt diode reverse biased. In the isolated arm, the shunt diode is forward biased and the series diode is reverse biased.

#### Driver Connections MASW-001100-1190

Control Level (DC Current) at	Condition of RF Output
J2	J1-J2
-20mA	Low Loss
+20mA	Isolation

#### MASW-002100-1191

Control Level (DC Current) at		Condition of RF Output	Condition of RF Output
J2	J3	J1-J2	J1-J3
-20mA	+20mA	Low Loss	Isolation
+20mA	-20mA	Isolation	Low Loss

#### MASW-003100-1192

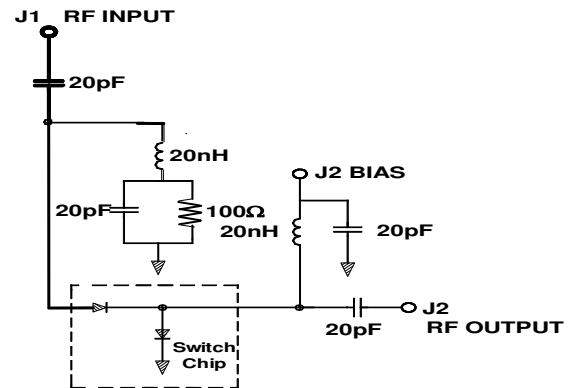
Control Level (DC Current) at			Cond. of RF Output	Cond. of RF Output	Cond. of RF Output
J2	J3	J4	J1-J2	J1-J3	J1-J4
-20mA	+20mA	+20mA	Low Loss	Isolation	Isolation
+20mA	-20mA	+20mA	Isolation	Low Loss	Isolation
+20mA	+20mA	-20mA	Isolation	Isolation	Low Loss

### Handling Considerations

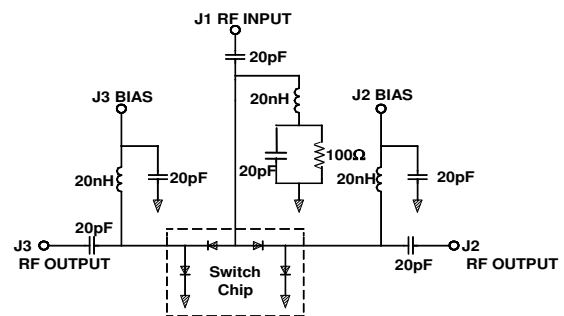
**Cleanliness:** These chips should be handled in a clean environment.

**Electro-Static Sensitivity:** The MASW series PIN switches are ESD, Class 1A sensitive (HBM). The proper ESD handling procedures should be used.

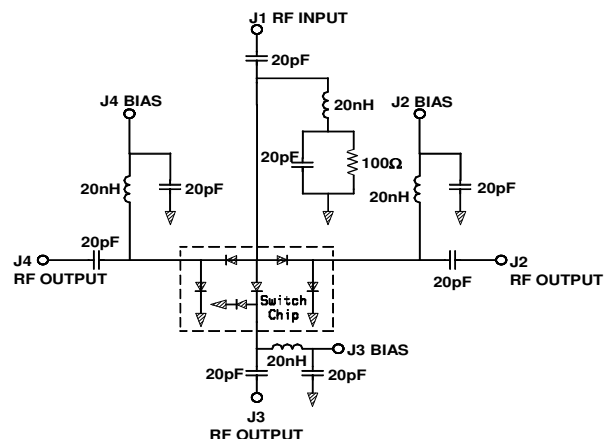
#### MASW-001100-1190 and Bias Connections<sup>1</sup>



#### MASW-002100-1191 and Bias Connections<sup>1</sup>



#### MASW-003100-1192 and Bias Connections<sup>1</sup>



#### Notes:

1. RLC values are for an operation frequency of 2-18GHz and bias current of  $\pm 20$ mA per diode.

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**Wire Bonding**

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

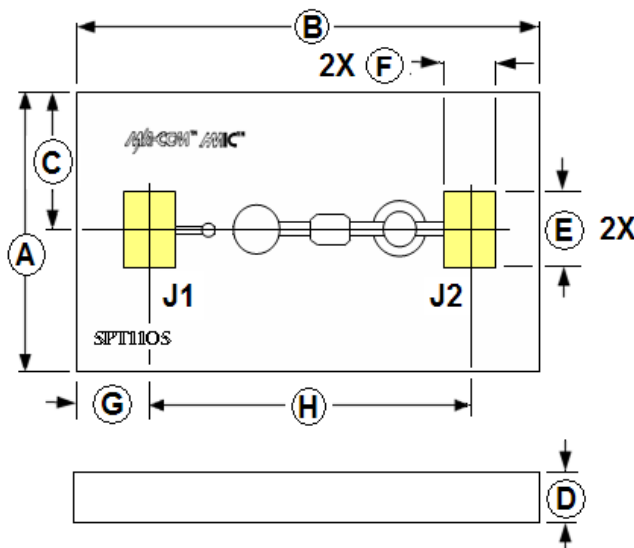
**Mounting**

These chips have Ti-Pt-Au back metal and can be mounted using 80Au/20Sn eutectic solder or electrically conductive Ag epoxy. Mounting surface must be flat and clean of oils and contaminants.

**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 controlled thickness of no more than 2 mils is recommended for the best electrical and thermal conductivity. A thin epoxy fillet should be visible around the perimeter of the chip after placement to ensure complete coverage. Cure epoxy per manufacturer's recommended schedule. Typically +150°C for 1 hour.

**Chip Outline Drawing<sup>1,2</sup>**



DIM	INCHES		MM	
	MIN.	MAX.	MIN.	MAX.
A	0.014	0.018	0.35	0.45
B	0.025	0.029	0.64	0.74
C	0.008 REF		0.20 REF	
D	0.004	0.006	0.10	0.15
E	0.004 REF		0.10 REF	
F	0.003 REF		0.08 REF	
G	0.003 REF		0.08 REF	
H	0.020 REF		0.52 REF	

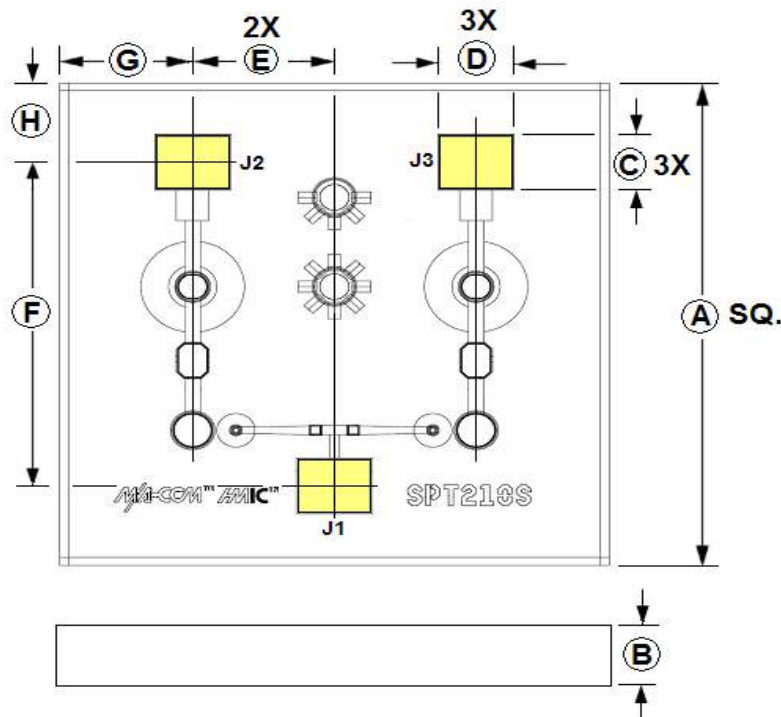
**Notes:**

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



### Chip Outline Drawing<sup>1,2</sup>

#### MASW-002100-1191



DIM	INCHES		MM	
	MIN.	MAX.	MIN.	MAX.
A	0.029	0.033	0.73	0.83
B	0.004	0.006	0.10	0.15
C	0.004 REF		0.10 REF	
D	0.005 REF		0.13 REF	
E	0.009 REF		0.23 REF	
F	0.023 REF		0.58 REF	
G	0.007 REF		0.17 REF	
H	0.004 REF		0.10 REF	

**Notes:**

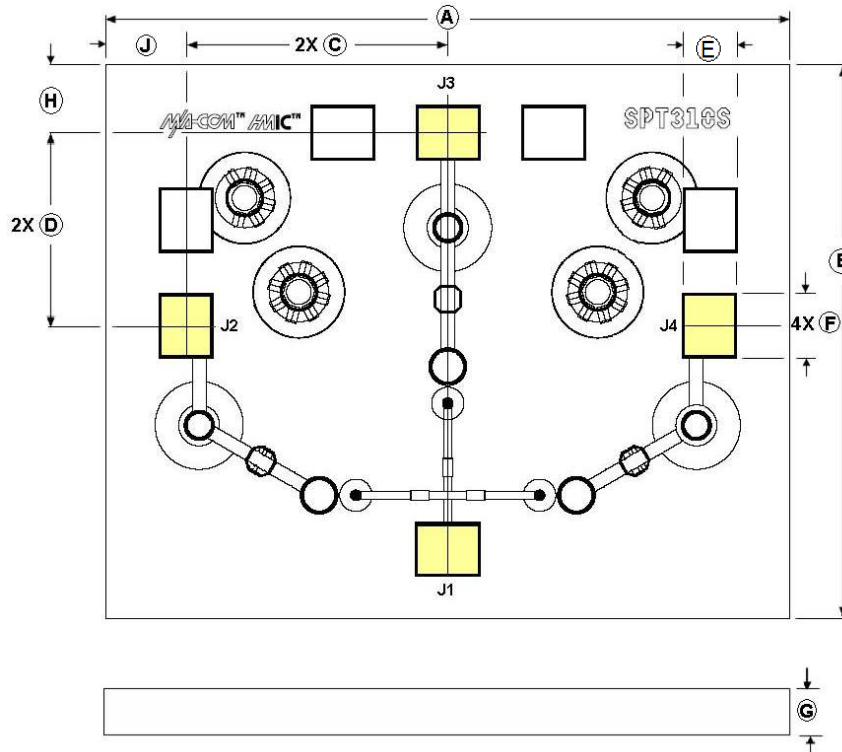
1. Topside and backside surface metallization is gold , 2.5µm thick typical.
2. Yellow areas indicate wire bonding pads

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**Chip Outline Drawing <sup>1,2</sup>**

**MASW-003100-1192**



DIM	INCHES		MM	
	MIN.	MAX.	MIN.	MAX.
A	0.046	0.050	1.16	1.26
B	0.036	0.040	0.92	1.02
C	0.019 REF		0.48 REF	
D	0.014 REF		0.36 REF	
E	0.004 REF		0.10 REF	
F	0.005 REF		0.13 REF	
G	0.004	0.006	0.10	0.15
H	0.005 REF		0.12 REF	
J	0.004 REF		0.10 REF	

**Notes:**

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



## Ordering Information

Part Number	Package
MASW-001100-11900W	Waffle Pack
MASW-001100-11900G	Gel Pack
MASW-002100-11910W	Waffle Pack
MASW-002100-11910G	Gel Pack
MASW-003100-11920W	Waffle Pack
MASW-003100-11920G	Gel Pack