

Preliminary Datasheet

MM5130 – DC to 18 GHz SP4T

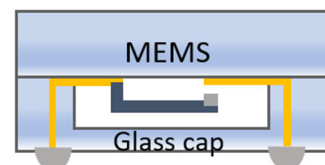
Product Overview

Description:

The MM5130 device is a high-power SP4T micro-mechanical switch offered by Menlo Micro. Menlo Micro has developed a new Ideal Switch™ fabrication process and applied it to DC and wideband RF/microwave switch applications. This innovative technology enables robust and highly reliable switches capable of greater than 25 W forward power. The MM5130 provides ultra-low insertion loss and superior linearity from 18 GHz down to DC, with greater than 3.0×10^9 switching cycles guaranteed at +85°C. The MM5130 is an ideal solution for replacing large RF electromechanical relays, as well as RF/microwave solid-state switches in applications where linearity and insertion loss are critical parameters. The four switch channels are individually controllable by applying voltage to the corresponding RF GATE pin.

Features:

- DC to 18 GHz Frequency Range
- 25 W (CW), 150 W (Pulsed) Max Power Handling
- Low On-State Insertion Loss: 0.2 dB @ 6.0 GHz
- High Linearity, IIP3 > 85 dBm
- 25 dB Isolation @ 6.0 GHz
- High Reliability > 3.0×10^9 Switching Operations
- 2.5 mm x 2.5 mm WLCSP Package

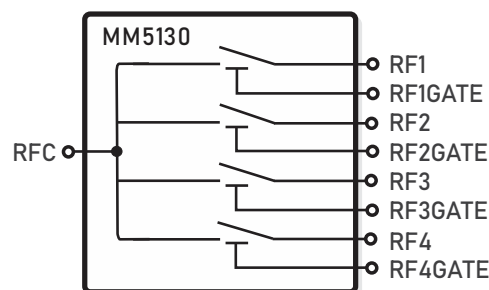


Applications:

- Switched Filter Banks and Tunable Filters
- High Power RF Front Ends
- Antenna Tuning
- Low-Loss Switch Matrices
- RF EM Relay Replacement

Markets:

- Defense and Aerospace
- Medical Equipment
- Test and Measurement Systems
- Wireless Infrastructure



Functional Block Diagram



Electrical Characteristics

Operating Characteristics

Absolute Maximum Ratings

Exceeding the maximum ratings as listed in Table 1 below may reduce the reliability of the device or cause permanent damage. Operation of the MM5130 should be restricted to the limits indicated in Table 2 recommended operating conditions listed below.

Electrostatic Discharge (ESD) Safeguards

The MM5130 is a Class 0 ESD device. When handling the MM5130, observe precautions as with any other ESD sensitive device. Do not exceed the voltage ratings specified in Table 1 below.

Table 1 Absolute Maximum Ratings ⁽¹⁾

Parameter	Minimum	Maximum	Unit
CW Input Power @ 6 GHz		25	W
Peak Input Power @ 6 GHz		150	W
Open State Voltage Rating / Switch RF1-4 to RFC ⁽²⁾		+/-150	V
Open State Voltage RF1-RF4, RFC to GND, GATE pin to GND Potential ⁽²⁾		+/-150	V
DC Voltage RFGATE Pins to RF1-RF4, RFC, GND ⁽²⁾		+/-100	V
DC Current Rating / Switch		500	mA
Hot Switching Current @ 0.5 V		10	mA
Operating Temperature Range	-40	+85	°C
Storage Temperature Range	-65	+150	°C

Notes:

- 1) All parameters must be within recommended operating conditions. Maximum DC and RF power can only be applied during the on-state condition (cold-switched condition).
- 2) This also applies to ESD events. This is a Class 0 device.



Table 2 DC and AC Electrical Specifications

All specifications valid over full operating temperature range and VBB range

Parameter	Minimum	Typical	Maximum	Unit
Operating Frequency Range	DC		18	GHz
CW Power @ 6 GHz ¹			25	W
Peak Power @ 6 GHz ²			150	W
Operating Temperature Range	-40		+85	°C
Insertion Loss @ 6 GHz		0.3		dB
Insertion Loss @ 18 GHz		1.3		dB
Input / Output Return Loss @ 6 GHz		15		dB
Input / Output Return Loss @ 18 GHz		10		dB
Isolation @ 6 GHz		25		dB
Isolation @ 18 GHz		20		dB
Channel to Channel Isolation @ 6 GHz		25		dB
Third-Order Intercept Point (IP3)		> 85		dBm
Second Harmonic (H2) ³		-130		dBc
Third Harmonic (H3) ³		-140		dBc
On / Off Switching Time ⁴		8	10	μs
Full Cycle Frequency			10	kHz
On / Off Switch Operations	3x10 ⁹			Cycles
DC Steady State Carry Current		500		mA
Off-State RFC to RFOUT Leakage Current		15	1000	nA
On-State Resistance (R _{On})		500	3000	mΩ
Off-State Capacitance (C _{Off})		15		fF
Video Feedthrough ⁵		16		mV _{Peak}
Gate Bias Voltage (VBB)	88	89	90	V _{DC}

1 For applications with > 1.0 W @ < 2.0 MHz, Gate Tracking is required, see Gate Tracking application note.

2 For 10 % Duty Cycle and 10 μs pulse width.

3 Measured at 1.0 GHz and 2.0 GHz fundamental frequency and 35 dBm input power.

4 Includes switch settling time and actuator bounce with 20 V/μs slew rate GATE pin voltage.

5 Performed with 1 MΩ termination



Gate Voltage Slew Rate			50	V/ μ s
Gate Bias Current		15	1000	nA



Package / Pinout Information

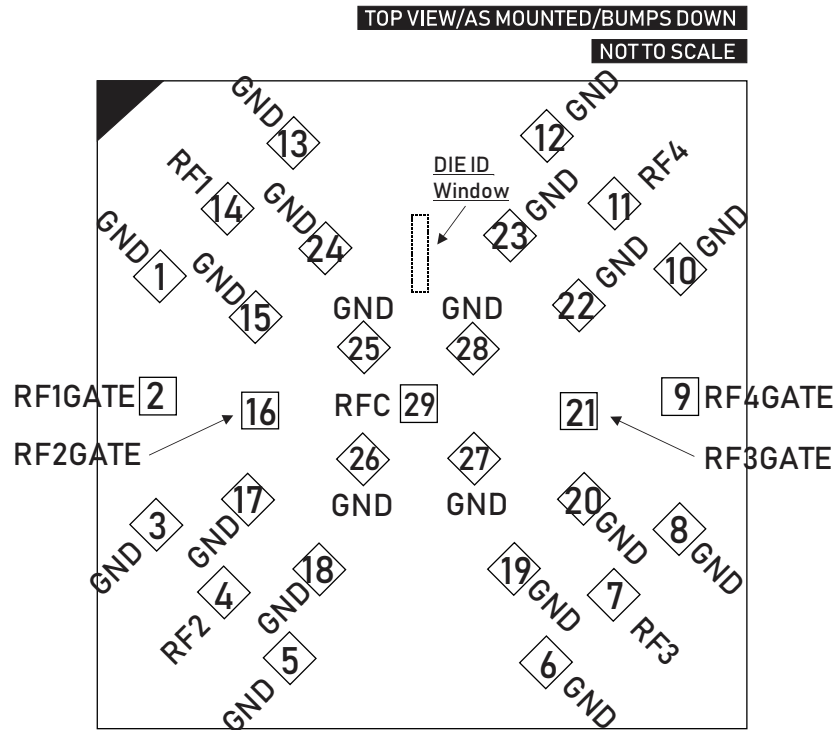


Table 2 Detailed Pin Description

Pin #	Pin Name	Description
1,3,5,6,8,10,12,13,15,17, 18,19,20,22,23,24,25,26,27,28	GND	RF Ground
2	RF1GATE	Control for Switch RF1
16	RF2GATE	Control for Switch RF2
4	RF2	RF Switch 2
7	RF3	RF Switch 3
21	RF3GATE	Control for Switch RF3
9	RF4GATE	Control for Switch RF4
11	RF4	RF Switch 4
14	RF1	RF Switch 1
29	RFC	RF Common



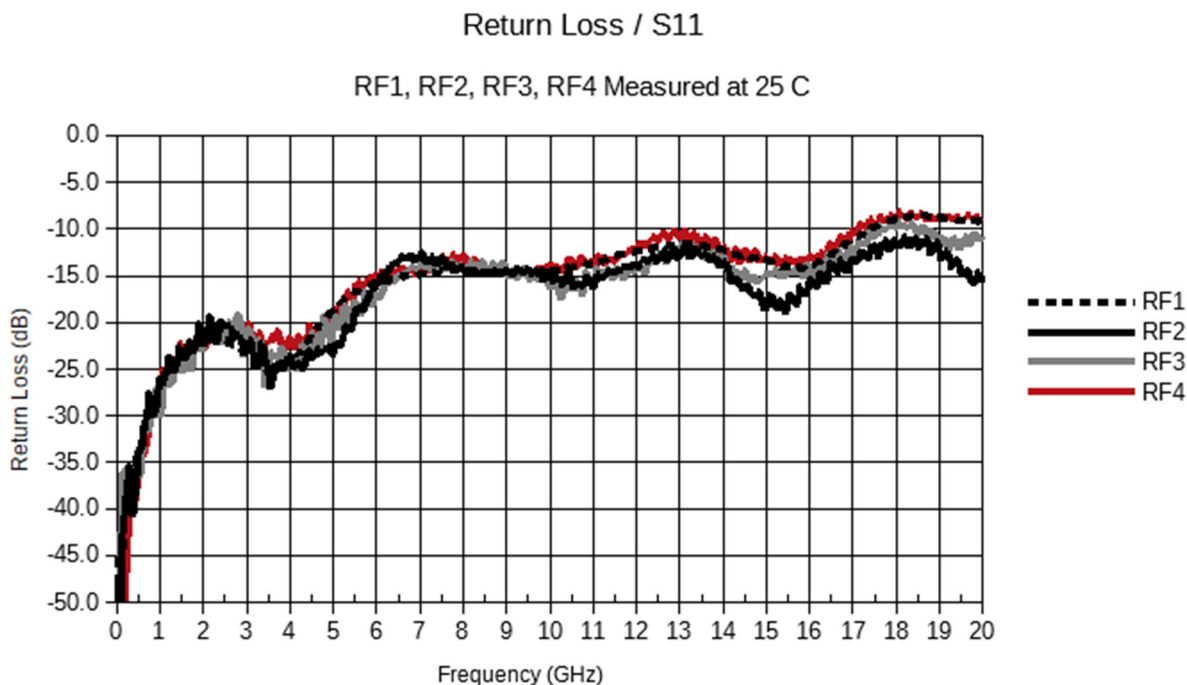
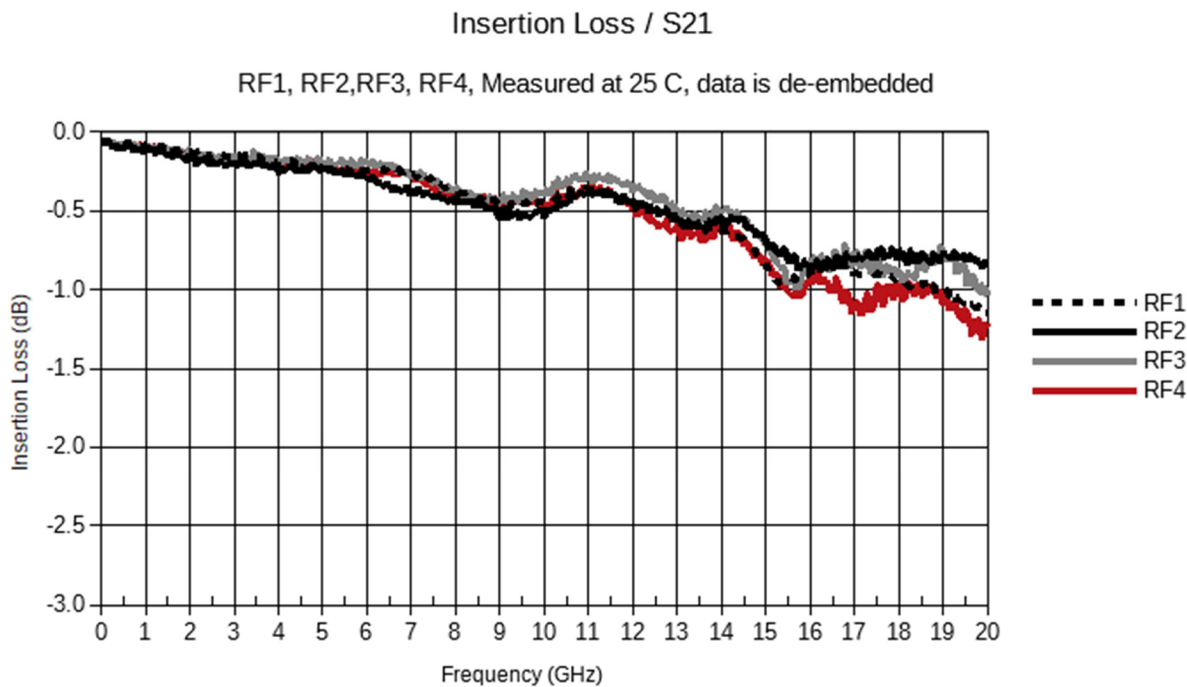
Table 3 Applied Gate Voltage vs. RF Switch States (On= Closed, Off = Open). Each switch is individually controllable. Primary usage states are highlighted in **bold**. Multiple branches may be closed simultaneously, however RF performance is not specified for such states.

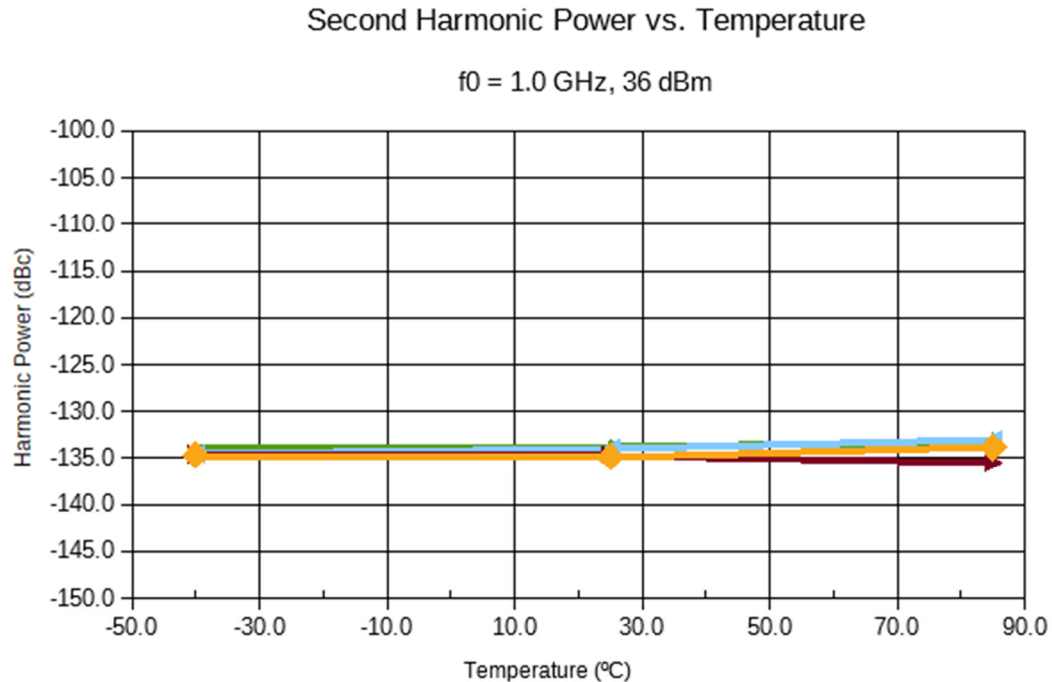
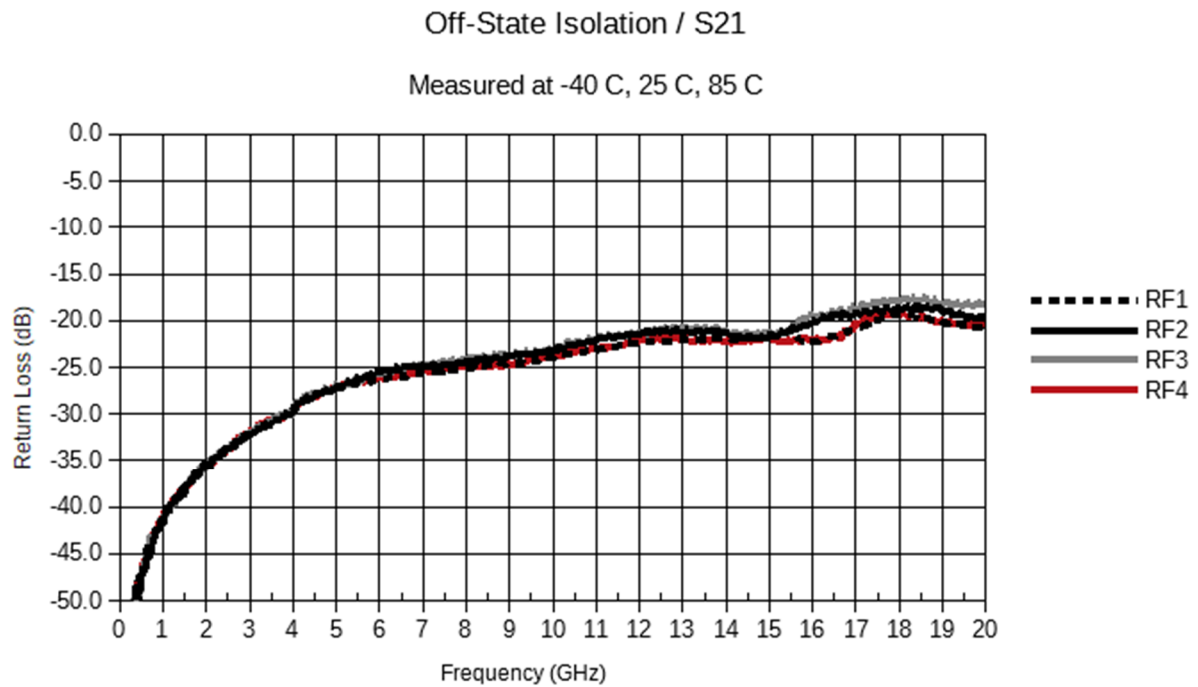
RFGATE4 (V)	RFGATE3 (V)	RFGATE2 (V)	RFGATE1 (V)	RFC – RF4	RFC – RF3	RFC– RF2	RFC– RF1
0	0	0	VBB	Off	Off	Off	On
0	0	VBB	0	Off	Off	On	Off
0	VBB	0	0	Off	On	Off	Off
VBB	0	0	0	On	Off	Off	Off
0	0	0	0	Off	Off	Off	Off
0	0	VBB	VBB	Off	Off	On	On
0	VBB	0	VBB	Off	On	Off	On
0	VBB	VBB	0	Off	On	On	Off
0	VBB	VBB	VBB	Off	On	On	On
VBB	0	0	VBB	On	Off	Off	On
VBB	0	VBB	0	On	Off	On	Off
VBB	0	VBB	VBB	On	Off	On	On
VBB	VBB	0	0	On	On	Off	Off
VBB	VBB	0	VBB	On	On	Off	On
VBB	VBB	VBB	0	On	On	On	Off
VBB	VBB	VBB	VBB	On	On	On	On



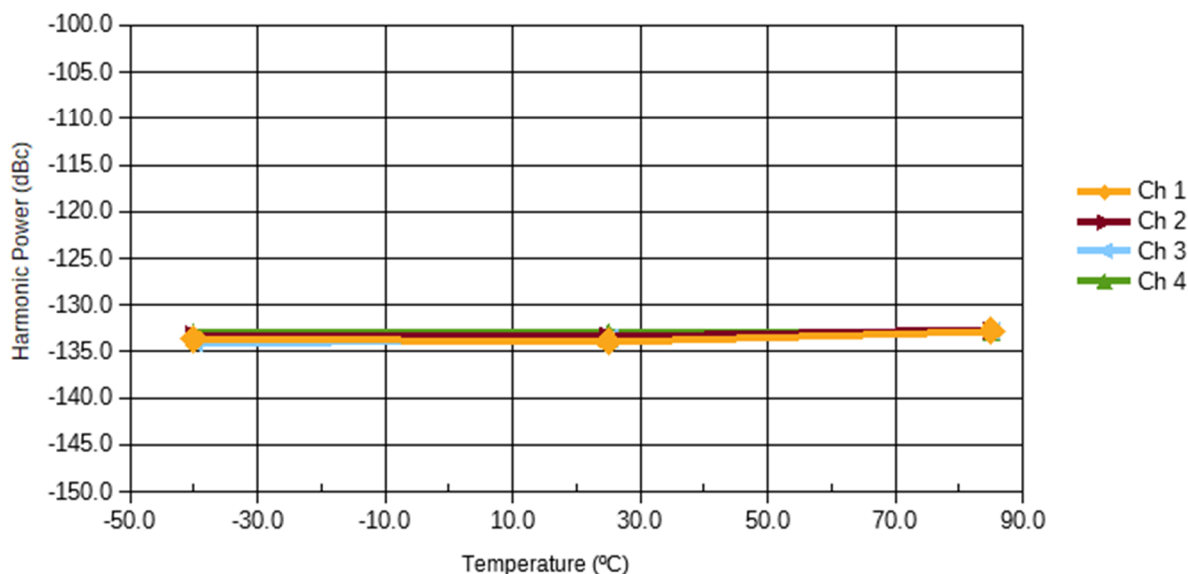
RF Performance

Typical device performance measured on evaluation board, de-embedded. For narrowband applications, the performance may be further improved with narrowband matching techniques.

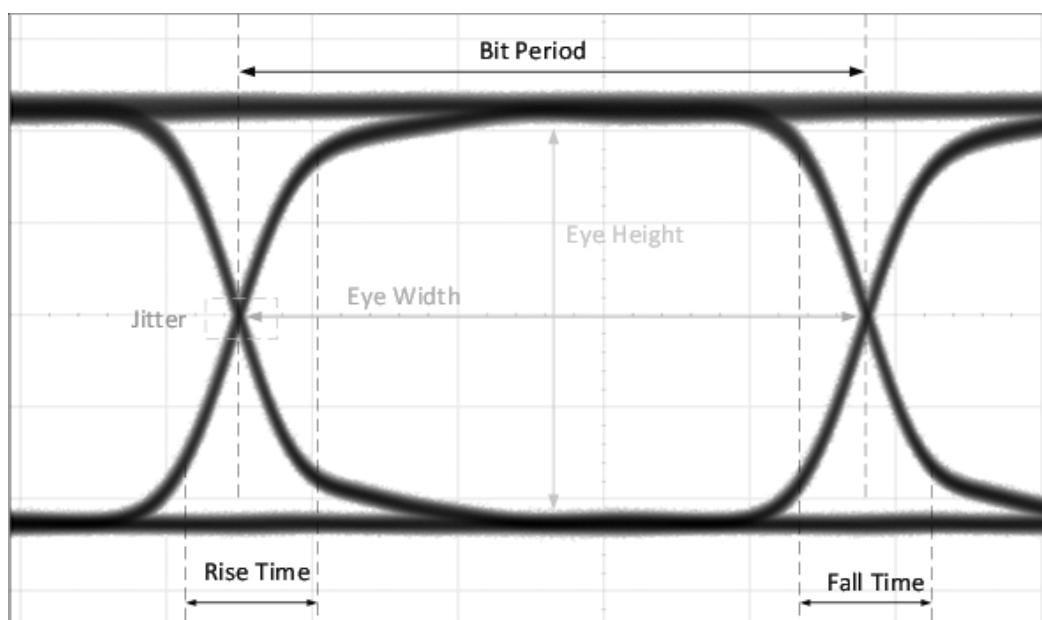




Third Harmonic Power vs. Temperature

 $f = 1.0 \text{ GHz}, 36 \text{ dBm}$ 

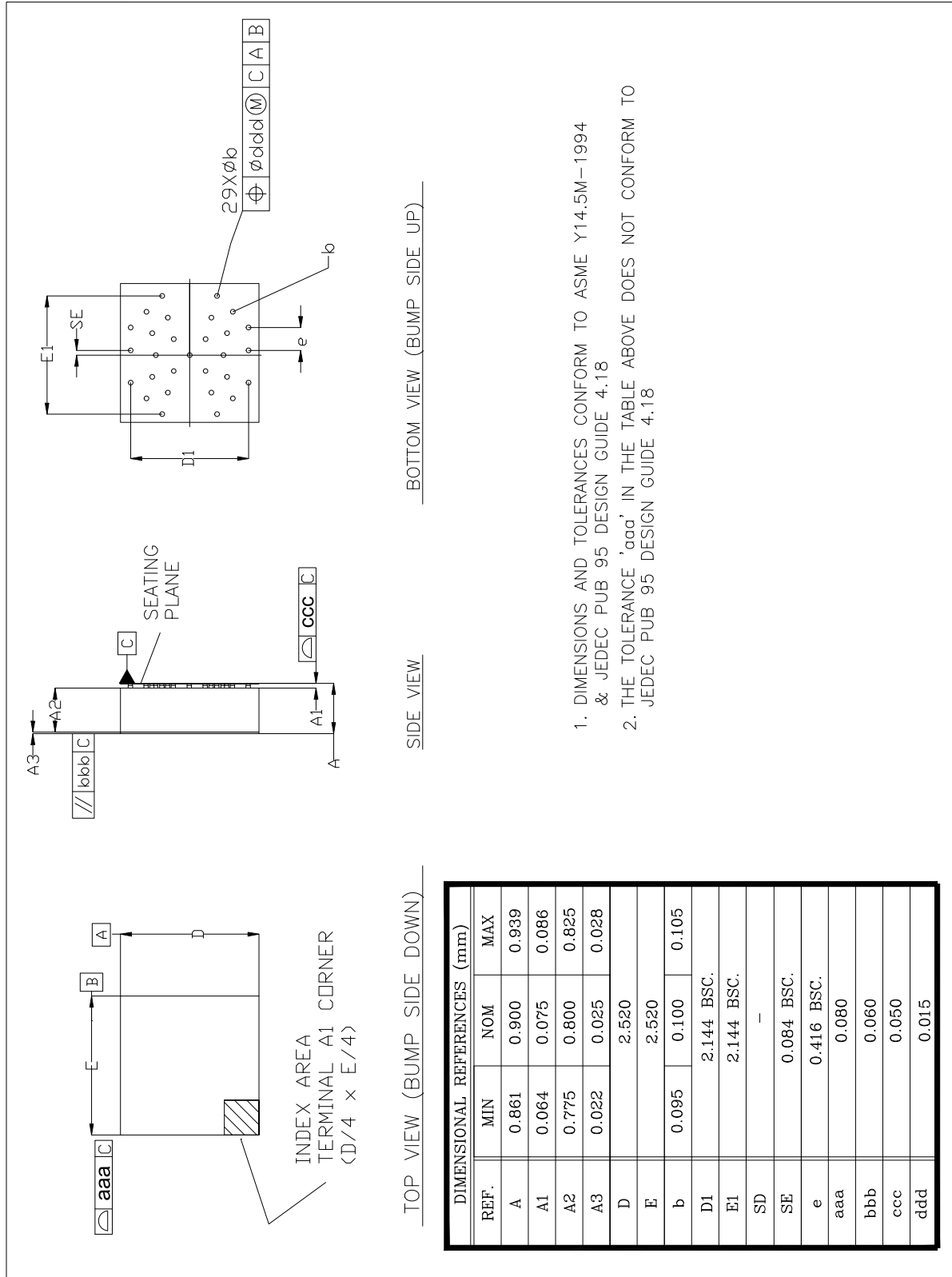
Single-Ended Eye Diagram Measurement



Test Cases	Bit rate	Eye Height	Eye Width	Jitter (Peak to Peak)	Rise Time (10%-90%)	Fall Time (90%-10%)
Baseline-Test System	20.000 Gbps	426.0mV	48.53 ps	1.733 ps	19.33 ps	19.33 ps
MM5130 EVK (w/cables) *	20.000 Gbps	250.6 mV	43.79 ps	5.867ps	33.87 ps	33.20 ps



Package Drawing



Bump Coordinates Detail

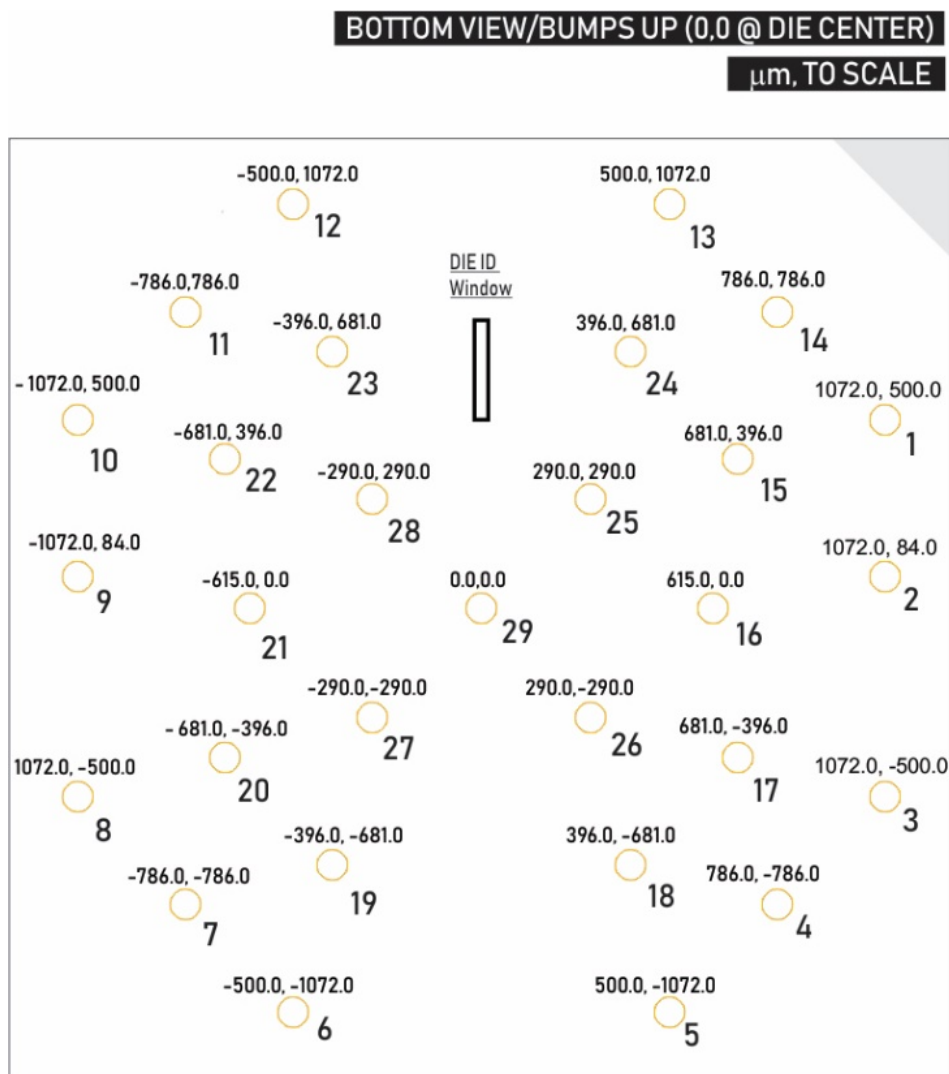


Figure 2: Bump Coordinates



Bump Coordinates Table

0.0,0.0 at die center

Pin	X(um)	Y(um)
1	1072	500
2	1072	84
3	1072	-500
4	786	-786
5	500	-1072
6	-500	-1072
7	-786	-786
8	-1072	-500
9	-1072	84
10	-1072	500
11	-786	786
12	-500	1072
13	500	1072
14	786	786
15	681	396
16	615	0
17	681	-396
18	396	-681
19	-396	-681
20	-681	-396
21	-615	0
22	-681	396
23	-396	681
24	396	681
25	290	290
26	290	-290
27	-290	-290
28	-290	290
29	0	0



Recommended PCB Layout

Layout recommendation for connecting the MM5130 with coplanar RF line or grounded coplanar line as used for the MM5130 evaluation board.

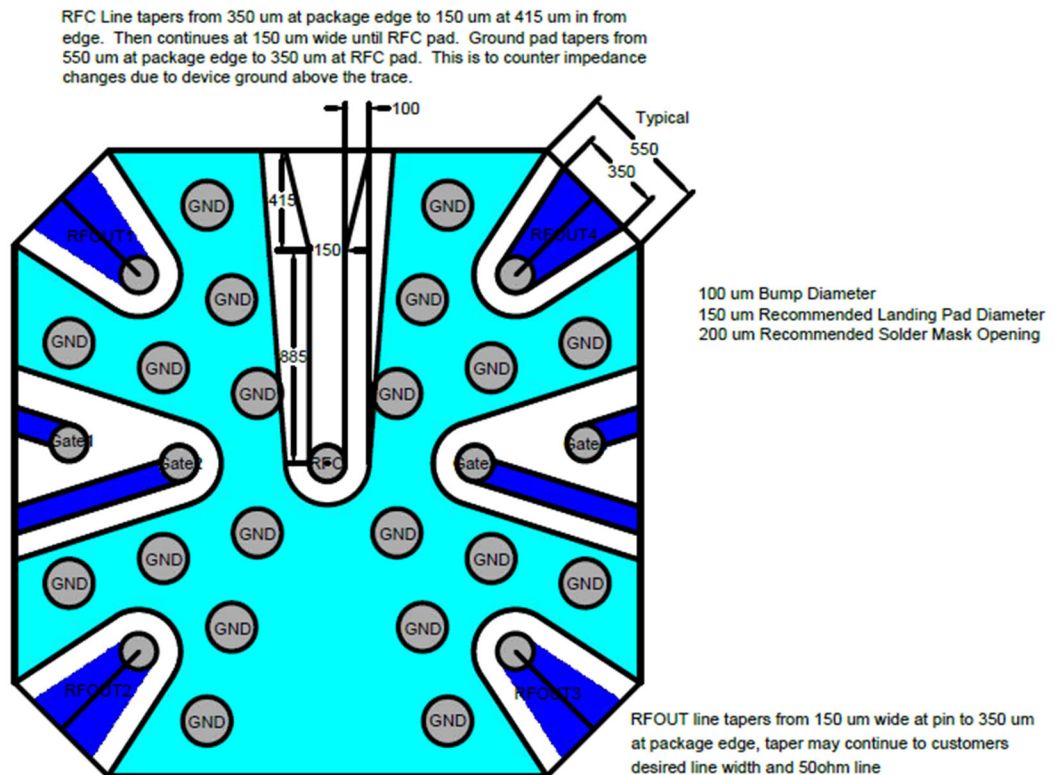
For the coplanar RF lines, it is recommended to taper the line to fit the 150 μm recommended landing pad while keeping the spacing to the ground metal constant and identical to the spacing used for the line.

In this example a 4.0 mil/0.10 mm spacing is used.

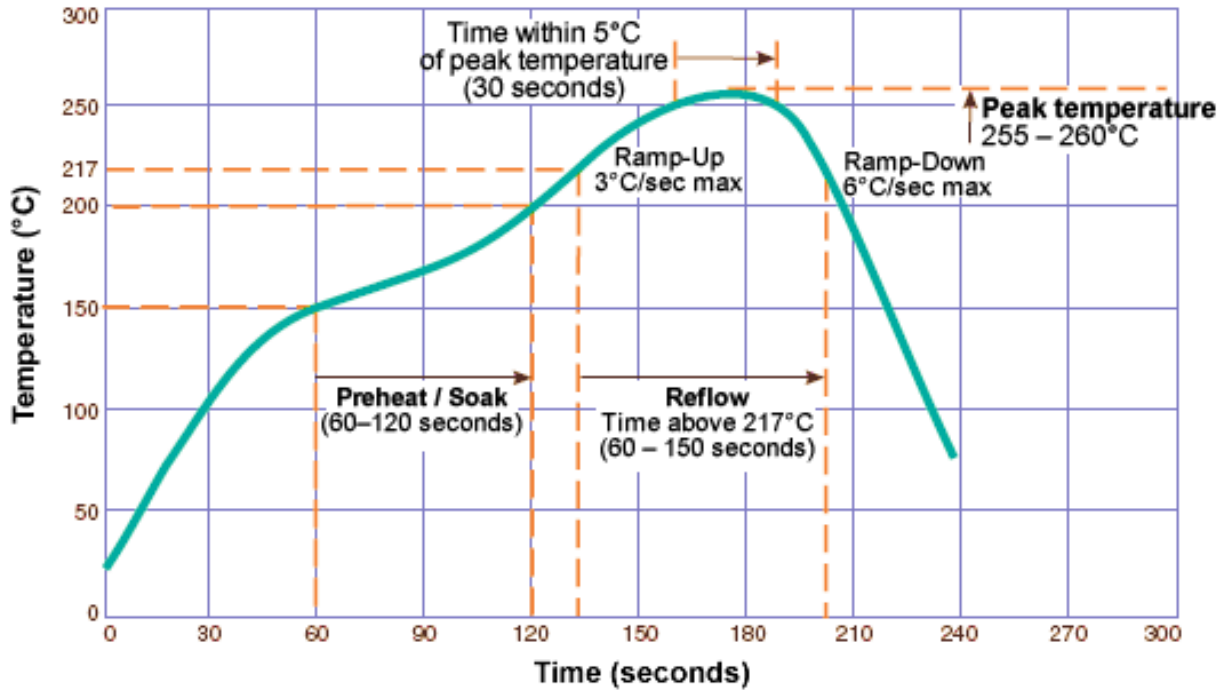
Recommended maximum solder resist thickness 20 μm .

Routing of the gate control lines is not critical for RF performance.

Dimensions in μm



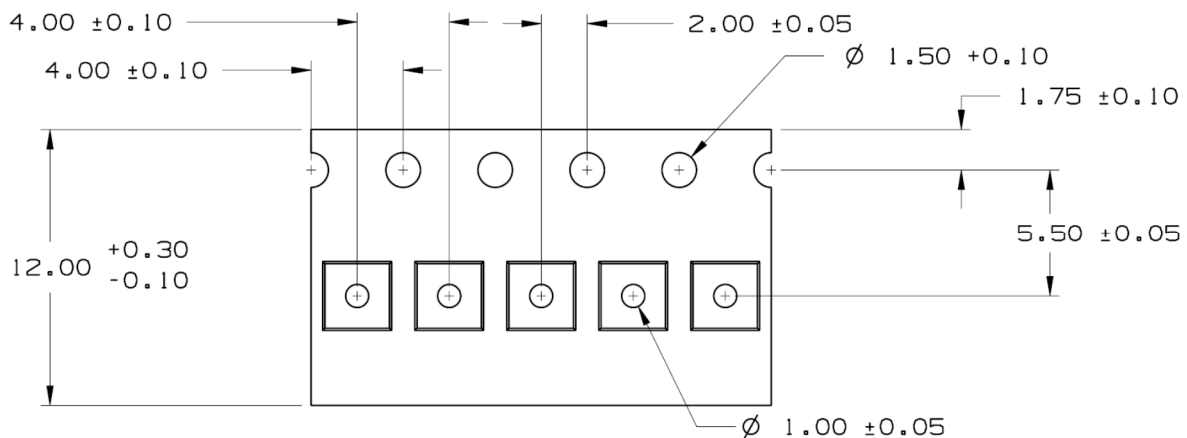
Recommended Solder Reflow Profile



For detailed information on soldering the MM5130, please refer to application note: “WL-FC Assembly Instructions”

- A ROHS compliant Solder Alloy used is SAC alloy: 96.5% Sn, 3.0%Ag, 0.5%Cu. These are the nominal percentages of the components. This alloy is designed to replace SnPb solders to eliminate Lead (Pb) from the process, requiring a higher reflow temperature. Moisture resistance performance may be impacted if not using the Pb-Free reflow conditions.

Tape & Reel Details



Available Options

Part Number	ECCN	Package	Temperature Range
MM5130-03	EAR99	2.5 mm x 2.5 mm 29 pin WL-FC	-40°C to +85°C
MM5130-03-E	EAR99	2.5 mm x 2.5 mm 29 pin WL-FC	-40°C to +100°C
MM5130EVK1	EAR99	Evaluation Board MM5130	10 GHz
MM5130EVK5	EAR99	Evaluation Board MM5130	18 GHz

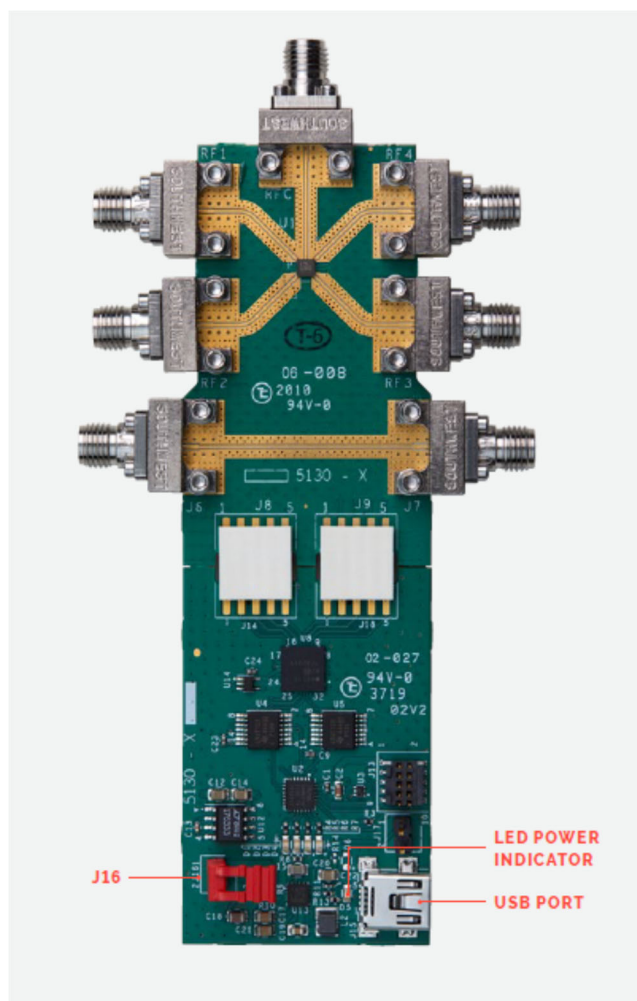


Figure 3: MM5130 EVK5 18 GHz Evaluation Board



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