SPDT30G

DC-30 GHz SPDT switch

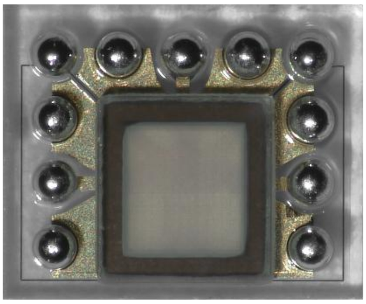

Figure 1 - Picture of the SPDT30G switch.

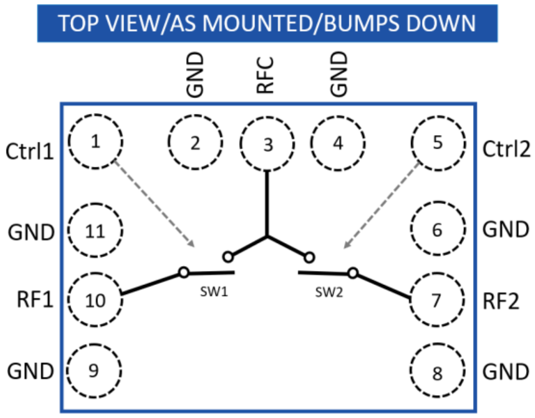

Figure 2 - Functional Block Diagram.

Features

- Wideband : *true DC-30 GHz*
- Low Insertion loss : < *0.9 dB up to 30 GHz*
- High isolation : *> 35 dB up to 30 GHz*
- High linearity : *IP3 > 90 dBm*
- Stand-off Voltage *: >170V*
- Low Consumption : *< 1 µA*
- Compact chip : *2.8 x 2.3* mm^2
- Reliable : *> 1 billion cycles*
- Lead free

Applications

- Relay replacement
- Compact wideband switch matrices
- Low loss RF and DC circuits
- Efficient millimeter wave modules
- High Q, high frequency reconfigurable circuits

General Description

The SPDT30G is an extremely wideband single pole, double throw (SPDT) switch based on a patented technology developed by AirMems. This Micro-Relay offers insertion loss at the lowest level of the semiconductor industry while maintaining an isolation higher than 32 dB on a DC-30 GHz frequency range. The SPDT30G also exhibits a high linearity (IP3 > 90 dBm). Available as a 2.8x2.3 mm^2 die easy to flipchip on a PCB Board, the SPDT30G is an ideal solution for all your applications where the switch needs to be compact and to preserve the maximum signal integrity.

Electrical Specifications

Table 1 provides the SPDT30G key electrical specifications at 25°C in a 50 Ω system for V_{Ctrl}=0V when SW1 and SW2 is OFF and V_{Ctrl}=80 V when SW1 and SW2 is ON, unless otherwise noted.

Parameters	Min	Typ.	Max	Unit	Test Conditions/Comments
Insertion Loss				dB	- All paths - Mounted on PC Board - Data is de-embedded
DC-500 MHz			0.3		
0.5-6GHz			0.4		
6-18GHz			0.7		
18-30GHz			0.9		
Return				dB	- RF1 to RFC when SW1 is ON - RF2 to RFC when SW2 is ON - Mounted on PC board - Data is de-embedded
DC-500 MHz	31				
0.5-6GHz	20				
6-18GHz	15				
18-30GHz	10				
Isolation				dB	- RF1 to RFc when SW2 is ON - RF2 to RFc when SW1 is ON - Mounted on PC board - Data is de-embedded
DC-500 MHz	64				
0.5-6GHz	45				
6-18GHz	42				
18-30GHz	35				
Crosstalk					- RF1 to RF2 when SW1 or SW2 is ON - Mounted on PC board - Data is de-embedded
DC-30GHz	30			dB	
Third-Order Intercept Point (IP3)	90			dBm	- tested at 1 GHz, Δf=0.25 MHz
Switching Speed					- bias line connected to a 100 kΩ resistor, (cf. recommended external circuitry)
RF rise time (10% to 90%)		0.4		µs	
RF fall time (90% to 10%)		2.0		µs	
50% Ctrl to 90% or 10% RF			80	µs	
Bias current consumption			1	µA	

Table 1 - Electrical specifications under recommend operating conditions.

Recommended Operating Conditions

Devices should not be used outside the recommended operating conditions described in Table 2 Exceeding the operating range for an extended period may reduce reliability or cause permanent damage.

Parameters	Min	Typ.	Max	Unit
Operating Temperature Range		+25		°C
Control				
Voltage Control on Ctrl1 or Ctrl2 (V_{Ctrl})	70	75	80	V
Supply current on Ctrl1 or Ctrl2			1	µA
Bias resistor to place in series with the bias path[1]	90	100	110	kΩ
Rise time or Fall time (10/90%) of the bias voltage[1]	1			µs
Power Handling				
RF input power, CW cold-switched (RFC-RFx)[2]			33	dBm
Hot Switching				
3V	1x10^6			Cycles
3.5V	5x10^5			
5V	1x10^5			
10V	5000			
ON/OFF Mechanical Life	1x10^9	3x10^9		Cycles

Table 2 - Recommended operating conditions.

Absolute Maximum Ratings

Exceeding absolute maximum ratings listed in Table 3 may damage the component.

Parameters	Min	Typ.	Max	Unit
Storage temperature range	-40		125	°C
Voltage Control on Ctrl1 or Ctrl2 (V_{Ctrl})	0		80	V
Stand-off Voltage			170	V
Between RFc and RF1 or RF2				

Table 3 - Absolute Maximum Ratings.

CAUTION: When handling the SPDT30G observe the same precautions as with any other ESD (electrostatic discharge) sensitive devices. Operators should always wear wrist or foot ground straps. ESD test equipment should be available to insure proper ESD grounding at all times.

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[1] See recommended circuitry on page 4.

[2] 50% duty cycles, 50 Ω, 1 GHz, 25°C.

Control Logic

The states 2 and 3 of the control logic truth table below are used for normal switching operations.

CTRL1	CTRL2	RFc-RF1	RFc-RF2	State
0 V	0V	OFF	OFF	1
80 V	0 V	ON	OFF	2
0 V	80 V	OFF	ON	3
80 V	80 V	ON	ON	4

Table 4 - Truth Table.

Recommended External Circuitry

To ensure reliable operations of the SPDT30G, AirMems recommends:

- To connect a 100 kΩ series resistor as close as possible of each Ctrl pins
- To control the rising or falling time of the bias signal to 1.0 µs

These guidelines permits to stabilize the switches dynamic and prevents for floating nodes that could damage the electrical contacts.

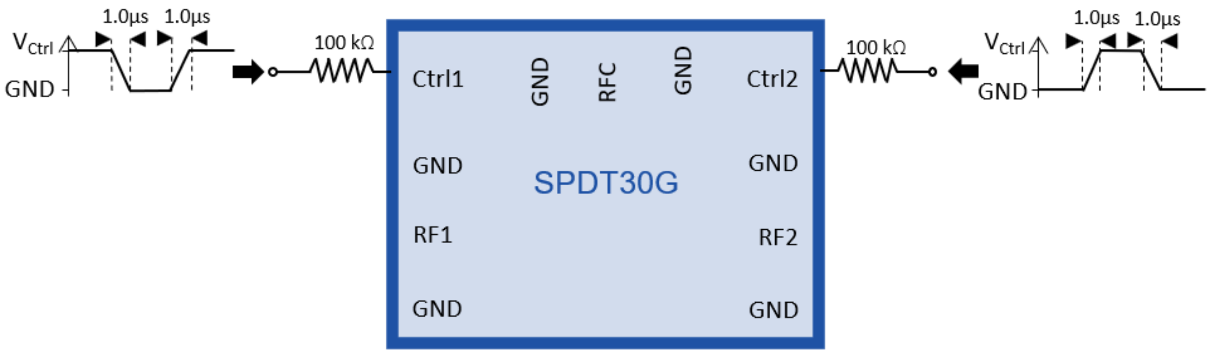

Figure 3 - Recommended external circuitry of the SPDT30G.

Typical RF Performances[3] (measured at 25°C, data is de-embedded)

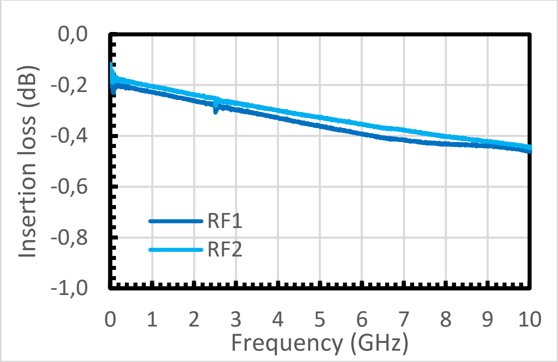

Figure 4 - Insertion Loss (DC-10 GHz).

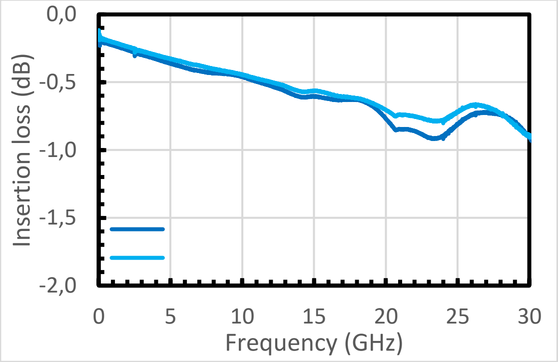

Figure 5 - Insertion Loss (DC-30 GHz).

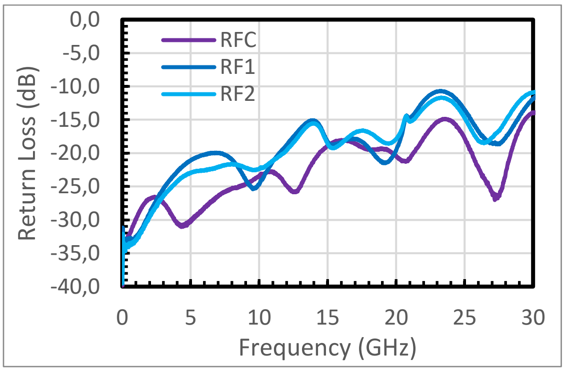

Figure 6 - Return Loss.

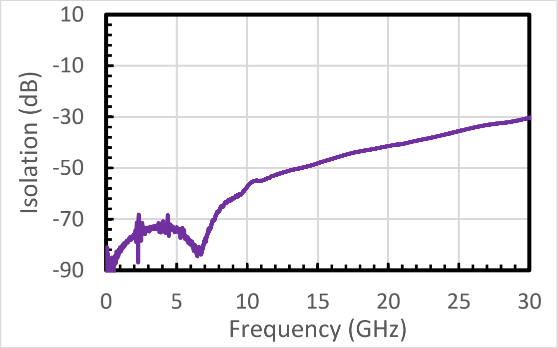

Figure 7 - Cross Talk (RF1-RF2).

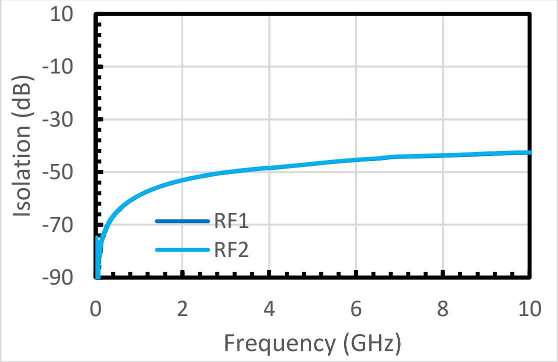

Figure 8 - Isolation (DC-10 GHz).

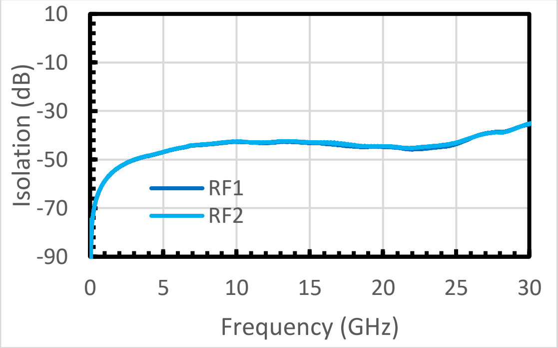

Figure 9 - Isolation (DC-30 GHz).

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[3] The SPDT30G SPDT MEMS switch is measured mounted on a evaluation board ($\varepsilon_r = 3.66$). Data is de-embedded.

Pin out Description

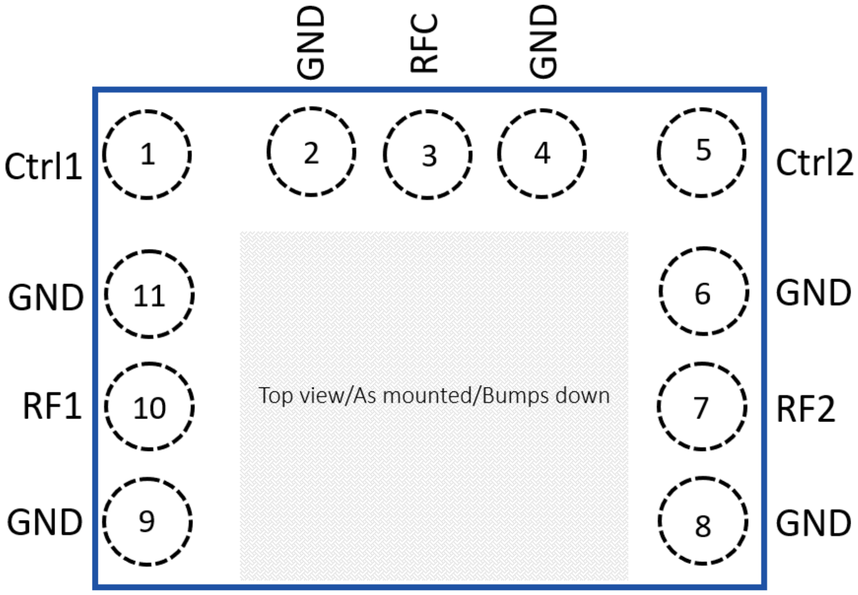

Figure 10 – SPDT30G Pin Configuration (Top view).

PIN no.	Pin Name	Description
2,4,6,8,9,11	GND	Must be connected to RF and DC Grounds
1	Ctrl1	Control input 1- When 0V, RF1 and RFC are opened. When 80V, RF1 and RFC are shorted.
3	RFC	RF common port
5	Ctrl2	Control input 2- When 0V, RF2 and RFC are opened. When 80V, RF2 and RFC are shorted.
7	RF2	RF port 2
10	RF1	RF port 1

Table 5 - Pin Description.

Die Mechanical Dimensions

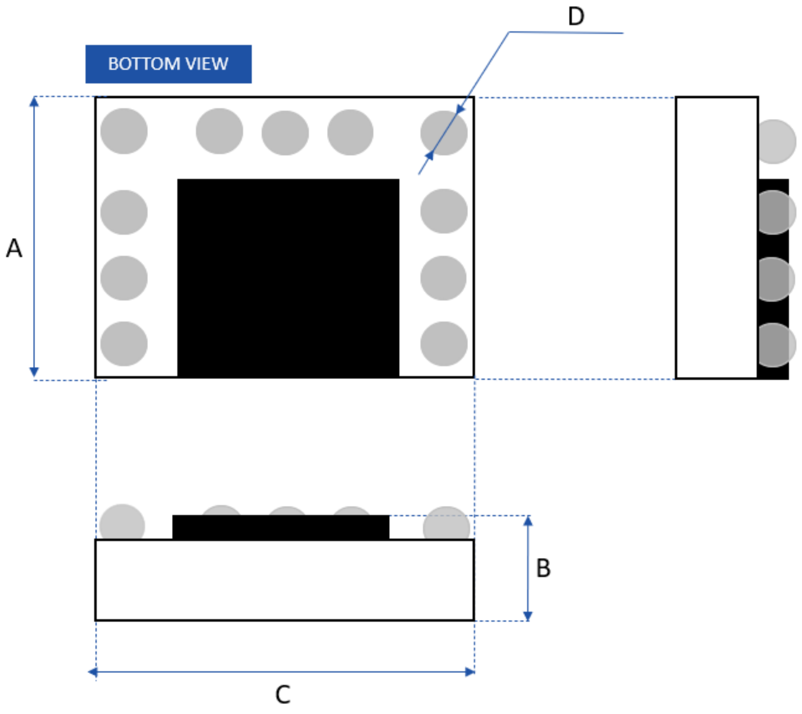

Figure 11 - Chip drawings (not a scale).

Parameters	Min	Typ.	Max	Unit
A		2.3		mm
B		0.8		mm
C		2.8		mm
D		0.35		mm

Table 6 - Die Mechanical Specifications.

Recommended PCB Layout

To ensure a high level of performance up to mm-wave, AirMems recommends to bond the SPDT30G SPDT micro relay on the following PCB pattern. This design has been optimized on a commercial laminate substrate RO4350B permitting 30 GHz operations[4]. The minimum isolation gaps and trace widths are compliant with a standard fabrication process. Complete dimensions of the PCB will be provided upon ordering the SPDT.

Warning: The ball bonding are 350µm diameter, but the soldermask pattern on the PCB is 300µm diameter.

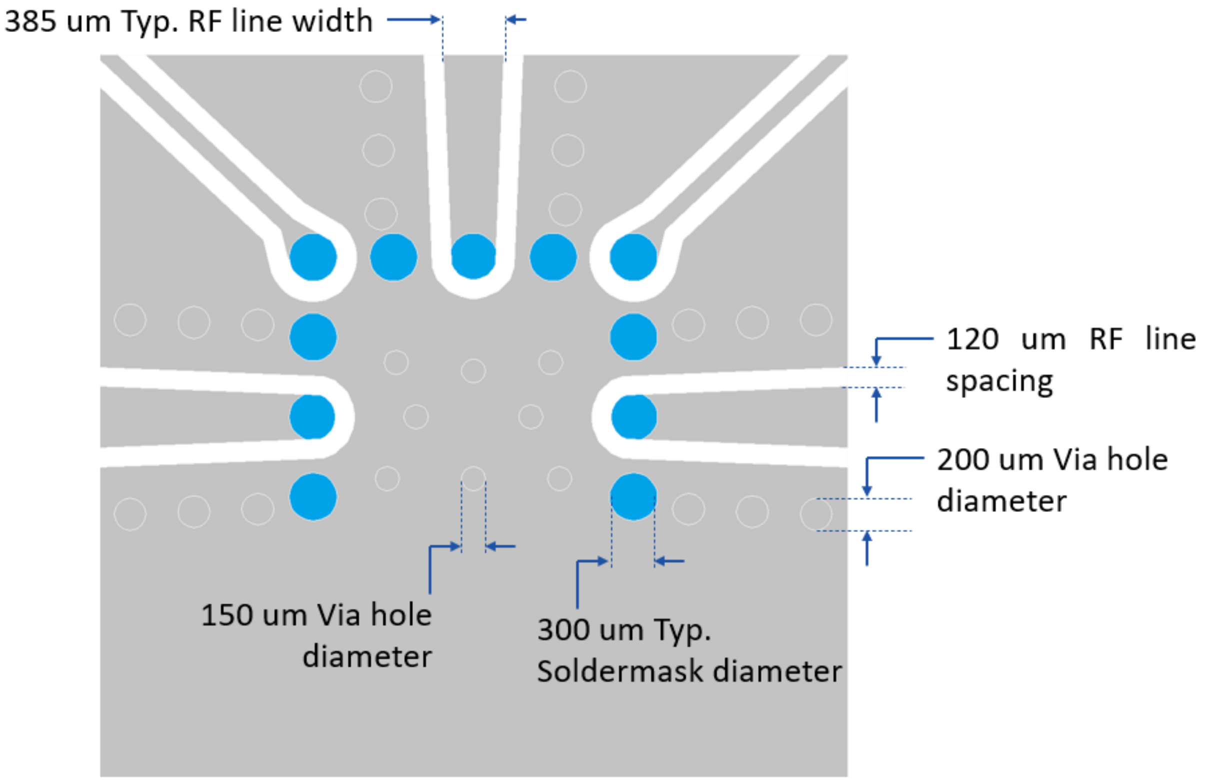

Figure 12 : Recommended PCB layout for a substrate RO4350B

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[4] Can be adapted to another commercial laminate substrate upon request.

Bump and Via hole Coordinates

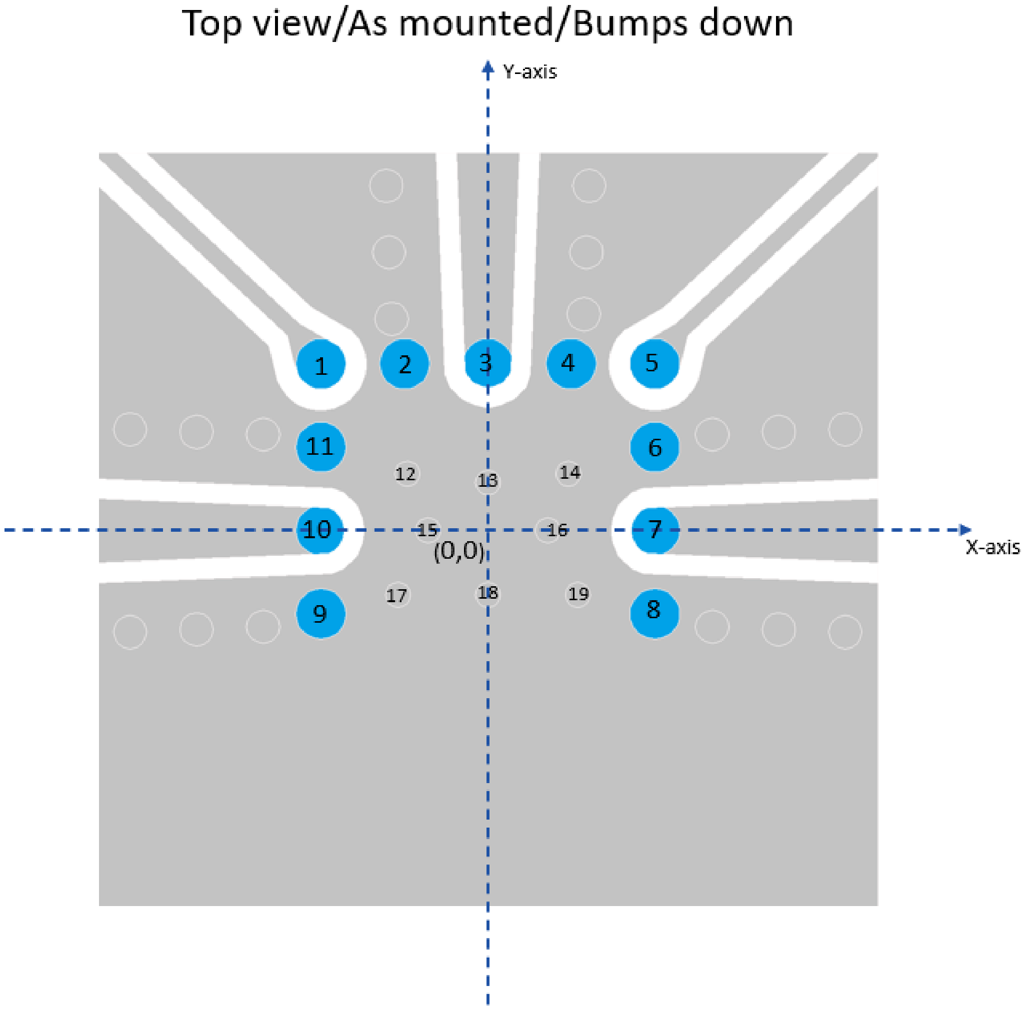

Figure 13 - Top view of the PCB.

Pin	1	2	3	4	5	6	7	8	9	10	11
X (um)	-1003.2	-500	0	500	1003.2	1003.2	1003.2	1003.2	-1003.2	-1003.2	-1003.2
Y (um)	1000.4	1000.4	1000.4	1000.4	1000.4	500	0	-503	-503	0	500

Table 7 - Bump Coordinates.

Pin	12	13	14	15	16	17	18	19
X (um)	-483.9	0	483.9	0	0	-539.8	0	539.8
Y (um)	340.3	287	340.3	-359.5	359.5	-388.7	-388.7	-388.7

Table 8 - Via hole Coordinates.

Mounting and Reflow Profile

The SPDT30G SPDT micro relay is provided ready for PC board mounting. It includes lead free solder balls based on a SAC alloy. It shall be mounted on PCB pads:

- previously connected to GND
- manufactured with an ENIG surface finish
- previously covered with a type 3 (or higher) SAC solder cream

The reflow profile shown in Figure 14 is recommended to ensure a proper attach on your board. The dwell at peak temperature should be optimized according to your PCB material.

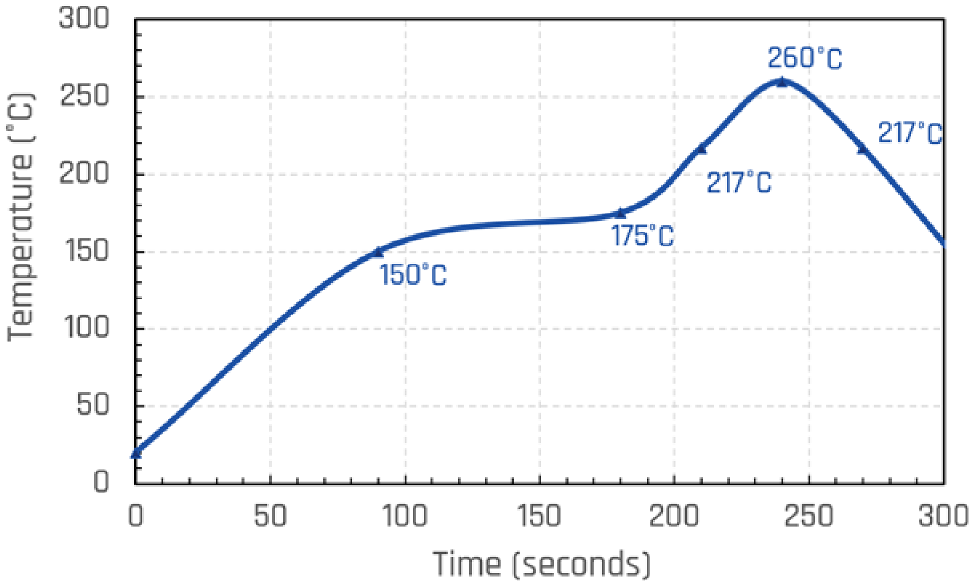

Figure 14 - Recommended Reflow Profile for the SPDT30G soldering process.

Other information

Document Category

This datasheet contains preliminary datas that should not be regarded as a guarantee of final specifications. AirMems reserves the right to add further information or to make changes in these specifications at any time in order to improve the product features.

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