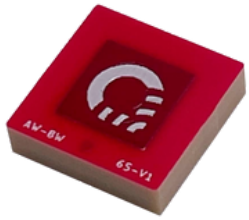
Datasheet

AntennaWare

Part Number: **AW-BW-65-V1**
Product Name: **6.5 GHz UWB BodyWave™ Antenna**



Introduction

The BodyWave™ antenna is a SMD mounted antenna, designed primarily for application in wearable devices operating at UWB channels. In this datasheet we show performance at channel 5, covering the frequency band (6240–6739.2 MHz). Bodywave has a number of features which makes it significantly better suited to wearable applications than existing commercially available off-the-shelf antennas used in wearables or on other difficult platforms.

Resistance to detuning and radiation performance variation

The BodyWave™ antenna is extremely resistant to detuning caused by close human body proximity, a major issue with antennas in wearable applications. The BodyWave™ antenna is also resistant to radiation performance variation caused by ground plane dimension variation and the on-ground design allows components, batteries, connectors, etc to be placed immediately below the antenna on the opposite side of the ground plane. This improves integration and removes the need for bespoke shaped PCB groundplanes, which can cause spurious radiation.

Ease of integration

The antenna's compact form factor, makes it easily integrable into miniaturised wearable devices and requires minimal RF expertise to integrate onto a PCB (although the antenna is self-resonant in the 6240 MHz – 6739.2 MHz UWB band, impedance matching may be required due to enclosure encapsulation, feeding method, etc.). The antenna also has high radiation efficiency despite its miniature size, even in close proximity with the human body.

Increased coverage

The most important characteristic of the BodyWave™ antenna is the greatly increased coverage it can provide when compared to existing wearable antennas. Shadowing caused by the human body will cause large nulls in the radiation pattern of a body-mounted antenna and will greatly affect the range and reliability of a wearable device, especially in unpredictable and dynamic applications.

However, the BodyWave™ antenna is designed to increase coverage in directions obscured by the human body, with 10 dB – 20 dB increased forward path gain in NLoS directions when compared to existing commercially available chip antennas.

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Headline Specifications

Part Number	AW-BW-65-V1
Electrical	
Frequency Range	6240 – 6739.2 MHz
Radiation Pattern	Omnidirectional
Impedance	50Ω
Avg. Free Space Efficiency	-1.3 dB
Avg. On-Body Efficiency 10mm Spacing 5mm Spacing	 -2.3dB -2.7dB
Mounting Style	Surface Mount (on GND)
Polarization	Linear
Mechanical	
Dimensions	12 x 12 x 3 mm
Weight	0.8g
Environmental	
Operating Temperature	-55°C to +125°C
RoHs Compliant	Yes

1. Typical Applications

The BodyWave™ antenna can be used in a wide range of wearable applications including:

- Sports positioning wearables
- Microphone bodypacks
- Audio headphones
- Medical vital signs monitors
- Motion capture sensors
- AR/VR headsets

2. RF Test Setup

2.1 RF Test Board

The RF performance of the BodyWave™ antenna was measured on an evaluation board with dimensions shown in Figure 1. The board substrate is 1.6 mm thick FR4 PCB with 35 µm copper cladding. This is an example test board – note that smaller PCBs can be used. The feed structure is a 50Ω microstrip line. A SMA connector is used to feed the test board

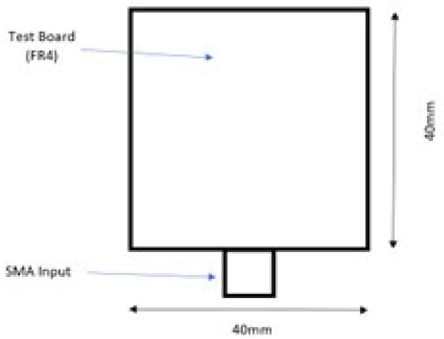


Figure 1 - RF Test Board

The AW-BW-65-V1 component was placed on the RF test board, with 5 mm clearance between the top edge of board and the antenna. It is important to note the BodyWave antenna must be placed directly above a PCB metal layer with the feed integrated using the layout and recommendations described in Section 6.

Note: Evaluation boards can be supplied upon request

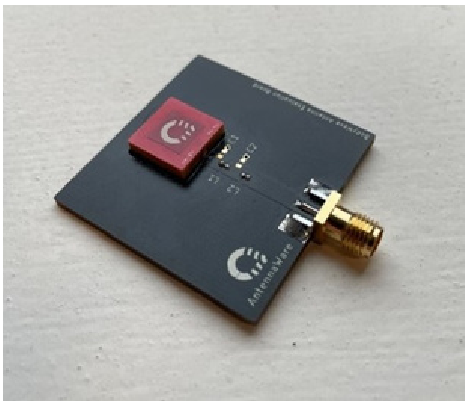


Figure 2 - BodyWave™ Antenna Evaluation Board

2.2 RF Wearable Testbed

To simulate body mounted performance, the Speag mmW-POPEYE10 Phantom Upper Body which includes Chest, Abdomen and Head phantoms was used (Figure 3). Suitable for Frequency range between 3 to >100 GHz and with Dimensions 356 mm x 212 mm x 770 mm (l x w x h). Manufactured from a lossy silicone-carbon based material with realistic losses for body-mounted devices. It is supported by a conductive inner skeleton providing a conductive connection between the head and abdomen.

A special low-loss silicone coating is applied to mmW-POPEYE10 that extends the frequency range beyond 100 GHz. Can be used to simulate any realistic human posture and entire range of device usage. Dimensions meet requirements for conservative testing (further information on this phantom available upon request).

Note: More information about this phantom can be found at the website: www.speag.swiss/products/em-phantoms/phantoms-3/popeye-v10/.

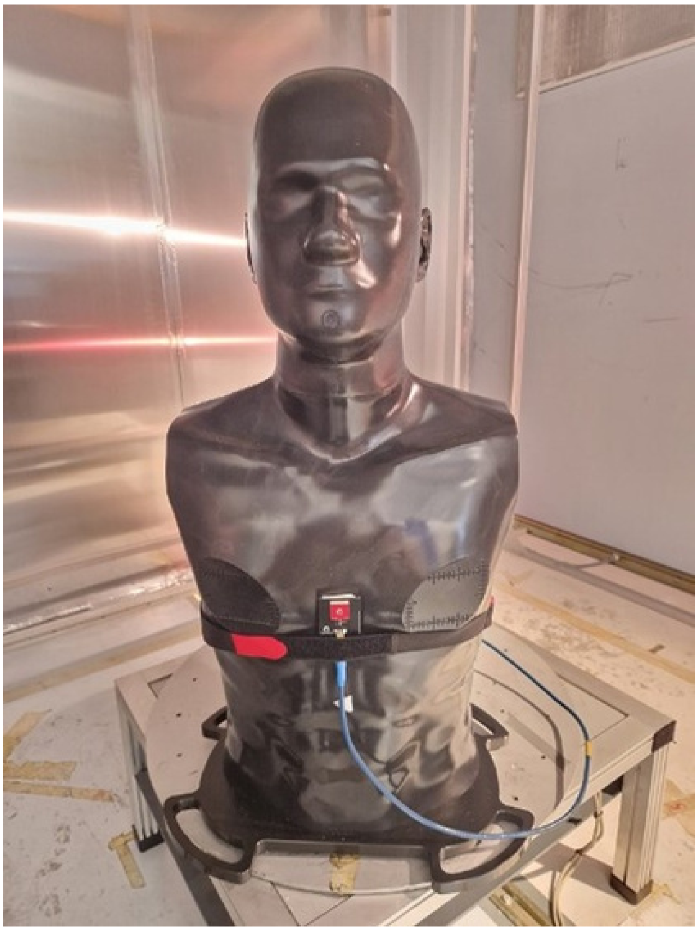


Figure 3 - Human tissue representative phantom testbed for wearable devices

3. Return Loss Performance

3.1 AW-BW-65-V1 Return Loss Performance

The S_{11} performance of the BodyWave™ Antenna was measured in free space and on the surface of the phantom at a spacings of 5mm. Rohacell spacers of the specified thickness were used to control the spacing.

We can see from Figure 4 that the BodyWave™ Antenna is virtually immune to detuning caused by close and varying proximity to the human body. This greatly increases reliability as this will reduce unpredictable antenna detuning once an antenna is integrated into a wearable device.

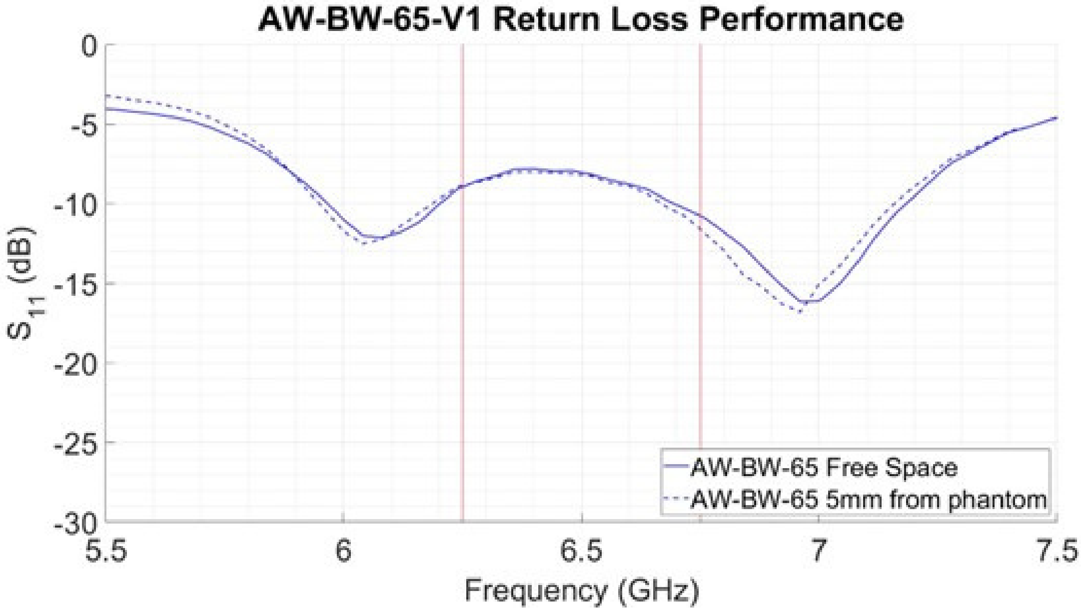


Figure 4 - AW-BW-65-V1 Return Loss vs Body Spacing

3.2 Antenna Matching Networks

As is standard practice, it is highly recommended to incorporate a matching network into the feed network to the antenna. Although resistant to detuning from the human body, minor detuning can occur due to extremely close proximity metal components (connectors, batteries, etc.) and enclosures.

Various topologies can be used but to ensure maximum flexibility, it is recommended to leave a 2 series and 2 parallel matching component layout. This will give maximum network topology flexibility (L, T, pi, etc.) with unused components replaced with 0 ohm components in the case of the series components or left unused in the case of the parallel components. The 4 component network footprint used in the BodyWave™ Antenna evaluation can be seen below in Figure 5

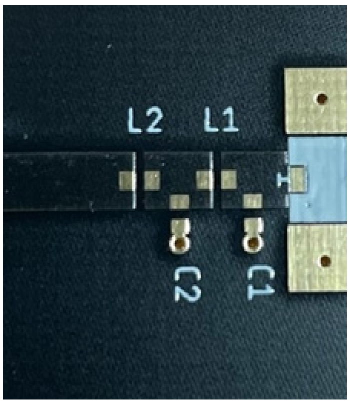


Figure 5 - BodyWave™ Antenna evaluation board matching network layout

Figure 6 below shows how the return loss performance of the BodyWave™ Antenna can be improved through the use of a simple L topology matching network.

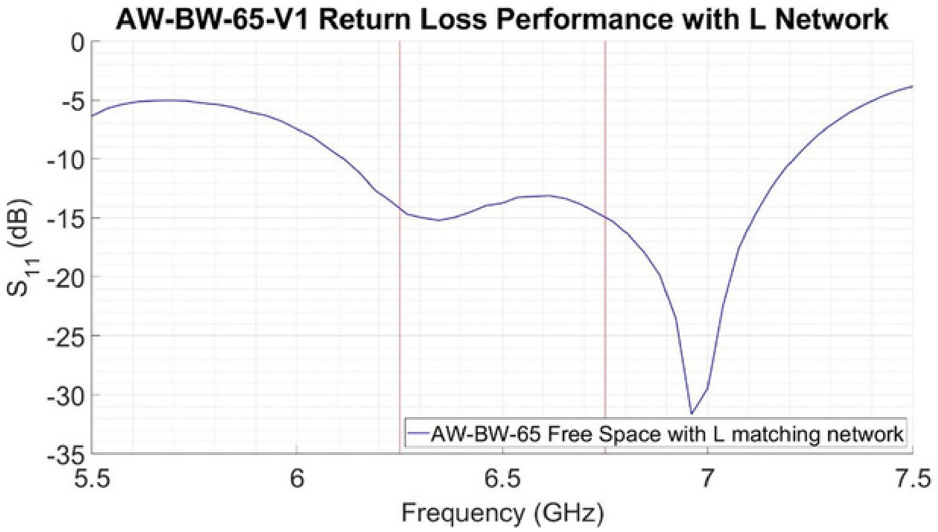


Figure 6 - AW-BW-65-V1 Return Loss vs Body Spacing with L Matching Network

4. Radiation Efficency Performance

The radiation efficiency of the BodyWave™ Antenna was measured in free space and on the surface of the phantom at spacings of 10mm and 5mm. The radiation efficiency was measured using a reverberation chamber with the frequency dependent radiation efficiency shown in Figure 7.

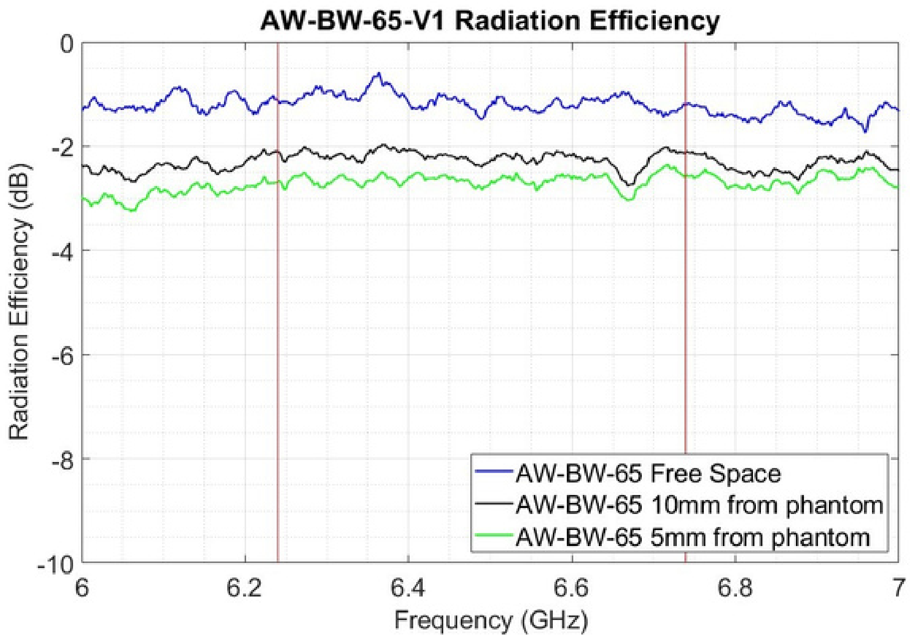


Figure 7 - AW-BW-65-V1 Radiation Efficiency

Figure 7 shows the high radiation efficiency of the BodyWave™ Antenna despite its small form factor. It is also more efficient when in close proximity to the human body compared to existing antennas and is significantly more consistent, increasing reliability of a wearable wireless link. It is also not reliant on large ground plane areas or specific placement locations (such as at the edge or corners of the PCB) for its efficiency.

5. Radiation Pattern

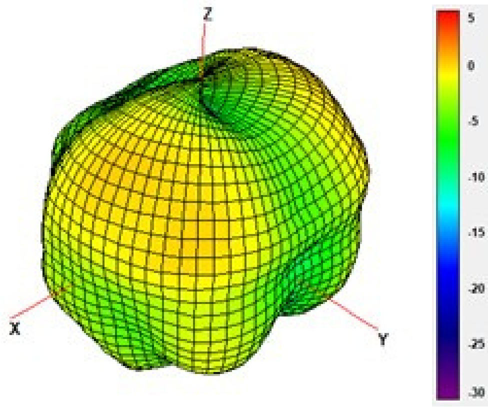
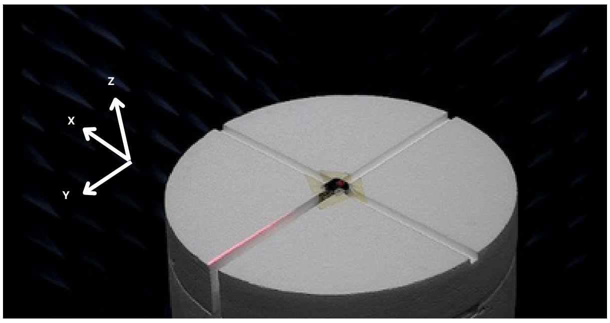


Figure 8 - AW-BW-65-V1 Total Gain (dBi) @ 6.5 GHz



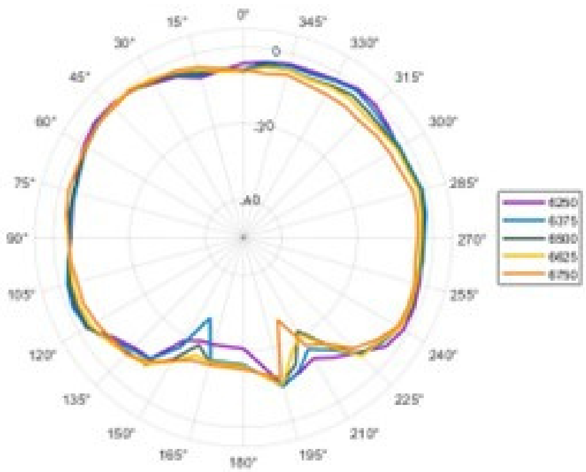


Figure 9 -YZ Cut Gain (dBi), 6250 - 6750 MHz

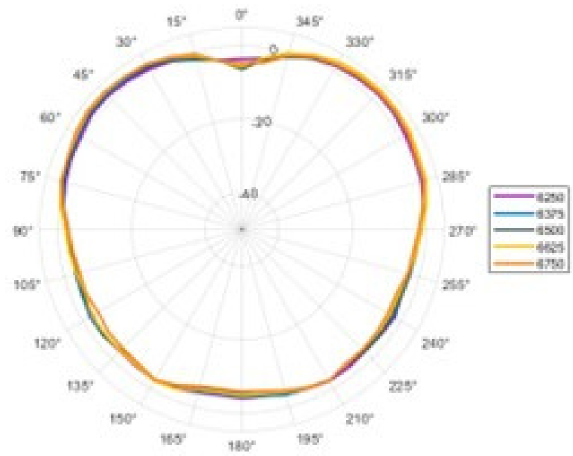


Figure 9 -XZ Cut Gain (dBi), 6250 - 6750 MHz

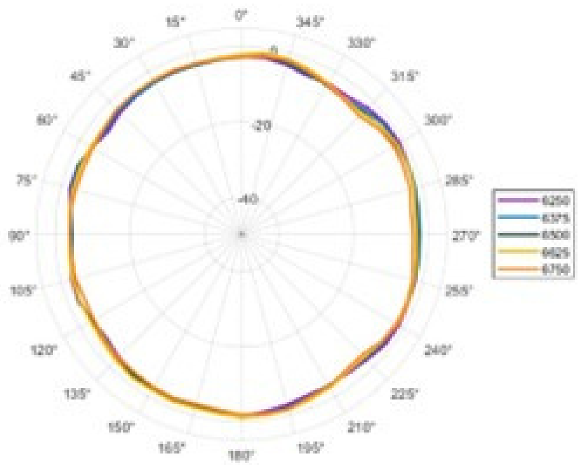


Figure 9 -XY Cut Gain (dBi), 6250 - 6750 MHz

6. Antenna PCB Footprint

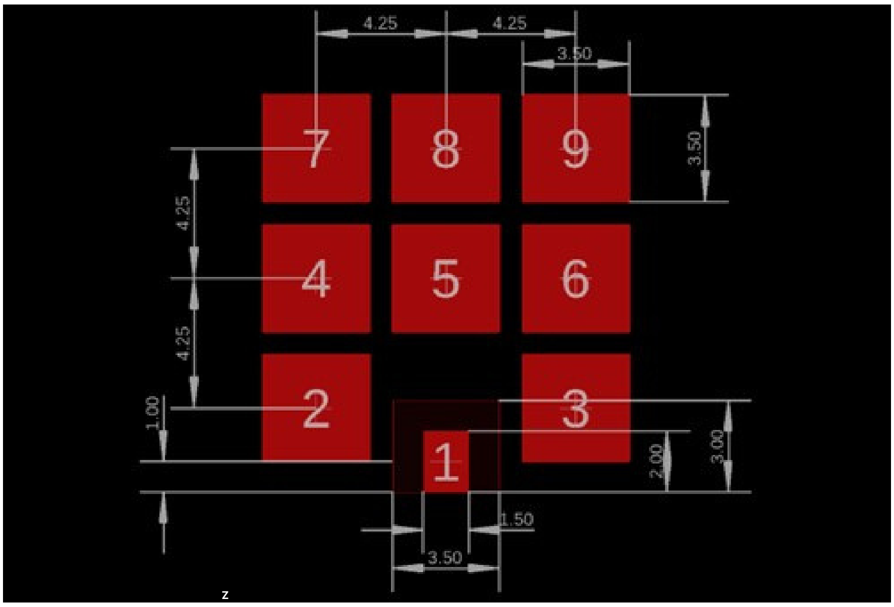


Figure 10 - AW-BW-65-V1 BodyWave Antenna footprint

Copper

Copper keepout

- Pad 1 is connected to the antenna 50 ohm feed line
- Pads 2,3,4,5,6,7,8 and 9 should be connected to GND (a via at each pad to GND plane below)
- Recommended minimum 2 mm separation from edge of PCB and other components
- Recommended minimum 2 mm separation from enclosure to top or edge of BodyWave™ Antenna
- Increased antenna separation from edge of PCB will improve wearable performance
- The antenna is designed for "on-ground" operation, a solid ground layer is required immediately underneath the antenna component layer
- A surrounding co-planar ground (connected to pads 2-9) on the same component layer as the antenna can be used but no co-planar ground surrounding the antenna with a microstrip feed is recommended.
- If used, a co-planar ground layer should be connected to pads 2-9 with thermal relief to aid in re-flow
- A minimum 3 component matching network at feed is recommended for fine tuning. High Q and tight tolerance components are recommended.
- Power planes, traces and components can be placed on PCB layers underneath the ground layer used by the antenna.
- Although not required, best results can be obtained by utilising maximum PCB substrate thickness and using PCB ground layer furthest from the layer the BodyWave™ Antenna is placed, with suitable keepout on all layers in between.

Note:
If assistance is required matching the antenna in the target device, please contact ***info@antennaware.co.uk***

7. Recommended Reflow Temperature Profile

The BodyWave™ Antenna can be assembled using the Pb-free IPC/JEDEC J-STD-020C standard with the recommended temperature profile shown below:

Electrical	Profile Features	Pb-Free Assembly
Ramp-up	Avg. Ramp-up Rate (Tsmax to Tp)	3 °C / second (max.)
Preheat	Temperature Min (Tsmin) Temperature Max (Tsmax) Time (tsmin to tsmax)	150 °C 200 °C 60-180 seconds
Reflow	Temperature (TL) Total Time above TL (tL)	217 °C 60-150 seconds
Peak	Temperature (Tp) Time (tp)	260 °C 20-40 seconds
Ramp-Down	Rate	6 °C/second max
Time from 25 °C to Peak Temperature		8 minutes max

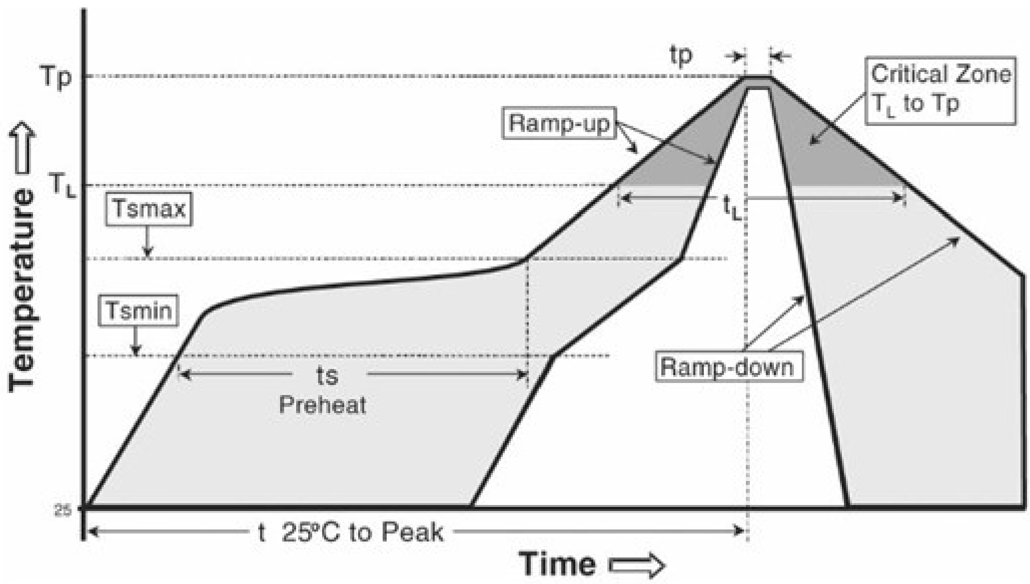


Figure 11 - Classification Reflow Profile

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