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# **SDIO PRODUCT SPECIFICATION**

**IEEE 802.11 b/g/n 2.4GHz 1T1R WiFi Module**

**JC-TSM89ES (Realtek RTL8189ES)  
Single Module**

Version 1.0

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## General Description

The Realtek RTL8189ES is a highly integrated single-chip 802.11n Wireless LAN (WLAN) network SDIO interface (SDIO 1.1/ 2.0/ 3.0 compliant) controller. It is a WLAN MAC, a 1T1R capable WLAN baseband, and WLAN RF in a single chip. The RTL8189ES provides a complete solution for a high throughput performance integrated wireless LAN device.

The RTL8189ES WLAN baseband implements Orthogonal Frequency Division Multiplexing (OFDM) with 1 transmit and 1 receive path and is compatible with the IEEE 802.11n specification. Features include one spatial stream transmission, short guard interval (GI) of 400ns, spatial spreading, and transmission over 20MHz and 40MHz bandwidth.

For legacy compatibility, Direct Sequence Spread Spectrum (DSSS), Complementary Code Keying (CCK) and OFDM baseband processing are included to support all IEEE 802.11b and 802.11g data rates. Differential phase shift keying modulation schemes, DBPSK and DQPSK with data scrambling capability, are available, and CCK provides support for legacy data rates, with long or short preamble. The high-speed FFT/IFFT paths, combined with BPSK, QPSK, 16QAM, and 64QAM modulation of the individual subcarriers and rate compatible punctured convolutional coding with coding rate of 1/2, 2/3, 3/4, and 5/6, provide higher data rates of 54Mbps and 150Mbps for IEEE 802.11g and 802.11n OFDM respectively.

The RTL8189ES WLAN Controller builds in an enhanced signal detector, an adaptive frequency domain equalizer, and a soft-decision Viterbi decoder to alleviate severe multi-path effects and mutual interference in the reception of multiple streams. Robust interference detection and suppression are provided to protect against Bluetooth, cordless phone, and microwave oven interference.

Efficient IQ-imbalance, DC offset, phase noise, frequency offset, and timing offset compensations are provided for the radio frequency front-end. Selectable digital transmit and receive FIR filters are provided to meet transmit spectrum mask requirements and to reject adjacent channel interference, respectively.

The RTL8189ES WLAN Controller supports fast receiver Automatic Gain Control (AGC) with synchronous and asynchronous control loops among antennas, antenna diversity functions, and adaptive transmit power control function to obtain the better performance in the analog portions of the transceiver.

The RTL8189ES WLAN MAC supports 802.11e for multimedia applications, 802.11i for security, and 802.11n for enhanced MAC protocol efficiency. Using packet aggregation techniques such as A-MPDU with BA and A-MSDU, protocol efficiency is significantly improved. Power saving mechanisms such as Legacy Power Save, and U-APSD, reduce the power wasted during idle time, and compensates for the extra power required to transmit OFDM. The RTL8189ES provides simple legacy and 20MHz/40MHz co-existence mechanisms to ensure backward and network compatibility.

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## Features

### General

32-pin QFN  
CMOS MAC, Baseband PHY, and RF in a single chip for IEEE 802.11b/g/n compatible WLAN

Complete 802.11n solution for 2.4GHz band

72.2Mbps receive PHY rate and 72.2Mbps transmit PHY rate using 20MHz bandwidth

150Mbps receive PHY rate and 150Mbps transmit PHY rate using 40MHz bandwidth

Compatible with 802.11n specification

Backward compatible with 802.11b/g devices while operating in 802.11n mode

### Host Interface

Complies with SDIO 1.1/ 2.0/ 3.0 for WLAN with clock rate up to 100MHz

GSPI interface for configurable endian for WLAN

### Standards Supported

IEEE 802.11b/g/n compatible WLAN

IEEE 802.11e QoS Enhancement (WMM)

802.11i (WPA, WPA2). Open, shared key, and pair-wise key authentication services

Selectable receiver FIR filters

Programmable scaling in transmitter and receiver to trade quantization noise against increased probability of clipping

Fast receiver Automatic Gain Control (AGC)

### WLAN MAC Features

Frame aggregation for increased MAC efficiency (A-MSDU, A-MPDU)

Low latency immediate High-Throughput Block Acknowledgement (HT-BA)

PHY-level spoofing to enhance legacy compatibility

Power saving mechanism

Channel management and co-existence

Transmit Opportunity (TXOP) Short Inter-Frame Space (SIFS) bursting for higher multimedia bandwidth

### WLAN PHY Features

IEEE 802.11n OFDM

One Transmit and one Receive path (1T1R) 20MHz and 40MHz bandwidth transmission

Short Guard Interval (400ns)

DSSS with DBPSK and DQPSK, CCK modulation with long and short preamble

OFDM with BPSK, QPSK, 16QAM, and 64QAM modulation.

Convolutional Coding Rate: 1/2, 2/3, 3/4, and 5/6

Maximum data rate 54Mbps in 802.11g and 150Mbps in 802.11n

Switch diversity for DSSS/CCK

Hardware antenna diversity in per packet base

On-chip ADC and DAC

### Peripheral Interfaces

General Purpose Input/Output (8 pins)

One configurable LED pins

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## PRODUCT SPECIFICATIONS

### Main chipset

WiFi Single Chip: Realtek RTL8189ES

#### Functional Specifications

<b>Standards</b>	<b>WiFi:</b> IEEE 802.11b, IEEE 802.11g, Draft IEEE 802.11n, IEEE 802.11d, IEEE 802.11e, IEEE 802.11h, IEEE 802.11i
<b>Bus Interface</b>	<b>WiFi:</b> GSPI/SDIO
<b>Form Factor</b>	L*W*H = 14mm*12.5mm*1.6mm +-0.2mm
<b>Data Rate</b>	<b>802.11b:</b> 11, 5.5, 2, 1 Mbps  <b>802.11g: 54, 48, 36, 24, 18, 12, 9, 6 Mbps</b>  <b>802.11n:</b> MCS 0 to 7 for HT20MHz MCS 0 to 7 for HT40MHz  <b>BT:</b>
<b>Media Access Control</b>	<b>WiFi:</b> CSMA/CA with ACK BT: AFH, Time Division
<b>Modulation Techniques</b>	<b>802.11b:</b> CCK, DQPSK, DBPSK <b>802.11g: 64 QAM, 16 QAM, QPSK, BPSK 802.11n:</b>  64 QAM, 16 QAM, QPSK, BPSK
<b>Network Architecture</b>	<b>WiFi:</b>

	Ad-hoc mode (Peer-to-Peer ) Infrastructure mode Scatter Net		
<b>Operating Channel</b>	<b>WiFi 2.4GHz:</b> 11: (Ch. 1-11) – United States 13: (Ch. 1-13) – Europe 14: (Ch. 1-14) – Japan		
<b>Frequency Range</b>	2.400GHz ~ 2.4835 GHz		
<b>Transmit Output Power – 1x1 (Tolerance: ±1dBm)</b>	<b>802.11b@11Mbps 17dBm</b>	<b>802.11g@6Mbps 16dBm</b>	<b>802.11n 16dBm (MCS 0_HT20)</b>
		<b>802.11g@54Mbps 15dBm</b>	13dBm (MCS 7_HT20) 13dBm (MCS 0_HT40) 13dBm (MCS 7_HT40)
<b>Receiver Sensitivity</b>	<b>802.11b@11Mbps -84dBm</b>	<b>802.11g@54Mbps -73dBm</b>	<b>802.11n -69dBm (MCS 7_HT20)</b>
			-66dBm (MCS 7_HT40)
<b>Security</b>	<b>WiFi :</b> WPA, WPA-PSK, WPA2, WPA2-PSK, WEP 64bit & 128bit, IEEE  802.11x, IEEE 802.11i BT:  Simple Paring		
<b>Operating Voltage</b>	3.3 V ±9% I/O supply voltage		
<b>OS supported</b>	Windows XP/Win7/Linux/Android		

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<p><b>Power Consumption (3.3V) (Typical)</b></p>	<p><b>WiFi :</b> <b>TX Mode: (Conituous mode)</b> 65mA (MCS7/BW40/13dBm)</p> <p><b>RX Mode: (Conituous mode)</b> 40mA (MCS7/BW40/-60dBm)</p> <p><b>Associated Idle:</b> 4mA</p> <p><b>Unassociated Idle:</b> 2.9mA</p> <p><b>RF disable Mode:</b> 3mA</p>
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### Mechanical

Dimensions (mm)	Length	Width	Height
	14 (Tolerance:±0.2mm)	12.5 (Tolerance:±0.2mm)	1.8 (Tolerance:±0.2mm)

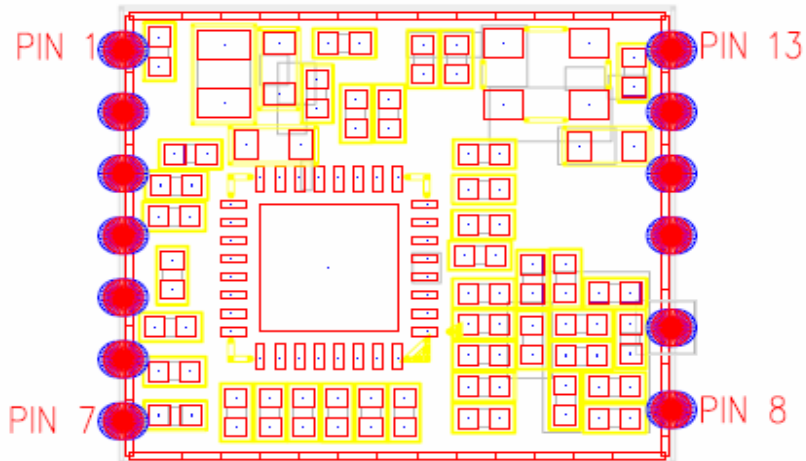


Fig.1 Top Layer (Top View)

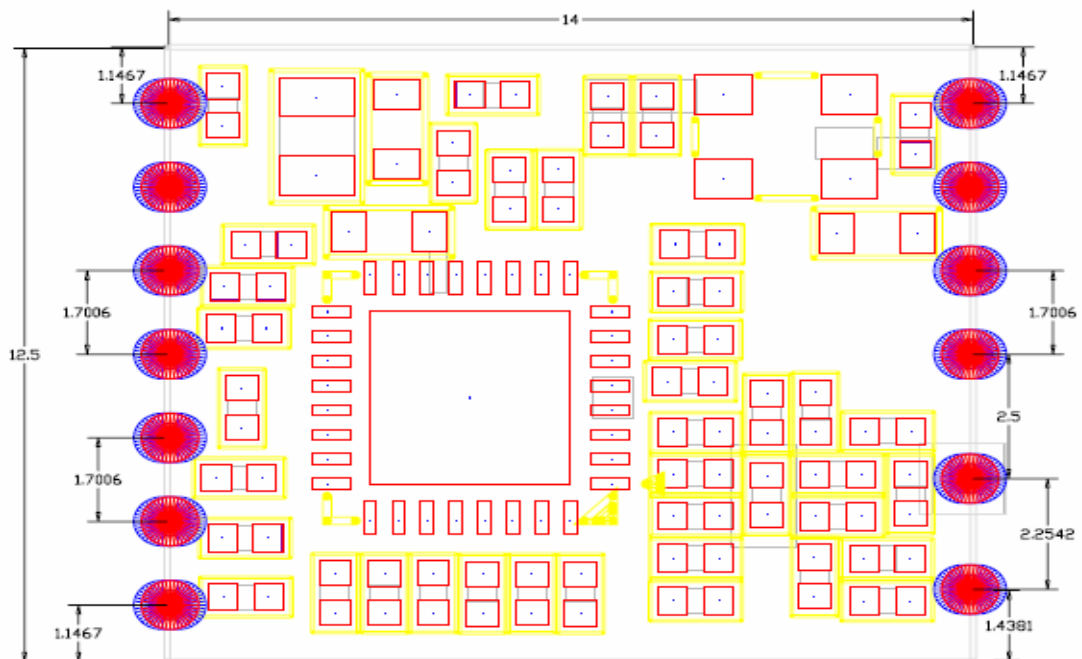
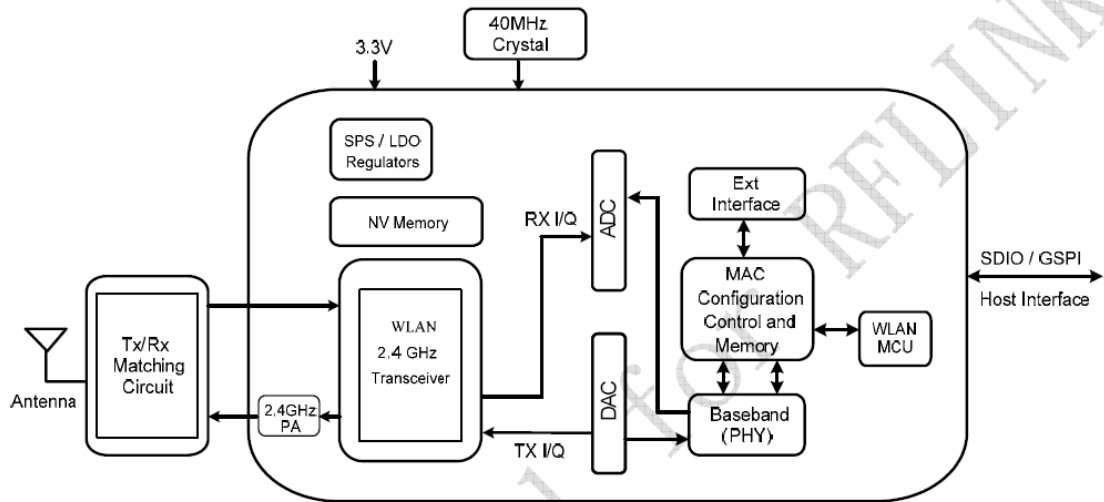


Fig.2 Size chart (Top View)

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## Block Diagram



**Figure 1. Single-Band 11n (1x1) Solution**

*Default this module only require 3.3V single power source and core voltage generated by internal voltage regulator.*

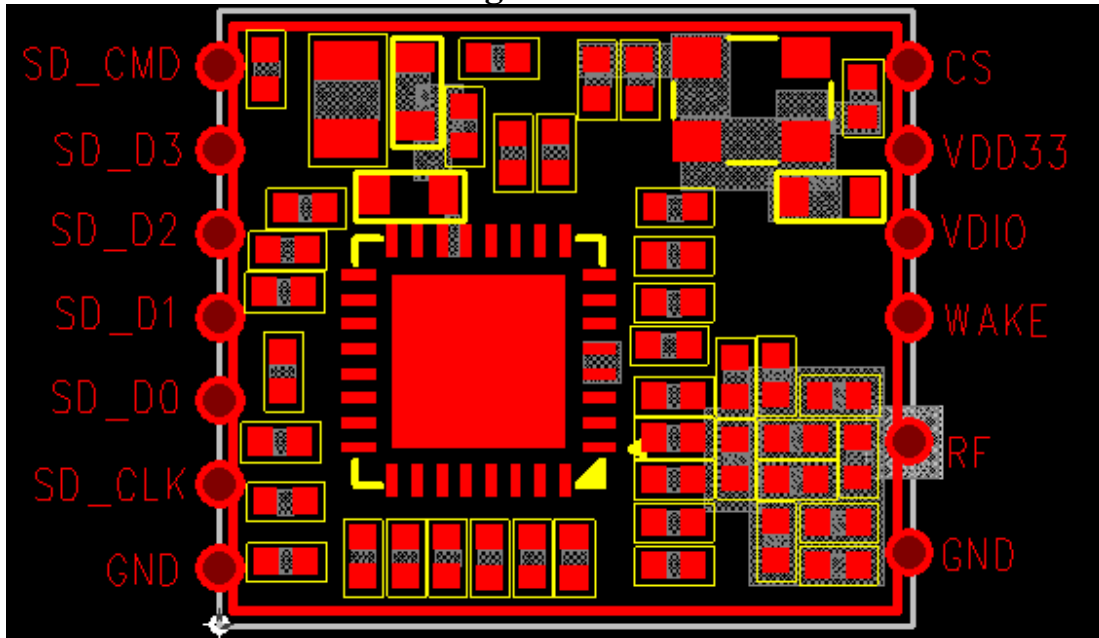
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## MODULE PIN ASSIGNMENT

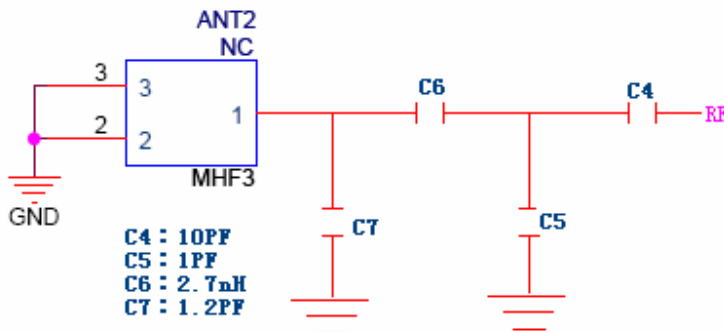
Pin	Function	Pin	Function
1	SD_CMD	8	GND
2	SD_D3	9	RF
3	SD_D2	10	WAKE
4	SD_D1	11	VDIO VDD for SDIO Pin, the power supply is same as the signal level of SDIO bus (3.3V ~ 1.8V)
5	SD_D0	12	VDD33
6	SD_CLK	13	CS
7	GND		

### Module PIN feet definition figure



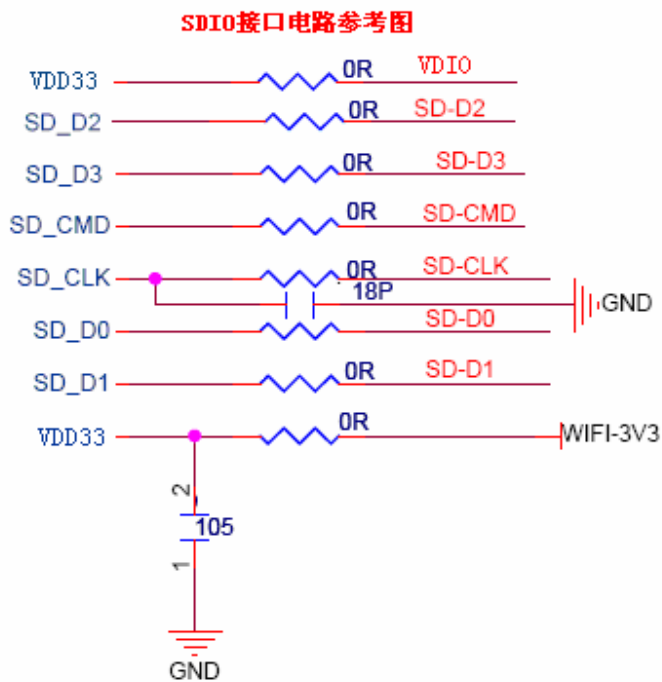
### WIFI\BT RF Circuit reference pictures

#### WIFI\BT RF电路参考图

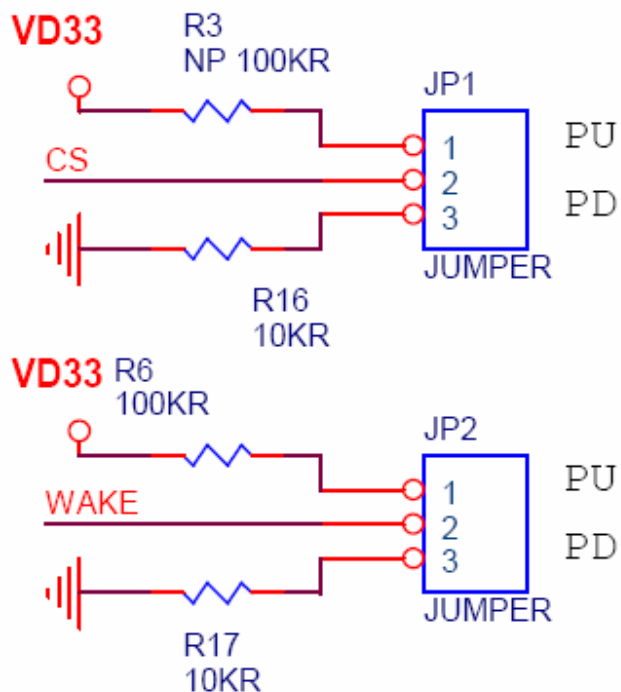


注：以上 RF 走线要做 50 欧的阻抗，走线不能走 90 度，单走线不能长于 15MM。

## SDIO interface Circuit reference pictures



## CS WAKE Reference circuits



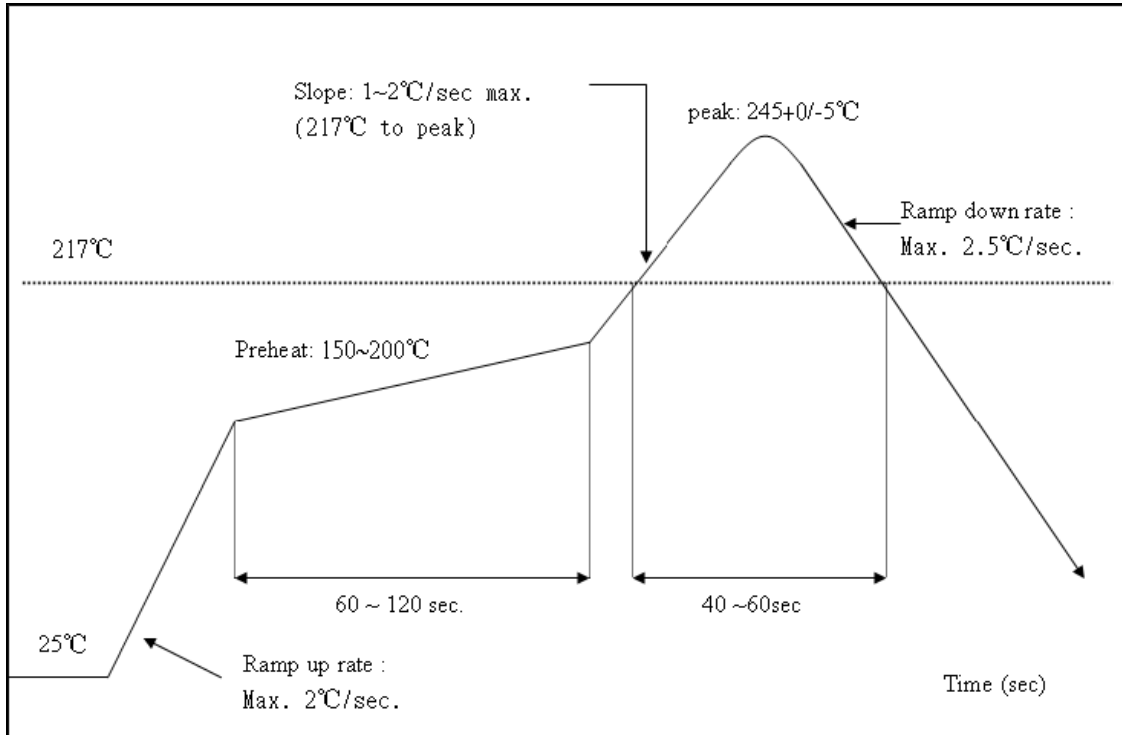
CS, WAKE config.

## Recommended Reflow Profile

Referred to IPC/JEDEC standard.

Peak Temperature :  $<250^{\circ}\text{C}$

Number of Times :  $\leq 2$  times



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## ID SETTING INFORMATION

Reg Domain	World Wide 13 Channels 1-11 with active scan Channels 12,13 with passive scan Channel 14 with no scan
Reg Domain Code	0x0A
Vendor ID	<i>WiFi :</i> 0x024C
Device ID	<i>WiFi :</i> 0x8179
Subsystem Device ID	0x8179 (Realtek demoboard)
Subsystem Vendor ID	0x024C

## ENVIRONMENTAL

### Operating

Operating Temperature: 0°C to +70 °C  
Relative Humidity: 5-90% (non-condensing)

### Storage

Temperature: -40°C to +80°C (non-operating)  
Relevant Humidity: 5-95% (non-condensing)

### MTBF caculation

Over 150,000hours

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