

## HDJD-S722-QR999

### Color Sensor



## Data Sheet

### Description

Avago Technologies' color sensor is a high performance, small in size, cost effective light to voltage converting sensor. The sensor combines a photodiode array and three trans-impedance amplifiers in a single monolithic CMOS IC solution. With a Red (R), Green (G) and Blue (B) color filters coated over the photodiode array, the sensor converts R, G, B light to analog voltage outputs, denoted by  $V_{R_{OUT}}$ ,  $V_{G_{OUT}}$  and  $V_{B_{OUT}}$ , respectively. The sensor is packaged in a 5x5x1 (mm) surface mount QFN-16 package.

### Applications

Avago Technologies' color sensor is ideal for open-loop color identification and closed-loop color point control. The sensor is designed for low illuminance applications including color detection, environmental lighting, industrial process, etc. With R, G, B photo-sensor and amplifier integrated in a single 5x5x1 (mm) package, Avago Technologies' color sensor provides a high performance, small in size and cost effective solution to color sensing.

### Features

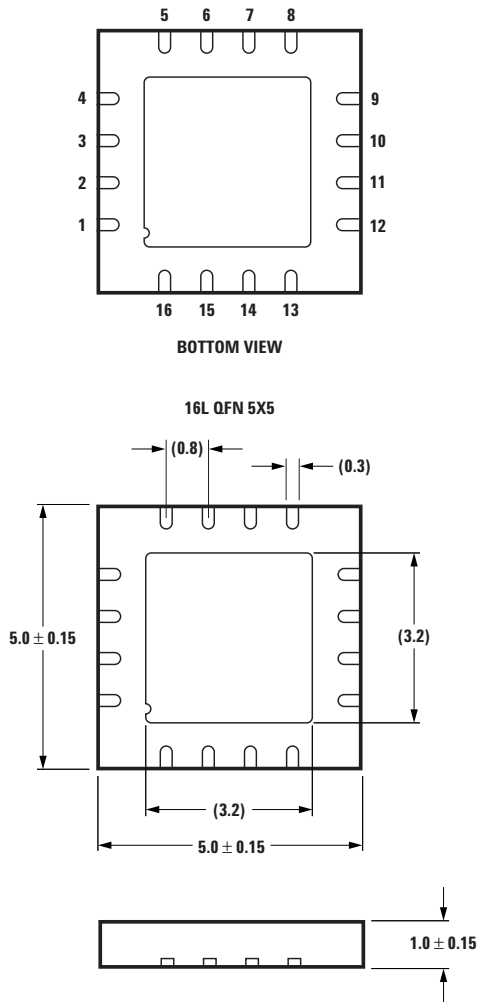
- Convert light to R, G, B voltage output
- Monolithic CMOS IC solution with integrated R, G, B color filter, photodiode array, trans-impedance amplifier in one chip
- 3 sets of 3x3 photodiode array design minimize the effect of contamination and optical aperture misalignment
- Small in size 5x 5x1 mm
- Independent gain selection options for each R, G, B channel

**ESD WARNING:** Standard CMOS handling precautions should be observed to avoid static discharge.

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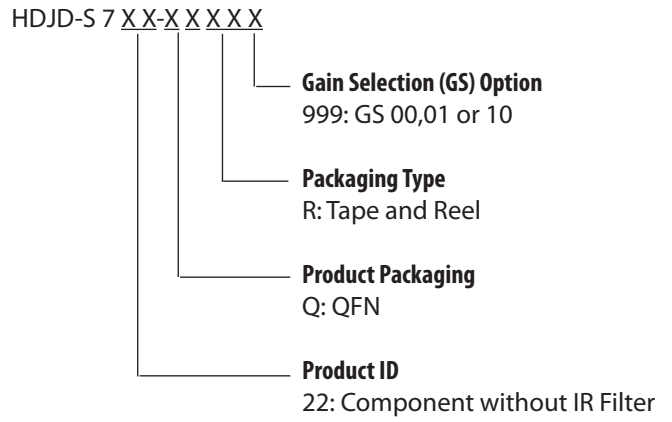


## Package Dimension



**NOTE: DIMENSIONS ARE IN MILLIMETERS (mm)**

## Part Numbering System



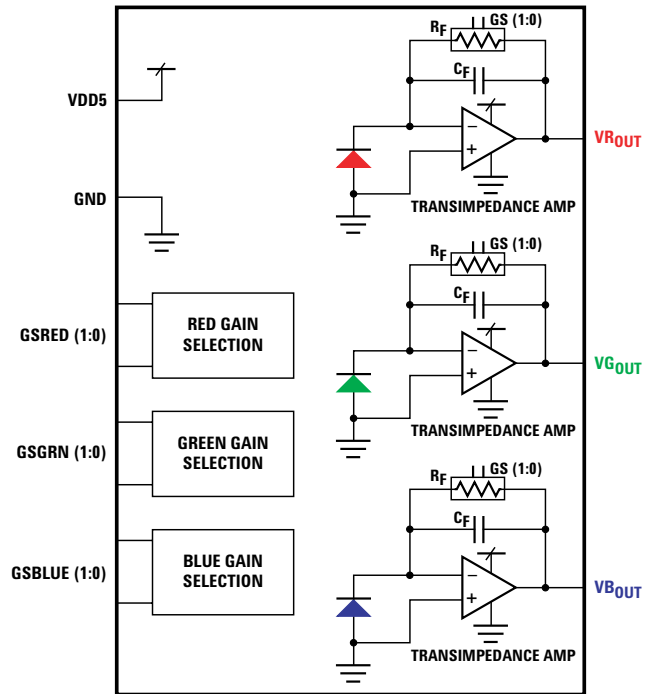
## Pin Out for HDJD-S722-QR999

Pin	Pin Name	Normal Operation
Pin 1	VB <sub>OUT</sub>	Analog output voltage for BLUE
Pin 2	VG <sub>OUT</sub>	Analog output voltage for GREEN
Pin 3	VR <sub>OUT</sub>	Analog output voltage for RED
Pin 4	VDD	5 V DC Supply
Pin 5	GND	Ground
Pin 6	GSGRN1	Gain Selection Green bit 1
Pin 7	GND	Ground
Pin 8	GSRED1	Gain Selection Red bit 1
Pin 9	GSREDO	Gain Selection Red bit 0
Pin 10	NC	No connection
Pin 11	NC	No connection
Pin 12	GGBLUE0	Gain Selection Blue bit 0
Pin 13	GGBLUE1	Gain Selection Blue bit 1
Pin 14	GND	Ground
Pin 15	GSGRNO	Gain Selection Green bit 0
Pin 16	GND	Ground

## Theory of Operation

The integral R, G, B color filters on the photodiode array detect the R, G, B components of the light falling on the sensor. The photodiode converts the R, G, B light components into photocurrents. The integrated transimpedance amplifiers for R, G, B components then convert the photocurrent to analog voltage outputs. The voltage output of each R, G, B channel increases linearly with increasing light intensity.

## Sensor IC Block Diagram



### Absolute Maximum Ratings<sup>[1,2]</sup>

Parameter	Symbol	Min.	Max.	Unit	Notes
Supply Voltage	$V_{DD}$	4.5	5.5	V	
Storage Temperature	$T_S$	-40	100	°C	
Operating Temperature	$T_A$	-40	85	°C	
Human Body Model ESD Rating	$ESD_{HBM}$		1	kV	

#### Notes:

1. Subjecting the part to stresses beyond those listed under this section may cause permanent damage to the device. These are stress ratings only and do not imply that the devices will function beyond these ratings. Exposure to the extremes of these conditions for extended periods may affect device reliability.
2. Unless otherwise specified, voltages are referenced to ground.

### Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Operating Temperature	$T_A$	0	25	70	°C	
Supply Voltage	$V_{DD}$	4.5	5.0	5.5	V	A decoupling capacitor of 100 nF between $V_{DD}$ and ground is recommended.

## Operating Conditions and Electrical Requirements

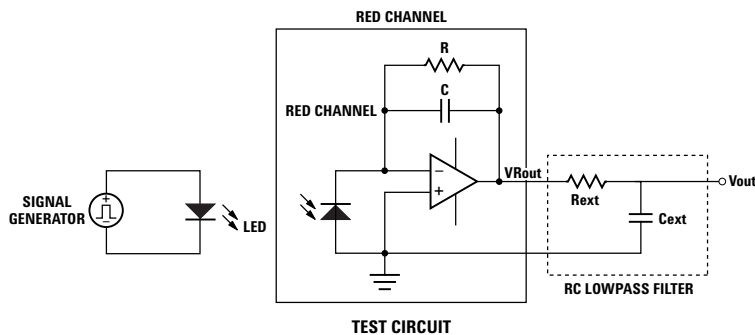
Electrical Characteristics at  $V_{DD} = 5V$ ,  $T_A = 25^\circ C$ ,  $R_L = 68k\Omega$

Parameter	Symbol	Remark	Min.	Typ.	Max.	Unit
Dark Voltage	$V_D$	$E_e = 0$		15		mV
Max. Output Voltage Swing	$V_{O_{MAX}}$			4.8		V
Supply Current	$I_{DD}$	$E_e = 0$		2.5		mA
Irradiance Responsivity	Re	GS:10, $\lambda_p = 460\text{ nm}^{[1]}$ (Blue Channel)		15		V/(mW/cm <sup>2</sup> )
		GS:10, $\lambda_p = 542\text{ nm}^{[2]}$ (Green Channel)		19		
		GS:10, $\lambda_p = 645\text{ nm}^{[3]}$ (Red Channel)		27		
Irradiance Responsivity	Re	GS:01, $\lambda_p = 460\text{ nm}^{[1]}$ (Blue Channel)		9		V/(mW/cm <sup>2</sup> )
		GS:01, $\lambda_p = 542\text{ nm}^{[2]}$ (Green Channel)		11		
		GS:01, $\lambda_p = 645\text{ nm}^{[3]}$ (Red Channel)		16		
Irradiance Responsivity	Re	GS:00, $\lambda_p = 460\text{ nm}^{[1]}$ (Blue Channel)		5		V/(mW/cm <sup>2</sup> )
		GS:00, $\lambda_p = 542\text{ nm}^{[2]}$ (Green Channel)		6		
		GS:00, $\lambda_p = 645\text{ nm}^{[3]}$ (Red Channel)		9		
Saturation Irradiance <sup>[4]</sup>		GS:10, $\lambda_p = 460\text{ nm}^{[1]}$ (Blue Channel)		0.32		mW/cm <sup>2</sup>
		GS:10, $\lambda_p = 542\text{ nm}^{[2]}$ (Green Channel)		0.25		
		GS:10, $\lambda_p = 645\text{ nm}^{[3]}$ (Red Channel)		0.18		
Saturation Irradiance <sup>[4]</sup>		GS:01, $\lambda_p = 460\text{ nm}^{[1]}$ (Blue Channel)		0.53		mW/cm <sup>2</sup>
		GS:01, $\lambda_p = 542\text{ nm}^{[2]}$ (Green Channel)		0.44		
		GS:01, $\lambda_p = 645\text{ nm}^{[3]}$ (Red Channel)		0.30		
Saturation Irradiance <sup>[4]</sup>		GS:00, $\lambda_p = 460\text{ nm}^{[1]}$ (Blue Channel)		0.96		mW/cm <sup>2</sup>
		GS:00, $\lambda_p = 542\text{ nm}^{[2]}$ (Green Channel)		0.80		
		GS:00, $\lambda_p = 645\text{ nm}^{[3]}$ (Red Channel)		0.53		
Output Rise Time	tr	GS:00 to GS01; Test Condition <sup>[5]</sup> (min $V_o = 0V$ , peak $V_o = 2V$ )		45		$\mu s$
		GS:10; Test Condition <sup>[5]</sup> (min $V_o = 0V$ , peak $V_o = 2V$ )		220		
Output Fall Time	tf	GS:00 to GS01; Test Condition <sup>[5]</sup> (min $V_o = 0V$ , peak $V_o = 2V$ )		50		$\mu s$
		GS:10; Test Condition <sup>[5]</sup> (min $V_o = 0V$ , peak $V_o = 2V$ )		240		

### Notes:

1. Test condition: using blue diffuse light of peak wavelength ( $\lambda_p$ ) 460 nm and spectral half width ( $\Delta\lambda^{1/2}$ ) 25 nm as light source.
2. Test condition: using green diffuse light of peak wavelength ( $\lambda_p$ ) 542 nm and spectral half width ( $\Delta\lambda^{1/2}$ ) 35 nm as light source.
3. Test condition: using red diffuse light of peak wavelength ( $\lambda_p$ ) 645 nm and spectral half width ( $\Delta\lambda^{1/2}$ ) 20 nm as light source.
4. Saturation irradiance = (Max. output voltage swing)/(Irradiance responsivity).
5. Test condition: The rise and fall time is measured with RC lowpass filter added to sensor output:

Gain Selection	Rext	Cext
GS:00 to GS:01	15 k $\Omega$	1 nF
GS:10	15 k $\Omega$	6.8 nF



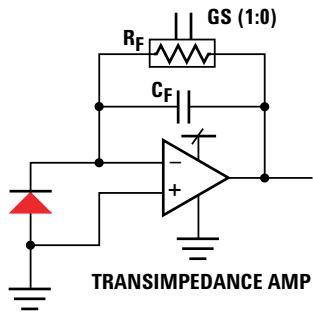
FOR ILLUSTRATION PURPOSE, ONLY RED CHANNEL IS SHOWN.  
THE SAME CIRCUIT APPLIES TO GREEN AND BLUE CHANNELS.

**Gain Selection Feedback Resistor Table**

GS: Bit 1	Bit 0	Feedback Resistor, $R_f$
0	0	4 M $\Omega$
0	1	7 M $\Omega$
1	0	12 M $\Omega$

**Notes:**

1. Gains selections, GS: Bit 1 Bit 0 are applicable for each Red, Green and Blue Channel.
2. Gain selections for each channel can be selected independently of each other.
3. Feedback resistor value is proportional to responsivity. Refer to block diagram below.
4. 0 indicates that the pin is connected to ground. 1 indicates no connection.



**Typical Characteristics**

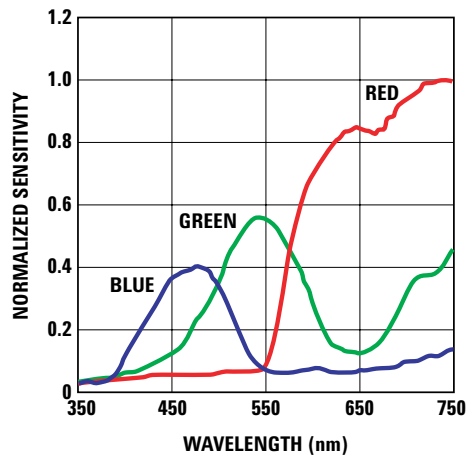


Figure 1. Spectral responsivity.

**Note:**

Test condition is when Gain Selection Jumpers are set to  
 GSBLUE1=0      GSGRN1=0      GSRED1=0  
 GSBLUE0=1      GSGRN0=1      GSRED0=1

in which 0 = connect to Ground, 1 = no connection. Refer to Gain Selection Feedback Resistor Table.

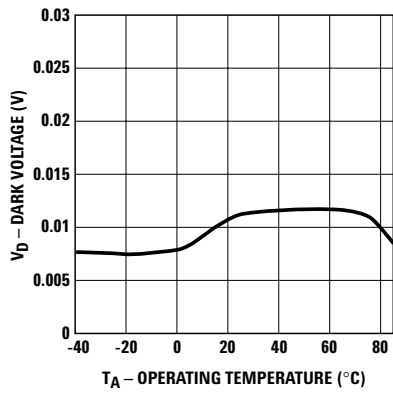


Figure 2. Dark voltage vs. operating temperature.

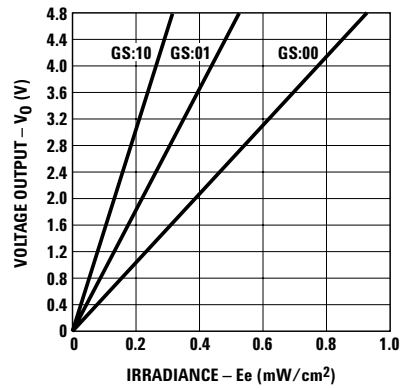


Figure 3. Voltage output of Blue Channel vs. irradiance ( $\lambda_p = 460$  nm).

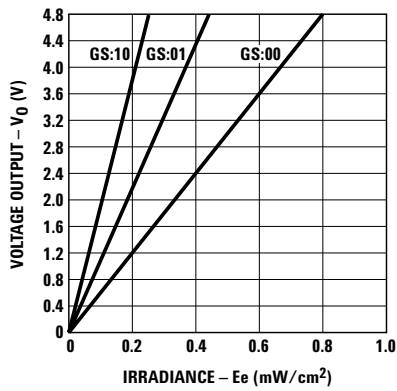


Figure 4. Voltage output of Green Channel vs. irradiance ( $\lambda_p = 542$  nm).

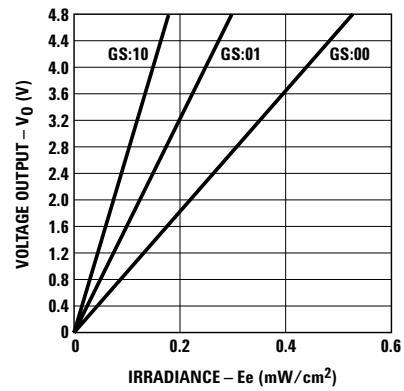


Figure 5. Voltage output of Red Channel vs. irradiance ( $\lambda_p = 645$  nm).

### Recommended Reflow Profile

It is recommended that Henkel Pb-free solder paste LF310 be used for soldering HDJD-S722-QR999. Below is the recommended reflow profile.

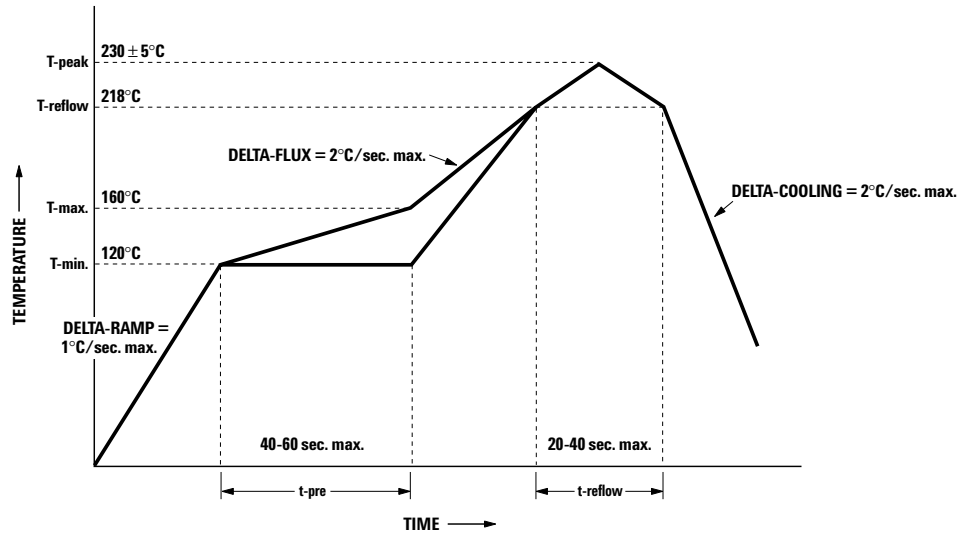


Figure 6. Recommended reflow soldering profile.

## 16 Lead QFN Recommended PCB Land Pad Design

IPC-SM-782 is used as the standard for the PCB land-pad design. Recommended PCB finishing is gold plated.

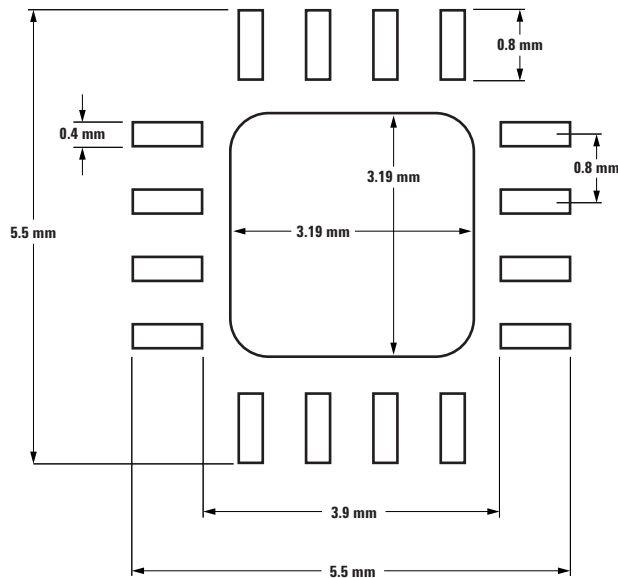


Figure 7.

## 16 Lead QFN Recommended Stencil Design

A stencil thickness of 2.18 mm (6 mils) for this QFN package is recommended.

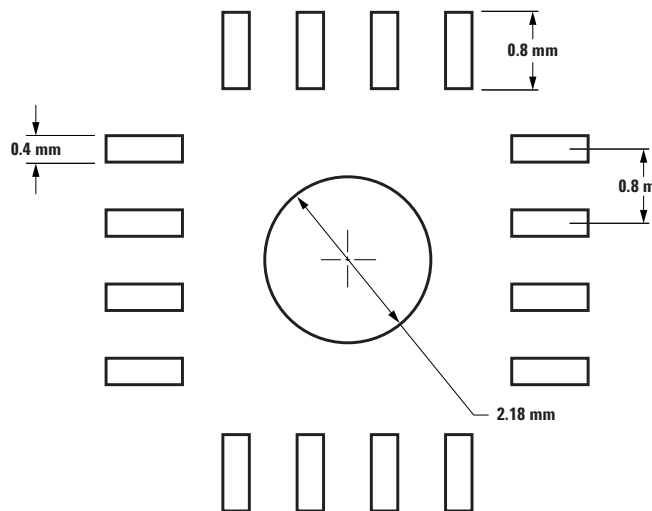


Figure 8.

## Recommendations for Handling and Storage of HDJD-S722-QR999

This product is qualified as Moisture Sensitive Level 4 per JEDEC J-STD-020. Precautions when handling this moisture sensitive product is important to ensure the reliability of the product. Do refer to Avago Application Note AN5305 Handling Of Moisture Sensitive Surface Mount Devices for details.

### A. Storage before use

- Unopened moisture barrier bag (MBB) can be stored at 30°C and 90%RH or less for maximum 1 year
- It is not recommended to open the MBB prior to assembly (e.g. for IQC)
- It should also be sealed with a moisture absorbent material (Silica Gel) and an indicator card (cobalt chloride) to indicate the moisture within the bag

### B. Control after opening the MBB

- The humidity indicator card (HIC) shall be read immediately upon opening of MBB
- The components must be kept at <30°C/60%RH at all time and all high temperature related process including soldering, curing or rework need to be completed within 72hrs

### C. Control for unfinished reel

- For any unused components, they need to be stored in sealed MBB with desiccant or desiccator at <5%RH

### D. Control of assembled boards

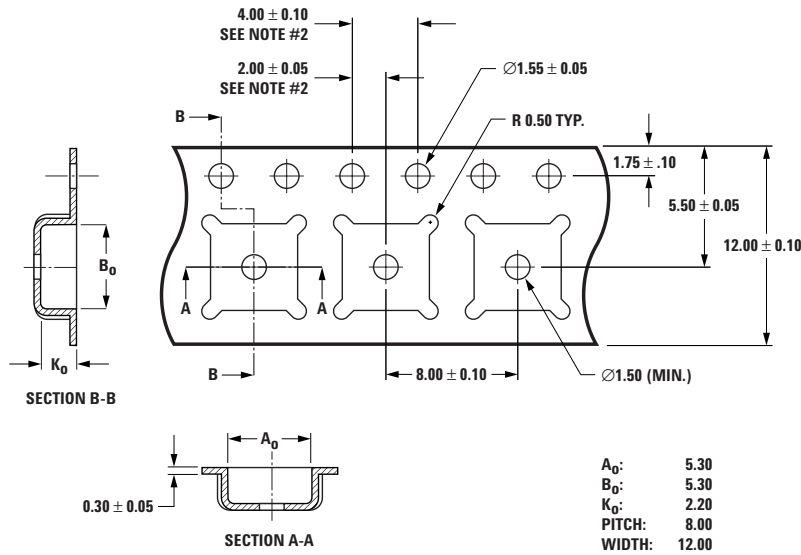
- If the PCB soldered with the components is to be subjected to other high temperature processes, the PCB need to be stored in sealed MBB with desiccant or desiccator at <5%RH to ensure no components have exceeded their floor life of 72hrs

### E. Baking is required if:

- "10%" or "15%" HIC indicator turns pink
- The components are exposed to condition of >30°C/60%RH at any time.
- The components floor life exceeded 72hrs
- Recommended baking condition (in component form): 125°C for 24hrs



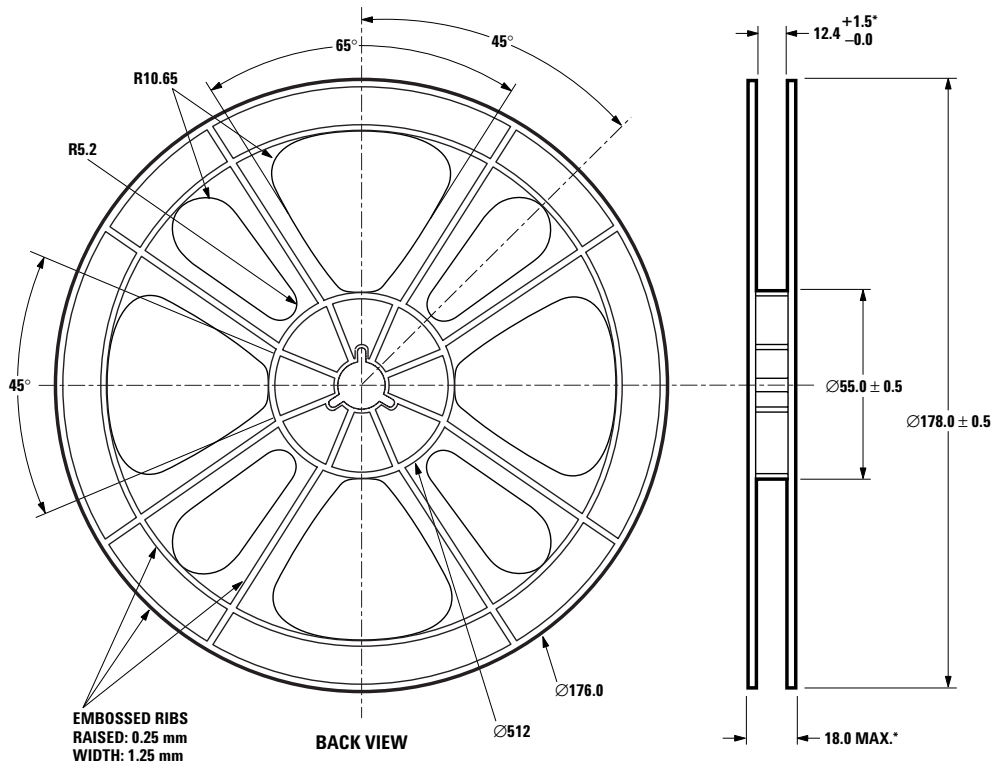
## Package Tape and Reel Dimensions



### NOTES:

1. A<sub>0</sub> AND B<sub>0</sub> MEASURED AT 0.3 mm ABOVE BASE OF POCKET.
2. 10 PITCHES CUMULATIVE TOLERANCE IS ± 0.2 mm.
3. DIMENSIONS ARE IN MILLIMETERS (mm).

## Reel Dimensions



### NOTES:

1. \*MEASURED AT HUB AREA.
2. ALL FLANGE EDGES TO BE ROUNDED.

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