

# ADJD-E622-QR999

## RGB Color Sensor in QFN Package



## Data Sheet

### Description

ADJD-E622-QR999 is a high performance, small in size, cost effective light to voltage converting sensor. The sensor combines a photodiode array and three transimpedance 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 RGB light to analog voltage outputs, denoted by VROUT, VGOUT and VBOUT, respectively. The sensor is packaged in a 5x5x0.75 [mm] surface mount QFN-16 package.

### Applications

- Ideal choice of light sensor in automotive applications such as dashboard lighting, automotive interior lighting, infotainment and navigational panel.
- Other potential applications are such as environmental lighting, cabin lighting, decorative lighting, general color detection, industrial process, etc.
- Can also be coupled with Avago Technologies' patented color controller, HDJD-J822, to form a closed loop color management system

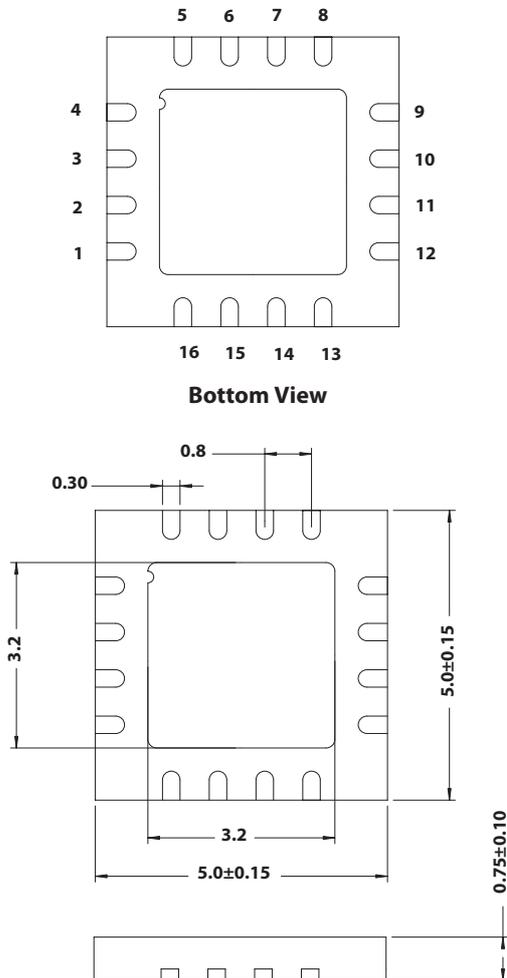
### Features

- Convert light to R,G,B voltage output
- Monolithic CMOS IC solution comprises of an array of photodiode coated with R,G, B color filter and integrated with transimpedance amplifier.
- Independent gain selection options for each R,G,B channel
- 3 sets of 3x3 photodiode array design to minimize the effect of contamination and optical aperture misalignment
- Qualified per Automotive AEC-Q100 Standard (Grade 3)
- Robust package and small in size 5x 5x 0.75 mm

**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

ADJD-E 6 XX -X X XXX

### Gain Selection (GS) Option

999: For component level

GS 000,001,010,011,100,101,110,111

### Packing Type

R: Tape and Reel

### Product Packaging

Q: QFN

### Product ID

22: component without IR filter (QFN 5x5)

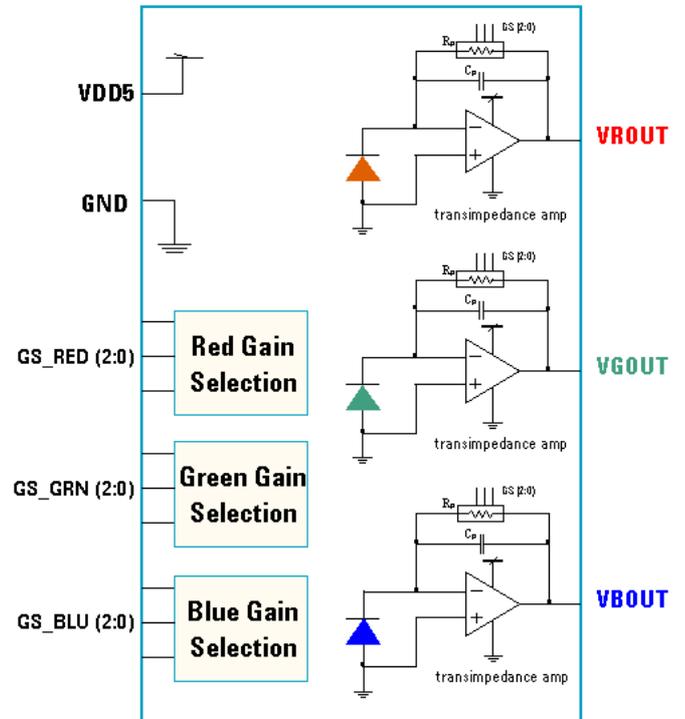
## Theory of Operation

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 convert 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.

### Pin Out for ADJD-E622-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	5V DC Supply
Pin 5	GSGRN2	Gain Selection Green bit 2
Pin 6	GSGRN1	Gain Selection Green bit 1
Pin 7	GSRED2	Gain Selection Red bit 2
Pin 8	GSRED1	Gain Selection Red bit 1
Pin 9	GSRED0	Gain Selection Red bit 0
Pin 10	NC	No connection
Pin 11	NC	No connection
Pin 12	GSBLUE0	Gain Selection Blue bit 0
Pin 13	GSBLUE1	Gain Selection Blue bit 1
Pin 14	GSBLUE2	Gain Selection Blue bit 2
Pin 15	GSGRN 0	Gain Selection Green bit 0
Pin 16	GND	Ground

## Sensor IC Block Diagram



## Absolute Maximum Ratings [1,2]

Parameter	Symbol	Min	Max	Unit	Notes
Supply Voltage	$V_{DD}$	4.5	5.5	V	
Storage Temperature	$T_S$	-50	105	°C	
Operating Temperature	$T_A$	-40	85	°C	
Human Body Model ESD Rating	$ESD_{HBM}$		8	kV	
Machine Model ESD Rating	$ESD_{MM}$		200	V	
Charge Device Model ESD Rating [3]	$ESD_{CDM}$		500	V	

Note:

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.
3. Maximum ESD rating for corner pin is 750V

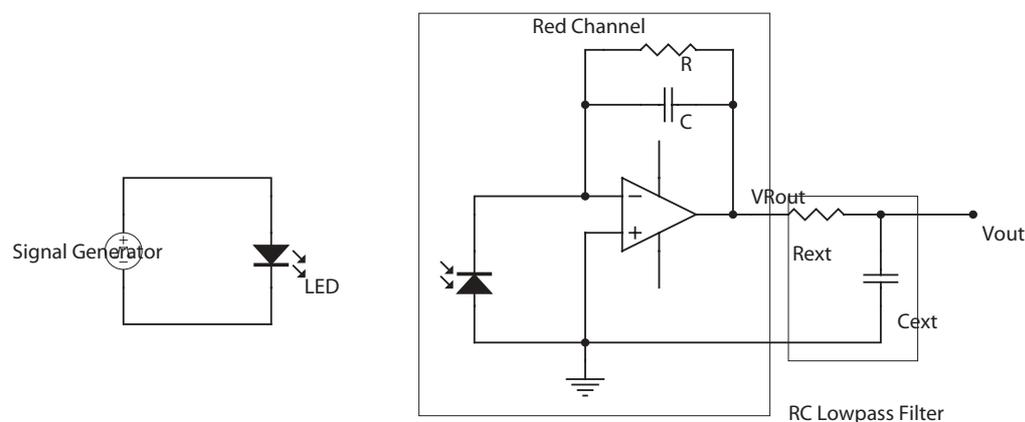
## Recommended Operating Conditions

Parameter	Sym.	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 100nF between $V_{DD}$ and ground is recommended.

Remarks:

1. The device is with moisture sensitivity level 3.
2. For optimized signal output, RC filters must be added at each of the R, G and B voltage output.

Gain Selection	$R_{ext}$	$C_{ext}$
GS:000 to GS:101	15k $\Omega$	1nF
GS:110 to GS:111	15k $\Omega$	6.8nF



For illustration purpose, only red channel is shown. The same circuit applies to green and blue channel.

## Operating Conditions and Electrical Requirements

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

Parameter	Sym.	Remark	Min.	Typ.	Max.	Unit
Dark voltage	$V_D$	$E_e = 0$			20	mV
Max. output voltage swing	$V_{OMAX}$			4.7		V
Supply current	$I_{DD}$	$E_e = 0$		2.4		mA
Irradiance Responsivity	Re	GS:111, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		12		V/ (mW/cm <sup>2</sup> )
		GS:111, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		18		
		GS:111, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		26		
Irradiance Responsivity	Re	GS:110, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		10		V/ (mW/cm <sup>2</sup> )
		GS:110, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		14		
		GS:110, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		20		
Irradiance Responsivity	Re	GS:101, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		7		V/ (mW/cm <sup>2</sup> )
		GS:101, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		11		
		GS:101, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		16		
Irradiance Responsivity	Re	GS:100, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		6		V/ (mW/cm <sup>2</sup> )
		GS:100, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		8		
		GS:100, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		12		
Irradiance Responsivity	Re	GS:011, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		5		V/ (mW/cm <sup>2</sup> )
		GS:011, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		6		
		GS:011, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		9		
Irradiance Responsivity	Re	GS:010, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		4		V/ (mW/cm <sup>2</sup> )
		GS:010, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		5		
		GS:010, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		7		
Irradiance Responsivity	Re	GS:001, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		3		V/ (mW/cm <sup>2</sup> )
		GS:001, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		4		
		GS:001, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		6		
Irradiance Responsivity	Re	GS:000, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		2		V/ (mW/cm <sup>2</sup> )
		GS:000, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		3		
		GS:000, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		4		
Saturation Irradiance <sup>[5]</sup>		GS:111, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		0.39		mW/cm <sup>2</sup>
		GS:111, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		0.26		
		GS:111, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		0.18		
Saturation Irradiance <sup>[5]</sup>		GS:110, $\lambda_p = 460\text{ nm}$ <sup>[2]</sup> (Blue Channel)		0.47		mW/cm <sup>2</sup>
		GS:110, $\lambda_p = 542\text{ nm}$ <sup>[3]</sup> (Green Channel)		0.34		
		GS:110, $\lambda_p = 645\text{ nm}$ <sup>[4]</sup> (Red Channel)		0.23		

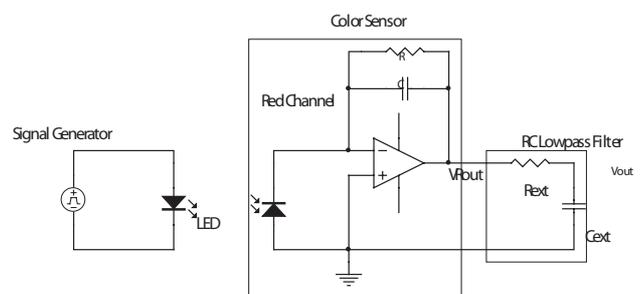
Parameter	Sym.	Remark	Min.	Typ.	Max.	Unit
Saturation Irradiance <sup>[5]</sup>		GS:101, $\lambda_p = 460 \text{ nm}$ <sup>[2]</sup> (Blue Channel)		0.67		mW/cm <sup>2</sup>
		GS:101, $\lambda_p = 542 \text{ nm}$ <sup>[3]</sup> (Green Channel)		0.43		
		GS:101, $\lambda_p = 645 \text{ nm}$ <sup>[4]</sup> (Red Channel)		0.29		
Saturation Irradiance <sup>[5]</sup>		GS:100, $\lambda_p = 460 \text{ nm}$ <sup>[2]</sup> (Blue Channel)		0.78		mW/cm <sup>2</sup>
		GS:100, $\lambda_p = 542 \text{ nm}$ <sup>[3]</sup> (Green Channel)		0.59		
		GS:100, $\lambda_p = 645 \text{ nm}$ <sup>[4]</sup> (Red Channel)		0.40		
Saturation Irradiance <sup>[5]</sup>		GS:011, $\lambda_p = 460 \text{ nm}$ <sup>[2]</sup> (Blue Channel)		0.94		mW/cm <sup>2</sup>
		GS: 011, $\lambda_p = 542 \text{ nm}$ <sup>[3]</sup> (Green Channel)		0.78		
		GS: 011, $\lambda_p = 645 \text{ nm}$ <sup>[4]</sup> (Red Channel)		0.53		
Saturation Irradiance <sup>[5]</sup>		GS:010, $\lambda_p = 460 \text{ nm}$ <sup>[2]</sup> (Blue Channel)		1.18		mW/cm <sup>2</sup>
		GS:010, $\lambda_p = 542 \text{ nm}$ <sup>[3]</sup> (Green Channel)		0.94		
		GS:010, $\lambda_p = 645 \text{ nm}$ <sup>[4]</sup> (Red Channel)		0.71		
Saturation Irradiance <sup>[5]</sup>		GS:001, $\lambda_p = 460 \text{ nm}$ <sup>[2]</sup> (Blue Channel)		1.57		mW/cm <sup>2</sup>
		GS:001, $\lambda_p = 542 \text{ nm}$ <sup>[3]</sup> (Green Channel)		1.18		
		GS:001, $\lambda_p = 645 \text{ nm}$ <sup>[4]</sup> (Red Channel)		0.85		
Saturation Irradiance <sup>[5]</sup>		GS:000, $\lambda_p = 460 \text{ nm}$ <sup>[2]</sup> (Blue Channel)		2.35		mW/cm <sup>2</sup>
		GS:000, $\lambda_p = 542 \text{ nm}$ <sup>[3]</sup> (Green Channel)		1.57		
		GS:000, $\lambda_p = 645 \text{ nm}$ <sup>[4]</sup> (Red Channel)		1.34		
Output rise time	$t_r$	GS:000 to GS101 Test Condition: Refer to note <sup>[1]</sup> (min $V_o = 0V$ , peak $V_o = 2V$ )		45		$\mu s$
		GS:110 to GS:111 Test Condition: Refer to note <sup>[1]</sup> (min $V_o = 0V$ , peak $V_o = 2V$ )		220		$\mu s$
Output fall time	$t_f$	GS:000 to GS101 Test Condition: Refer to note <sup>[1]</sup> (min $V_o = 0V$ , peak $V_o = 2V$ )		50		$\mu s$
		GS:110 to GS:111 Test Condition: Refer to note <sup>[1]</sup> (min $V_o = 0V$ , peak $V_o = 2V$ )		240		$\mu s$

Notes:

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

Remarks: For illustration purpose, only red channel is shown. The same circuit applies to green and blue channel.

Gain Selection	Rext	Cext
GS:000 to GS:101	15k $\Omega$	1nF
GS:110 to GS:111	15k $\Omega$	6.8nF



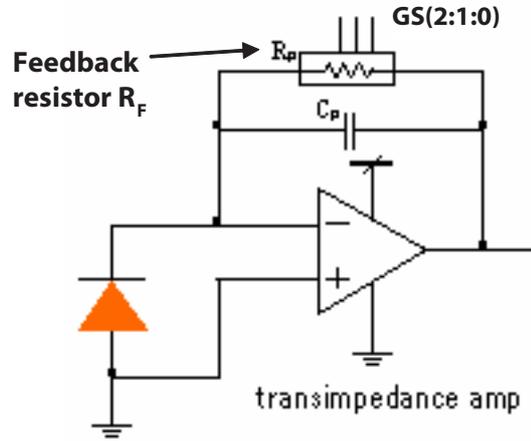
Test Circuit

### Gain Selection Feedback Resistor Table

GS: Bit 2	GS: Bit 1	Bit 0	Feedback Resistor, R <sub>F</sub>
0	0	0	1.9 MΩ
0	0	1	2.5 MΩ
0	1	0	3.2 MΩ
0	1	1	4.1 MΩ
1	0	0	5.3 MΩ
1	0	1	7 MΩ
1	1	0	9 MΩ
1	1	1	11.7 MΩ

Note:

1. Gains selections, GS: Bit 2 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

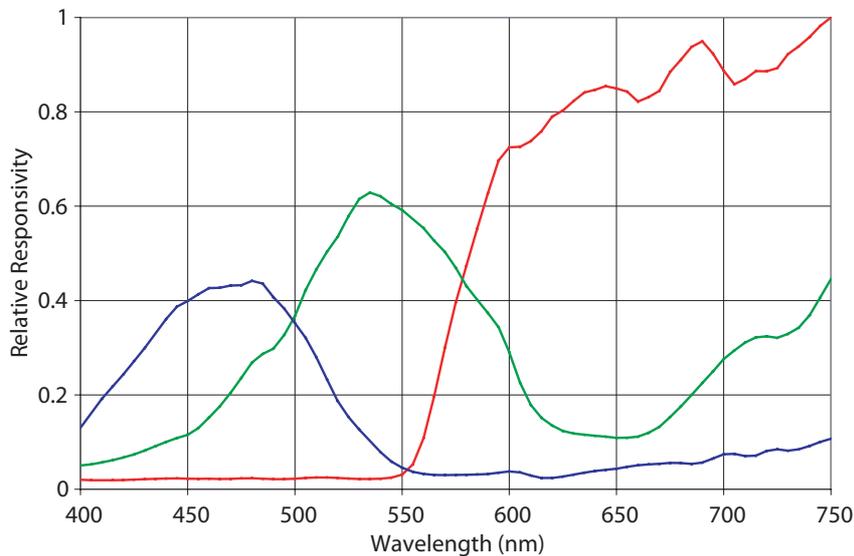


Figure 1. Spectral Responsivity

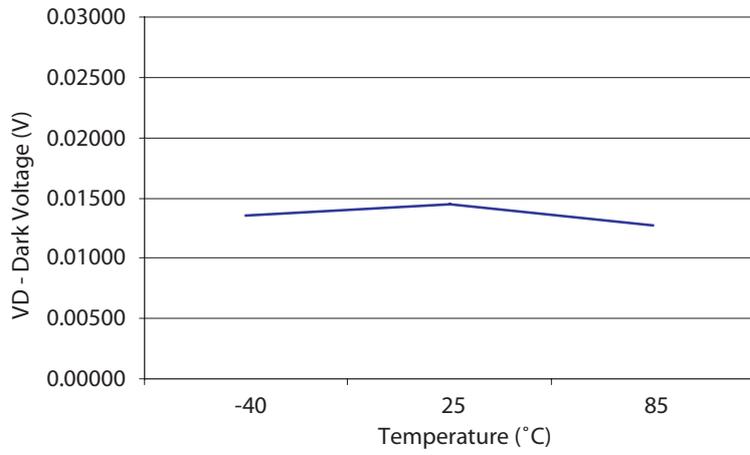
Note:

Test condition is when Gain Selection Jumpers are set to

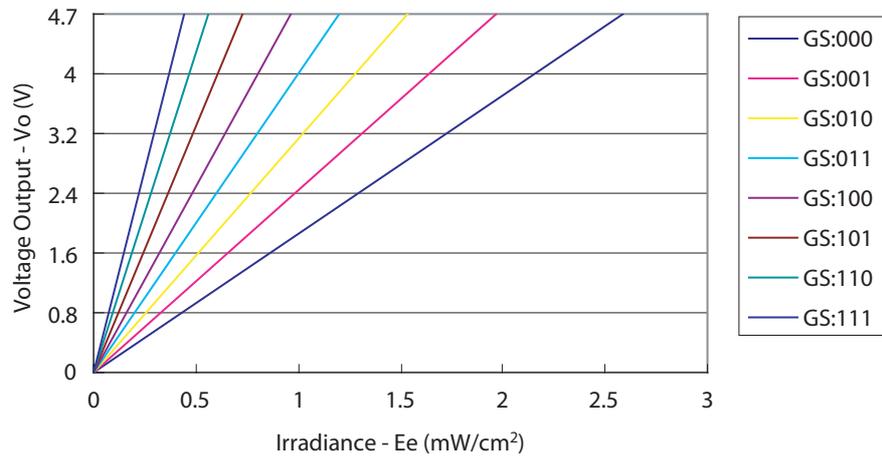
GSBLUE2=1      GSGRN2=1      GSRED2=1  
 GSBLUE1=1      GSGRN1=1      GSRED1=1  
 GSBLUE0=1      GSGRN0=1      GSRED0=1

in which 0=connect to Ground, 1=no connection.

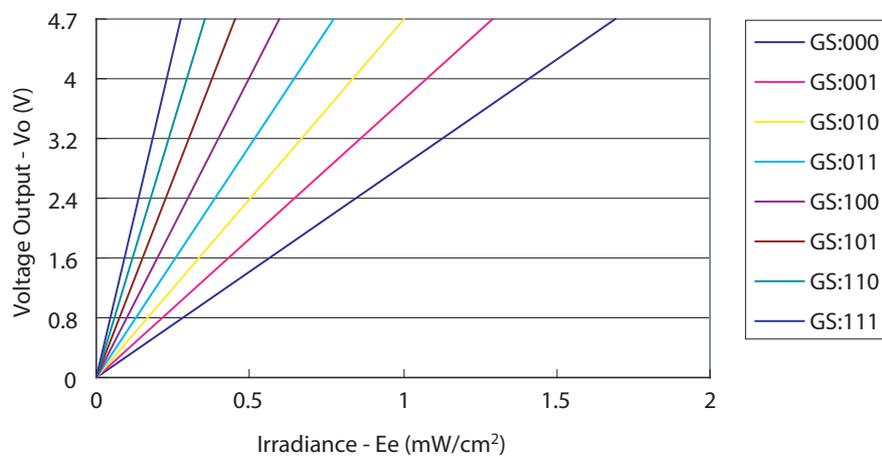
Refer to Gain Selection Feedback Resistor Table.



**Figure 2. Dark Voltage vs Operating Temperature**



**Figure 3. Voltage Output of Blue Channel vs Irradiance ( $I_p = 460$  nm)**



**Figure 4. Voltage Output of Green Channel vs Irradiance ( $I_p = 542$  nm)**

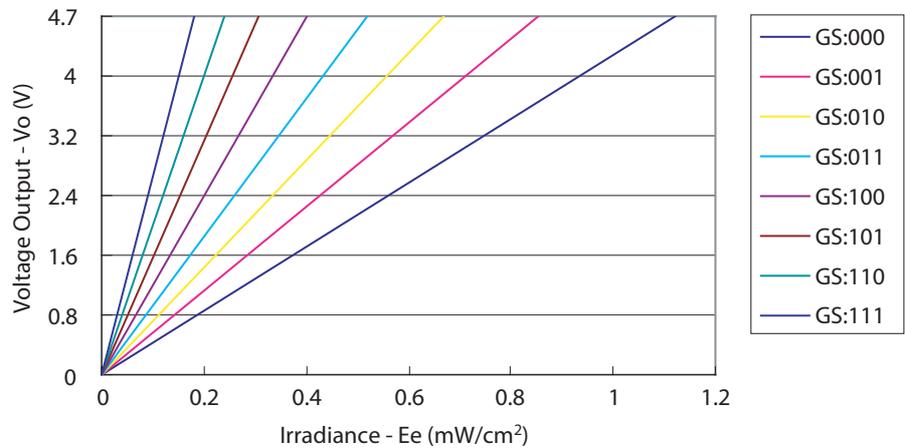


Figure 5. Voltage Output of Red Channel vs Irradiance ( $I_p = 645 \text{ nm}$ )

### Recommended Reflow Profile

It is recommended that Henkel Pb-free solder paste LF310 be used for soldering ADJD- E622-QR999. Below is the recommended reflow profile.

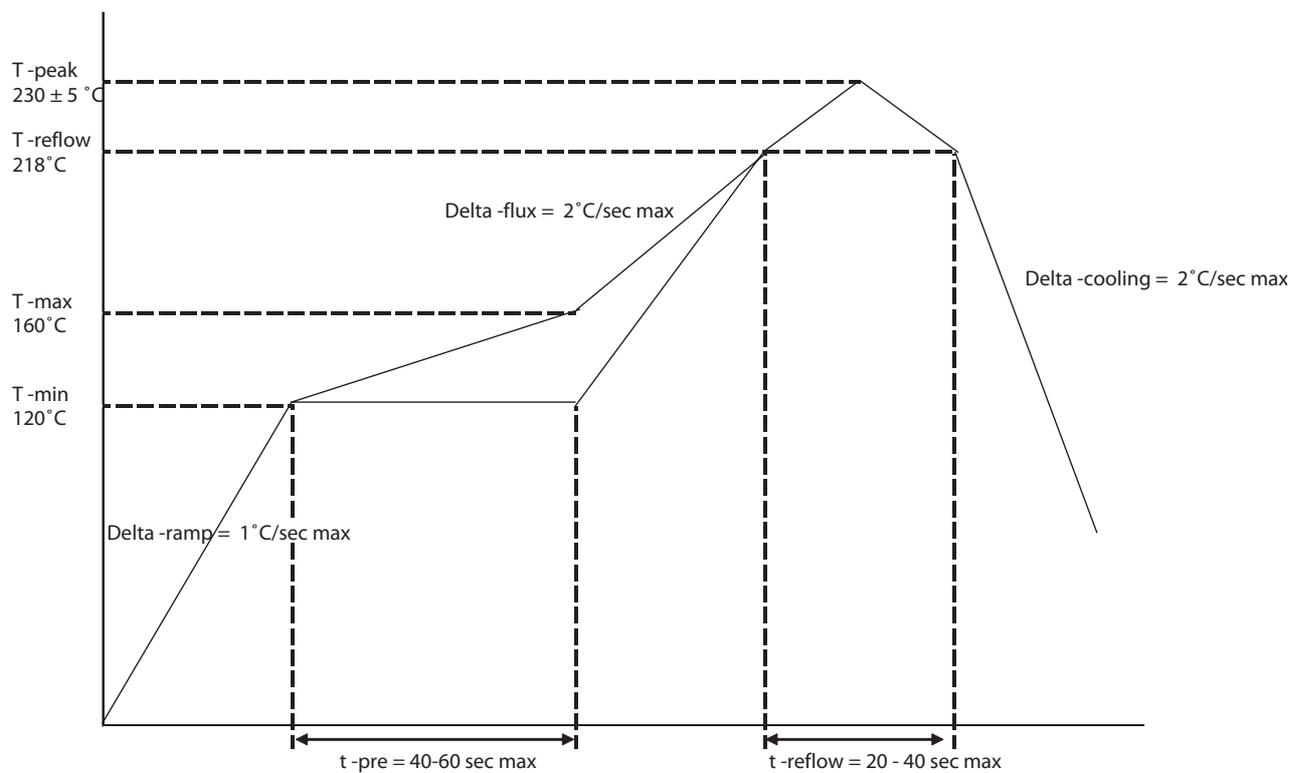


Figure 6. Recommended Reflow Soldering Profile

## 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.

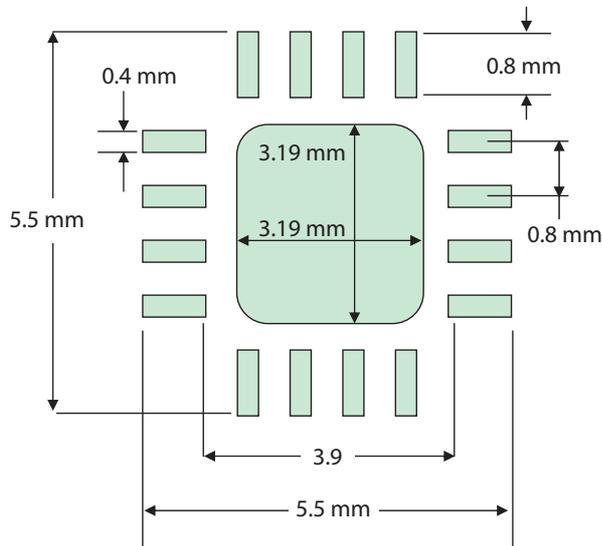


Figure 7.

## 16 Lead QFN Recommended Stencil Design

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

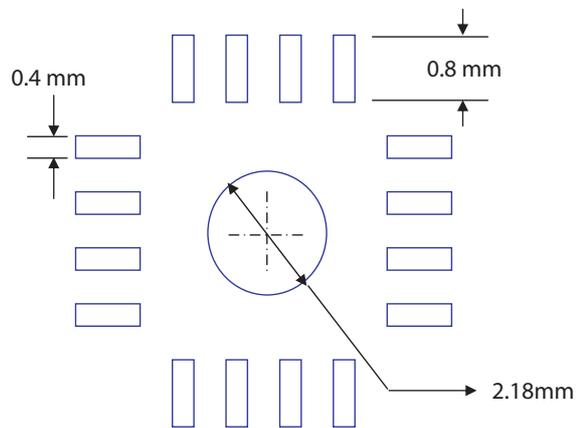


Figure 8.

## Recommendations for Handling and Storage of ADJD E622 QR999

This product is qualified as Moisture Sensitive Level 3 per Jecdec 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 168hrs

### 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

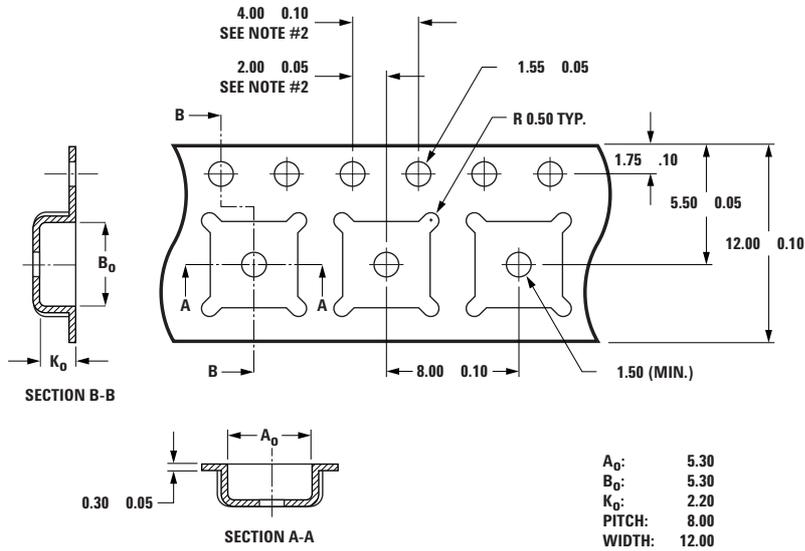
- If the PCB soldered with the components is to be subjected to other high temperature processes, the PCB need to be stored in sealed MBB with desiccant or desiccator at <5%RH to ensure no components have exceeded their floor life of 168hrs

### 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 168hrs
- Recommended baking condition (in component form): 125°C for 24hrs

## Package Tape and Reel Dimensions

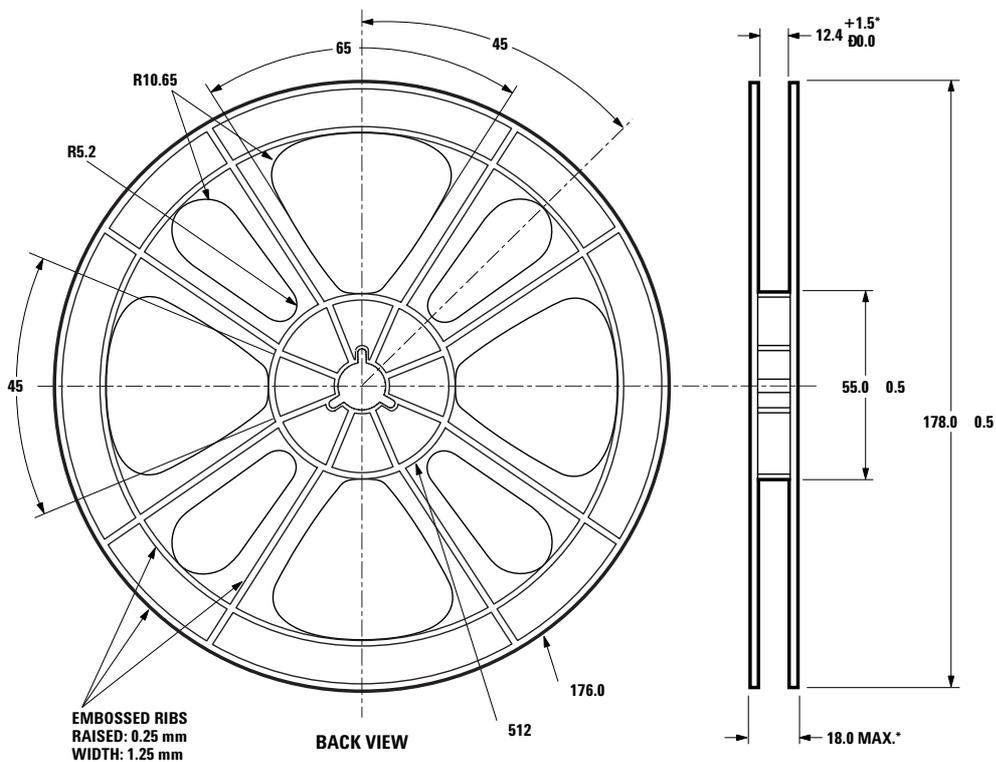
### Carrier Tape Dimensions



#### 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.

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

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