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 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 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.

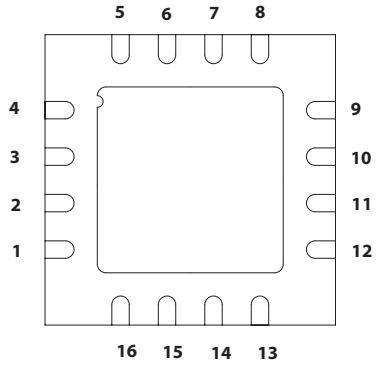
Applications

- 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

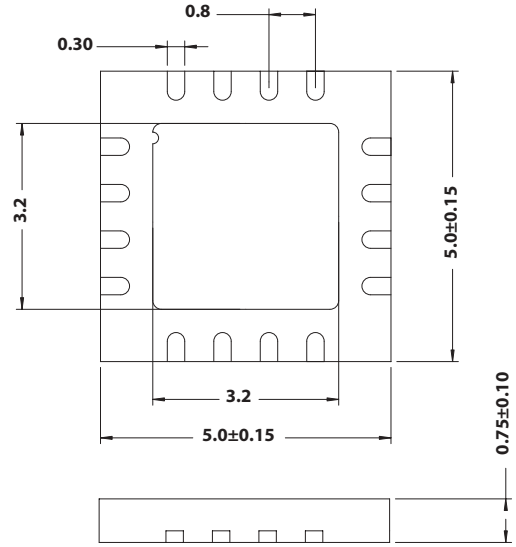
Features

- 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

Package Dimension



Bottom View



Note: Dimensions are in millimeters (mm)

Part Numbering System

ADJD-E 6 X X -X X X X X

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)

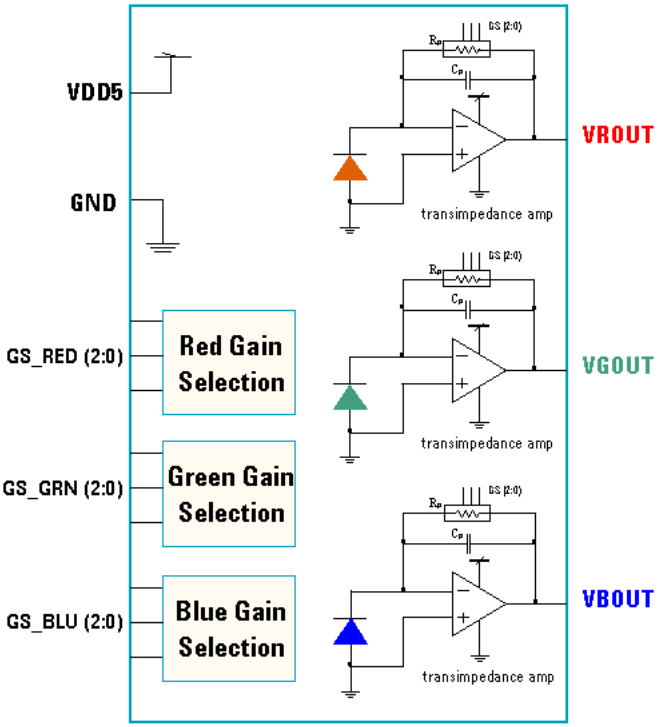
Theory of Operation

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 transimpedence amplifiers for R,G,B components then converts 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_{OUT}	Analog output voltage for BLUE
Pin 2	VG_{OUT}	Analog output voltage for GREEN
Pin 3	VR_{OUT}	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	GSBLUE 2	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

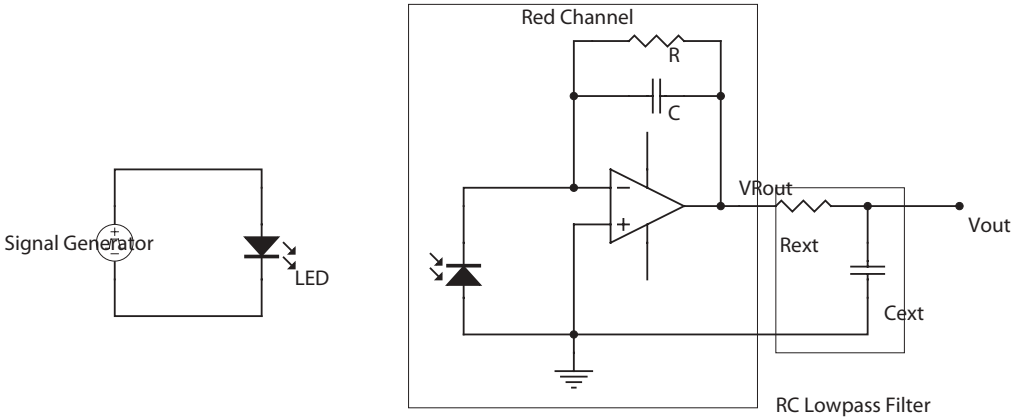
Recommended Operating Conditions

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	Rext	Cext
GS:000 to GS:101	15kΩ	1nF
GS:110 to GS:111	15kΩ	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°C, RL = 68kΩ

Parameter	Sym.	Remark	Min.	Typ.	Max.	Unit
Dark voltage	V_D	Ee = 0			20	mV
Max. output voltage swing	V_{OMAX}			4.7		V
Supply current	I_{DD}	Ee = 0		2.4		mA
Irradiance Responsivity	Re	GS:111, λ_P = 460 nm [2] (Blue Channel)		12		V/(mW/cm²)
		GS:111, λ_P = 542 nm [3] (Green Channel)		18		
		GS:111, λ_P = 645 nm [4] (Red Channel)		26		
Irradiance Responsivity	Re	GS:110, λ_P = 460 nm [2] (Blue Channel)		10		V/(mW/cm²)
		GS:110, λ_P = 542 nm [3] (Green Channel)		14		
		GS:110, λ_P = 645 nm [4] (Red Channel)		20		
Irradiance Responsivity	Re	GS:101, λ_P = 460 nm [2] (Blue Channel)		7		V/(mW/cm²)
		GS:101, λ_P = 542 nm [3] (Green Channel)		11		
		GS:101, λ_P = 645 nm [4] (Red Channel)		16		
Irradiance Responsivity	Re	GS:100, λ_P = 460 nm [2] (Blue Channel)		6		V/(mW/cm²)
		GS:100, λ_P = 542 nm [3] (Green Channel)		8		
		GS:100, λ_P = 645 nm [4] (Red Channel)		12		
Irradiance Responsivity	Re	GS:011, λ_P = 460 nm [2] (Blue Channel)		5		V/(mW/cm²)
		GS:011, λ_P = 542 nm [3] (Green Channel)		6		
		GS:011, λ_P = 645 nm [4] (Red Channel)		9		
Irradiance Responsivity	Re	GS:010, λ_P = 460 nm [2] (Blue Channel)		4		V/(mW/cm²)
		GS:010, λ_P = 542 nm [3] (Green Channel)		5		
		GS:010, λ_P = 645 nm [4] (Red Channel)		7		
Irradiance Responsivity	Re	GS:001, λ_P = 460 nm [2] (Blue Channel)		3		V/(mW/cm²)
		GS:001, λ_P = 542 nm [3] (Green Channel)		4		
		GS:001, λ_P = 645 nm [4] (Red Channel)		6		
Irradiance Responsivity	Re	GS:000, λ_P = 460 nm [2] (Blue Channel)		2		V/(mW/cm²)
		GS:000, λ_P = 542 nm [3] (Green Channel)		3		
		GS:000, λ_P = 645 nm [4] (Red Channel)		4		
Saturation Irradiance [5]		GS:111, λ_P = 460 nm [2] (Blue Channel)		0.39		mW/cm²
		GS:111, λ_P = 542 nm [3] (Green Channel)		0.26		
		GS:111, λ_P = 645 nm [4] (Red Channel)		0.18		
Saturation Irradiance [5]		GS:110, λ_P = 460 nm [2] (Blue Channel)		0.47		mW/cm²
		GS:110, λ_P = 542 nm [3] (Green Channel)		0.34		
		GS:110, λ_P = 645 nm [4] (Red Channel)		0.23		

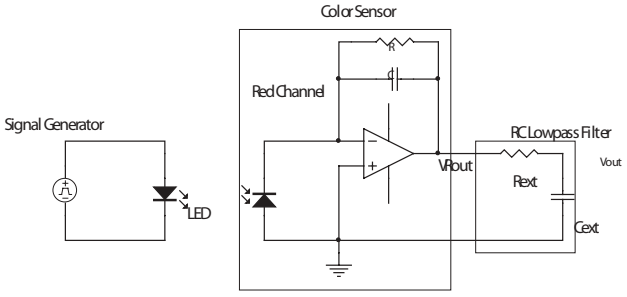
Parameter	Sym.	Remark	Min.	Typ.	Max.	Unit
Saturation Irradiance [5]		GS:101, λ_P = 460 nm [2] (Blue Channel)		0.67		mW/cm2
		GS:101, λ_P = 542 nm [3] (Green Channel)		0.43		
		GS:101, λ_P = 645 nm [4] (Red Channel)		0.29		
Saturation Irradiance [5]		GS:100, λ_P = 460 nm [2] (Blue Channel)		0.78		mW/cm2
		GS:100, λ_P = 542 nm [3] (Green Channel)		0.59		
		GS:100, λ_P = 645 nm [4] (Red Channel)		0.40		
Saturation Irradiance [5]		GS:011, λ_P = 460 nm [2] (Blue Channel)		0.94		mW/cm2
		GS: 011, λ_P = 542 nm [3] (Green Channel)		0.78		
		GS: 011, λ_P = 645 nm [4] (Red Channel)		0.53		
Saturation Irradiance [5]		GS:010, λ_P = 460 nm [2] (Blue Channel)		1.18		mW/cm2
		GS:010, λ_P = 542 nm [3] (Green Channel)		0.94		
		GS:010, λ_P = 645 nm [4] (Red Channel)		0.71		
Saturation Irradiance [5]		GS:001, λ_P = 460 nm [2] (Blue Channel)		1.57		mW/cm2
		GS:001, λ_P = 542 nm [3] (Green Channel)		1.18		
		GS:001, λ_P = 645 nm [4] (Red Channel)		0.85		
Saturation Irradiance [5]		GS:000, λ_P = 460 nm [2] (Blue Channel)		2.35		mW/cm2
		GS:000, λ_P = 542 nm [3] (Green Channel)		1.57		
		GS:000, λ_P = 645 nm [4] (Red Channel)		1.34		
Output rise time	t_r	GS:000 to GS101 Test Condition: Refer to note [1]		45		µs
		GS:110 to GS:111 Test Condition: Refer to note [1]		220		µs
Output fall time	t_f	GS:000 to GS101 Test Condition: Refer to note [1]		50		µs
		GS:110 to GS:111 Test Condition: Refer to note [1]		240		µs

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 (λ_P) 460nm and spectral half width ($\Delta\lambda$½) 25nm as light source.
3. Test condition: using green diffuse light of peak wavelength (λ_P) 542nm and spectral half width ($\Delta\lambda$½) 35nm as light source.
4. Test condition: using red diffuse light of peak wavelength (λ_P) 645nm and spectral half width ($\Delta\lambda$½) 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	15kΩ	1nF
GS:110 to GS:111	15kΩ	6.8nF



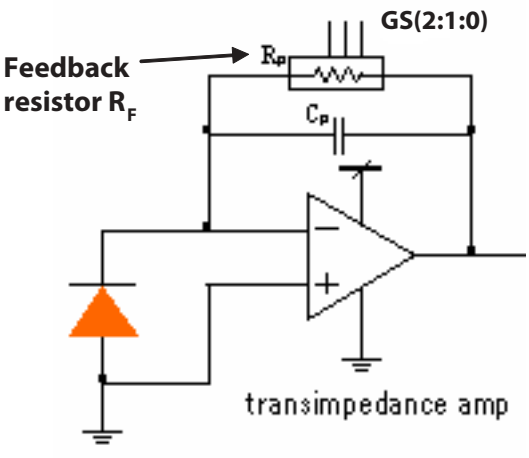
Test Circuit

Gain Selection Feedback Resistor Table

GS: Bit 2	GS: Bit 1	Bit 0	Feedback Resistor, RF
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

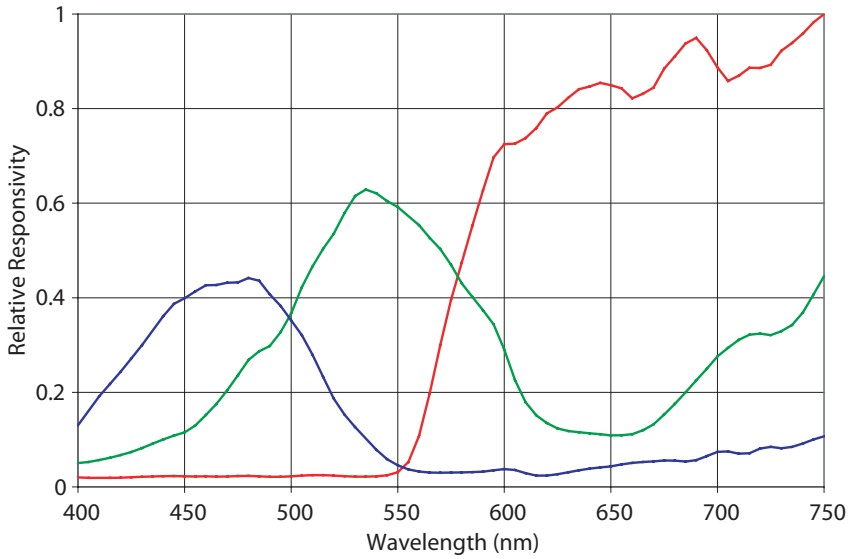


Figure 1. Spectral Responsivity

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.

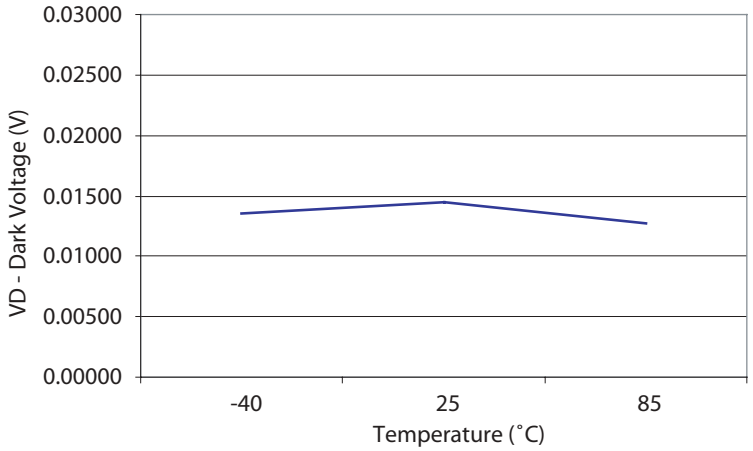


Figure 2. Dark Voltage vs Operating Temperature

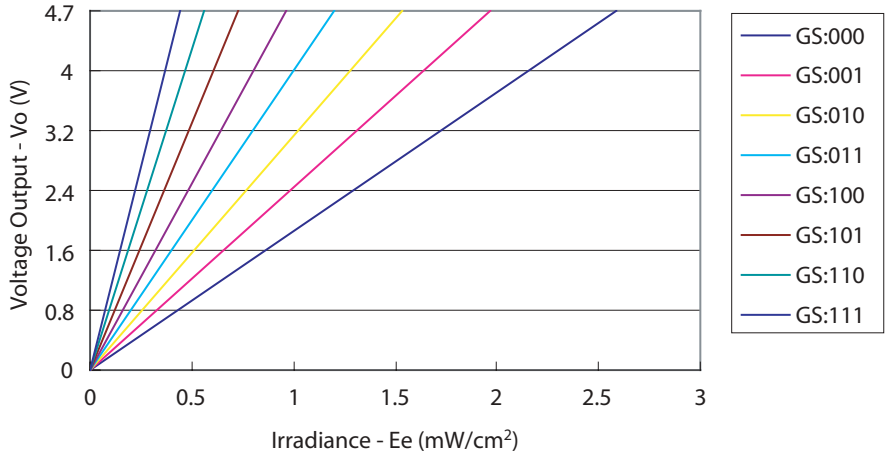


Figure 3. Voltage Output of Blue Channel vs Irradiance (lp = 460 nm)

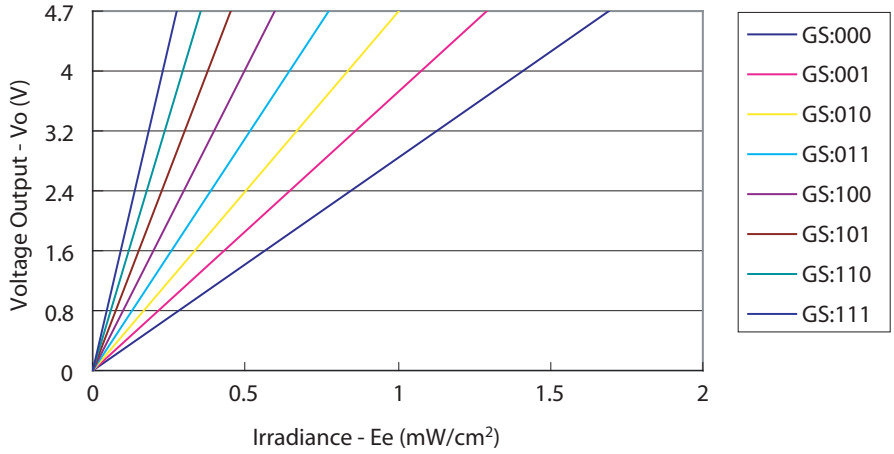


Figure 4. Voltage Output of Green Channel vs Irradiance (lp = 542 nm)

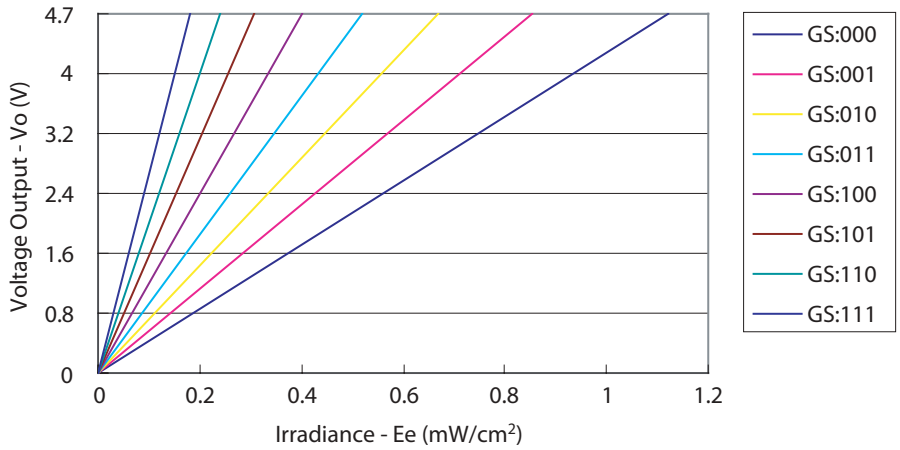


Figure 5. Voltage Output of Red Channel vs Irradiance (lp = 645 nm)

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.

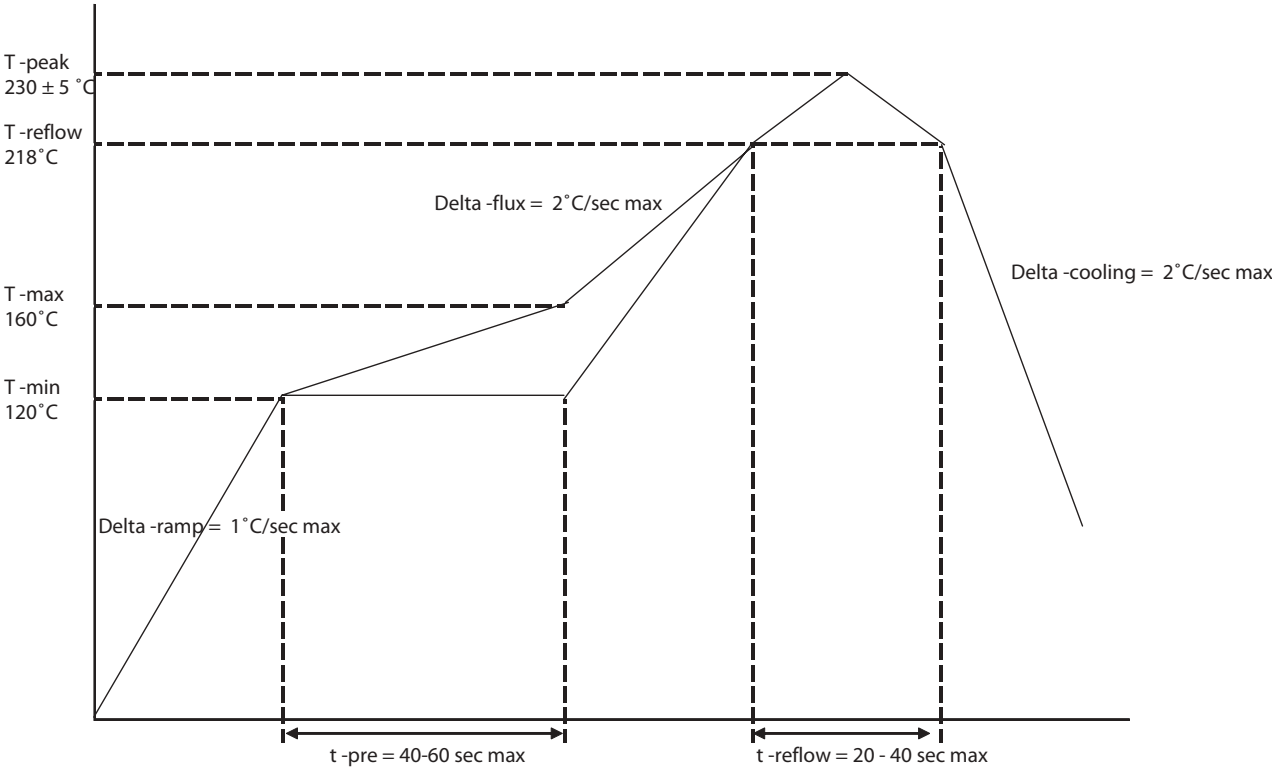


Figure 6. Recommended Reflow Soldering Profile

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.

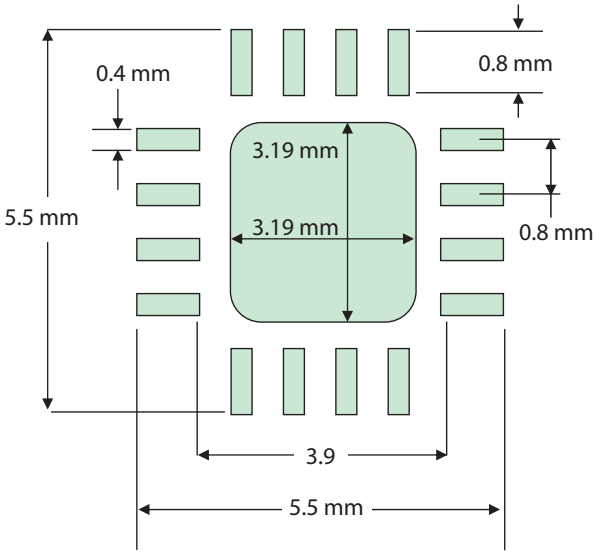


Figure 7.

16 Lead QFN Recommended Stencil Design

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

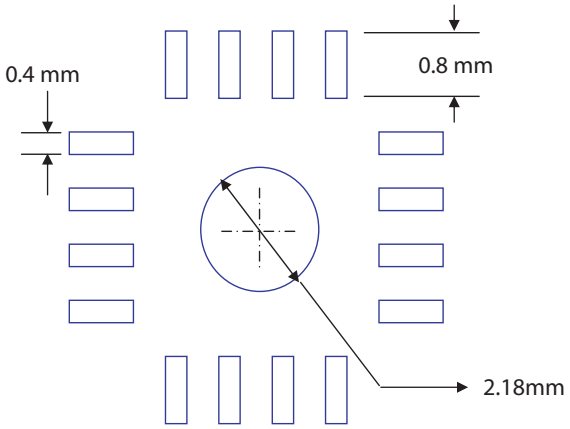


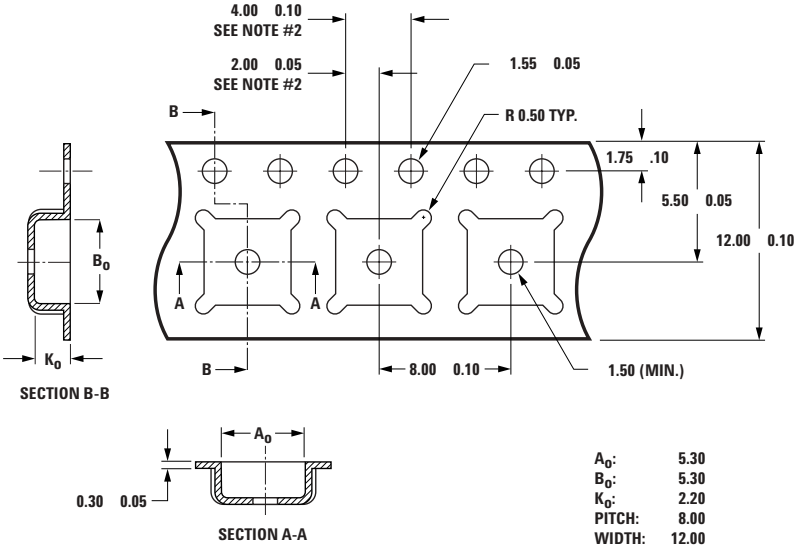
Figure 8.

Recommendations for Handling and Storage of ADJD E622 QR999

- The device is with moisture sensitivity level 3
- Before Opening the MBB (Moisture Barrier Bag)
  - The sensor component must be kept sealed in a MBB (Moisture Barrier Bag) stored at 30°C and 70%RH or less at all times.
- After Opening the MBB (Moisture Barrier Bag)
  - The sensor component must be kept at 30°C and 60%RH or less
  - The sensor component should have a MET (Manufacturing Exposure Time) of </= 168hrs hours starting from the time of removal from the MBB to the soldering oven.
  - If unused sensor component remain, it is recommended to store them back to the MBB.
  - If the indicator card has turned from blue to pink or it has exceeded the recommended MET (Manufacturing Exposure Time) of </= 168hrs, baking treatment should be performed using the following conditions before continue to IR reflow soldering.
  - Baking treatment: 24 hours at 125°C

Package Tape and Reel Dimensions

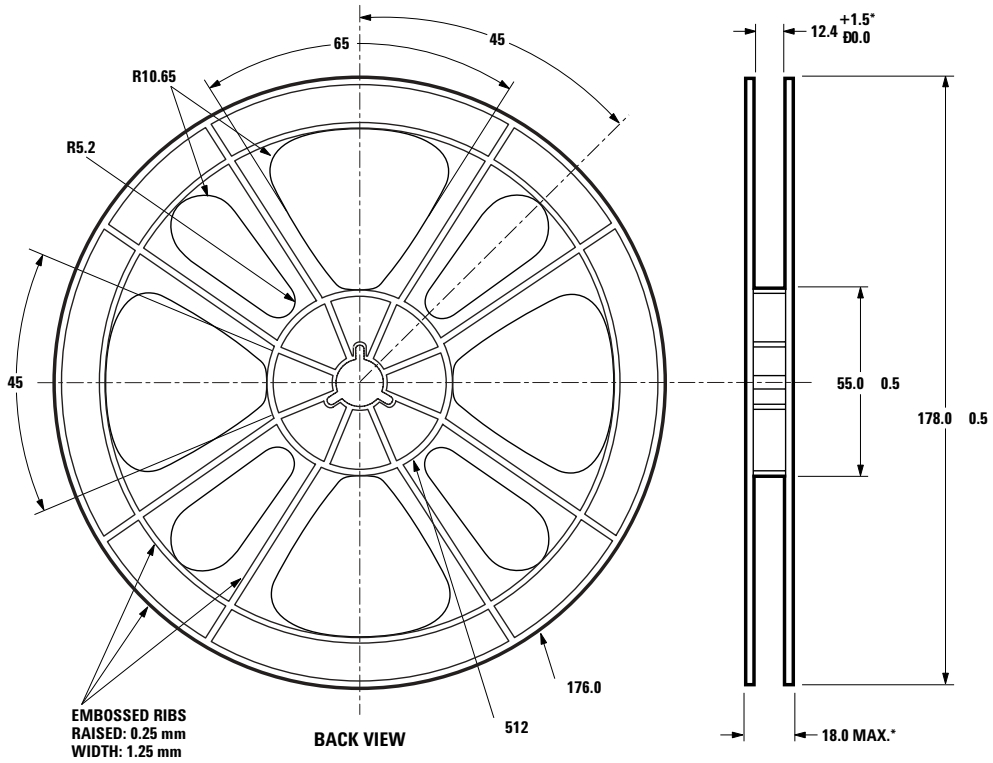
Carrier Tape Dimensions



A_0:	5.30
B_0:	5.30
K_0:	2.20
PITCH:	8.00
WIDTH:	12.00

NOTES:
1. A_0 AND B_0 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.

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

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