TLK4211EA

4.25 Gbps Cable and PC Board Equalizer

FEATURES

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- Multi-Rate Operation Up To 4.25 Gbps
- Compensates Up To 12 dB Loss At 2.1 GHz
- Suitable To Receive 4.25-Gbps Data Over Up To 30 Inches (0.76 Meters) Of FR4 PC Boards
- Suitable To Receive 4.25-Gbps Data Over Up To 30 Feet (9,1 Meters) Of CX4 Cable
- **Ultra-Low Power Consumption**
- Input Offset Cancellation
- High Input Dynamic Range
- **Output Disable**
- **Output Polarity Select**
- **CML** Data Outputs
- Single 3.3-V Supply
- Surface Mount Small Footprint 3 mm × 3 mm 16-Pin QFN Package

DESCRIPTION

The TLK4211EA is a versatile high-speed limiting equalizer for applications in digital high-speed links with data rates up to 4.25 Gbps.

This device provides a high frequency boost of 12 dB at 2.1 GHz as well as sufficient gain to ensure a fully differential output swing for input signals as low as 200 mVp-p (at the input of the interconnect line).

The high input signal dynamic range ensures low jitter output signals even when overdriven with input signal swings as high as 2000 mVp-p.

The TLK4211EA is available in a small footprint 3 mm × 3 mm 16-pin QFN package. It requires a single 3.3-V supply.

This power efficient equalizer is characterized for operation from -40°C to 85°C.



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APPLICATIONS

- 1.0625 Gbps, 2.125 Gbps, and 4.25 Gbps Fibre **Channel Systems**
- High Speed Links In Communication and Data Systems
- **Backplane Interconnect**
- **Rack-to-Rack Interconnect**





BLOCK DIAGRAM

A simplified block diagram of the TLK4211EA is shown in Figure 1.

This compact, low-power 4.25-Gbps equalizer consists of a high-speed data path with offset cancellation circuitry, a bandgap voltage reference, and bias current generation block.

The equalizer requires a single 3.3-V supply voltage. All circuit parts are described in detail in below.

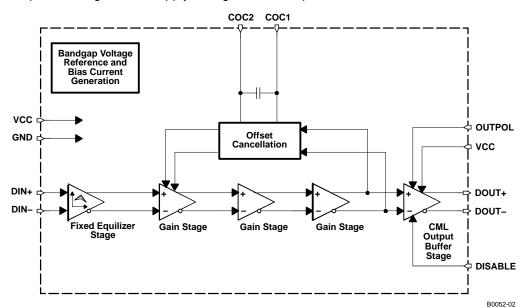


Figure 1. Simplified Block Diagram of the TLK4211EA

HIGH-SPEED DATA PATH

The high-speed data signal with frequency dependent loss is applied to the data path by means of the input signal pins DIN+/DIN-. The data path consists of the fixed equalizer input stage with 100- Ω differential on-chip line termination, three gain stages, which provide the required gain to ensure a limited output signal, and a CML output stage. The equalized and amplified data output signal is available at the output pins DOUT+/DOUT-, which provide 2 × 50- Ω back-termination to VCC. The output stage also includes a data polarity switching function, which is controlled by the OUTPOL input, and a disable function controlled by the signal applied to the DISABLE input pin.

An offset cancellation compensates inevitable internal offset voltages and thus ensures proper operation even for small input data signals.

The low frequency cutoff is as low as 10 kHz with the built-in filter capacitor.

For applications which require even lower cutoff frequencies, an additional external filter capacitor may be connected to the COC1/COC2 pins.

BANDGAP VOLTAGE AND BIAS GENERATION

The TLK4211EA equalizer is supplied by a single 3.3-V \pm 10% supply voltage connected to the VCC pins. This voltage is referred to ground (GND).

An on-chip bandgap voltage circuitry generates a supply voltage independent reference from which all other internally required voltages and bias currents are derived.

PACKAGE

The TLK4211EA is available in a small footprint 3 mm \times 3 mm, 16-pin QFN package with a lead pitch of 0,5 mm. The pin out is shown below in Figure 2.

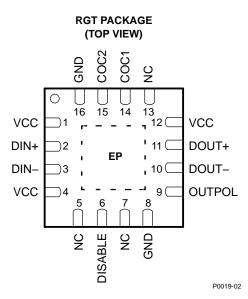


Figure 2. Pin Out of TLK4211EA in a 3 mm \times 3 mm 16-Pin QFN Package

TERMINAL		ТҮРЕ	DESCRIPTION					
NAME	NO.	ITPE	DESCRIPTION					
VCC	1, 4 , 12	Supply	3.3-V ±10% supply voltage					
DIN+	2	Analog in	Non-inverted data input. On-chip 100-Ω terminated to DIN-					
DIN-	3	Analog in	Inverted data input. On-chip 100- Ω terminated to DIN+					
NC	5, 7, 13		Not connected					
DISABLE	6	CMOS in	Disables CML output stage when set to high level					
GND	8, 16	Supply	Circuit ground.					
OUTPOL	9	CMOS in	Output data signal polarity select (internally pulled up): Setting to high-level or leaving pin open selects normal polarity. Low-level selects inverted polarity.					
DOUT-	10	CML out	Inverted data output. On-chip 50- Ω back-terminated to VCC.					
DOUT+	11	CML out	Non-inverted data output. On-chip 50- Ω back-terminated to VCC.					
COC1	14	Analog	Offset cancellation filter capacitor terminal 1. Connect an additional filter capacitor between this pin and COC2 (pin 15). To disable the offset cancellation loop connect COC1 and COC2 (pins 14 and 15).					
COC2	15	Analog	Offset cancellation filter capacitor terminal 2. Connect an additional filter capacitor between this pin and COC1 (pin 14). To disable the offset cancellation loop connect COC1 and COC2 (pins 14 and 15).					
EP	EP		Exposed die pad (EP) must be grounded.					

TERMINAL FUNCTIONS

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

		VALUE / UNIT
V _{CC}	Supply voltage ⁽²⁾	–0.3 V to 4 V
V _{DIN+} , V _{DIN-}	Voltage at DIN+, DIN- ⁽²⁾	0.5 V to 4 V
V _{DISABLE} , V _{OUTPOL} , V _{DOUT+} , V _{DOUT-} , V _{COC1} , V _{COC2}	Voltage at DISABLE, OUTPOL, DOUT+, DOUT-, COC1, COC2 ⁽²⁾	–0.3 V to 4 V
V _{COC,DIFF}	Differential voltage between COC1 and COC2	±1 V
V _{DIN,DIFF}	Differential voltage between DIN+ and DIN-	±2.5 V
I _{DIN+} , I _{DIN-} , I _{DOUT+} , I _{DOUT-}	Continuous current at inputs and outputs	– 25 mA to 25 mA
ESD	ESD rating at all pins	2.5 kV (HBM)
T _{J(max)}	Maximum junction temperature	125°C
T _{STG}	Storage temperature range	–65°C to 85°C
T _A	Characterized free-air operating temperature range	-40°C to 85°C
TL	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute–maximum–rated conditions for extended periods may affect device reliability.

(2) All voltage values are with respect to network ground terminal.

RECOMMENDED OPERATING CONDITIONS

		MIN	NOM	MAX	UNIT
V _{CC}	Supply voltage	3	3.3	3.6	V
T _A	Operating free-air temperature	-40		85	°C
	CMOS input high voltage	2.1			V
	CMOS input low voltage			0.6	V

DC ELECTRICAL CHARACTERISTICS

over recommended operating conditions, typical operating condition is at V_{CC} = 3.3 V and T_A = 25°C(unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{CC}	Supply voltage		3	3.3	3.6	V
I _{CC}	Supply current	DISABLE = low, including CML output current		30	38	mA
R _{IN}	Data input resistance	Differential		100		Ω
R _{OUT}	Data output resistance	Single-ended to VCC		50		Ω

AC ELECTRICAL CHARACTERISTICS

over recommended operating conditions, typical operating condition is at V_{CC} = 3.3 V and T_A = 25°C (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Low frequency –3 dB	C _{OC} = open		10	50	kHz
	bandwidth	$C_{OC} = 0.22 \ \mu F$		0.8		KIIZ
	Data rate		4.25			Gbps
V _{IN,MIN}	Data input sensitivity ⁽¹⁾	BER < 10^{-12} , voltage at the input of the interconnect line		200	250	mV _{p-p}
V _{IN,MAX}	Data input overload	Voltage at the input of the interconnect line	2000			mV _{p-p}
	High frequency boost	f = 2.1 GHz		12		dB
V	Differential data output voltage swing	DISABLE = high		0.25 10		
V _{OD}		DISABLE = low	580	780	1200	mV _{p-p}

(1) The given differential input signal swing is measured at the input of the interconnect line. The high frequency components of the signal at the output of the interconnect line (which is connected the input pins DIN+/DIN- of the TLK4211EA) may be attenuated by 0 dB up to 12 dB at 2.1 GHz dependent of the interconnect line length.

AC ELECTRICAL CHARACTERISTICS (continued)

over recommended operating conditions, typical operating condition is at $V_{CC} = 3.3$ V and $T_A = 25^{\circ}C$ (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN TYP	MAX	UNIT
		No board or cable	20		
	Deterministic jitter,	12 inches of 7 mils wide microstrip interconnect line on standard FR4	30		
	4.25 Gbps, K28.5 pattern, V _{IN} = 200 mVpp (differential voltage at the	24 inches of 7 mils wide microstrip interconnect line on standard FR4	30		ps _{p-p}
DJ	cable input)	36 inches of 7 mils wide microstrip interconnect line on standard FR4			
		30 feet CX4 cable	20		
	Deterministic jitter,	No board or cable	20		
	3.3 Gbps, K28.5 pattern, V _{IN} = 200 mVpp (differential voltage at the	46 inches of 7 mills wide microstrip interconnect line on standard EP4			ps _{p-p}
	cable input)	30 feet CX4 cable	20		
RJ	Random jitter	Input = 200 mV _{p-p} , 36 inches of 7 mils wide stripline interconnect line on standard FR4 (voltage at the input of the interconnect line)	4.5		ps _{RMS}
	Latency	From DIN± to DOUT±	250		ps
t _r	Output rise time	20% to 80%, without microstrip line loss at input	55	85	ps
t _f	Output fall time	20% to 80%, without microstrip line loss at input	55	85	ps
T _{DIS}	Disable response time		20		ns

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APPLICATION INFORMATION

Figure 3 shows the TLK4211EA connected with an ac-coupled interface to the data signal source via a microstrip interconnect line. The output load is ac-coupled as well.

The ac coupling capacitors C_1 through C_4 in the input and output data signal lines are the only required external components. In addition, if a low cutoff frequency is required, as an option, an external filter capacitor C_{OC} may be used.

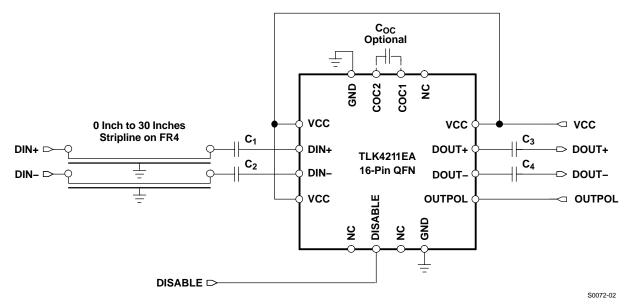


Figure 3. Basic Application Circuit With AC Coupled I/Os



TYPICAL CHARACTERISTICS

Typical operating condition is at V_{CC} = 3.3 V and T_A = 25°C (unless otherwise noted).

DIFFERENTIAL EQUALIZER INPUT SIGNAL (TOP) AND OUTPUT SIGNAL (BOTTOM) AT 4.25 GBPS USING A K28.5 PATTERN

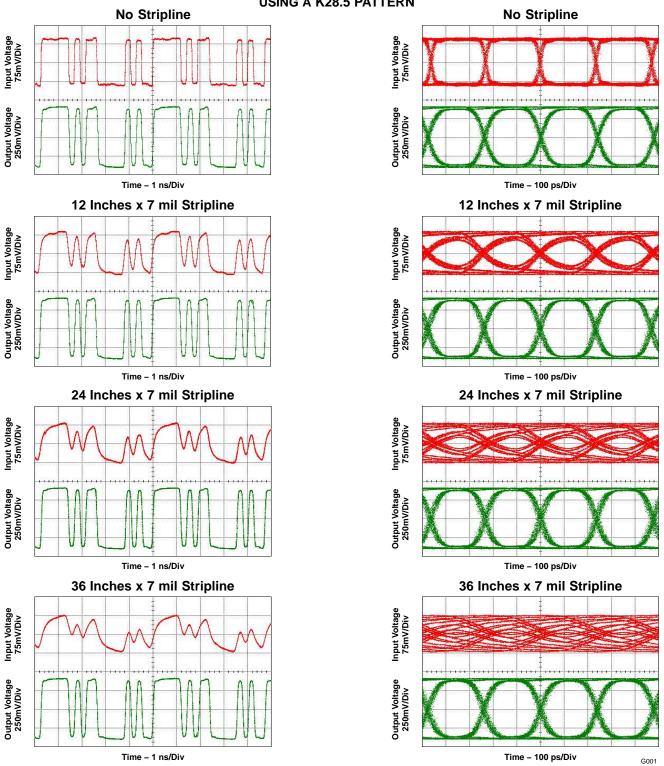


Figure 4. Equalizer Input and Output Signals With Different Interconnect Lines Patterns



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TYPICAL CHARACTERISTICS (continued)

Typical operating condition is at V_{CC} = 3.3 V and T_A = 25°C (unless otherwise noted).

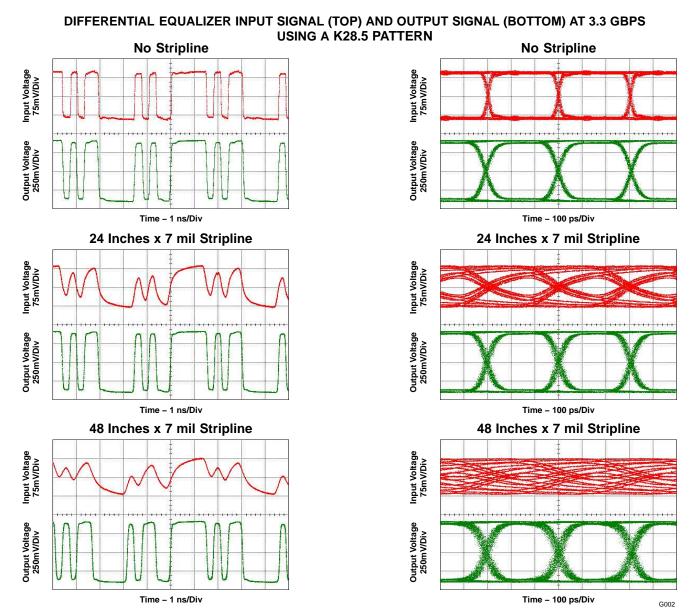
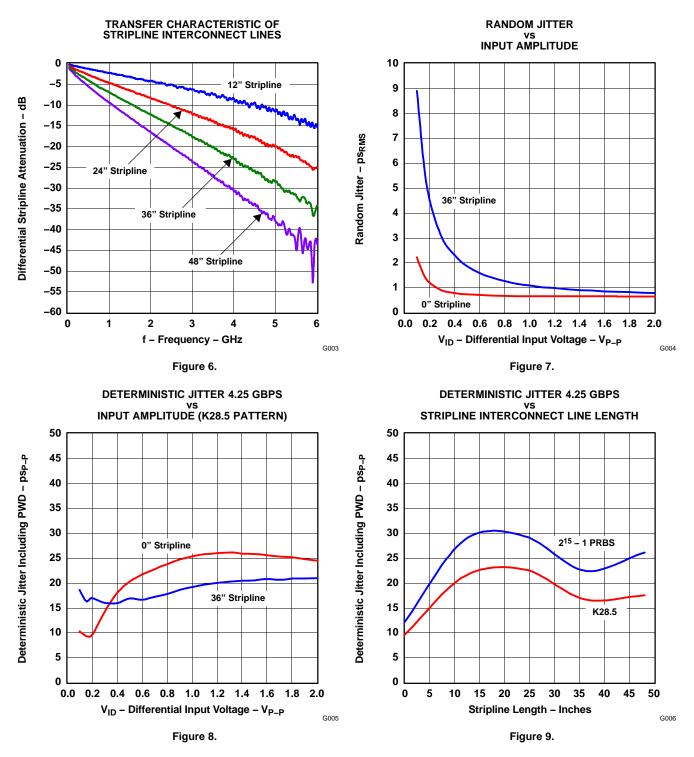


Figure 5. Equalizer Input and Output Signals With Different Interconnect Lines and Data



TYPICAL CHARACTERISTICS (continued)

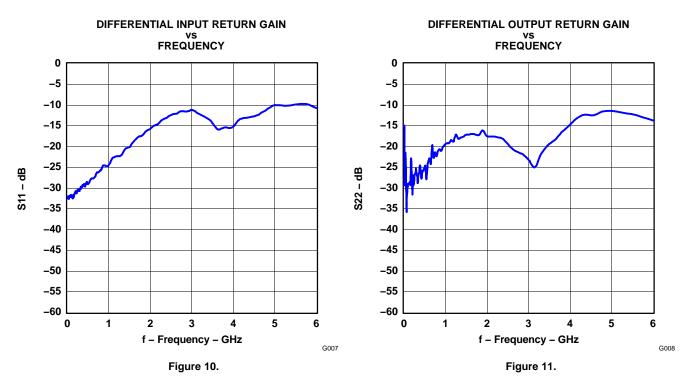
Typical operating condition is at V_{CC} = 3.3 V and T_A = 25°C (unless otherwise noted).





TYPICAL CHARACTERISTICS (continued)

Typical operating condition is at V_{CC} = 3.3 V and T_{A} = 25°C (unless otherwise noted).



PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	e Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TLK4211EARGTR	NRND	QFN	RGT	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
TLK4211EARGTRG4	NRND	QFN	RGT	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
TLK4211EARGTT	NRND	QFN	RGT	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
TLK4211EARGTTG4	NRND	QFN	RGT	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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PACKAGE MATERIALS INFORMATION

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TAPE AND REEL INFORMATION

REEL DIMENSIONS

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TAPE AND REEL INFORMATION

TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

*All dimensions are nominal												
Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLK4211EARGTR	QFN	RGT	16	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TLK4211EARGTT	QFN	RGT	16	250	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2

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PACKAGE MATERIALS INFORMATION

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*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLK4211EARGTR	QFN	RGT	16	3000	338.1	338.1	20.6
TLK4211EARGTT	QFN	RGT	16	250	338.1	338.1	20.6

MECHANICAL DATA



- Quad Flatpack, No-leads (QFN) package configuration. C. D.
- The package thermal pad must be soldered to the board for thermal and mechanical performance. E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
- F. Falls within JEDEC MO-220.



RGT (S-PVQFN-N16)

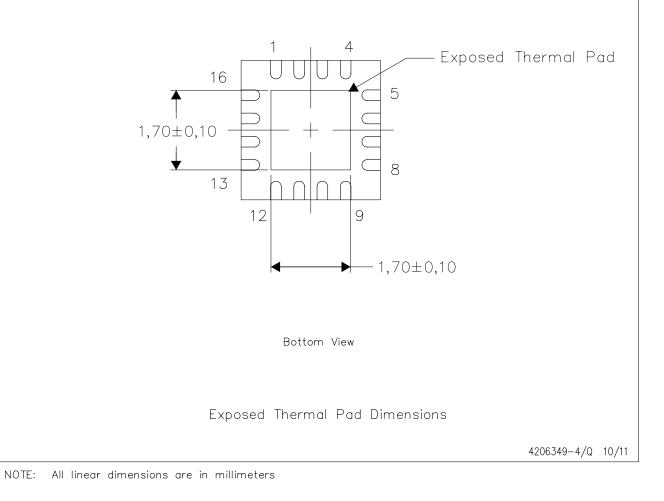
PLASTIC QUAD FLATPACK NO-LEAD

THERMAL INFORMATION

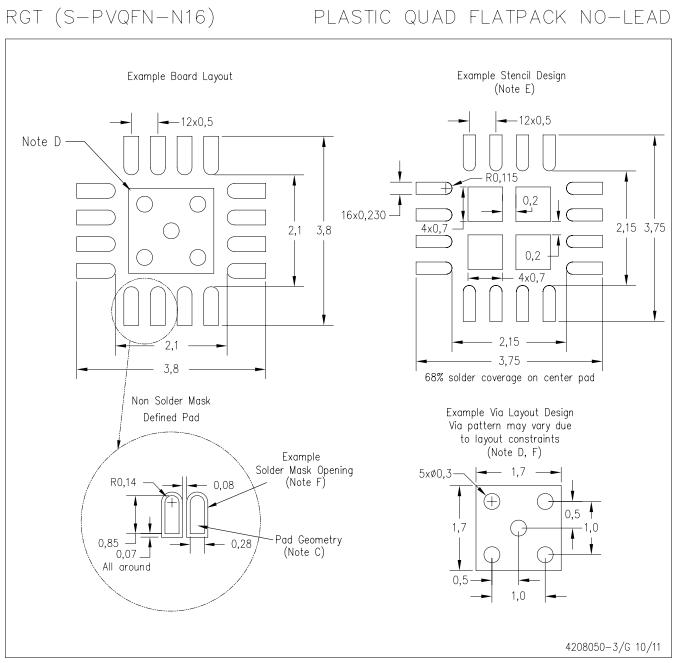
This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.







- NOTES: A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>.
 - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
 - F. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.



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