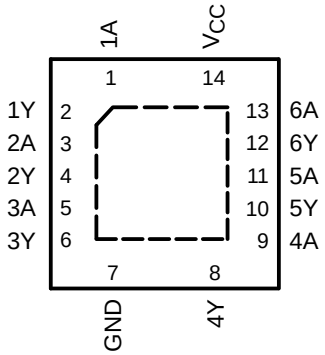
FEATURES

- **Optimized for 1.8-V Operation and Is 3.6-V I/O Tolerant to Support Mixed-Mode Signal Operation**
- **Sub-1-V Operable**
- **Max t_{pd} of 1.5 ns at 1.8 V**
- **Low Power Consumption, 10-μA Max I_{CC}**
- **±8-mA Output Drive at 1.8 V**
- **Unbuffered Outputs**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **ESD Protection Exceeds JESD 22**
  - **– 2000-V Human-Body Model (A114-A)**
  - **– 200-V Machine Model (A115-A)**
  - **– 1000-V Charged-Device Model (C101)**

RGY PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

This hex inverter is operational at 0.8-V to 2.7-V V_{CC}, but is designed specifically for 1.65-V to 1.95-V V_{CC} operation.

The SN74AUCU04 contains six independent inverters with unbuffered outputs and performs the Boolean function $Y = \overline{A}$.

ORDERING INFORMATION

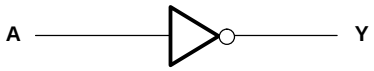
T_A	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	QFN – RGY	Tape and reel	SN74AUCU04RGYR	MSU04

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE
(EACH INVERTER)

INPUT A	OUTPUT Y
H	L
L	H

LOGIC DIAGRAM, EACH INVERTER (POSITIVE LOGIC)



Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	3.6	V
V_I	Input voltage range(2)		–0.5	3.6	V
V_O	Output voltage range(2)		–0.5	V_{CC} + 0.5	V
I_{IK}	Input clamp current	V_I < 0		–50	mA
I_{OK}	Output clamp current	V_O < 0		–50	mA
I_O	Continuous output current			±20	mA
	Continuous current through V_{CC} or GND			±100	mA
θ_{JA}	Package thermal impedance(3)			47	°C/W
T_{stg}	Storage temperature range		–65	150	°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) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
(3) The package thermal impedance is calculated in accordance with JESD 51-5.

Recommended Operating Conditions(1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage		0.8	2.7	V
V_{IH}	High-level input voltage	I_O = –100 µA	0.65 × V_{CC}		V
V_{IL}	Low-level input voltage	I_O = 100 µA		0.35 × V_{CC}	V
V_I	Input voltage		0	3.6	V
V_O	Output voltage		0	V_{CC}	V
I_{OH}	High-level output current	V_{CC} = 0.8 V		–0.7	mA
		V_{CC} = 1.1 V		–3	
		V_{CC} = 1.4 V		–5	
		V_{CC} = 1.65 V		–8	
		V_{CC} = 2.3 V		–9	
I_{OL}	Low-level output current	V_{CC} = 0.8 V		0.7	mA
		V_{CC} = 1.1 V		3	
		V_{CC} = 1.4 V		5	
		V_{CC} = 1.65 V		8	
		V_{CC} = 2.3 V		9	
$\Delta t/\Delta v$	Input transition rise or fall rate			20	ns/V
T_A	Operating free-air temperature		–40	85	°C

(1) All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

Electrical Characteristics

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

PARAMETER		TEST CONDITIONS		V_{CC}	MIN	TYP(1)	MAX	UNIT
V_{OH}		I_{OH} = –100 µA	V_{IL} = GND	0.8 V to 2.7 V	V_{CC} – 0.1			V
		I_{OH} = –0.7 mA		0.8 V		0.55		
		I_{OH} = –3 mA		1.1 V	0.8			
		I_{OH} = –5 mA		1.4 V	1			
		I_{OH} = –8 mA		1.65 V	1.2			
		I_{OH} = –9 mA		2.3 V	1.8			
V_{OL}		I_{OL} = 100 µA	V_{IH} = V_{CC}	0.8 V to 2.7 V			0.2	V
		I_{OL} = 0.7 mA		0.8 V		0.25		
		I_{OL} = 3 mA		1.1 V			0.3	
		I_{OL} = 5 mA		1.4 V			0.4	
		I_{OL} = 8 mA		1.65 V			0.45	
		I_{OL} = 9 mA		2.3 V			0.6	
I_I	A inputs	V_I = V_{CC} or GND		0 to 2.7 V			±5	µA
I_{CC}		V_I = V_{CC} or GND,	I_O = 0	0.8 V to 2.7 V			10	µA
C_i		V_I = V_{CC} or GND		2.5 V		4		pF

(1) All typical values are at T_A = 25°C.

Switching Characteristics

over recommended operating free-air temperature range, C_L = 15 pF (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 0.8 V	V_{CC} = 1.2 V ± 0.1 V		V_{CC} = 1.5 V ± 0.1 V		V_{CC} = 1.8 V ± 0.15 V			V_{CC} = 2.5 V ± 0.2 V		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	TYP	MAX	MIN	MAX	
t_{pd}	A	Y	2.8	0.7	2.3	0.6	1.7	0.5	0.9	1.5	0.4	1.2	ns

Switching Characteristics

over recommended operating free-air temperature range, C_L = 30 pF (unless otherwise noted) (see Figure 1)

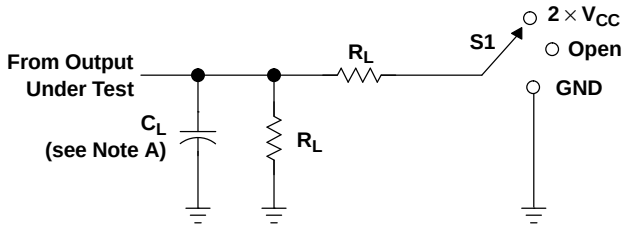
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 1.8 V ± 0.15 V			V_{CC} = 2.5 V ± 0.2 V		UNIT
			MIN	TYP	MAX	MIN	MAX	
t_{pd}	A	Y	0.9	1.4	2	0.8	1.7	ns

Operating Characteristics

T_A = 25°C

PARAMETER		TEST CONDITIONS	V_{CC} = 0.8 V	V_{CC} = 1.2 V	V_{CC} = 1.5 V	V_{CC} = 1.8 V	V_{CC} = 2.5 V	UNIT
			TYP	TYP	TYP	TYP	TYP	
C_{pd}	Power dissipation capacitance	f = 10 MHz	7	7	7	8	14	pF

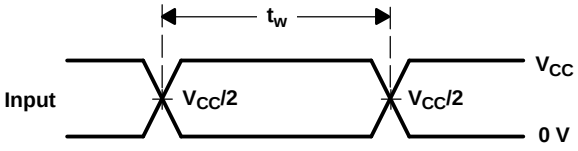
PARAMETER MEASUREMENT INFORMATION



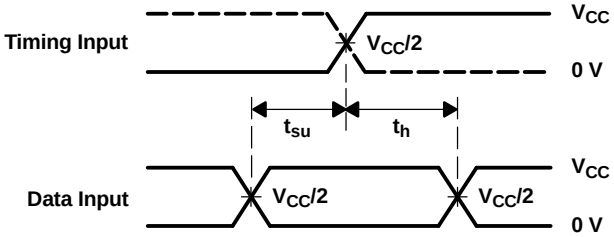
LOAD CIRCUIT

TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND

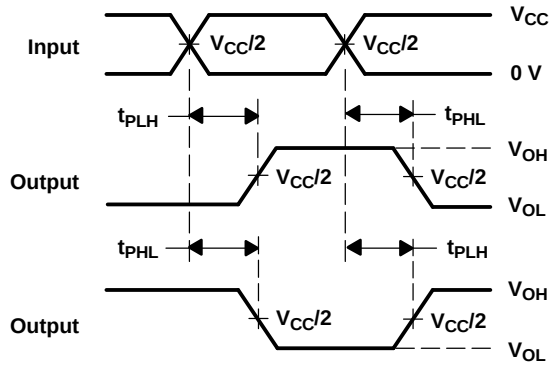
V_{CC}	C_L	R_L	V_Δ
0.8 V	15 pF	2 kΩ	0.1 V
1.2 V ± 0.1 V	15 pF	2 kΩ	0.1 V
1.5 V ± 0.1 V	15 pF	2 kΩ	0.1 V
1.8 V ± 0.15 V	15 pF	2 kΩ	0.15 V
2.5 V ± 0.2 V	15 pF	2 kΩ	0.15 V
1.8 V ± 0.15 V	30 pF	1 kΩ	0.15 V
2.5 V ± 0.2 V	30 pF	500 Ω	0.15 V



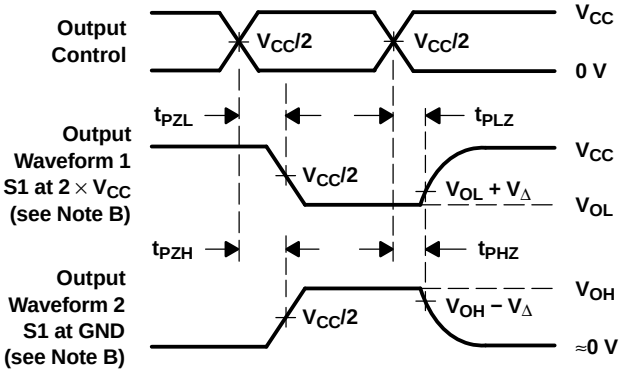
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, slew rate ≥ 1 V/ns.
D. The outputs are measured one at a time, with one transition per measurement.
E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
F. t_{PZL} and t_{PZH} are the same as t_{en}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.
H. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
SN74AUCU04RGYR	ACTIVE	QFN	RGY	14	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN74AUCU04RGYRG4	ACTIVE	QFN	RGY	14	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

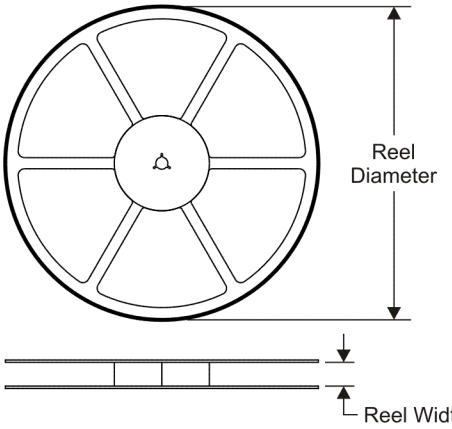
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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)

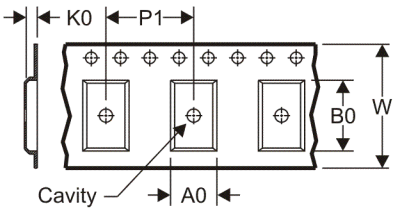
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

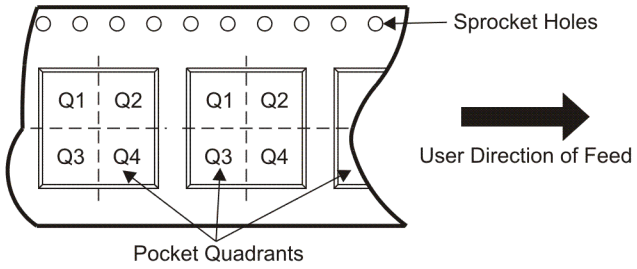


TAPE DIMENSIONS



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

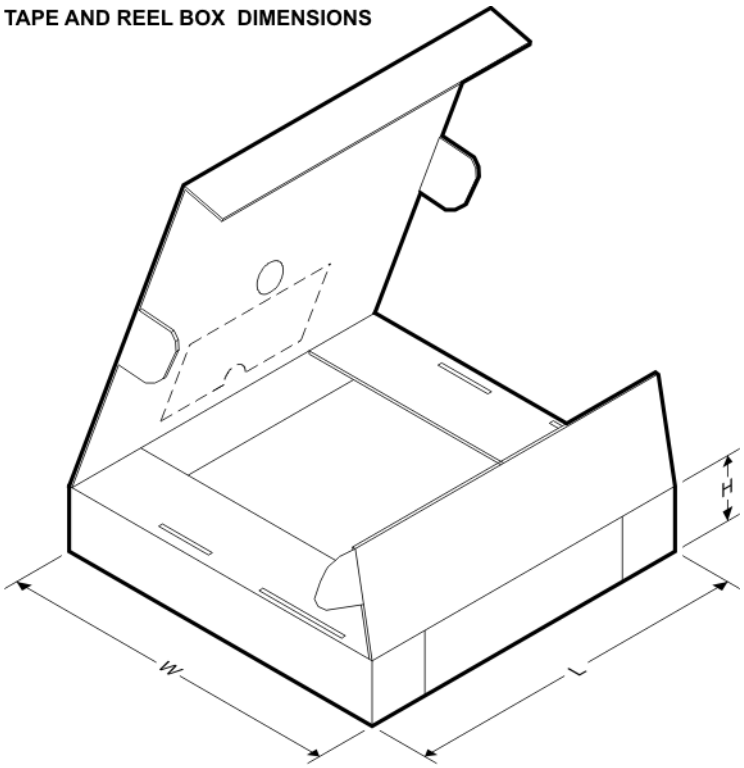
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74AUCU04RGYR	QFN	RGY	14	1000	180.0	12.4	3.85	3.85	1.35	8.0	12.0	Q1

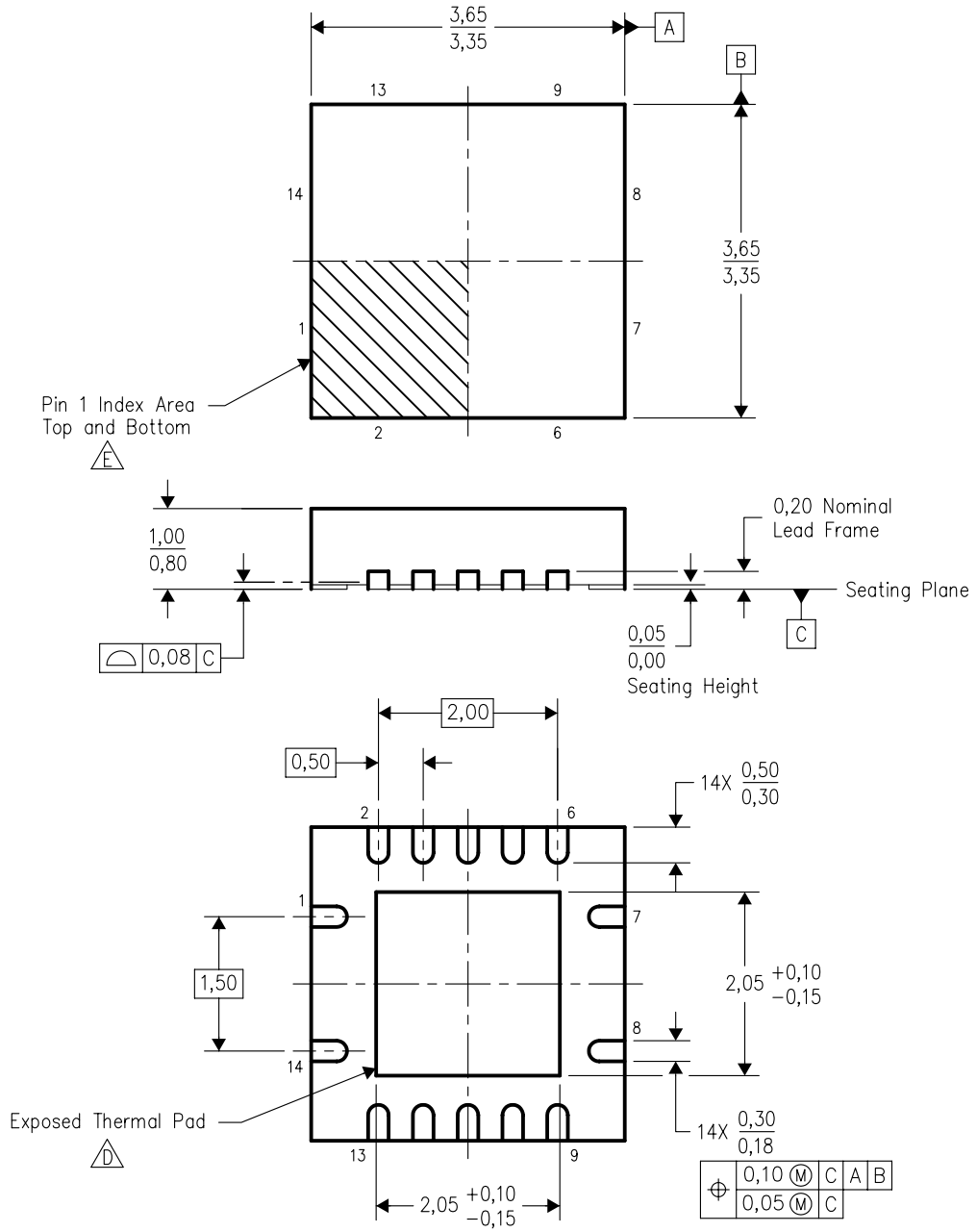
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AUCU04RGYR	QFN	RGY	14	1000	190.5	212.7	31.8

RGY (S–PQFP–N14) PLASTIC QUAD FLATPACK



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–Lead) package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
E. Pin 1 identifiers are located on both top and bottom of the package and within the zone indicated. The Pin 1 identifiers are either a molded, marked, or metal feature.
F. Package complies to JEDEC MO–241 variation BA.

THERMAL PAD MECHANICAL DATA

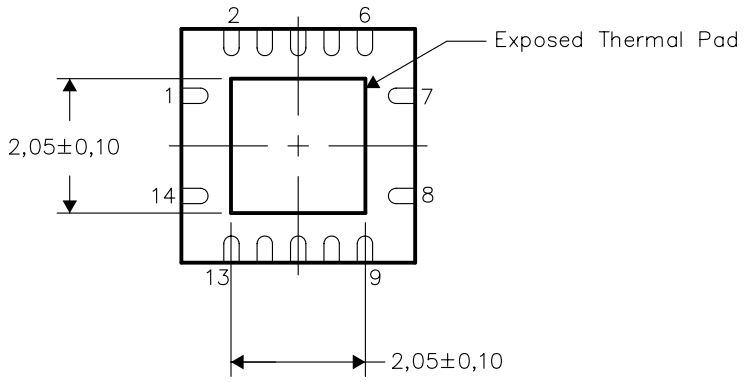
RGY (S–PQFP–N14)

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, Quad Flatpack No–Lead Logic Packages, Texas Instruments Literature No. SCBA017. This document is available at www.ti.com.

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

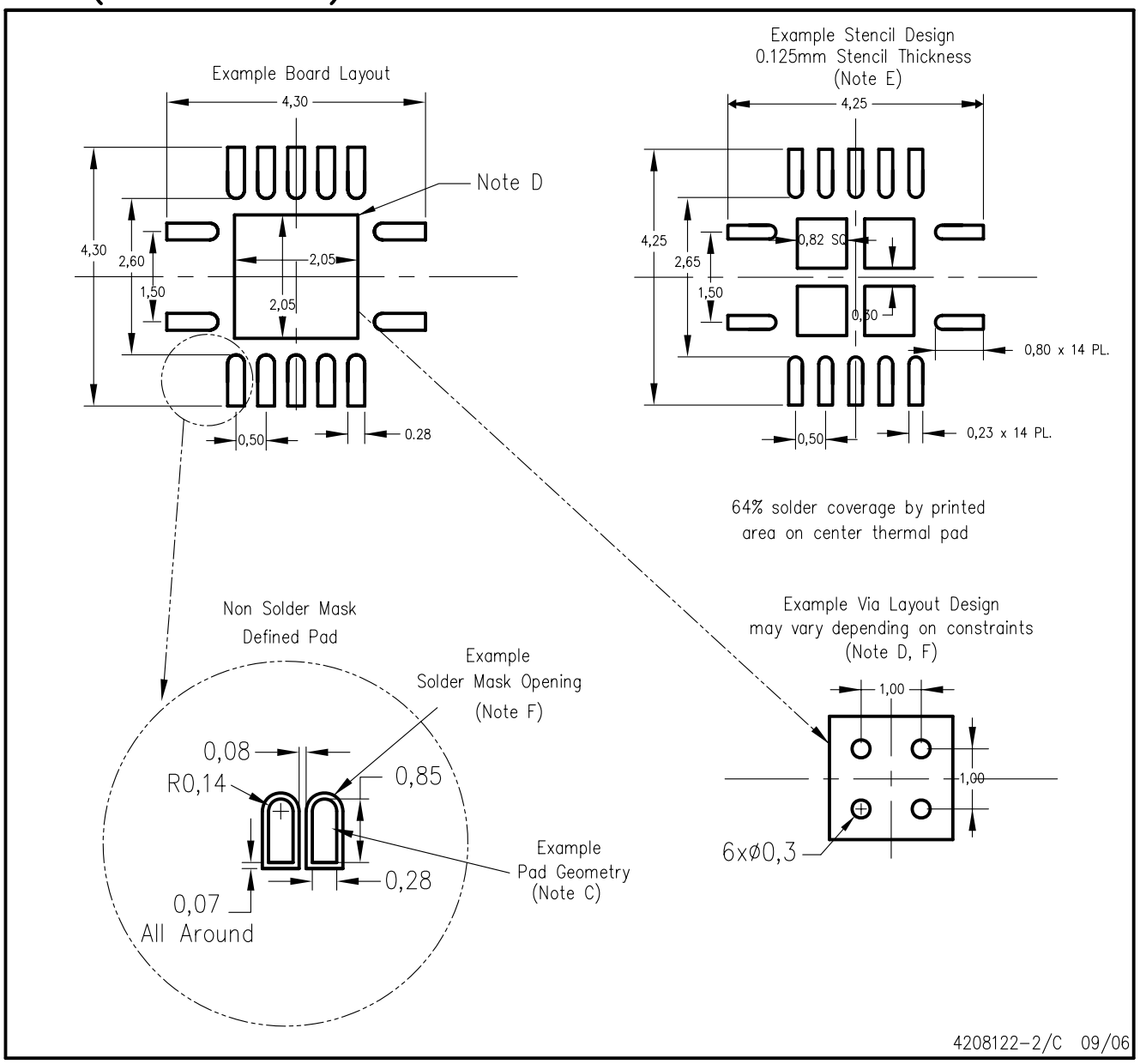


Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

RGY (R–PQFP–N14)



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, Quad Flat–Pack Packages, Texas Instruments Literature No. SCBA017, 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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