SN74SSTV16859
13-BIT TO 26-BIT REGISTERED BUFFER
WITH SSTL_2 INPUTS AND OUTPUTS

- Member of the Texas Instruments Widebus™ Family
- 1-to-2 Outputs to Support Stacked DDR DIMMs
- Supports SSTL_2 Data Inputs
- Outputs Meet SSTL_2 Class II Specifications
- Differential Clock (CLK and $\overline{\text{CLK}}$) Inputs
- Supports LVCMOS Switching Levels on the $\overline{\text{RESET}}$ Input
- $\overline{\text{RESET}}$ Input Disables Differential Input Receivers, Resets All Registers, and Forces All Outputs Low
- Pinout Optimizes DIMM PCB Layout
- 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)

description/ordering information

This 13-bit to 26-bit registered buffer is designed for 2.3-V to 2.7-V V_{CC} operation.

All inputs are SSTL_2, except the LVCMOS reset ($\overline{\text{RESET}}$) input. All outputs are SSTL_2, Class II compatible.

The SN74SSTV16859 operates from a differential clock (CLK and $\overline{\text{CLK}}$). Data are registered at the crossing of CLK going high and $\overline{\text{CLK}}$ going low.

DGG PACKAGE
(TOP VIEW)

Q13A	1		64	V_{DDQ}
Q12A	2		63	GND
Q11A	3		62	D13
Q10A	4		61	D12
Q9A	5		60	V_{CC}
V_{DDQ}	6		59	V_{DDQ}
GND	7		58	GND
Q8A	8		57	D11
Q7A	9		56	D10
Q6A	10		55	D9
Q5A	11		54	GND
Q4A	12		53	D8
Q3A	13		52	D7
Q2A	14		51	$\overline{\text{RESET}}$
GND	15		50	GND
Q1A	16		49	$\overline{\text{CLK}}$
Q13B	17		48	CLK
V_{DDQ}	18		47	V_{DDQ}
Q12B	19		46	V_{CC}
Q11B	20		45	V_{REF}
Q10B	21		44	D6
Q9B	22		43	GND
Q8B	23		42	D5
Q7B	24		41	D4
Q6B	25		40	D3
GND	26		39	GND
V_{DDQ}	27		38	V_{DDQ}
Q5B	28		37	V_{CC}
Q4B	29		36	D2
Q3B	30		35	D1
Q2B	31		34	GND
Q1B	32		33	V_{DDQ}

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	QFN – RGQ (Tin–Pb Finish)	Tape and reel	SN74SSTV16859RGQR	SS859
	QFN – RGQ (Matte–Tin Finish)		SN74SSTV16859RGQ8	
	TSSOP – DGG	Tape and reel	SN74SSTV16859DGGR	SSTV16859

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

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description/ordering information (continued)

The device supports low-power standby operation. When $\overline{\text{RESET}}$ is low, the differential input receivers are disabled, and undriven (floating) data, clock, and reference voltage (V_{REF}) inputs are allowed. In addition, when $\overline{\text{RESET}}$ is low, all registers are reset, and all outputs are forced low. The LVCMOS $\overline{\text{RESET}}$ input always must be held at a valid logic high or low level.

To ensure defined outputs from the register before a stable clock has been supplied, $\overline{\text{RESET}}$ must be held in the low state during power up.

RGQ PACKAGE
(TOP VIEW)

Pin	Name		Pin	Name
1	Q7A		42	D10
2	Q6A		41	D9
3	Q5A		40	D8
4	Q4A		39	D7
5	Q3A		38	$\overline{\text{RESET}}$
6	Q2A		37	GND
7	Q1A		36	CLK
8	Q13B		35	$\overline{\text{CLK}}$
9	V_{DDQ}		34	V_{DDQ}
10	Q12B		33	V_{CC}
11	Q11B		32	V_{REF}
12	Q10B		31	D6
13	Q9B		30	D5
14	Q8B		29	D4

Top pins (56–43): Q8A, V_{DDQ}, Q9A, Q10A, Q11A, Q12A, Q13A, V_{DDQ}, GND, D13, D12, V_{CC}, V_{DDQ}, D11

Bottom pins (15–28): Q7B, Q6B, V_{DDQ}, Q5B, Q4B, Q3B, Q2B, Q1B, V_{DDQ}, D1, D2, V_{CC}, V_{DDQ}, D3

Center: GND†
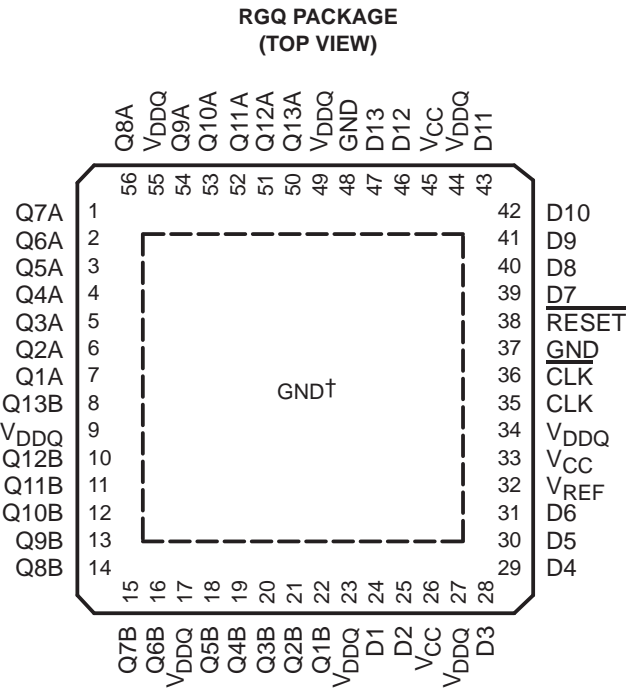
† The center die pad must be connected to GND.

FUNCTION TABLE

INPUTS				OUTPUT
$\overline{\text{RESET}}$	CLK	$\overline{\text{CLK}}$	D	Q
H	↑	↓	H	H
H	↑	↓	L	L
H	L or H	L or H	X	Q_0
L	X or floating	X or floating	X or floating	L

logic diagram (positive logic)
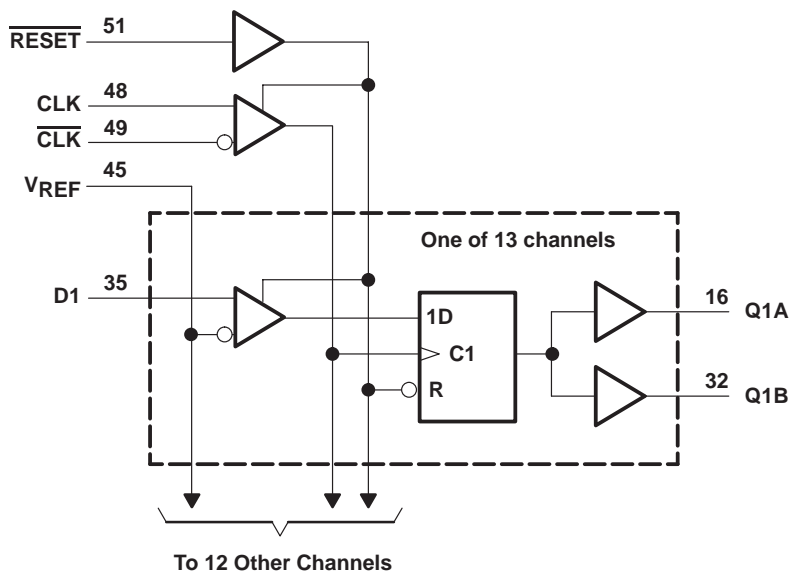
Pin numbers shown are for the DGG package.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC} or V_{DDQ} .... –0.5 V to 3.6 V
Input voltage range, V_I (see Notes 1 and 2) .... –0.5 V to V_{CC} + 0.5 V
Output voltage range, V_O (see Notes 1 and 2) .... –0.5 V to V_{DDQ} + 0.5 V
Input clamp current, I_{IK} (V_I < 0) .... –50 mA
Output clamp current, I_{OK} (V_O < 0 or V_O > V_{DDQ}) .... ±50 mA
Continuous output current, I_O (V_O = 0 to V_{DDQ}) .... ±50 mA
Continuous current through each V_{CC}, V_{DDQ}, or GND .... ±100 mA
Package thermal impedance, θ_{JA} (see Note 3): DGG package .... 55°C/W
                     (see Note 4): RGQ package .... 22°C/W
Storage temperature range, T_{stg} .... –65°C to 150°C

† 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.

NOTES: 1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. This value is limited to 3.6 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51-7.
4. The package thermal impedance is calculated in accordance with JESD 51-5.

recommended operating conditions (see Note 5)

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		V_{DDQ}		2.7	V
V_{DDQ}	Output supply voltage		2.3		2.7	V
V_{REF}	Reference voltage ($V_{REF} = V_{DDQ}/2$)		1.15	1.25	1.35	V
V_{TT}	Termination voltage		$V_{REF} - 40$ mV	V_{REF}	$V_{REF} + 40$ mV	V
V_I	Input voltage		0		V_{CC}	V
V_{IH}	AC high-level input voltage	Data inputs	$V_{REF} + 310$ mV			V
V_{IL}	AC low-level input voltage	Data inputs			$V_{REF} - 310$ mV	V
V_{IH}	DC high-level input voltage	Data inputs	$V_{REF} + 150$ mV			V
V_{IL}	DC low-level input voltage	Data inputs			$V_{REF} - 150$ mV	V
V_{IH}	High-level input voltage	$\overline{RESET}$	1.7			V
V_{IL}	Low-level input voltage	$\overline{RESET}$			0.7	V
V_{ICR}	Common-mode input voltage range	CLK, $\overline{CLK}$	0.97		1.53	V
$V_{I(PP)}$	Peak-to-peak input voltage	CLK, $\overline{CLK}$	360			mV
I_{OH}	High-level output current				−20	mA
I_{OL}	Low-level output current				20	mA
T_A	Operating free-air temperature		0		70	°C

NOTE 5: The $\overline{RESET}$ input of the device must be held at valid logic voltage levels (not floating) to ensure proper device operation. The differential inputs must not be floating unless $\overline{RESET}$ is low. 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‡	MAX	UNIT
V_{IK}		$I_I = -18$ mA		2.3 V			−1.2	V
V_{OH}		$I_{OH} = -100$ μA		2.3 V to 2.7 V	$V_{DDQ} - 0.2$			V
		$I_{OH} = -16$ mA		2.3 V	1.95			
V_{OL}		$I_{OL} = 100$ μA		2.3 V to 2.7 V			0.2	V
		$I_{OL} = 16$ mA		2.3 V			0.35	
I_I	All inputs	$V_I = V_{CC}$ or GND		2.7 V			±5	μA
I_{CC}	Static standby	$\overline{RESET}$ = GND	$I_O = 0$	2.7 V			10	μA
	Static operating	$\overline{RESET} = V_{CC}$, $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$					40	mA
I_{CCD}	Dynamic operating – clock only	$\overline{RESET} = V_{CC}$, $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$, CLK and $\overline{CLK}$ switching 50% duty cycle	$I_O = 0$	2.5 V		30		μA/MHz
	Dynamic operating – per each data input	$\overline{RESET} = V_{CC}$, $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$, CLK and $\overline{CLK}$ switching 50% duty cycle, One data input switching at one-half clock frequency, 50% duty cycle				10		μA/clock MHz/ D input
r_{OH}	Output high	$I_{OH} = -20$ mA		2.3 V to 2.7 V	7		20	Ω
r_{OL}	Output low	$I_{OL} = 20$ mA		2.3 V to 2.7 V	7		20	Ω
$r_{O(\Delta)}$	$|r_{OH} - r_{OL}|$	$I_O = 20$ mA, $T_A = 25$°C, One output		2.5 V			6	Ω
C_i§	Data inputs	$V_I = V_{REF} \pm 310$ mV		2.5 V	2.5	3	3.5	pF
	CLK, $\overline{CLK}$	$V_{ICR} = 1.25$ V, $V_{I(PP)} = 360$ mV			2.5	3	3.5	
	$\overline{RESET}$	$V_I = V_{CC}$ or GND				3		

† For this test condition, V_{DDQ} always is equal to V_{CC}.
‡ All typical values are at $V_{CC} = 2.5$ V, $T_A = 25$°C.
§ Measured with 50-MHz input frequency for the QFN package and 10-MHz input frequency for the TSSOP package

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timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

			V_{CC} = 2.5 V ± 0.2 V†		UNIT
			MIN	MAX	
f_{clock}	Clock frequency			200	MHz
t_w	Pulse duration, CLK, $\overline{CLK}$ high or low		2.5		ns
t_{act}	Differential inputs active time (see Note 6)			22	ns
t_{inact}	Differential inputs inactive time (see Note 7)			22	ns
t_{su}	Setup time, fast slew rate (see Notes 8 and 10)	Data before CLK↑, $\overline{CLK}$↓	0.75		ns
	Setup time, slow slew rate (see Notes 9 and 10)		0.9		
t_h	Hold time, fast slew rate (see Notes 8 and 10)	Data after CLK↑, $\overline{CLK}$↓	0.75		ns
	Hold time, slow slew rate (see Notes 9 and 10)		0.9		

† For this test condition, V_{DDQ} always is equal to V_{CC}.
NOTES: 6. V_{REF} must be held at a valid input level, and data inputs must be held low for a minimum time of t_{act} max, after $\overline{RESET}$ is taken high.
   7. V_{REF}, data, and clock inputs must be held at valid voltage levels (not floating) for a minimum time of t_{inact} max, after $\overline{RESET}$ is taken low.
   8. For data signal input slew rate ≥ 1 V/ns
   9. For data signal input slew rate ≥ 0.5 V/ns and < 1 V/ns
   10. CLK, $\overline{CLK}$ signals input slew rates are ≥ 1 V/ns.

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 2.5 V ± 0.2 V†		UNIT
			MIN	MAX	
f_{max}			200		MHz
t_{pd}	CLK and $\overline{CLK}$	Q	1.1	2.8	ns
t_{PHL}	$\overline{RESET}$	Q		5	ns

† For this test condition, V_{DDQ} always is equal to V_{CC}.

PARAMETER MEASUREMENT INFORMATION

LOAD CIRCUIT

**VOLTAGE WAVEFORMS
PULSE DURATION**

**VOLTAGE AND CURRENT WAVEFORMS
INPUTS ACTIVE AND INACTIVE TIMES**

**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES**

**VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES**

**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES**
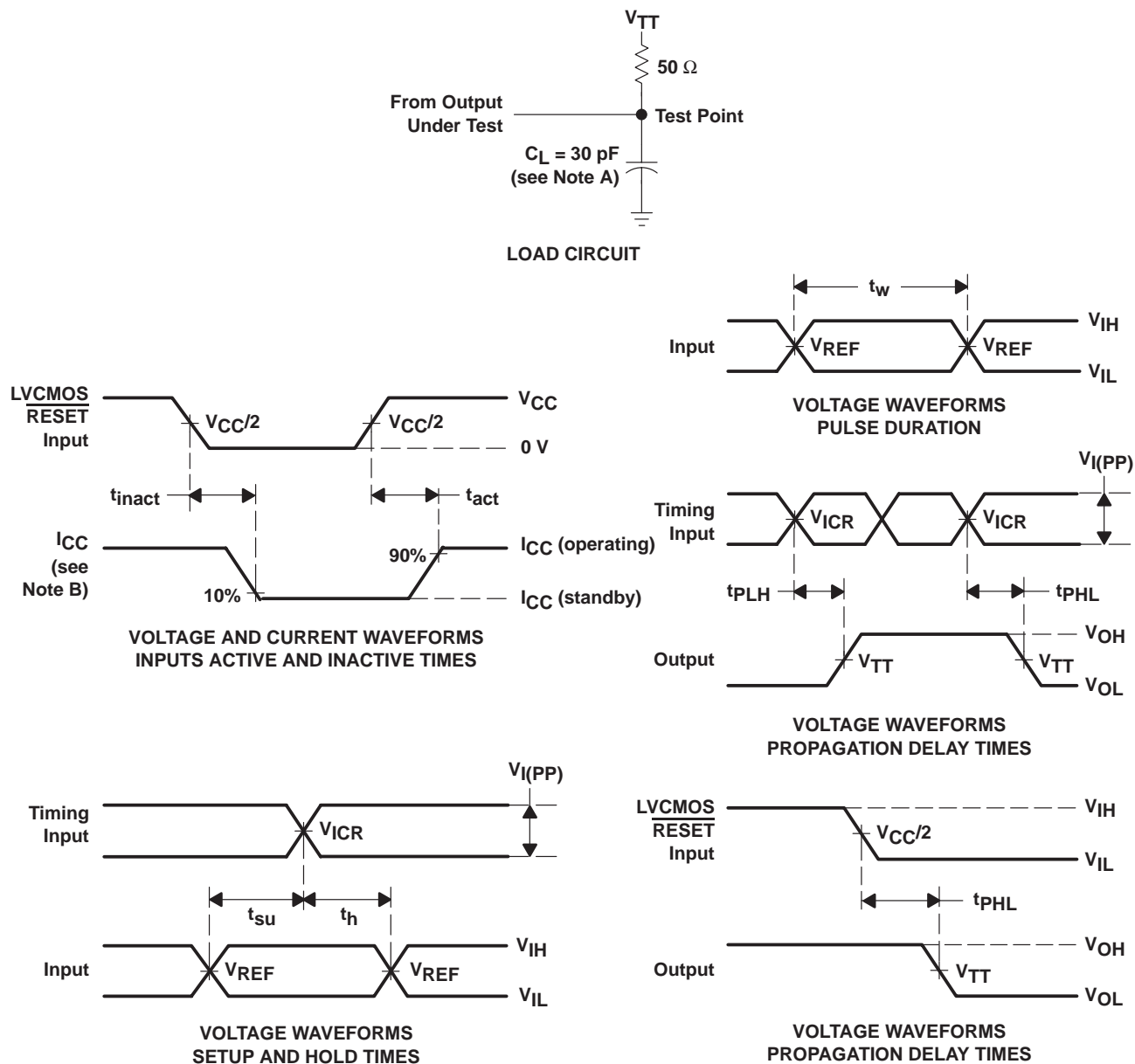
NOTES: A. C_L includes probe and jig capacitance.
      B. I_{CC} tested with clock and data inputs held at V_{CC} or GND, and I_O = 0 mA.
      C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω,
         input slew rate = 1 V/ns ±20% (unless otherwise noted).
      D. The outputs are measured one at a time, with one transition per measurement.
      E. V_{TT} = V_{REF} = V_{DDQ}/2
      F. V_{IH} = V_{REF} + 310 mV (ac voltage levels) for differential inputs. V_{IH} = V_{CC} for LVCMOS input.
      G. V_{IL} = V_{REF} − 310 mV (ac voltage levels) for differential inputs. V_{IL} = GND for LVCMOS input.
      H. t_{PLH} and t_{PHL} are the same as t_{pd}.

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]
74SSTV16859DGGRG4	ACTIVE	TSSOP	DGG	64	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
74SSTV16859RGQ8G3	ACTIVE	QFN	RGQ	56	2000	Green (RoHS & no Sb/Br)	CU SN	Level-3-260C-168 HR
SN74SSTV16859DGGR	ACTIVE	TSSOP	DGG	64	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN74SSTV16859RGQ8	ACTIVE	QFN	RGQ	56	2000	Green (RoHS & no Sb/Br)	CU SN	Level-3-260C-168 HR
SN74SSTV16859RGQR	ACTIVE	QFN	RGQ	56	2000	TBD	CU SNPB	Level-3-235C-168 HR

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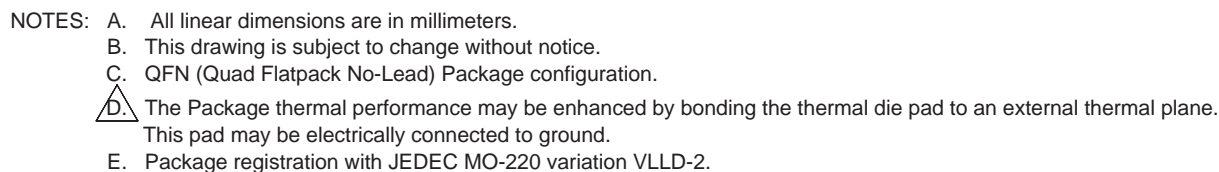
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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RGQ (S–PQFP–N56)   **PLASTIC QUAD FLATPACK**

8,15
7,85   A

B

42   29

43   28

8,15
7,85

Pin 1 Identifier

56   15

1   14

1,00
0,80   7,85
7,65 Sq   0,20 Nominal
Lead Frame

0,08 C   Seating Plane

0,05
0,00   C

5,35
5,05

56X 0,50
0,30

1   14

56   15

Pin 1 Identifier

4,65
4,35   4X 6,50

43   28

42   29   0,50

56X 0,23 +0,07
−0,05

Exposed Thermal Die Pad

D

⊕ 0,10 Ⓜ C A B
0,05 Ⓜ C

Bottom View   4203438/D 08/2002

NOTES: A.   All linear dimensions are in millimeters.
        B.   This drawing is subject to change without notice.
        C.   QFN (Quad Flatpack No-Lead) Package configuration.
      ⚠D.   The Package thermal performance may be enhanced by bonding the thermal die pad to an external thermal plane.
           This pad may be electrically connected to ground.
        E.   Package registration with JEDEC MO-220 variation VLLD-2.

DGG (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE PACKAGE**

48 PINS SHOWN

PINS ** DIM	48	56	64
A MAX	12,60	14,10	17,10
A MIN	12,40	13,90	16,90

4040078 / F 12/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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