

SN74SSTVF16859

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

SCES429B – MARCH 2003 – REVISED FEBRUARY 2004

- Member of the Texas Instruments Widebus™ Family
- Operates at 2.3 V to 2.7 V for PC1600, PC2100, and PC2700
- Operates at 2.5 V to 2.7 V for PC3200 (QFN Package)
- Pinout and Functionality Compatible With JEDEC Standard SSTV16859
- 600 ps Faster (Simultaneous Switching) Than the JEDEC Standard SSTV16859 in PC2700 DIMM Applications
- 1-to-2 Outputs to Support Stacked DDR DIMMs
- Output Edge-Control Circuitry Minimizes Switching Noise in an Unterminated Line
- Outputs Meet SSTL_2 Class I Specifications
- Supports SSTL_2 Data Inputs
- 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)
 - 1000-V Charged-Device Model (C101)

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}

description/ordering information

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

ORDERING INFORMATION

T _A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	QFN – RGQ (Tin-Pb Finish)	Tape and reel	SN74SSTVF16859SR	SSF859
	QFN – RGQ (Matte-Tin Finish)		SN74SSTVF16859S8	
	TSSOP – DGG	Tape and reel	SN74SSTVF16859GR	SSTVF16859

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



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WITH SSTL_2 INPUTS AND OUTPUTS

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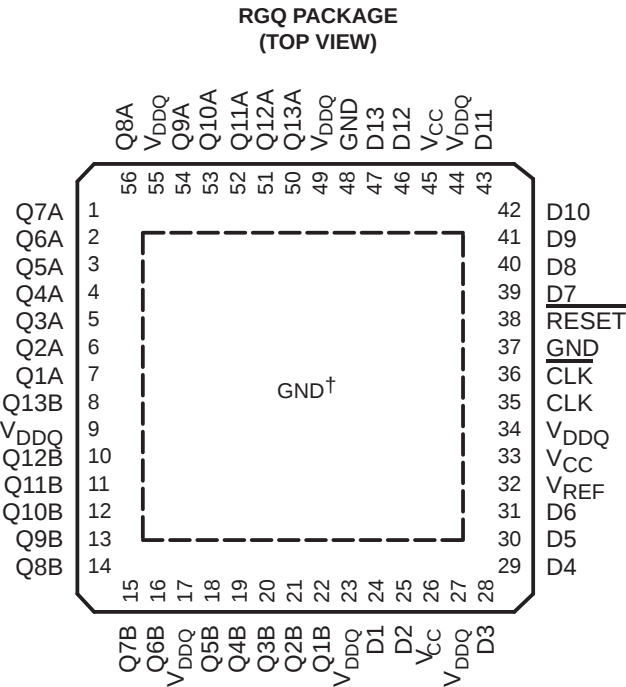
description/ordering information (continued)

All inputs are SSTL_2, except the LVCMOS reset ($\overline{\text{RESET}}$) input. All outputs are edge-controlled LVCMOS circuits optimized for unterminated DIMM loads.

The SN74SSTVF16859 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.

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.

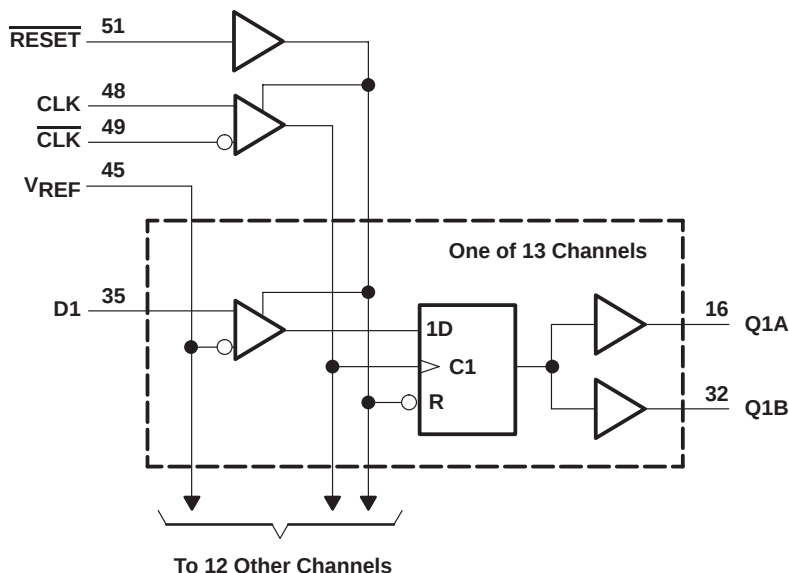


† The center die pad must be connected to GND.

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.

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recommended operating conditions (see Note 5)

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		V_{DDQ}		2.7	V
V_{DDQ}	Output supply voltage	PC1600, PC2100, PC2700	2.3		2.7	V
		PC3200	2.5		2.7	V
V_{REF}	Reference voltage ($V_{REF} = V_{DDQ}/2$)	PC1600, PC2100, PC2700	1.15	1.25	1.35	V
		PC3200	1.25	1.3	1.35	V
V_I	Input voltage		0		V_{CC}	V
V_{IH}	AC high-level input voltage	Data inputs	$V_{REF}+310\text{mV}$			V
V_{IL}	AC low-level input voltage	Data inputs			$V_{REF}-310\text{mV}$	V
V_{IH}	DC high-level input voltage	Data inputs	$V_{REF}+150\text{mV}$			V
V_{IL}	DC low-level input voltage	Data inputs			$V_{REF}-150\text{mV}$	V
V_{IH}	High-level input voltage	$\overline{\text{RESET}}$	1.7			V
V_{IL}	Low-level input voltage	$\overline{\text{RESET}}$			0.7	V
V_{ICR}	Common-mode input voltage range	CLK, $\overline{\text{CLK}}$	0.97		1.53	V
$V_{I(PP)}$	Peak-to-peak input voltage	CLK, $\overline{\text{CLK}}$	360			mV
I_{OH}	High-level output current				-16	mA
I_{OL}	Low-level output current				16	mA
T_A	Operating free-air temperature		0		70	°C

NOTE 5: The $\overline{\text{RESET}}$ 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 $\overline{\text{RESET}}$ is low. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics for PC1600, PC2100, and PC2700 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} = −8 mA		2.3 V	1.95					
V _{OL}		I _{OL} = 100 μA		2.3 V to 2.7 V	0.2			V		
		I _{OL} = 8 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	RESET = GND		2.7 V			10	μA		
	Static operating	RESET = V _{CC} , V _I = V _{IH} (AC) or V _{IL} (AC)					25	mA		
I _{CCD}	Dynamic operating – clock only	RESET = V _{CC} , V _I = V _{IH} (AC) or V _{IL} (AC), CLK and CLK switching 50% duty cycle		2.5 V			19	μA/ MHz		
	Dynamic operating – per each data input	RESET = V _{CC} , V _I = V _{IH} (AC) or V _{IL} (AC), CLK and CLK switching 50% duty cycle, One data input switching at one-half clock frequency, 50% duty cycle					7	μA/ clock MHz/ D input		
C _i [§]	Data inputs	V _I = V _{REF} ± 310 mV		2.5 V			2.5	3	3.5	pF
	CLK, CLK	V _{ICR} = 1.25 V, V _I (PP) = 360mV					2.5	3	3.5	
	RESET	V _I = V _{CC} or GND					2.3	3	3.5	

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

‡ All typical values are at $V_{CC} = 2.5\text{ V}$, $T_A = 25^\circ\text{C}$.

§ Measured at 50-MHz input frequency



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electrical characteristics for PC3200 over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	$V_{CC}^{\dagger}$	MIN	TYP [‡]	MAX	UNIT
V_{IK}		$I_I = -18 \text{ mA}$	2.5 V			-1.2	V
V_{OH}		$I_{OH} = -100 \mu\text{A}$	2.5 V to 2.7 V	$V_{DDQ} - 0.2$			V
		$I_{OH} = -8 \text{ mA}$	2.5 V	1.95			
V_{OL}		$I_{OL} = 100 \mu\text{A}$	2.5 V to 2.7 V			0.2	V
		$I_{OL} = 8 \text{ mA}$	2.5 V			0.35	
I_I	All inputs	$V_I = V_{CC}$ or GND	2.7 V			± 5	μA
I_{CC}	Static standby	$\overline{\text{RESET}} = \text{GND}$	2.7 V			10	μA
	Static operating	$\overline{\text{RESET}} = V_{CC}$, $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$				25	mA
I_{CCD}	Dynamic operating – clock only	$\overline{\text{RESET}} = V_{CC}$, $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$, CLK and CLK switching 50% duty cycle	2.6 V		19		$\mu\text{A}/\text{MHz}$
	Dynamic operating – per each data input	$\overline{\text{RESET}} = V_{CC}$, $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$, CLK and CLK switching 50% duty cycle, One data input switching at one-half clock frequency, 50% duty cycle			7		$\mu\text{A}/\text{clock MHz}/\text{D input}$
$C_i^{\S}$	Data inputs	$V_I = V_{REF} \pm 310 \text{ mV}$	2.6 V	2.5	3	3.5	pF
	CLK, $\overline{\text{CLK}}$	$V_{ICR} = 1.25 \text{ V}$, $V_{I(PP)} = 360 \text{ mV}$		2.5	3	3.5	
	$\overline{\text{RESET}}$	$V_I = V_{CC}$ or GND		2.3	3	3.5	

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

[‡] All typical values are at $V_{CC} = 2.6 \text{ V}$, $T_A = 25^\circ\text{C}$.

[§] Measured at 50-MHz input frequency

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

			$V_{CC} = 2.5 \text{ V} \pm 0.2 \text{ V}^{\dagger}$		$V_{CC} = 2.6 \text{ V} \pm 0.1 \text{ V}^{\dagger}$		UNIT
			MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency			500		500	MHz
t_w	Pulse duration, CLK, $\overline{\text{CLK}}$ high or low		1		1		ns
t_{act}	Differential inputs active time (see Note 6)			22		22	ns
t_{inact}	Differential inputs inactive time (see Note 7)			22		22	ns
t_{su}	Setup time	Fast slew rate (see Notes 8 and 10)	Data before $\text{CLK}\uparrow$, $\overline{\text{CLK}}\downarrow$		0.65	0.65	ns
		Slow slew rate (see Notes 9 and 10)			0.75	0.75	
t_h	Hold time	Fast slew rate (see Notes 8 and 10)	Data after $\text{CLK}\uparrow$, $\overline{\text{CLK}}\downarrow$		0.65	0.65	ns
		Slow slew rate (see Notes 9 and 10)			0.8	0.8	

[†] 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 $t_{\text{act}} \text{ max}$, after $\overline{\text{RESET}}$ is taken high.

7. V_{REF} , data, and clock inputs must be held at valid voltage levels (not floating) for a minimum time of $t_{\text{inact}} \text{ max}$, after $\overline{\text{RESET}}$ is taken low.

8. For data signal input slew rate $\geq 1 \text{ V/ns}$.

9. For data signal input slew rate $\geq 0.5 \text{ V/ns}$ and $< 1 \text{ V/ns}$.

10. CLK, $\overline{\text{CLK}}$ signals input slew rates are $\geq 1 \text{ V/ns}$.

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}^\dagger$		UNIT
			MIN	MAX	
$f_{\max}$			500		MHz
$t_{pd}^\ddagger$	CLK and $\overline{\text{CLK}}$	Q	1.1	2.5	ns
t_{PHL}	$\overline{\text{RESET}}$	Q		5	ns

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

[‡] Single-bit switching

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}^\dagger$		$V_{CC} = 2.6\text{ V}$ $\pm 0.1\text{ V}^\dagger$		UNIT
			MIN	MAX	MIN	MAX	
$f_{\max}$			500		500		MHz
$t_{pd}^\ddagger$	CLK and $\overline{\text{CLK}}$	Q	1.1	2.5	1.1	2.2	ns
t_{PHL}	$\overline{\text{RESET}}$	Q		5		5	ns

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

[‡] Single-bit switching

output slew rates over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

PARAMETER	FROM	TO	$V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}^\dagger$		$V_{CC} = 2.6\text{ V}$ $\pm 0.1\text{ V}^\dagger$		UNIT
			MIN	MAX	MIN	MAX	
dV/dt_r	20%	80%	1	4	1	4	V/ns
dV/dt_f	80%	20%	1	4	1	4	V/ns
$dV/dt_{\Delta}^\S$	20% or 80%	80% or 20%		1		1	V/ns

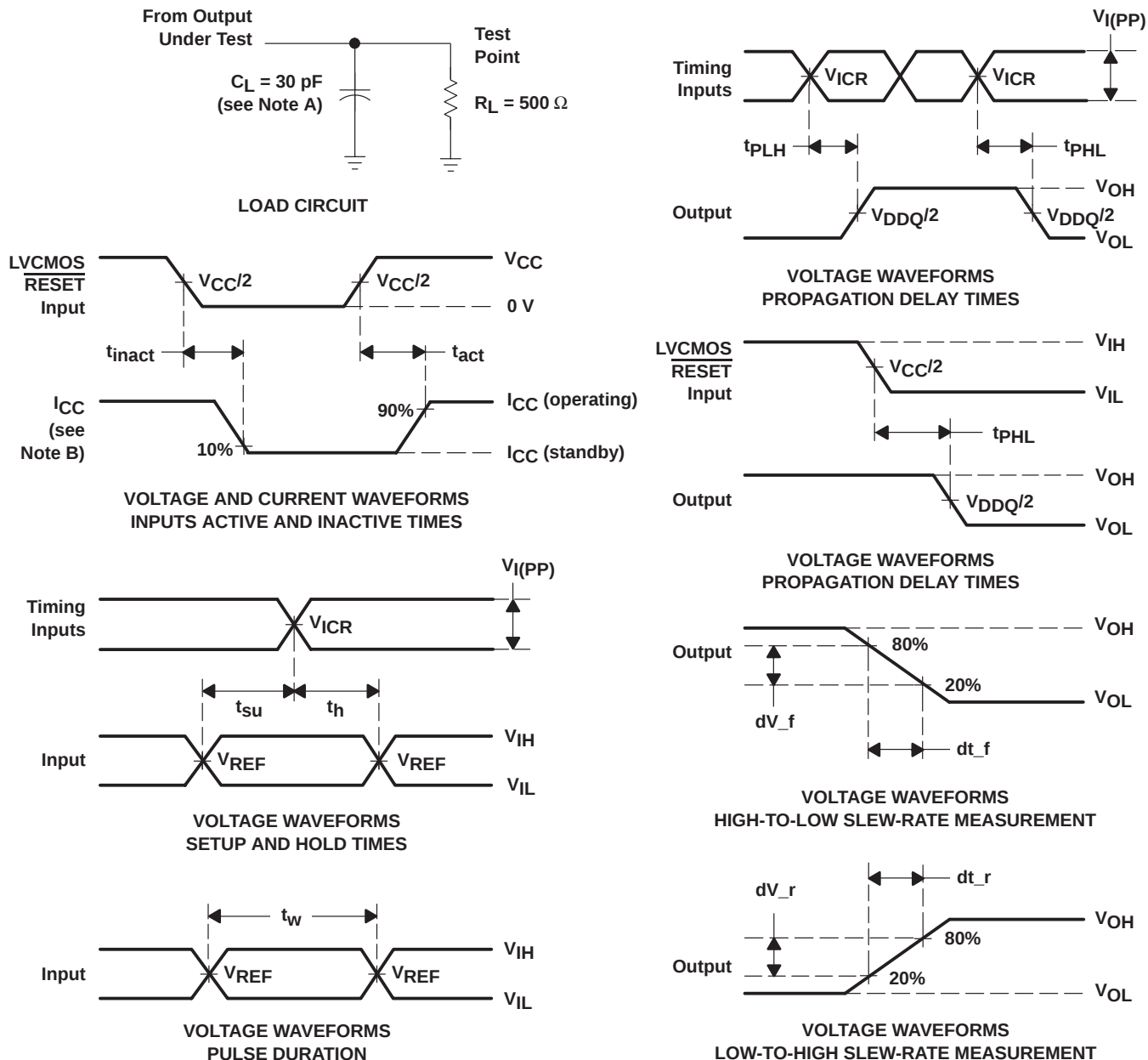
[†] For this test condition, V_{DDQ} always is equal to V_{CC} .

[§] Difference between dV/dt_r (rising edge rate) and dV/dt_f (falling edge rate).



PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ AND $V_{CC} = 2.6\text{ V} \pm 0.1\text{ V}$



- 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 $I_O = 0\text{ mA}$.
 - C. All input pulses are supplied by generators having the following characteristics: PRR $\leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, input slew rate $= 1\text{ V/ns} \pm 20\%$ (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. $V_{IH} = V_{REF} + 310\text{ mV}$ (ac voltage levels) for differential inputs. $V_{IH} = V_{CC}$ for LVC MOS input.
 - G. $V_{IL} = V_{REF} - 310\text{ mV}$ (ac voltage levels) for differential inputs. $V_{IL} = \text{GND}$ for LVC MOS 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⁾
SN74SSTVF16859G4R	ACTIVE	QFN	RGQ	56	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
SN74SSTVF16859GR	ACTIVE	TSSOP	DGG	64	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN74SSTVF16859GRG4	ACTIVE	TSSOP	DGG	64	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN74SSTVF16859S8	ACTIVE	QFN	RGQ	56	2000	TBD	CU SN	Level-3-235C-168 HR
SN74SSTVF16859SR	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) 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.

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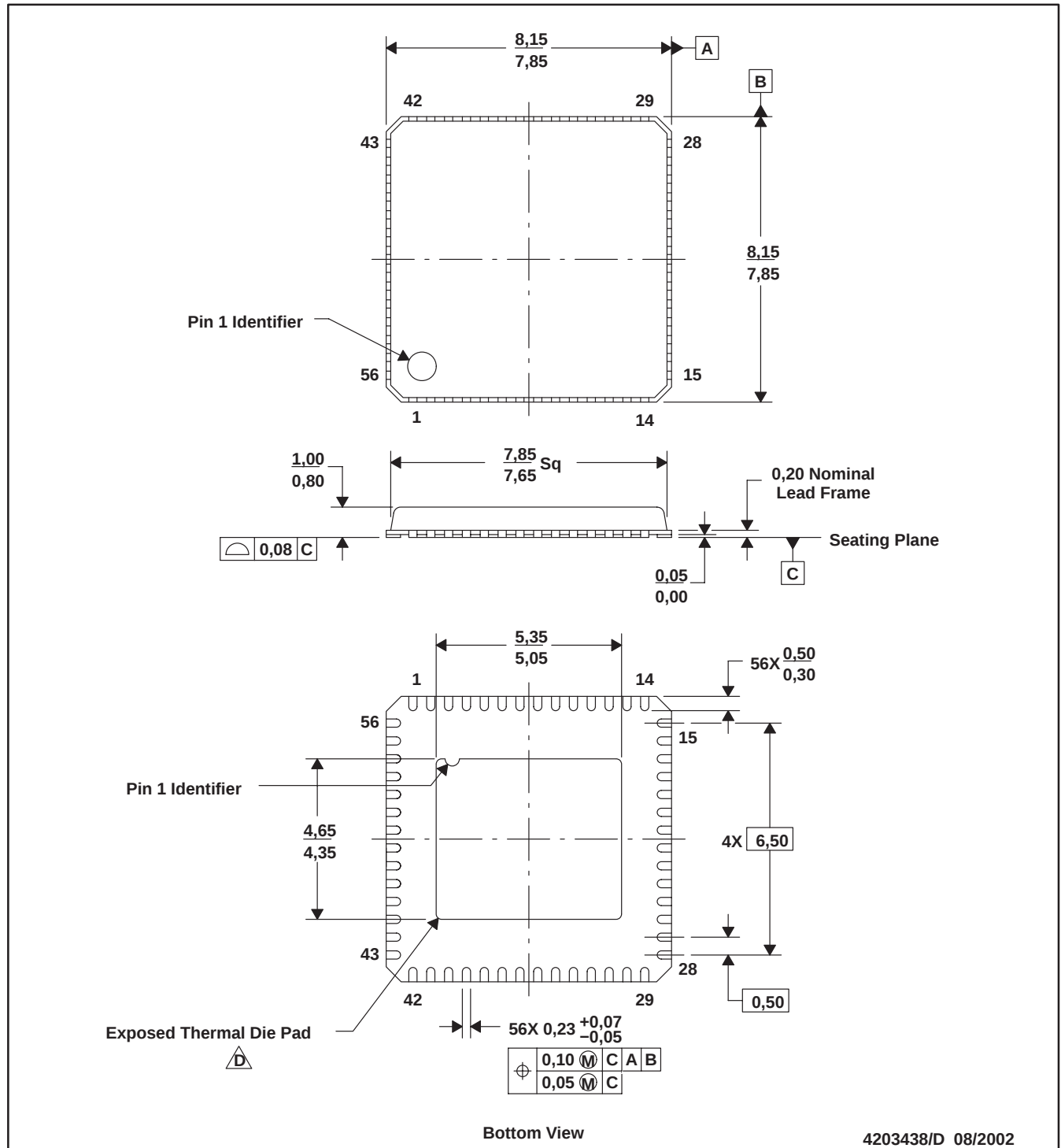
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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RGQ (S-PQFP-N56)

PLASTIC QUAD FLATPACK



- 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



- 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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