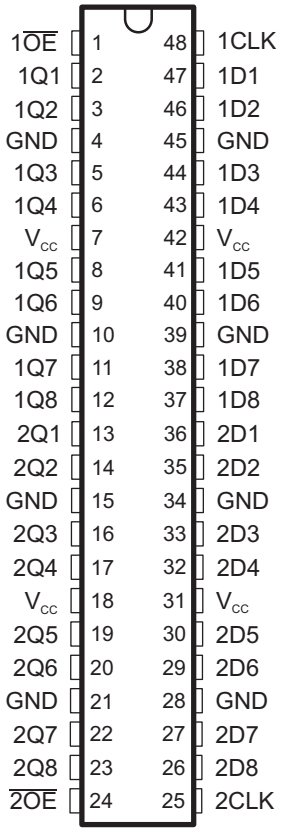
SN54ALVTH16374, SN74ALVTH16374
2.5-V/3.3-V 16-BIT EDGE-TRIGGERED D-TYPE FLIP-FLOPS WITH 3-STATE OUTPUTS

SCES068G – JUNE 1996 – REVISED NOVEMBER 2006

FEATURES

- **State-of-the-Art Advanced BiCMOS Technology (ABT) Widebus™ Design for 2.5-V and 3.3-V Operation and Low Static Power Dissipation**
- **Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 2.3-V to 3.6-V V_{CC})**
- **Typical V_{OLP} (Output Ground Bounce) <0.8 V at V_{CC} = 3.3 V, T_A = 25°C**
- **High Drive (–24/24 mA at 2.5-V V_{CC} and –32/64 mA at 3.3-V)**
- **Power Off Disables Outputs, Permitting Live Insertion**
- **High-Impedance State During Power Up and Power Down Prevents Driver Conflict**
- **Uses Bus Hold on Data Inputs in Place of External Pullup/Pulldown Resistors to Prevent the Bus From Floating**
- **Auto3-State Eliminates Bus Current Loading When Output Exceeds V_{CC} + 0.5 V**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **ESD Protection**
  - **Exceeds 2000 V Per MIL-STD-883, Method 3015**
  - **Exceeds 200 V Using Machine Model**
  - **Exceeds 1000 V Using Charged-Device Model, Robotic Method**
- **Flow-Through Architecture Facilitates Printed Circuit Board Layout**
- **Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise**
- **Package Options Include Plastic Shrink Small-Outline (DL), Thin Shrink Small-Outline (DGG), Thin Very Small-Outline (DGV) Packages, and 380-mil Fine-Pitch Ceramic Flat (WD) Package**

SN54ALVTH16374...WD PACKAGE
SN74ALVTH16374...DGG, DGV, OR DL PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

The 'ALVTH16374 devices are 16-bit edge-triggered D-type flip-flops with 3-state outputs designed for 2.5-V or 3.3-V V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment. These devices are particularly suitable for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers.

These devices can be used as two 8-bit flip-flops or one 16-bit flip-flop. On the positive transition of the clock (CLK), the flip-flops store the logic levels set up at the data (D) inputs.

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

A buffered output-enable ($\overline{OE}$) input can be used to place the eight outputs in either a normal logic state (high or low logic levels) or a high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and the increased drive provide the capability to drive bus lines without need for interface or pullup components.

$\overline{OE}$ does not affect internal operations of the flip-flop. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

When V_{CC} is between 0 and 1.2 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.2 V, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

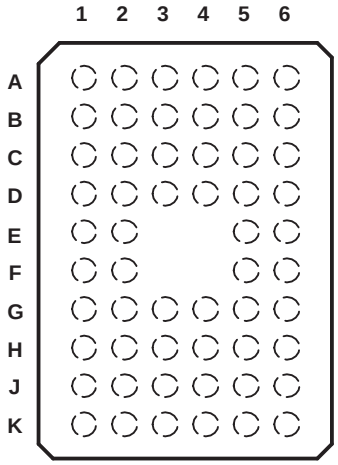
The SN54ALVTH16374 is characterized for operation over the full military temperature range of –55°C to 125°C.

The SN74ALVTH16374 is characterized for operation from –40°C to 85°C.

ORDERING INFORMATION

T_A	PACKAGE		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TSSOP – DGG	Reel of 2000	74ALVTH16374GRE4	
			SN74ALVTH16374GR	
	TVSOP – DGV	Reel of 2000	74ALVTH16374VRE4	
			SN74ALVTH16374VR	
	SSOP – DL	Tube of 25	74ALVTH16374DL	
			SN74ALVTH16374DLG4	
		Reel of 1000	SN74ALVTH16374DLR	
			SN74ALVTH16374DLRG4	

ZQL PACKAGE
(TOP VIEW)



TERMINAL ASSIGNMENTS(1)

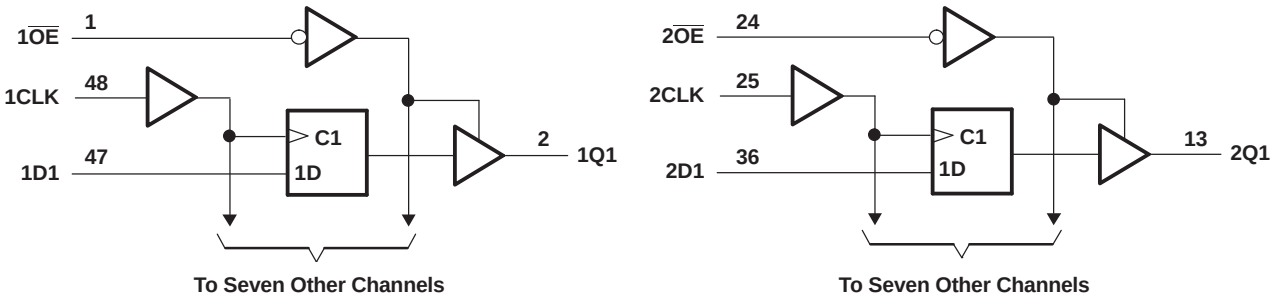
	1	2	3	4	5	6
A	1$\overline{OE}$	NC	NC	NC	NC	1CLK
B	1Q2	1Q1	GND	GND	1D1	1D2
C	1Q4	1Q3	V_{CC}	V_{CC}	1D3	1D4
D	1Q6	1Q5	GND	GND	1D5	1D6
E	1Q8	1Q7			1D7	1D8
F	2Q1	2Q2			2D2	2D1
G	2Q3	2Q4	GND	GND	2D4	2D3
H	2Q5	2Q6	V_{CC}	V_{CC}	2D6	2D5
J	2Q7	2Q8	GND	GND	2D8	2D7
K	2$\overline{OE}$	NC	NC	NC	NC	2CLK

(1) NC – No internal connection

FUNCTION TABLE
(each 8-bit section)

INPUTS			OUTPUT
$\overline{OE}$	CLK	D	Q
L	↑	H	H
L	↑	L	L
L	H or L	X	Q_0
H	X	X	Z

LOGIC DIAGRAM (POSITIVE LOGIC)



Pin numbers shown are for the DGG, DL, and WD packages.

Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	4.6	V
V_I	Input voltage range(2)		–0.5	7	V
V_O	Voltage range applied to any output in the high-impedance or power-off state(2)		–0.5	7	V
V_O	Voltage range applied to any output in the high state(2)		–0.5	7	V
I_O	Output current in the low state	SN54ALVTH16374(3)		96	mA
		SN74ALVTH16374		128	
I_O	Output current in the high state	SN54ALVTH16374(3)		–48	mA
		SN74ALVTH16374		–64	
I_{IK}	Input clamp current	$V_I < 0$		–50	mA
I_{OK}	Output clamp current	$V_O < 0$		–50	mA
θ_{JA}	Package thermal impedance(4)	DGG package		89	°C/W
		DGV package		93	
		DL package		94	
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 and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
(3) Product preview
(4) The package thermal impedance is calculated in accordance with JESD 51.

Recommended Operating Conditions(1)

V_{CC} = 2.5 V ± 0.2 V

			SN54ALVTH16374(2)			SN74ALVTH16374			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{CC}	Supply voltage		2.3		2.7	2.3		2.7	V
V_{IH}	High-level input voltage		1.7			1.7			V
V_{IL}	Low-level input voltage				0.7			0.7	V
V_I	Input voltage		0	V_{CC}	5.5	0	V_{CC}	5.5	V
I_{OH}	High-level output current				–6			–8	mA
I_{OL}	Low-level output current				6			8	mA
	Low-level output current; current duty cycle ≤ 50%; f ≥ 1 kHz				18			24	
Δt/Δv	Input transition rise or fall rate	Outputs enabled			10			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200			200			µs/V
T_A	Operating free-air temperature		–55		125	–40		85	°C

(1) All unused control 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.
(2) Product preview

Recommended Operating Conditions(1)

V_{CC} = 3.3 V ± 0.3 V

			SN54ALVTH16374(2)			SN74ALVTH16374			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{CC}	Supply voltage		3		3.6	3		3.6	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.8			0.8	V
V_I	Input voltage		0	V_{CC}	5.5	0	V_{CC}	5.5	V
I_{OH}	High-level output current				–24			–32	mA
I_{OL}	Low-level output current				24			32	mA
	Low-level output current; current duty cycle ≤ 50%; f ≥ 1 kHz				48			64	
Δt/Δv	Input transition rise or fall rate	Outputs enabled			10			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200			200			µs/V
T_A	Operating free-air temperature		–55		125	–40		85	°C

(1) All unused control 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.
(2) Product preview

Electrical Characteristics

over operating free-air temperature range V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN54ALVTH16374(1)			SN74ALVTH16374			UNIT
				MIN	TYP(2)	MAX	MIN	TYP(2)	MAX	
V_{IK}		V_{CC} = 2.3 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}		V_{CC} = 2.3 V to 2.7 V, I_{OH} = –100 µA		V_{CC} – 0.2			V_{CC} – 0.2			V
		V_{CC} = 2.3 V	I_{OH} = –6 mA	1.8						
			I_{OH} = –8 mA				1.8			
V_{OL}		V_{CC} = 2.3 V to 2.7 V, I_{OL} = 100 µA				0.2			0.2	V
		V_{CC} = 2.3 V	I_{OL} = 6 mA			0.4				
			I_{OL} = 8 mA						0.4	
			I_{OL} = 18 mA			0.5				
			I_{OL} = 24 mA						0.5	
I_I	Control inputs	V_{CC} = 2.7 V,	V_I = V_{CC} or GND			±1			±1	µA
		V_{CC} = 0 or 2.7 V,	V_I = 5.5 V			10			10	
	Data inputs	V_{CC} = 2.7 V	V_I = 5.5 V			10			10	
			V_I = V_{CC}			1			1	
			V_I = 0			–5			–5	
I_{off}		V_{CC} = 0, V_I or V_O = 0 to 4.5 V							±100	µA
I_{BHL}(3)		V_{CC} = 2.3 V,	V_I = 0.7 V		115			115		µA
I_{BHH}(4)		V_{CC} = 2.3 V,	V_I = 1.7 V		–10			–10		µA
I_{BHLO}(5)		V_{CC} = 2.7 V,	V_I = 0 to V_{CC}	300			300			µA
I_{BHHO}(6)		V_{CC} = 2.7 V,	V_I = 0 to V_{CC}	–300			–300			µA
I_{EX}(7)		V_{CC} = 2.3 V,	V_O = 5.5 V			125			125	µA
$I_{OZ(PU/PD)}$(8)		V_{CC} ≤ 1.2 V, V_O = 0.5 V to V_{CC}, V_I = GND or V_{CC}, $\overline{OE}$ = don't care				±100			±100	µA
I_{OZH}		V_{CC} = 2.7 V, V_O = 2.3 V, V_I = 0.7 V or 1.7 V				5			5	µA
I_{OZL}		V_{CC} = 2.7 V, V_O = 0.5 V, V_I = 0.7 V or 1.7 V				–5			–5	µA
I_{CC}		V_{CC} = 2.7 V, I_O = 0, V_I = V_{CC} or GND	Outputs high		0.04	0.1			0.1	mA
			Outputs low		2.3	4.5			4.5	
			Outputs disabled		0.04	0.1			0.1	
C_i		V_{CC} = 2.5 V,	V_I = 2.5 V or 0		3.5					pF
C_o		V_{CC} = 2.5 V,	V_O = 2.5 V or 0		6					pF

(1) Product preview
(2) All typical values are at V_{CC} = 2.5 V, T_A = 25°C.
(3) The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.
(4) The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.
(5) An external driver must source at least I_{BHLO} to switch this node from low to high.
(6) An external driver must sink at least I_{BHHO} to switch this node from high to low.
(7) Current into an output in the high state when $V_O > V_{CC}$
(8) High-impedance state during power up or power down

Electrical Characteristics

over recommended operating free-air temperature range V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN54ALVTH16374[1]			SN74ALVTH16374			UNIT
				MIN	TYP[2]	MAX	MIN	TYP[2]	MAX	
V_{IK}		V_{CC} = 3 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}		V_{CC} = 3 V to 3.6 V,	I_{OH} = –100 µA	V_{CC} – 0.2			V_{CC} – 0.2			V
		V_{CC} = 3 V	I_{OH} = –24 mA	2						
			I_{OH} = –32 mA				2			
V_{OL}		V_{CC} = 3 V to 3.6 V,	I_{OL} = 100 µA			0.2			0.2	V
		V_{CC} = 3 V	I_{OL} = 16 mA						0.4	
			I_{OL} = 24 mA			0.5				
			I_{OL} = 32 mA						0.5	
			I_{OL} = 48 mA			0.55				
			I_{OL} = 64 mA						0.55	
I_I	Control inputs	V_{CC} = 3.6 V, V_I = V_{CC} or GND				±1			±1	µA
		V_{CC} = 0 or 3.6 V, V_I = 5.5 V				10			10	
	Data inputs	V_{CC} = 3.6 V	V_I = 5.5 V			10			10	
			V_I = V_{CC}			1			1	
			V_I = 0			–5			–5	
I_{off}		V_{CC} = 0, V_I or V_O = 0 to 4.5 V							±100	µA
I_{BHL}[3]		V_{CC} = 3 V,	V_I = 0.8 V	75			75			µA
I_{BHH}[4]		V_{CC} = 3 V,	V_I = 2 V	–75			–75			µA
I_{BHLO}[5]		V_{CC} = 3.6 V,	V_I = 0 to V_{CC}	500			500			µA
I_{BHHO}[6]		V_{CC} = 3.6 V,	V_I = 0 to V_{CC}	–500			–500			µA
I_{EX}[7]		V_{CC} = 3 V,	V_O = 5.5 V			125			125	µA
$I_{OZ(PU/PD)}$[8]		V_{CC} ≤ 1.2 V, V_O = 0.5 V to V_{CC}, V_I = GND or V_{CC}, $\overline{OE}$ = don't care				±100			±100	µA
I_{OZH}		V_{CC} = 3.6 V, V_O = 3 V, V_I = 0.8 V or 27 V				5			5	µA
I_{OZL}		V_{CC} = 3.6 V, V_O = 0.5 V, V_I = 0.8 V or 2 V				–5			–5	µA
I_{CC}		V_{CC} = 3.6 V, I_O = 0, V_I = V_{CC} or GND	Outputs high		0.07	0.1		0.07	0.1	mA
			Outputs low		3.2	5		3.2	5	
			Outputs disabled		0.07	0.1			0.1	
ΔI_{CC}[9]		V_{CC} = 3 V to 3.6 V, One input at V_{CC}– 0.6 V, Other inputs at V_{CC} or GND				0.4			0.4	mA
C_i		V_{CC} = 3.3 V,	V_I = 3.3 V or 0		3.5			3.5		pF
C_o		V_{CC} = 3.3 V,	V_O = 3.3 V or 0		6			6		pF

(1) Product preview
(2) All typical values are at V_{CC} = 2.5 V, T_A = 25°C.
(3) The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.
(4) The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.
(5) An external driver must source at least I_{BHLO} to switch this node from low to high.
(6) An external driver must sink at least I_{BHHO} to switch this node from high to low.
(7) Current into an output in the high state when V_O > V_{CC}
(8) High-impedance state during power up or power down
(9) This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

Timing Requirements

over recommended operating free-air temperature range V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

			SN54ALVTH16374(1)		SN74ALVTH16374		UNIT
			MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency			150		150	MHz
t_w	Pulse duration, CLK high or low		1.5		1.5		ns
t_{su}	Setup time, data before CLK↑	Data high	1.1		1		ns
		Data low	1.4		1.3		
t_h	Hold time, data after CLK↑	Data high	0.6		0.5		ns
		Data low	0.9		0.8		

(1) Product preview

Timing Requirements

over recommended operating free-air temperature range V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 2)

			SN54ALVTH16374(1)		SN74ALVTH16374		UNIT
			MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency			25		250	MHz
t_w	Pulse duration, CLK high or low		1.5		1.5		ns
t_{su}	Setup time, data before CLK↑	Data high	1.1		1		ns
		Data low	1.6		1.5		
t_h	Hold time, data after CLK↑	Data high	0.6		0.5		ns
		Data low	1.1		1		

(1) Product preview

Switching Characteristics

over recommended operating free-air temperature range, C_L = 30 pF, V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH16374(1)		SN74ALVTH16374		UNIT
			MIN	MAX	MIN	MAX	
f_{max}			150		150		MHz
t_{PLH}	CLK	Q	1.4	3.9	1.5	3.8	ns
t_{PHL}			1.4	3.9	1.5	3.8	
t_{PZH}	$\overline{OE}$	Q	1	4.2	1	4.1	ns
t_{PZL}			1	3.8	1	3.7	
t_{PHZ}	$\overline{OE}$	Q	1.7	4.3	1.8	4.2	ns
t_{PLZ}			1	3.5	1	3.4	

(1) Product preview

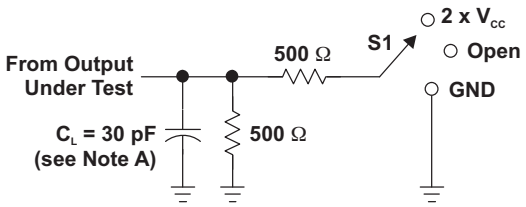
Switching Characteristics

over recommended operating free-air temperature range, C_L = 50 pF, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH16374(1)		SN74ALVTH16374		UNIT
			MIN	MAX	MIN	MAX	
f_{max}			250		250		MHz
t_{PLH}	CLK	Q	1	3.4	1	3.2	ns
t_{PHL}			1	3.3	1	3.2	
t_{PZH}	$\overline{OE}$	Q	1	3.9	1	3.8	ns
t_{PZL}			1	3.4	1	3.3	
t_{PHZ}	$\overline{OE}$	Q	1	4.7	1	4.6	ns
t_{PLZ}			1	4.4	1	4.2	

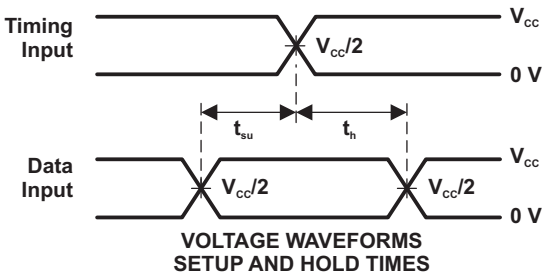
(1) Product preview

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 2.5 V ± 0.2 V

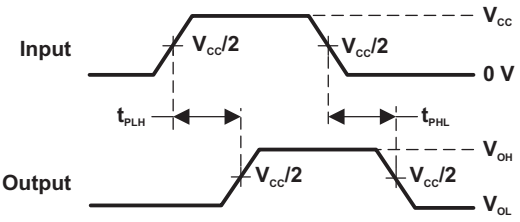


LOAD CIRCUIT

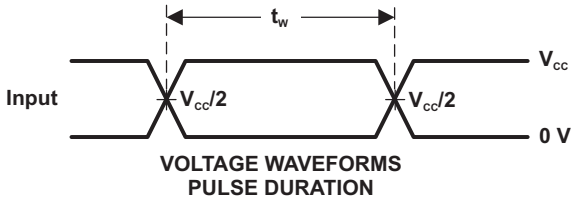
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	2 x V_{CC}
t_{PHZ}/t_{PZH}	GND



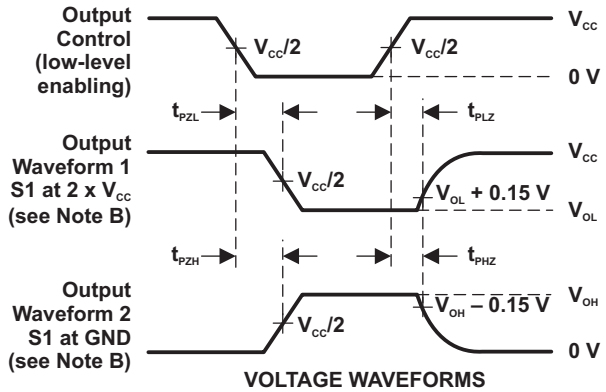
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION

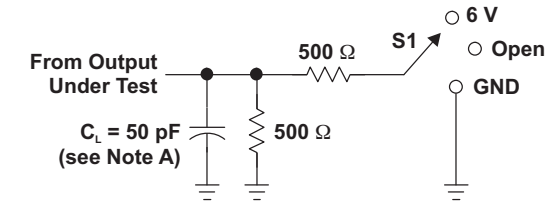


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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, t_r ≤ 2 ns, t_f ≤ 2 ns.
D. The outputs are measured one at a time, with one transition per measurement.

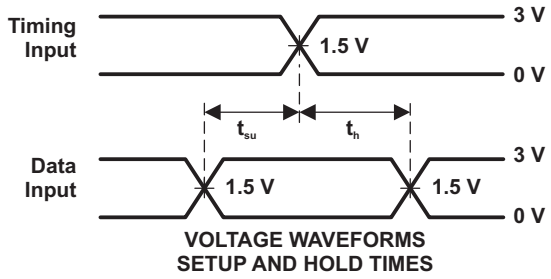
Figure 1. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 3.3 V ±0.3 V

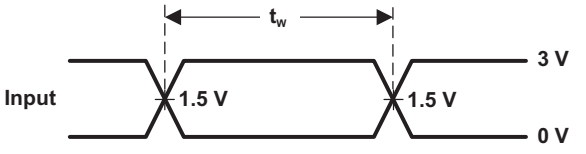


LOAD CIRCUIT

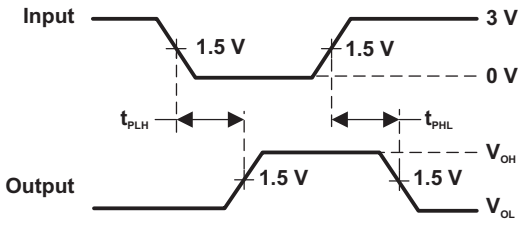
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



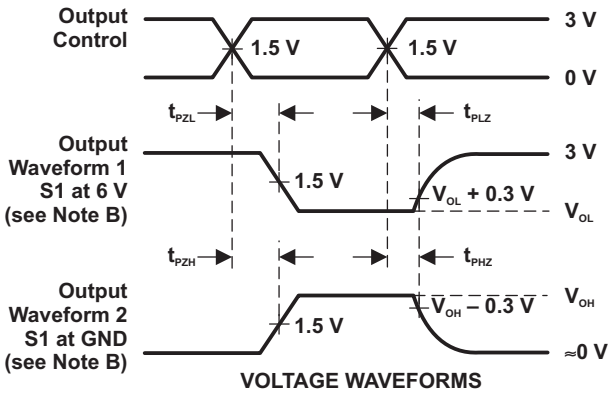
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
D. The outputs are measured one at a time, with one transition per measurement.

Figure 2. 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)
74ALVTH16374DLG4	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVTH16374DLRG4	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVTH16374GRE4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVTH16374VRE4	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVTH16374ZQLR	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	56	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM
SN74ALVTH16374DL	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVTH16374DLR	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVTH16374GR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVTH16374KR	ACTIVE	BGA MICROSTAR JUNIOR	GQL	56	1000	TBD	SNPB	Level-1-240C-UNLIM
SN74ALVTH16374VR	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

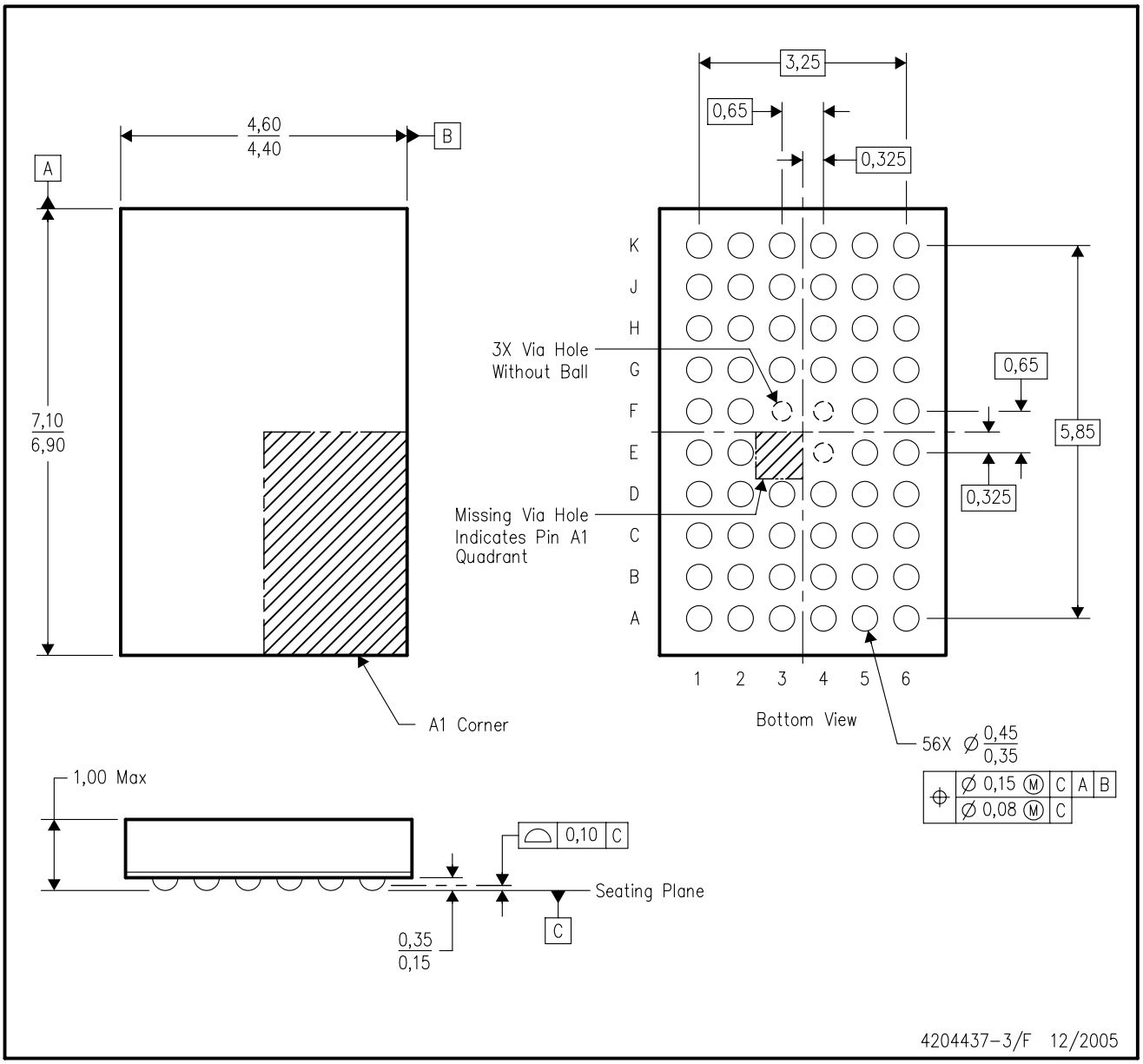
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers,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

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

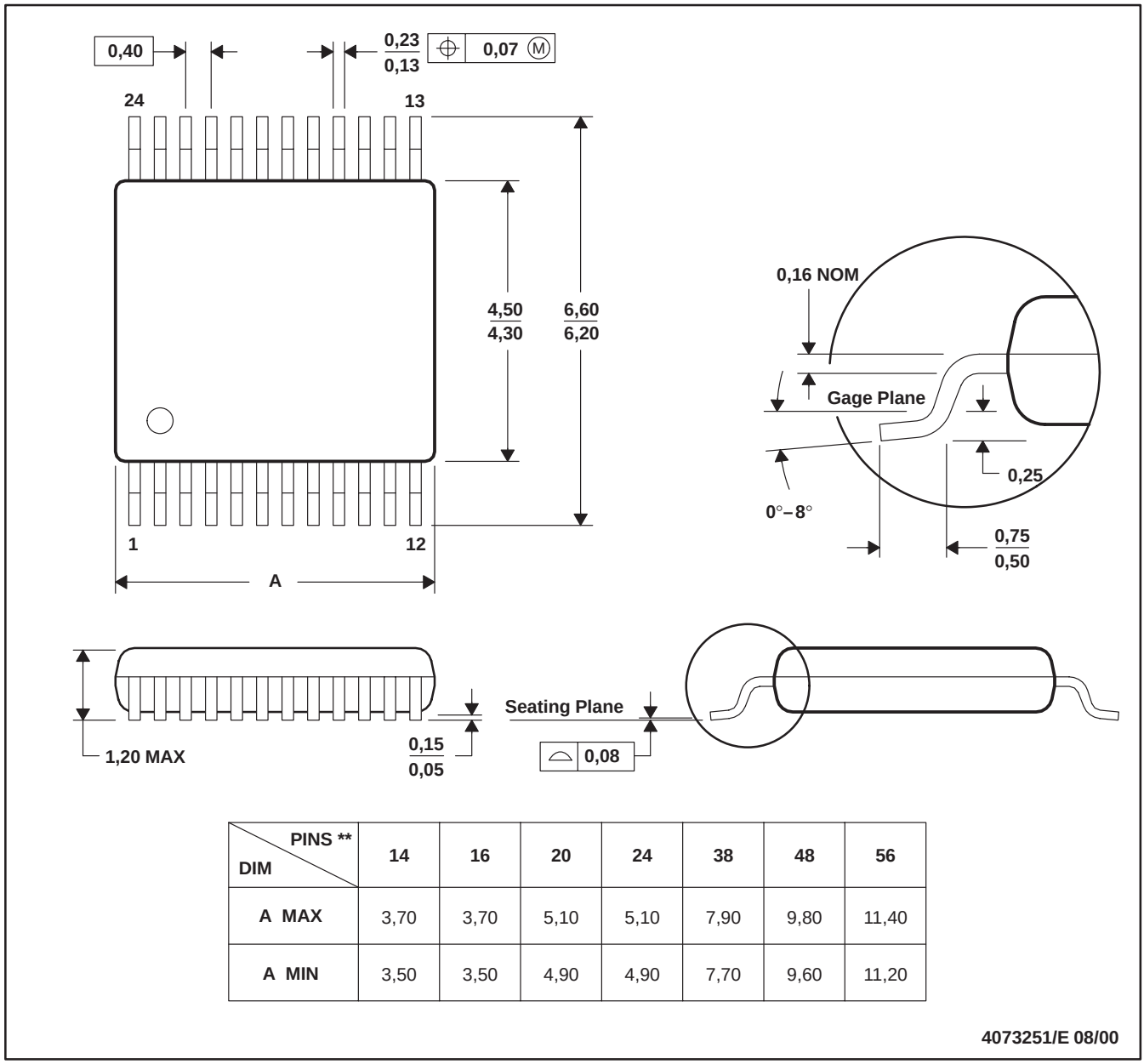
ZQL (R–PBGA–N56) PLASTIC BALL GRID ARRAY



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. Falls within JEDEC MO–225 variation BA.
D. This package is lead–free. Refer to the 56 GQL package (drawing 4200583) for tin–lead (SnPb).

DGV (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

24 PINS SHOWN



DIM \ PINS **	14	16	20	24	38	48	56
A MAX	3,70	3,70	5,10	5,10	7,90	9,80	11,40
A MIN	3,50	3,50	4,90	4,90	7,70	9,60	11,20

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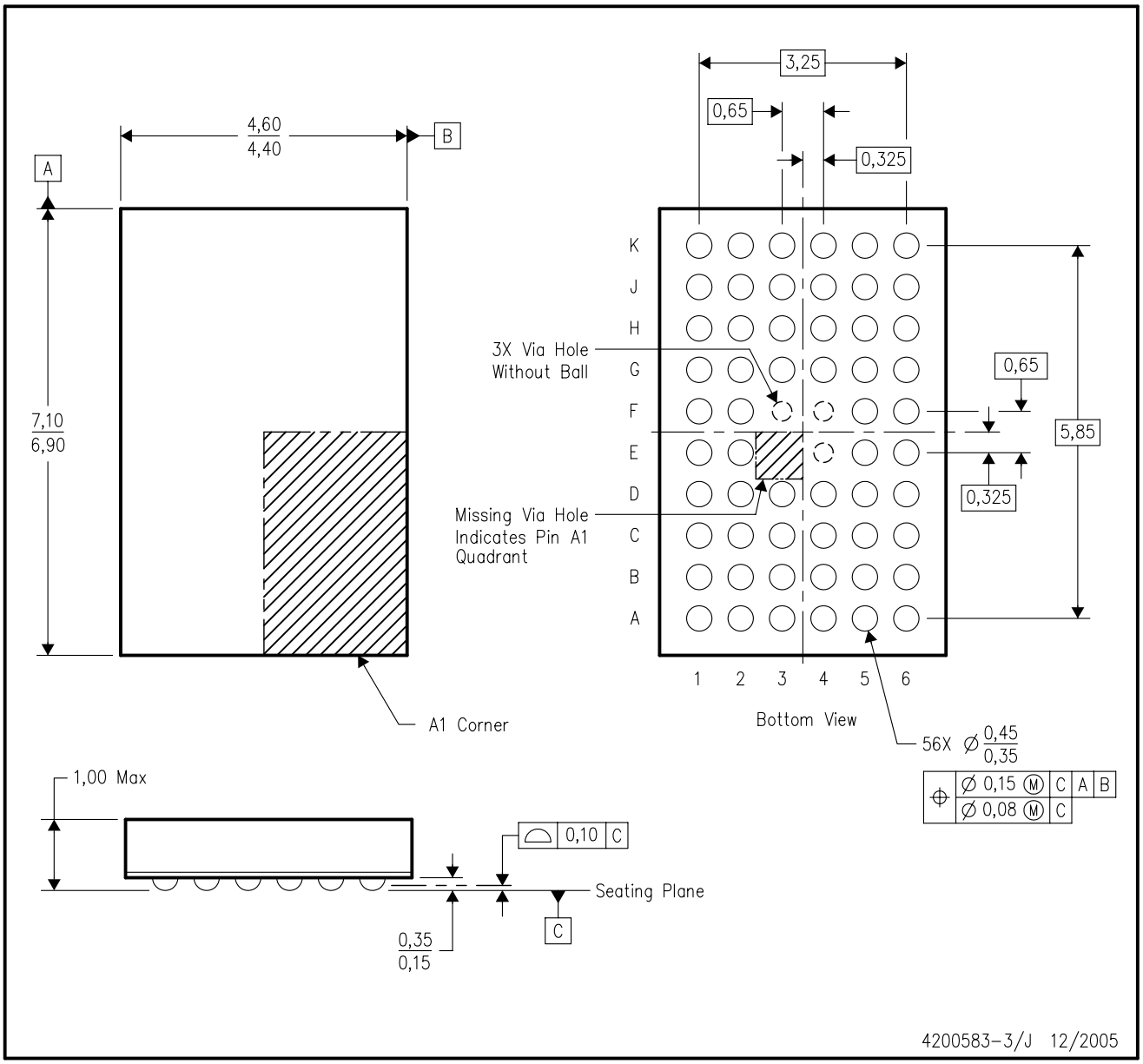
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
D. Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

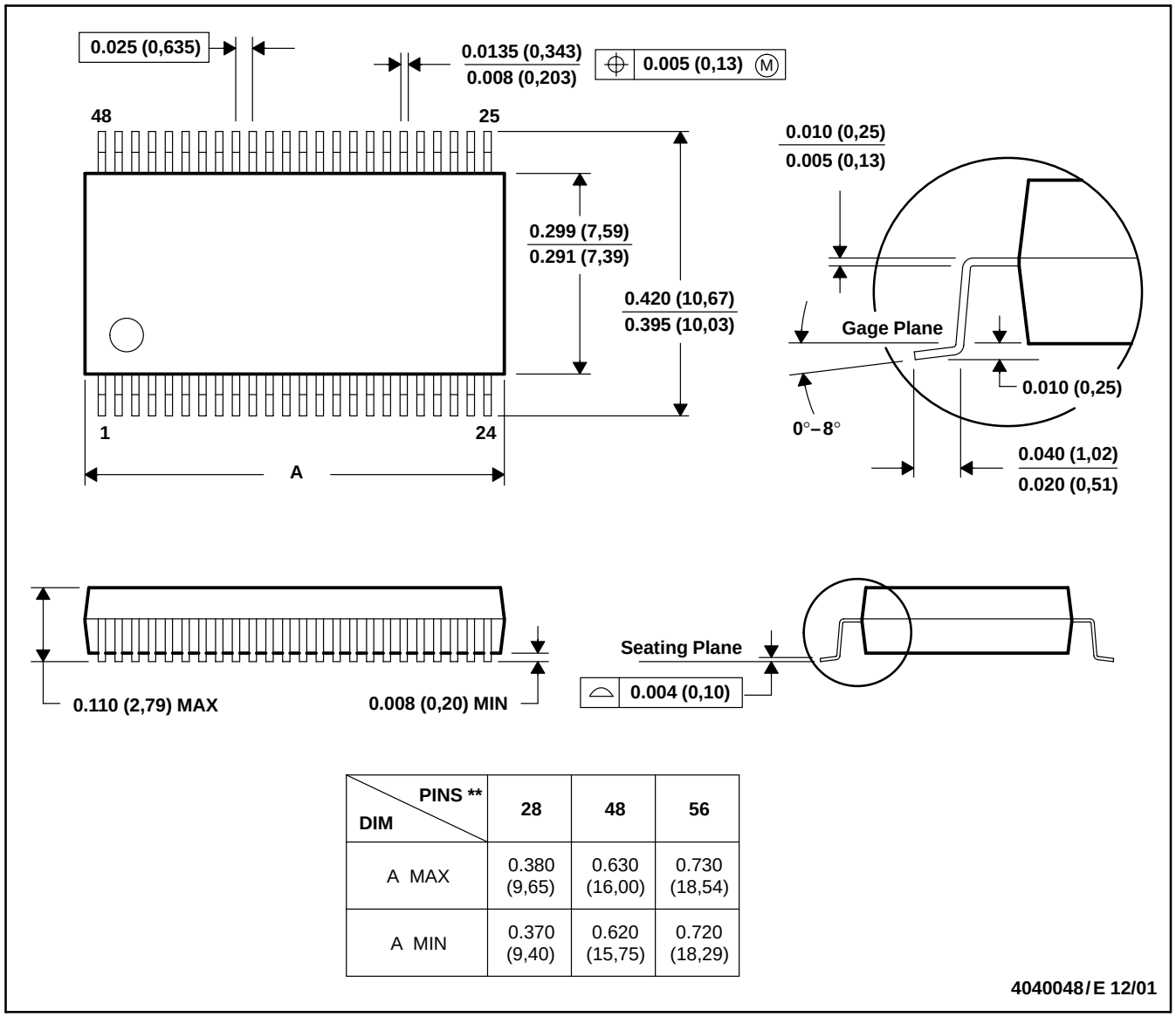
GQL (R–PBGA–N56) PLASTIC BALL GRID ARRAY



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. Falls within JEDEC MO–225 variation BA.
D. This package is tin–lead (SnPb). Refer to the 56 ZQL package (drawing 4204437) for lead–free.

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

48 PINS SHOWN



DIM \ PINS **	28	48	56
A MAX	0.380 (9,65)	0.630 (16,00)	0.730 (18,54)
A MIN	0.370 (9,40)	0.620 (15,75)	0.720 (18,29)

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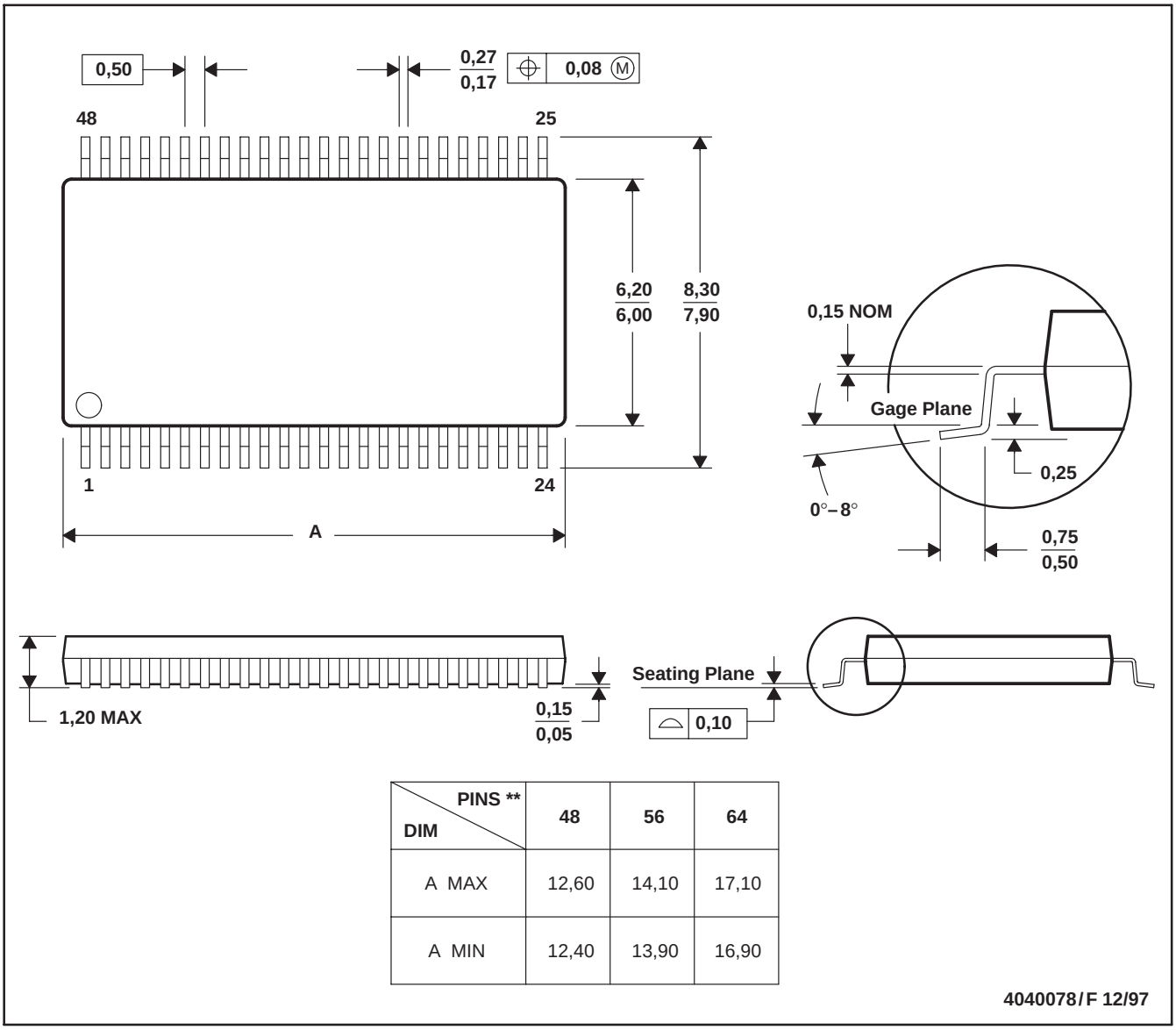
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MO-118

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

48 PINS SHOWN



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

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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