

SN74GTLP2033

8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER WITH SPLIT LVTTTL PORT AND FEEDBACK PATH

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

description (continued)

GTLP is the Texas Instruments derivative of the Gunning Transceiver Logic (GTL) JEDEC standard JESD 8-3. The ac specification of the SN74GTLP2033 is given only at the preferred higher noise-margin GTLP, but the user has the flexibility of using this device at either GTL ($V_{TT} = 1.2\text{ V}$ and $V_{REF} = 0.8\text{ V}$) or GTLP ($V_{TT} = 1.5\text{ V}$ and $V_{REF} = 1\text{ V}$) signal levels. For information on using GTLP devices in FB+/BTL applications, refer to TI application reports, *Texas Instruments GTLP Frequently Asked Questions*, literature number SCEA019, and *GTLP in BTL Applications*, literature number SCEA017.

Normally, the B port operates at GTLP signal levels. The A-port and control inputs operate at LVTTTL logic levels, but are 5-V tolerant and can be directly driven by TTL or 5-V CMOS devices. V_{REF} is the B-port differential input reference voltage.

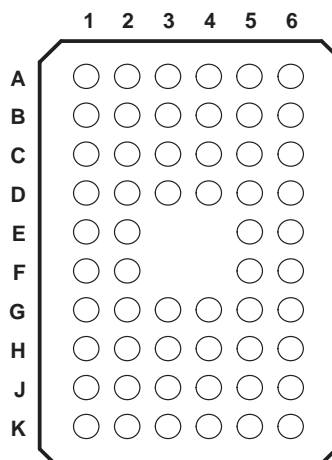
This device is fully specified for live-insertion applications using I_{off} , power-up 3-state, and BIAS V_{CC} . The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict. The BIAS V_{CC} circuitry precharges and preconditions the B-port input/output connections, preventing disturbance of active data on the backplane during card insertion or removal, and permits true live-insertion capability.

This GTLP device features TI-OPC circuitry, which actively limits overshoot caused by improperly terminated backplanes, unevenly distributed cards, or empty slots during low-to-high signal transitions. This improves signal integrity, which allows adequate noise margin to be maintained at higher frequencies.

High-drive GTLP backplane interface devices feature adjustable edge-rate control (ERC). Changing the ERC input voltage between low and high adjusts the B-port output rise and fall times. This allows the designer to optimize system data-transfer rate and signal integrity to the backplane load.

When V_{CC} is between 0 and 1.5 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V, \overline{OEAB} should be tied to V_{CC} through a pullup resistor and OEAB and OEBA should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sinking/current-sourcing capability of the driver.

**GQL PACKAGE
(TOP VIEW)**



terminal assignments

	1	2	3	4	5	6
A	IMODE1	NC	NC	NC	NC	IMODE0
B	AO1	AI1	GND	GND	BIAS V_{CC}	B1
C	AO2	AI2	V_{CC}	ERC	\overline{OEAB}	B2
D	AO3	AI3	GND	GND	\overline{OEAB}	B3
E	AO4	AI4			CLKAB/LEAB	B4
F	AO5	AI5			CLKBA/LEBA	B5
G	AO6	AI6	GND	GND	OEBA	B6
H	AO7	AI7	V_{CC}	V_{CC}	LOOPBACK	B7
J	AO8	AI8	GND	GND	V_{REF}	B8
K	OMODE0	NC	NC	NC	NC	OMODE1

NC = No internal connection

SN74GTLP2033

**8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER
WITH SPLIT LVTTTL PORT AND FEEDBACK PATH**

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

ORDERING INFORMATION

T _A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TSSOP – DGG	Tape and reel	SN74GTLP2033DGGR	GTLP2033
	TVSOP – DGV	Tape and reel	SN74GTLP2033DGVR	GT2033
	VFBGA – GQL	Tape and reel	SN74GTLP2033GQLR	GR033

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

functional description

The SN74GTLP2033 is a high-drive (100 mA), 8-bit, three-wire registered transceiver containing D-type latches and D-type flip-flops for data-path operation in the transparent, latched, or flip-flop modes. Data transmission is complementary, with inverted AI data going to the B port and inverted B data going to AO. The split LVTTTL AI and AO provides a feedback path for control and diagnostics monitoring.

The logic element for data flow in each direction is configured by two mode (IMODE1 and IMODE0 for B to A, OMODE1 and OMODE0 for A to B) inputs as a buffer, D-type flip-flop, or D-type latch. When configured in the buffer mode, the inverted input data appears at the output port. In the flip-flop mode, data is stored on the rising edge of the appropriate clock (CLKAB/LEAB or CLKBA/LEBA) input. In the latch mode, the clock inputs serve as active-high transparent latch enables.

Data flow in the B-to-A direction, regardless of the logic element selected, is further controlled by the LOOPBACK input. When LOOPBACK is low, B-port data is the B-to-A input. When LOOPBACK is high, the output of the selected A-to-B logic element (prior to inversion) is the B-to-A input.

The AO enable/disable control is provided by OEBA. When OEBA is low or when V_{CC} is less than 1.5 V, AO is in the high-impedance state. When OEBA is high, AO is active (high or low logic levels).

The B port is controlled by OEAB and \overline{OEAB} . If OEAB is low, \overline{OEAB} is high, or V_{CC} is less than 1.5 V, the B port is inactive. If OEAB is high and \overline{OEAB} is low, the B port is active.

The A-to-B and B-to-A logic elements are active, regardless of the state of their associated outputs. The logic elements can enter new data (in flip-flop and latch modes) or retain previously stored data while the associated outputs are in the high-impedance (AO) or inactive (B port) states.

8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER WITH SPLIT LVTTTL PORT AND FEEDBACK PATH

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

Function Tables

FUNCTION/MODE

INPUTS								OUTPUT	MODE
OEBA	OEAB	\overline{OEAB}	OMODE1	OMODE0	IMODE1	IMODE0	LOOPBACK		
L	L	X	X	X	X	X	X	Z	Isolation
L	X	H	X	X	X	X	X	Z	Isolation
X	H	L	L	L	X	X	X	Inverted AI to B	Buffer
X	H	L	L	H	X	X	X	Inverted AI to B	Flip-flop
X	H	L	H	X	X	X	X	Inverted AI to B	Latch
H	L	X	X	X	L	L	L	Inverted B to AO	Buffer
H	X	H	X	X	L	L	L	Inverted B to AO	Buffer
H	L	X	X	X	L	H	L	Inverted B to AO	Flip-flop
H	X	H	X	X	L	H	L	Inverted B to AO	Flip-flop
H	L	X	X	X	H	X	L	Inverted B to AO	Latch
H	X	H	X	X	H	X	L	Inverted B to AO	Latch
H	L	X	X	X	L	L	H	AI to AO	Buffer
H	X	H	X	X	L	L	H	AI to AO	Buffer
H	L	X	X	X	L	H	H	AI to AO	Flip-flop
H	X	H	X	X	L	H	H	AI to AO	Flip-flop
H	L	X	X	X	H	X	H	AI to AO	Latch
H	X	H	X	X	H	X	H	AI to AO	Latch
H	H	L	X	X	X	X	L	Inverted AI to B, Inverted B to AO	Transparent with feedback path

ENABLE/DISABLE

INPUTS			OUTPUTS	
OEBA	OEAB	\overline{OEAB}	AO	B
L	X	X	Z	
H	X	X	Active	
X	L	L		Z
X	L	H		Z
X	H	L		Active
X	H	H		Z

BUFFER

INPUT	OUTPUT
L	H
H	L

LATCH

INPUTS		OUTPUT
CLK/LE	DATA	
H	L	H
H	H	L
L	X	Q ₀

SN74GTLP2033

**8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER
WITH SPLIT LVTTTL PORT AND FEEDBACK PATH**

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

Function Tables (Continued)

LOOPBACK

LOOPBACK	Q [†]
L	B port
H	Point P [‡]

[†]Q is the input to the B-to-A logic element.

[‡]P is the output of the A-to-B logic element (see functional block diagram).

SELECT

INPUTS		SELECTED LOGIC ELEMENT
MODE1	MODE0	
L	L	Buffer
L	H	Flip-flop
H	X	Latch

FLIP-FLOP

INPUTS		OUTPUT
CLK/LE	DATA	
L	X	Q ₀
↑	L	H
↑	H	L

B-PORT EDGE-RATE CONTROL (ERC)

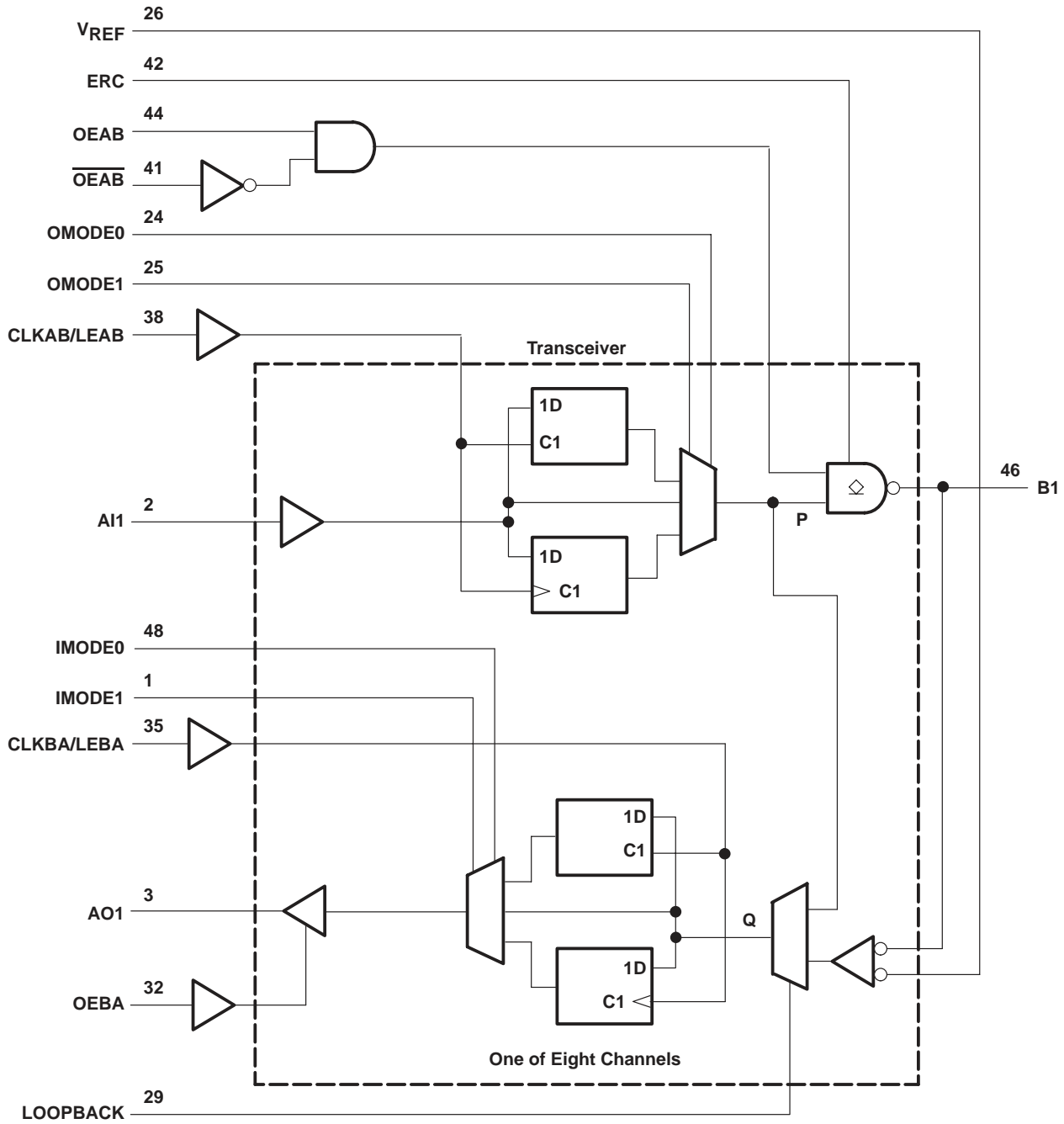
INPUT ERC	OUTPUT B-PORT EDGE RATE
LOGIC LEVEL	
H	Slow
L	Fast

SN74GTLP2033

8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER WITH SPLIT LVTTTL PORT AND FEEDBACK PATH

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

functional block diagram



Pin numbers shown are for the DGG and DGV packages.

SN74GTLP2033

**8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER
WITH SPLIT LVTTTL PORT AND FEEDBACK PATH**

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

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

Supply voltage range, V_{CC} and BIAS V_{CC}	-0.5 V to 4.6 V
Input voltage range, V_I (see Note 1): AI port, ERC, and control inputs	-0.5 V to 7 V
B port and V_{REF}	-0.5 V to 4.6 V
Voltage range applied to any output in the high-impedance or power-off state, V_O (see Note 1): AO port	-0.5 V to 7 V
B port	-0.5 V to 4.6 V
Current into any output in the low state, I_O : AO port	48 mA
B port	200 mA
Current into any A-port output in the high state, I_O (see Note 2)	48 mA
Continuous current through each V_{CC} or GND	± 100 mA
Input clamp current, I_{IK} ($V_I < 0$)	-50 mA
Output clamp current, I_{OK} ($V_O < 0$)	-50 mA
Package thermal impedance, θ_{JA} (see Note 3): DGG package	70°C/W
DGV package	58°C/W
GQL package	42°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 current flows only when the output is in the high state and $V_O > V_{CC}$.
 3. The package thermal impedance is calculated in accordance with JESD 51-7.



SN74GTLP2033

8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER WITH SPLIT LVTTTL PORT AND FEEDBACK PATH

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

recommended operating conditions (see Notes 4 through 7)

		MIN	NOM	MAX	UNIT	
V_{CC} , BIAS V_{CC}	Supply voltage	3.15	3.3	3.45	V	
V_{TT}	Termination voltage	GTL	1.14	1.2	1.26	V
		GTLP	1.35	1.5	1.65	
V_{REF}	Reference voltage	GTL	0.74	0.8	0.87	V
		GTLP	0.87	1	1.1	
V_I	Input voltage	B port	V_{TT}		V	
		Except B port and V_{REF}	V_{CC}	5.5		
V_{IH}	High-level input voltage	B port	$V_{REF}+0.05$		V	
		Except B port	2			
V_{IL}	Low-level input voltage	B port	$V_{REF}-0.05$		V	
		Except B port	0.8			
I_{IK}	Input clamp current			-18	mA	
I_{OH}	High-level output current	AO			-24	mA
I_{OL}	Low-level output current	AO			24	mA
		B port			100	
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10	ns/V	
$\Delta t/\Delta V_{CC}$	Power-up ramp rate	20			$\mu s/V$	
T_A	Operating free-air temperature	-40		85	$^{\circ}C$	

- NOTES: 4. All unused control and B-port 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.
5. Proper connection sequence for use of the B-port I/O precharge feature is GND and BIAS $V_{CC} = 3.3$ V first, I/O second, and $V_{CC} = 3.3$ V last, because the BIAS V_{CC} precharge circuitry is disabled when any V_{CC} pin is connected. The control and V_{REF} inputs can be connected anytime, but normally are connected during the I/O stage. If B-port precharge is not required, any connection sequence is acceptable but, generally, GND is connected first.
6. V_{TT} and R_{TT} can be adjusted to accommodate backplane impedances if the dc recommended I_{OL} ratings are not exceeded.
7. V_{REF} can be adjusted to optimize noise margins, but normally is two-thirds V_{TT} . TI-OPC circuitry is enabled in the A-to-B direction and is activated when $V_{TT} > 0.7$ V above V_{REF} . If operated in the A-to-B direction, V_{REF} should be set to within 0.6 V of V_{TT} to minimize current drain.



SN74GTL2033

**8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER
WITH SPLIT LVTTTL PORT AND FEEDBACK PATH**

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

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

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V _{IK}		V _{CC} = 3.15 V, I _I = -18 mA				-1.2	V
V _{OH}	AO	V _{CC} = 3.15 V to 3.45 V, I _{OH} = -100 μA		V _{CC} -0.2			V
		V _{CC} = 3.15 V		2.4			
V _{OL}	AO	V _{CC} = 3.15 V to 3.45 V, I _{OL} = 100 μA				0.2	V
		V _{CC} = 3.15 V		I _{OL} = 12 mA		0.4	
				I _{OL} = 24 mA		0.5	
	B port	V _{CC} = 3.15 V		I _{OL} = 10 mA		0.2	
				I _{OL} = 64 mA		0.4	
				I _{OL} = 100 mA		0.55	
I _I ‡	AI and control inputs	V _{CC} = 3.45 V, V _I = 0 or 5.5 V				±10	μA
I _{OZ} ‡	AO	V _{CC} = 3.45 V, V _O = 0 to 5.5 V				±10	μA
	B port	V _{CC} = 3.45 V, V _{REF} within 0.6 V of V _{TT} , V _O = 0 to 2.3 V				±10	
I _{CC}	AO or B port	V _{CC} = 3.45 V, I _O = 0, V _I (A-port or control input) = V _{CC} or GND, V _I (B port) = V _{TT} or GND		Outputs high		40	mA
				Outputs low		40	
				Outputs disabled		40	
ΔI _{CC} §		V _{CC} = 3.45 V, One AI or control input at V _{CC} - 0.6 V, Other AI or control inputs at V _{CC} or GND				1.5	mA
C _i	AI	V _I = 3.15 V or 0			3.5	4.5	pF
	Control inputs				3.5	5.5	
C _o	AO	V _O = 3.15 V or 0			5	6	pF
C _{io}	B port	V _O = 1.5 V or 0			8.5	10	pF

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

‡ For I/O ports, the parameter I_{OZ} includes the input leakage current.

§ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

hot-insertion specifications for A port over recommended operating free-air temperature range

PARAMETER	TEST CONDITIONS			MIN	MAX	UNIT
I _{off}	V _{CC} = 0,	V _I or V _O = 0 to 5.5 V			10	μA
I _{OZPU}	V _{CC} = 0 to 1.5 V,	V _O = 0.5 V to 3 V,	OEBA = V _{CC}		±30	μA
I _{OZPD}	V _{CC} = 1.5 V to 0,	V _O = 0.5 V to 3 V,	OEBA = V _{CC}		±30	μA

live-insertion specifications for B port over recommended operating free-air temperature range

PARAMETER	TEST CONDITIONS			MIN	MAX	UNIT
I _{off}	V _{CC} = 0,	BIAS V _{CC} = 0,	V _I or V _O = 0 to 1.5 V		10	μA
I _{OZPU}	V _{CC} = 0 to 1.5 V, BIAS V _{CC} = 0, V _O = 0.5 V to 1.5 V, OEAB = 0 and OEAB = V _{CC}				±30	μA
I _{OZPD}	V _{CC} = 1.5 V to 0, BIAS V _{CC} = 0, V _O = 0.5 V to 1.5 V, OEAB = 0 and OEAB = V _{CC}				±30	μA
I _{CC} (BIAS V _{CC})	V _{CC} = 0 to 3.15 V	BIAS V _{CC} = 3.15 V to 3.45 V, V _O (B port) = 0 to 1.5 V			5	mA
	V _{CC} = 3.15 V to 3.45 V				10	
V _O	V _{CC} = 0,	BIAS V _{CC} = 3.3 V,	I _O = 0	0.95	1.05	V
I _O	V _{CC} = 0,	BIAS V _{CC} = 3.15 V to 3.45 V,	V _O (B port) = 0.6 V	-1		μA



SN74GTLP2033

8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER WITH SPLIT LVTTTL PORT AND FEEDBACK PATH

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

timing requirements over recommended ranges of supply voltage and operating free-air temperature, $V_{TT} = 1.5\text{ V}$ and $V_{REF} = 1\text{ V}$ for GTLP (unless otherwise noted)

			MIN	MAX	UNIT
f_{clock}	Clock frequency			175	MHz
t_w	Pulse duration	CLKAB/LEAB or CLKBA/LEBA	2.8		ns
t_{su}	Setup time	A1 before CLKAB \uparrow	1.1		ns
		A1 before CLKBA \uparrow	1.4		
		B before CLKBA \uparrow	1		
		A1 before LEAB \downarrow	1.6		
		A1 before LEBA \downarrow	2.1		
		B before LEBA \downarrow	2.2		
t_h	Hold time	A1 after CLKAB \uparrow	0.3		ns
		A1 after CLKBA \uparrow	0.2		
		B after CLKBA \uparrow	0.6		
		A1 after LEAB \downarrow	0.3		
		A1 after LEBA \downarrow	0		
		B after LEBA \downarrow	0		



SN74GTLP2033

**8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER
WITH SPLIT LVTTTL PORT AND FEEDBACK PATH**

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $V_{TT} = 1.5\text{ V}$ and $V_{REF} = 1\text{ V}$ for GTLP (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	EDGE RATE†	MIN	TYP‡	MAX	UNIT
f_{max}				175			MHz
t_{PLH}	AI (buffer)	B	Slow	3		7.4	ns
t_{PHL}				3		7.1	
t_{PLH}	AI (buffer)	B	Fast	2		5.9	ns
t_{PHL}				2		5.8	
t_{PLH}	B (buffer)	AO	–	1		5.7	ns
t_{PHL}				1		5	
t_{PLH}	LEAB (latch mode)	B	Slow	4.2		8.6	ns
t_{PHL}				3.2		7.7	
t_{PLH}	LEAB (latch mode)	B	Fast	3.2		7.6	ns
t_{PHL}				2.8		6.7	
t_{PLH}	LEAB (latch mode)	AO	–	2		7	ns
t_{PHL}				1.8		6.3	
t_{PLH}	LEBA (latch mode)	AO	–	1		5.7	ns
t_{PHL}				1		4.7	
t_{PLH}	OEAB	B	Slow	3.8		7.5	ns
t_{PHL}				3.1		7	
t_{PLH}	OEAB	B	Fast	2.5		6	ns
t_{PHL}				2.5		6	
t_{PLH}	$\overline{\text{OEAB}}$	B	Slow	3.5		7.5	ns
t_{PHL}				3		7.2	
t_{PLH}	$\overline{\text{OEAB}}$	B	Fast	2.5		6	ns
t_{PHL}				2.5		6	
t_{PZH}	OEBA	AO	–	1		4.7	ns
t_{PZL}				1		3.4	
t_{PHZ}	OEBA	AO	–	1		5.2	ns
t_{PLZ}				1		4.9	
t_{PLH}	CLKAB (flip-flop mode)	B	Slow	4.4		8.8	ns
t_{PHL}				3.6		8.1	
t_{PLH}	CLKAB (flip-flop mode)	B	Fast	3.2		7.2	ns
t_{PHL}				3.1		6.9	
t_{PLH}	CLKAB (flip-flop mode)	AO	–	2		6.9	ns
t_{PHL}				1.8		6.4	
t_{PLH}	CLKBA (flip-flop mode)	AO	–	1		5.6	ns
t_{PHL}				1		4.9	
t_{PLH}	OMODE	B	Slow	3.8		8.7	ns
t_{PHL}				3.2		8.2	
t_{PLH}	OMODE	B	Fast	2.7		7.2	ns
t_{PHL}				2.7		7.2	
t_{PLH}	IMODE	AO	–	1		5.6	ns
t_{PHL}				1		4.6	

† Slow (ERC = H) and Fast (ERC = L)

‡ All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.



SN74GTLP2033

8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER WITH SPLIT LVTTTL PORT AND FEEDBACK PATH

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $V_{TT} = 1.5\text{ V}$ and $V_{REF} = 1\text{ V}$ for GTLP (see Figure 1) (continued)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	EDGE RATE†	MIN	TYP‡	MAX	UNIT
t_{PLH}	LOOPBACK	AO	–	2.5	6.2	6.2	ns
t_{PHL}				2	5	5	
t_{PLH}	AI (loopback high)	AO	–	1	5.6	5.6	ns
t_{PHL}				1	5	5	
t_r	Rise time, \bar{B} -port outputs (20% to 80%)		Slow	2.8		ns	
			Fast	1.5			
	Rise time, AO (10% to 90%)			3.5			
t_f	Fall time, \bar{B} -port outputs (80% to 20%)		Slow	3		ns	
			Fast	1.8			
	Fall time, AO (90% to 10%)			1.5			

† Slow (ERC = H) and Fast (ERC = L)

‡ All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

skew characteristics over recommended ranges of supply voltage and operating free-air temperature (see Figure 1)§

PARAMETER	FROM (INPUT)	TO (OUTPUT)	EDGE RATE†	MIN	TYP‡	MAX	UNIT
$t_{sk(LH)}^{\parallel}$	AI	B	Slow	0.5	1	ns	
$t_{sk(HL)}^{\parallel}$				0.5	1		
$t_{sk(LH)}^{\parallel}$	AI	B	Fast	0.4	0.9	ns	
$t_{sk(HL)}^{\parallel}$				0.4	0.9		
$t_{sk(LH)}^{\parallel}$	CLKAB/LEAB	B	Slow	0.5	1	ns	
$t_{sk(HL)}^{\parallel}$				0.5	1		
$t_{sk(LH)}^{\parallel}$	CLKAB/LEAB	B	Fast	0.4	0.9	ns	
$t_{sk(HL)}^{\parallel}$				0.4	0.9		
$t_{sk(t)}^{\parallel}$	AI	B	Slow	1.4	2	ns	
			Fast	0.6	1.4		
	CLKAB/LEAB	B	Slow	1.8	2.5		
			Fast	0.9	1.8		

† Slow (ERC = L) and Fast (ERC = H)

‡ All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

§ Actual skew values between the GTLP outputs could vary on the backplane due to the loading and impedance seen by the device.

¶ $t_{sk(LH)}/t_{sk(HL)}$ and $t_{sk(t)}$ – Output-to-output skew is defined as the absolute value of the difference between the actual propagation delay for all outputs with the same packaged device. The specifications are given for specific worst-case V_{CC} and temperature and apply to any outputs switching in the same direction either high to low [$t_{sk(HL)}$] or low to high [$t_{sk(LH)}$] or in opposite directions, both low to high and high to low [$t_{sk(t)}$].

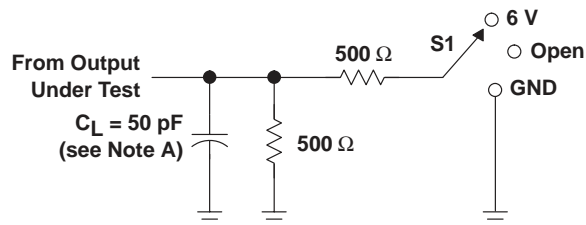


SN74GTL2033

8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER WITH SPLIT LVTTTL PORT AND FEEDBACK PATH

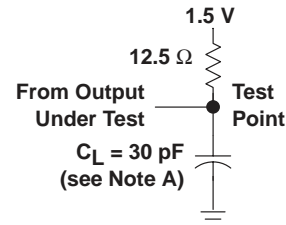
SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

PARAMETER MEASUREMENT INFORMATION

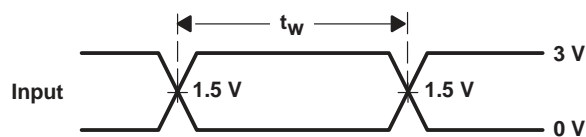


LOAD CIRCUIT FOR A OUTPUTS

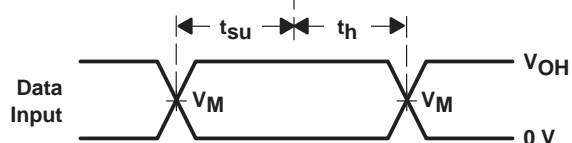
TEST	S1
t _{PLH} /t _{PHL}	Open
t _{PLZ} /t _{PZL}	6 V
t _{PHZ} /t _{PZH}	GND



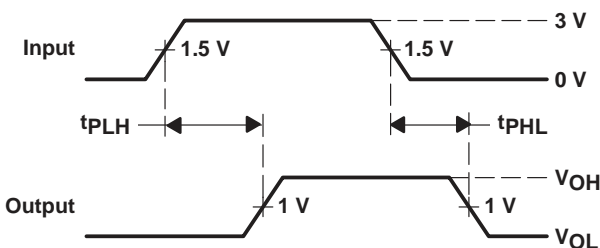
LOAD CIRCUIT FOR B OUTPUTS



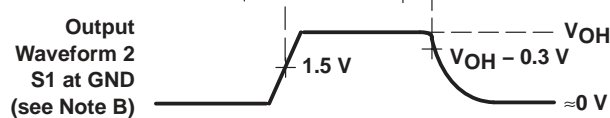
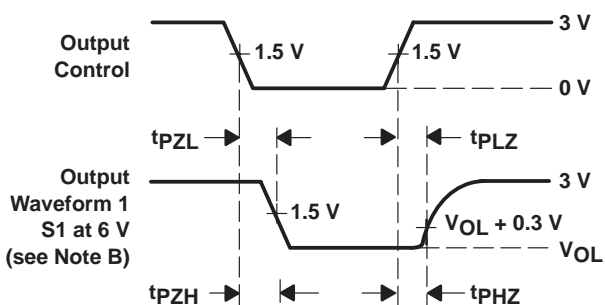
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES
(VM = 1.5 V for A port and 1 V for B port)
(VOH = 3 V for A port and 1.5 V for B port)



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
(A to B port)



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
(AO)

- NOTES: A. CL 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, ZO = 50 Ω, tr ≈ 2 ns, tf ≈ 2 ns.
 D. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms

DISTRIBUTED-LOAD BACKPLANE SWITCHING CHARACTERISTICS

The preceding switching characteristics table shows the switching characteristics of the device into a lumped load (Figure 1). However, the designer’s backplane application is probably a distributed load. The physical representation is shown in Figure 2. This backplane, or distributed load, can be approximated closely to a resistor inductance capacitance (RLC) circuit, as shown in Figure 3. This device has been designed for optimum performance in this RLC circuit. The following switching characteristics table shows the switching characteristics of the device into the RLC load, to help the designer to better understand the performance of the GTLP device in this typical backplane. See www.ti.com/sc/gtlp for more information.

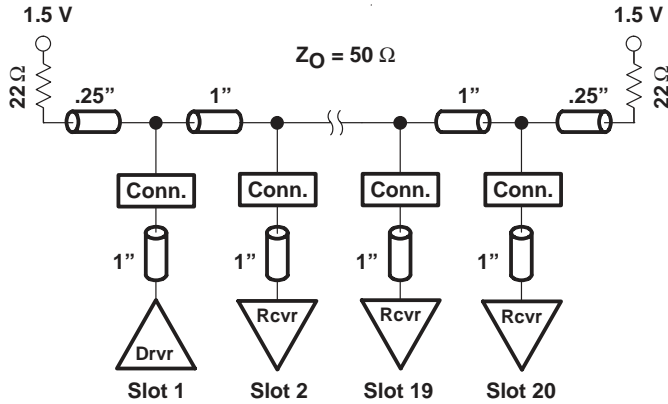


Figure 2. High-Drive Test Backplane

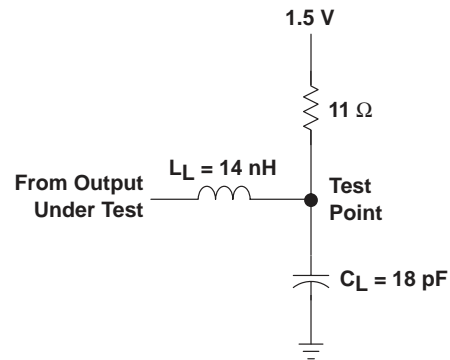


Figure 3. High-Drive RLC Network

SN74GTLP2033

8-BIT LVTTTL-TO-GTLP ADJUSTABLE-EDGE-RATE REGISTERED TRANSCEIVER WITH SPLIT LVTTTL PORT AND FEEDBACK PATH

SCES352C – JUNE 2001 – REVISED SEPTEMBER 2001

switching characteristics over recommended operating conditions for the bus transceiver function (unless otherwise noted) (see Figure 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	EDGE RATE†	TYP‡	UNIT
t _{PLH}	AI (buffer)	B	Slow	4.7	ns
t _{PHL}				5	
t _{PLH}	AI (buffer)	B	Fast	3.7	ns
t _{PHL}				4	
t _{PLH}	LEAB (latch mode)	B	Slow	5.5	ns
t _{PHL}				5.8	
t _{PLH}	LEAB (latch mode)	B	Fast	4.6	ns
t _{PHL}				4.8	
t _{PLH}	CLKAB (flip-flop mode)	B	Slow	5.8	ns
t _{PHL}				6	
t _{PLH}	CLKAB (flip-flop mode)	B	Fast	4.9	ns
t _{PHL}				4.9	
t _{PLH}	OMODE	B	Slow	5.5	ns
t _{PHL}				5.7	
t _{PLH}	OMODE	B	Fast	4.5	ns
t _{PHL}				4.7	
t _r	Rise time, \overline{B} -port outputs (20% to 80%)		Slow	1.8	ns
			Fast	1.1	
t _f	Fall time, \overline{B} -port outputs (80% to 20%)		Slow	3.4	ns
			Fast	2.6	

† Slow (ERC = H) and Fast (ERC = L)

‡ All typical values are at V_{CC} = 3.3 V, T_A = 25°C. All values are derived from TI-SPICE models.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
74GTLP2033DGGRE4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	GTLP2033	Samples
74GTLP2033DGGRG4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	GTLP2033	Samples
SN74GTLP2033DGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	GTLP2033	Samples
SN74GTLP2033ZQLR	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	56		TBD	Call TI	Call TI	-40 to 85	GR033	Samples

(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.

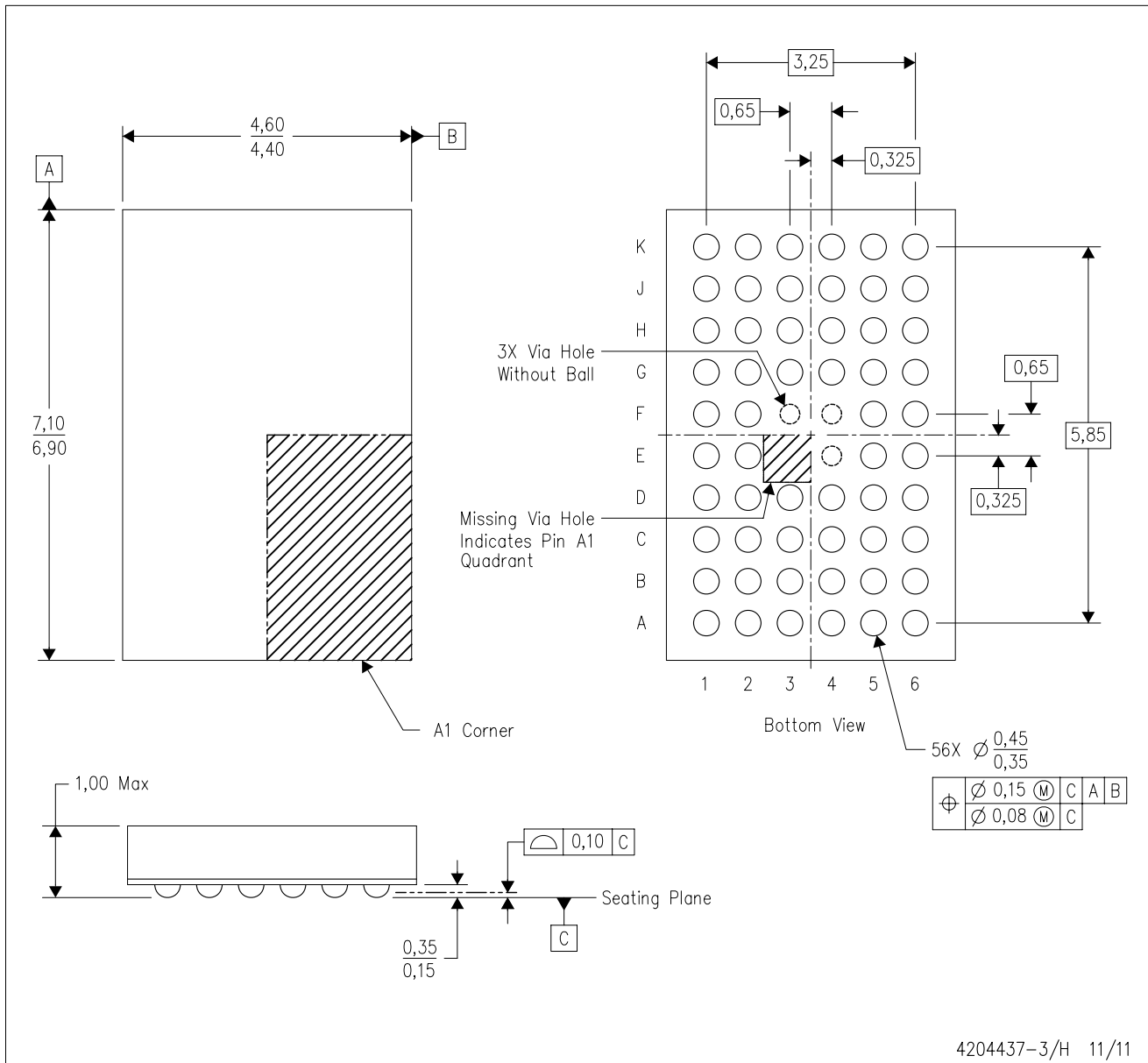
(4) Only one of markings shown within the brackets will appear on the physical device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

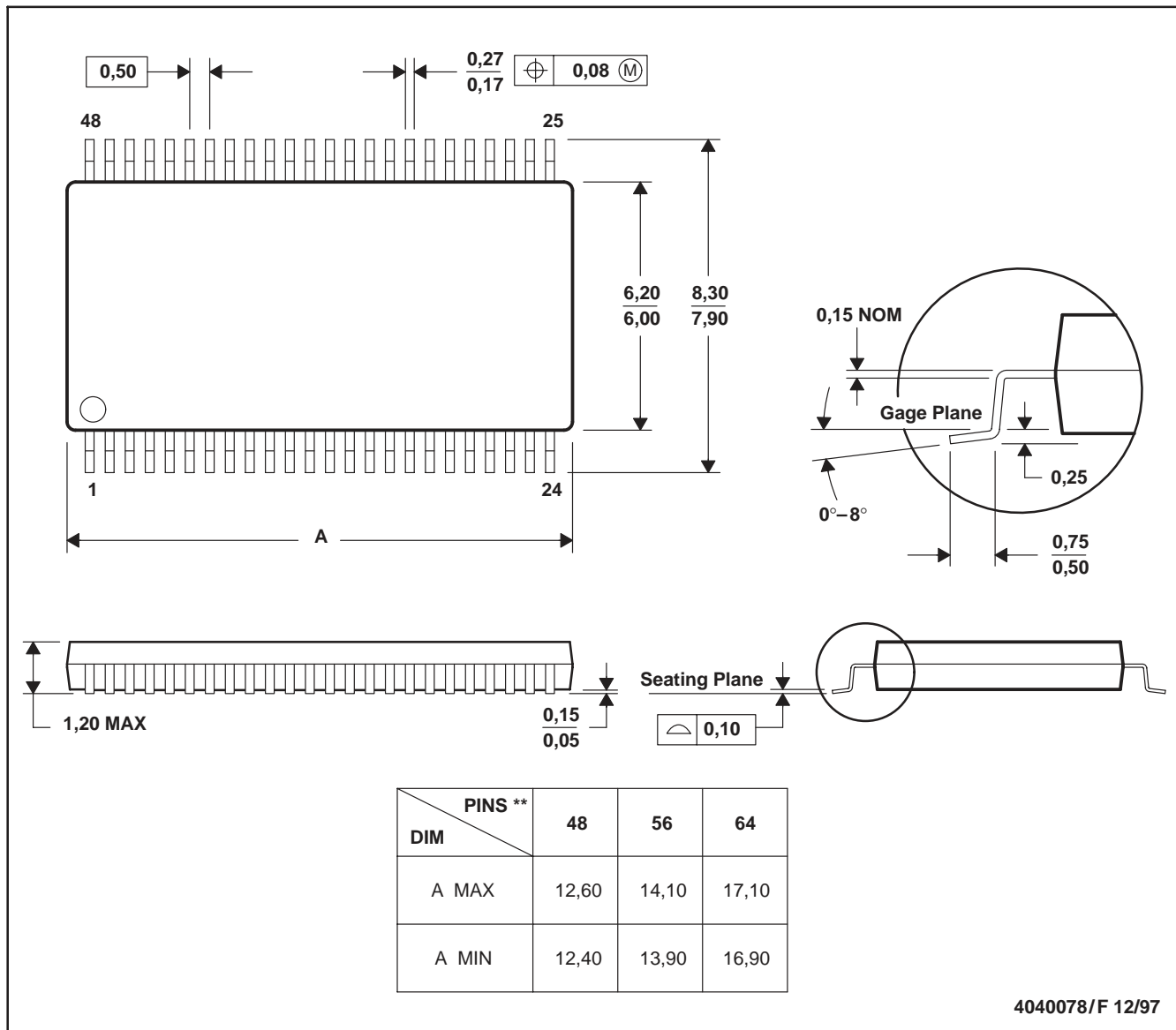


- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MO-285 variation BA-2.
 - D. This package is Pb-free. Refer to the 56 GQL package (drawing 4200583) for tin-lead (SnPb).

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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com