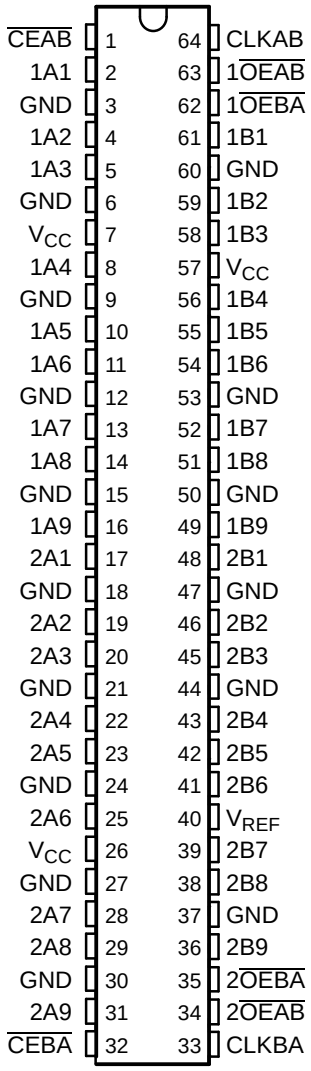
SN74GTL16923
18-BIT LVTTL-TO-GTL/GTL+ BUS TRANSCEIVER

SCBS674G – AUGUST 1996 – REVISED APRIL 2005

FEATURES

- **Member of the Texas Instruments Widebus™ Family**
- **OEC™ Circuitry Improves Signal Integrity and Reduces Electromagnetic Interference**
- **D-Type Flip-Flops With Qualified Storage Enable**
- **Translates Between GTL/GTL+ Signal Levels and LVTTL Logic Levels**
- **Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltages With 3.3-V V_{CC})**
- **I_{off} Supports Partial-Power-Down Mode Operation**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors on A Port**
- **Distributed V_{CC} and GND Pins Minimize High-Speed Switching Noise**
- **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)



DESCRIPTION/ORDERING INFORMATION

The SN74GTL16923 is an 18-bit registered bus transceiver that provides LVTTL-to-GTL/GTL+ and GTL/GTL+-to-LVTTL signal-level translation. This device is partitioned as two 9-bit transceivers with individual output-enable controls and contains D-type flip-flops for temporary storage of data flowing in either direction. This device provides an interface between cards operating at LVTTL logic levels and a backplane operating at GTL/GTL+ signal levels. Higher-speed operation is a direct result of the reduced output swing (<1 V), reduced input threshold levels, and OEC™ circuitry.

The user has the flexibility of using this device at either GTL (V_{TT} = 1.2 V and V_{REF} = 0.8 V) or the preferred higher noise margin GTL+ (V_{TT} = 1.5 V and V_{REF} = 1 V) signal levels. GTL+ is the Texas Instruments derivative of the Gunning Transceiver Logic (GTL) JEDEC standard JESD 8-3. The B port normally operates at GTL or GTL+ signal levels, while the A-port and control inputs are compatible with LVTTL logic levels. All inputs can be driven from either 3.3-V or 5-V devices, which allows use in a mixed 3.3-V/5-V system environment. V_{REF} is the reference input voltage for the B port.

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

Data flow in each direction is controlled by the output-enable ($\overline{OEAB}$ and $\overline{OEBA}$) and clock (CLKAB and CLKBA) inputs. The clock-enable ($\overline{CEAB}$ and $\overline{CEBA}$) inputs enable or disable the clock for all 18 bits at a time. However, $\overline{OEAB}$ and $\overline{OEBA}$ are designed to control each 9-bit transceiver independently, which makes the device more versatile.

For A-to-B data flow, the device operates on the low-to-high transition of CLKAB if $\overline{CEAB}$ is low. When $\overline{OEAB}$ is low, the outputs are active. When $\overline{OEAB}$ is high, the outputs are in the high-impedance state. Data flow for B to A is similar to that of A to B, but uses $\overline{OEBA}$, CLKBA, and $\overline{CEBA}$.

This device is fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

Active bus-hold circuitry holds unused or undriven LVTTL inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

To ensure the high-impedance state during power up or power down, $\overline{OE}$ 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.

ORDERING INFORMATION

T_A	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TSSOP – DGG	Tape and reel	SN74GTL16923DGGR	GTL16923

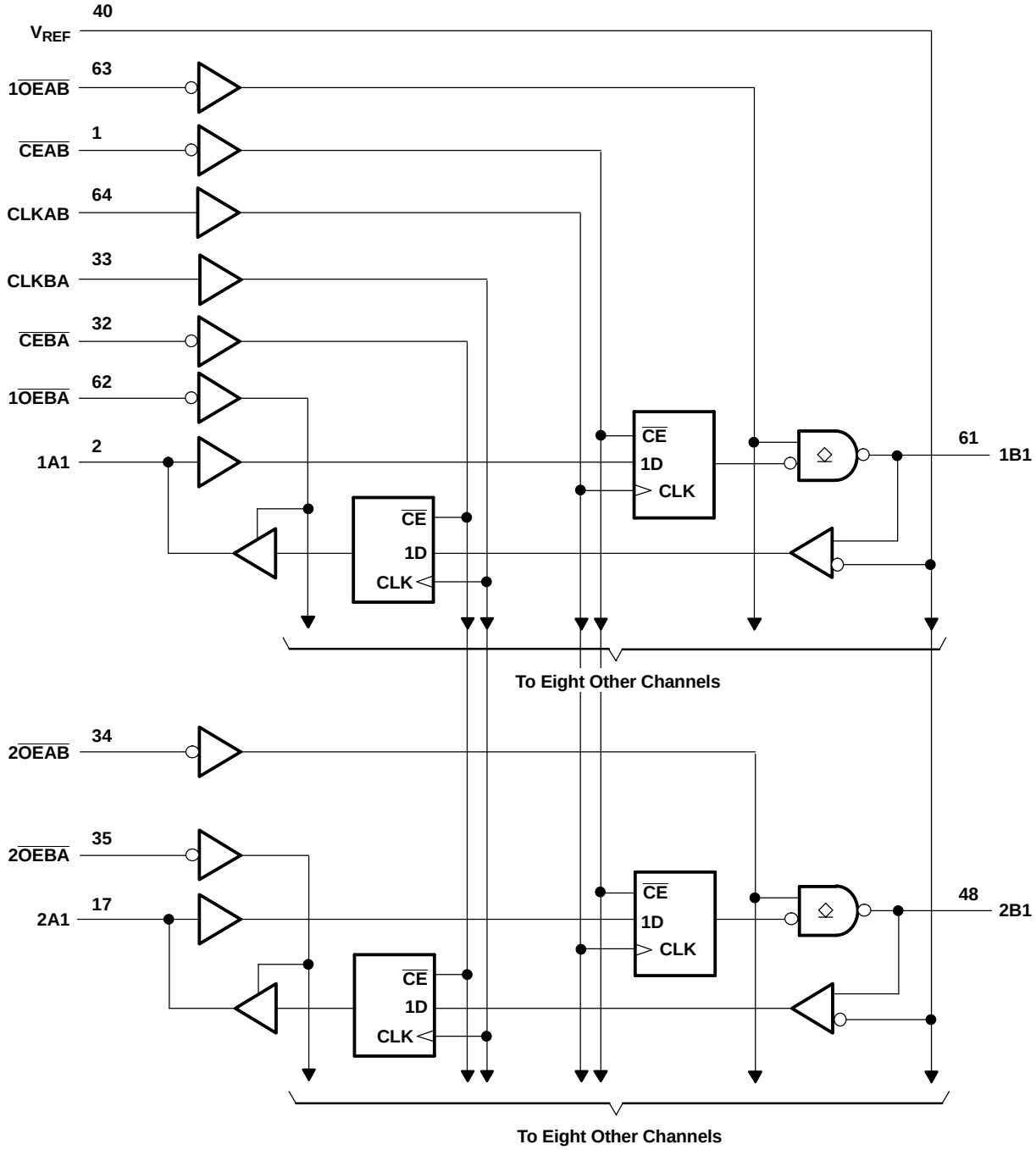
(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE(1)

INPUTS				OUTPUT B	MODE
$\overline{CEAB}$	$\overline{OEAB}$	CLKAB	A		
X	H	X	X	Z	Isolation
H	L	X	X	B_0(2)	Latched storage of A data
X	L	H or L	X	B_0(2)	
L	L	↑	L	L	Clocked storage of A data
L	L	↑	H	H	

(1) A-to-B data flow is shown. B-to-A data flow is similar, but uses $\overline{OEBA}$, CLKBA, and $\overline{CEBA}$.
(2) Output level before the indicated steady-state input conditions were established

LOGIC DIAGRAM (POSITIVE LOGIC)



Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	4.6	V
V_I	Input voltage range(2)		–0.5	7	V
V_O	Voltage range applied to any output in the high or power-off state(2)		–0.5	7	V
I_O	Current into any output in the low state	A port		48	mA
		B port		100	
I_O	Current into any A-port output in the high state(3)			48	mA
	Continuous current through each V_{CC} or GND			±100	mA
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)			55	°C/W
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
(3) This current flows only when the output is in the high state and $V_O > V_{CC}$.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions(1)(2)(3)(4)

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		3.15	3.3	3.45	V
V_{TT}	Termination voltage	GTL	1.14	1.2	1.26	V
		GTL+	1.35	1.5	1.65	
V_{REF}	Reference voltage	GTL	0.74	0.8	0.87	V
		GTL+	0.87	1	1.1	
V_I	Input voltage	B port	0		V_{TT}	V
		Except B port	0		5.5	
V_{IH}	High-level input voltage	B port	V_{REF} + 50 mV			V
		Except B port	2			
V_{IL}	Low-level input voltage	B port			V_{REF} – 50 mV	V
		Except B port			0.8	
I_{IK}	Input clamp current				–18	mA
I_{OH}	High-level output current	A port			–24	mA
I_{OL}	Low-level output current	A port			24	mA
		B port			50	
T_A	Operating free-air temperature		–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) Normal connection sequence is GND first, V_{CC} = 3.3 V, I/O, control inputs, V_{TT}, V_{REF} (any order) last.
(3) V_{TT} and R_{TT} can be adjusted to accommodate backplane impedances if the dc recommended I_{OL} ratings are not exceeded.
(4) V_{REF} can be adjusted to optimize noise margins, but normally is two-thirds V_{TT}.

Electrical Characteristics

over recommended operating free-air temperature range for GTL/GTL+ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
V_{IK}		V_{CC} = 3.15 V, I_I = –18 mA				–1.2	V
V_{OH}	A port	V_{CC} = 3.15 V to 3.45 V,	I_{OH} = –100 μA	V_{CC} – 0.2			V
		V_{CC} = 3.15 V	I_{OH} = –12 mA	2.4			
			I_{OH} = –24 mA	2			
V_{OL}	A port	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 to 3.45 V,	I_{OL} = 100 μA			0.2	
		V_{CC} = 3.15 V	I_{OL} = 10 mA			0.2	
			I_{OL} = 40 mA			0.4	
			I_{OL} = 50 mA			0.55	
I_I	B port	V_{CC} = 3.45 V,	V_I = 5.5 V or GND			±5	μA
	A-port and control inputs	V_{CC} = 3.45 V	V_I = V_{CC} or GND			±5	
			V_I = 5.5 V or GND			±20	
I_{off}		V_{CC} = 0, V_I or V_O = 0 to 5.5 V				±100	μA
$I_{I(hold)}$	A port	V_{CC} = 3.15 V	V_I = 0.8 V	75			μA
			V_I = 2 V	–75			
		V_{CC} = 3.45 V(2),	V_I = 0.8 V to 2 V			±500	
I_{OZ}(3)	A port	V_{CC} = 3.45 V,	V_O = V_{CC} or GND			±10	μA
I_{OZH}	B port	V_{CC} = 3.45 V,	V_O = 1.5 V			10	μA
I_{CC}	A or B port	V_{CC} = 3.45 V, I_O = 0, V_I = V_{CC} or GND	Outputs high			60	mA
			Outputs low			60	
			Outputs disabled			60	
ΔI_{CC}(4)		V_{CC} = 3.45 V, A-port or control inputs at V_{CC} or GND, One input at V_{CC} – 0.6 V				500	μA
C_i	Control inputs	V_I = 3.15 V or 0			2.5	3	pF
C_{io}	A port	V_O = 3.15 V or 0			6	8.5	pF
	B port	V_O = 3.15 V or 0			7	9.5	

(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
(2) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.
(3) For I/O ports, the parameter I_{OZ} includes the input leakage current.
(4) 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 ranges of supply voltage and operating free-air temperature for GTL (unless otherwise noted)

			MIN	MAX	UNIT
f_{clock}	Clock frequency			200	MHz
t_w	Pulse duration, CLK high or low		2.5		ns
t_{su}	Setup time	Data before CLK↑	2.6		ns
		$\overline{CE}$ before CLK↑	3.3		
t_h	Hold time	Data after CLK↑	0.1		ns
		$\overline{CE}$ after CLK↑	0		

Switching Characteristics

over recommended ranges of supply voltage and operating free-air temperature for GTL (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP(1)	MAX	UNIT
f_{max}			200			MHz
t_{PLH}	CLKAB	B	2.2		5.8	ns
t_{PHL}			2.1		6.3	
t_{dis}	$\overline{OEAB}$	B	1.7		5.3	ns
t_{en}			2		5	
Slew rate	Both transitions			0.5		V/ns
t_r	Transition time, B outputs (0.6 V to 1 V)		0.3		2.9	ns
t_f	Transition time, B outputs (1 V to 0.6 V)		0.1		3.9	ns
t_{PLH}	CLKBA	A	1.8		5	ns
t_{PHL}			1.7		4.8	
t_{en}	$\overline{OEBA}$	A	1.3		4.8	ns
t_{dis}			2		4.8	

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

Timing Requirements

over recommended ranges of supply voltage and operating free-air temperature for GTL+ (unless otherwise noted)

			MIN	MAX	UNIT
f_{clock}	Clock frequency			200	MHz
t_w	Pulse duration, CLK high or low		2.5		ns
t_{su}	Setup time	Data before CLK↑	2.3		ns
		$\overline{CE}$ before CLK↑	3.3		
t_h	Hold time	Data after CLK↑	0.1		ns
		$\overline{CE}$ after CLK↑	0		

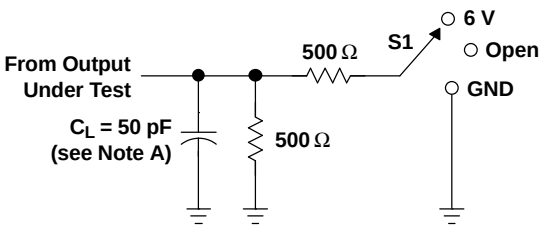
Switching Characteristics

over recommended ranges of supply voltage and operating free-air temperature for GTL+ (see Figure 1)

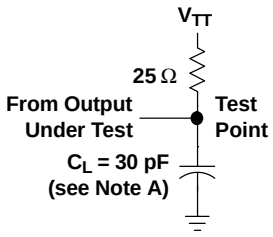
PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP(1)	MAX	UNIT
f_{max}			200			MHz
t_{PLH}	CLKAB	B	2.2	4	5.9	ns
t_{PHL}			2.1	4	6.1	
t_{PLH}	$\overline{OEAB}$	B	1.9	3.4	5.2	ns
t_{PHL}			1.7	3.1	5.1	
Slew rate	Both transitions			0.5		V/ns
t_r	Transition time, B outputs (0.6 V to 1.3 V)		0.6	1.3	2.6	ns
t_f	Transition time, B outputs (1.3 V to 0.6 V)		0.4	1.3	3	ns
t_{PLH}	CLKBA	A	1.8	3.5	5.1	ns
t_{PHL}			1.7	3.3	4.9	
t_{en}	$\overline{OEBA}$	A	1.3	2.9	4.8	ns
t_{dis}			2	3.2	5	

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

PARAMETER MEASUREMENT INFORMATION
V_{TT} = 1.5 V, V_{REF} = 1 V

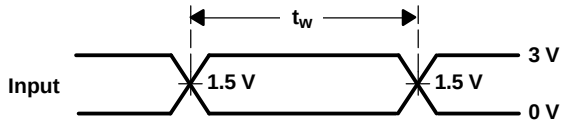


TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND

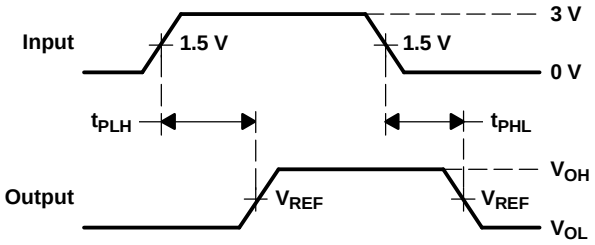


LOAD CIRCUIT FOR A OUTPUTS

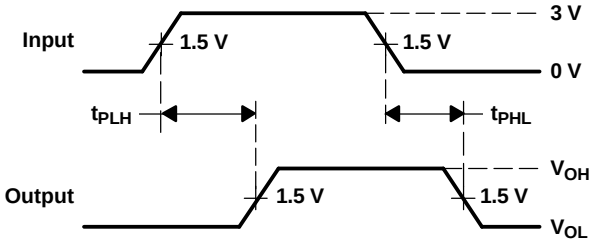
LOAD CIRCUIT FOR B OUTPUTS



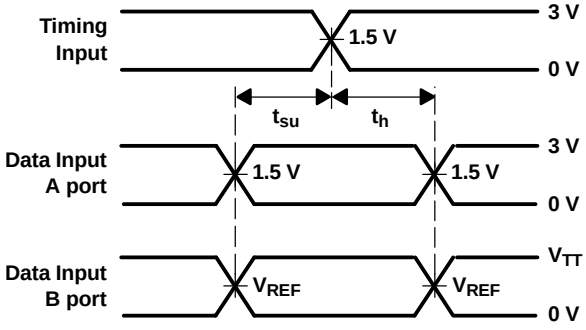
VOLTAGE WAVEFORMS
PULSE DURATION



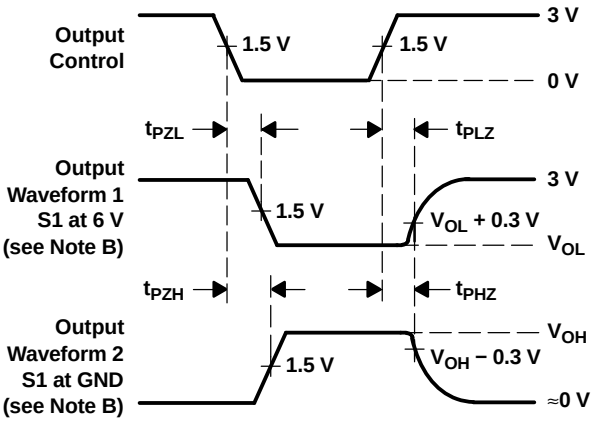
VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
(CLKAB to B port)



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
(CLKBA to A port)



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
(A port)

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 1. Load Circuits 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)	Op Temp (°C)	Device Marking (4/5)	Samples
74GTL16923DGGRE4	ACTIVE	TSSOP	DGG	64		TBD	Call TI	Call TI	-40 to 85	GTL16923	Samples
74GTL16923DGGRG4	ACTIVE	TSSOP	DGG	64		TBD	Call TI	Call TI	-40 to 85	GTL16923	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)

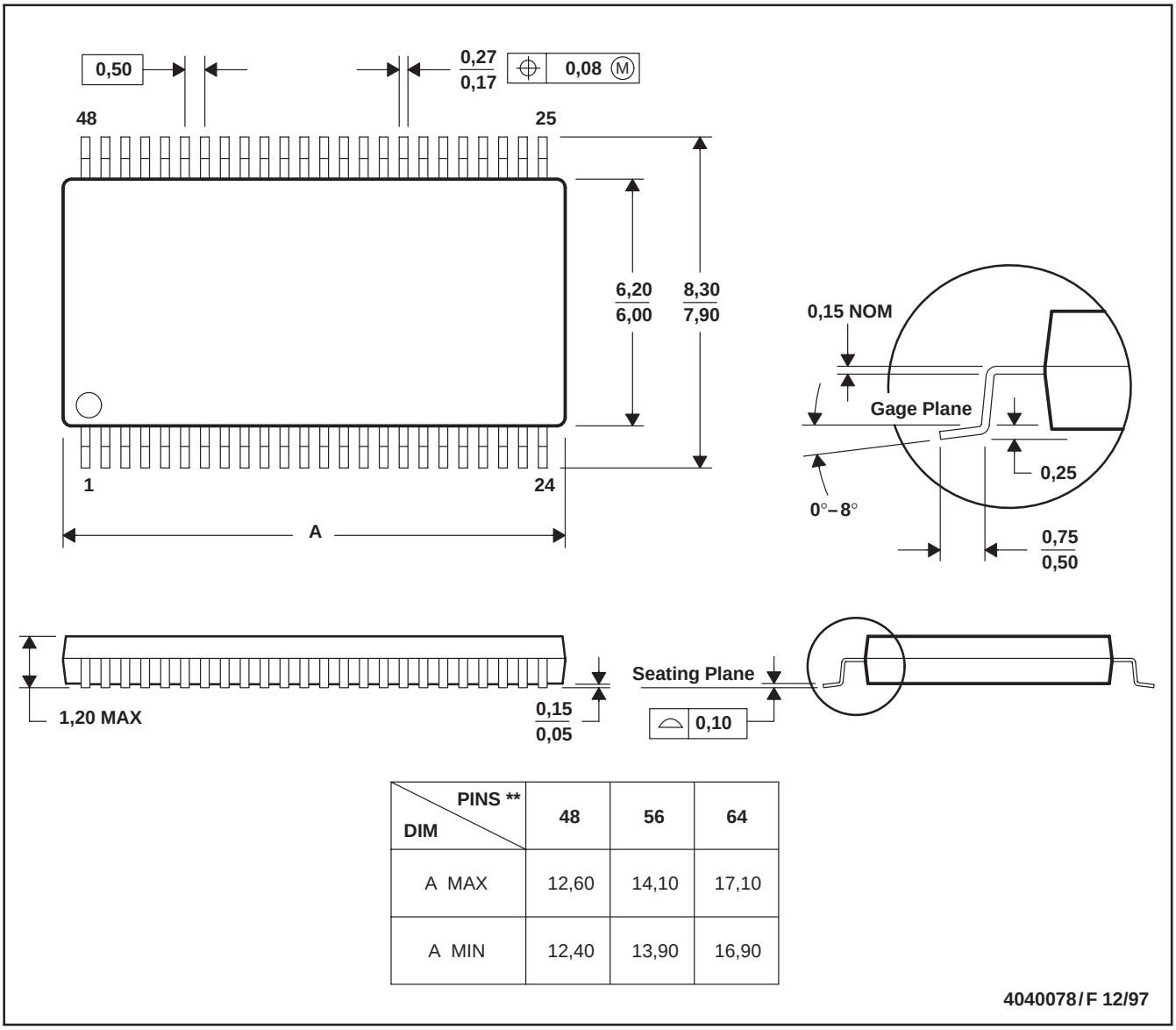
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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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