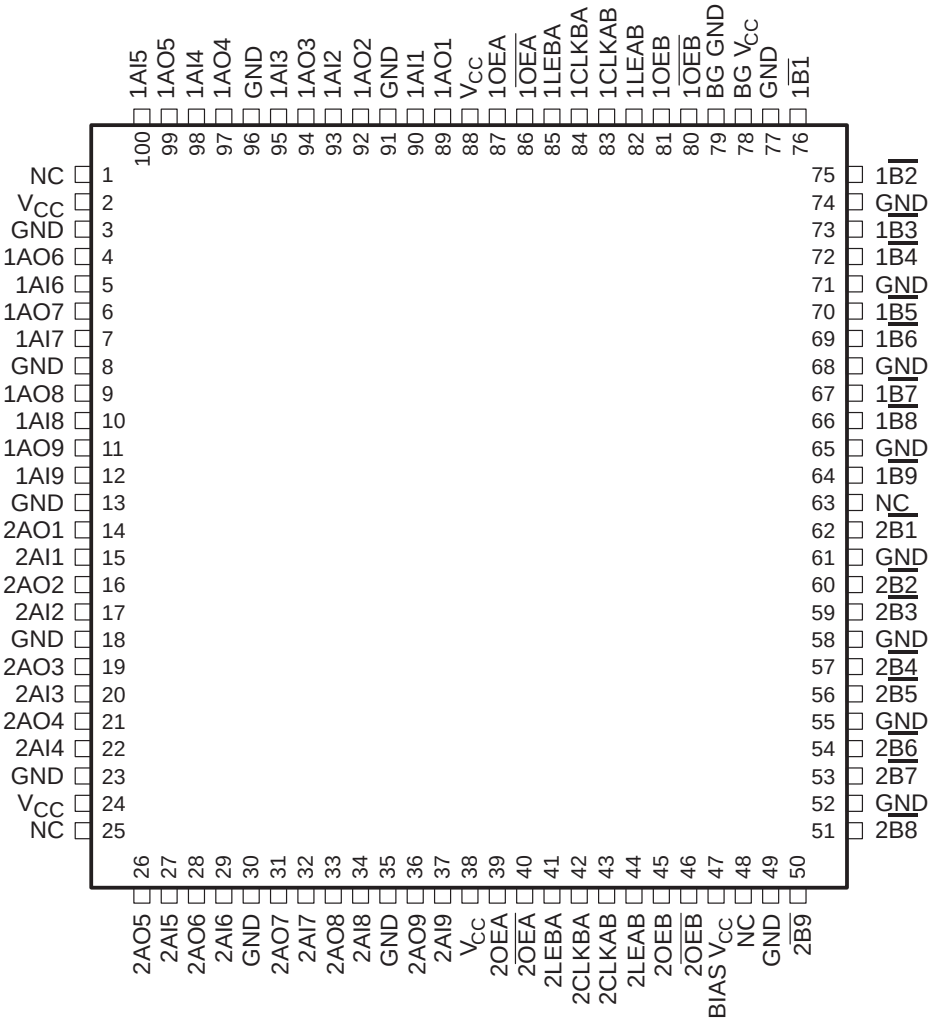
- **Compatible With IEEE Std 1194.1-1991 (BTL)**
- **TTL A Port, Backplane Transceiver Logic (BTL) $\overline{B}$ Port**
- **Open-Collector $\overline{B}$-Port Outputs Sink 100 mA**
- **BIAS V_{CC} Minimizes Signal Distortion During Live Insertion or Withdrawal**
- **High-Impedance State During Power Up and Power Down**
- **$\overline{B}$-Port Biasing Network Preconditions the Connector and PC Trace to the BTL High-Level Voltage**
- **TTL-Input Structures Incorporate Active Clamping to Aid in Line Termination**

PCA PACKAGE
(TOP VIEW)



NC − No internal connection

description/ordering information

The SN74FB1650 contains two 9-bit transceivers designed to translate signals between TTL and backplane transceiver-logic (BTL) environments. The device is designed specifically to be compatible with IEEE Std 1194.1-1991.

The $\overline{B}$ port operates at BTL-signal levels. The open-collector $\overline{B}$ ports are specified to sink 100 mA. Two output enables (OEB and $\overline{OEB}$) are provided for the $\overline{B}$ outputs. When OEB is low, $\overline{OEB}$ is high, or V_{CC} is less than 2.1 V, the $\overline{B}$ port is turned off.

The A port operates at TTL-signal levels. The A outputs reflect the inverse of the data at the $\overline{B}$ port when the A-port output enable (OEA) is high. When OEA is low or when V_{CC} is less than 2.1 V, the A outputs are in the high-impedance state.

BIAS V_{CC} establishes a voltage between 1.62 V and 2.1 V on the BTL outputs when V_{CC} is not connected.

BG V_{CC} and BG GND are the supply inputs for the bias generator.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	TQFP − PCA	Tube	SN74FB1650PCA	FB1650

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

Function Tables

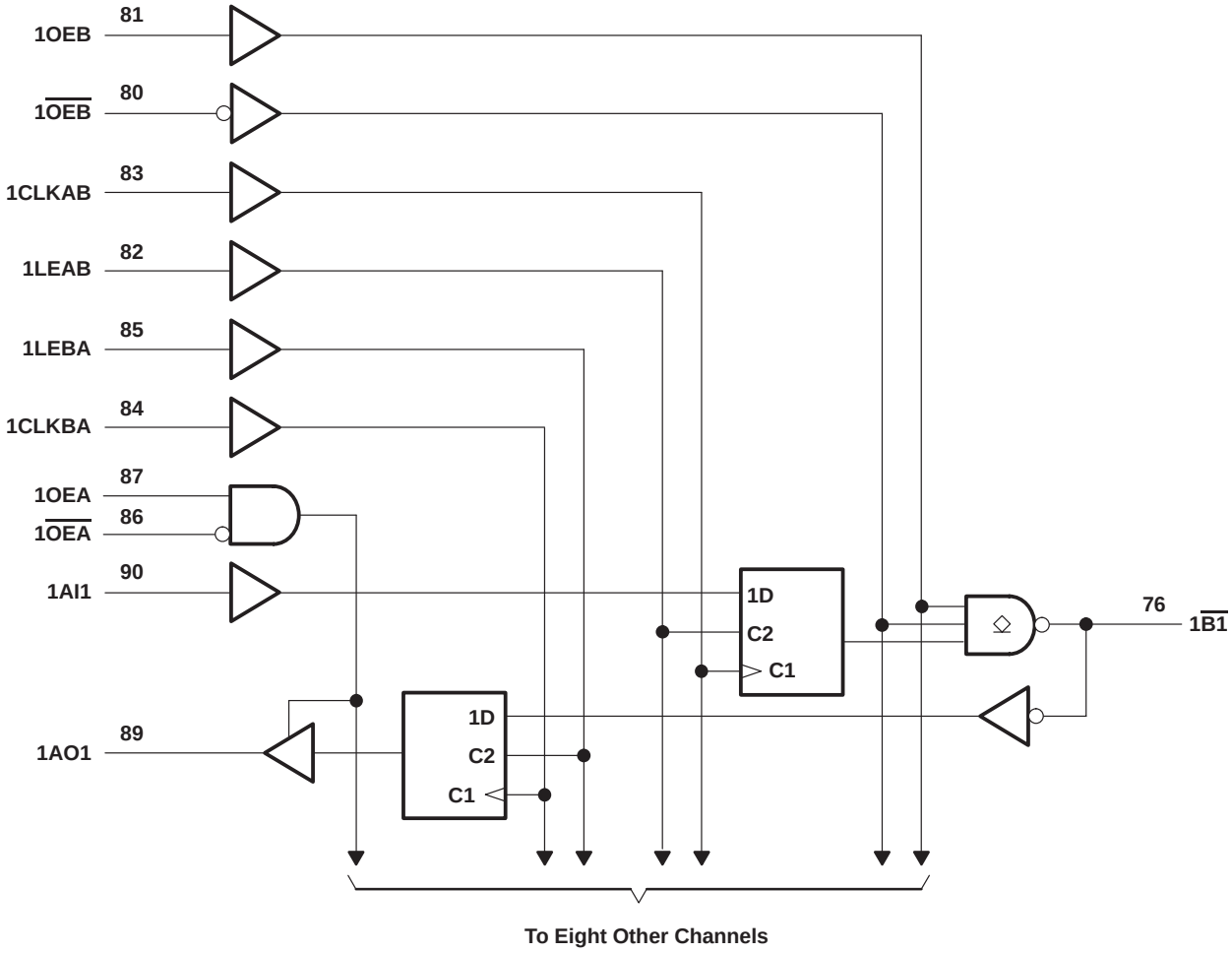
TRANSCEIVER

INPUTS				FUNCTION
$\overline{OEA}$	OEA	OEB	$\overline{OEB}$	
X	X	H	L	$\overline{A}$ data to B bus
L	H	X	X	$\overline{B}$ data to A bus
L	H	H	L	$\overline{A}$ data to B bus, $\overline{B}$ data to A bus
X	X	L	X	B-bus isolation
X	X	X	H	
H	X	X	X	A-bus isolation
X	L	X	X	

STORAGE MODE

INPUTS		FUNCTION
LE	CLK	
H	X	Transparent
L	↑	Store data
L	L	Storage

functional block diagram



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

Supply voltage range, V_{CC}, BIAS V_{CC}, BG V_{CC} . . . . . −0.5 V to 7 V
Input voltage range, V_I: Except $\overline{B}$ port . . . . . −1.2 V to 7 V
$\overline{B}$ port . . . . . −1.2 V to 3.5 V
Voltage range applied to any $\overline{B}$ output in the disabled or power-off state, V_O . . . . . −0.5 V to 3.5 V
Voltage range applied to any output in the high state, V_O . . . . . −0.5 V to V_{CC}
Input clamp current, I_{IK}: Except $\overline{B}$ port . . . . . −40 mA
$\overline{B}$ port . . . . . −18 mA
Current applied to any single output in the low state, I_O: A port . . . . . 48 mA
$\overline{B}$ port . . . . . 200 mA
Package thermal impedance, θ_{JA} (see Note 1) . . . . . 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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 2)

			MIN	NOM	MAX	UNIT
V_{CC}, BG V_{CC}, BIAS V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage	$\overline{B}$ port	1.62		2.3	V
		Except $\overline{B}$ port	2			
V_{IL}	Low-level input voltage	$\overline{B}$ port	0.75		1.47	V
		Except $\overline{B}$ port			0.8	
I_{IK}	Input clamp current				−18	mA
I_{OH}	High-level output current	A port			−3	mA
I_{OL}	Low-level output current	A port			24	mA
		$\overline{B}$ port			100	
T_A	Operating free-air temperature		0		70	°C

NOTE 2: To ensure proper device operation, all unused inputs must be terminated as follows: A and control inputs to V_{CC}(5 V) or GND, and B inputs to GND only. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IK}	$\overline{B}$ port	V_{CC} = 4.5 V,	I_I = −18 mA			−1.2	V
	Except $\overline{B}$ port	V_{CC} = 4.5 V,	I_I = −40 mA			−0.5	
V_{OH}	AO port	V_{CC} = 4.5 V,	I_{OH} = −3 mA	2.5	3.3		V
V_{OL}	AO port	V_{CC} = 4.5 V,	I_{OL} = 24 mA		0.35	0.5	V
	$\overline{B}$ port	V_{CC} = 4.5 V	I_{OL} = 80 mA	0.75		1.1	
			I_{OL} = 100 mA			1.15	
I_I	Except $\overline{B}$ port	V_{CC} = 5.5 V,	V_I = 5.5 V			50	µA
I_{IH}‡	Except $\overline{B}$ port	V_{CC} = 5.5 V,	V_I = 2.7 V			50	µA
I_{IL}‡	Except $\overline{B}$ port	V_{CC} = 5.5 V,	V_I = 0.5 V			−50	µA
	$\overline{B}$ port	V_{CC} = 5.5 V,	V_I = 0.75 V			−100	
I_{OZH}	AO port	V_{CC} = 5.5 V,	V_O = 2.7 V			50	µA
I_{OZL}	AO port	V_{CC} = 5.5 V,	V_O = 0.5 V			−50	µA
I_{OZPU}	AO port	V_{CC} = 0 to 2.1 V,	V_O = 0.5 V to 2.7 V			50	µA
I_{OZPD}	AO port	V_{CC} = 2.1 V to 0,	V_O = 0.5 V to 2.7 V			−50	µA
I_{OH}	$\overline{B}$ port	V_{CC} = 0 to 5.5 V,	V_O = 2.1 V			100	µA
I_{OS}§	A port	V_{CC} = 5.5 V,	V_O = 0	−30		−150	mA
I_{CC}	A port to $\overline{B}$ port	V_{CC} = 5.5 V,	I_O = 0			100	mA
	$\overline{B}$ port to A port					120	
C_i	AI port	V_I = V_{CC} or GND			5.5		pF
	Control inputs				5.5		
C_o	AO ports	V_O = V_{CC} or GND			5.5		pF
C_{io}	$\overline{B}$ port per IEEE Std 1194.1-1991	V_{CC} = 0 to 5.5 V				5.5	pF

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ For I/O ports, the parameters I_{IH} and I_{IL} include the off-state output current.
§ Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.

live-insertion specifications over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS			MIN	MAX	UNIT
I_{CC} (BIAS V_{CC})		V_{CC} = 0 to 4.5 V	V_B = 0 to 2 V,	V_I (BIAS V_{CC}) = 4.5 V to 5.5 V		450	μA
		V_{CC} = 4.5 V to 5.5 V				10	
V_O	$\overline{B}$ port	V_{CC} = 0,	V_I (BIAS V_{CC}) = 5 V		1.62	2.1	V
I_O	$\overline{B}$ port	V_{CC} = 0 ,	V_B = 1 V,	V_I (BIAS V_{CC}) = 4.5 V to 5.5 V	−1		μA
		V_{CC} = 0 to 2.2 V,	OEB = 0 to 5 V			100	
		V_{CC} = 0 to 5.5 V,	OEB = 0 to 0.8 V			1	mA

timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)

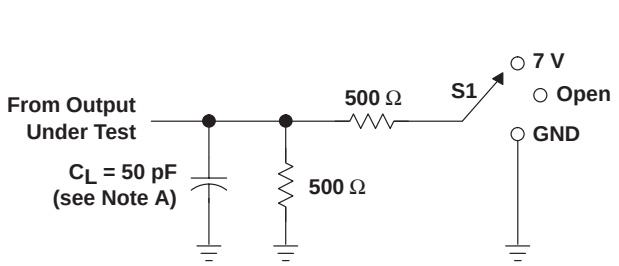
			V_{CC} = 5 V, T_A = 25°C		MIN	MAX	UNIT
			MIN	MAX			
f_{clock}	Clock frequency			150		150	MHz
t_w	Pulse duration	CLK or LE	3.3		3.3		ns
t_{su}	Setup time	Data before LE	4.8		4.8		ns
		Data before CLK↑	4.9		4.9		
t_h	Hold time	Data after LE	1.8		1.8		ns
		Data after CLK↑	1.1		1.1		

switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)

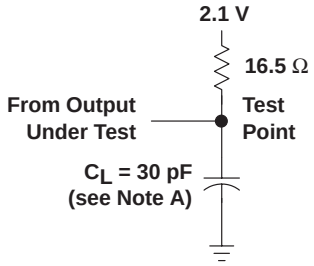
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 5 V, T_A = 25°C			MIN	MAX	UNIT
			MIN	TYP	MAX			
f_{max}			150			150		MHz
t_{PLH}	AI	$\overline{B}$	1.8	3.7	5.3	1.8	6.2	ns
t_{PHL}			2.9	4.4	6	2.9	7.2	
t_{PLH}	LEAB	$\overline{B}$	2.7	4.2	5.8	2.7	6.4	ns
t_{PHL}			3.5	5	6.5	3.5	7.3	
t_{PLH}	CLKAB	$\overline{B}$	2.3	3.9	5.5	2.3	6	ns
t_{PHL}			2.9	4.5	6.1	2.9	6.7	
t_{PLH}	$\overline{B}$	AO	3.5	5.9	7.9	3.5	8.6	ns
t_{PHL}			2.2	3.7	5.3	2.2	5.7	
t_{PLH}	LEBA	AO	1.8	3.2	4.6	1.8	5.1	ns
t_{PHL}			1.7	3	4.4	1.7	4.7	
t_{PLH}	CLKBA	AO	1.8	3.1	4.6	1.8	5.1	ns
t_{PHL}			1.7	3.1	4.6	1.7	4.9	
t_{PLH}	OEB	$\overline{B}$	2.7	4.6	6.4	2.7	6.7	ns
t_{PHL}			2.9	4.1	5.9	2.9	6.6	
t_{PLH}	$\overline{OEB}$	$\overline{B}$	2.6	4.3	6.2	2.6	6.6	ns
t_{PHL}			3.4	4.6	6.4	3.4	7	
t_{PZH}	OEA	AO	1.4	2.9	4.4	1.4	4.9	ns
t_{PZL}			1.4	2.6	4	1.4	4.6	
t_{PHZ}	OEA	AO	1.7	3.4	5.1	1.7	5.8	ns
t_{PLZ}			2.2	3.6	5	2.2	5.5	
t_{PZH}	$\overline{OEA}$	AO	1.7	3.3	4.7	1.7	5.5	ns
t_{PZL}			1.7	3.1	4.4	1.7	5.1	
t_{PHZ}	$\overline{OEA}$	AO	1.5	2.9	4.5	1.5	5.1	ns
t_{PLZ}			2	3.1	4.6	2	4.8	
$t_{sk(p)}$†	Pulse skew, AI to $\overline{B}$ or $\overline{B}$ to AO			1				ns
$t_{sk(o)}$†	Output skew, AI to $\overline{B}$ or $\overline{B}$ to AO			0.5				ns
t_t Transition time	$\overline{B}$ outputs (1.3 V to 1.8 V)		0.9	1.7	3.1	0.5	4.6	ns
	AO outputs (10% to 90%)		0.5	2	3.6	0.4	4.2	
$t_{(pr)}$	$\overline{B}$-port input pulse rejection		1			1		ns

† Skew values are applicable for through mode only.

PARAMETER MEASUREMENT INFORMATION

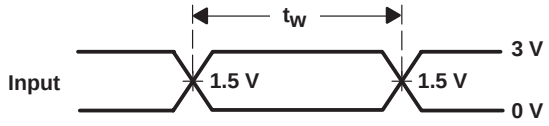


LOAD CIRCUIT FOR A OUTPUTS

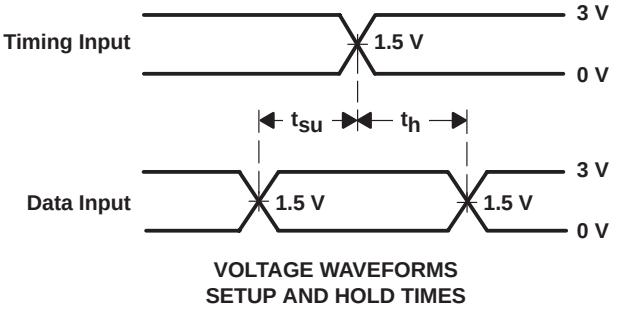


TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	7 V
t_{PHZ}/t_{PZH}	Open

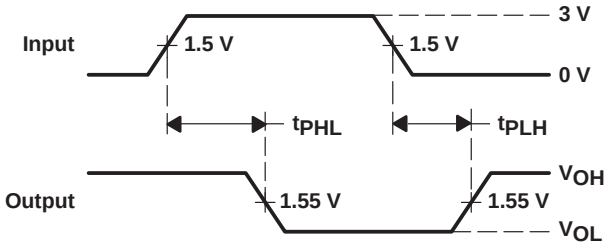
LOAD CIRCUIT FOR B OUTPUTS



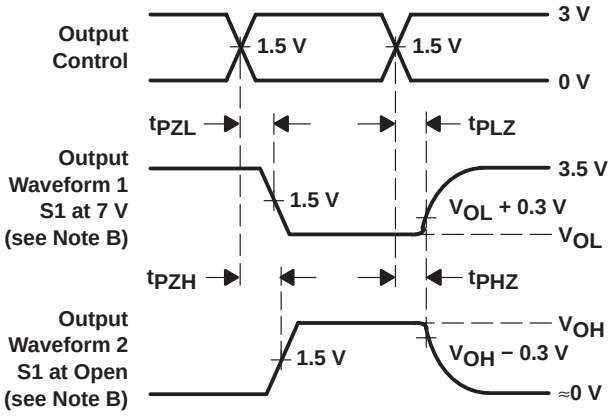
VOLTAGE WAVEFORMS
PULSE DURATION



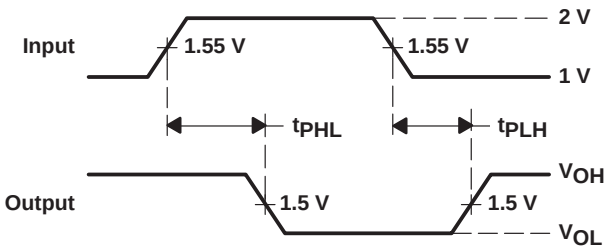
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES (A TO B)



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES (A PORT)



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES (B TO A)

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: TTL inputs: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns; BTL inputs: 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 finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74FB1650PCA	ACTIVE	HLQFP	PCA	100	90	RoHS & Green	NIPDAU	Level-3-260C-168 HR	0 to 70	FB1650	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

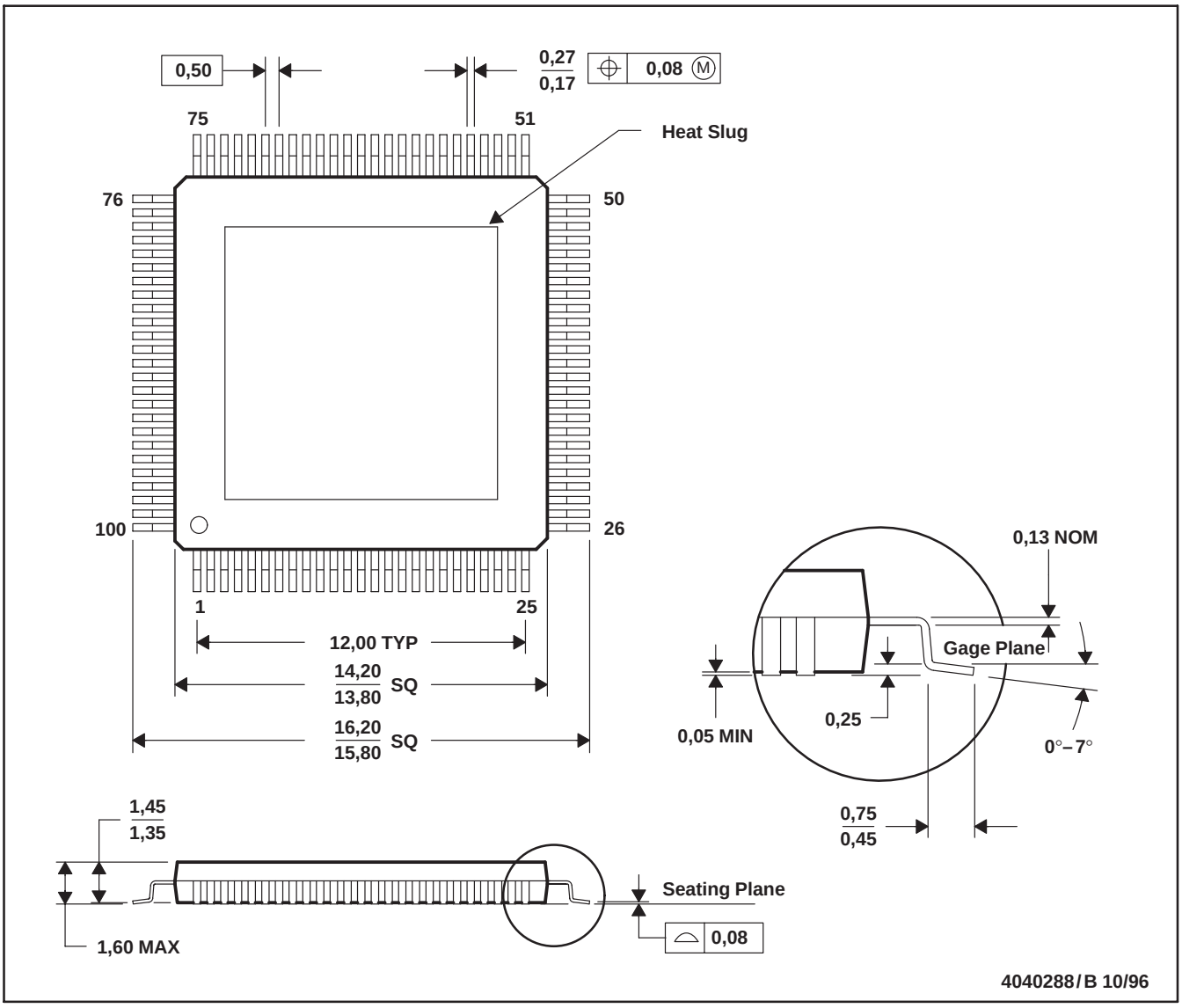
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

MHTQ003A – JANUARY 1995 – REVISED DECEMBER 1996

PCA (S-PQFP-G100) **PLASTIC QUAD FLATPACK (DIE DOWN)**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Thermally enhanced molded plastic package with a heat slug (HSL)
D. Falls within JEDEC MS-026

THERMAL PAD MECHANICAL DATA

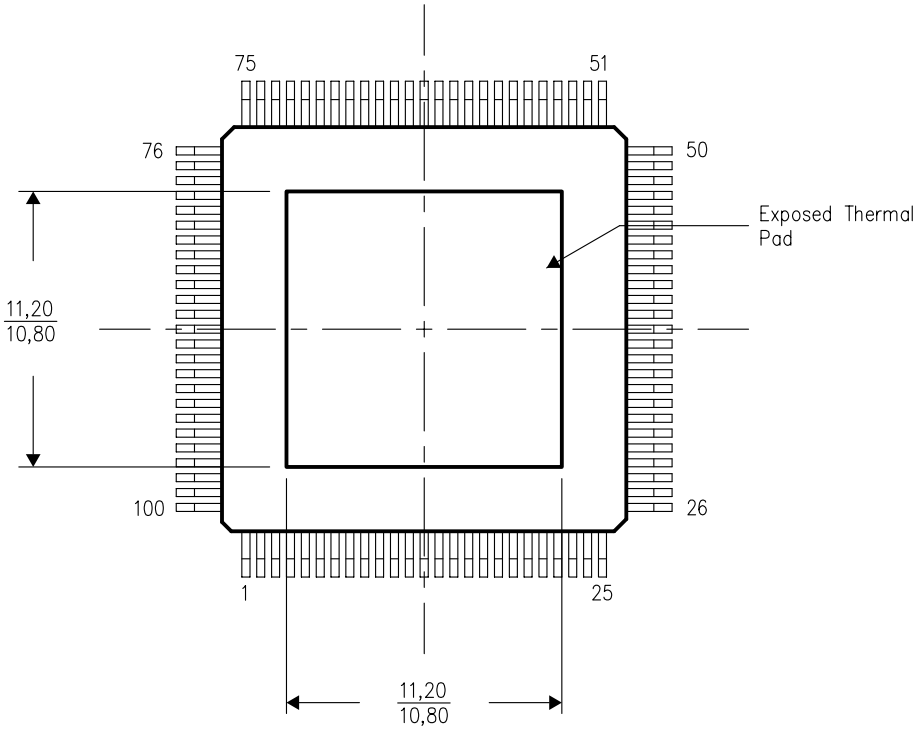
PCA (S–PQFP–G100)

THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. This design optimizes the heat transfer from the integrated circuit (IC).

For additional information on the PowerPAD package and how to take advantage of its heat dissipating abilities, refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 and Application Brief, PowerPAD Made Easy, Texas Instruments Literature No. SLMA004. Both documents are available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



Top View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

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