TEXAS INSTRUMENTS

CY74FCT163501
CY74FCT163H501

18-Bit Registered Transceivers

Features

- **Low power, pin-compatible replacement for LCX and LPT families**
- **5V tolerant inputs and outputs**
- **24 mA balanced drive outputs**
- **Power-off disable outputs permits live insertion**
- **Edge-rate control circuitry for reduced noise**
- **FCT-C speed at 4.6 ns**
- **Latch-up performance exceeds JEDEC standard no. 17**
- **ESD > 2000V per MIL-STD-883D, Method 3015**
- **Typical output skew < 250ps**
- **Industrial temperature range of –40˚C to +85˚C**
- **TSSOP (19.6-mil pitch) or SSOP (25-mil pitch)**
- **Typical V_{olp} (ground bounce) performance exceeds Mil Std 883D**
- **V_{CC} = 2.7V to 3.6V**

CY74FCT163501 Features:

- **Balanced output drivers: 24 mA**
- **Reduced system switching noise**
- **Typical V_{OLP} (ground bounce) <0.6V at V_{CC} = 3.3V, T_A= 25˚C**

CY74FCT163H501 Features:

- **Bus hold retains the last active state**
- **Devices with bus hold are not recommended for translating rail-to-rail CMOS signals to 3.3V logic levels**

- **Eliminates the need for external pull-up or pull-down resistors**

Functional Description

These 18-bit universal bus transceivers can be operated in transparent, latched or clock modes by combining D-type latches and D-type flip-flops. Data flow in each direction is controlled by output enable (OEAB and $\overline{OEBA}$), latch enable (LEAB and LEBA), and clock inputs (CLKAB and CLKBA). For A-to-B data flow, the device operates in transparent mode when LEAB is HIGH. When LEAB is LOW, the A data is latched if CLKAB is held at a HIGH or LOW logic level. If LEAB is LOW, the A bus data is stored in the latch/flip-flop on the LOW-to-HIGH transition of CLKAB. OEAB performs the output enable function on the B port. Data flow from B-to-A is similar to that of A-to-B and is controlled by $\overline{OEBA}$, LEBA, and CLKBA. The output buffers are designed with a power-off disable feature to allow live insertion of boards.

THE CY74FCT163501 has 24-mA balanced output drivers with current limiting resistors in the outputs. This reduces the need for external terminating resistors, as well as provides for minimal undershoot and reduced ground bounce. The CY74FCT163501 is ideal for driving transmission lines.

The CY74FCT163H501 is a 24-mA balanced output part, that has "bus hold" on the data inputs. The device retains the input's last state whenever the input goes to high impedance. This eliminates the need for pull-up/down resistors and prevents floating inputs.

Functional Block Diagram; CY74FCT163501, CY74FCT163H501

TO 17 OTHER CHANNELS

FCT163501-1
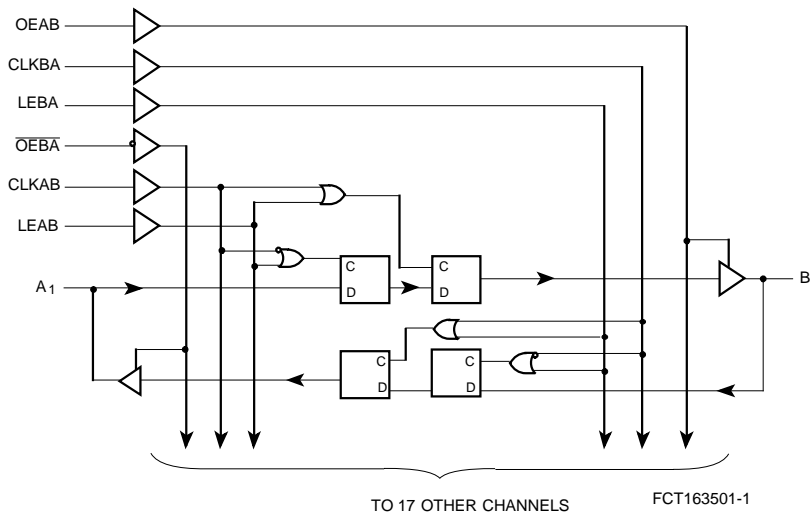
Pin Configuration
SSOP/TSSOP
Top View

OEAB	1	56 GND
LEAB	2	55 CLKAB
A_1	3	54 B_1
GND	4	53 GND
A_2	5	52 B_2
A_3	6	51 B_3
V_{CC}	7	50 V_{CC}
A_4	8	49 B_4
A_5	9	48 B_5
A_6	10	47 B_6
GND	11	46 GND
A_7	12	45 B_7
A_8	13	44 B_8
A_9	14	43 B_9
A_{10}	15	42 B_{10}
A_{11}	16	41 B_{11}
A_{12}	17	40 B_{12}
GND	18	39 GND
A_{13}	19	38 B_{13}
A_{14}	20	37 B_{14}
A_{15}	21	36 B_{15}
V_{CC}	22	35 V_{CC}
A_{16}	23	34 B_{16}
A_{17}	24	33 B_{17}
GND	25	32 GND
A_{18}	26	31 B_{18}
$\overline{OEBA}$	27	30 CLKBA
LEBA	28	29 GND

FCT163501-2

Pin Description

Name	Description
OEAB	A-to-B Output Enable Input
$\overline{\text{OEBA}}$	B-to-A Output Enable Input (Active LOW)
LEAB	A-to-B Latch Enable Input
LEBA	B-to-A Latch Enable Input
CLKAB	A-to-B Clock Input
CLKBA	B-to-A Clock Input
A	A-to-B Data Inputs or B-to-A Three-State Outputs[1]
B	B-to-A Data Inputs or A-to-B Three-State Outputs[1]

Function Table[2, 3]

Inputs				Outputs
OEAB	LEAB	CLKAB	A	B
L	X	X	X	Z
H	H	X	L	L
H	H	X	H	H
H	L	⌐	L	L
H	L	⌐	H	H
H	L	L	X	B[4]
H	L	H	X	B[5]

1. On the 74FCT163H501 these pins have bus hold.
2. A-to-B data flow is shown. B-to-A data flow is similar but uses $\overline{\text{OEBA}}$, LEBA, and CLKBA.
3. H = HIGH Voltage Level
   L = LOW Voltage Level
   X = Don't Care
   Z = High-impedance
   ⌐ = LOW-to-HIGH Transition
4. Output level before the indicated steady-state input conditions were established.
5. Output level before the indicated steady-state input conditions were established, provided that CLKAB was HIGH before LEAB went LOW.
6. Operation beyond the limits set forth may impair the useful life of the device. Unless otherwise noted, these limits are over the operating free-air temperature range.
7. Unused inputs must always be connected to an appropriate logic voltage level, preferably either V_CC or ground.

Maximum Ratings[6, 7]

(Above which the useful life may be impaired. For user guidelines, not tested.)

Storage Temperature ....−55°C to +125°C

Ambient Temperature with
Power Applied..−55°C to +125°C

DC Input Voltage ....−0.5V to +7.0V

DC Output Voltage ....−0.5V to +7.0V

DC Output Current
(Maximum Sink Current/Pin) ....−60 to +120 mA

Power Dissipation 1.0W

Static Discharge Voltage...>2001V
(per MIL-STD-883, Method 3015)

Operating Range

Range	Ambient Temperature	V_{CC}
Industrial	−40°C to +85°C	2.7V to 3.6V

TEXAS INSTRUMENTS

Electrical Characteristics for Non Bus Hold Devices Over the Operating Range V_{CC} = 2.7V to 3.6V

Parameter	Description	Test Conditions	Min.	Typ.[8]	Max.	Unit
V_{IH}	Input HIGH Voltage	All Inputs	2.0		5.5	V
V_{IL}	Input LOW Voltage				0.8	V
V_H	Input Hysteresis[9]			100		mV
V_{IK}	Input Clamp Diode Voltage	V_{CC}=Min., I_{IN}=−18 mA		−0.7	−1.2	V
I_{IH}	Input HIGH Current	V_{CC}=Max., V_I=5.5			±1	µA
I_{IL}	Input LOW Current	V_{CC}=Max., V_I=GND			±1	µA
I_{OZH}	High Impedance Output Current (Three-State Output pins)	V_{CC}=Max., V_{OUT}=5.5V			±1	µA
I_{OZL}	High Impedance Output Current (Three-State Output pins)	V_{CC}=Max., V_{OUT}=GND			±1	µA
I_{OS}	Short Circuit Current[10]	V_{CC}=Max., V_{OUT}=GND	−60	−135	−240	mA
I_{OFF}	Power-Off Disable	V_{CC}=0V, V_{OUT}≤4.5V			±100	µA
I_{CC}	Quiescent Power Supply Current	V_{IN}≤0.2V, V_{IN}≥V_{CC}−0.2V / V_{CC}=Max.		0.1	10	µA
ΔI_{CC}	Quiescent Power Supply Current (TTL inputs HIGH)	V_{IN}=V_{CC}−0.6V[11] / V_{CC}=Max.		2.0	30	µA

Notes:
8. Typical values are at V_{CC}=3.3V, T_A = +25°C ambient.
9. This parameter is specified but not tested.
10. Not more than one output should be shorted at a time. Duration of short should not exceed one second. The use of high-speed test apparatus and/or sample and hold techniques are preferable in order to minimize internal chip heating and more accurately reflect operational values. Otherwise prolonged shorting of a high output may raise the chip temperature well above normal and thereby cause invalid readings in other parametric tests. In any sequence of parameter tests, I_{OS} tests should be performed last.
11. Per TTL driven input (V_{IN}=3.4V); all other inputs at V_{CC} or GND.

TEXAS INSTRUMENTS

Electrical Characteristics For Bus Hold Devices Over the Operating Range V_{CC}=2.7V to 3.6V

Parameter	Description	Test Conditions		Min.	Typ.[8]	Max.	Unit
V_{IH}	Input HIGH Voltage	All Inputs		2.0		V_{CC}	V
V_{IL}	Input LOW Voltage					0.8	V
V_H	Input Hysteresis[9]				100		mV
V_{IK}	Input Clamp Diode Voltage	V_{CC}=Min., I_{IN}=−18 mA			−0.7	−1.2	V
I_{IH}	Input HIGH Current	V_{CC}=Max., V_I=V_{CC}				±100	µA
I_{IL}	Input LOW Current	V_{CC}=Max., V_I=GND				±100	µA
I_{BBH} I_{BBL}	Bus Hold Sustain Current on Bus Hold Input[12]	V_{CC}=Min.	V_I=2.0V	−50			µA
			V_I=0.8V	+50			µA
I_{BHHO} I_{BHLO}	Bus Hold Overdrive Current on Bus Hold Input[12]	V_{CC}=Max., V_I=1.5V				±500	µA
I_{OZH}	High Impedance Output Current (Three-State Output pins)	V_{CC}=Max., V_{OUT}=V_{CC}				±1	µA
I_{OZL}	High Impedance Output Current (Three-State Output pins)	V_{CC}=Max., V_{OUT}=GND				±1	µA
I_{OS}	Short Circuit Current[10]	V_{CC}=Max., V_{OUT}=GND		−60	−135	−240	mA
I_{OFF}	Power-Off Disable	V_{CC}=0V, V_{OUT}≤4.5V				±100	µA
I_{CC}	Quiescent Power Supply Current	V_{IN}≤0.2V, V_{IN}≥V_{CC}−0.2V	V_{CC}=Max.			+40	µA
ΔI_{CC}	Quiescent Power supply Current (TTL inputs HIGH)	V_{IN}=V_{CC}−0.6V[11]	V_{CC}=Max.			+350	µA

Electrical Characteristics For Balanced Drive Devices Over the Operating Range V_{CC}=2.7V to 3.6V

Parameter	Description	Test Conditions	Min.	Typ.[8]	Max.	Unit
I_{ODL}	Output LOW Dynamic Current[10]	V_{CC}=3.3V, V_{IN}=V_{IH} or V_{IL}, V_{OUT}=1.5V	45		180	mA
I_{ODH}	Output HIGH Dynamic Current[10]	V_{CC}=3.3V, V_{IN}=V_{IH} or V_{IL}, V_{OUT}=1.5V	−45		−180	mA
V_{OH}	Output HIGH Voltage	V_{CC}=Min., I_{OH}= −0.1 mA	V_{CC}−0.2			V
		V_{CC}=3.0V, I_{OH}= −8 mA	2.4[13]	3.0		V
		V_{CC}=3.0V, I_{OH}= −24 mA	2.0	3.0		V
V_{OL}	Output LOW Voltage	V_{CC}=Min., I_{OL}= 0.1mA			0.2	V
		V_{CC}=Min., I_{OL}= 24 mA		0.3	0.55	

Capacitance[9](T_A = +25°C, f = 1.0 MHz)

Parameter	Description	Test Conditions	Typ.[8]	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V	4.5	6.0	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V	5.5	8.0	pF

Notes:
12. Pins with bus hold are described in Pin Description.
13. V_{OH}=V_{CC} − 0.6V at rated current.

Power Supply Characteristics

Sym.	Parameter	Test Conditions[14]		Min.	Typ.[8]	Max.	Unit
I_{CCD}	Dynamic Power Supply Current[15]	V_{CC}=Max., Outputs Open $OEAB=\overline{OEBA}=V_{CC}$ or GND One Input Toggling, 50% Duty Cycle	$V_{IN}=V_{CC}$ or V_{IN}=GND	—	75	120	μA/ MHz
I_C	Total Power Supply Current[16]	V_{CC}=Max., Outputs Open f_0 =10MHz (CLKAB) 50% Duty Cycle $OEAB=\overline{OEBA}=V_{CC}$ LEAB = GND, One Bit Toggling f_1 = 5MHz, 50% Duty Cycle	$V_{IN}=V_{CC}$ or V_{IN}=GND	—	0.8	1.7	mA
			V_{IN}=3.4V or V_{IN}=GND	—	1.3	3.2	
		V_{CC}=Max., Outputs Open f_0 = 10MHz (CLKAB) 50% Duty Cycle $OEAB=\overline{OEBA}=V_{CC}$ LEAB=GND Eighteen Bits Toggling f_1=2.5MHz, 50% Duty Cycle	$V_{IN}=V_{CC}$ or V_{IN}=GND	—	3.8	6.5[17]	
			V_{IN}=3.4V or V_{IN}=GND	—	8.5	20.8[17]	

Notes:
14. For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
15. This parameter is not directly testable, but is derived for use in Total Power Supply Current.
16. I_C= $I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
    I_C = $I_{CC}+\Delta I_{CC}D_H N_T+I_{CCD}(f_0/2 + f_1 N_1)$
    I_{CC} = Quiescent Current with CMOS input levels
    ΔI_{CC} = Power Supply Current for a TTL HIGH input (V_{IN}=3.4V)
    D_H = Duty Cycle for TTL inputs HIGH
    N_T = Number of TTL inputs at D_H
    I_{CCD} = Dynamic Current caused by an input transition pair (HLH or LHL)
    f_0 = Clock frequency for registered devices, otherwise zero
    f_1 = Input signal frequency
    N_1 = Number of inputs changing at f_1
    All currents are in milliamps and all frequencies are in megahertz.
17. Values for these conditions are examples of the I_{CC} formula. These limits are specified but not tested.

Switching Characteristics Over the Operating Range V_{CC}=3.0V to 3.6V[18]

Parameter	Description		CY74FCT163501C CY74FCT163H501C		Unit	Fig.No.[19]
			Min.	Max.		
f_{MAX}	CLKAB or CLKBA frequency[9]		—	150	MHz	—
t_{PLH} t_{PHL}	Propagation Delay A to B or B to A		1.5	4.6	ns	1,3
t_{PLH} t_{PHL}	Propagation Delay LEBA to A, LEAB to B		1.5	5.3	ns	1,5
t_{PLH} t_{PHL}	Propagation Delay CLKBA to A, CLKAB to B		1.5	5.3	ns	1,5
t_{PZH} t_{PZL}	Output Enable Time $\overline{OEBA}$ to A, OEAB to B		1.5	5.6	ns	1,7,8
t_{PHZ} t_{PLZ}	Output Disable Time $\overline{OEBA}$ to A, OEAB to B		1.5	5.2	ns	1,7,8
t_{SU}	Set-Up Time, HIGH or LOW A to CLKAB, B to CLKBA		3.0	—	ns	4
t_{H}	Hold Time HIGH or LOW A to CLKAB, B to CLKBA		0	—	ns	4
t_{SU}	Set-Up Time, HIGH or LOW A to LEAB, B to LEBA	Clock LOW	3.0	—	ns	4
		Clock HIGH	1.5	—	ns	4
t_{H}	Hold Time, HIGH or LOW, A to LEAB, B to LEBA		1.5	—	ns	4
t_{W}	LEAB or LEBA Pulse Width HIGH[9]		3.0	—	ns	5
t_{W}	CLKAB or CLKBA Pulse Width HIGH or LOW[9]		3.0	—	ns	5
$t_{SK(O)}$	Output Skew[20]		—	0.5	ns	—

Notes:
18. Minimum limits are specified, but not tested, on propagation delays.
19. See "Parameter Measurement Information" in the General Information section.
20. Skew between any two outputs of the same package switching in the same direction. This parameter ensured by design.

Ordering Information CY74FCT163501T

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
4.6	CY74FCT163501CPACT	Z56	56-Lead (240-Mil) TSSOP	Industrial
	CY74FCT163501CPVC/PVCT	O56	56-Lead (300-Mil) SSOP	

Ordering Information CY74FCT163H501T

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
4.6	74FCT163H501CPACT	Z56	56-Lead (240-Mil) TSSOP	Industrial
	CY74FCT163H501CPVC	O56	56-Lead (300-Mil) SSOP	
	74FCT163H501CPVCT	O56	56-Lead (300-Mil) SSOP	

Package Diagrams

56-Lead Shrunk Small Outline Package O56

DIMENSIONS IN INCHES MIN.
                    MAX.
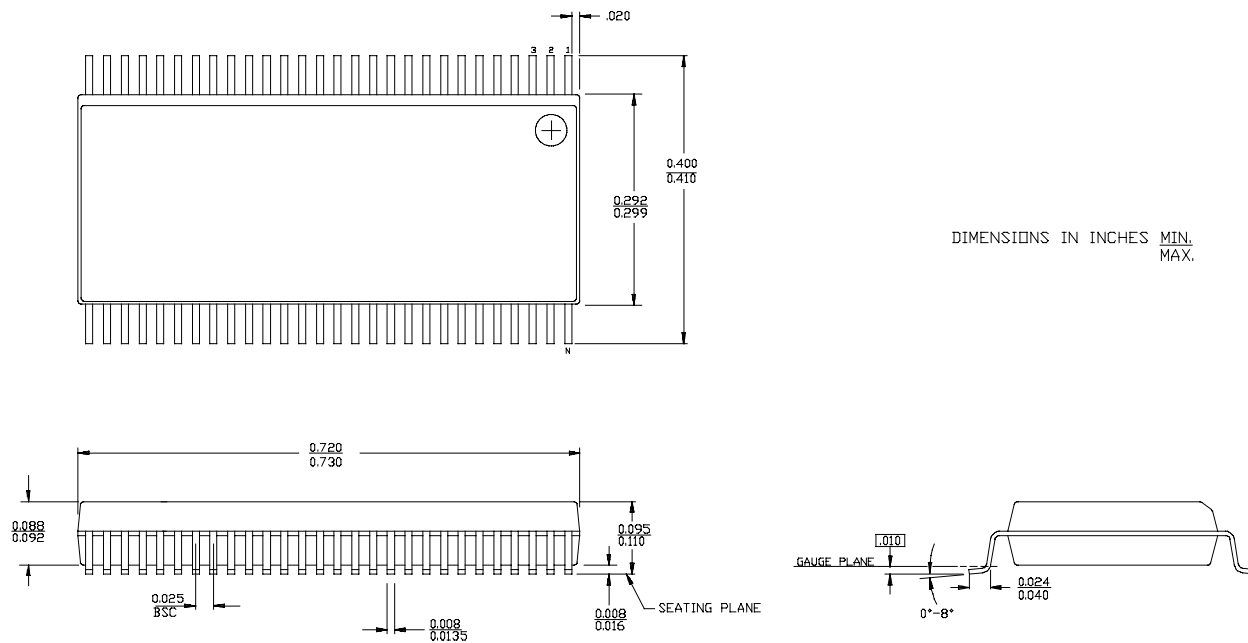
Package Diagrams (continued)

56-Lead Thin Shrunk Small Outline Package Z56
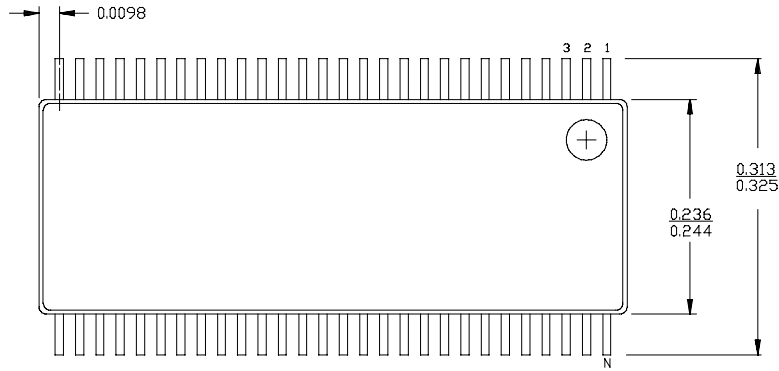
DIMENSIONS IN INCHES $\frac{\text{MIN.}}{\text{MAX.}}$
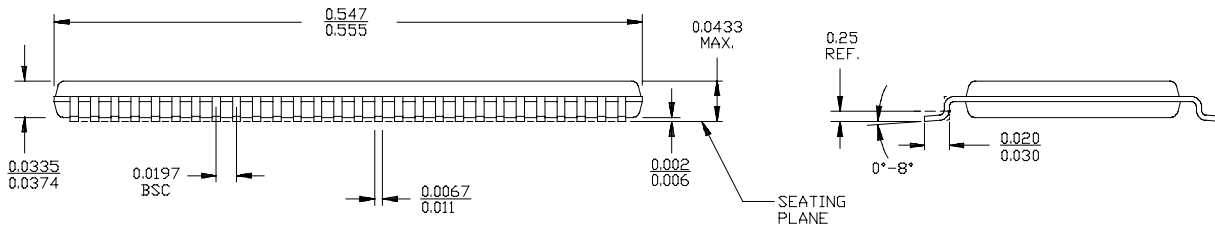
PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
74FCT163H501CPACT	OBSOLETE	TSSOP	DGG	56		TBD	Call TI	Call TI
74FCT163H501CPVCT	OBSOLETE	SSOP	DL	56		TBD	Call TI	Call TI
CY74FCT163501CPAC	OBSOLETE	TSSOP	DGG	56		TBD	Call TI	Call TI
CY74FCT163501CPACT	OBSOLETE	TSSOP	DGG	56		TBD	Call TI	Call TI
CY74FCT163501CPVC	OBSOLETE	SSOP	DL	56		TBD	Call TI	Call TI
CY74FCT163501CPVCT	OBSOLETE	SSOP	DL	56		TBD	Call TI	Call TI
CY74FCT163H501CPAC	OBSOLETE	TSSOP	DGG	56		TBD	Call TI	Call TI
CY74FCT163H501CPVC	OBSOLETE	SSOP	DL	56		TBD	Call TI	Call TI

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check
http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
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.

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.

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

48 PINS SHOWN

PINS ** DIM	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)

4040048 / E 12/01

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

TEXAS INSTRUMENTS

POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN

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

4040078 / F 12/97

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

TEXAS INSTRUMENTS

POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

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

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments

Post Office Box 655303 Dallas, Texas 75265