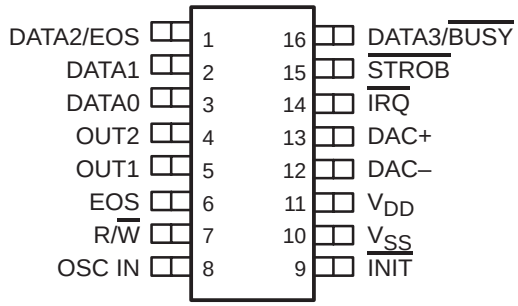
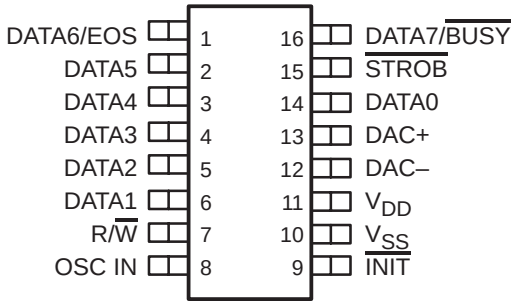
- **Slave Speech Synthesizers, LPC, MELP, CELP**
- **Two Channel FM Synthesis, PCM**
- **8-Bit Microprocessor With 61 instructions**
- **3.3V to 6.5V CMOS Technology for Low Power Dissipation**
- **Direct Speaker Drive Capability**
- **Internal Clock Generator That Requires No External Components**
- **Two Software-Selectable Clock Speeds**
- **10-kHz or 8-kHz Speech Sample Rate**

MSP53C391
N PACKAGE
(TOP VIEW)



MSP53C392
N PACKAGE
(TOP VIEW)



description

The MSP53C391 and MSP53C392 are catalog MSP50C3x codes which implements the functionality of a slave speech synthesizer. They communicate with a master microprocessor using two control lines (R/$\overline{W}$ and $\overline{STROBE}$) and either a 4-bit data bus (MSP53C391) or an 8-bit data bus (MSP53C392).

Either the MSP53C391 or the MSP53C392 can synthesize speech using several different compression algorithms; LPC, MELP, or CELP. They also can synthesize two-channel music using FM synthesis.

See the MSP50C3x User's Guide (literature number: SLOU006B) for more information about the MSP50C3x family.

Table 1. MSP53C39x Family

DEVICE	FEATURES
MSP53C391	4-bit data bus
MSP53C392	8-bit data bus

absolute maximum ratings over operating free-air temperature range†

Supply voltage range, V_{DD} (see Note 1) . . . . . –0.3 V to 8 V
Supply current, I_{DD} or I_{SS} (see Note 2) . . . . . 100 mA
Input voltage range, V_I (see Note 1) . . . . . –0.3 V to V_{DD} + 0.3 V
Output voltage range, V_O (see Note 1) . . . . . –0.3 V to V_{DD} + 0.3 V
Storage temperature range . . . . . –30°C to 125°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. All voltages are with respect to ground.
2. The total supply current includes the current out of all the I/O terminals and DAC terminals as well as the operating current of the device.

recommended operating conditions

			MAX	MAX	UNIT
V_{DD}	Supply voltage†		3.3	6.5	V
V_{IH}	High-level input voltage	V_{DD} = 3.3 V	2.5	3.3	V
		V_{DD} = 5 V	3.8	5	
		V_{DD} = 6 V	4.5	6	
V_{IL}	Low-level input voltage	V_{DD} = 3.3 V	0	0.65	V
		V_{DD} = 5 V	0	1	
		V_{DD} = 6 V	0	1.3	
T_A	Operating free-air temperature	Device functionality	0	70	°C
Rspeaker	Minimum speaker impedance	Direct speaker drive using 2 pin push-pull DAC option	32		Ω

† Unless otherwise noted, all voltages are with respect to V_{SS}.

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{T+}	Positive-going threshold voltage (INIT)	V_{DD} = 3.5 V			2		V
		V_{DD} = 6 V			3.4		
V_{T-}	Negative-going threshold voltage (INIT)	V_{DD} = 3.5 V			1.6		V
		V_{DD} = 6 V			2.3		
V_{hys}	Hysteresis ($V_{T+} - V_{T-}$) (INIT)	V_{DD} = 3.5 V			0.4		V
		V_{DD} = 6 V			1.1		
I_{lkg}	Input leakage current (except for OSC IN)					2	µA
$I_{standby}$	Standby current ($\overline{INIT}$ low, SETOFF)					10	µA
I_{DD}†	Supply current	V_{DD} = 3.3 V,	V_{OH} = 2.75 V		2.1		mA
		V_{DD} = 5 V,	V_{OH} = 4.5 V		3.1		
		V_{DD} = 6 V,	V_{OH} = 5.5 V		4.5		
I_{OH}	High-level output current (DATA0 – DATA7, OUT1, OUT2)	V_{DD} = 3.3 V,	V_{OH} = 2.75 V	–4	–12		mA
		V_{DD} = 5 V,	V_{OH} = 4.5 V	–5	–14		
		V_{DD} = 6 V,	V_{OH} = 5.5 V	–6	–15		
		V_{DD} = 3.3 V,	V_{OH} = 2.2 V	–8	–20		mA
		V_{DD} = 5 V,	V_{OH} = 3.33 V	–14	–40		
		V_{DD} = 6 V,	V_{OH} = 4 V	–20	–51		
I_{OL}	Low-level output current (DATA0 – DATA7, OUT1, OUT2)	V_{DD} = 3.3 V,	V_{OL} = 0.5 V	5	9		mA
		V_{DD} = 5 V,	V_{OL} = 0.5 V	5	9		
		V_{DD} = 6 V,	V_{OL} = 0.5 V	5	9		
		V_{DD} = 3.3 V,	V_{OL} = 1.1 V	10	19		mA
		V_{DD} = 5 V,	V_{OL} = 1.67 V	20	29		
		V_{DD} = 6 V,	V_{OL} = 2 V	25	35		
I_{OH}	High-level output current (DAC)	V_{DD} = 3.3 V,	V_{OH} = 2.75 V	–30	–50		mA
		V_{DD} = 5 V,	V_{OH} = 4.5 V	–35	–60		
		V_{DD} = 6 V,	V_{OH} = 5.5 V	–40	–65		
		V_{DD} = 3.3 V,	V_{OH} = 2.3 V	–50	–90		mA
		V_{DD} = 5 V,	V_{OH} = 4 V	–90	–140		
		V_{DD} = 6 V,	V_{OH} = 5 V	–100	–150		
I_{OL}	Low-level output current (DAC)	V_{DD} = 3.3 V,	V_{OL} = 0.5 V	50	80		mA
		V_{DD} = 5 V,	V_{OL} = 0.5 V	70	90		
		V_{DD} = 6 V,	V_{OL} = 0.5 V	80	110		
		V_{DD} = 3.3 V,	V_{OL} = 1 V	100	140		mA
		V_{DD} = 5 V,	V_{OL} = 1 V	140			
		V_{DD} = 6 V,	V_{OL} = 1 V	150			
$f_{osc(low)}$	Oscillator frequency‡	V_{DD} = 5 V, T_A = 25°C, Target frequency = 15.36 MHz		14.89	15.36	15.86	MHz
$f_{osc(high)}$	Oscillator frequency‡	V_{DD} = 5 V, T_A = 25°C, Target frequency = 19.2 MHz		18.62	19.2	19.7	MHz

† Operating current assumes all inputs are tied to either V_{SS} or V_{DD} with no input currents due to programmed pullup resistors. The DAC output and other outputs are open circuited.

‡ The frequency of the internal clock has a temperature coefficient of approximately –0.2 %/°C and a V_{DD} coefficient of approximately ±1%/V.

switching characteristics

PARAMETER		TEST CONDITIONS			MIN	NOM	MAX	UNIT
t_r	Rise time, DATA0 – DATA7, DAC	V_{DD} = 3.3 V,	C_L = 100 pF,	10% to 90%		50		ns
t_f	Fall time, DATA0– DATA7, DAC	V_{DD} = 3.3 V,	C_L = 100 pF,	10% to 90%		50		ns

timing requirements

		MIN	MAX	UNIT
Initialization				
t_{INIT}	$\overline{INIT}$ pulsed low while the MSP53C39x has power applied (see Figure 1)	1		µs
t_{SETUP}	Delay between rising edge of $\overline{INIT}$ and device initialization complete	5		ms
Writing (Slave Mode)				
$t_{su1(R/W)}$	Setup time, R/$\overline{W}$ low before $\overline{STROB}$ goes low (see Figure 2)	20		ns
$t_{su(d)}$	Setup time, data valid before $\overline{STROB}$ goes high (see Figure 2)	100		ns
$t_{h1(R/W)}$	Hold time, R/$\overline{W}$ low after $\overline{STROB}$ goes high (see Figure 2)	20		ns
$t_{h(d)}$	Hold time, data valid after $\overline{STROB}$ goes high (see Figure 2)	30		ns
t_w	Pulse duration, $\overline{STROB}$ low (see Figure 2)	100		ns
t_r	Rise time, $\overline{STROB}$ (see Figure 2)		50	ns
t_f	Fall time, $\overline{STROB}$ (see Figure 2)		50	ns
Reading (Slave Mode)				
$t_{su2(R/W)}$	Setup time, R/$\overline{W}$ before $\overline{STROB}$ goes low (see Figure 3)	20		ns
$t_{h2(R/W)}$	Hold time, R/$\overline{W}$ after $\overline{STROB}$ goes high (see Figure 3)	20		ns
t_{dis}	Output disable time, data valid after $\overline{STROB}$ goes high (see Figure 3)	0	30	ns
t_w	Pulse duration, $\overline{STROB}$ low (see Figure 3)	100		ns
t_r	Rise time, $\overline{STROB}$ (see Figure 3)		50	ns
t_f	Fall time, $\overline{STROB}$ (see Figure 3)		50	ns
t_d	Delay time for $\overline{STROB}$ low to data valid (see Figure 3)		50	ns

PARAMETER MEASUREMENT INFORMATION

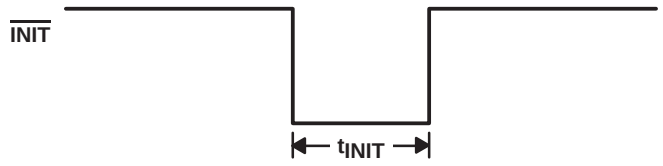


Figure 1. Initialization Timing Diagram

PARAMETER MEASUREMENT INFORMATION

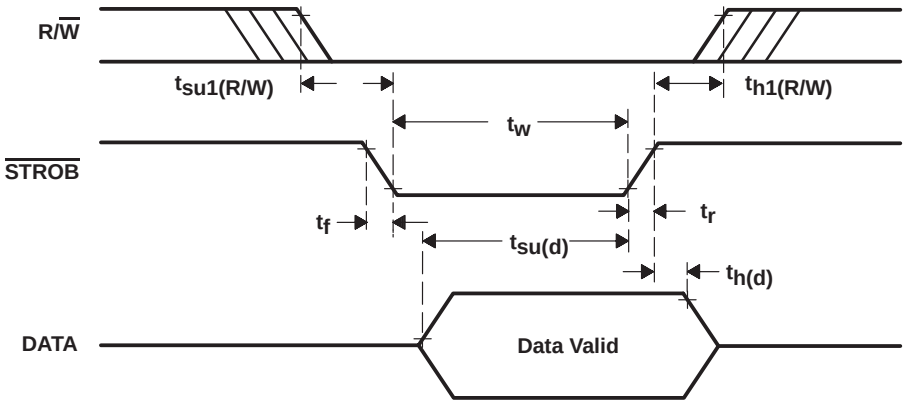


Figure 2. Write Timing Diagram (Slave Mode)

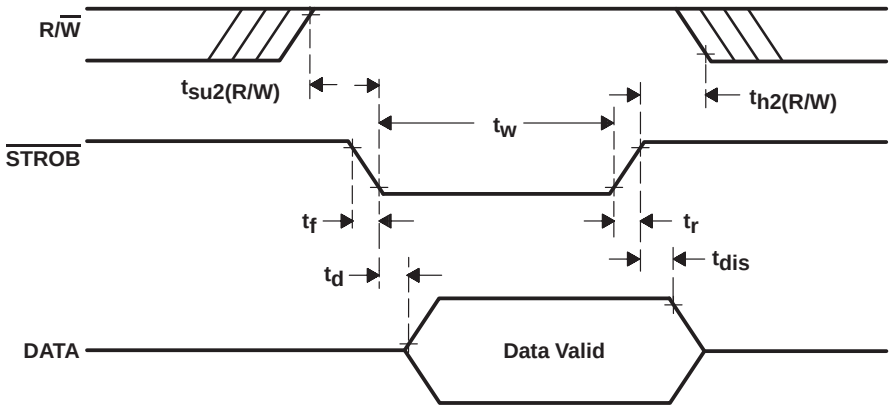


Figure 3. Read Timing Diagram (Slave Mode)

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
MSP53C391NI2D	OBSOLETE	PDIP	N	16		TBD	Call TI	Call TI
MSP53C392DWI2D	OBSOLETE	SOIC	DW	16		TBD	Call TI	Call TI
MSP53C392NI2D	OBSOLETE	PDIP	N	16		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.

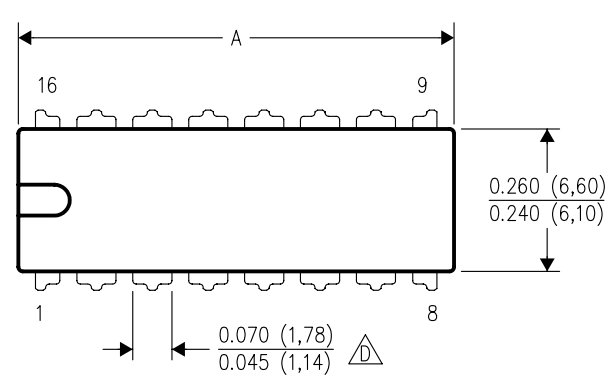
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): 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.

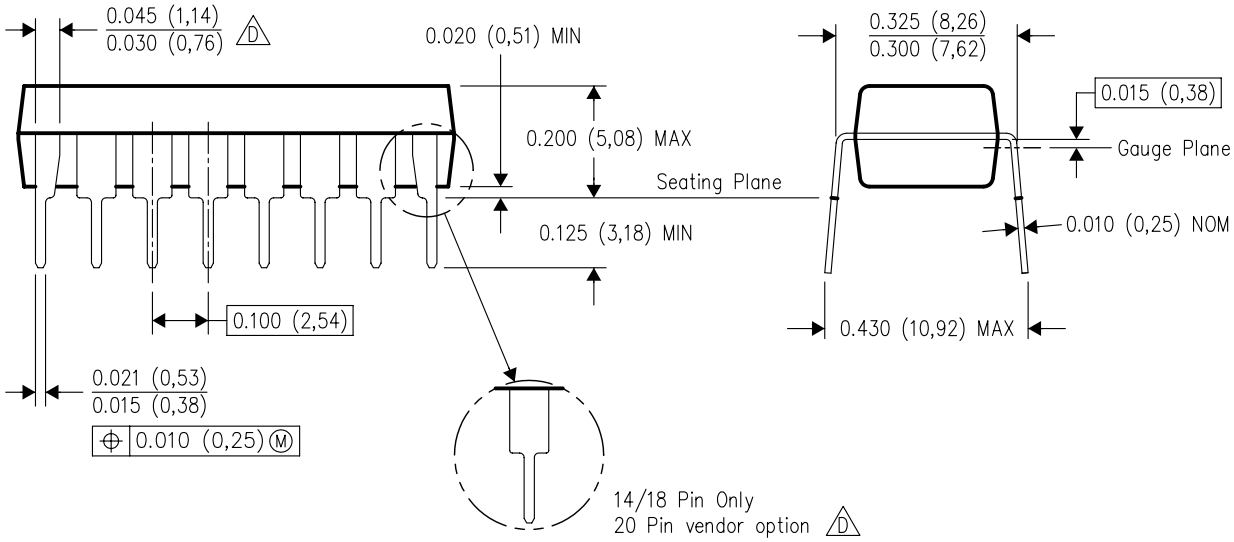
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



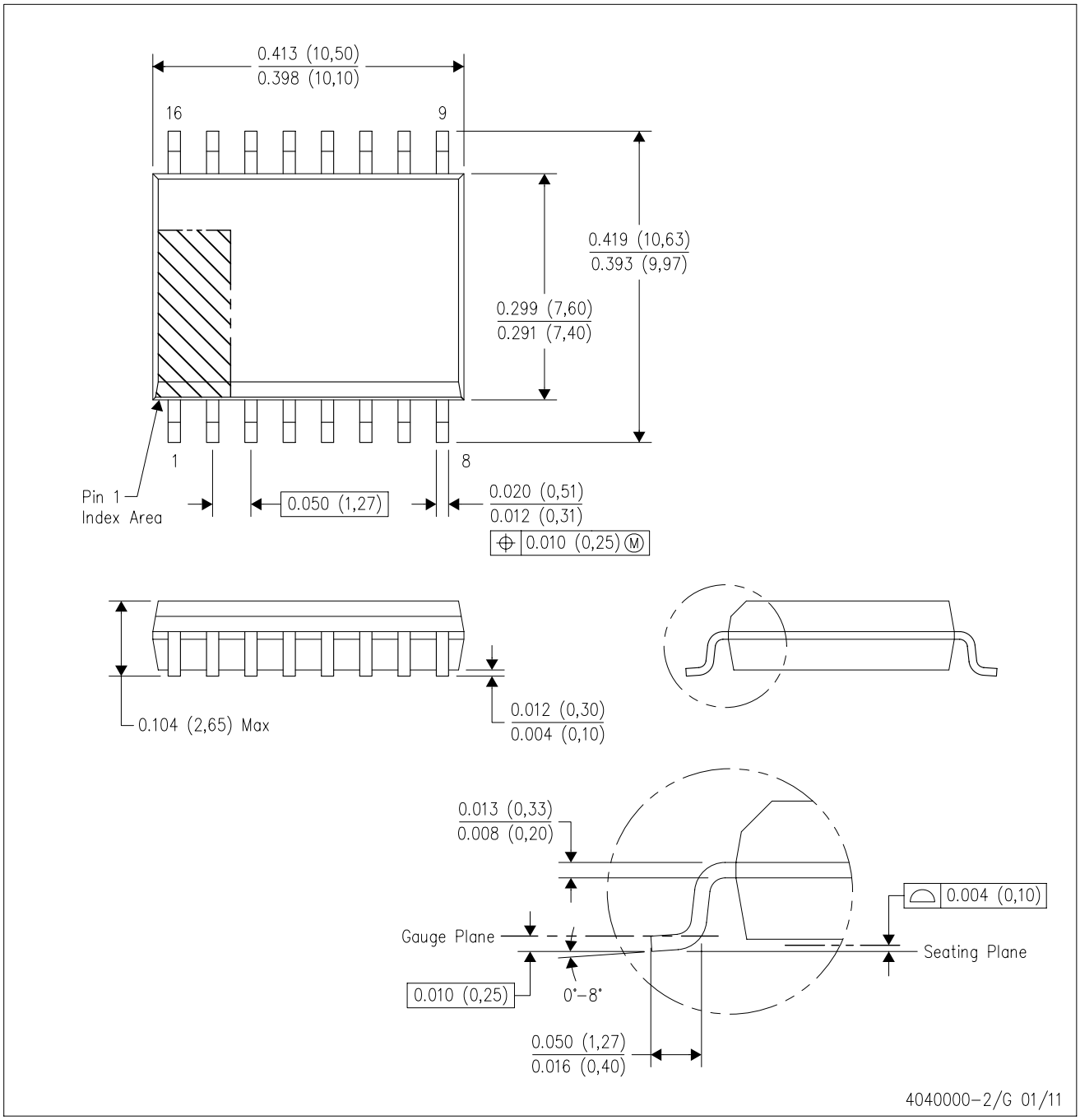
DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

DW (R–PDSO–G16) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M–1994.
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 MS–013 variation AA.

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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

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

Products		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com	Wireless	www.ti.com/wireless-apps
RF/IF and ZigBee® Solutions	www.ti.com/lprf		
	TI E2E Community Home Page		e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265