

# High Power Factor Preregulator

## FEATURES

- Complete 8-pin Power Factor Solution
- Reduced External Components
- RMS Line Voltage Compensation
- Precision Multiplier/Squarer/Divider
- Internal 63kHz Synchronizable Oscillator
- Average Current Mode PWM Control
- Overvoltage Protection Comparator
- High Current, Clamped Gate Driver

## DESCRIPTION

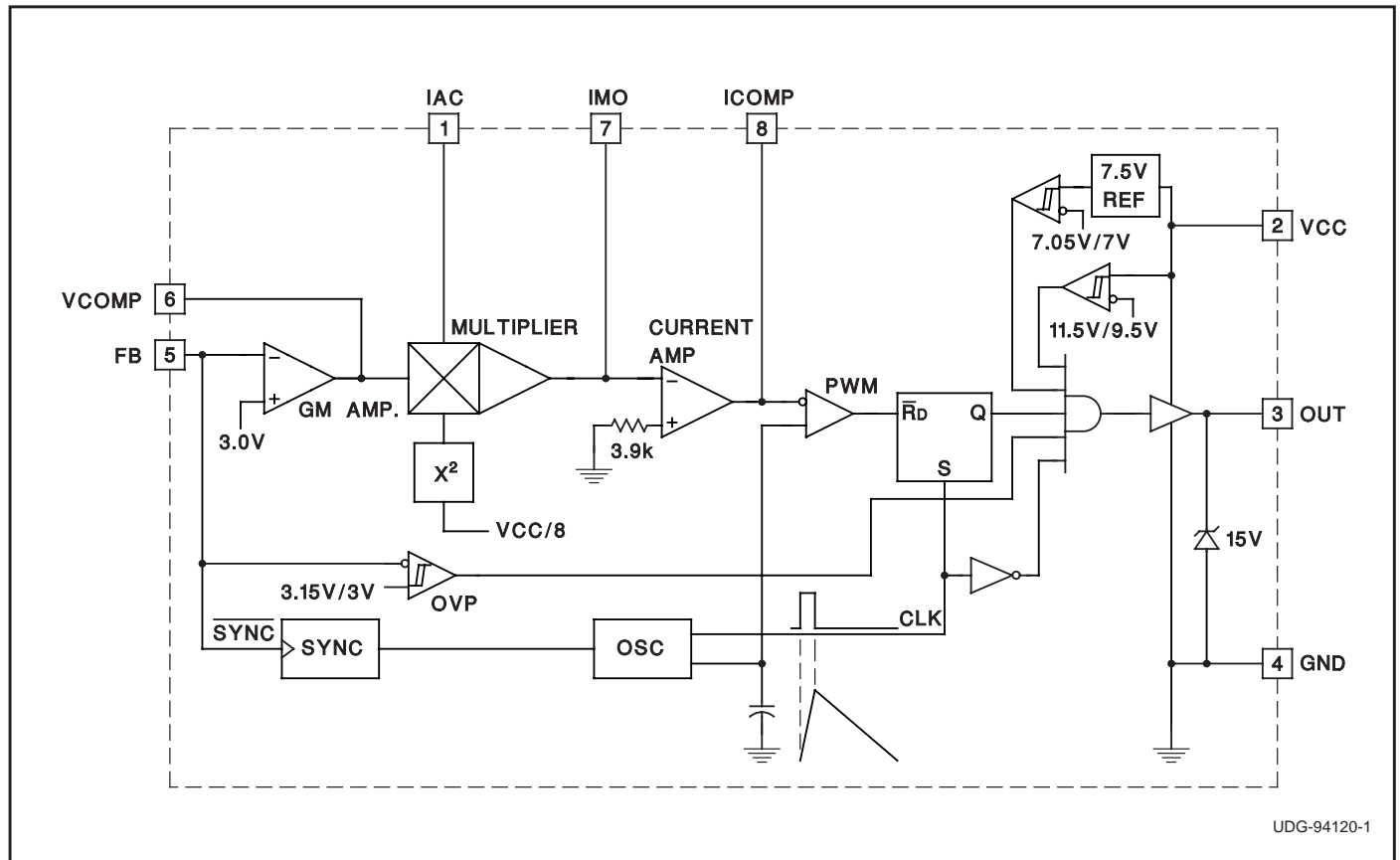
The UC2853A provides simple, yet high performance active power factor correction. Using the same control technique as the UC1854, this 8-pin device exploits a simplified architecture and an internal oscillator to minimize external component count. The UC2853A incorporates a precision multiplier/squarer/divider circuit, voltage and current loop error amplifiers, and a precision voltage reference to implement average current mode control with RMS line voltage compensation. This control technique maintains constant loop gain with changes in input voltage, which minimizes input line current distortion over the worldwide input voltage range.

The internal 63kHz oscillator includes an external clock input, allowing synchronization to downstream converters. Additionally, the device features an overvoltage protection comparator, a clamped MOSFET gate driver which self-biases low during undervoltage lockout, and low startup and supply current.

The UC2853A is identical to the UC2853 except the internal oscillator frequency has been reduced from 75kHz to 63kHz. The switching frequency is lowered in order to keep the second harmonic of the switching frequency below a 150kHz. For EMI specifications at 150kHz this makes it easier for a design to meet system requirements.

## BLOCK DIAGRAM

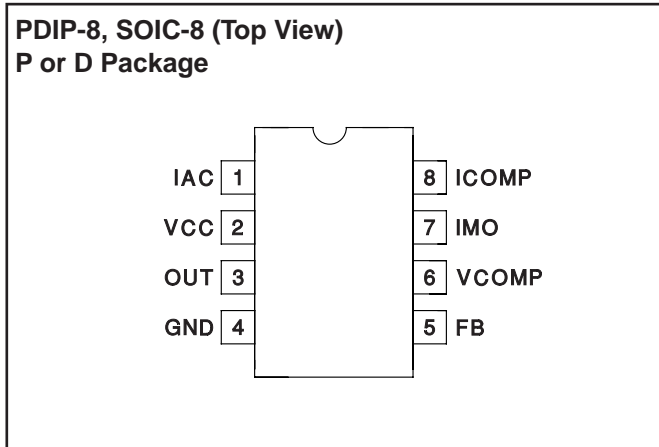
These devices are available in 8-pin PDIP (P) and SOIC (D) packages. The UC2853A is specified for operation from  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$ .



**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage (VCC) . . . . .	40V
Output Drive Current,	
Continuous . . . . .	0.125A
Peak . . . . .	0.5A
Output Minimum Voltage . . . . .	-0.3V
IAC Maximum Input Current . . . . .	1mA
IMO Maximum Output Current . . . . .	-2mA
IMO Minimum Voltage . . . . .	-0.3V
FB Maximum Input Voltage . . . . .	5V
VCOMP Maximum Voltage . . . . .	6.2V
ICOMP Sourcing Current . . . . .	Self-Limiting
ICOMP Sinking Current . . . . .	20mA
ICOMP Maximum Voltage . . . . .	7.2V
Storage Temperature . . . . .	-65°C to +150°C
Junction Temperature . . . . .	-55°C to +150°C
Lead Temperature (Soldering, 10 sec.) . . . . .	+300°C

All voltages with respect to GND. Currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages.

**CONNECTION DIAGRAM****ELECTRICAL CHARACTERISTICS**

Unless otherwise stated, these parameters apply for  $T_A = -40^\circ\text{C}$  to  $105^\circ\text{C}$  for the UC2853A;  $V_{CC} = 16\text{V}$ ,  $V_{FB} = 3\text{V}$ ,  $I_{AC} = 100\mu\text{A}$ ,  $V_{VCOMP} = 3.75\text{V}$ ,  $V_{ICOMP} = 3\text{V}$ ,  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Undervoltage Lockout Section</b>					
VCC Turn-on Threshold	$V_{VCOMP}$ , $V_{ICOMP}$ Open		11.5	13	V
Hysteresis		1.5	1.8	2.1	V
<b>Supply Current Section</b>					
$I_{VCC}$ Startup	$V_{CC} = 8\text{V}$ , $I_{AC} = 100\mu\text{A}$ ; $V_{VCOMP}$ , $V_{ICOMP}$ Open		250	500	$\mu\text{A}$
$I_{VCC}$	$I_{AC} = 0\mu\text{A}$ , $V_{ICOMP} = 0\text{V}$		10	15	$\text{mA}$
<b>Voltage Loop Error Amplifier Section</b>					
Transconductance	$I_{OUT} = \pm 20\mu\text{A}$ 0-70C	300	450	575	$\mu\text{mho}$
	Temperature	135		640	$\mu\text{mho}$
Input Voltage	0-70C	2.925	3	3.075	V
	Temperature	2.9		3.1	V
AVOL	$V_{VCOMP} = 1\text{V} - 4\text{V}$	50	60		dB
Output Sink Current	$V_{FB} = 3.2\text{V}$ , $V_{VCOMP} = 3.75\text{V}$	20	50		$\mu\text{A}$
Output Source Current	$V_{FB} = 2.8\text{V}$ , $V_{VCOMP} = 3.75\text{V}$		-50	-20	$\mu\text{A}$
Output Voltage High		5.5	6		V
Output Voltage Low			0.6	0.9	V
<b>Current Loop Error Amplifier Section</b>					
Offset Voltage		0		6	mV
Voltage Gain	$V_{ICOMP} = 1\text{V} - 4\text{V}$		70		dB
Sink Current	$V_{IMO} = 100\text{mV}$ , $V_{ICOMP} = 3\text{V}$	1			$\text{mA}$
Source Current	$V_{IMO} = -0.1\text{V}$ , $V_{ICOMP} = 3\text{V}$		-150	-80	$\mu\text{A}$
Output High	$I_{ICOMP} = -50\text{mA}$	6	6.8		V
Output Low	$I_{ICOMP} = 50\mu\text{A}$		0.3	0.8	V
PWM Modulator Gain	$V_{ICOMP} = 2\text{V} - 3\text{V}$ (Note 1)		20		%/V

**ELECTRICAL CHARACTERISTICS**  
**(continued)**

Unless otherwise stated, these parameters apply for  $T_A = -40^\circ\text{C}$  to  $105^\circ\text{C}$  for the UC2853A;  $V_{CC} = 16\text{V}$ ,  $V_{FB} = 3\text{V}$ ,  $I_{AC} = 100\mu\text{A}$ ,  $V_{VCOMP} = 3.75\text{V}$ ,  $V_{ICOMP} = 3\text{V}$ ,  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Multiplier Section</b>					
Output Current – IAC Limited	$V_{CC} = 11\text{V}$ , $V_{VCOMP} = 6\text{V}$	-230	-200	-170	$\mu\text{A}$
Output Current – Zero	$I_{AC} = 0\mu\text{A}$	-2	-0.2	2	$\mu\text{A}$
Output Current – Power Limited	$V_{CC} = 12\text{V}$ , $V_{VCOMP} = 5.5\text{V}$	-236	-178	-168	$\mu\text{A}$
Output Current	$V_{CC} = 12\text{V}$ , $V_{VCOMP} = 2\text{V}$		-22		$\mu\text{A}$
	$V_{CC} = 12\text{V}$ , $V_{VCOMP} = 5\text{V}$		-156		$\mu\text{A}$
	$V_{CC} = 40\text{V}$ , $V_{VCOMP} = 2\text{V}$		-2		$\mu\text{A}$
	$V_{CC} = 40\text{V}$ , $V_{VCOMP} = 5\text{V}$		-14		$\mu\text{A}$
Multiplier Gain Constant	$V_{CC} = 12\text{V}$ , $V_{VCOMP} = 5.5\text{V}$ (Note 2)	-1.05	-0.9	-0.75	$\text{V}^{-1}$
<b>Oscillator Section</b>					
Oscillator Initial Frequency	$T_A = 25^\circ\text{C}$	56	63	70	kHz
Oscillator Frequency	Line, Load, Temperature	50	63	74	kHz
Synchronization Frequency Range				100	kHz
Synchronization Pulse Amplitude	Pulse slew rate = $100\text{V}/\mu\text{sec}$ (Note 3)		2		V
<b>Output Driver Section</b>					
Maximum Output Voltage	0mA load, $V_{CC} = 20\text{V}$	12	15	17.5	V
Output High	0mA load, $V_{CC} = 12\text{V}$ , ref. to VCC	-2.7	-1.7		V
	-50mA load, $V_{CC} = 12\text{V}$ , ref. to VCC	-3	-2.2		V
Output Low (Device Inactive)	$V_{CC} = 0\text{V}$ , 20mA load (Sinking)		0.9	2.0	V
Output Low (Device Active)	50mA load (Sinking)		0.5	1	V
OUT Rise Time	1nF from OUT to GND		55	100	ns
OUT Fall Time	1nF from OUT to GND		35	100	ns
OUT Maximum Duty Cycle	$V_{ICOMP} = 0\text{V}$	88	93		%
<b>OVP Comparator Section</b>					
Threshold Voltage	Volts Above EA Input V	90	150		mV
Hysteresis			80		mV

Note 1:

$$1\text{PWM modulator gain} = \frac{\Delta\text{DutyCycle}}{\Delta V_{ICOMP}}$$

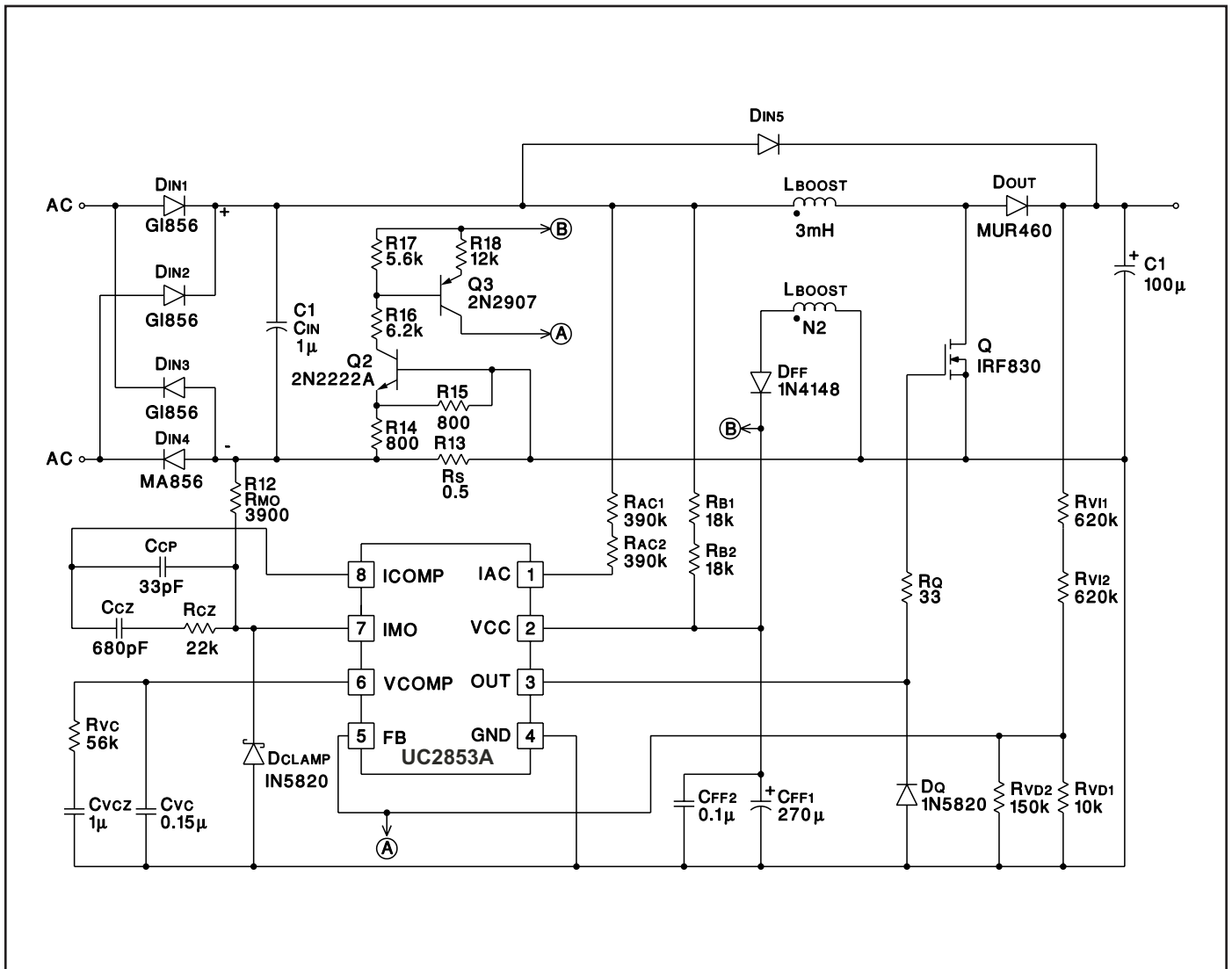
Note 2:

$$\text{Gain constant (K)} = \frac{I_{AC} \cdot (V_{COMP} - 1.5\text{V})}{I_{MO} \cdot V_{CC} \cdot \frac{V_{CC}}{64}}, \quad V_{CC} = 12\text{V}.$$

Note 3:

Synchronization is accomplished with a falling edge of 2V magnitude and  $100\text{V}/\mu\text{sec}$  slew rate.

UC2853A TYPICAL APPLICATION



Note: the application circuit shown is a 100W, 63KHz design. Additional application information can be found in Application Note U-159 (TI literature Number SLUA080) and Design Note DN-78.

## PIN DESCRIPTIONS

**FB:** Voltage Amplifier Inverting Input, Overvoltage Comparator Input, Sync Input. This pin serves three functions. FB accepts a fraction of the power factor corrected output voltage through a voltage divider, and is nominally regulated to 3V. FB voltages 5% greater than nominal will trip the overvoltage comparator, and shut down the output stage until the output voltage drops 5%. The internal oscillator can be synchronized through FB by injecting a 2V clock signal through a capacitor. To prevent false tripping of the overvoltage comparator, the clock signal must have a fast falling edge, but a slow rising edge. See Application Note U-159 for more information.

**GND:** Ground. All voltages are measured with respect to GND. The VCC bypass capacitor should be connected to ground as close to the GND pin as possible.

**IAC:** AC Waveform Input. This input provides voltage waveform information to the multiplier. The current loop will try to produce a current waveform with the same shape as the IAC signal. IAC is a low impedance input, nominally at 2V, which accepts a current proportional to the input voltage. Connect a resistor from the rectified input line to IAC which will conduct 500 $\mu$ A at maximum line voltage.

**IMO:** Multiplier Output and Current Sense Inverting Input. The output of the multiplier and the inverting input of the current amplifier are connected together at IMO. Avoid bringing this input below  $-0.5\text{V}$  to prevent the internal protection diode from conducting. The multiplier output is a current, making this a summing node and allowing a differential current error amplifier configuration to reject ground noise. The input resistance at this node should be 3.9k to minimize input bias current induced offset voltage. See the Applications section for the recommended circuit configuration.

**OUT:** Gate Driver Output. OUT provides high current gate drive for the external power MOSFET. A 15V clamp pre-

vents excessive MOSFET gate-to-source voltage so that the UC2853A can be operated with VCC and high as 40V. A series gate resistor of at least 5 ohms should be used to minimize clamp voltage overshoot. In addition, a Schottky diode such as a 1N5818 connected between OUT and GND may be necessary to prevent parasitic substrate diode conduction.

**ICOMP:** Current Loop Error Amplifier Output. The current loop error amplifier is a conventional operational amplifier with a 150 $\mu$ A current source class A output stage. Compensate the current loop by placing an impedance between ICOMP and IMO. This output can swing above the oscillator peak voltage, allowing zero duty cycle when necessary.

**VCC:** Input Supply Voltage. This pin serves two functions. It supplies power to the chip, and an input voltage level signal to the squarer circuit. When this input is connected to a DC voltage proportional to the AC input RMS voltage, the voltage loop gain is reduced by

$$\frac{64}{V_{CC}^2}$$

This configuration maintains constant loop gain. The UC2853A input voltage range extends from 12V to 40V, allowing an AC supply voltage range in excess of 85VAC to 265VAC. Bypass VCC with at least a 0.1 $\mu$ F ceramic capacitor to ensure proper operation. See the Applications section for the recommended circuit configuration.

**VCOMP:** Voltage Loop Error Amplifier Output. The voltage loop error amplifier is a transconductance type operational amplifier. A feedback impedance between VCOMP and FB for loop compensation must be avoided to maintain proper operation of the overvoltage protection comparator. Instead, compensate the voltage loop with an impedance between VCOMP and GND. When VCOMP is below 1.5V, the multiplier output current is zero.

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
UC2853ADTR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
UC2853ADTR	SOIC	D	8	2500	367.0	367.0	35.0

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.



D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AA.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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

### Applications

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

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)