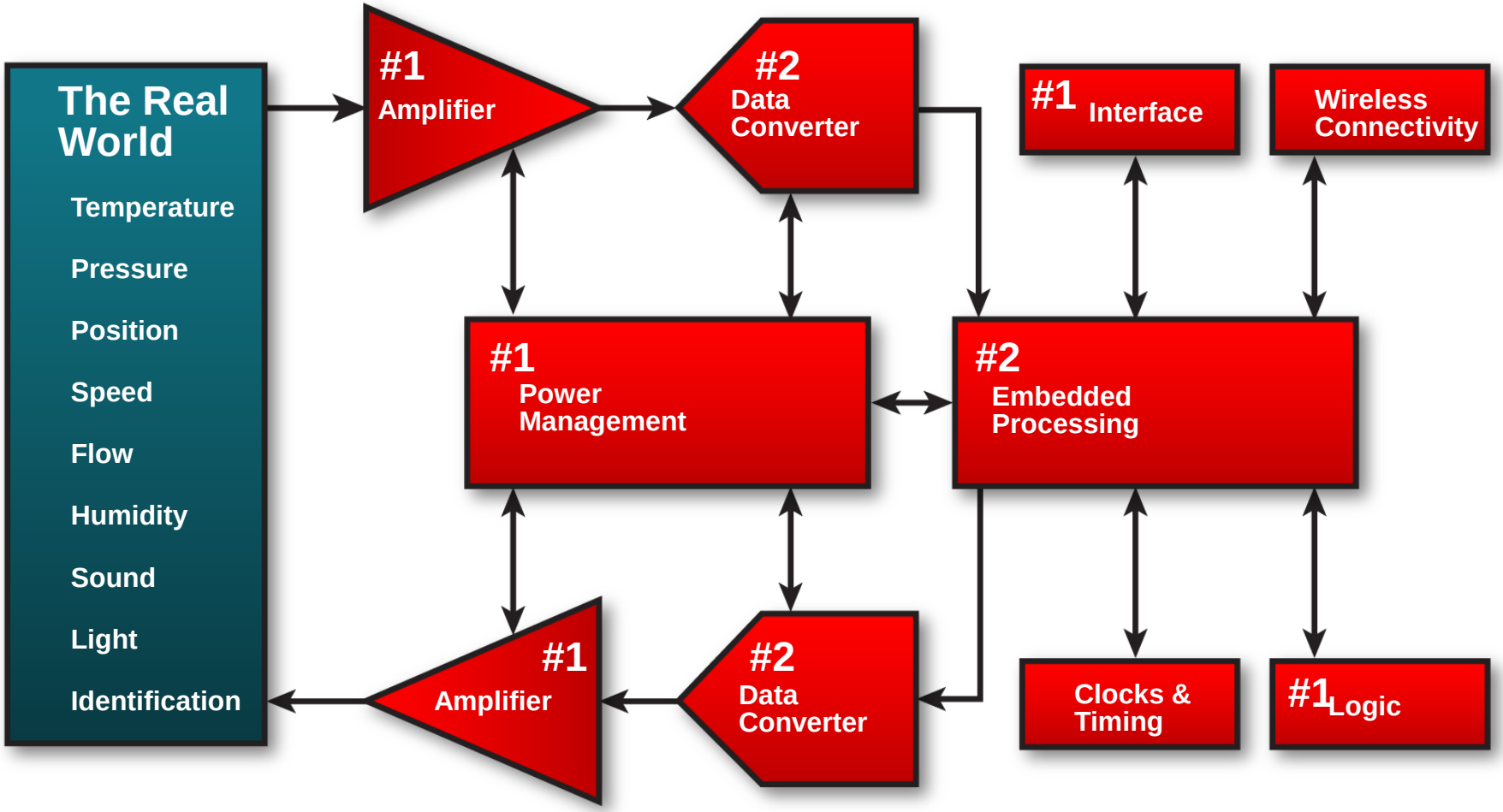
TI signal chain tech seminar for UIH

Van Yang
Analog FAE
van-yang@ti.com

The Signal Chain…

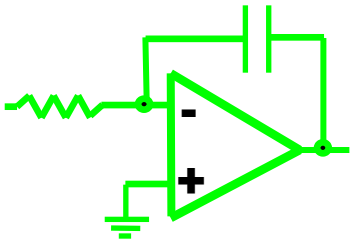


TI has an Amplifier For your Application

TI delivers a broad portfolio of amplifiers including precision and high speed op amps, instrumentation and differential amplifiers along with comparators. Ti has all types of packages to fi your space constrained needs.

High Speed Amplifiers…

- Test & Measurement
- Wireless/Wired Communications
- Defense: SIGINT, RADAR, EW

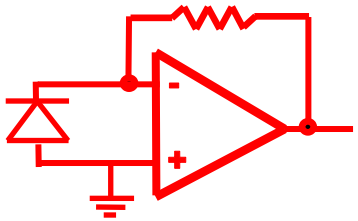


Low Power Amplifiers…

- Cellphones / Tablets
- Metering
- Mobile Devices

Audio Amplifiers…

- Cellphones / Tablets
- Portable Audio
- Home Theater
- Stand-alone speakers

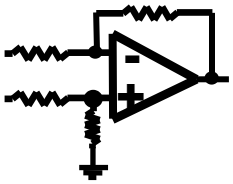


Precision Amplifiers…

- Battery Operated Systems
- Battery Monitoring
- High Impedance Sensors

Instrumentation Amplifiers…

- Scales
- Measurement
- Data Acquisition
- Medical



Special Function Amplifiers…

- Audio Equipment
- Multiplexers
- High Impedance Sensors
- Opto-electronics

Comparators, Current Shunt Monitors, Difference Amplifiers, Voltage to Current, 4-20mA loop Amps, Video Amps, Voltage References

And More…

Ti Has All Types…

Precision Op Amps	
Parameter	**Value**
Voltage Offset (V_{OS})	1µV – 20mV
V_{OS} Drift	3nV/C - 50µV/ºC
Input Voltage Noise	.88 – 800nV/rtHz
Input Bias Current	.02pA - 7µA

High Speed Op Amps	
Parameter	**Value**
Bandwidth	1MHz – 7 GHz
Gain	1 – 19 V/V
Slew Rate	1.4 – 18,000 V/µS
Supply Current	.25 – 150mA
Supply Voltage	1.4 – 44V

Low Power Op Amps	
Parameter	**Value**
Supply Current	.400nA – 5mA
Supply Voltage Range	1.1 – 45V
Voltage Offset (V_{OS})	5µV – 15mV
Package	1.9 – 170mm^2

Instrumentation Op Amps	
Parameter	**Value**
CMRR	60 – 130dB
Voltage Offset (V_{OS})	15µV – 10mV
Input Offset Drift	0.1 - 850µV/ºC
Gain	.1 – 2000 V/V
Input Bias Current	.025pA - 12µA

Audio Op Amps	
Parameter	**Value**
THD+Noise	0.003 – 0.00001%
Input Voltage Noise	0.88 - 11nV/rtHz
Slew Rate	3.7 – 2,000V/µS
Supply Current	1.1mA – 23mA

Product Nomenclature….

Prefix	Type
OPA	Operational Amplifier
INA	Instrumentation Amplifier or Difference Amplifier or Current Shunt
LOG	Logarithmic Amplifier
XTR	Current Loop Driver
PGA	Programable Gain Amplifier (Digital)
VCA	Voltage Controlled Variable Gain Amplifier
IVC	Current to Voltage Converter
TLV	Low Voltage CMOS Amplifiers & Comparators
TLC	CMOS Amplifier
TLE	Bipolar/BiFET Amplifier
TL	Bipolar Amplifier
THS	High Speed Amplifier
TPA	Audio Power Amplifier
LMH	High Speed Amplifier
LMP	Current Shunt Monitor

Amplifiers At a Glance…

Low Power

INA333
Lowest Input Bias Zero Drift In-Amp
0.2nA Ib, 75µA

OPA2835
Lowest Power >50MHz Bandwidth VFB Amp
250uA, 59MHz GBW

LPV521
Industry's lowest power
RRIO Op-Amp

OPA333
Lowest Power Zero Drift Op Amp
25µA, RFI filtering

OPA170
Lowest Power >1MHz Wide Supply Amp
RRO,SOT553,110µA

THS4531A
Ultra Low Power Fully Differential
36MHz bandwidth with 250µA

OPA378
Lowest Noise/Power Zero-Drift Op Amp
20nV/rtHz, 100µA

Precision Input

LMP7721
Industry's lowest bias current
(3 fA) Amplifier

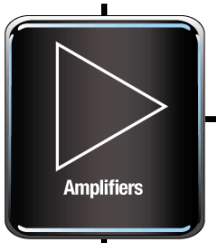
OPA140
High Precision 11MHz JFET
120uVVos, 1µV/°C drift, 11MHz GBW

OPA209
Low Noise
2.2nV/rtHz, 18MHz, Precision, RRO, 36V

OPA211
Lowest Noise Bipolar Amp
1.1nV/rtHz, 36V

OPA188
36V Zero-drift, Low Noise
0.03 µV/°C drift, 8.8nV/rtHz

OPA320
1pA Ibias Precision Amplifier
for Sensor Signal Conditioning (20MHz, 1.8-5.5V)



Wide Bandwidth

LMH3401
Ultra Linear Differential ADC Driver
2.8 GHz BW, flat to 830 MHz

OPA365
Widest GBW RRIO Zero-Crossover CMOS Op Amp
50MHz, 16-Bit Performance

LMH6629
Highest Performance Low-Noise
Op-Amp : 0.69nV/rtHz, 900 MHz BW

THS4541
Low Power Fully Differential
Quiescent current 10.1 mA/ch
RRO, 850MHz BW

OPA2673
Dual Wideband High Output Current
Slew Rate: 3000 V/µs
BW: 340MHz

LMH6521
High Performance Dual DVGA
48.5dB OIP3 @ 200MHz

Industrial Amplifiers

DRV84032
Highest Power Integrated Driver
7A RMS / 12A peak Per Bridge

OPA836
Single-ended and Pseudo differential ADC Driver
4.6nV/rtHz, 205MHz BW for 1mA Iq

OPA564
Ideal for OFDM Power Line Communications
1.5A Out, 24V, 17MHz

THS3095
Power-Down Capability
Iq 500 µA

OPA653
Industry's fastest FET Input
2675V/µs Slew Rate
500MHz Bandwidth

OPA192
Industry's first 36V RRIO E-trim True-Precision Op-amp
Zero-drift, 10MHz, Cap load 1nF

Tools & Resources….

Design Tools	
TINA-TI	SPICE-Based Analog Simulation Program
FilterPro	Active Filter Design Application
Opamps Selection Guide	Amplifier Product Selection Guide Software

TIDesigns

- Haptic Feedback with Bluetooth® Low Energy and iOS App Reference Design
- 50 mA-20 A, Single-Supply, Low-Side or High-Side Current Sensing Solution
- Low Side 0.5A 8ch Digital Output Module for PLC

TI E2E™ Community
engineer to engineer, solving problems

Clock & Timing Portfolio

Buffer / Distributor

Key Features
- Low additive jitter
- Integrated LDO
- Prog. outputs formats
- Prog. output dividers
- High max. clock freq
- Low output skew

Applications
- Wired & wireless comm
- Telecom / Networking
- Test & measurement
- Medical Eq (Ultrasound,…)
- Consumer / Prosumer

Devices
LMK0033x – low-noise PCIe
LMK0030x – differential (PCIe,…)
LMK0010x – single-ended
CDCLVCxxx – single-ended
LMK0180x – diff w/ dividers

Clock Generator

Key Features
- Ultra-low jitter
- Flexible in/out formats
- Flexible freq. plan
- Crystal or XO input
- Fractional / integer dividers
- I2C/SPI/EPROM Programming

Replace Crystals & Oscillators

Applications
- Wired & wireless comm
- Telecom / Networking
- Test & measurement
- Medical Eq (Ultrasound,…)
- Consumer / Prosumer

Devices
CDCM6208 – ultra flexible
LMK03806 – 100-fsec jitter
CDCM9102 – PCIe Gen 2/3
CDCE(L)9xx – xtal replacement
CDCS501/2 – xtal replacement

Jitter Cleaner
"Best Electronic Design 2012"

Key Features
- Single or dual PLL
- Sub 50-fsec RMS jitter
- Maximum programmability
- High max. clock freq.
- Holdover mode
- JESD204B support

Best Performance for smallest BOM

Applications
- Wired & wireless comm
- Telecom / Networking
- Test & measurement
- Military & Satellite

Devices
LMK04828 – JESD204B support
LMK04906 – networking clocks
LMK04816 – 4-in redundancy
LMK0480x – 4-in redundancy

PLLatinum™ RF PLL / Synth

Key Features
- High RF freq. range
- Low spurious fractional PLL
- Ultra wideband synth.
- Low phase noise & spurs
- Ultra-Low power for mobile
- Integrated VCO(s)

Extend the Range of your Wireless

Applications
- Wireless communications
- Test & measurement
- Consumer / Prosumer
- Military & Satellite
- Automotive

Devices
LMX2581 – wideband synth
LMX2541 – low noise synth
LMX2531 – low-power synth
LMX248x – Frac-N PLL
LMX2492 -- 14 GHz PLL

EXAMPLES

- One of the *Largest Clock & Timing Portfolios*
- *Lead the Industry on Performance*
- *Easy Design-in* with WEBENCH Clock Architect

Texas Instruments

WEBENCH® Clock Architect

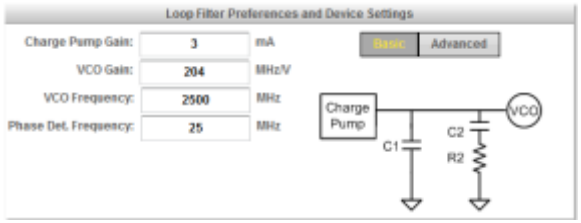
Input Frequencies

Fixed Output Frequencies

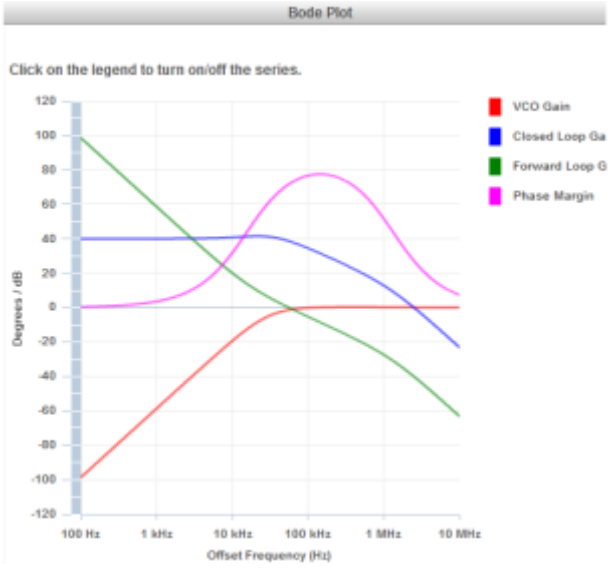
Tunable Output Frequencies

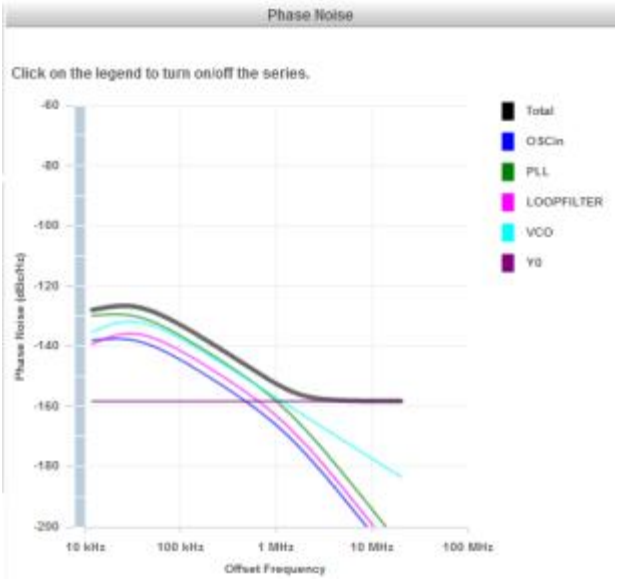
Product Features

Advanced Selection Algorithm



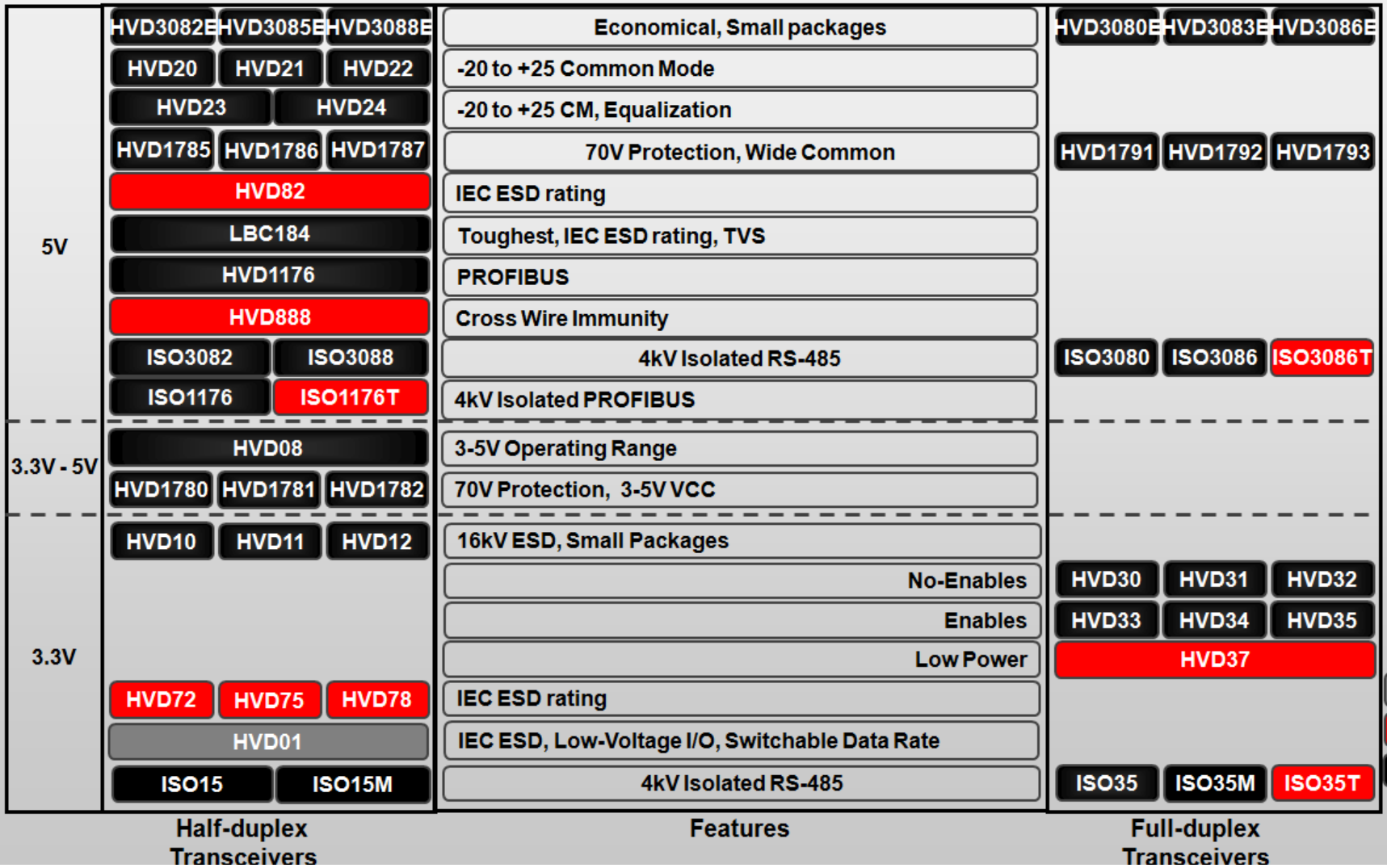
Configure & Simulate



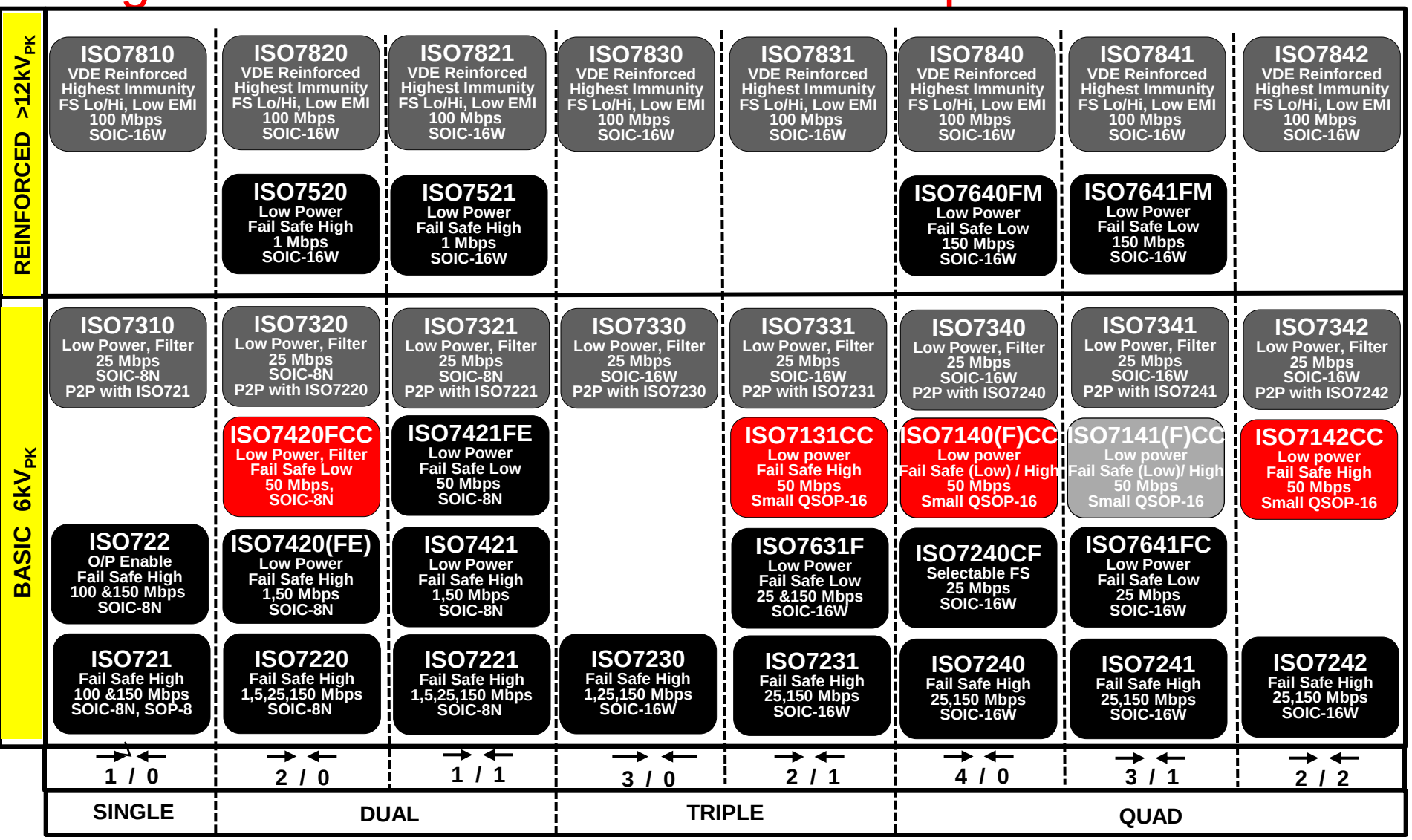


Texas Instruments

RS-485 portfolio



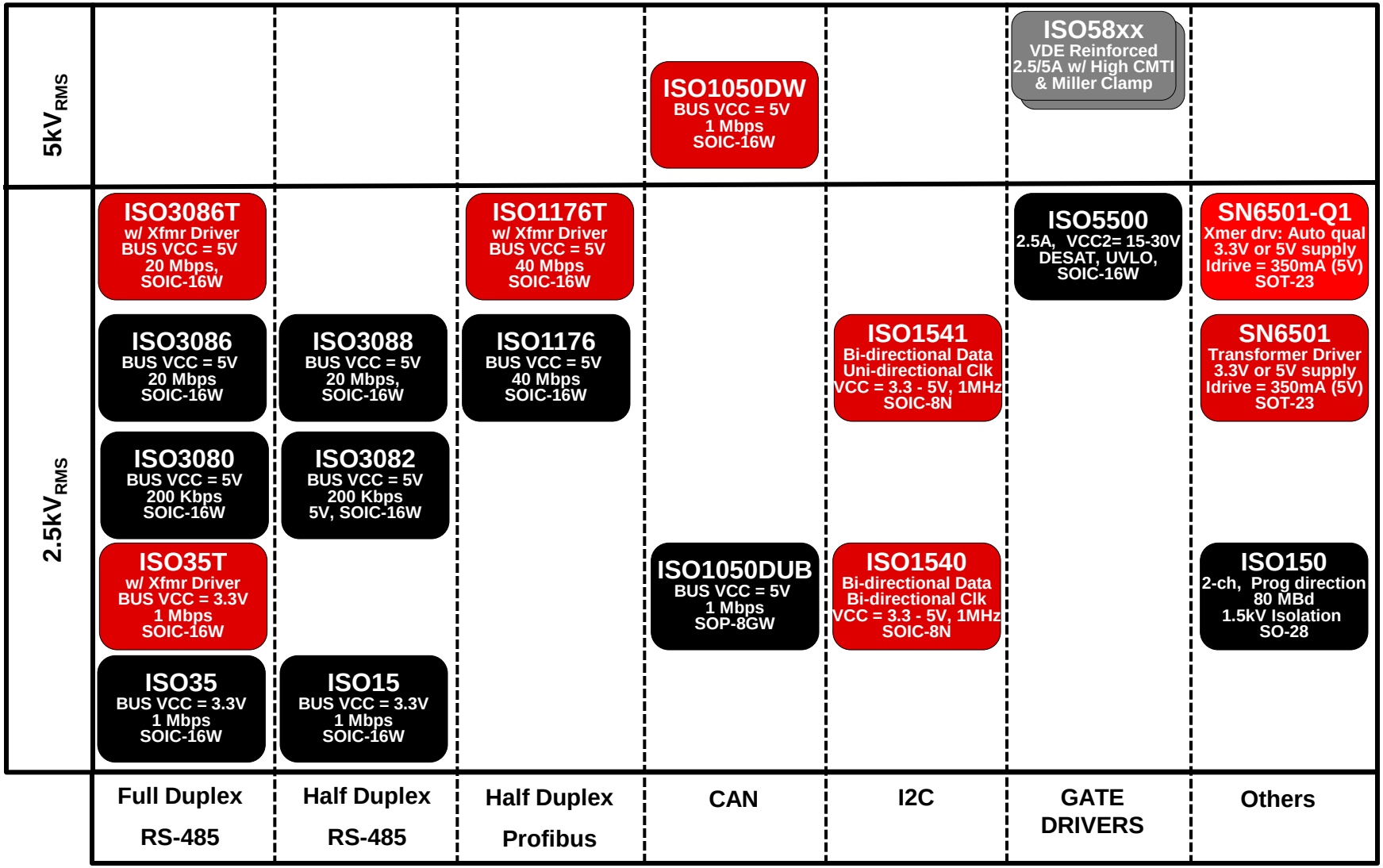
Digital Isolators Portfolio & Roadmap



Existing | New | Roadmap

Texas Instruments

Isolated Functions



Existing | New | Roadmap

Texas Instruments

Reference Material

Go to www.TI.com and enter the bold literature numbers into the Keyword Search field.

- Removing Ground Noise in Data Transmission Systems (slla268)
- Interface Circuits for TIA/EIA-485 (RS-485) (Rev. C) (slla036c)
- Detection of RS-485 signal loss (slyt257)
- Overtemperature Protection in RS-485 Line Circuits (slla200)
- Device spacing on RS-485 buses (slyt241)
- PROFIBUS Electrical-Layer Solutions (Rev. A) (slla177a)
- A statistical survey of common-mode noise (slyt153)
- Failsafe in RS-485 data buses (slyt080)
- The RS-485 unit load and maximum number of bus connections (slyt086)
- Using Signaling Rate and Transfer Rate (Rev. A) (slla098a)
- Operating RS-485 Transceivers at Fast Signaling Rates (slla173)
- RS-485 for E-Meter Applications (Rev. A) (slla112a)
- Failsafe in RS-485 Data Buses (slyt064)
- Use Receiver Equalization to Extend RS-485 Data Communications* (slla169)
- The RS-485 Unit Load and Maximum Number of Bus Connections (slla166)
- Comparing Bus Solutions (Rev. A) (slla067a)
- RS-485 for Digital Motor Control Applications (slla143)
- 422 and 485 Standards Overview and System Configurations (Rev. C) (slla070c)
- TIA/EIA-485 and M-LVDS, Power and Speed Comparison (slla106)
- Live Insertion with Differential Interface Products (slla107)
- The ISO72x Family of High-Speed Digital Isolators (slla198)

TI CAN Transceiver Portfolio

S / STB / SLP = Operating Modes: S=Silent, STB = Low Power Standby Mode with bus wake (RXD active), SLP = Low Power Sleep Mode
SC = Driver slope control
LBK / AB = Loopback modes: LBK = Diagnostic, AB = Autobaud
TDTO = TXD Dominant Time Out
LS = Level Shifting RXD pin for 2.8 – 5.5V µP I/O
Turbo = Optimized Loop Times for Industrial Networks & CAN timing margin
MT = Multi-Topology CAN
DN = Optimized for DeviceNet
EMC = Optimized for lowest emissions
V_{REF} = Vcc/2 V_{REF} or SPLIT output
D / P / DRJ / DW / DUB = Package

ISOLATED CAN

ISO255
-27/+40V, -55/105C, DW, TDTO, Turbo
Isolation: 5kV$_{RMS}$

ISO1050
-27/+40V, -55/105C, DW / DUB, TDTO, ISO: 5k / 2.5kV$_{RMS}$

ISO1050L
-27/+40V, -55/105C, DW, TDTO, ISO: 2.5kV$_{RMS}$

CAN

SN65HVDxxx
HV Standoff CAN

SN65HVD253
-27/+40V, -40/125C, D, S, AB, DN

SN65HVD252
-27/+40V, -40/125C, D, S, V_{REF}, DN

SN55HVD251
+/- 36V, -55/125C, DRJ, STB, SC, V_{REF}

SN65HVD251
+/- 36V, -40/125C, D / P, STB, SC, V_{REF}

SN65HVD1040
-27/+40V, -40/125C, D, STB, TDTO, V_{REF}, EMC

SN65HVD1050
-27/+40V, -40/125C, D, S, TDTO, V_{REF}, EMC

SN65HVD257
-27/+40V, -40/125C, D, S, TDTO, MT, Turbo

SN65HVD256
-27/+40V, -40/125C, D, S, TDTO, LS, Turbo

SN65HVD255
-27/+40V, -40/125C, D, S, TDTO, Turbo

SN65HVD232
-4/+16V, -40/85C, D

SN65HVD231
-4/+16V, -40/85C, D, SLP, SC, V_{REF}

SN65HVD230
-4/+16V, -40/85C, D, STB, SC, V_{REF}

SN65HVD235
+/- 36V, -40/125C, D, AB, STB, SC, V_{REF}

SN65HVD234
+/- 36V, -40/125C, D, STB, SLP, SC, V_{REF}

SN65HVD233
+/- 36V, -40/125C, D, LBK, STB, SC, V_{REF}

5V CAN Transceivers

3.3V CAN Transceivers

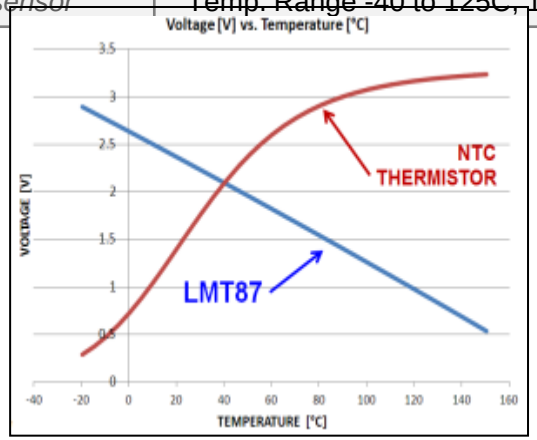
Scott Monroe

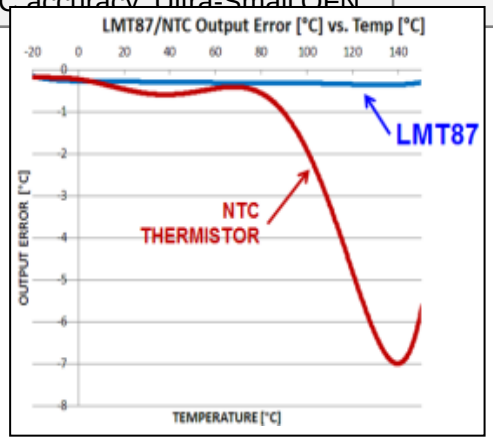
EXISTING | NEW | PREVIEW | ROADMAP

Texas Instruments

Silicon Temp. Sensors (Thermistor Alternative)

2014 Hero Products			
Digital Output: *Thermistor Alternative utilizing I2C, SPI, or other Digital interfaces*	**TMP112:** SOT-563 Pkg, Iq 10uA (Max), Alert, Local = 0.5°C	**TMP103:** WCSP 0.76x0.76mm, Iq 3uA (Max), Local = 3°C	• *Eliminates calibration needs making it easier on the software* • *Added power savings* • *Fewer components for smaller, easier layout* • *Highly linear across temperature*
Analog Output: *Thermistor Alternative provides increased linearity, accuracy, and power consumption across a wide Temp. Range*	**LMT8x (x = 4,5,6,7):** Vin 1.5V-5.5V, Temp Range -50 to 150C, SC70 Pkg, Local = 2.7°C		
SPI Output: *SPI™-Compatible ADC device with an integrated temp. sensor*	**ADS1018:** 12-Bit ADC with Integrated Temp. Sensor Temp. Range -40 to 125C, 1°C accuracy, Ultra-Small QFN		*SPI output temperature sensor*





Case Study – LMT87 Lab Results

Left: Output Voltage from Sensors; **Right**: Accuracy Comparison at ADC Input

HDC1000

Integrated Low Power Humidity and Temperature Digital Sensor

Features

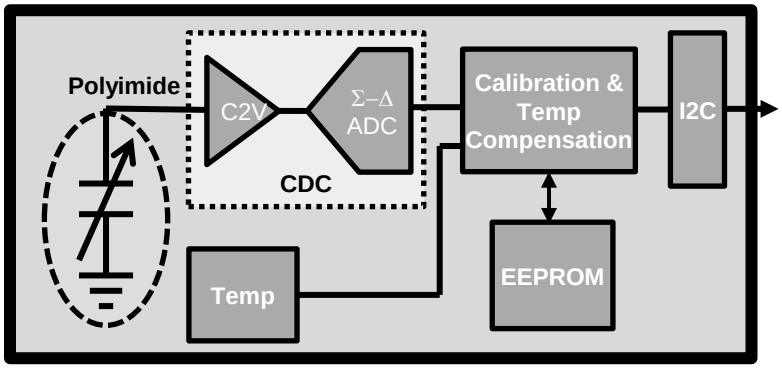
- Relative Humidity Range 0% to 100%
- Humidity Accuracy ±3%
- Supply Current (Measuring) 110 uA
- Avg. Supply Current (H+T @1sps) 1.2uA
- Temperature Accuracy ±0.2ºC
- Temperature Range -40ºC to +125ºC
- Operating Voltage 3V to 5V
- Package 8 pin WCSP (1.59 x 2.04mm)

Applications

- HVAC
- White goods (dryer, fridge, microwave, dishwasher)
- Printers
- Handheld Meters
- Camera Defog
- Smart Thermostats and Room Monitors
- Medical Devices

Benefits

- Completely integrated humidity and temperature IC provides guaranteed performance
- Fully calibrated sensor enables quick time-to-market
- Very low power consumption
- Small package size supports compact designs

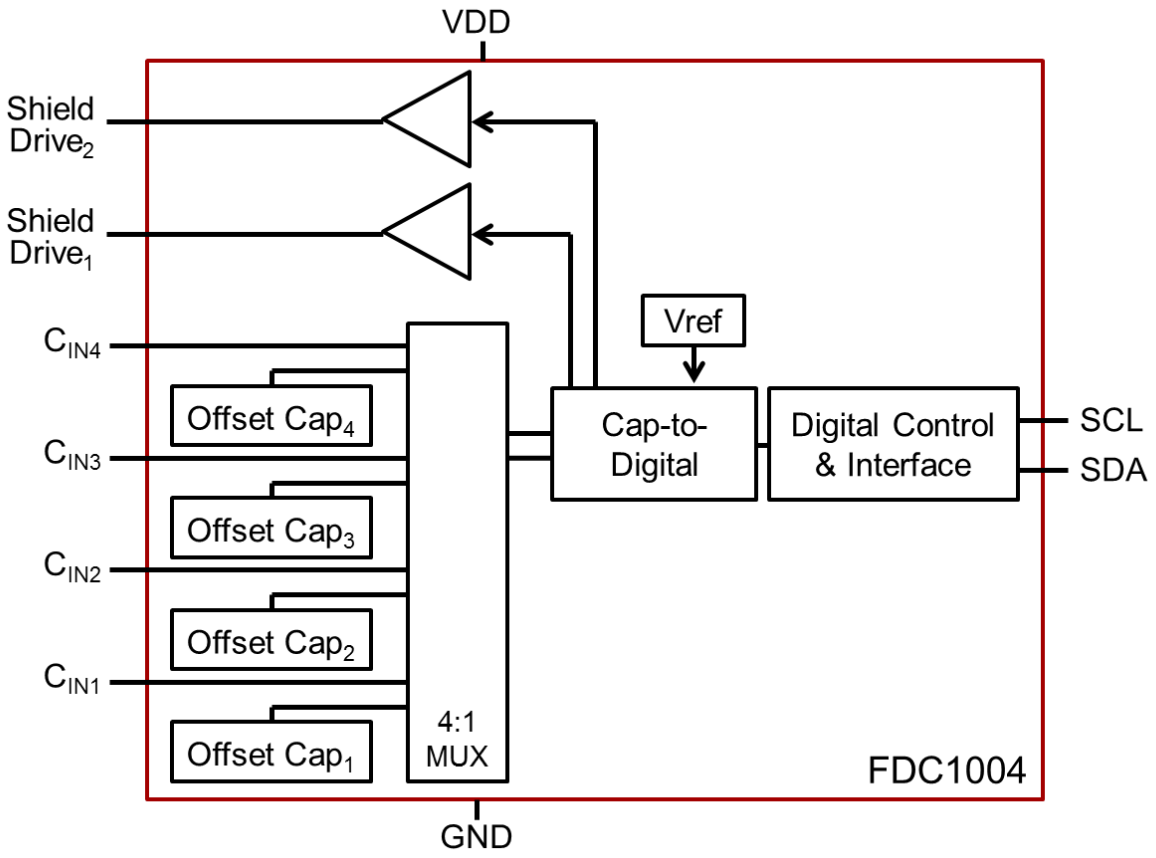


FDC1004

4-Ch General Purpose Cap-to-Digital Converter

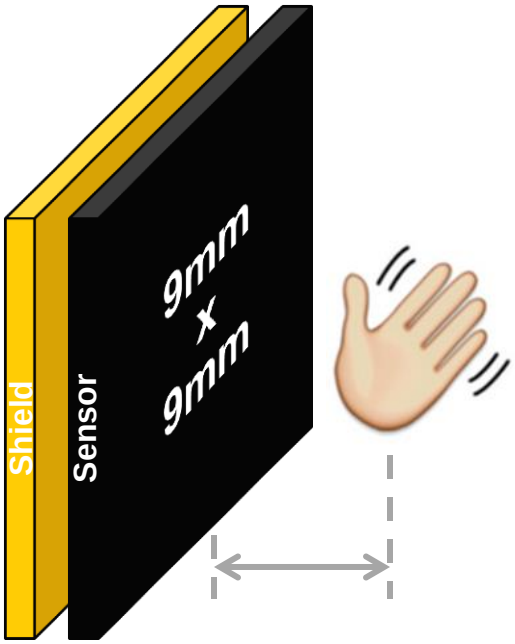
Key Specifications & Features

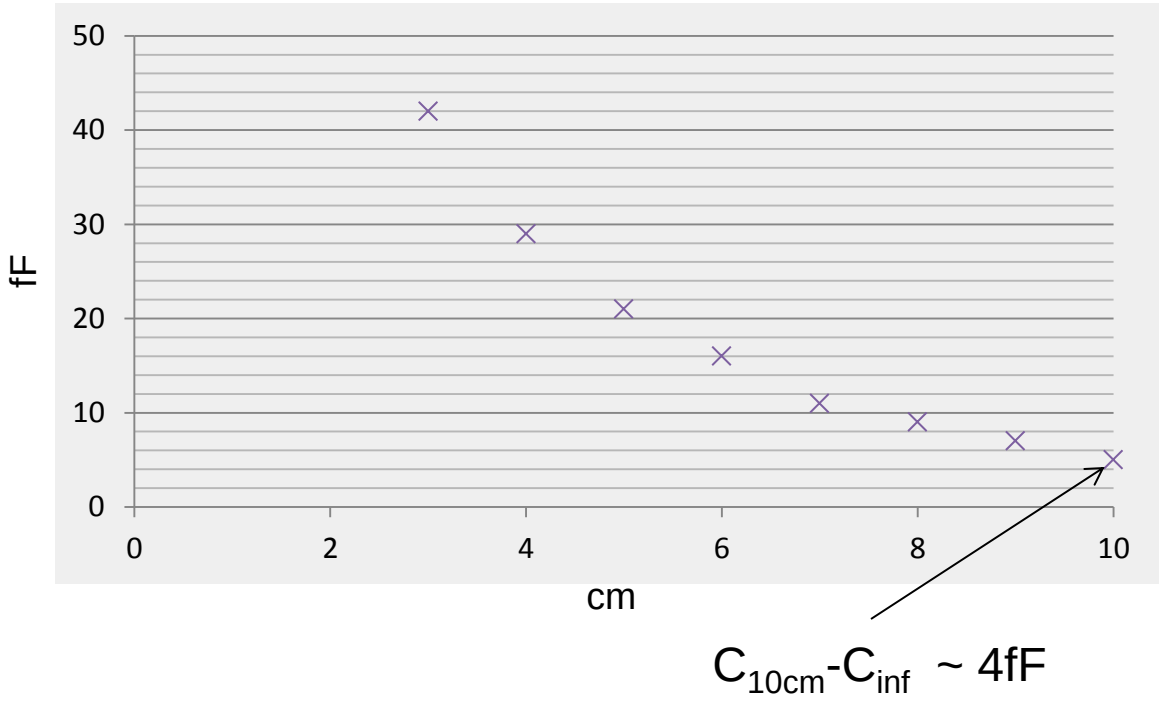
- Four measurement channels
- Input full-scale range: +/-15pF
- Noise-free Resolution: 0.5fF at 100sps
- 100pF max. input common mode (Offset Cap)
  - Large offset supports long cables/remote
  - External offset cap allows time-varying offset
- 400pF max. shield driving capability
  - Shield allows focusing of sensor
  - Shield reduces impact of interferers and temp/humidity variations
- I2C interface
- Programmable Sampling Rate
  - 100/200/400 sps
- Power
  - 3.3V, 750uA active
  - 3.3V, 27uA standby
- 10-pin QFN Package



Released

FDC Applications





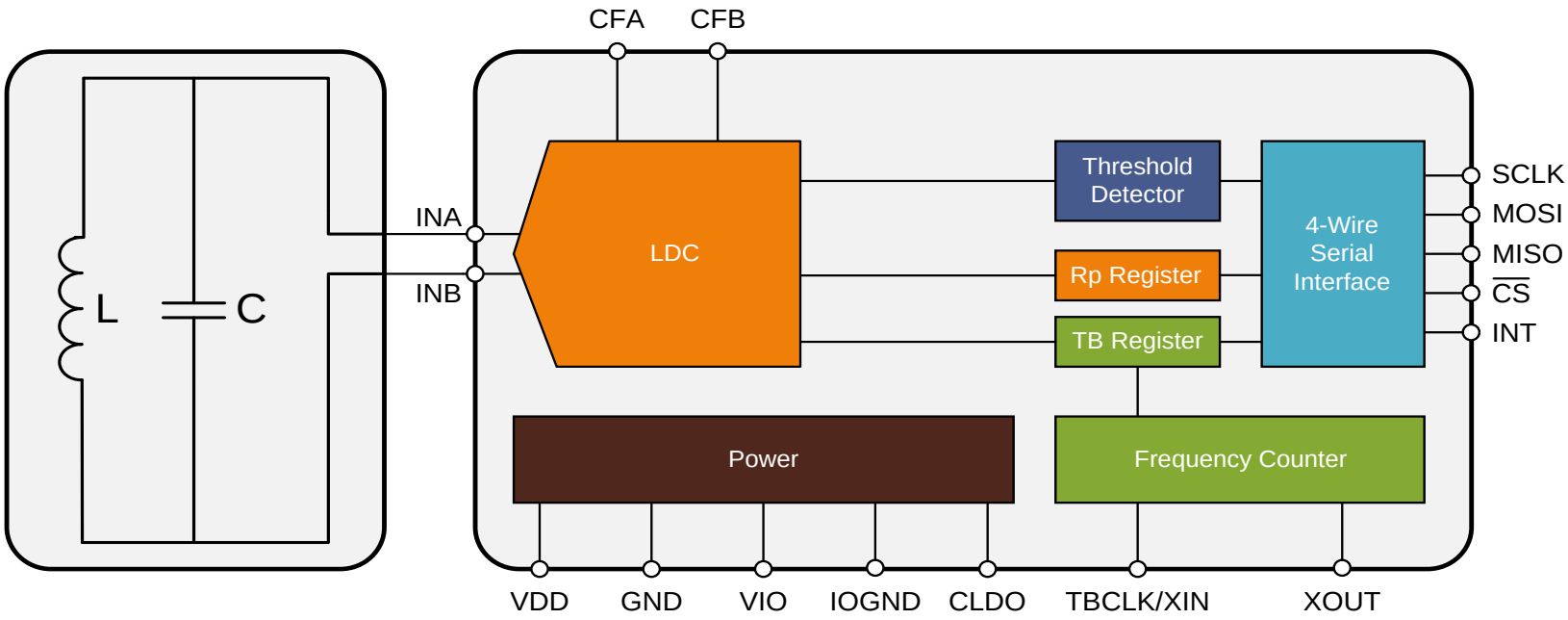
→ Detecting a target at 10cm can be achieved with the FDC1004 resolution

Advantages vs. Existing Technologies

- Lower power solution
- Lower system cost
- Flexible sensor design

- Display wakeup
- Car kick sensor
- Door activation

LDC1000



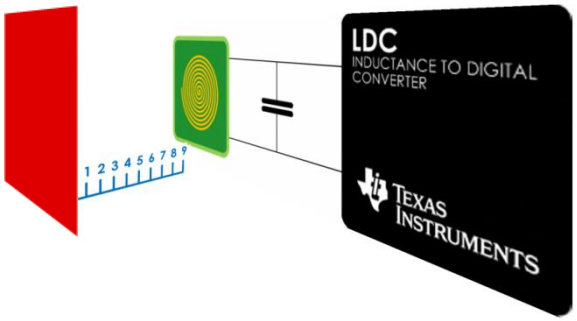
LDC	Oscillation Frequency Range	5kHz-5MHz
	Oscillation Amplitudes	1Vpp, 2Vpp, 3Vpp, 4Vpp
	Rp Range	1.25kΩ-5MΩ
	Rp Measurement Resolution	0.1%
	Response Time	96-3072 cycles
	Recovery Time	<10*Tosc
f Counter	Time-Base Clock/XTAL Frequency	8MHz

Power	VDD Range	4.5-5.5V
	VIO Range	3.0-3.6V
	Isupply	2mA (max)
Interface	Interface	4-Wire SPI
	Interface Speed	4MHz
Package	Package	DFN
	Pin Count	16

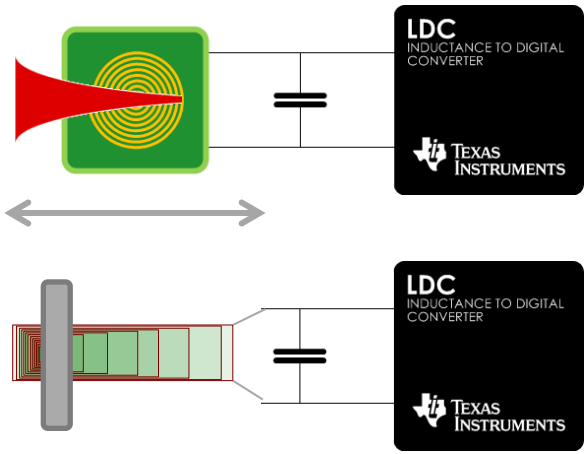
Application Use Cases

Inductive Sensing

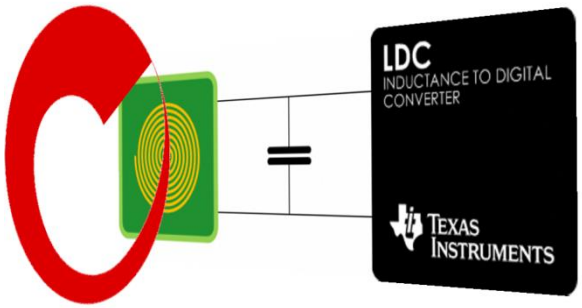
Axial distance Measurement



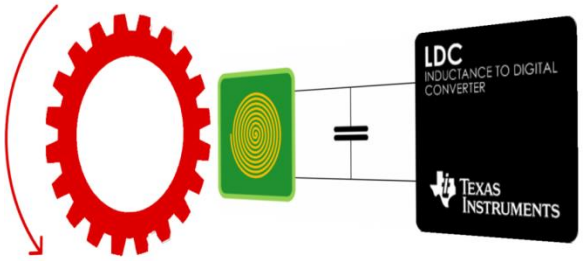
Linear Position Sensing



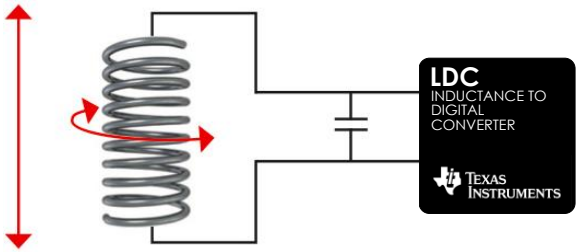
Angular Position Sensing



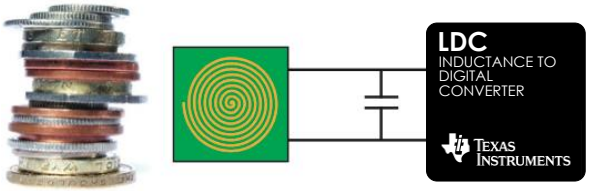
Event Counting



Spring Measurement



Metal Identification



OPT3001: Ambient Light Sensor

Features

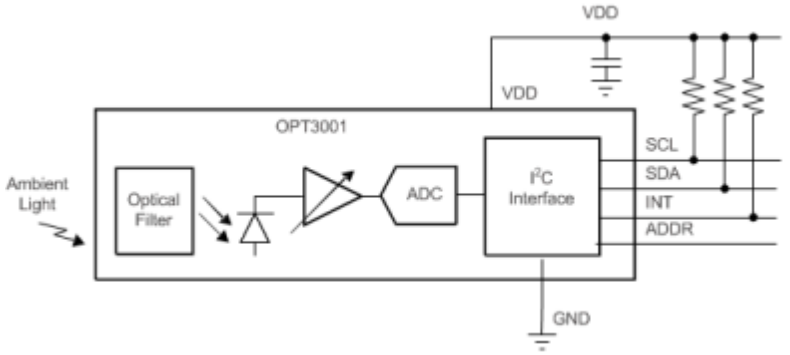
- High Performance Optical Filtering To Match The Human Eye.
  - Over 99% IR rejection
- Broad Capabilities:
  - Wide Dynamic Range: 0.01 Lux to 83k Lux
  - 23-Bit Effective Resolution
- Automatic Gain Configuration
- Ultra Low Power & Small Packaging
  - Supply Range: 1.6V to 3.6V
  - Quiescent Current: 2.5uA (max)
  - Shutdown Current: 1uA (max)
  - 2.0 x 2.0mm

Benefits

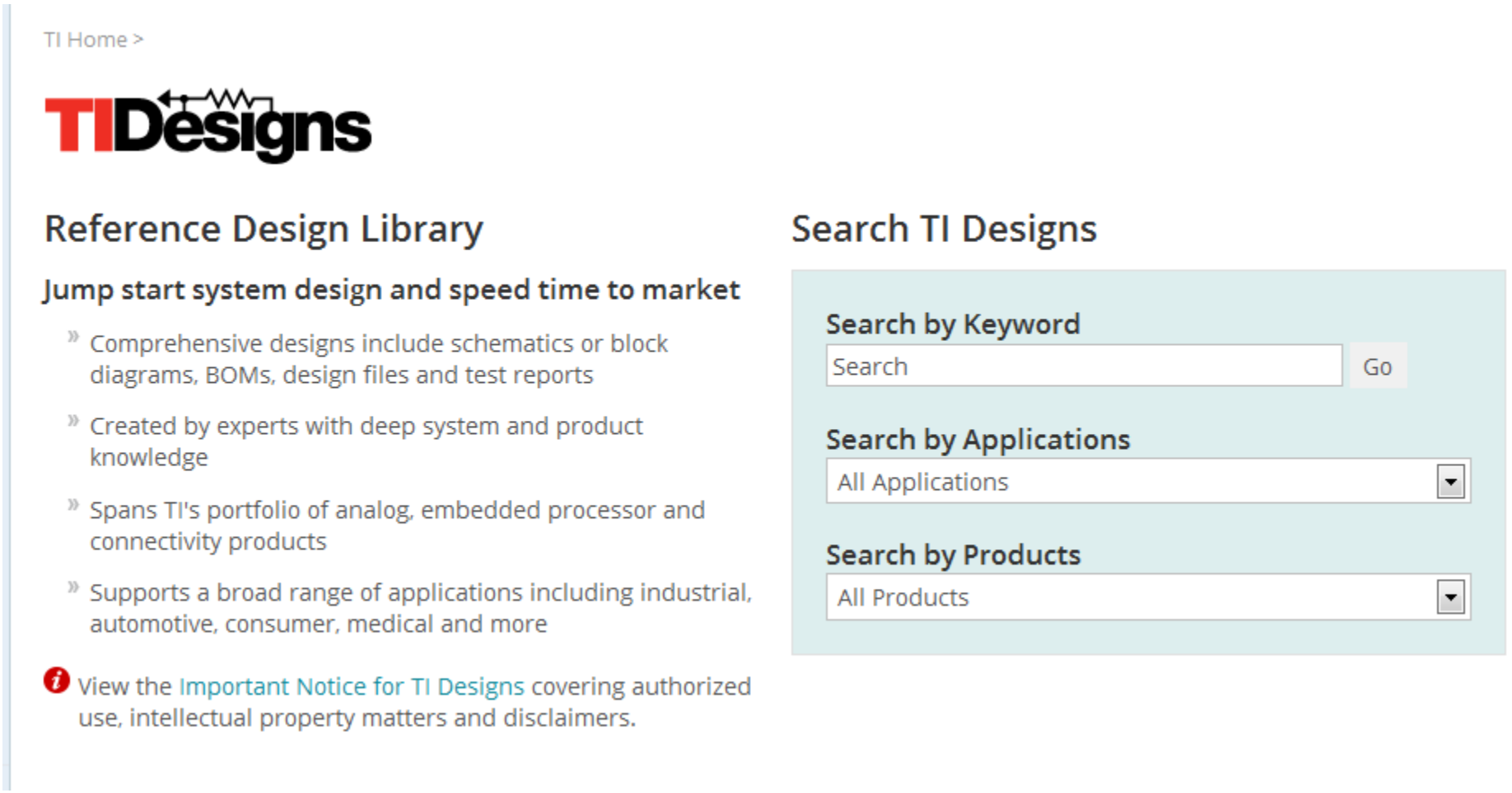
- Directly reports out Lux equivalent to what the human eye perceives regardless of light source (Sun, Halogen, Incandescent, Fluorescent, LED)
  - Strong IR rejection helps maintain accuracy when sensor is placed behind dark glass
- High resolution even at low light levels
- Simplifies system design
  - Automatically maximize full scale range of ADC in all lighting conditions

Applications

- Backlight Control
  - Thermostat, Notebook, Tablets
- Outdoor Displays
  - Digital Signage, Sporting Equipment with displays
- Building Automation
  - Daylight Sensors & Artificial lighting control



TI designs


TI Home >
TIDesigns
Reference Design Library
Jump start system design and speed time to market
» Comprehensive designs include schematics or block diagrams, BOMs, design files and test reports
» Created by experts with deep system and product knowledge
» Spans TI's portfolio of analog, embedded processor and connectivity products
» Supports a broad range of applications including industrial, automotive, consumer, medical and more
View the Important Notice for TI Designs covering authorized use, intellectual property matters and disclaimers.
Search TI Designs
Search by Keyword
Search
Go
Search by Applications
All Applications
Search by Products
All Products

TI designs example

Contactless Current Sensing using Hall Sensing

Contactless monitoring for AC wire loads using the DRV5053 Hall Sensor

Capacitive-based technology using conductive ink/paint as sensor for flexible industrial design

Thermopile-based Occupancy Detection

Thermopile-based occupancy sensing with an 8x8 array enabling people counting applications

Technical writers putting together the doc now

Thank You

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

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