Integrated filters reduce power and increase board density in ADSL CO

Op amp provides high output current and low distortion for ADSL CPE and ADSL2 driver applications

Includes Burr-Brown Products from Texas Instruments

Read Sine On online at www.ti.com/sc/sineon
**CO synthesized output impedance line driver/receiver dissipates 1.1 W**

**THS7102/3**  
*Product Preview*  

Applications include:
- ADSL CO

Get samples, datasheets and app reports at:
- www.ti.com/sc/device/THS7102
- www.ti.com/sc/device/THS7103

- Full-rate ADSL central-office (CO) line driver/receiver
- Single-supply +15-V operation
- Low 1.1-W total power consumption:
  - Drive channel, 0.9 W
  - Receive channel, 0.2 W
- Synthesized output impedance differential line drivers:
  Eliminate external line-matching resistors, reducing the required output voltage by 50 percent
- Integrated analog filters in both transmit and receive channels:
  - THS7102 filters support DSL over POTS
  - THS7103 filters support DSL over ISDN
- Multiple power-saving modes: Bias current is adjustable in 25-percent increments to allow lower power modes for shorter line lengths
- Low-impedance shutdown
- Thermal shutdown and short-circuit protection
- Packaging: available in 32-pin TQFP PowerPAD™
- Suggested resale price starts at $6.31 each in quantities of 1,000

*This product is in product preview stage of development. Contact your distributor or Ti sales office for availability. Expected availability 2Q 2001.

**THS7102 block diagram**

Integrated filters reduce power and increase board density.

![THS7102 block diagram](image)

**Class-G CO line driver dissipates 1.35 W**

**THS6032**

Applications include:
- ADSL CO

Get samples, datasheets, app reports and EVMs at:
- www.ti.com/sc/device/THS6032

- Low-power dissipation driving full-rate ADSL downstream signals:
  - Class-G mode: 1.35 W
  - Class-AB mode: 2 W
- Output power delivered to line: 21 dBm
  ($V_{CCH} = \pm 15 \text{ V to } \pm 5 \text{ V, } R_L = 100 \Omega, \text{ CF = } 5.6, \text{ 1:2 transformer, series-matching resistors}$)
- Output drive: 400 mA (min)
- Bandwidth: 65 MHz
- Slew rate: 1,200 V/µs
- Total harmonic distortion: -62 dBc at 1 MHz
- Low-impedance shutdown allows reception of signals during standby
- Thermal shutdown and short-circuit protection
- Supply voltage: ±5 V to ±15 V
- Packaging: available in 20-pin SOIC PowerPAD™ (DWP), MicroStar Junior™ BGA (GQE) and 32-pin PowerPAD plastic quad flatpack (VFP)
- Suggested resale price starts at $4.49 each in quantities of 1,000

**THS6032 application diagram**

Class-G line driver uses four supplies to lower power dissipation.
Line driver delivers up to 21-dBm output power

**THS6012**

Get samples, datasheets, app reports and EVMs at: www.ti.com/sc/device/THS6012

- Output power delivered to line: 21 dBm (V_{CC} = \pm 15 V, R_L = 100 \Omega, CF = 5.6, 1:2 transformer, series-matching resistors)
- 2.0 W power dissipation in ADSL CO systems (with 12.5-\Omega series-matching resistors)
- Output drive: 400 mA (min)
- Bandwidth: 140 MHz
- Slew rate: 1,300 V/\mu s
- Total harmonic distortion: -65 dBc at 1 MHz
- Supply voltage: \pm 5 V to \pm 15 V
- Packing: available in 28-pin TSSOP PowerPAD™ (DWP), MicroStar Junior™ BGA (GQE) and 32-pin PowerPAD plastic quad flatpack
- Suggested resale price starts at $4.35 each in quantities of 1,000

**ADSL CO application diagram**

The THS6012 drives full-rate downstream signals using two 15-V supplies.

Integrated line driver/receiver deliver up to 21-dBm output power

**THS6007**

Get samples, datasheets and app reports at: www.ti.com/sc/device/THS6007

- Driver features:
  - Output power delivered to line: 21 dBm (V_{CC} = \pm 15 V, R_L = 100 \Omega, CF = 5.6, 1:2 transformer, series-matching resistors)
  - Output drive: 400 mA (min)
  - Slew rate: 140-MHz bandwidth and 1,300 V/\mu s
  - Total harmonic distortion: -65 dBc at 1 MHz
- Receiver features:
  - Voltage noise: 10 nV/\sqrt{Hz}
  - Slew rate: 175-MHz bandwidth and 230 V/\mu s
- 2.2-W power dissipation in ADSL CO systems (with 12.5-\Omega series-matching resistors)
- Thermal shutdown and short-circuit protection
- Supply voltage: \pm 5 V to \pm 15 V
- Packing: available in 28-pin TSSOP PowerPAD™
- Suggested resale price starts at $5.40 each in quantities of 1,000

**THS6007 block diagram**

Integrated driver and receiver reduce board space.
Dual wideband, high-output-current op amp for line-driver applications

**OPA2677**

Get samples and datasheets at: www.ti.com/sc/device/OPA2677

- Wideband +12-V operation: 200 MHz, G = 4
- Unity gain stable: 220 MHz, G = 1
- High output current: 500 mA
- High output voltage swing: ±5 V
- High slew rate: 1,800 V/μs
- Low supply current: 18 mA
- Flexible power control
- Packaging: available in 8-pin SO
- Suggested resale price starts at $2.29 each in quantities of 1,000

Single-supply ADSL upstream driver

The OPA2677 provides the high output current and low distortion required for ADSL and HDSL2 driver applications. Its high 200-MHz bandwidth also supports demanding VDSL-line driver requirements.

Low-noise ADSL CPE line drivers support +12-V or ±12-V operation

**THS6042/3, THS6052/3, THS6092/3**

Get datasheets at: www.ti.com/sc/device/partnumber

Replace *partnumber* in URL with THS6042, THS6043, THS6052, THS6053, THS6092 or THS6093

- Low-current noise ADSL line drivers reduce noise feedback through the hybrid into the downstream channel, increasing the ADSL CO data rate/reach
- Supply voltage: ±5 V to ±15 V (THS6042/3); ±5 V to ±15 V (THS6052/3); +5 V to +14 V (THS6092/3)
- Output power: 17.7 dBm (1:1 transformer) (THS6042/3); 15.0 dBm (1:1 transformer) (THS6052/3); 14.1 dBm (1:2 transformer) (THS6092/3)
- Noninverting current noise: 2.5 pA/√Hz (THS6042/3, THS6092/3); 1.2 pA/√Hz (THS6052/3)
- High-impedance shutdown (THS6043/53/93)
- Packaging: available in 8-pin SOIC, 8-pin/14-pin SOIC PowerPAD™, 14-pin TSSOP PowerPAD™
- Suggested resale price starts at $2.29 each in quantities of 1,000

**THS6042 application diagram**

Low transmit-channel noise decreases noise feedback into the downstream channel.

**Applications include:**
- xDSL line driver
- Cable modem driver
- Broadband-video line driver
- Matched-I/Q channel amplifier

**Applications include:**
- Line drivers for ADSL CPE, HDSL, HDSL2, SDSL, G.SHDSL, VDSL

For technical support and literature, see page 15.
Dual, 700-MHz voltage-feedback op amp for price-sensitive applications

**OPA2652**

Get samples, datasheets and app reports at: www.ti.com/sc/device/OPA2652

- Wideband buffer: 700 MHz, $G = 1$
- Wideband line driver: 200 MHz, $G = 2$
- High output current: 140 mA
- Low supply current: 5.5 mA/channel
- Low $dG/dØ$: 0.05 percent/0.03 degrees
- High slew rate: 335 V/µs
- Supply voltage: ±3 V to ±6 V
- Packaging: available in 8-pin SO and SOT-23
- Suggested resale price starts at $1.29 each in quantities of 1,000

**Differential ADC driver**

OPA2652 drives ADS807 ADC differentially at a gain of 2 V/V. The differential topology minimizes even-order distortion products, such as second-harmonic distortion.

**Applications include:**
- ADC drivers
- Consumer video
- Active filters
- Pulse-delay circuits

Line driver delivers up to 18.1-dBm output power

**THS6022**

Get samples, datasheets, app reports and EVMs at: www.ti.com/sc/device/THS6022

- Output power delivered to line: 18.1 dBm ($V_{CC} = ±15$ V, $R_L = 100$ Ω, $CF = 5.6$, 1:1.4 transformer, series-matching resistors)
- Output drive: 200 mA (min)
- Bandwidth: 210 MHz
- Slew rate: 1,900 V/µs
- Total harmonic distortion: -66 dBc at 1 MHz
- Thermal shutdown and short-circuit protection
- Supply voltage: ±5 V to ±15 V
- Packaging: available in 14-pin TSSOP PowerPAD™ (PWP) and MicroStar Junior™ BGA (GQE)
- Suggested resale price starts at $2.90 each in quantities of 1,000

**Applications include:**
- ADSL CPE
- HDSL
- HDSL2
- SDSL
- G.SHDSL
- VDSL

---

**THS6022 ADSL CPE application diagram**

Higher supply voltages allow THS6022 to drive a 1:1 transformer in ADSL CPE applications.

---

Read Sine On online at www.ti.com/sc/sineon
DSL receivers offer low noise or low power options

**THS6062/72**

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/THS6062
www.ti.com/sc/device/THS6072

- Low-voltage, low-noise receiver: 1.6 nV/√Hz (THS6062), 10 nV/√Hz (THS6072)
- Bandwidth: 100 MHz (THS6062), 175 MHz (THS6072)
- Slew rate: 100 V/µs (THS6062), 230 V/µs (THS6072)
- Total harmonic distortion: 72 dBc at 1 MHz (THS6062), 79 dBc at 1 MHz (THS6072)
- Supply current: 8.5 mA/channel (THS6062), 3.4 mA/channel (THS6072)
- Supply voltage: ±5 V to ±15 V (THS6072)
- Packaging: available in 8-pin SOIC and MSOP PowerPAD™
- Suggested resale price starts at $2.24 each in quantities of 1,000

DSL receivers

Two devices offer either the lowest noise or lowest power ADSL receiver.

<table>
<thead>
<tr>
<th></th>
<th>Voltage noise (nV/√Hz)</th>
<th>I_{CC}/channel (mA)</th>
<th>Power (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>THS6062</td>
<td>1.6</td>
<td>8.5</td>
<td>408</td>
</tr>
<tr>
<td>THS6072</td>
<td>10</td>
<td>3.5</td>
<td>168</td>
</tr>
</tbody>
</table>

Applications include:
- ADSL CO
- ADSL CPE
- HDSL
- HDSL2
- SDSL
- G.SHDSL
- VDSL

Wideband current- and voltage-feedback op amps for high-speed applications

**OPA685/687**

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/OPA685
www.ti.com/sc/device/OPA687

- Ultra-wideband, current-feedback operational amplifier (OPA685)
- Output voltage swing: ±3.6 V
- Ultra-high slew rate: 4,200 V/µs
- Ultra-low-noise, voltage-feedback operational amplifier (OPA687)
- Low-input voltage noise: 0.95 nV/√Hz
- Very low distortion: -95 dBc at 5 MHz
- Bandwidth: 900 MHz, G = 2; 450 MHz, G = 8 (OPA685)
- High-gain bandwidth: 3.8 GHz (OPA687)
- Packaging: available in 8-pin SO and 6-pin SOT-23
- Suggested resale price starts at $1.89 (OPA685) and $3.49 (OPA687) each in quantities of 1,000

**OPA685: Low-distortion, 12-dB gain SAW driver**

Optimized for high-gain operation, the OPA685 is ideally suited to buffering surface acoustic wave (SAW) filters in an IF strip or delivering high output power at low distortion for cable modem upstream line drivers.

<table>
<thead>
<tr>
<th>Voltage noise (nV/√Hz)</th>
<th>Current (mA)</th>
<th>Power (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>THS6062</td>
<td>1.6</td>
<td>8.5</td>
</tr>
<tr>
<td>THS6072</td>
<td>10</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Applications (OPA685) include:
- Broadband video
- Cable modem upstream driver
- Broadband-video line driver

Applications (OPA687) include:
- Low-distortion ADC driver
- OC-3 fiber-optic receiver
- Ultrasound channel amplifiers
DSL Line Drivers and Receivers

DSL receiver offers programmable gain to compensate for line lengths

**THS7002**

Get samples, datasheets, app reports and EVMs at: www.ti.com/sc/device/THS7002

- Programmable gain amplifier (PGA) features:
  - Digital programmable gain with 3-bit control
  - Gain range: -22 dB to 20 dB with 6-dB step resolution
  - Constant -3-dB bandwidth across gain settings
  - Output clamp protection
- Pre-amp features:
  - Low-noise: 1.7 nV/√Hz
  - Accessible output pin for external filtering
- Bandwidth: 70 MHz
- Slew rate: 200 V/µs
- Shutdown control
- Supply voltage: ±5 V to ±15 V
- Packaging: available in 28-pin TSSOP PowerPAD™
- Suggested resale price starts at $5.41 each in quantities of 1,000

**THS7002 block diagram**

Programmable gain ADSL receiver adjusts gain to compensate for various line lengths.

![THS7002 block diagram](image)

- Applications include:
  - ADSL CO
  - ADSL CPE
  - HDSL
  - HDL2
  - SDLS
  - G.SHDSL
  - VDSL

Power Management

Low-power, 750-mA LDOs for fast transient response and precision

**TPS777xx/778xx**

Get samples, datasheets and app reports at:
- www.ti.com/sc/device/TPS77701
- www.ti.com/sc/device/TPS77801

- Integrated supervisory circuit improves system reliability and reduces design cost (TPS777xx)
- Power Good output features available (TPS778xx)
- Ultra-low quiescent current: 85 µA (independent of load)
- Fast transient response using low-cost ceramic capacitors improves system accuracy during rapid line and load changes
- Total output accuracy of 2 percent and load regulation of less than 2 mV
- Packaging: available in 8-pin SOIC and 20-pin TSSOP PowerPAD™
- Suggested resale price starts at $1.62 each in quantities of 1,000

**TPS777xx/778xx options table**

The TPS777xx family of devices have a low-output-voltage range, making them ideal for powering CPE modems.

<table>
<thead>
<tr>
<th>Device</th>
<th>Output voltage (V)</th>
<th>Device</th>
<th>Output voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS77701</td>
<td>1.5 to 5.5</td>
<td>TPS77801</td>
<td>1.2 to 5.5</td>
</tr>
<tr>
<td>TPS77715</td>
<td>1.5</td>
<td>TPS77815</td>
<td>1.5</td>
</tr>
<tr>
<td>TPS77718</td>
<td>1.8</td>
<td>TPS77818</td>
<td>1.8</td>
</tr>
<tr>
<td>TPS77725</td>
<td>2.5</td>
<td>TPS77825</td>
<td>2.5</td>
</tr>
<tr>
<td>TPS77733</td>
<td>3.3</td>
<td>TPS77833</td>
<td>3.3</td>
</tr>
</tbody>
</table>

- Applications include:
  - Powering high-performance CPE applications
  - Powering high-performance processors (DSPs, microprocessors, FPGAs)

Read Sine On online at www.ti.com/sc/sineon
Power Management

Dual-process supervisory circuit with power fail in 8-pin MSOP

TPS3306

Get samples, datasheets and app reports at:
www.ti.com/sc/device/TPS3306

Applications include:
- Dual supervisory circuits reduce part count and composite cost
- Integrated delay time of 100 ms ensures stabilization of supply voltage
- Low supply current of 15 µA (typ) extends battery life
- Precision voltage monitoring of 1.5 V/3.3 V, 1.8 V/3.3 V, 2.0 V/3.3 V, 2.5 V/3.3 V, 3.3 V/5.0 V and additional adjustable input support latest generations of DSP core/input/output voltages
- Packaging: available in 8-pin MSOP or standard 8-pin SO
- Suggested resale price starts at $1.19 each in quantities of 1,000

Supervision of a dual-voltage DSP

The TPS3306 supervisory circuit circuit monitors two independent supply voltages.

Dual output synchronous buck controller supports wide input voltage

TPS5102

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TPS5102

Applications include:
- Powering CO and CPE
- Powering high-performance DSPs, FPGAs, microprocessors, microcontrollers

For technical support and literature, see page 15.
Latchable negative floating Hot Swap power manager

**UCC3921**

Get samples, datasheets and EVMs at:
www.ti.com/sc/device/UCC3921

- Precision inrush current control
- High-speed over-current protection with immunity from false triggering
- Full housekeeping, including output-power-status monitoring and fault reporting
- Precision fault threshold
- Precise, programmable over-current limit and circuit breaker thresholds
- Fault output indication signal
- Automatic-retry mode or latched-operation mode
- Shutdown control
- Under-voltage lockout
- Input voltage from -10.5 V
- Glitch filter of 250 µs on the SDFLTCH pin
- Packaging: available in 8-pin DIL and SO
- Suggested resale price starts at $1.56 each in quantities of 1,000

**UCC3921 application diagram**

UCC3921 is configured for a -48-V Hot Swap application.

---

Isolated DC/DC converter saves board space

**PT4564**

Get samples, datasheets and app reports at:
www.ti.com/sc/device/PT4564

- Isolation: 1,500 VDC
- Input voltage range: 36 V to 75 V
- UL, CSA, IEC, VDE approvals
- Quick, reliable plug-in solution for reduced time-to-market
- Packaging: available in Excalibur™ surface- or vertical-mount option, which allows design flexibility and saves board space
- Suggested resale price starts at $45.68 each in quantities of 1,000

**PT4564 application diagram**

The PT4564’s differential remote sense maintains precise voltage regulation across the load and provides increased transient response.

---

**Safe operating area**

With nominal airflow, the PT4560 series offers board safe operating area without derating the output current.

---

**Applications include:**

- Telecom CO
- Networking
- High-end servers and workstations

---

Read Sine On online at www.ti.com/sc/sineon
G.SHDSL analog front end for upstream/downstream data transmission

**AFE1230**

Get samples, datasheets and app reports at: www.ti.com/sc/device/AFE1230

- Complies with G.SHDSL, HDSL2 and SDSL
- E1, T1 and substrate operation
- On-chip line driver for G.SHDSL
- Serial digital interface
- Scalable data rate
- Programmable transmit (tx) and receive (rx) filters
- Flexible design speed: 64 kbps to 2.32 Mbps
- G.SHDSL at E1: 750-mW power
- HDSL2 at E1: 650-mW power
- Power supply: 5 V/3.3 V
- Packaging: available in 28-pin SSOP
- Suggested resale price starts at $14.40 each in quantities of 1,000

**AFE1230 block diagram**

The AFE1230 consists of a transmit and receive section to handle upstream and downstream data transmission.

![AFE1230 block diagram](image)

- Applications include:
  - G.SHDSL
  - HDSL2

ADSL analog front end reduces system size and cost

**AFE1302**

Get datasheets and app reports at: www.ti.com/sc/device/AFE1302

- ADSL analog interface
- Design speed: 4 Mbps and higher
- Receive and transmit word rate: 1.1 to 8.8 MWords/s
- ADC: 16-bit receive
- DAC: 16-bit transmit
- Receive noise: -147 dBm/Hz
- Nominal power dissipation: 570 mW
- VCXO
- VCXO control DAC
- Power supply circuitry: 5 V/3.3 V
- Packaging: available in 48-pin TQFP
- Suggested resale price starts at $11.00 each in quantities of 1,000

**AFE1302 block diagram**

The AFE1302 provides the active analog circuitry needed to connect an ADSL DSP to an external line driver, receiver, transmit/receive filters, hybrid, transformer and POTS filter.

![AFE1302 block diagram](image)

- Applications include:
  - ADSL

For technical support and literature, see page 15.
Integrated codec and line driver/receiver reduce system cost

**TLFD600**

- Compliant to ADSL G.dmt (full-rate) and G.lite standards
- Integrates codec, line driver and receiver
- Integrated 14-bit ADCs and DACs
- Integrated transmit/receive channel filters
- Integrated transmit/receive attenuation/gain
- Glueless interface to TMS320C54x™ and TMS320C6x™ DSP generation devices
- Integrated clock-divide circuit
- Packaging: available in 64-pin PowerPAD™

**TLFD600 block diagram**

The TLFD600 offers an integrated codec, line driver and line receiver for ADSL modems.

**Applications include:**
- DSL PCI-based modems
- PCI cards
- USB- and Ethernet-based external ADSL modems
- ADSL soft modems
- Residential gateways and integrated access devices

Integrated DSL codec/line receiver increases board density in CO

**TLV320AD16**

- Integrated codec and line receiver for CO DSL applications
- Compliant to ADSL G.dmt (full-rate) and G.lite standards
- Integrated 14-bit ADC and DAC
- Integrated transmit/receive channel filters
- Integrated transmit/receive attenuation/gain
- Integrated course programmable gain amplifier (CPGA)
- Single 3.3-V supply operation
- Software and hardware power-down
- Packaging: available in 100-pin TQFP

**TLV320AD16 block diagram**

The TLV320AD16 device offers single-channel codec and line receiver for ADSL CO systems.

**Applications include:**
- Digital subscriber line access multiplexers (DSLAM)
- Digital loop-carrier equipment (DLC)
**Cable Modem Drivers**

Low-power upstream cable modem line driver supports DOCSIS standard

**THS6101**

Get datasheets and app reports at:
www.ti.com/sc/device/THS6101

- **Low-power solution:**
  - Disable-mode power consumption of 15 mW
  - Power-consumption scales with gain
  - Single-supply operation of 5 V
- **Low noise and distortion exceeds all industry-standard DOCSIS requirements:**
  - Third-order harmonic distortion (HD3): 64 dB at 29.3 MHz, $V_O = 56 $dBmV
  - Noise level 47 dBmV at minimum gain
- **Wide range of output power levels:**
  - Output power drive: 62-dBm $V_{RMS}$
  - Range of programmable gain: 54 dB
  - Gain steps: 6 dB
- **Packaging:** available in 24-pin TSSOP PowerPAD™
- **Suggested resale price** starts at $3.55 each in quantities of 1,000

**THS6101 application diagram**

Cable modem upstream line driver offers DOCSIS compatibility.

**Applications include:**

- Upstream cable modem line driver

---

**Find real-world solutions at the 2001 Signal Conditioning Design Seminar**

TI’s 2001 Signal Conditioning Design Seminar focuses on the complexities and challenges of analog circuit design for real-world applications. This one-day technical seminar is designed for both the novice and experienced engineer and will provide practical tips and information useful in making analog designs a success.

Presenters will cover a variety of topics based on the book, *Op Amps for Everyone*. Their many years of hands-on experience will provide added depth and uniqueness to this seminar. Topics include:

- **Sharpening fundamental circuit design tools:** This session begins with a review of fundamental circuit equations, frequency analysis and the significance of bode plots. Discussion continues with the development of formulas for current-feedback and voltage-feedback circuits and concludes with a review of common-mode range and rejection issues.
- **Adding new circuit design tools:** Adding new tools to the fundamentals described above enhances the broad spectrum of analog design options available. Topics include designing single-supply circuits, low-voltage designs, matching amplifier bandwidth to the application and designing active anti-aliasing filters. This session concludes with a tutorial describing the use and selection of general-purpose, high-speed instrumentation and current-loop amplifiers.
- **General case sensor-to-ADC design example:** This is a step-by-step tutorial that begins with the characterization of a sensor and its selection parameters. The next step requires the performance mapping of the sensor to the parameters required by the ADC within the system. The session concludes with choosing the correct amplifier and design recommendations for the interface circuitry between the sensor and the ADC.
- **Communications sensor-to-ADC design example:** In a high-speed communications system, signals are received from sources other than typical sensors. The first part of the discussion covers the process of characterizing the signal and is followed by the ADC selection criteria based on the signal’s analysis. Selecting the correct amplifier and designing the interface circuit ends the session.
- **DAC-to-actuator design example:** This last session describes using the output of a DAC to drive a transducer. The DAC selection criteria are based on the analysis of the transducer’s characteristics. These components are then combined with the appropriate amplifier to achieve optimal circuit design.

Check the listing above to find the seminar nearest you. The cost for this one-day technical seminar is $95 US per person and includes continental breakfast and lunch. Every attendee will receive a copy of the book, *Op Amps for Everyone*, as well as comprehensive seminar reference materials.

Registration begins at 8 a.m. Sessions begin at 8:30 a.m. and will end at approximately 4:30 p.m. To register in North America, call 1-800-477-8924, or go to the website at www.ti.com/sc/signal2001son. In Europe, contact your local Product Information Center (see page 15).

**2001 TI-Unitrode Power Supply Design Seminar. See back cover.**

---

For technical support and literature, see page 15.
## Line Drivers

<table>
<thead>
<tr>
<th>Device</th>
<th>Maximum power delivered to line at supply voltage**</th>
<th>I&lt;sub&gt;OUT&lt;/sub&gt;</th>
<th>-3 dB BW</th>
<th>Slew rate</th>
<th>THD</th>
<th>Integrated receive amps</th>
<th>Shutdown</th>
<th>Supply voltage</th>
<th>SUC</th>
<th>SSO</th>
<th>VFP</th>
<th>BGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>THS6002</td>
<td>21.5 dBm at ±15 V</td>
<td>400</td>
<td>140</td>
<td>1400</td>
<td>-62</td>
<td>-1 MHz</td>
<td></td>
<td>5 V</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6007</td>
<td>21.5 dBm at ±15 V</td>
<td>400</td>
<td>140</td>
<td>1300</td>
<td>-65</td>
<td>-1 MHz</td>
<td></td>
<td>5 V</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6012</td>
<td>21.5 dBm at ±15 V</td>
<td>400</td>
<td>140</td>
<td>1300</td>
<td>-65</td>
<td>-1 MHz</td>
<td></td>
<td>5 V</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6022</td>
<td>18.8 dBm at ±15 V</td>
<td>200</td>
<td>210</td>
<td>1900</td>
<td>-66</td>
<td>-1 MHz</td>
<td></td>
<td>5 V</td>
<td>14</td>
<td>5 x 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6032</td>
<td>21 dBm at ±1.9V, ±5V</td>
<td>400</td>
<td>65</td>
<td>1200</td>
<td>-62</td>
<td>-1 MHz</td>
<td></td>
<td>5 V</td>
<td>20</td>
<td>5 x 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6042</td>
<td>17.7 dBm at ±12 V</td>
<td>200</td>
<td>120</td>
<td>1200</td>
<td>-80</td>
<td>250 kHz</td>
<td></td>
<td>5 V</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6043</td>
<td>17.7 dBm at ±12 V</td>
<td>200</td>
<td>120</td>
<td>1200</td>
<td>-80</td>
<td>250 kHz</td>
<td></td>
<td>5 V</td>
<td>14</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6052</td>
<td>15.0 dBm at ±12 V</td>
<td>100</td>
<td>100</td>
<td>1200</td>
<td>-85</td>
<td>250 kHz</td>
<td></td>
<td>5 V</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6053</td>
<td>15.0 dBm at ±12 V</td>
<td>100</td>
<td>100</td>
<td>1200</td>
<td>-85</td>
<td>250 kHz</td>
<td></td>
<td>5 V</td>
<td>14</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS6092</td>
<td>14.1 dBm at ±12 V</td>
<td>200</td>
<td>100</td>
<td>800</td>
<td>-80</td>
<td>250 kHz</td>
<td></td>
<td>5 V</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS7102</td>
<td>20.0 dBm at +15 V**</td>
<td>350</td>
<td>N/A</td>
<td>N/A</td>
<td>-65</td>
<td>1 MHz</td>
<td></td>
<td>5 V</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THS7103</td>
<td>20.0 dBm at +15 V*</td>
<td>350</td>
<td>N/A</td>
<td>N/A</td>
<td>-65</td>
<td>1 MHz</td>
<td></td>
<td>5 V</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPA2607</td>
<td>19.6 dBm at ±15 V</td>
<td>250</td>
<td>35</td>
<td>600</td>
<td>-75</td>
<td>1 MHz</td>
<td></td>
<td>5 V</td>
<td>8/14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPA2676</td>
<td>16.4 dBm at +12 V</td>
<td>350</td>
<td>220</td>
<td>1800</td>
<td>-85</td>
<td>250 kHz</td>
<td></td>
<td>5 V</td>
<td>8/14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRV1100</td>
<td>10 dBm at +5 V</td>
<td>200</td>
<td>6</td>
<td>80</td>
<td>-83</td>
<td>100 kHz</td>
<td></td>
<td>5 V</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRV1101</td>
<td>10 dBm at +5 V</td>
<td>200</td>
<td>23</td>
<td>100</td>
<td>-83</td>
<td>100 kHz</td>
<td></td>
<td>5 V</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Calculated using a 5.6-crest factor, 100-Ω line impedance, series-matching line resistors.

## Analog Front End and Codecs

<table>
<thead>
<tr>
<th>Device</th>
<th>End equip.</th>
<th>Standards supported</th>
<th>No. of channels</th>
<th>Speed (kbps)</th>
<th>Line code</th>
<th>Data/</th>
<th>ADC/DAC</th>
<th>Interface voltage [V]</th>
<th>Power V&lt;sub&gt;CC&lt;/sub&gt;</th>
<th>Supply packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLFD600</td>
<td>CPE</td>
<td>Full-rate ADSL, G.lite ADSL</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>1210*</td>
<td>+3.3 (+12)*</td>
<td>No TQFP-64</td>
</tr>
<tr>
<td>TLFD500</td>
<td>CPE</td>
<td>G.lite ADSL</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>700</td>
<td>+3.3</td>
<td>No TQFP-80</td>
</tr>
<tr>
<td>TLV320AD13A</td>
<td>CPE</td>
<td>ADSL over ISDN</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>14/14</td>
<td>Parallel/serial</td>
<td>800</td>
<td>+3.3</td>
<td>Yes TQFP-100</td>
</tr>
<tr>
<td>AFE1302</td>
<td>CPE</td>
<td>ADSL</td>
<td>1</td>
<td>1536</td>
<td>DMT</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>500</td>
<td>+5 V/+3.3 V^1</td>
<td>Yes TQFP-48</td>
</tr>
<tr>
<td>AFE1230</td>
<td>CPE</td>
<td>G.SDSD/LHDSL2</td>
<td>1</td>
<td>2320</td>
<td>PAM</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>700</td>
<td>+5 V/+3.3 V</td>
<td>No SSOP-28</td>
</tr>
<tr>
<td>AFE1137</td>
<td>CPE</td>
<td>DSL</td>
<td>1</td>
<td>1000</td>
<td>QAM</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>300</td>
<td>+5 V/+3.3 V</td>
<td>Yes SSOP-56</td>
</tr>
<tr>
<td>AFE1144</td>
<td>CPE</td>
<td>HDSL</td>
<td>1</td>
<td>1168</td>
<td>2B1Q</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>250</td>
<td>+5 V/+3.3 V</td>
<td>No SSOP-28</td>
</tr>
<tr>
<td>AFE1115</td>
<td>CPE</td>
<td>HDSL/SDDSL</td>
<td>1</td>
<td>1168</td>
<td>2B1Q</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>300</td>
<td>+5 V/+3.3 V</td>
<td>Yes SSOP-56</td>
</tr>
<tr>
<td>AFE1124</td>
<td>CPE</td>
<td>HDSL/SDDSL</td>
<td>1</td>
<td>1168</td>
<td>2B1Q</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>250</td>
<td>+5 V/+3.3 V</td>
<td>No SSOP-28</td>
</tr>
<tr>
<td>AFE1203</td>
<td>CPE</td>
<td>HDSL/SDDSL</td>
<td>1</td>
<td>2320</td>
<td>2B1Q</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>400</td>
<td>+5 V/+3.3 V</td>
<td>No SSOP-48</td>
</tr>
<tr>
<td>AFE1205</td>
<td>CPE</td>
<td>HDSL/SDDSL</td>
<td>1</td>
<td>2320</td>
<td>2B1Q</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>400</td>
<td>+5 V/+3.3 V</td>
<td>No SSOP-48</td>
</tr>
<tr>
<td>AFE1224</td>
<td>CPE</td>
<td>HDSL/SDDSL</td>
<td>1</td>
<td>2320</td>
<td>2B1Q</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>355</td>
<td>+5 V/+3.3 V</td>
<td>No SSOP-28</td>
</tr>
<tr>
<td>AFE1224</td>
<td>CPE</td>
<td>HDSL/SDDSL</td>
<td>1</td>
<td>2320</td>
<td>2B1Q</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>250^2</td>
<td>+5 V/+3.3 V</td>
<td>No SSOP-48</td>
</tr>
<tr>
<td>AFE1226</td>
<td>CPE</td>
<td>HDSL/SDDSL</td>
<td>1</td>
<td>1168</td>
<td>2B1Q</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>280^2</td>
<td>+5 V/+3.3 V</td>
<td>No SSOP-48</td>
</tr>
<tr>
<td>TLV320AD15</td>
<td>CO</td>
<td>Full-rate ADSL, G.lite ADSL</td>
<td>8</td>
<td>—</td>
<td>—</td>
<td>14/14</td>
<td>Serial/serial</td>
<td>+3.3 (+1.5)**</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

* 1210 mW with line driver active/710 mW without

* 12 V is for on-chip line driver

** 1.5 V is optional for power reduction

---

** BB NOTES: Analog is +5 V; digital is +3.3 V to +5 V. Duals per channel specification.**
## Selection Guide for Analog & Mixed-Signal Broadband

### Low Dropout Regulators

<table>
<thead>
<tr>
<th>Device</th>
<th>Single-output current (mA)</th>
<th>$V_{IN}$ max (V)</th>
<th>$V_{OUT}$ options (V)</th>
<th>$V_{OUT}$ or $I_{OUT}$</th>
<th>SVS/PG</th>
<th>Enable</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS768xx*</td>
<td>1000</td>
<td>13.5</td>
<td>Adj. 1.5 - 5.5, 1.8, 2.5, 2.8, 3.0, 3.3, 5.0</td>
<td>Yes</td>
<td>PG</td>
<td>Yes</td>
</tr>
<tr>
<td>TPS777xx</td>
<td>750</td>
<td>13.5</td>
<td>Adj. 1.5 to 5.5, 1.8, 2.5, 3.3</td>
<td>Yes</td>
<td>SVS</td>
<td>Yes</td>
</tr>
<tr>
<td>TPS766xx</td>
<td>500</td>
<td>13.5</td>
<td>Adj. 1.5 to 5.5, 1.8, 2.5, 3.3</td>
<td>No</td>
<td>PG</td>
<td>Yes</td>
</tr>
<tr>
<td>TPS774xx</td>
<td>250</td>
<td>13.5</td>
<td>Adj. 1.5 - 5.5, 1.8, 2.7, 2.8, 3.3</td>
<td>No</td>
<td>PG</td>
<td>Yes</td>
</tr>
<tr>
<td>TPS765xx</td>
<td>150</td>
<td>13.5</td>
<td>Adj. 1.25 - 5.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 5.0</td>
<td>No</td>
<td>PG</td>
<td>Yes</td>
</tr>
<tr>
<td>TPS761xx</td>
<td>100</td>
<td>16</td>
<td>3.0, 3.2, 3.3, 3.8, 5.0</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>TPS760xx</td>
<td>50</td>
<td>16</td>
<td>3.0, 3.2, 3.3, 3.8, 5.0</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

### Dual-voltage output

<table>
<thead>
<tr>
<th>Device</th>
<th>Input bus voltage</th>
<th>Description</th>
<th>$P_{OUT}$ or $I_{OUT}$</th>
<th>Isolated outputs</th>
<th>$V_{O}$ (V) range</th>
<th>$V_{O}$ adjustable</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS707xx</td>
<td>125 and 250</td>
<td>7</td>
<td>Adj./Adj. 1.22 - 5.5, 3.3/1.2, 3.3/1.5, 3.3/1.8, 3.3/2.5</td>
<td>Yes</td>
<td>SVS</td>
<td>Yes</td>
</tr>
<tr>
<td>TPS701xx</td>
<td>250 and 500</td>
<td>7</td>
<td>Adj./Adj. 1.22 - 5.5, 3.3/1.2, 3.3/1.5, 3.3/1.8, 3.3/2.5</td>
<td>Yes</td>
<td>SVS</td>
<td>Yes</td>
</tr>
<tr>
<td>TPS767D3xx</td>
<td>2 at 1000</td>
<td>13.5</td>
<td>3.3/Adj. 1.5 - 5.5, 3.3/2.5, 3.3/1.8</td>
<td>No</td>
<td>SVS</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* This part is available in the Excalibur™ series (see page 9).

### Plug-In Power Solutions

<table>
<thead>
<tr>
<th>Device</th>
<th>Input bus voltage</th>
<th>Description</th>
<th>$P_{OUT}$ or $I_{OUT}$</th>
<th>Isolated outputs</th>
<th>$V_{O}$ (V) range</th>
<th>$V_{O}$ adjustable</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT4560*</td>
<td>48 V</td>
<td>30-W, 48-V-input, isolated DC/DC converter</td>
<td>30 W</td>
<td>Yes</td>
<td>1.8 to 15</td>
<td>Yes</td>
</tr>
<tr>
<td>PT620</td>
<td>12 V</td>
<td>12-V, input adjustable integrated switching regulators (ISR)</td>
<td>6 A</td>
<td>No</td>
<td>1.5 to 9</td>
<td>Yes</td>
</tr>
<tr>
<td>PT6213</td>
<td>Wide input</td>
<td>2-A, wide input adjustable step-down ISR</td>
<td>2 A</td>
<td>No</td>
<td>3.3</td>
<td>Yes</td>
</tr>
<tr>
<td>PT8ST100</td>
<td>Wide input</td>
<td>1.5-A, wide input positive step-down ISR</td>
<td>1.5 A</td>
<td>No</td>
<td>3.3 to 15</td>
<td>No</td>
</tr>
<tr>
<td>PT8NR100</td>
<td>Wide input</td>
<td>1-A, wide input plus to minus voltage ISR</td>
<td>-1 A</td>
<td>No</td>
<td>-3.0 to -15</td>
<td>No</td>
</tr>
</tbody>
</table>

### Switching DC/DC Regulators

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
<th>$V_{IN}$ range (V)</th>
<th>$V_{OUT}$ (V)</th>
<th>$I_{OUT}$</th>
<th>Protection*</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS5102</td>
<td>Dual-output PWM controller</td>
<td>4.5-25</td>
<td>down to 12 V</td>
<td>External FET</td>
<td>OCP, UVLO</td>
</tr>
<tr>
<td>TPS5103</td>
<td>Single-output PWM controller</td>
<td>4.5-25</td>
<td>down to 12 V</td>
<td>External FET</td>
<td>OCP, UVLO</td>
</tr>
<tr>
<td>TPS56300</td>
<td>Switcher and LDO controller</td>
<td>2.8-5.5</td>
<td>1.3-3.3</td>
<td>External FET</td>
<td>OCP, OVP UVLO, PG</td>
</tr>
<tr>
<td>UC3572</td>
<td>Inverting controller</td>
<td>4.75-30</td>
<td>1.5-24</td>
<td>External FET</td>
<td>OCP, UVLO</td>
</tr>
<tr>
<td>TPS6734</td>
<td>Inverting converter</td>
<td>5-12</td>
<td>12</td>
<td>225 mA</td>
<td>Shutdown</td>
</tr>
<tr>
<td>TPS62000</td>
<td>Buck converter</td>
<td>2-5.5</td>
<td>0.9-3.3</td>
<td>600 mA</td>
<td>—</td>
</tr>
</tbody>
</table>

* Over-current protection (OCP), under-voltage (UVLO), short-circuit protection (SCP), Power Good (PG), over-voltage protection (OVP)

### Supply Voltage Supervisor

<table>
<thead>
<tr>
<th>Device</th>
<th>Supervised voltages (V)</th>
<th>No. of supervisors</th>
<th>$V_{DD}$ (V) (max)</th>
<th>Time delay (ms)</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS3306-xx</td>
<td>1.5/1.8/2.0/2.5/3.3/5.0</td>
<td>2</td>
<td>6</td>
<td>100</td>
<td>8-pin MSOP/SO</td>
</tr>
<tr>
<td>TPS3125</td>
<td>1.2/1.5/1.8/3.0</td>
<td>1</td>
<td>3.3</td>
<td>180</td>
<td>5-pin SO-23</td>
</tr>
</tbody>
</table>

### Hot Swap Controllers

<table>
<thead>
<tr>
<th>Device</th>
<th>Attributes</th>
<th>$V_{IN}$ range (V)</th>
<th>Fault reporting</th>
<th>Average power limiting</th>
<th>Supply current (mA)</th>
<th>Enable/shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCC3921</td>
<td>Negative floating, $\Delta V/\Delta t$ control</td>
<td>&lt; -0.5</td>
<td>Yes</td>
<td>Yes</td>
<td>1</td>
<td>SH: Active-high</td>
</tr>
<tr>
<td>UCC3917</td>
<td>Positive floating, $\Delta V/\Delta t$ control</td>
<td>&gt; 15</td>
<td>Yes</td>
<td>Yes</td>
<td>5</td>
<td>SH: Active-low</td>
</tr>
</tbody>
</table>

For technical support and literature, see page 15.
Evaluation Modules

The following evaluation modules (EVMs) are available. To order, please call the toll-free order desk, 1-800-477-8924, ext. 5800, in North America. To order from other regions, please contact the TI Product Information Center (see listings on this page) or local TI distributor.

<table>
<thead>
<tr>
<th>Line Drivers and Receivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIS7002EVM</td>
</tr>
<tr>
<td>75-MHz, programmable-gain amplifier         $50</td>
</tr>
<tr>
<td>TIS7001EVM</td>
</tr>
<tr>
<td>75-MHz, programmable-gain amplifier         $50</td>
</tr>
<tr>
<td>TIS902EVM</td>
</tr>
<tr>
<td>Low-noise ADSL dual-differential receiver   $50</td>
</tr>
<tr>
<td>TIS902VE</td>
</tr>
<tr>
<td>Low-power ADSL dual-differential receiver   $99</td>
</tr>
<tr>
<td>TIS9022EVM</td>
</tr>
<tr>
<td>Low-power ADSL CO line driver            $50</td>
</tr>
<tr>
<td>TIS9012EVM</td>
</tr>
<tr>
<td>200-mA dual-differential line driver       $50</td>
</tr>
<tr>
<td>TIS9002EVM</td>
</tr>
<tr>
<td>500-mA dual-differential line driver       $50</td>
</tr>
<tr>
<td>TIS9002EVM</td>
</tr>
<tr>
<td>ADSL line driver/receiver, quad           $50</td>
</tr>
</tbody>
</table>

Power Management

<table>
<thead>
<tr>
<th>Product Information Center (see listings on this page) or local TI distributor.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact TI sales rep or distributor for more info.</td>
</tr>
</tbody>
</table>

TPS5010EVM-135 Dual-channel synchronous buck PWM controller with wide input voltage range $50
TPS5010EVM-136 PWM/Hysteresis buck controller with wide input voltage range $50
TPS6300EVM-139 High-performance, low-input-voltage, dual-channel buck regulator with internal sequencing $50
TPS6346EVM 12-V, 120-mA output boost converter with 3.75-V to 12-V input EVM $50
TPS6300EVM-168 Synchronous buck converter with adjustable output *

* Contact TI sales rep or distributor for more info.

Safe Harbor Statement

This publication may contain forward-looking statements that involve a number of risks and uncertainties. These "forward-looking statements" are intended to qualify for the safe harbor from liability established by the Private Securities Litigation Reform Act of 1995. These forward-looking statements generally can be identified by phrases such as TI or its management "believes," "expects," "anticipates," "intends," "forecasts," "estimates" or other similar import. Sensitive, such statements herein that describe the company's products, business strategy, outlook, objectives, plans, intentions or offers also are forward-looking statements. All such forward-looking statements are subject to certain risks and uncertainties that could cause actual results to differ materially from those in forward-looking statements. Please refer to TI's most recent Form 10-K for more information on the risks and uncertainties that could materially affect future results of operations. We disclaim any intention or obligation to update any forward-looking statements as a result of developments occurring after the date of this publication.

Important Notice: The products and services of Texas Instruments and its subsidiaries described herein are sold subject to TI’s standard terms and conditions of sale. Customers are advised to obtain the most current and complete information about TI products and services before placing orders. TI assumes no liability for applications assistance, customer’s applications or product designs, software performance, or infringement of patents. The publication of information regarding any other company’s products or services does not constitute TI’s approval, warranty or endorsement thereof.

© Copyright 2001 Texas Instruments Incorporated

Printed in U.S.A. by Jarvis Press, Dallas, Texas

© Printed on recycled paper.

Read Sine On online at www.ti.com/sc/sineon
TI's 2001 Signal Conditioning Design Seminar

Don't miss this informative seminar focusing on the complexities and challenges of analog circuit design for real-world applications. Designed for both the novice and experienced engineer, this one-day technical seminar will provide practical tips and information useful in making analog designs a success. For more information on cities, dates, session topics and registration, see page 12.

TI-Unitrode Power Supply Design Seminar

TI again is presenting the TI-Unitrode Power Supply Design Seminar with a familiar format, but entirely new information. With seasoned Unitrode presenters and enhanced with the specialized power management product capabilities of TI, the program for 2001 continues the tradition of a technical, but highly practical presentation of state-of-the-art power supply design tools, techniques, topologies and examples. The seminars will be offered in 53 cities around the world, beginning in April and continuing through October. For more information, see www.ti.com/sc/sineon

Texas Instruments Incorporated
P.O. Box 954
Santa Clarita, CA 91380

Address service requested

Includes:

[BB] Burr-Brown Products from Texas Instruments