# Dual 700MHz, $A_V \geq 10$, 200mA Operational Amplifier

September 1999

## FEATURES

- **700MHz Gain Bandwidth, Gain-of-10 Stable**
- **±200mA Minimum $I_{OUT}$**
- **Low Distortion: –72dBc at 200kHz**
- ±4.3V Minimum Output Swing, $V_S$ = ±6V, $R_L$ = 25Ω
- 7mA Quiescent Supply Current per Amplifier
- 200V/µs Slew Rate
- 4nV/√Hz Input Noise Voltage
- 0.7pA/√Hz Input Noise Current
- 4mV Maximum Input Offset Voltage
- 4µA Maximum Input Bias Current
- 400nA Maximum Input Offset Current
- ±4.5V Minimum Input CMR, $V_S$ = ±6V
- Specified at ±6V, ±2.5V

## APPLICATIONS

- DSL Modems
- xDSL PCI Cards
- USB Modems
- Line Drivers
- Video Distribution

## DESCRIPTION

The LT®1886 is a gain-of-ten stable, 200mA minimum output current, dual op amp with outstanding distortion performance. The LT1886 features balanced, high impedance inputs with 4µA maximum input bias current and 4mV maximum input offset voltage. Single supply applications are easy to implement, and the LT1886 has lower total noise than current feedback amplifier implementations.

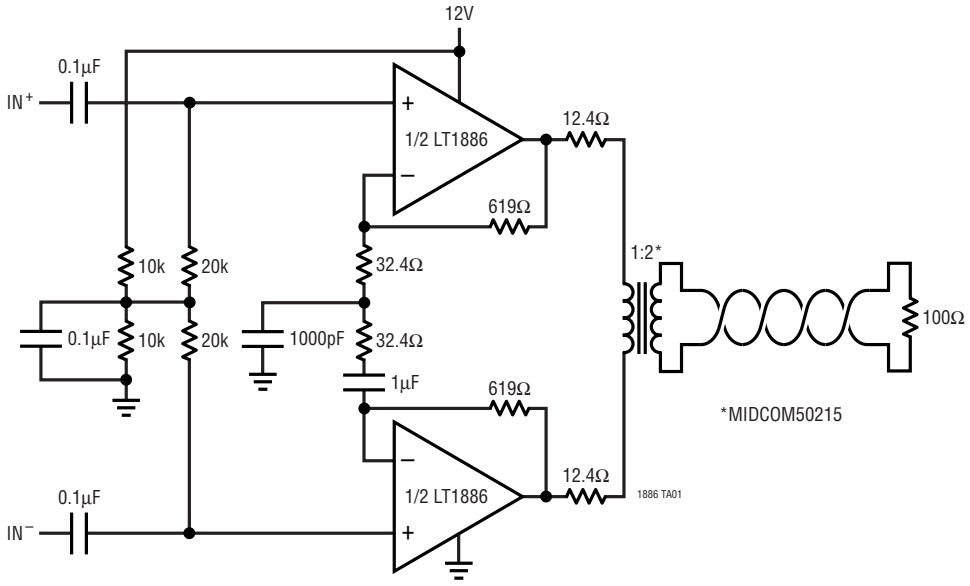
The output drives a 25Ω load to ±4.3V with ±6V supplies. On ±2.5V supplies the output swings ±1.5V with a 100Ω load. The amplifier is stable with a 100pF capacitive load, making it useful in buffer and cable driver applications.

The LT1886 is manufactured on Linear Technology's advanced low voltage complementary bipolar process.



## TYPICAL APPLICATION

**Single 12V Supply G.lite Line Driver**

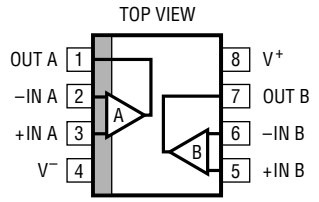


## ABSOLUTE MAXIMUM RATINGS

**(Note 1)**

Total Supply Voltage ($V^+$ to $V^-$) ..... 13.2V
Input Current (Note 2) ..... ±10mA
Input Voltage (Note 2) ..... $\pm V_S$
Maximum Continuous Output Current (Note 3)
DC ..... ±100mA
AC ..... ±300mA
Operating Temperature Range ..... –40°C to 85°C
Specified Temperature Range (Note 9) .. –40°C to 85°C
Maximum Junction Temperature ..... 150°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec)..... 300°C

## PACKAGE/ORDER INFORMATION




S8 PACKAGE
8-LEAD PLASTIC SO

$T_{JMAX}$ = 150°C, $\theta_{JA}$ = 80°C/W (Note 4)

| ORDER PART NUMBER |
|---|
| LT1886CS8 |
| **S8 PART MARKING** |
| 1886 |

Consult factory for Industrial and Military grade parts.

## ELECTRICAL CHARACTERISTICS

**The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A$ = 25°C. $V_S$ = ±6V, $V_{CM}$ = 0V, pulse power tested unless otherwise noted.**

| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| $V_{OS}$ | Input Offset Voltage | (Note 5) | <br>● | | 1 | 4<br>5 | mV<br>mV |
| | Input Offset Voltage Drift | (Note 8) | ● | | 3 | 17 | µV/°C |
| $I_{OS}$ | Input Offset Current | | <br>● | | 150 | 400<br>600 | nA<br>nA |
| $I_B$ | Input Bias Current | | <br>● | | 1.5 | 4<br>6 | µA<br>µA |
| $e_n$ | Input Noise Voltage | f = 10kHz | | | 4 | | nV/√Hz |
| $i_n$ | Input Noise Current | f = 10kHz | | | 0.7 | | pA/√Hz |
| $R_{IN}$ | Input Resistance | $V_{CM}$ = ±4.5V<br>Differential | | 5 | 10<br>35 | | MΩ<br>kΩ |
| $C_{IN}$ | Input Capacitance | | | | 2 | | pF |
| | Input Voltage Range (Positive)<br>Input Voltage Range (Negative) | | ●<br>● | 4.5 | 5<br>–5 | <br>–4.5 | V<br>V |
| CMRR | Common Mode Rejection Ratio | $V_{CM}$ = ±4.5V | ● | 77 | 98 | | dB |
| PSRR | Power Supply Rejection Ratio | $V_S$ = ±2V to ±6.5V | <br>● | 80<br>78 | 86 | | dB<br>dB |
| $A_{VOL}$ | Large-Signal Voltage Gain | $V_{OUT}$ = ±4V, $R_L$ = 100Ω | <br>● | 5.0<br>4.5 | 12 | | V/mV<br>V/mV |
| | | $V_{OUT}$ = ±4V, $R_L$ = 25Ω | <br>● | 4.5<br>4.0 | 12 | | V/mV<br>V/mV |
| $V_{OUT}$ | Output Swing | $R_L$ = 100Ω, 10mV Overdrive | <br>● | 4.85<br>4.70 | 5 | | ±V<br>±V |
| | | $R_L$ = 25Ω, 10mV Overdrive | <br>● | 4.30<br>4.10 | 4.6 | | ±V<br>±V |
| | | $I_{OUT}$ = 200mA, 10mV Overdrive | <br>● | 4.30<br>4.10 | 4.5 | | ±V<br>±V |

## ELECTRICAL CHARACTERISTICS

**The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A$ = 25°C. $V_S$ = ±6V, $V_{CM}$ = 0V, pulse power tested unless otherwise noted.**

| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| $I_{SC}$ | Short-Circuit Current (Note 3) | | | | 800 | | mA |
| SR | Slew Rate | $A_V$ = –10 (Note 6) | <br>● | 133<br>110 | 200 | | V/µs<br>V/µs |
| | Full Power Bandwidth | 4V Peak (Note 7) | | | 8 | | MHz |
| GBW | Gain Bandwidth | f = 1MHz | | | 700 | | MHz |
| $t_r$, $t_f$ | Rise Time, Fall Time | $A_V$ = 10, 10% to 90%, 0.1V, $R_L$ = 100Ω | | | 4 | | ns |
| | Overshoot | $A_V$ = 10, 0.1V, $R_L$ = 100Ω | | | 15 | | % |
| | Propagation Delay | 50% $V_{IN}$ to 50% $V_{OUT}$, 0.1V, $R_L$ = 100Ω | | | 2.5 | | ns |
| $R_{OUT}$ | Output Resistance | $A_V$ = 10, f = 1MHz | | | 0.033 | | Ω |
| | Channel Separation | $V_{OUT}$ = ±4V, $R_L$ = 25Ω | <br>● | 82<br>80 | 92 | | dB<br>dB |
| $I_S$ | Supply Current | Per Amplifier | <br>● | | 7 | 8.25<br>8.50 | mA<br>mA |

**The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A$ = 25°C. $V_S$ = ±2.5V, $V_{CM}$ = 0V, pulse power tested unless otherwise noted.**

| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| $V_{OS}$ | Input Offset Voltage | (Note 5) | <br>● | | 1.5 | 5<br>6 | mV<br>mV |
| | Input Offset Voltage Drift | (Note 8) | ● | | 5 | 17 | µV/°C |
| $I_{OS}$ | Input Offset Current | | <br>● | | 100 | 350<br>550 | nA<br>nA |
| $I_B$ | Input Bias Current | | <br>● | | 1 | 3.5<br>5.5 | µA<br>µA |
| $e_n$ | Input Noise Voltage | f = 10kHz | | | 4 | | nV/√Hz |
| $i_n$ | Input Noise Current | f = 10kHz | | | 0.7 | | pA/√Hz |
| $R_{IN}$ | Input Resistance | $V_{CM}$ = ±1V<br>Differential | | 10 | 20<br>50 | | MΩ<br>kΩ |
| $C_{IN}$ | Input Capacitance | | | | 2 | | pF |
| | Input Voltage Range (Positive)<br>Input Voltage Range (Negative) | | ●<br>● | 1 | 1.5<br>–1.5 | <br>–1 | V<br>V |
| CMRR | Common Mode Rejection Ratio | $V_{CM}$ = ±1V | ● | 75 | 91 | | dB |
| $A_{VOL}$ | Large-Signal Voltage Gain | $V_{OUT}$ = ±1V, $R_L$ = 100Ω | <br>● | 5.0<br>4.5 | 10 | | V/mV<br>V/mV |
| | | $V_{OUT}$ = ±1V, $R_L$ = 25Ω | <br>● | 4.5<br>4.0 | 10 | | V/mV<br>V/mV |
| $V_{OUT}$ | Output Swing | $R_L$ = 100Ω, 10mV Overdrive | <br>● | 1.50<br>1.40 | 1.65 | | ±V<br>±V |
| | | $R_L$ = 25Ω, 10mV Overdrive | <br>● | 1.35<br>1.25 | 1.50 | | ±V<br>±V |
| | | $I_{OUT}$ = 200mA, 10mV Overdrive | <br>● | 0.87<br>0.80 | 1 | | ±V<br>±V |

## ELECTRICAL CHARACTERISTICS

**The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A$ = 25°C. $V_S$ = ±2.5V, $V_{CM}$ = 0V, pulse power tested unless otherwise noted.**

| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| $I_{SC}$ | Short-Circuit Current (Note 3) | | | | 600 | | mA |
| SR | Slew Rate | $A_V$ = –10 (Note 6) | <br>● | 66<br>60 | 100 | | V/µs<br>V/µs |
| | Full Power Bandwidth | 1V Peak (Note 7) | | | 16 | | MHz |
| GBW | Gain Bandwidth | f = 1MHz | | | 500 | | MHz |
| $t_r$, $t_f$ | Rise Time, Fall Time | $A_V$ = 10, 10% to 90%, 0.1V, $R_L$ = 100Ω | | | 7 | | ns |
| | Overshoot | $A_V$ = 10, 0.1V, $R_L$ = 100Ω | | | 5 | | % |
| | Propagation Delay | 50% $V_{IN}$ to 50% $V_{OUT}$, 0.1V, $R_L$ = 100Ω | | | 5 | | ns |
| $R_{OUT}$ | Output Resistance | $A_V$ = 10, f = 1MHz | | | 0.065 | | Ω |
| | Channel Separation | $V_{OUT}$ = ±1V, $R_L$ = 25Ω | <br>● | 82<br>80 | 92 | | dB<br>dB |
| $I_S$ | Supply Current | Per Amplifier | <br>● | | 5 | 5.75<br>6.25 | mA<br>mA |

**Note 1:** Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

**Note 2:** The inputs are protected by back-to-back diodes. If the differential input voltage exceeds 0.7V, the input current should be limited to less than 10mA.

**Note 3:** A heat sink may be required to keep the junction temperature below absolute maximum.

**Note 4:** Thermal resistance varies depending upon the amount of PC board metal attached to the device. $\theta_{JA}$ is specified for a 2500mm$^2$ test board covered with 2 oz copper on both sides.

**Note 5:** Input offset voltage is exclusive of warm-up drift.

**Note 6:** Slew rate is measured between ±1.5V on a ±4V output for ±6V supplies, and between ±1V on a ±2V output for ±2.5V supplies.

**Note 7:** Full power bandwidth is calculated from the slew rate: FPBW = SR/2π$V_P$.

**Note 8:** This parameter is not 100% tested.

**Note 9:** The LT1886C is guaranteed to meet specified performance from 0°C to 70°C and is designed, characterized and expected to meet these extended temperature limits, but is not tested at –40°C and 85°C. Guaranteed I grade parts are available, consult factory.

## RELATED PARTS

| PART NUMBER | DESCRIPTION | COMMENTS |
|---|---|---|
| LT1207 | Dual 250mA, 60MHz Current Feedback Amplifier | Shutdown/Current Set Function |
| LT1361 | Dual 50MHz, 800V/µs Op Amp | |
| LT1497 | Dual 125mA, 50MHz Current Feedback Amplifier | 900V/µs Slew Rate |
| LT1795 | Dual 500mA, 50MHz Current Feedback Amplifier | Shutdown/Current Set Function |
| LT1813 | Dual 100MHz, $V_{FB}$ Op Amp | Low Power Differential Receiver |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