Linear Technology Chronicle

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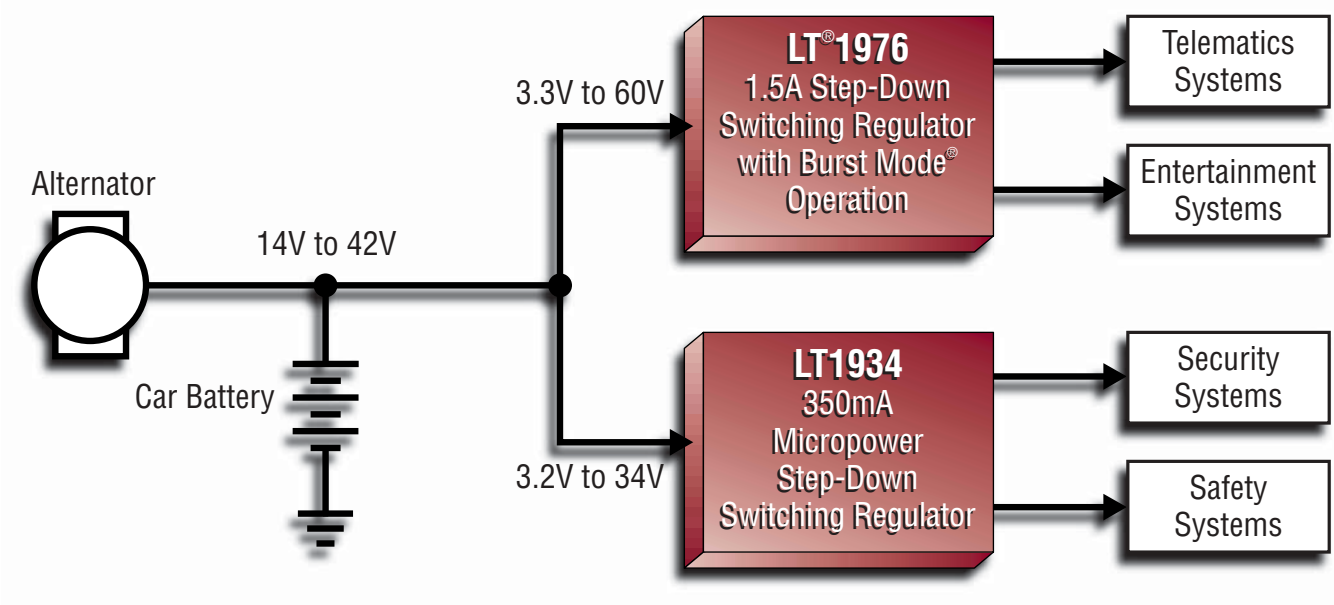
January Focus…

Solutions for Automotive Systems



Inside This Issue:

The quest for new features in luxury automobiles is driving an ever increasing demand for high performance analog solutions. New navigation, telematics, entertainment, security and improved safety systems are all rich in electronic content. The sensitive electronics needed in these systems must meet the demanding automotive standards for quality and reliability and operate under the harsh conditions of the automotive environment.

Linear Technology designs and manufactures high performance analog products to meet the exacting standards of automobile manufacturers. Products including voltage regulators and operational amplifiers have been designed to operate over a wide temperature range and to withstand the potentially high voltages present in automotive systems.

Linear Technology is a world class manufacturer, certified ISO 9001, QS 9000 and TS16949 compliant.

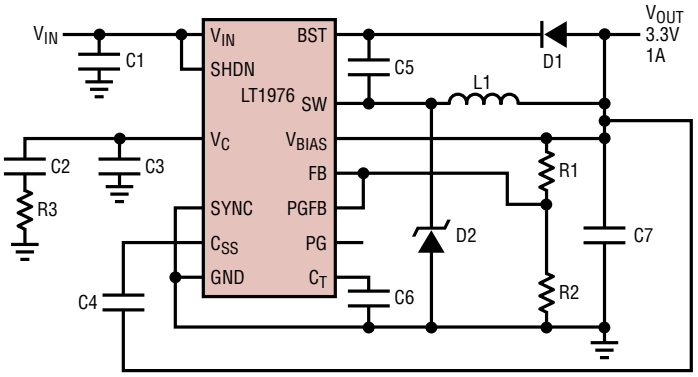
High Input Voltage (60V) Monolithic Step-Down Regulators

Generating system supplies from the automobile's battery requires a rugged, high voltage regulator. The nominal 12V car system voltage can dip as low as 6V under cold crank conditions or be as high as 42V. Any voltage regulator must also withstand load dump conditions and extreme ambient temperatures. In addition, the overall system power consumption must be minimized to prevent excessive drain on the battery.

The LT1976 1.5A monolithic buck regulator is designed specifically to meet these tough conditions. Its wide input voltage range, high output current and low quiescent current make it ideal for automotive applications. Innovative packaging minimizes the area required for the solution while maximizing the power that can be delivered by the device.

- **A wide input voltage range of 3.3V to 60V allows direct connection to the battery**
- **1.25A output current**
- **Low 100µA quiescent current during Burst Mode operation and zero current in shutdown**
- **Small, thermally enhanced TSSOP-16 package**

14V to 3.3V Step-Down Converter
100µA No Load Quiescent Current
60V InputTransient



High Voltage Monolithic Step-Down Regulators

Monolithic Buck

Part Number	V_{IN} Min	V_{IN} Max	V_{OUT} Min	V_{OUT} Max	Output Current	Max Switch Current	Switching Frequency	I_Q	I_{SHDN}	Package
LT3430	5.5V	**60V**	1.2V	$0.96V_{IN}$	2.75A	3.00A	200kHz	2.5mA	25µA	TSSOP-16E
LT1976	3.3V	**60V**	1.25V	$0.90V_{IN}$	1.20A	1.50A	200kHz	100µA	0	TSSOP16/TSSOP-16E
LT1956	5.5V	**60V**	1.2V	$0.90V_{IN}$	1.20A	1.50A	500kHz	2.5mA	25µA	TSSOP-16/TSSOP-16E
LT1766	5.5V	**60V**	1.2V	$0.96V_{IN}$	1.20A	1.50A	200kHz	2.5mA	25µA	TSSOP-16/TSSOP-16E
LT1676	7.4V	**60V**	1.24V	$0.90V_{IN}$	0.44A	0.55A	100kHz	3.2mA	2.5µA	SO-8
LT1776	7.4V	40V	1.24V	$0.90V_{IN}$	0.56A	0.70A	200kHz	3.2mA	30µA	N8,SO-8
LT1777	7.0V	48V	1.24V	$0.90V_{IN}$	0.44A	0.55A	100kHz	620µA	12µA	SO-16

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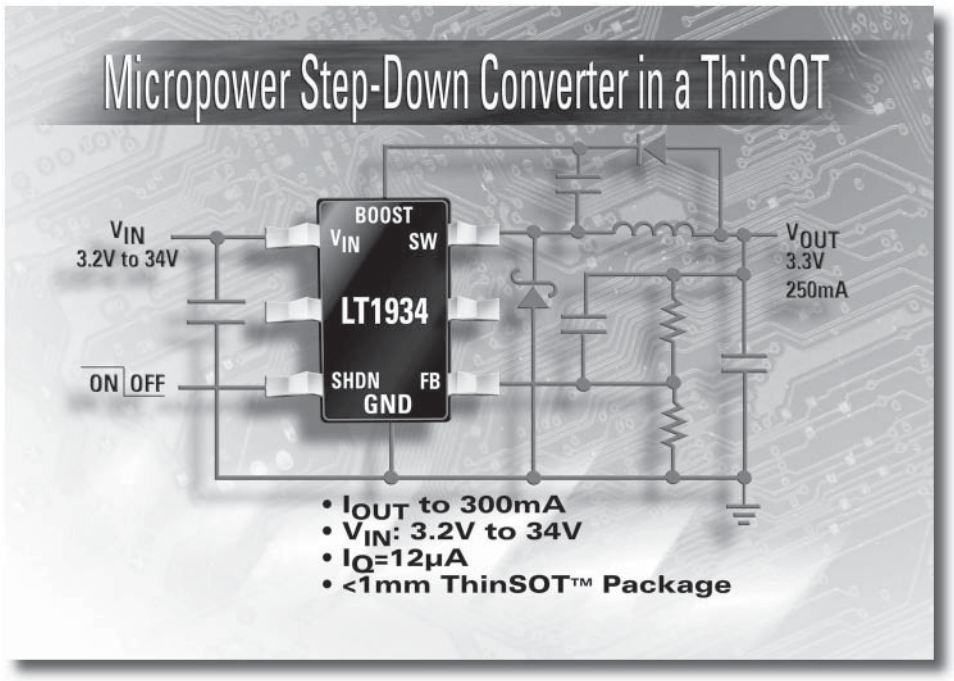
High Voltage Step-Down Converter in SOT-23

Many automotive systems are required to be active even when the vehicle is not in operation. These systems must be extremely low power in order to prevent excessive drain on the battery. Providing system power for these applications requires a highly efficient switching regulator.

The LT1934 is a high voltage, Burst Mode operation buck regulator that can provide up to 300mA of output current. Under light load and system standby conditions, the device's quiescent current is a mere 12µA—ideal for always-on systems.

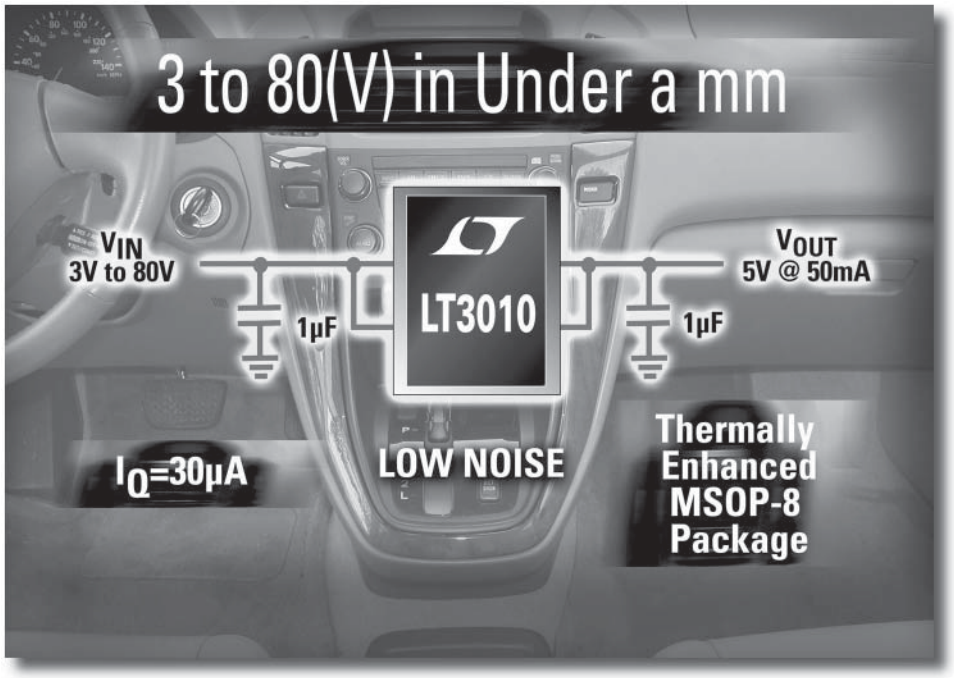
- **Wide input voltage range of 3.2V to 34V**
- **Up to 300mA output current**
- **Very low 12µA quiescent current and less than 1µA of shutdown current**
- **Burst Mode operation results in high efficiency over a wide range of load currents**
- **Tiny ThinSOT package**



High Voltage (80V), Low Noise LDO

When a simple solution for providing low load currents is required, a linear regulator is a good choice. The LT3010 is a low dropout linear regulator that offers a very wide input voltage range and extremely low noise. It can be used to generate low current supplies directly from the car's main supply (battery or alternator) and is robust enough for harsh automotive conditions.

- **Wide 3V to 80V input voltage range can be run directly from the battery**
- **Up to 50mA output current**
- **Thermally enhanced MSOP-8 package**
- **Very low 30µA quiescent current and less than 1µA of shutdown current**
- **Reverse battery protection**



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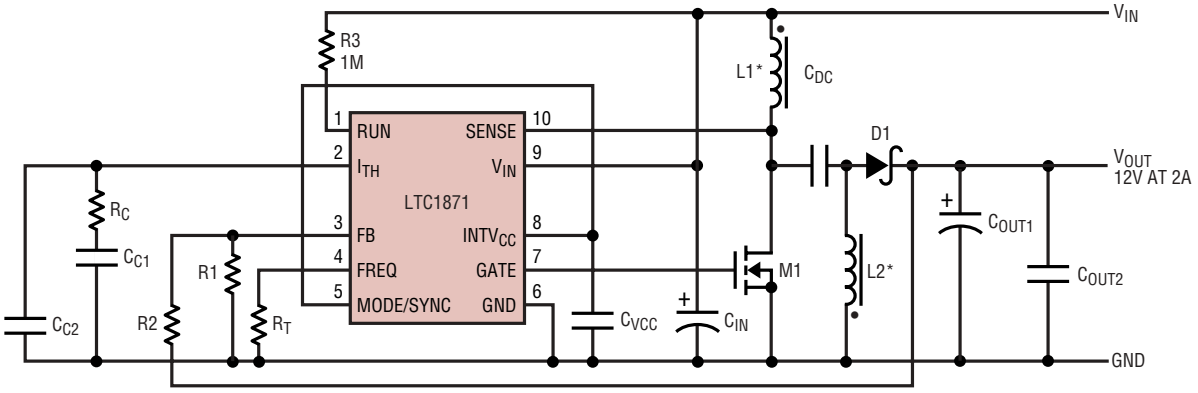
Designing for Cold Crank Conditions

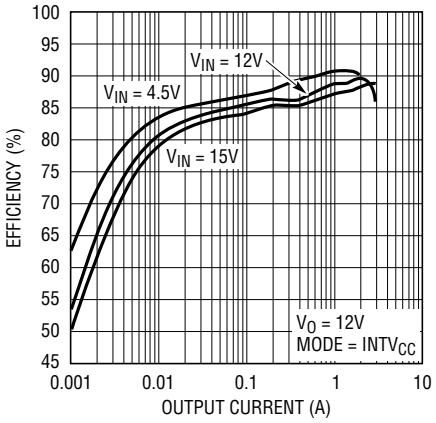
Maintaining a regulated 12V supply directly from the battery or alternator is a difficult task. The system supply can be as low as 6V under cold crank conditions or as high as 14V when the alternator is operating. The LTC®1871 in a SEPIC configuration easily solves this complex problem by providing a high current regulated 12V output from an input voltage range of 2.5V to 36V.

- **Wide input voltage range of 2.5V to 36V**
- **Output currents up to 10A**
- **Current mode operation provides excellent transient response**
- **Up to 1MHz switching frequency**
- **MS10 package**

LTC1871 4.5V to 15V, 12V/2A SEPIC Converter



LTC1871 SEPIC Converter Efficiency



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CCFL Backlighting

Automotive instrument panels typically require the bright backlighting provided by a cold cathode fluorescent lamp (CCFL). The requirements for the CCFL controller in these automotive applications can be quite demanding. Wide dimming range, high reliability and robust protection features to maximize lamp life are all required.

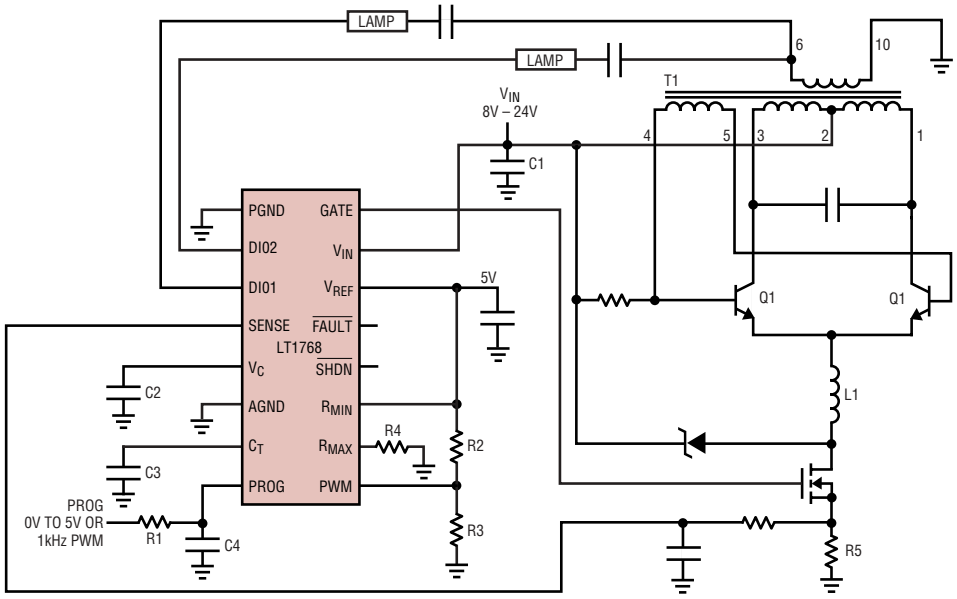
The LT1768 is a CCFL controller designed to control single or multiple CCFLs. This device provides the maximum flexibility and reliability with a minimum number of external components.

- **Ultrawide Multimode Dimming™ range**
- **Precision maximum and minimum lamp currents maximize lamp lifetime**
- **No lamp flicker under all supply and load conditions**
- **Open lamp detection and protection**

CCFL Backlight

Part Number	V_{IN} Min	V_{IN} Max	V_{OUT} Max	Switch Current	Frequency	I_Q	I_{SHDN}	Package
LT1768	8V	24V	28V	1.50A	350kHz	8mA	100µA	SSOP-16
LT1186F	3.5V	30V	60V	0.90A	200kHz	6mA	5µA	SO-16
LT1786F	3.5V	30V	60V	0.90A	100kHz	6mA	5µA	SO-16
LT1184/F	3V	20V	60V	1.20A	200kHz	9mA	3µA	SO-16
LT1182/LT1183	3V	30V	60V	1.2/.625A	200kHz	9mA	3µA	SO-16

LT1768 CCFL Supply Produces a 100:1 Dimming Ratio while Maintaining Minimum and Maximum Lamp Current Specifications



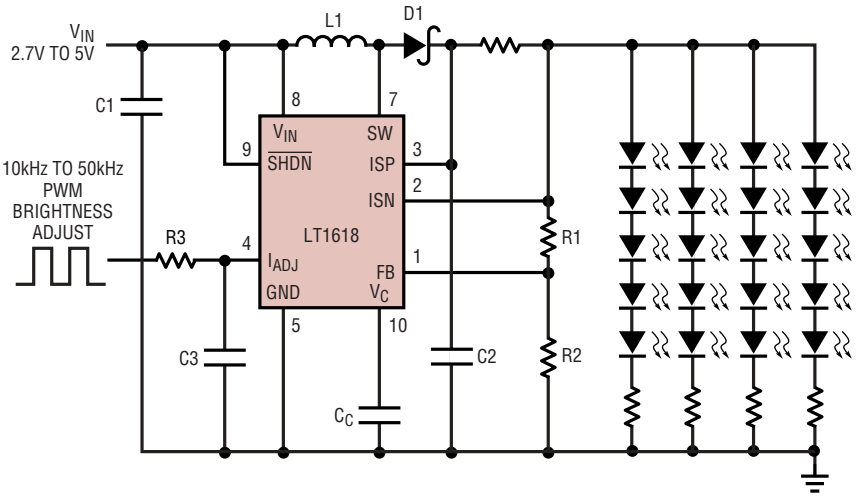
LED Drivers

LEDs are used in a variety of automotive applications. White LEDs are used for simple backlighting for telematics or car entertainment systems. Arrays of LEDs are also being used for turn signals, taillights and even headlights. The advantages of LED arrays for these applications include reliability and a nearly instantaneous turn on time (especially important in taillights).

Driving white LEDs typically requires a step-up or boost regulator due do their high forward voltage drop. The LT1618 monolithic boost regulator can drive up to 20 white LEDs while maintaining excellent current control. The LT1615 monolithic boost in SOT-23 can be used to drive up to 8 white LEDs in series.

- **Wide input voltage range: 1.6V to 18V (LT1618)**
- **Accurate output voltage control: ±1%**
- **Accurate input and output current control over temperature maintains consistent brightness**
- **High output voltages of up to 35V can drive multiple LEDs in series**

LT1618 High Power White LED Driver



Monolithic Boost Regulators

Part Number	V_{IN} Min	V_{IN} Max	V_{OUT} Max	Output Current	Switch Current	Frequency	I_Q	I_{SHDN}	Package
LT1615	1.2V	15V	36V	0.25 • V_{IN}/V_{OUT}	0.30A	PFM	20µA	<1µA	ThinSOT
LT1937	1V	10V	36V	0.25 • V_{IN}/V_{OUT}	0.30A	1.2MHz	1.9mA	<1µA	ThinSOT
LT1610	1V	8V	30V	0.37 • V_{IN}/V_{OUT}	0.45A	1.7MHz	30µA	<1µA	MSOP-8, SO-8
LT1613	1V	10V	36V	0.46 • V_{IN}/V_{OUT}	0.55A	1.4MHz	3 mA	<1µA	ThinSOT
LT1932	1V	10V	36V	0.46 • V_{IN}/V_{OUT}	0.55A	1.2MHz	1.2mA	<1µA	ThinSOT
LT1949	1.5V	12V	30V	0.83 • V_{IN}/V_{OUT}	1.00A	600kHz/1.1MHz	4.5mA	<25µA	SO-8, MSOP-8/MSOP-8
LT1930	2.6V	16V	16V	0.83 • V_{IN}/V_{OUT}	1.00A	1.2MHz/2.2MHz	5.5mA	<1µA	ThinSOT
LT1618	1.6V	18V	36V	1.25 • V_{IN}/V_{OUT}	1.50A	1.4MHz	1.8mA	<1µA	MSOP-10
LT1946	2.5V	16V	36V	1.25 • V_{IN}/V_{OUT}	1.50A	1.2MHz/2.7MHz	3.2mA	<1µA	MSOP-8

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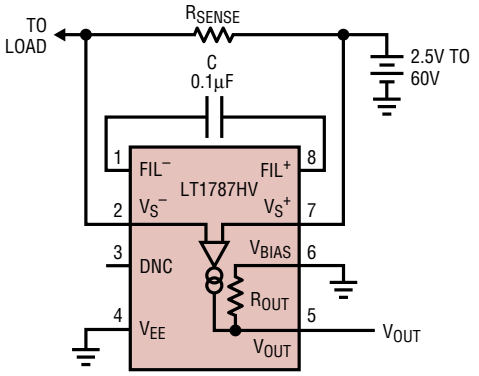
Precision High Side Current Sense Amplifiers

The LT1787 is a precision, micropower high side current sense amplifier capable of running from supplies up to 60V. With this wide input voltage range and an extended temperature range, the part can be used to directly measure the currents flowing into or out of the automotive battery.

- **60V operation (LT1787HV)**
- **12-bit dynamic range, 75µV input offset voltage**
- **Bidirectional high side current sensing**
- **60µA operating current**
- **–40°C to 125°C operating temperature range for underhood applications**

LT1787HV 60V High Side Current Sense



Precision Measurements at Extended Temperatures and High Voltages

Nearly every major automotive system, from engine control to telematics, requires high performance amplifiers, comparators and voltage references. Many of these systems will require guaranteed high performance operation over extreme temperature ranges, as wide as –40°C to 125°C for under the hood applications. Amplifiers intended for these difficult environments would also value wide supply voltage range, reverse battery protection and Over-The-Top® inputs for high side current sensing. The table below lists our amplifier products offered with extended –40°C to 125°C specifications.

–40°C to 125°C Amplifiers

Part Number	Feature	V_{SUPPLY}	Rev Bat	I_Q	V_{OS}	V_{OS} Drift	Package	GBP Typ	SR Typ
LT1490A	Over-The-Top	2.5V to 44V	Yes	50µA	500µV	6µV/°C	MSOP-8, SO-8	180kHz	60V/ms
LT1491A	Over-The-Top	2.5V to 44V	Yes	50µA	1mV	6µV/°C	SO-14	180kHz	60V/ms
LT1494H	Over-The-Top	2.5V to 44V	Yes	6µA	1.1mV	N/A	SO-8	180kHz	60V/ms
LT1495/LT1496	Over-The-Top	2.5V to 44V	Yes	6µA	1.1mV	N/A	SO-8, SO-14	2.7kHz	1V/ms
LT1636/LT1637/LT1638	Over-The-Top	2.5V to 44V	Yes	50µA	325µV	10µV to 15µV°C	SO-8	200kHz	70V/ms
LT1639	Over-The-Top	2.5V to 44V	Yes	230µA	750µV	15µV/°C	SO-14	1.MHz	0.38V/µs
LT1782	Over-The-Top	2.5V to 18V	Yes	55µA	800µV	15µV/°C	SOT-23-5, SOT-23-6	200kHz	70V/ms
LT1783	Over-The-Top	2.5V to 18V	Yes	300µA	850µV	15µV/°C	SOT-23-5, SOT-23-6	1.2MHz	0.38V/µs
LT1787	I_{SENSE}	2.5V to 36V/60V	N/A	60µA	75µV	2µV/°C	SO-8	N/A	N/A
LTC2051	Zero Drift	2.7V to 6V	No	1.5mA	3µV	0.05µV/°C	MSOP-8, SO-8	3MHz	2V/µs
LTC2052	Zero Drift	2.7V to 6V	No	1.5mA	3µV	0.05µV/°C	SSOP-16, SO-14	3MHz	2V/µs
LTC6800	Zero Drift	2.7V to 6V	No	1.9mA	100µV	0.25µV/°C	MSOP-8	200kHz	0.2V/µs

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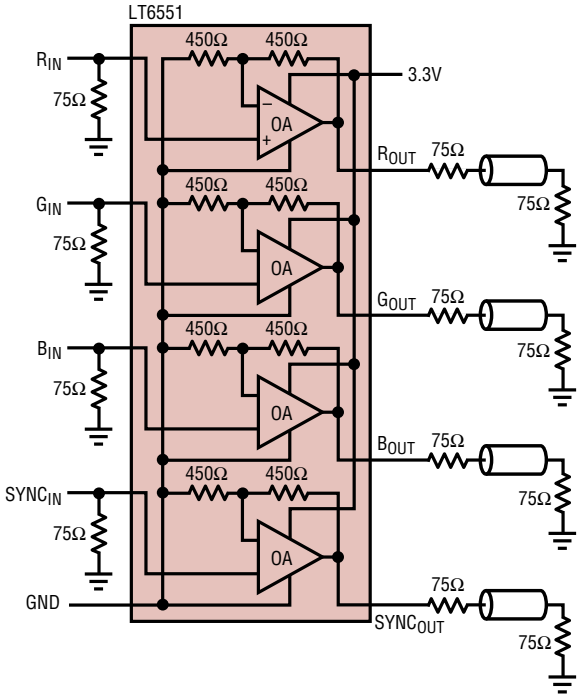
Low Voltage RGB Video Amplifiers

Video displays for entertainment, telematics, or navigation systems are increasingly common accessories in today's automobiles. The LT6550 and LT6551 are triple and quad amplifiers ideal for automotive systems. With small package size and few external components, the LT6550/LT6551 make designing for space constrained automotive systems easy. Guaranteed low voltage operation allows these amplifiers to be powered from the 3.3V supply commonly available to automotive entertainment systems.

- **Guaranteed performance on 3.3V single supplies**
- **Fixed gain of 2 eliminates external gain setting resistors**
- **110MHz gain bandwidth, 340V/µs slew rate ideal for driving 1024 × 768 pixel displays**
- **MSOP-10 package**

3.3V Single Supply RGB Plus SYNC Cable Driver



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