Lighting and Display Power Selection Guide

1Q 2006

Lighting and Display Power Solutions Tree

White LED and Xenon Camera Flash

TPS61059: Synchronous Boost Converter with Down-Mode High-Power White LED Driver

TPS65552A: Integrated Photo Flash Charger and IGBT Driver

White LED Backlight Drivers

TPS60230: Current-Regulated 125-mA Charge Pump for White LED Backlight in 3 mm x 3 mm QFN, Up to Five LEDs

TPS61061: 19-V, 400-mA Switch, 1-MHz Boost Converter with Brightness Control for White LED Power Supplies

TPS61042: 30-V, 500-mA Switch Boost Converter, QFN-8

OLED and TFT Display

TPS63700: Inverting DC/DC Converter, Generates Up to –15 V

TPS65110: Triple Charge Pump for LTPS LCD

TPS65120: Quad-Output Supply for Small Form Factor TFT Display in QFN-16, 3.3-V LDO, Auto-Seq

TPS65130: Adjustable, Dual Output, Positive and Negative 800-mA Switch Boost DC/DC, 4 mm x 4 mm QFN-24, for OLED, TFT, CCD

LCD Display Bias

TPS65160: Bias Power Supply for TV and Monitor TFT LCD Panels

TPS65150: Low-Input Voltage LCD Bias with VCOM Buffer, QFN-24

CCFL Backlighting

TPS68000: High-Efficiency Phase-Shift Full Bridge CCFL Controller

RGB LED Drivers

TLC5940: 16-Channel LED Driver with Dot Correction and Grayscale PWM Control, Integrated EEPROM, 4 mm x 4 mm QFN

TLC5923: 16-Channel LED Driver with Dot Correction and LED Open Detection

- **TLC5940**—16-Channel LED Driver with Dot Correction and PWM Grayscale
- **TLC5923**—16-Channel LED Driver with Dot Correction and LED Open Detection
- **TPS61060/1/2**—Constant Current LED Driver with Digital and PWM Brightness Control
- **TPS60230/1**—White LED Charge Pump Source with PWM Brightness Control
- **TPS61045**—28-V, 85% Efficiency Boost Converter for PMOLED Applications
- **TPS65130**—Positive and Negative 800-mA Switch Boost DC/DC OLED, TFT, CCD
- **TPS65120**—Quad-Output Supply for Small Form Factor TFT Display
- **TPS65160**—Bias Power Supply for TV and Monitor TFT LCD Panels
- **TPS65552A**—Integrated Photoflash Capacitor Charger and IGBT Driver
- **TPS61059**—White LED Flash Driver
- **TPS68000**—High-Efficiency Phase-Shift Full Bridge CCFL Controller

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Download the current Analog Applications Journal (and past issues) to make your design challenges easier.

RGB LED Drivers

16-Channel Driver with Dot Correction and PWM Grayscale
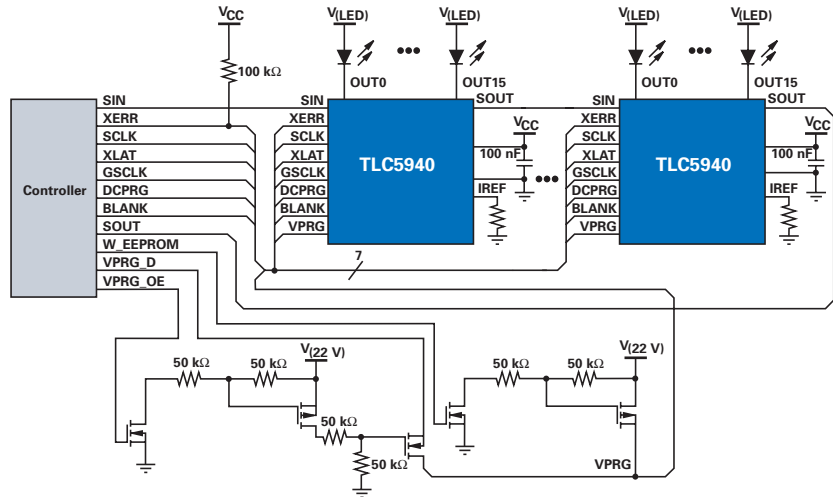## TLC5940

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/TLC5940**

Key Features
- 16 channels
- 12-bit (4096 steps) PWM grayscaling
- 6-bit (64 steps) dot correction
- 3.0-V to 5.5-V input voltage range
- 120-mA constant current/channel
- 30-MHz transfer rate
- Chip-to-chip accuracy: 2.7% typ
- Channel-to-channel accuracy: 1% typ
- Integrated EEPROM

Applications
- Mono-color, multi-color, full-color LED displays
- LED signboards
- Display backlighting

Cascading connection of TLC5940 devices connected to a controller building a basic module of an LED display system.

## 16-Channel Driver with Dot Correction and LED Open Detection
TLC5923

Get samples and datasheets at: **www.ti.com/sc/device/TLC5923**

Key Features
- 16 channels
- 7-bit (128 steps) dot correction
- 3.0-V to 5.5-V input voltage range
- Channel voltage up to 17-V input
- 80-mA constant current/channel
- Chip-to-chip accuracy: 4% typ
- Channel-to-channel accuracy: 1% typ
- Two built-in error flags
  (LED open and thermal error)
- Controlled in-rush current

Applications
- Mono-color, multi-color, full color LED displays
- LED signboards
- Alphanumeric displays
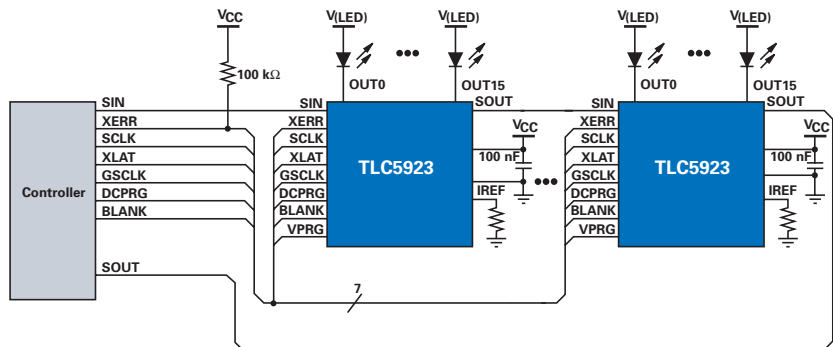
An example application with TLC5923 devices connected to a controller. The maximum number of cascaded devices depends on application system and data transfer rate.
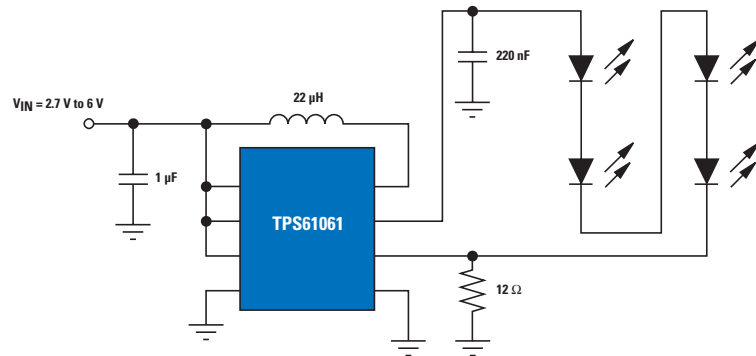
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Constant Current LED Driver with Digital and PWM Brightness Control
TPS61060, TPS61061, TPS61062

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/PARTnumber**
(Replace **PARTnumber** with **TPS61060**, **TPS61061** or **TPS61062**)

Key Features
- LED driver with integrated over-voltage protection
- 2.7-V to 6-V input voltage range
- TPS61060 powers up to three LEDs
- TPS61061 powers up to four LEDs
- TPS61062 powers up to five LEDs
- PWM brightness control on enable
- Digital brightness control on ILED
- 1-MHz fixed switching frequency
- 400-mA internal power MOSFET switch
- LEDs disconnected during shutdown
- Operates with small output capacitors down to 220 nF

TPS61061 powering four white LEDs.

Applications
- Cellular phones
- PDAs, pocket PCs and smart phones
- Digital still cameras
- 3.3-V to 5-V point-of-load

### Additional Devices
- TPS61040/1/2/3

White LED Charge Pump Current Source with PWM Brightness Control
TPS60230, TPS60231

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/PARTnumber**
(Replace **PARTnumber** with **TPS60230** or **TPS60231**)

Key Features
- Regulated output current with 0.4% matching over temperature
- Drives up to five LEDs at 25 mA each (TPS60230)
- Drives up to three LEDs at 25 mA each (TPS60231)
- LED brightness control through PWM control signal
- High efficiency by fractional conversion with 1x and 1.5x modes
- 1-MHz switching frequency
- 2.7-V to 6.5-V operating input voltage range
- Internal softstart limits in-rush current
- Low input ripple and low EMI
- Overcurrent and overtemperature protected
- Undervoltage lockout with hysteresis
- Packaging: ultra-small 3 mm x 3 mm QFN
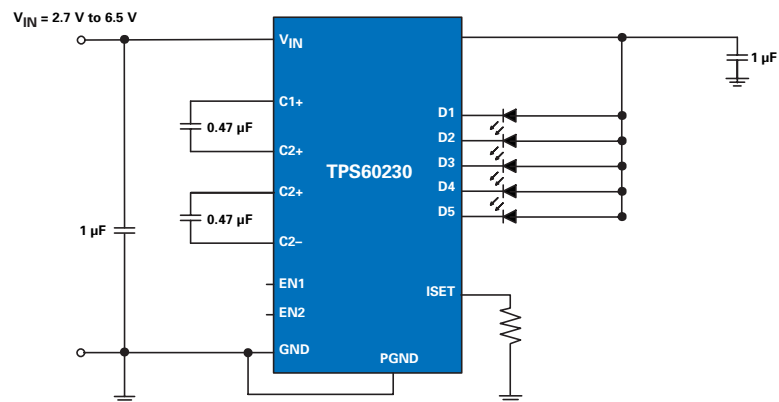
TPS60230 powering five LEDs.

Applications
- White LED backlight for color displays in cell phones, smart phones, PDAs, pocket PCs, digital cameras and camcorders
- Key backlight

## 28-V, 85% Efficiency Boost Converter for LCD Applications in QFN-8
TPS61045

Get samples, datasheets, EVMs and app reports at: **www.ti.com/sc/device/TPS61045**

Key Features
- Input voltage range: 1.8 V to 6.0 V
- Output voltage: up to 28 V, digitally adjustable
- Output current: 20 mA
- Quiescent current: 0.04 mA (typ)
- Switching frequency: 1 MHz (max)
- Package: 3 mm x 3 mm QFN

Applications
- LCD bias supply for small to medium form factors
- OLED display power supply in PDAs, cell phones, smart phones
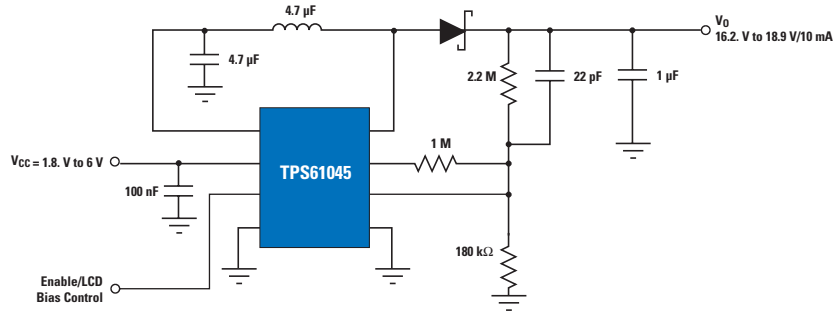
Typical application with digital adjusted output voltage.

Additional Devices
- TPS61040/1

Positive and Negative 800-mA Switch Boost DC/DC for OLED, TFT, CCD
TPS65130

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/TPS65130**

Key Features
- Dual adjustable output voltages up to +15 V and down to –15 V
- 800-mA typical switch current limit at boost and inverter main switches at TPS65130
- 2-A typical switch current limit at boost and inverter main switches at TPS65131
- Power-save mode for high-efficiency at low load currents
- Independent enable inputs for power-up and power-down sequencing
- Control output for external PFET to support completely disconnecting the battery
- 2.7-V to 5.5-V input voltage range
- Minimum 1.25-MHz fixed frequency PWM operation
- Overvoltage protection on both outputs
- Packaging: small 4 mm x 4 mm QFN-24 (RGE)
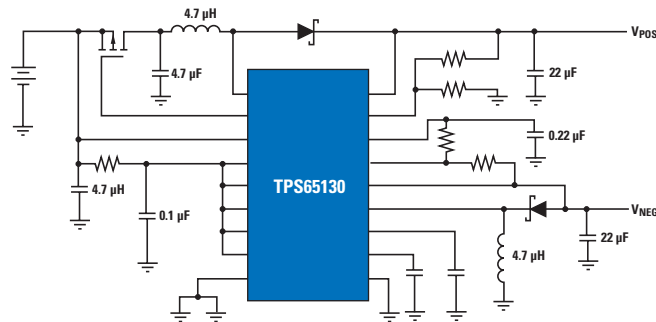
Typical application diagram.

Applications
- Small to medium size OLED displays
- (TFT) LCD and CCD bias supply
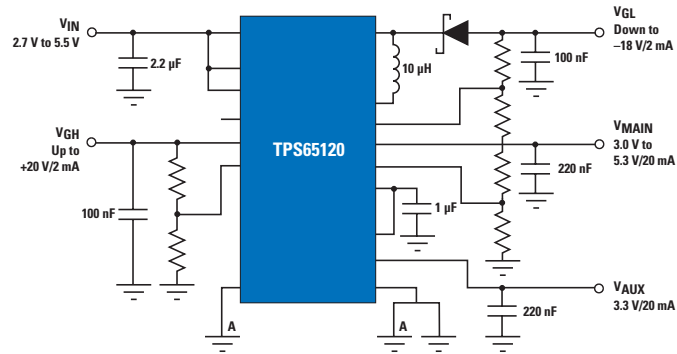- PDAs, pocket PCs, smartphones, digital cameras and camcorders

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Quad-Output Supply for Small Form Factor TFT Display
TPS65120

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/TPS65120**

Key Features
- Main Output, V_{MAIN}
  - Adjustable voltage, 3.0 V to 5.6 V/25 mA
  - Post-regulated for low ripple (5 mV$_{PP}$)
  - ±0.8% typical accuracy positive output, V_{GH}
  - Adjustable voltage up to 20 V/2 mA
  - ±3% typical accuracy negative output, V_{GL}
  - Adjustable voltage down to −18 V/2 mA
  - ±3% typical accuracy
- Auxiliary 1.8-V/3.3-V linear regulator
- Automatic or programmable power sequencing
- 2.5-V to 5.5-V input voltage range
- Output short circuit protected
- Packaging: 16-pin QFN (3 x 3 x 0.9 mm)

Typical application diagram.

Applications
- Cell phones
- Smart phones
- PDAs
- Pocket PCs
- Portable DVDs
- Digital still cameras (DSCs)
- Camcorders
- Portable GPSs
- Car navigation systems
- Handheld instruments

Bias Power Supply for TV and Monitor TFT LCD Panels
TPS65160

Get samples and datasheets at: **www.ti.com/sc/device/TPS65160**

Key Features
- Input voltage range: 8 V to 14 V
- Number of regulated outputs: 4
- Boost converter, buck converter, negative and positive charge pump
- Output voltage: up to 20 V
- Adjustable sequencing
- Switching frequency: 500 kHz or 750 kHz
- Package: HTSSOP-28

Applications
- TFT LCD display for monitor and LCD TV
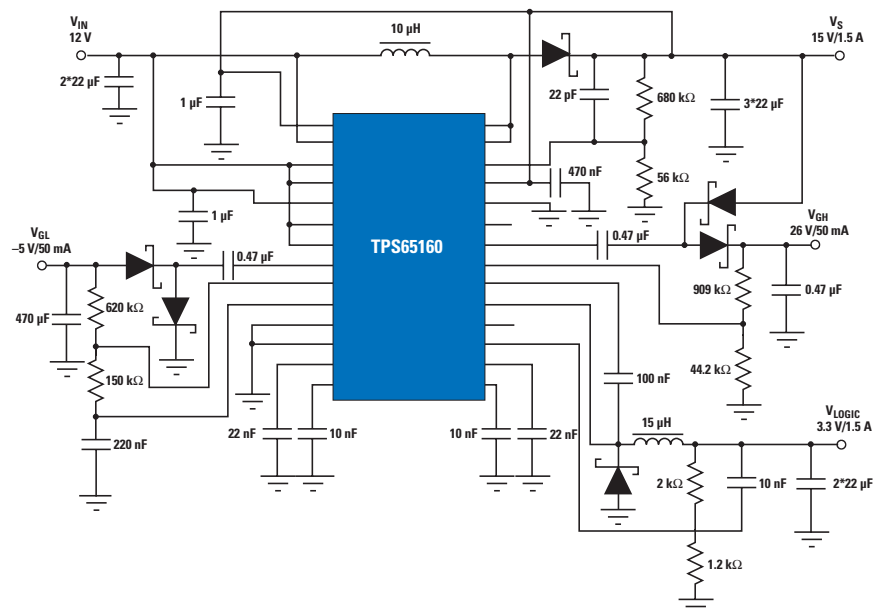
Positive-charge pump doubler running from the output V_S (SUP = V_S) required when higher V_{GH} voltages are needed.

## Integrated Photoflash Capacitor Charger and IGBT Driver
TPS65552A

Get samples, datasheets, EVMs and app reports at: **www.ti.com/sc/device/TPS65552A**

Key Features
- Highly integrated solution to reduce components
- Integrated IGBT driver
- High efficiency
- Programmable peak current, 0.95 A to 1.8 A
- Input voltage of 1.8 V to 12 V
- Optimized control loop for fast charge time
- Sensing all trigger from primary side
- Packaging: 10-pin MSOP and 16-pin QFN

Applications
- Digital still cameras (DSCs)
- Optical film cameras
- Mobile phones with cameras
- PDAs with cameras
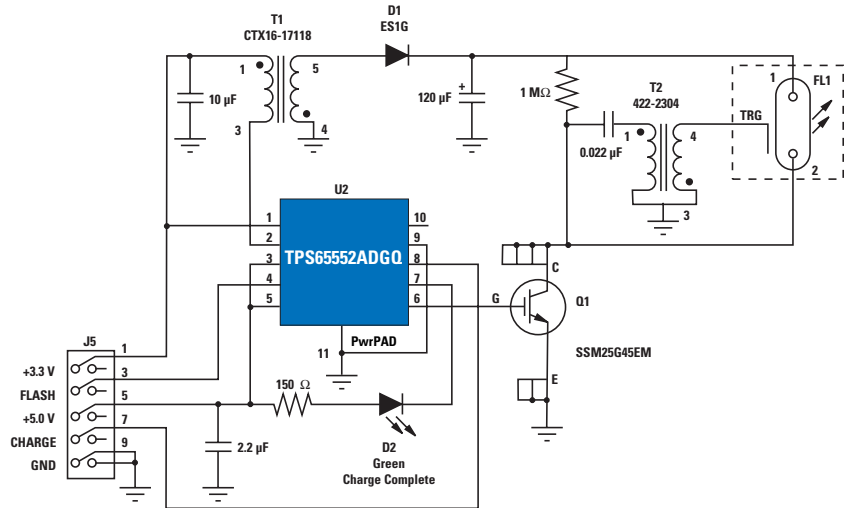
*TPS65552A application circuit.*

High-Power White LED Flash Driver
TPS61059

Get samples and datasheets at: **www.ti.com/sc/device/TPS61059**

Key Features
- 80% efficient synchronous boost converter
- Input voltage range: 2.7 V to 5.5 V
- Fixed frequency 650-kHz operation
- LED disconnect during shutdown
- Open/shorted LED protection
- Internal softstart
- Overtemperature protection
- Low shutdown current: 0.1 µA
- Output current: 500 mA (TPS61058), 800 mA (TPS61059)
- Packaging: small 3 mm x 3 mm QFN

Applications
- Torch/camera white LED supply for cell phones, smart phones, and PDAs
- General lighting applications
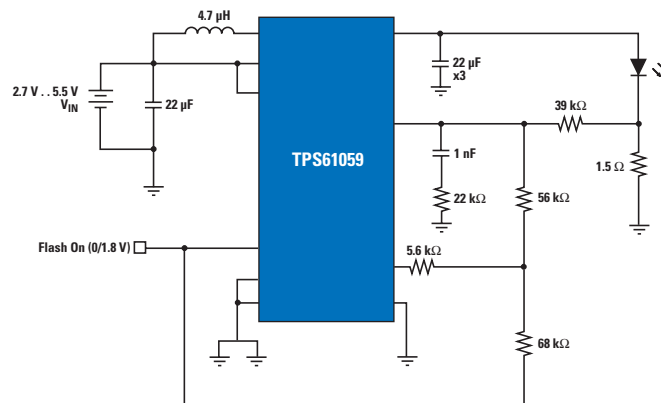

800-mA single LED flashlight application.

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High-Efficiency Phase Shift Full Bridge CCFL Controller
TPS68000

Get samples and datasheets at: **www.ti.com/sc/device/TPS68000**

Key Features
- 8-V to 30-V input voltage range
- Full bridge topology with integrated gate drives for 4-NMOS switches
- Synchronizable constant frequency operation
- Programmable phase delays of operating frequency for master slave operation
- Lamp-voltage and lamp-current regulation
- Analog and burst dimming
- Configurable distributed burst dimming in multiple controller applications
- Programmable voltage regulation timeout for startup and fault conditions
- Open-lamp and short-circuit protection
- Internal overtemperature protection
- Undervoltage lockout
- Packaging: 30-pin TSSOP
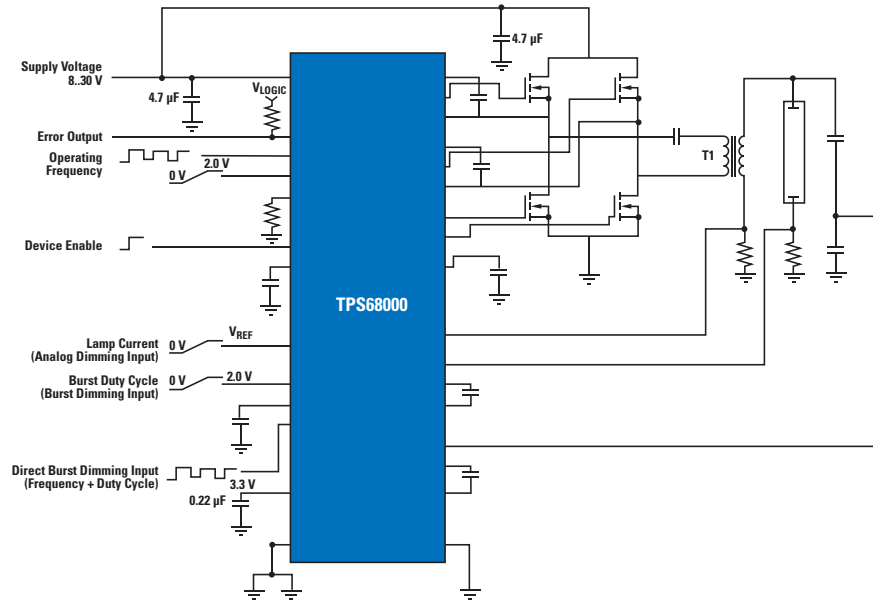
TPS68000 application circuit for single lamp.

Applications
- CCFL backlight power supplies for desktop monitors and LCD TVs
- CCFL backlight power supplies for notebooks
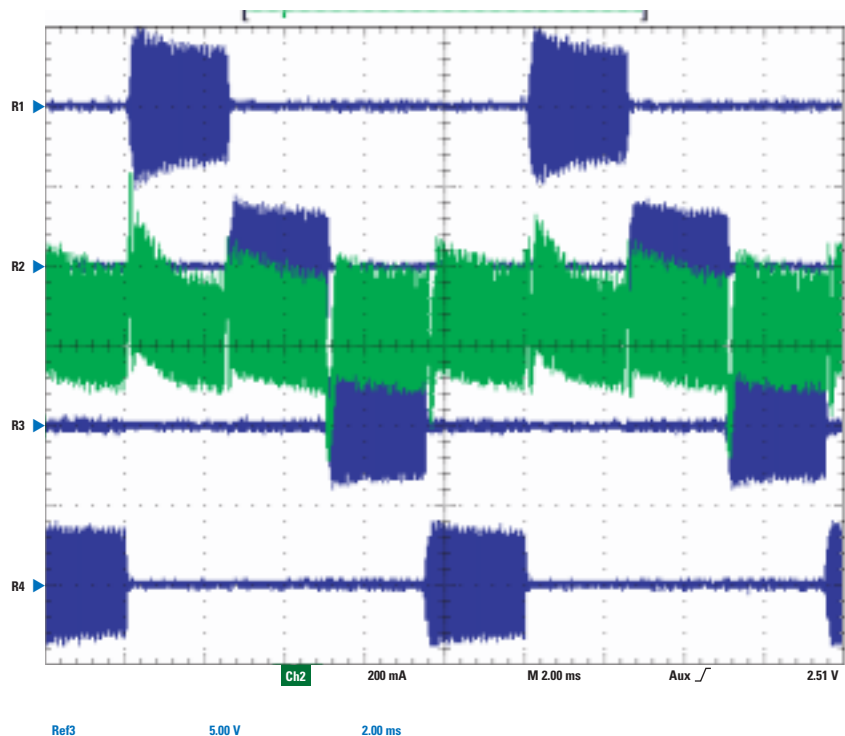
The Distributed Dimming™ capability of the TPS68000 provides uniform lighting across display panels while reducing power line noise and image distortion.

RGB LED Drivers

Device	Data Input (Bits)	Output Count (Bits)	Input Voltage Range (V)	Output Current Drive (mA)	Channel-to-Channel Accuracy (typ) (%)	Data Transfer Rate (MHz)	Brightness Adjustment (Steps)	Dot Correction (Steps)	PWM Grayscale (Steps)	EEPROM	OVM[1]	LOD[2]	TEF[3]	WDT[4]	TSD[5]	Price[6]
TLC5904	8-bit parallel	8, 16	4.5 to 5.5	120	±4	15	32	—	256	—	Yes	Yes	No	Yes	Yes	3.70
TLC5905	1	8, 16	4.5 to 5.5	120	±4	15	32	—	256	—	Yes	Yes	No	Yes	Yes	2.85
TLC5911	7, 10	16	4.5 to 5.5	80	±4	20	64	128	1024	—	No	Yes	No	Yes	Yes	4.50
TLC5930	1	12	3.0 to 3.6	40	±1	20	64	256	1024	—	Yes	Yes	Yes	No	No	4.15
TLC5920	1	16	4.5 to 5.5	30	±6	10	—	—	—	—	No	No	No	No	No	1.10
TLC5921	1	16	4.5 to 5.5	80	±1	20	—	—	—	—	No	Yes	No	No	Yes	1.25
TLC5922	1	16	3.0 to 5.5	80	±1	30	—	128	—	—	No	No	Yes	No	No	1.35
TLC5923	1	16	3.0 to 5.5	80	±1	30	—	128	—	—	No	Yes	Yes	No	No	1.90
TLC5940	1	16	3.0 to 5.5	120	±1	30	—	64	4096	Yes	No	Yes	Yes	No	No	1.90
TLC5941	1	16	3.0 to 5.5	80	±1	30	—	64	4096	—	No	Yes	Yes	No	No	1.65

[1]Output voltage monitoring.
[2]LED open detection.
[3]Thermal error flag.
[4]Watchdog timer.
[5]Thermal shutdown.
[6]Suggested resale price in U.S. dollars in quantities of 1,000.

*New devices are listed in **bold red**.*

White LED Drivers

Device	V$_{IN}$ (V)	Type	Number of LEDs[1]	LED Configuration	Switch Current Limit (typ) (mA)	Current Regulation	Over-Voltage Protection (min) (V)	Synchronous	Output Capacitor	Load-Disconnect During Shutdown	Dimming[2]	Peak Efficiency[3] (%)	Quiescent Current (typ) (mA)	Shutdown Current (typ) (µA)	Package(s)	Price[4]
TPS61041	1.8 to 6.0	Inductive	4	Series	250	No	No	No	1 µF	No	Yes	85	0.028	0.1	SOT-23	0.75
TPS61040	1.8 to 6.0	Inductive	6	Series	400	No	No	No	1 µF	No	Yes	86	0.028	0.1	SOT-23	0.95
TPS61043	1.8 to 6.0	Inductive	4	Series	400	Yes	17	No	100 nF	Yes	Yes	85	0.038	0.1	QFN-8	0.99
TPS61042	1.8 to 6.0	Inductive	6	Series	500	Yes	28	No	100 nF	Yes	Yes	85	0.038	0.1	QFN-8	1.20
TPS61060	2.7 to 6.0	Inductive	3	Series	400	Yes	14	Yes	220 pF	Yes	Yes	83	—	1	QFN-8/WCSP-8	1.35
TPS61061	2.7 to 6.0	Inductive	4	Series	400	Yes	18	Yes	220 pF	Yes	Yes	82	—	1	QFN-8/WCSP-8	1.35
TPS61062	2.7 to 6.0	Inductive	5	Series	400	Yes	22	Yes	220 pF	Yes	Yes	81	—	1	QFN-8/WCSP-8	1.35
TPS61020	0.9 to 5.5	Inductive	1	Series	1500	Yes	Optional	Yes	2.2 µF	Yes	Flash	90	0.025	0.1	QFN-10	1.40
REG71050	3.2 to 5.5	Charge pump	3	Parallel	—	No	—	—	2.2 µF	—	Yes	70	0.065	0.01	SOT-23	0.65
TPS60231	2.7 to 6.5	Charge pump	3	Parallel	—	Yes	—	—	1 µF	—	Yes	85	0.200	0.1	QFN-16	0.95
TPS60230	2.7 to 6.5	Charge pump	5	Parallel	—	Yes	—	—	1 µF	—	Yes	85	0.200	0.1	QFN-16	1.50
TPS61058	2.7 to 5.5	Inductive	1	Series	800	Yes	6.1	Yes	22 µF	Yes	Yes	92	5.5	0.1	QFN-10	0.85
TPS61059	2.7 to 5.5	Inductive	1	Series	500	Yes	6.1	Yes	22 µF	Yes	Yes	92	5.5	0.1	QFN-10	0.95

[1]More LEDs can be driven in parallel string configuration.
[2]May be via ENABLE pin, CONTROL pin or analog feedback network.
[3]Depends on LED current, input voltage, number of LEDs, ILED pin.
[4]Suggested resale price in U.S. dollars in quantities of 1,000.

*New devices are listed in **bold red**.*

LCD and OLED Display Bias Power

Device	V_{IN} (V)	Charger	No. of Regulator Outputs	DC/DC Converter	DC/DC Controller	Charge Pump	LDO	LDO Controller	Communication Interface	Quiescent Current (mA)	Shutdown Current (μA)	Description	Package(s)	Price[1]
Integrated Power Management for TFT/TFD LCD and OLED Displays														
TPS61045	1.8 to 6.0	—	1	1	—	—	—	—	—	0.035	1	Digitally adjustable, small form factor LCD and passive-matrix OLED bias supply	QFN-8	1.35
TPS63700	2.7 to 5.5	—	1	1	—	—	—	—	—	0.2	1	Inverting DC/DC converter with 200-mA output current and up to –15-V output voltage	SON-10	2.35
TPS65110/1	2.4 to 5.5	—	3	—	—	3	—	—	—	0.05	1	High-accuracy, small form factor, inductor-less LTPS LCD bias supply with low ripple	QFN-24	1.70
TPS65120/1/3/4	2.5 to 5.5	—	4	1	—	—	2	—	—	0.14	0.1	High-accuracy, small form factor, LTPS and a-Si LCD bias supply, sequencing	QFN-16	1.75
TPS65130/1	2.7 to 5.5	—	2	2	—	—	—	—	—	0.5	0.2	Positive/negative small form factor OLED, TFT and CCD bias supply, dual rail	QFN-24	2.95
TPS65100/5	2.7 to 5.8	—	4	1	—	1	—	1	—	3.5	1	High-accuracy, large form factor TFT LCD bias supply w/ vcom buffer, sequencing	QFN/TSSOP-24	2.30
TPS65140/5	2.7 to 5.8	—	4	1	—	1	—	1	—	3.5	1	High-accuracy, large form factor TFT LCD bias supply w/ Power Good, sequencing	QFN/TSSOP-24	2.00
TPS65150	1.8 to 6	—	3	1	—	2	—	—	—	—	—	High-accuracy, large form factor TFT LCD bias supply w/ flicker compensation, sequencing	QFN/TSSOP-24	2.40
TPS65160	8 to 14	—	4	2	—	2	—	—	—	—	—	LCD TV/Monitor TFT display bias supply w/ protection, softstart, sequencing	TSSOP-28	2.60

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

*New devices are listed in **bold red**.*
*Preview devices are listed in **bold blue**.*

Camera Flash Solutions

Device	Input Voltage (V)	V_{CC} (V)	Programmable Peak Current (A)	Power Switch (V)	IGBT Driver	Protection			Packaging	Price[1]
						Max On Time	Over-Voltage Shutdown	Thermal Monitor		
TPS65552A	1.8 to 12	5	0.95 to 1.8	50	Yes	Yes	Yes	Yes	10-pin MSOP, 16-pin QFN	1.90

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

*New devices are listed in **bold red**.*

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Phone
  Belgium (English)   +32 (0) 27 45 54 32
  Finland (English)   +358 (0) 9 25173948
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Fax   +49 (0) 8161 80 2045
Internet   support.ti.com/sc/pic/euro.htm

Japan
Fax
  International   +81-3-3344-5317
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  International   support.ti.com/sc/pic/japan.htm
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  International   +886-2-23786800
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Post Office Box 655303 Dallas, Texas 75265

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