Signals LED and panels
Applications

Basic Information Signs
Applications

Large video screen
Typical LED panel requirements

- Multiple outputs – 16 per IC
- Digital interface – 30MHz
- PWM Dimming – 4,096 or 65,536 steps (12 or 16 bit)
- Dot Correction – up to 128 steps (7 bit)
- High Current – up to 120mA per channel
- High Accuracy – 1%
- Status Information – Open LED, Thermal shutdown, Silent Detect
Driving a Panel

AC/DC

Processor

Clock
Latch
Blank

TLC59xx

TLC59xx
Brightness Control

- Analog dimming
  - Changing the LED’s DC current changes LED intensity
  - i.e., 25% brightness by running a 20mA LED at 5mA
  - Implemented with digital interface

- PWM Dimming
  - Changing duty cycle of applied current
  - i.e., 25% brightness by running 20mA for only 25% of the time.
  - PWM frequency should be greater than response time of human eye (approx 60Hz)
  - Implemented with digital interface
Analog vs PWM

Analog Dimming

PWM Dimming

LED Forward Current

Time

0.25T

T
Basic TLC59xx LED Driver

- Digital Control
- PWM Dimming
- 16 Constant Current Outputs
- Status Information
- Dot Correction
**On/Off vs PWM Mode**

**On/Off**
- PWM GS made by external controller.
  - **Pro:** Only simple LED-driver needed
  - **Con:** Serial data rate is high

**PWM Mode**
- PWM GS integrated in LED-driver
  - **Pro:** More easy to use than external solution
  - **Con:** At high bit PWM high serial data rate
  - More signal pins needed
- PWM GS integrated in LED-driver with variable clock frequency
  - **Pro:** >16-bit possible
  - Low serial data rate
  - **Con:** Slightly more processing in controller needed
Changing PWM Frequency

Changing PWM Grayscale clock frequency allows fast changing of overall LED panel brightness without change of maximum LED current, for example brighter panel during day and slightly dimmed panel for night.

Higher PWM GS clock frequency means brighter display while lower PWM GS clock frequency means darker display.
Data Speeds

- Need to calculate data rates to determine how much processing power is needed for each panel.

- 48 drivers requires 9216 bits of information for each image.

\[(48 \text{ drivers} \times 16 \text{ channels} \times 12 \text{ bits}) = 9216\]
Video Definition

- **Frame Rate**: how often new data (a new image) is displayed on the display.

- **Frame Refresh Rate**: how often the same image is redrawn for each frame. Typically, one PWM period.

- For NTSC video, the Frame Rate only needs to be 60Hz.

- The Frame Refresh Rate is usually set very high to avoid aliasing with video cameras that are viewing the display.
Highest Quality Video

- **12 Bit PWM Dimming** ➔ 4096 steps
  - ➔ $2^{12} \times 2^{12} \times 2^{12} = 68.7$ billion colors
  - 10MHz GSCLK ➔ 410uS ➔ 2.4kHz frame refresh rate

- **16 Bit PWM Dimming** ➔ 65536 steps
  - ➔ $2^{16} \times 2^{16} \times 2^{16} = 281$ trillion colors
  - 10MHz GSCLK ➔ 6.5mS ➔ 152Hz frame refresh rate

- Customers need >400Hz refresh rate to eliminate artifacts with video cameras.
Image Data vs Time

Frame Rate: How fast new data is shifted in. Must be >50Hz for smooth video

Image B data is shifted in while Image A is being displayed

| IMAGE A | IMAGE A | IMAGE B | IMAGE B |

Frame Refresh Rate: One PWM cycle. Same frame is repeated each cycle. Typically ranges between 50Hz - 2000Hz

What are the minimum serial data clock and grayscale (PWM) clocks for the following panel:

48 drivers with 120Hz Frame Rate and 2500Hz Frame Refresh Rate?
Minimum Required Clock Speeds

\[ \text{GSCLK} \geq (\text{Frame Refresh Rate}) \times 2^N \]
\[ \text{GSCLK} \geq 2500 \times 2^{12} = 10.2\text{MHz} \]

\( N = \) number of PWM bits

\[ \text{Serial Clock} \geq (\text{Frame Rate}) \times (\#\text{bits per frame}) \]
\[ \text{Serial Clock} \geq 120 \times 9216 = 1.1\text{MHz} \]

Texas Instruments LED drivers provide 30MHz clock speeds to minimize aliasing with video equipment.
Reducing system costs and extending display life using LED dot correction
A problem with RGB LEDs

Each Pixel is comprised of three LEDs (Red, Green and Blue). Each LED has a different intensity due to manufacturing differences so the combination of the three LEDs does not equal true white and each white pixel has a different intensity.
What is dot correction?

• Dot Correction is a method to adjust the individual brightness of LED’s in multiple LED display systems.

• The current though each LED is adjusted so that all LED’s have the same brightness (luminous intensity) so that the display’s image is uniform.

• Dot Correction adjusts the maximum current (used for PWM gray scaling) through each LED. Can apply a linear correction factor between 0 and 100%.
Dot correction concept

Top Graph: 8 LED’s driven by the same forward current. Each LED has a different intensity due to manufacturing differences.

Bottom Graph: 8 LED’s after Dot Correction is applied. Now all have different forward currents but the same intensity.
A table is stored in a microprocessor’s memory. Software fetches the dot correction number for each LED and adjusts the PWM brightness based on the table value.

This method requires a fast microprocessor for high display frame rates. There is a large burden on the system software.
Hardware Dot Correction Method

- A Dot Correction table is stored in the LED driver circuitry (either RAM or EEPROM).
- The LED driver automatically linearly scales the LED current whenever the LED is on.
- The microprocessor only needs to control the PWM grayscale brightness.
Hardware Dot Correction

• The grayscale and dot correction circuits can all be integrated into one LED driver IC for simplicity.
• A driver IC can handle 16 LED’s each with its own dedicated PWM and Dot Correction circuits which greatly reduces complexity.
• DC table is stored in memory (RAM or EEPROM) in the driver circuit.
• Matching of LED’s is determined by the number of bits, N, of dot correction available

\[
\text{Intensity Matching} = \pm \frac{50}{2^N - 1} \% 
\]

• For example, a TLC5940 with 6 bit dot correction can match the LED intensities to within +/- 0.79%
**Measured Results**

A/D values shown are upper 12 bits only

<table>
<thead>
<tr>
<th>LED</th>
<th>LED Age</th>
<th>Uncorrected A/D Value</th>
<th>DC A/D value</th>
<th>Uncorrected Intensity (% of LED 1)</th>
<th>DC Intensity (% of LED 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Old</td>
<td>36544</td>
<td>36608</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>2</td>
<td>New</td>
<td>42160</td>
<td>36432</td>
<td>15.37%</td>
<td>-0.48%</td>
</tr>
<tr>
<td>3</td>
<td>New</td>
<td>41680</td>
<td>36576</td>
<td>14.05%</td>
<td>-0.09%</td>
</tr>
<tr>
<td>4</td>
<td>New</td>
<td>41968</td>
<td>36624</td>
<td>14.84%</td>
<td>0.04%</td>
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<tr>
<td>5</td>
<td>New</td>
<td>42336</td>
<td>36624</td>
<td>15.85%</td>
<td>0.04%</td>
</tr>
<tr>
<td>6</td>
<td>New</td>
<td>42160</td>
<td>36528</td>
<td>15.37%</td>
<td>-0.22%</td>
</tr>
<tr>
<td>7</td>
<td>New</td>
<td>42112</td>
<td>36560</td>
<td>15.24%</td>
<td>-0.13%</td>
</tr>
<tr>
<td>8</td>
<td>New</td>
<td>42240</td>
<td>36768</td>
<td>15.59%</td>
<td>0.44%</td>
</tr>
</tbody>
</table>
Over time, $\Delta L$ increases due to aging. The difference becomes detectable to the eye.

Dot Correct panel so that $\Delta L$ is not detectable to the eye.
Dot Correction Can Be Used For...

- To increase the time between panel (or LED) replacement thus reducing repair and operational costs.
- To adjust the brightness of individual LEDs or panels to account for aging.
- Creating uniform pixel color and intensity across the display to produce high quality images.
- To eliminate the need to purchase LEDs that are binned based on intensity thus reducing manufacturing costs.
- Hardware based dot correction reduces system costs by reducing the software and processing power required by the system. Cheaper control circuits can be used thus reducing manufacturing costs.
Time Multiplexing

• What is Time Multiplexing
  – Driving Multiple LEDs with a single LED driver output
  – Only one LED is on at any given time for a driver output

• Why Time Multiplexing
  – System level cost savings.
  – Reduces the number of LED drivers
  – LED driver is approx 5-15 % material cost of a typical LED panel

• When to Use Time Multiplexing
  – Low Lighting Conditions
  – Indoor Applications
Static vs. Multiplexing

**Static Type**
- Get high brightness
- Simple system
- Low speed PWM

**Multiplexing Type**
- Reduce Space
- Reduce Device Cost
- Need many Space (PCB)

**Merit**
- Get high brightness
- Simple system
- Low speed PWM

**Demerit**
- Many IC
- Need many Space (PCB)

**Merit**
- Reduce Space
- Reduce Device Cost

**Demerit**
- Need High brightness
- Complex system
- High speed PWM
Multiplexing creates ghosting

- “Ghosting” - “Spike Noise” - “Phantom Noise”
- Unwanted illumination of LEDs in a time multiplexed system
- Causes
  - Short current spikes in LEDs
  - Diode voltage mismatch
  - Stray board capacitance
- Affects video quality
  - Usually in low light and low brightness conditions
Topology of Multiplexing (TLC5924/TLC5944)
Working of Multi-plexing

Test Schematic

VLED 5.0V
SW-A
SW-B
OUT

Repeat
Test Sequence

LED

Switch-A
Turned ON
By BLANK
Blue

Switch-B
Turned ON
By BLANK
Red

Texas Instruments
What is ghost?

Switch-A

Turned ON By BLANK

Switch-B

Turned ON By BLANK

LED

Called Ghost

TLC5941

TLC5944

No Ghost
Test sequence for comparison TLC5941 vs TLC5944

Switch-A
Turned ON By BLANK
Blue
Switch-B
Turned OFF

LED
Repeat
Pre-charge FET based on Freq.

Test Sequence for comparison TLC5941 vs TLC5944

<table>
<thead>
<tr>
<th>Frequency</th>
<th>TLC5941 (Non-Pre-Charge)</th>
<th>TLC5944 (Pre-Charge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>f=450Hz</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td>f=4.5kHz</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td>f=45kHz</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
</tbody>
</table>
Pre-charge FET
Brightness data vs ghosting

You cannot see ‘Ghosting’

GSData=1000d

Ghosting current

LED frame current

GSData=1000d

You can see ‘Ghosting’

GSData=1d

GSData=1d
Power Dissipation

\[ P_D = \left( V_{CC} \times I_{CC} \right) + \left( V_{OUT} \times I_{MAX} \times N \times \frac{DC_n}{63} \times d_{PWM} \right) \]

- \( V_{CC} \): device supply voltage
- \( I_{CC} \): device supply current
- \( V_{OUT} \): TLC5941 OUTn voltage when driving LED current
- \( I_{MAX} \): LED current adjusted by \( R_{(IREF)} \) Resistor
- \( DC_n \): maximum dot correction value for OUTn
- \( N \): number of OUTn driving LED at the same time
- \( d_{PWM} \): duty cycle defined by BLANK pin or GS PWM value

Treat it like a linear regulator
### Superior Power Dissipation

<table>
<thead>
<tr>
<th>Texas Instruments</th>
<th>Toshiba</th>
<th>Macroblock</th>
<th>Silicon Touch</th>
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</thead>
<tbody>
<tr>
<td>TLC5921 3.9W 3.5W</td>
<td>TB62706 0.92W 1.78W</td>
<td>MBI5016 0.79W 0.67W</td>
<td>DM163 1.36W</td>
</tr>
<tr>
<td>TLC5923 3.9W 3.5W</td>
<td>TB62706 1.00W 1.25W</td>
<td>MBI5027 1.87W 2.51W</td>
<td>DM413 0.86W 1.3W 2.5W</td>
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<tr>
<td>TLC5940 3.9W 3.5W</td>
<td>TB62726 0.57W 2.12W</td>
<td>MBI5029 1.87W 2.12W</td>
<td>ST2226A 0.82W 2.92W</td>
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<tr>
<td>TLC5942 3.9W 3.5W</td>
<td>TB62727 2.12W</td>
<td></td>
<td></td>
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<tr>
<td>HTSSOP-28 QFN-32</td>
<td>SDIP-24 SOP-24</td>
<td>SPDIP-24 SOP-24</td>
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</tr>
<tr>
<td>HTSSOP-28 QFN-32</td>
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<td>SOP-24</td>
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</tr>
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<td>SOP-24</td>
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</tr>
<tr>
<td>QFP-44</td>
<td>SOP-16</td>
<td>SOP-28 QFN-32</td>
<td></td>
</tr>
</tbody>
</table>
LED open detect (LOD)

- Intelligent LOD – Only looks at enabled outputs
- Automatic LOD – No special programming
- Continuous LOD – Doesn’t affect normal operation
- Competitors do not have all these features
LED short detect

TLC5926
TLC5927
Where you are standing?

- **Backlighting**
  - TN/STN Display
  - Color STN Display

- **Color TFT Display**

- **High Resolution** (Accuracy, Efficiency)

- **LED Driver**
  - High performance (DC, PWM, GS)

- **Simple Structure**

- **Video Display**

- **Low cost**

- **Signboard & Gaming**

- **Professional (Architecture) Lighting**

- **High Performance (DC, PWM, GS)**

- **Texas Instruments**
Video Display

Billboard
Large Signboard
General Signboard
Required Features (Video Display)

- **Reliability**
  - Built-in in outdoor

- **Focused on uniformity for LED**
  - Need additional circuit

- **High Resolution**
  - PWM step-over 12bit, # of Channel

---

### Current
- **TLC5940**
  - 120mA, 6bit DC
  - EEPROM

- **TLC5941**
  - 80mA, 6bit DC
  - No Output Delay

- **TLC5942**
  - 50mA, 7bit DC
  - w/o EEPROM

- **TLC5943**
  - 50mA, 7bit gain
  - Control 16 bits ES-PWM

- **TLC5944**
  - 60mA, 6bit DC
  - Pre-Charge FET

- **TLC5945**
  - 80mA, 6bit DC

- **TLC5946**
  - 40mA, 6bit DC
  - Pin Comp TLC5945

- **TLC5947**
  - 40mA, 6bit DC
  - w/o EEPROM

- **TLC5948**
  - Not Auto-off

### Next
- **TLC5949**
  - 24CH, 7bit DC, 8bit BC, 3 GS clock input, 40mA

### Future
- **TLC5950**
  - 30mA, 24CH
  - High voltage, Internal OSC
Backlighting

LCD TV
LCD Monitor & NotePC
Required Features (BLU)

Function for Uniformity & Performance
Dot Correction & PWM Dimming
Grayscale, High Transfer Rate

Power dissipation.
Thermal Pad & PKG
Integrated Driver

Reliability
Type of PKG

Backlight for LCD Display

16 CH

TLC5940/41
- 17V, 120mA/80mA
- 12bit PWM
- 6bit DC

TLC5946
- 17V, 40mA
- 12bit PWM
- 6bit DC

TLC5960
- 16ch, 50V, 80mA
- 10bit PWM
- 6bit DC
- HVM (*)

TLC596x
- 16ch
- 40V
- 80mA
- 10bit PWM
- High accuracy
- HVM (*)

TLC5961
- HB LED
- External FET
- Linear type
- 6ch

Current ➔ Next ➔ Future

Texas Instruments
TFT monitor backlight system overview

- **TFT Display Panel**
- **High Brightness LEDs in series replaces CCFL**
- **The LEDs are driven for each color independently**
- **The RGB sensor get brightness value for each color separately for active feedback loop**
- **A high accuracy current source, capable of PWM dimming is needed to drive the LEDs**
- **The diffuser, prism foil and reflector provides uniform color and brightness over whole display.**
- **The light guide distributes light over whole display area**
- **The temperature sensor to integrate overtemp. protection**
- **The Controller computes the PWM signal needed for the current source, depending on feedback sensor and backlight setting**
- **The brightness setting comes from user input or computer generated**

**TI Solution available**
TFT TV backlight system overview

- **TFT Display Panel**
- **Backlight**
- **Brightness / Color Sensor**
- **Temp. Sensor**
- **Diffusor**
- **MCU / CPU / Controller**
- **Current source**

**The Diffuser** provides uniform color and brightness over the whole display.

**The RGB sensor** gets the brightness value for each color separately.

**The temperature sensor** to integrate overtemp. protection.

- **High Brightness LEDs are spread over the Backlight area to provide uniform brightness and color. Different configurations possible.**
- **The LEDs are driven for each color independently.**
- **A high accuracy current source, capable of PWM dimming, is needed to drive the LEDs.**
- **The Controller computes the PWM signal needed for the current source, depending on feedback sensor and backlight setting.**
- **The brightness setting comes from user input or computer generated.**
- **TI Solution available**
Signboard & Gaming

Signboard
Pachinko/Slot
Professional (Architecture) Lighting
LED driver roadmap
professional lighting

Current

Next

Future

TLC5970: 150mA, 3ch, Differential Signaling, Buck DC-DC, 12 bit PWM, EEPROM
TLC5971: 100mA, 3ch, Differential Signaling, DC-DC, 12bit PWM, EEPROM
TLC597X: 100mA, 3ch, Differential Signaling, DC-DC, 12bit PWM, EEPROM
TL4242: Single CH, 500mA

Current

Next

Future

Production
Developing
Plan
Idea
Products
**TLC5940**

16CH, 120mA $I_{\text{LED}}$ Driver w/DC & PWM GS w/ EEPROM

**Features**
- 16 Channels
- 12-bit (4096 steps) PWM Gray scaling
- 6-bit (64 steps) Dot Correction
- 3.0V-5.5V Input Voltage Range
- **120mA** Constant Current/Channel
- 30MHz Transfer Rate
- Chip to Chip Accuracy: 2.7% typ
- Channel to Channel Accuracy: 1%ty
- Integrated EEPROM

**Applications**
- Mono-color, Multi-color, Full color LED Displays
- LED Signboards
- Display Backlighting

**Why Buy?**
High integration level; grayscale & Dot Correction; high accuracy; fast data transfer rates; wide input voltage range

**Benefits**
- Superior display quality through PWM Grayscaling and Dot Correction
- Increased system reliability with LOD & Thermal Error Flag

![Diagram of TLC5940](image)
TLC5940 $I_{out}$ vs $V_{out}$

TLC5940 $I_{out}$ vs $V_{out}$ Curve
**TLC5941**

16CH, 80mA $I_{LED}$ Driver w/ DC & PWM GS

### Features
- 16 Channels
- 12-bit (4096 steps) **PWM Gray scaling**
- 6-bit (64 steps) **Dot Correction**
- 3.0V-5.5V Input Voltage Range
- **80mA** Constant Current/Channel
- **30MHz** Transfer Rate
- Chip to Chip Accuracy: 2.7% typ
- Channel to Channel Accuracy: 1%typ

### Why Buy?
- Fast Refresh Rate
- Power Dissipation
- Accuracy

### Benefits
- Superior display quality through PWM Grayscaling and Dot Correction
- Increased system reliability with LOD & Thermal Shutdown

### Applications
- Mono-color, Multi-color, Full color LED Displays
- LED Signboards
- LED Backlight

![TLC5941 Diagram](image)

2.7% Chip-Chip Accuracy

---

**Texas Instruments**
TLC5942
16 CH, 12 bit PWM w/ dedicated DC

Features
- **12-bit** PWM Gray scaling
- **7-bit** Dot Correction with Dedicated port
- Independent GSCLK and DCCLK operation
- 3.0V-5.5V Input Voltage Range
- **50mA** Constant Current
- **30MHz** Transfer Rate
- Continuous LED Open Detection
- Chip to Chip Accuracy: 2.7% typ
- Channel to Channel Accuracy: 1%typ
- 4 grouped output delay for noise reduction

Applications
- Mono-color, Multi-color, Full color LED Displays
- LED Sianboards

Why Buy?
- Board level Dot Correction
- Easy to system maintenance

Benefits
- Superior display quality through board level Dot Correction
- Increased system reliability
TLC5943
16 bit ES - PWM w/ 7 bit device level brightness control

Features
- 16-bit PWM Gray scaling
- 7-bit brightness control (0-100%)
- Auto data refresh
- Auto display repeat
- 50mA Constant Current
- 30MHz Transfer Rate
- 3.0V-5.5V Input Voltage Range
- Continuous LED Open Detection
- Chip to Chip Accuracy: 2.7% typ
- Channel to Channel Accuracy: 1% typ
- 4 grouped output delay for noise reduction

Benefits
- TLC5940/41 pin to pin compatible solution
- 65536 gray scale for 281 trillion color LED display
- Easy to adjust display brightness between 0~100%
- Easy to synchronize data write timing
- ES (Enhanced Spectrum) PWM for improving image quality with flicker noise reduction
- Increased system reliability with thermal shutdown and LOD Flag
- Fast data transfer rates
- Space saving high power thin (PowerPAD PKG)

Why Buy?
Highly gray scaled, Flicker noise reduced, fast refresh rate solution

Applications
- 281 trillion color solution
TLC5945
80mA $I_{\text{LED}}$, 12 bit PWM w/ 6 bit DC & w/o Output delay

**Features**
- 16 Channels
- 12-bit (4096 steps) PWM Gray scaling
- 6-bit (64 steps) Dot Correction
- 3.0V-5.5V Input Voltage Range
- **80mA** Constant Current/Channel
- **30MHz** Transfer Rate
- Chip to Chip Accuracy: 2.7% typ
- Channel to Channel Accuracy: 1%typ

**Applications**
- Mono-color, Multi-color, Full color LED Displays
- LED Signboards
- Indoor Display

**Benefits**
- Superior display quality through PWM Grayscaling and Dot Correction
- Increased system reliability with LOD & Thermal Shutdown

**Why Buy?**
Fast GSCLK support

2.7% Chip-Chip Accuracy
TLC5916/7 (8-Ch) - TLC5926/7 (16-Ch)

Prog. Constant Current Sink LED Drivers

**Features**

- 8/16 constant current outputs (up to 120mA)
- Current output programmable by external resistor (REXT)
- Programmable current gain (8-bit / 256-Steps)
- Current accuracy between channels ±3% (max)
- Current accuracy between IC ±6% (max)
- Protection and Diagnostic
  - Open load
  - Channel over temperature
  - Short Circuit detection (only TLC59x7)
- Serial interface (4 wire, Cascadable, 30MHz)
- Schmitt Trigger inputs
- Thermally enhanced packaging concept for efficient heat management
- Supply 3.3V or 5V

**Applications**

- LED illumination and intensity control
- Video walls and signs
- Traffic signalization

**Benefits**

- Programmable constant load current
- Fault reporting
Large scale video LED panels

DC/DC 5V

Mounted on PCB as autonomous module

6x TLC5917

DC/DC $V_{\text{supply red}}$

DC/DC $V_{\text{supply green}}$

DC/DC $V_{\text{supply blue}}$
TLC59116
16 Channel, I²C Constant Current Sink LED Driver

Features

- 16 constant current outputs (up to 10mA)
- Current output programmable by external resistor (REXT)
- 8-bit PWM per pin
- 256 step group blinking (24Hz to 10.73 seconds)
- Programmable current gain (8-bit / 256-Steps)
- Current accuracy between channels ±6% (max)
- Current accuracy between IC ±8% (max)
- Protection and Diagnostic
  - Open load
  - Channel over temperature
- I²C interface (1-MHz Fast Mode +)
- 4 Software programmable I2C addresses
- Supply 3.3V or 5V

Applications

- LED illumination and intensity control
- Video walls and signs
- Traffic signalization
- Gaming

Benefits

- Programmable constant load current
- Fault reporting
- Independent PWM per channel
TLC59109
Const. Current Sink LED Drivers, 8 Channel, I2C Interface

Features

- 8 CH(10mA to 50mA), Supply 3.3V or 5V
- Current output prog. by external resistor (REXT)
- Current accuracy between channels ±3% (max)
- Current accuracy between IC ±6% (max)
- Protection and Diagnostic
  - Open load
  - Short Circuit detection
- I2C interface (2 wire, up to 100kHz, 400kHz)
- Prog. to 14 different addresses for adding multiple LED drivers on the same bus, ALLCALL
- Thermally enhanced packaging(20-pin QFN)
- Automatic Error checking with Interrupt pin on error
- Independent internal PWMs for Dimming and Blinking
- Synchronization of blinking available through CEXT

Applications

- LED illumination and intensity control
- Video walls and signs
- Traffic signalization
- Communications equipment

Benefits

- Programmable constant load current
- Automatic Fault reporting

In Design
TLC59103
Constant Current Sink LED Drivers, 3 Channel, RGB

**Features**
- 3 constant current outputs (up to 150mA)
- Current outputs programmable by independent external resistor (REXTR, REXTG, REXTB)
- Current accuracy between channels ±3% (max)
- Current accuracy between IC ±6% (max)
- Independent input for each driver
- Thermally enhanced packaging concept for efficient heat management
- Supply 3.3V or 5V
- LED supply up to 17V
- VOL < 250mV

**Applications**
- LED illumination and intensity control
- Video walls and signs
- Traffic signalization

**Benefits**
- Programmable constant load current
- Independent programming of R/G/B LEDs

**In Definition**

![TLC59103 Diagram](image-url)
**TL4242** (500mA $I_{LED}$, Serial LED w/ 42V-$V_{in}$)  
Constant Current LED driver

### Features
- Adjustable constant current up to 500 mA (±5%)  
- Wide output voltage range up to 42 V  
- Open load detection  
- Over-temperature protection  
- Short circuit proof  
- Reverse polarity proof  
- Wide temperature range: -40 °C to 150 °C  
- QFN-8 Power Package

### Applications
- LED illumination and intensity control  
- Exterior: DRLs, fog light, turn lamp, headlamp, …  
- Interior: vanity light, map light, courtesy light, …

### Benefits
- Supply voltage independent constant current / brightness  
- PWM capability for dimming  
- No external power resistor required  
- Diagnostic capability
**Topology**

- Directly connected to switched supply line
- Linear current control for voltage drop
- DC/DC supply for long strings of LEDs

**Configuration**

b) several strings of 2 – 4 LEDs with linear current control and PWM

c) possible: booster to 35V and strings with up to 14 LED @ 50mA - 350mA

c) Boost + long strings with individual linear current control and PWM possibility
TL4242 EVM

• **EVM Features**
  – User supply of input: 4.5V to 42V
  – On-board or user $R_{\text{REF}}$
  – On-board or user
  – Dual LED configuration
  – No external control required
  – User access to all pins: ST, PWM, Q, IN, REF, D
  – Jumpers for easy configuration