

Linear LED Display Drivers

Analog

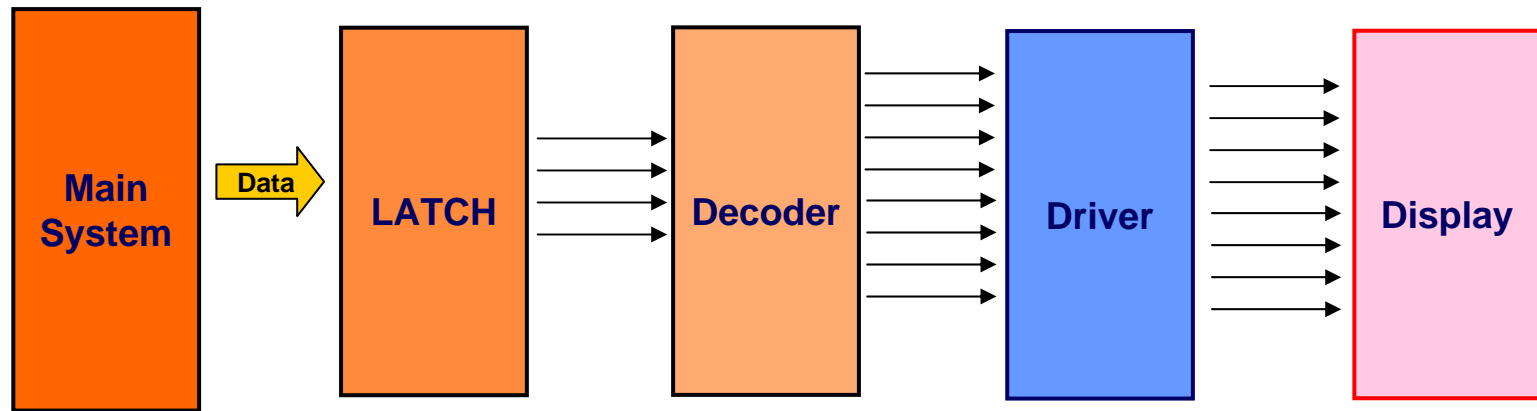
Standard Linear and Logic

Samuel Lin

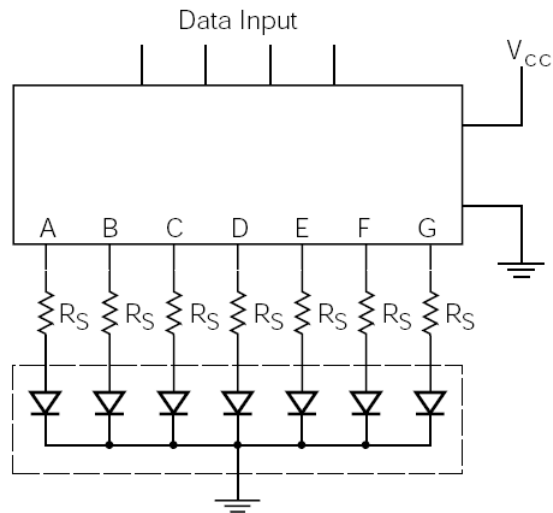
Asia Market Development

Sep-2008

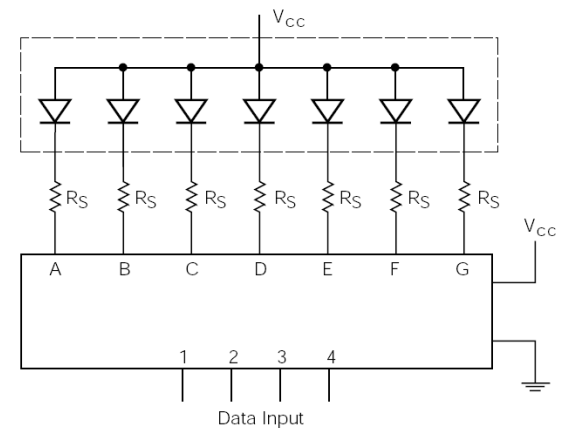
LED Display Basic



Common cathode display with driver



Common anode display with driver



LED Display Driver Type

7-Segment LED Display Driver

Device	Output	Sink-Current	Max. Voltage	Inputs
SN7446A	Open-Collector	40-mA	30-V	4-Inputs
SN7447A	Open-Collector	40-mA	15-V	4-Inputs
SN7448	2-K Ω Pull-Up	6.4-mA	5.5V	4-Inputs
SN74LS49	Open-Collector	8mA	5.5V	4-Inputs
CD4028B	High Volt. CMOS	6.8mA	20V (Vcc)	4-Inputs

Different Application, Different Requirements

■ Billboard

- RGB LED Driver
- More LEDs on each channels
- Programmable I/F (SPI/I²C)
- Medium/High Output Current
- Higher MAX. Voltage
- Wider Bits

■ Portable

- Fixed LED Color
- RGB LED (Optional)
- Low Power Consumption
- I²C Bus
- Blinking/Brightness Levels
- Smaller Package

■ Decoration/Amusement

- RGB LED Drivers
- Programmable I/F (SPI/I²C)
- Blinking/Brightness Levles
- 8/16-Bits.
- Standard Packages

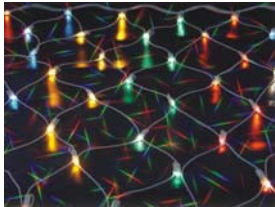
Signage/Funny LED Driver ICs

PIPO SINK Driver

TLC59211
30V/200mA

TLC59210
30V/200mA

TLC59212
24V/40mA



PIPO SOURCE Driver

TLC81011
13.2V/500mA

SPI LED Driver

8CH, 120mA

TLC5917

8CH, 120mA

TLC5916

80mA, 16 CH

TLC5921

16CH, TLC5917

TLC5927

TLC5926

TLC5925

TLC5915

SN74LV8153
Serial In Parallel Output

I²C LED Driver

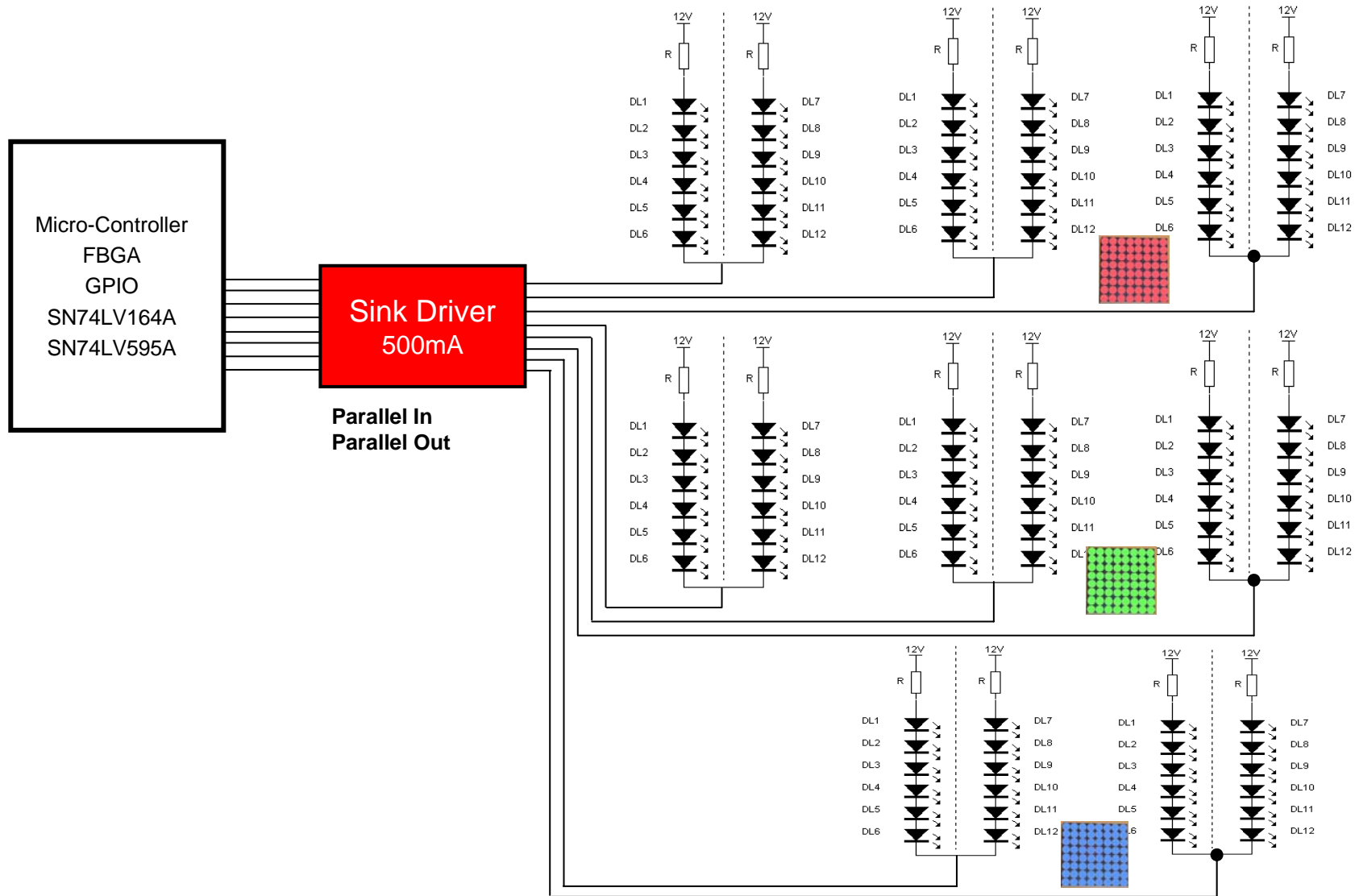
TLC59116
16CH, 110mA

TLC59116F
16CH, 110mA

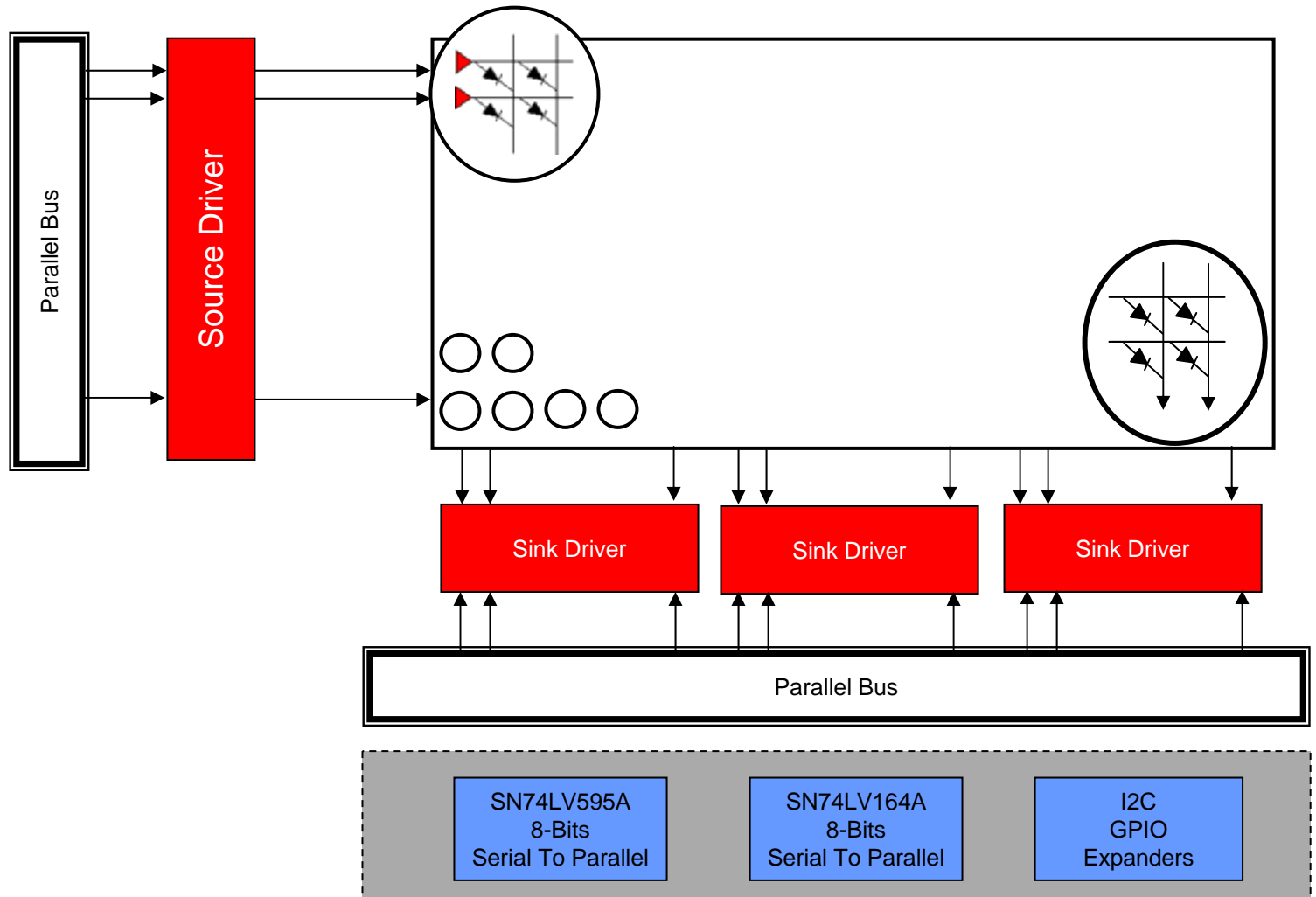
TLC5904
4CH, 50mA

Parallel In Parallel Out Sink/Source LED Driver

Sink Driver for Common Cathode LED



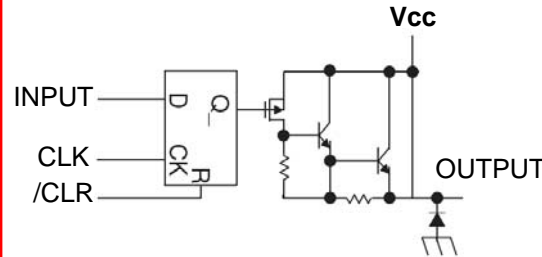
Sink/Source Driver for LED



Device Selections for Sink/Source

TLC8101I (Source)

- Each Channel – 500 mA Maximum
- VCE(SUS) = 13.2V
- TTL/5V CMOS Compatible Input.
- /Clear and Clock Control Inputs.
- /Clear Control Input to Off the Output.
- Clock Input up to 1Mhz
- Darlington Source Driver
- 20-Pin DIP and TSSOP Package



TLC59211 (Sink)

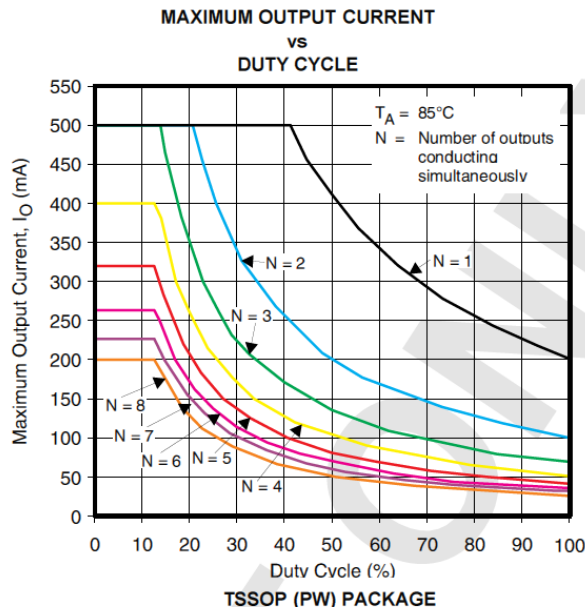
- Each Channel 200 mA Maximum
- High Voltage Output = 30V
- TTL/5V CMOS Compatible Input.
- 20-Pin DIP and TSSOP Package

TLC59210 (Sink)

- Each Channel 200 mA Maximum
- High Voltage Output = 30V
- TTL/5V CMOS Compatible Input.
- Latch Input
- /Clear and Clock Control Inputs
- 20-Pin DIP and TSSOP Package.

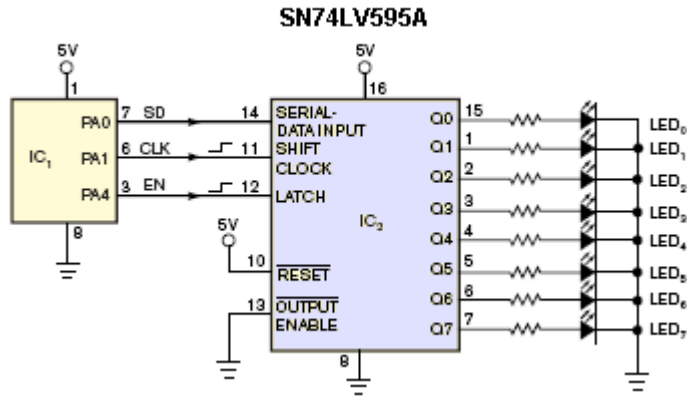
TLC59212 (Sink)

- Each Channel 40 mA Maximum
- High Voltage Output = 24V
- TTL/5V CMOS Compatible Input.
- Latch Input
- /Clear and Clock Control Inputs
- 20-Pin DIP and TSSOP Package.

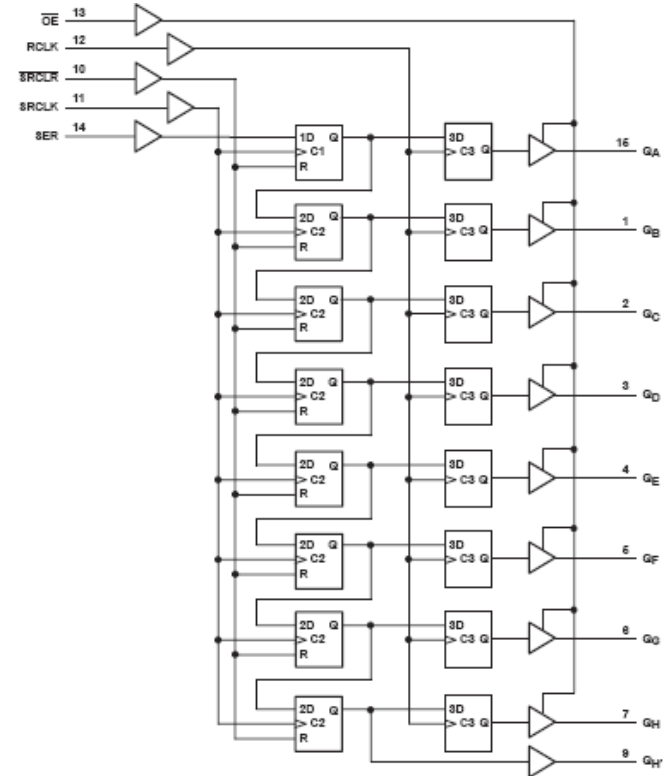


Serial To Parallel

Serial To Parallel Logic for LEDs



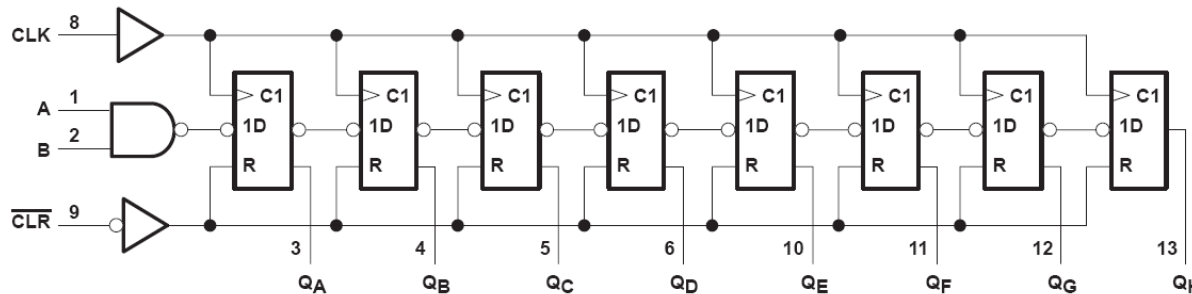
SN74LV595A



Target Application:

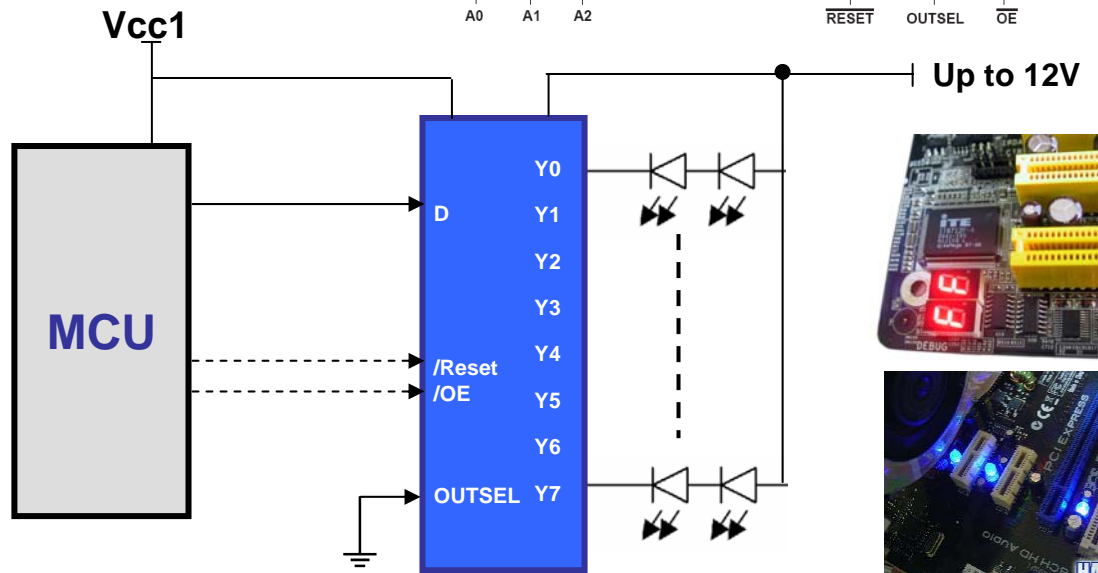
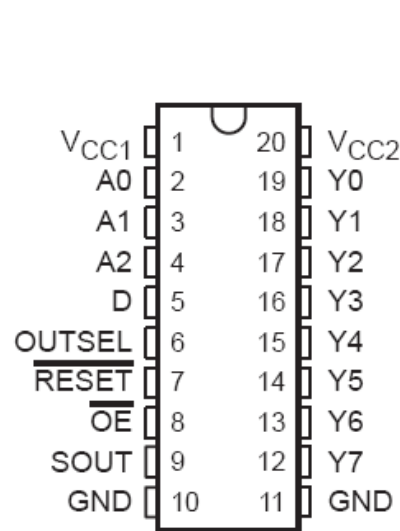
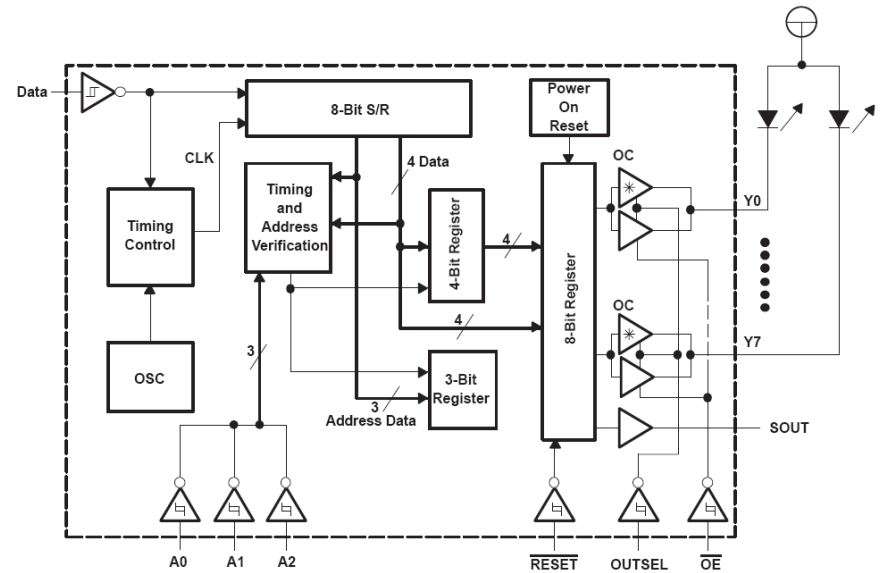
- System LED Indicator
- Each bit for each LED connection.
- Maximum Voltage out is equal to Power Supply.
- Not Suitable for Large Display Board/High Current.

SN74LV164A



SN74LV8153

- ▶ Single-Wire Serial Data Input.
- ▶ Compatible UART Serial Data Format.
- ▶ Open-Collector Mode 40mA @ 4.5V
- ▶ Individual Power Vcc2 for Output Driver.
- ▶ Internal OSC and counter for Data-rate detection.
- ▶ Up to Eight Devices (64-bits Parallel)
- ▶ /Reset and /OE Control Pins.
- ▶ Output Levels are referenced to Vcc2 and can be configured from 3V to 12V.



TLC5916/17 (SPI Bus)

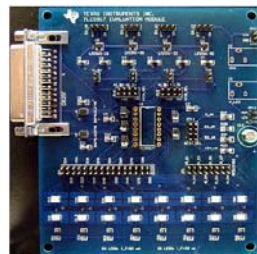
8-bits Constant Current Sink LED Drivers

Features

- 8 constant current outputs (0mA – 120mA)
- Current output programmable by external resistor (R_{ext})
- Programmable current gain (8-bit)
- Current accuracy between channels $\pm 3\%$ (typ)
- Current accuracy between IC $\pm 6\%$ (typ)
- Protection and Diagnostic
 - Open load
 - Channel over temperature
 - Short Circuit detection
- Serial communications interface (4 wire, Cascadable)
- Schmitt Trigger input
- Thermally enhanced packaging concept for efficient heat management
- Supply 3.3V or 5V

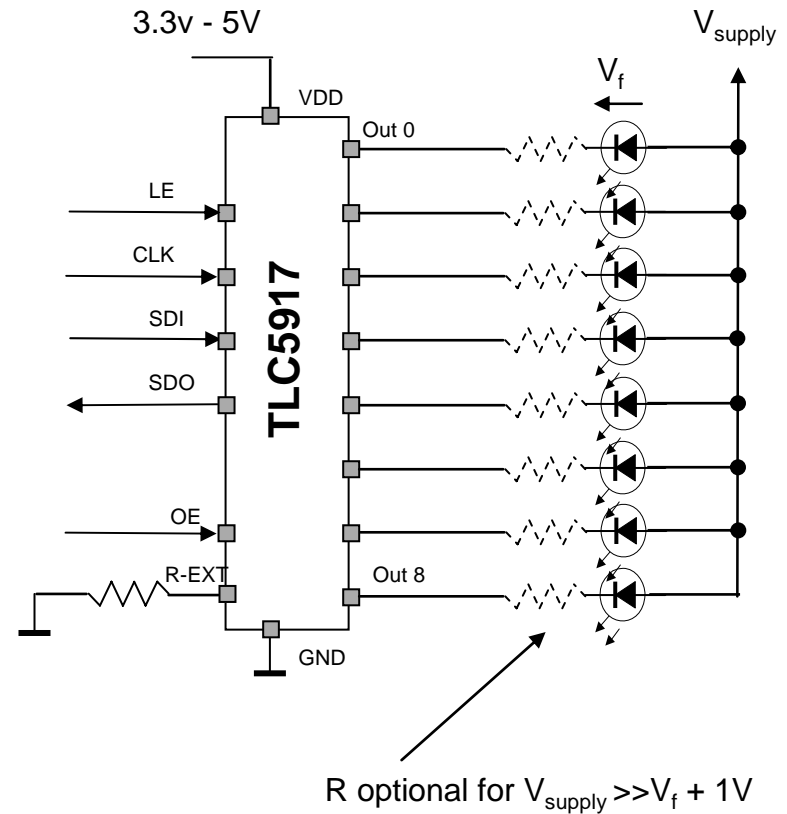
Target Applications

- General LED Lighting
- LED Display System
- Billboard, LED Signage
- Gaming Machine/Entertainment



EVM

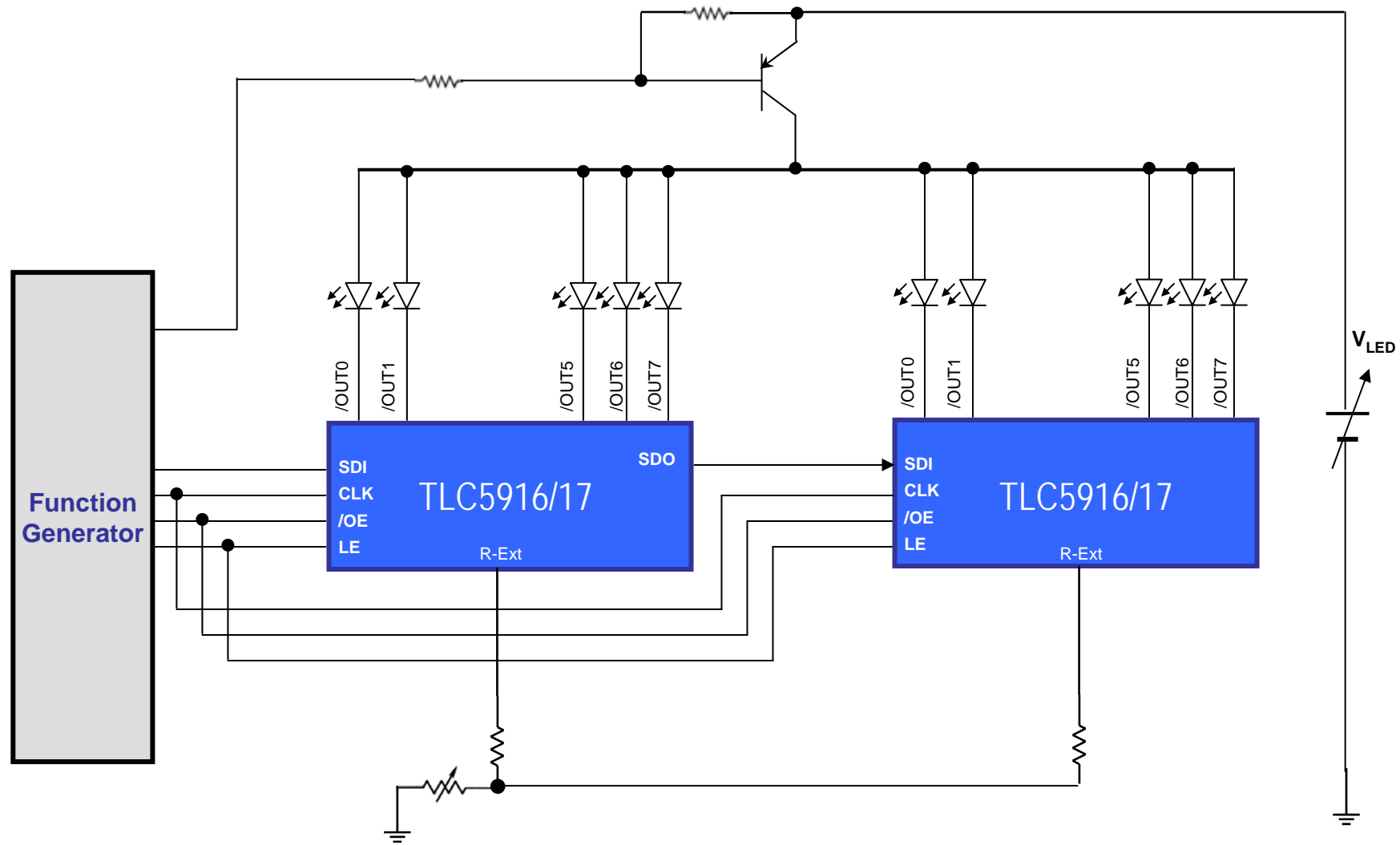
Applications



DEVICE (1)	OVERTEMPERATURE DETECTION	OPEN-LOAD DETECTION	SHORT TO GND DETECTION	SHORT TO V _{LED} DETECTION
TLC5916	X	X	X	
TLC5917	X	X	X	X

TLC5916/17 (Typical Design Example)

8-bits Constant Current Sink LED Drivers



SPI-Constant Current Sink LED Driver

	<i>Available</i> TLC5916	<i>Available</i> TLC5917	<i>Design</i> TLC5926	<i>Design</i> TLC5927
Channels	8	8	16	16
Current	5mA - 120mA	5mA - 120mA	5mA - 120mA	5mA - 120mA
Input Voltage	3V - 5.5V	3V - 5.5V	3V - 5.5V	3V - 5.5V
Output Voltage	17V	17V	17V	17V
accuracy channel / chip	3% / 6%	3% / 6%	3% / 6%	3% / 6%
Data transfer	30MHz	30MHz	30MHz	30MHz
Switch time on/ off (ns)	370 / 105ns	370 / 105ns	485 / 245ns	485 / 245ns
Open Load (Current detection)	yes	yes	yes	yes
short circuit/ overvoltage detection	no	Fixed 2.5V Threshold	no	Fixed 2.5V Threshold
Over-temperature protection	yes	yes	yes	yes
Current gain	256 steps	256 steps	256 steps	256 steps
Packages	16 (D, N, PW)	16 (D, N, PW)	24 (DBQ, PWP, DW)	24 (DBQ, PWP, DW)

I²C to Parallel LED Display Driver

TCA6507 (Open Drain Output)

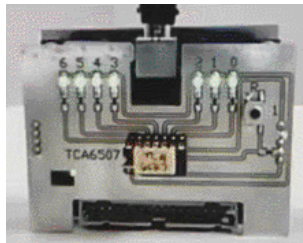
TCL59116 (Constant Current)

TCA6507 (Low Power/Low Voltage)

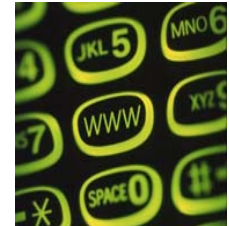
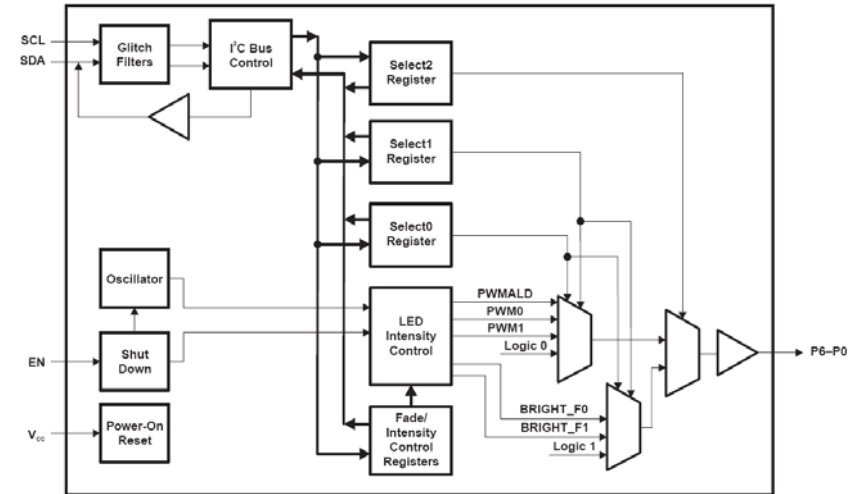
7-Bits Open Drain 40mA With Blinking Features

- Two programmable dimming/blinking modules (PWM0 and 1)
- Can be configured into Two Independent Banks of LEDs.
- Un-used port can be configured as GPIO Port.
- Open-Drain Output Directly Drive LEDs to 40 mA Max.
- 256- Steps of Intensity Control Fade-Off-On.
- 16- Steps of Intensity Control Fully Off to On States.
- Internal OSC Circuit
- 5.5V Tolerant Open-Drain Outputs
- Schmitt-Trigger allows Slow Input Transition for better Switching Noise for inputs.

- EVM Board Available



High Voltage, Current
TLC59116 up to
100mA
With Fm+I2C Bus



- ▶ Car Audio Front Panel
- ▶ LED Backlight
- ▶ Key-Board Backlight
- ▶ Blinking LED Indicators
- ▶ Printer LCD Backlight

TLC59116 (Fm+I²C Bus)

16-Bits 100mA Constant Current LED Sink Driver With Blinking/Brightness

Features:

- 1-Mhz Fast Mode I²C Bus Controlled LED Driver with 4 x Hardware Address up to 14-devices.
- 16 Constant-Current Open Drain Output Channels.
- (Each Output Programmable At Off, On, Brightness, Group Dimming/Blinking Mixed With Individual LED Brightness)
- 256-Step (8-Bit) Brightness Per LED Output at 97-kHz PWM Signal
- 256-Step Group Brightness Control at 190-Hz PWM Signal
- 256-Step Group Blinking From 24 Hz to 10.73 s and Duty Cycle From 0% to 99.6%
- Software Reset Feature (SWRST Call)
- Open-Load/Over temperature Detection Mode to Detect Individual LED Errors
- Output Current Adjusted Through an External Resistor
- Constant Output Current Range: 10 mA to 100 mA
- Maximum Output Voltage: 17 V
- 25-MHz Internal Oscillator Requires No External Components
- Internal Power-On Reset
- Active-Low Reset
- Supports Hot Insertion
- Low Standby Current
- 3.3-V or 5-V Supply Voltage
- 5.5-V Tolerant Inputs
- Offered in 28-pin TSSOP (PW) Package
- -40°C to 85°C Operation

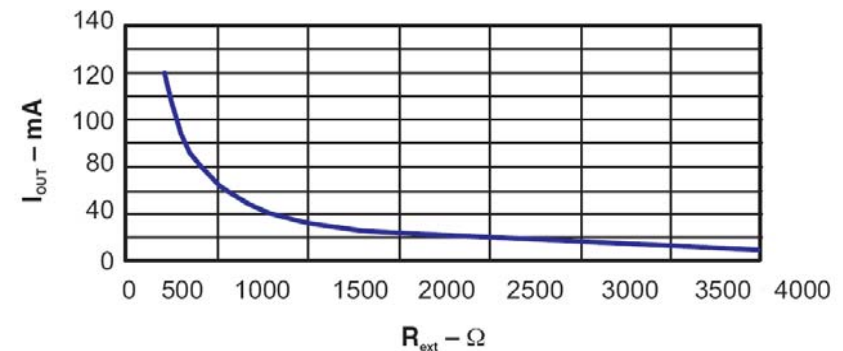
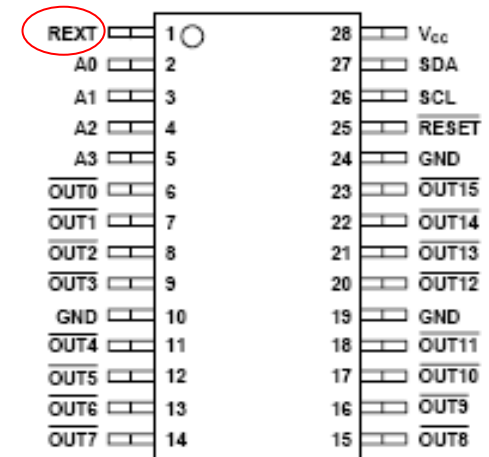


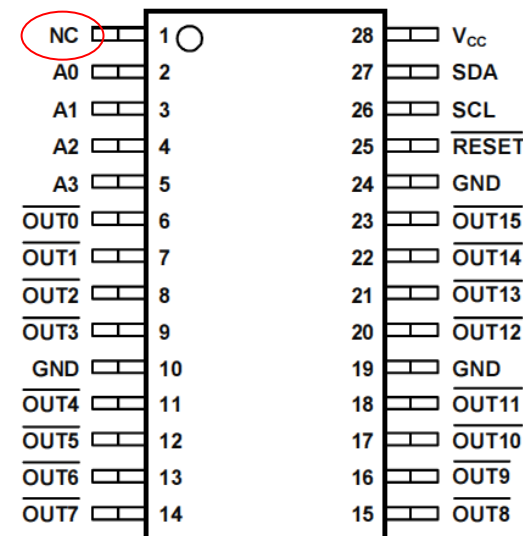
Figure 8. I_{OUT,target} vs R_{ext}

TLC59116FI (Fm+I²C Bus)

16-Bits 100mA Constant Current LED Sink Driver With Blinking/Brightness

Features:

- **1-Mhz Fast Mode I²C Bus** Controlled LED Driver with 4 x Hardware Address up to **14-devices**.
- 16 Constant-Current Open Drain Output Channels.
- (Each Output Programmable At Off, On, Brightness, Group Dimming/Blinking Mixed With Individual LED Brightness)
- 256-Step (8-Bit) Brightness Per LED Output at 97-kHz PWM Signal
- 256-Step Group Brightness Control at 190-Hz PWM Signal
- 256-Step Group Blinking From 24 Hz to 10.73 s and Duty Cycle From 0% to 99.6%
- Software Reset Feature (SWRST Call)
- Constant Output Current Range: **10 mA to 120 mA**
- Maximum Output Voltage: **17 V**
- **25-MHz** Internal Oscillator Requires No External Components
- Internal Power-On Reset
- Active-Low Reset
- Supports Hot Insertion
- Low Standby Current
- 3.3-V or 5-V Supply Voltage
- 5.5-V Tolerant Inputs
- Offered in 28-pin TSSOP (PW) Package
- -40°C to 85°C Operation



I²C LED Roadmap

TCA6507



Low Voltage, 7-Bits
Intensity Control
Blinking/Brightness



TLC59116

16-Channels
3.3V/5V Operating Vcc
100mA on Each Channel
Blinking/Brightness
17-V Output Tolerant
R,G,B LED Driver

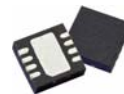
1H'08



TLC59116FI

16-Channels
3.3V/5V Operating Vcc
100mA on Each Channel
Blinking/Brightness
17-V Output Tolerant
R,G,B LED Driver

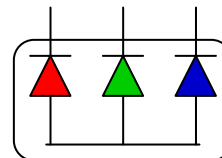
3Q08



TLC5904 (In Work)

4-Bits
R,G,B LED Driver
Blinking/Brightness
30mA Source, 10mA Sink

Mobile Funny LED Indicator



In Concept

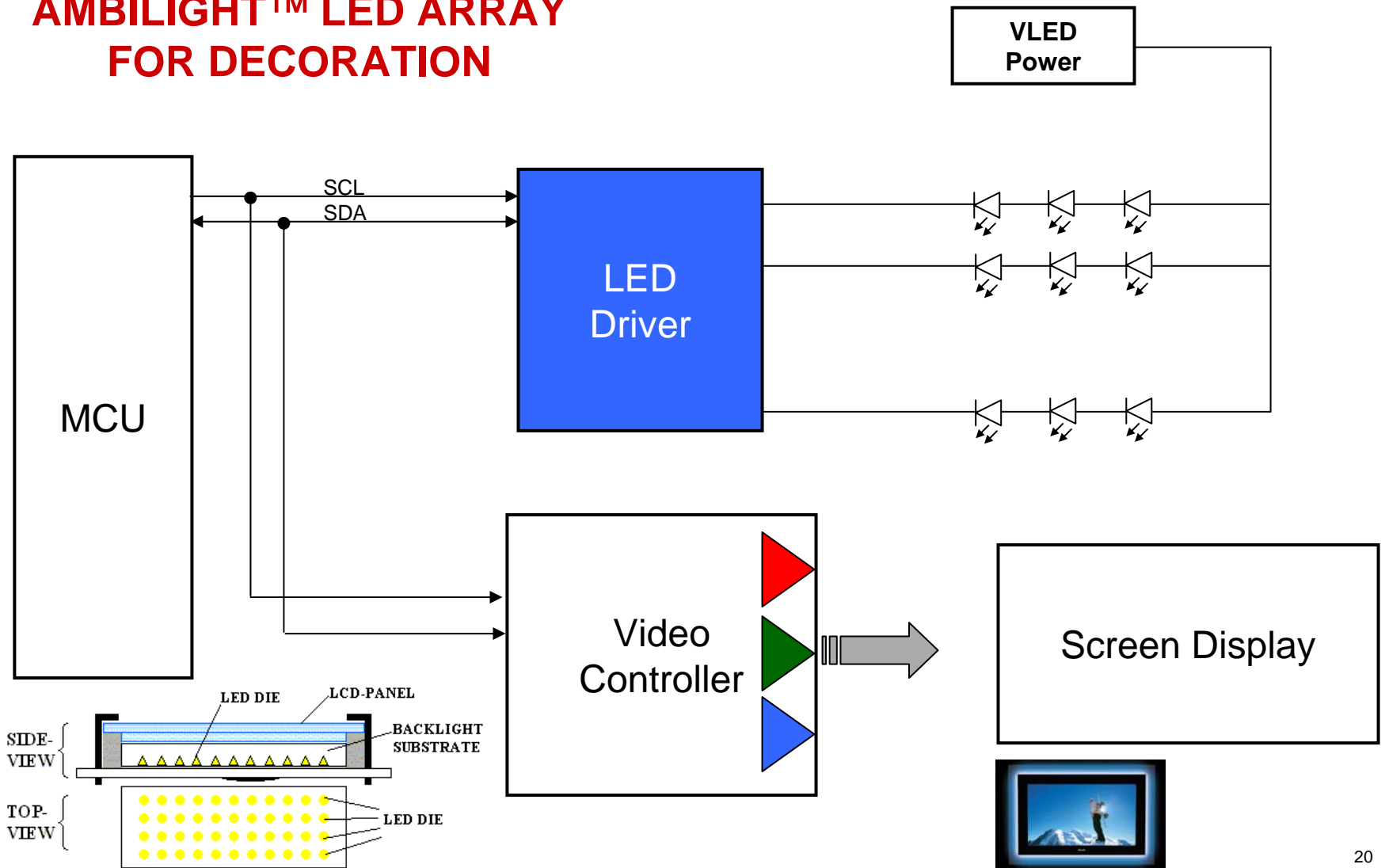
18 Channels

4Q08

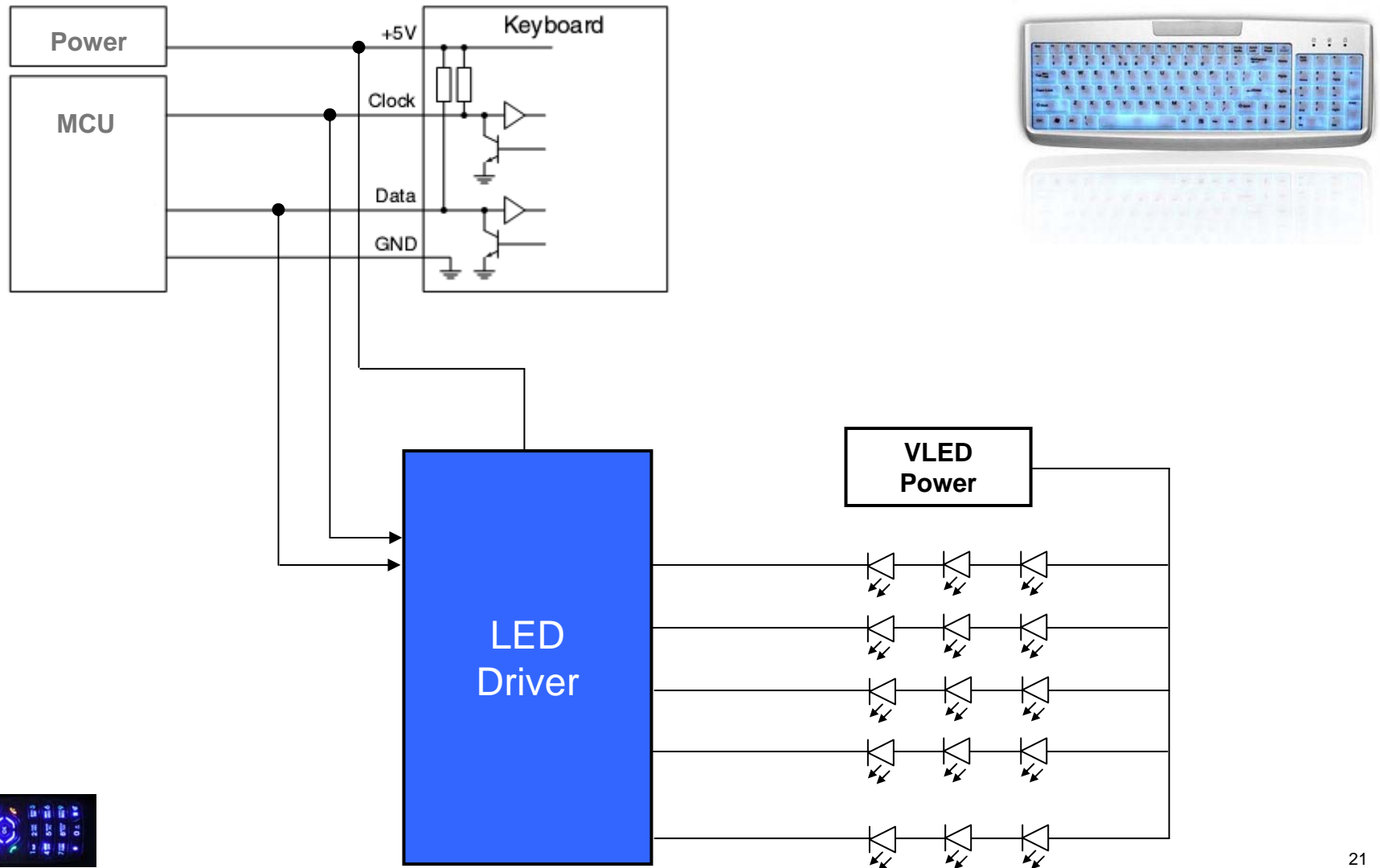
1Q09

I²C LED Typical Applications

AMBILIGHT™ LED ARRAY FOR DECORATION

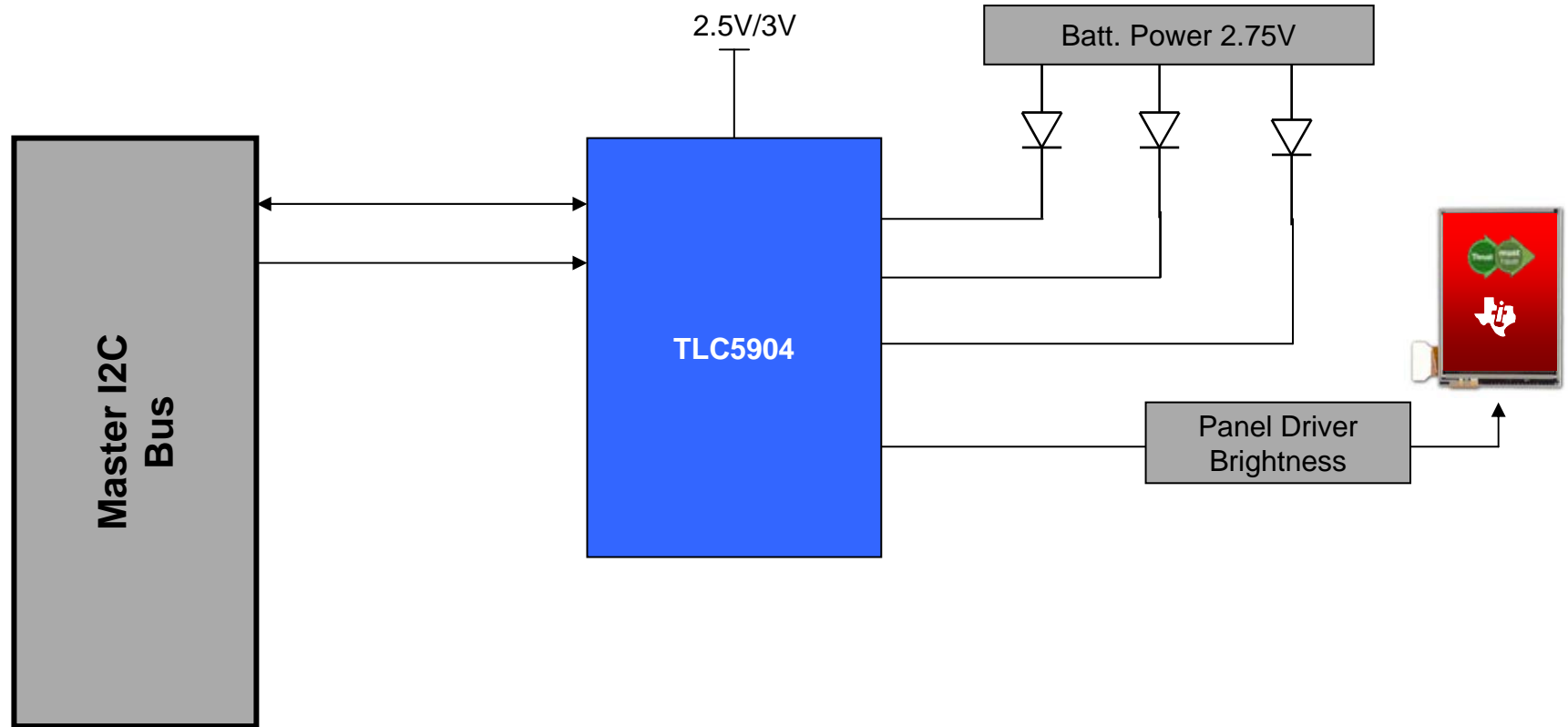


I²C LED Driver for Keyboard Lights



I²C LED Typical Applications

R,G,B LED Indicator



Power Devices for LED

TL4242 (Constant Current LED Driver)

MC33063A (1.5 A Buck/Boost/Inverting Switching Regulator)

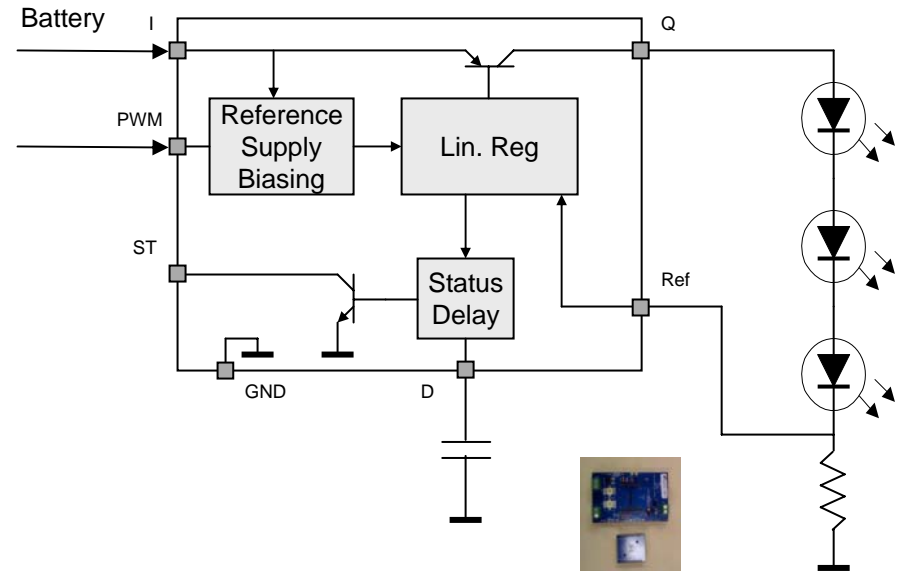
TL2575/TL2575HV (Step Down Switching Regulator)

TL4242

Constant Current LED driver

Features

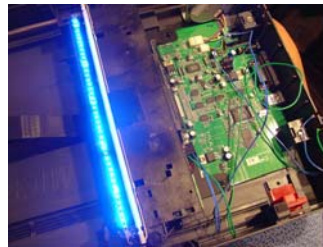
- ➔ Adjustable constant current up to 500 mA ($\pm 5\%$)
- ➔ Wide input voltage range up to 42 V
- ➔ Low drop voltage
- ➔ Open load detection
- ➔ Overtemperature protection
- ➔ Short circuit proof
- ➔ Reverse polarity proof
- ➔ Wide temperature range: $-40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$
- ➔ QFN-8 package



EVM Board ready

Benefits

- ➔ Supply voltage independent constant current / brightness
- ⇨ PWM capability for dimming
- ⇨ No external power resistor required
- ⇨ Diagnostic capability



**Scanner-Printer
LED Light**

Applications

- ➔ LED illumination and intensity control
- ➔ Exterior: DRLs, fog light, turn lamp, headlamp, ...
- ➔ Interior: vanity light, map light, courtesy light, ...

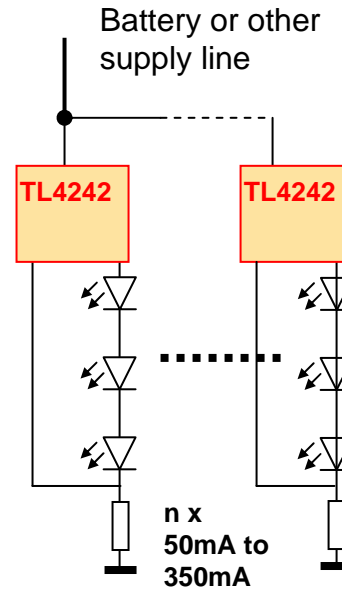
TL4242 (Application Example)

Topology:

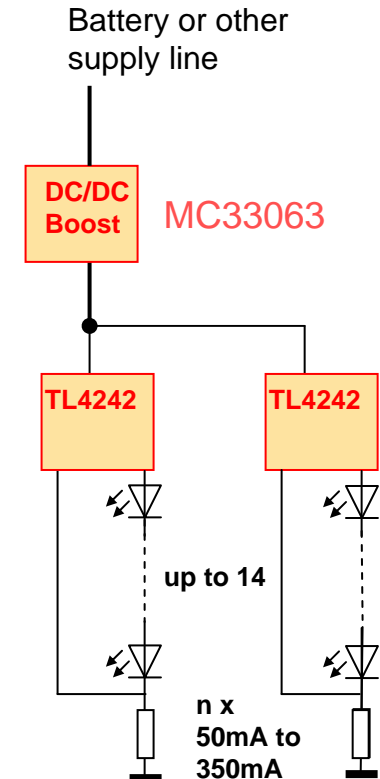
- directly connected to switched supply line
- linear current control for voltage drop
- DC/DC supply for long strings of LEDs

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



b) strings with individual linear current control and PWM input



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

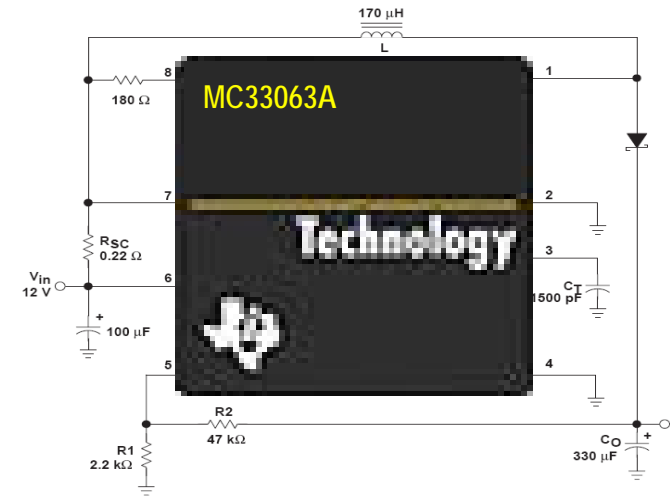
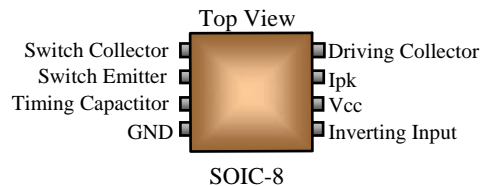
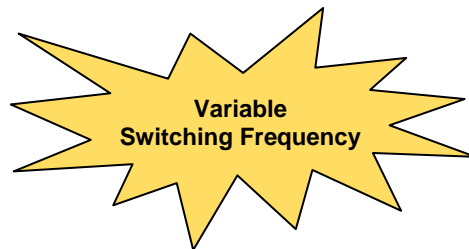
MC33063A (1.5A)

Buck/Boost/Inverting Switching Regulator

Features

- Wide Input Voltage Range . . . 3 V to 40 V
- High Output Switch Current . . . Up to 1.5 A
- Adjustable Output Voltage
- Oscillator Frequency . . . Up to 100 kHz
- Precision Internal Reference . . . 2%
- Short-Circuit Current Limiting
- Low Standby Current
- Qualified for Automotive Applications

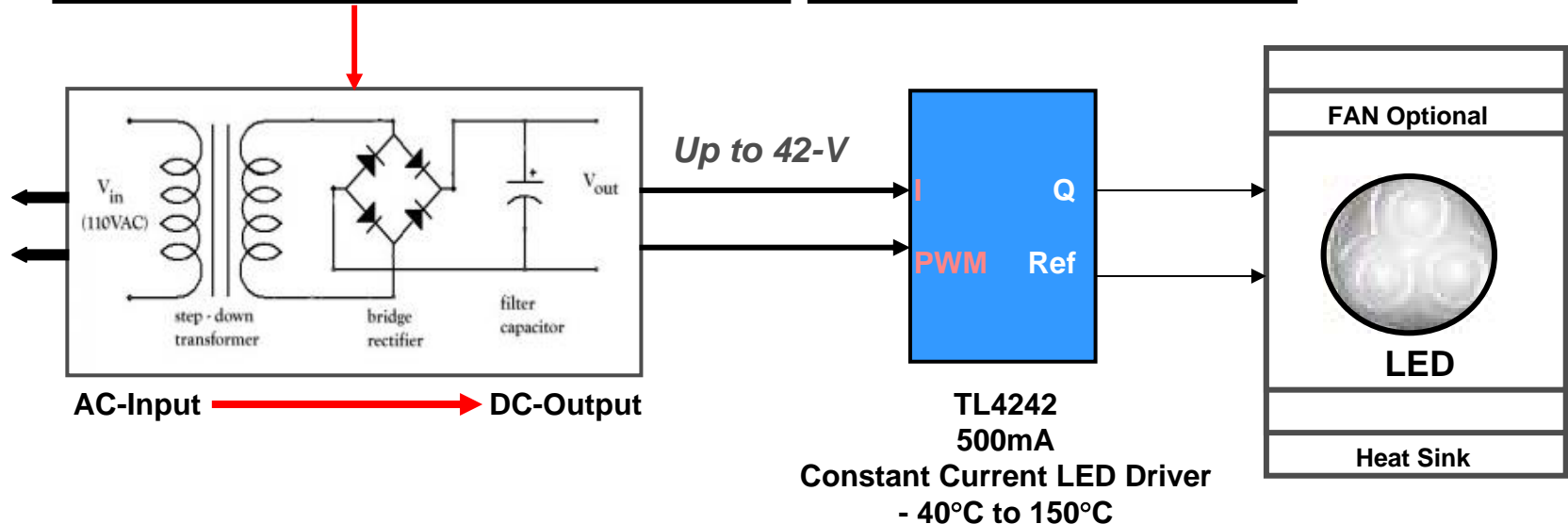
Part Number	Vin Range (V)	Vout Range (V)	f _{osc} (max) (kHz)	Switch Current Limit (A)	Iq (max) (mA)
MC33063A	3 - 40	1.25 - 40	100 (Adj)	1.5	4



LED LAMP Lighting

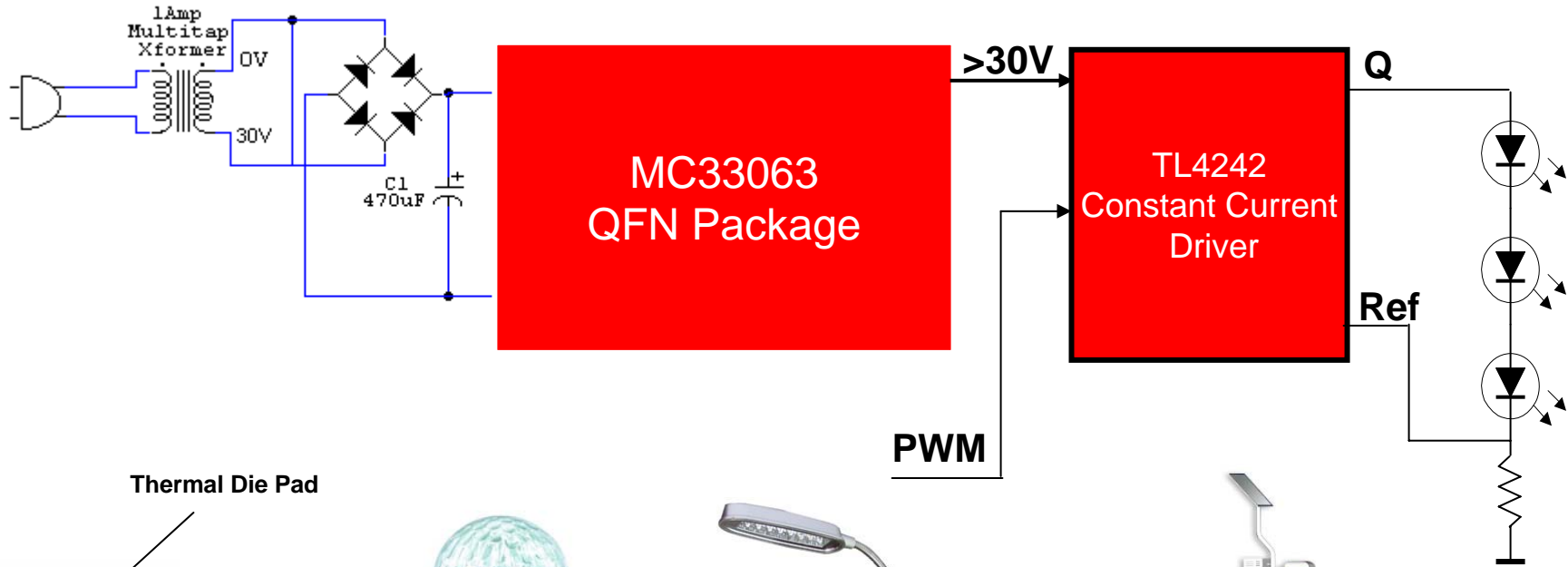
TL103W – Integrated (Dual OpAmp + Reference)
TSM104W – Integrated (Quad OpAmp + Reference)
TSM102A – (Dual OpAmp + Dual Comparator + Reference)
LM392 – Single OpAmp + Comparator

TL2575/TL2575 HV/MC34063A
- Step-Down Switch Regulator
- Adj, 12V, 5V, 3.3V...
- High Voltage Input up to 60V

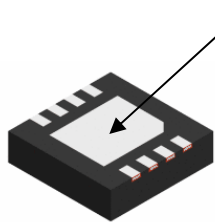


MC33063 QFN Application

Portable Equipments and LED Lamp Light



Thermal Die Pad



4 x 4 x 0.8 mm
Height: 0.8



LED Lamp Bulb



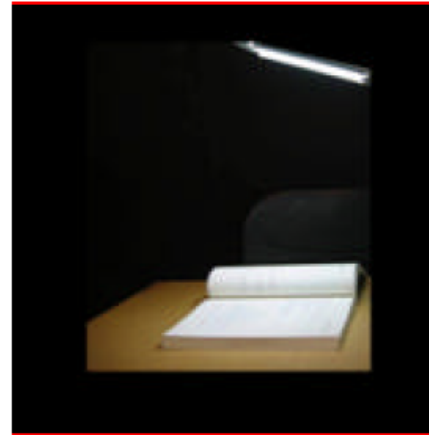
Desk LED Lamp



Solar Street LED Lamp

LED Power Source Design

Electrical characteristics		
Input		
Parameter	Min	Max
Input Voltage Range	85Vac	264Vac
Input Frequency	47Hz	63Hz
Input Current	N/A	2.0A-115Vac/60Hz
Efficiency		Typical 80%~85%
Output		
Parameter	Min	Max
Output Current	350mA+/-10%	
Output Voltage Range	2.5Vdc	45.0Vdc



Using 350mA



The standard power for LED Lighting:

- 350mA
- 700mA

LED Selections vs Equipments

SPI	<ul style="list-style-type: none"> • Billboard • Signboard 	<div style="border: 1px solid green; border-radius: 10px; padding: 5px; text-align: center;"> TLC5916/17 8-Bits </div> <div style="border: 1px solid green; border-radius: 10px; padding: 5px; text-align: center;"> TLC5926/27 16-Bits </div>	<div style="border: 1px solid yellow; border-radius: 10px; padding: 10px;"> <ul style="list-style-type: none"> • 16/ 8 constant current outputs (0mA – 120mA) • Current output programmable by external resistor (Rext) • Programmable current gain (8-bit) • Current accuracy between channels $\pm 3\%$ (typ) • (On) • Serial communications interface (4 wire, cascable) </div>
I2C	<ul style="list-style-type: none"> • Amusement • Ambilight® • Panel Backlight 	<div style="border: 1px solid green; border-radius: 10px; padding: 5px; text-align: center;"> TLC59116/FI 16-Bits </div>	<ul style="list-style-type: none"> • Portable Decoration • Car A/V Screen backlight <div style="border: 1px solid green; border-radius: 10px; padding: 5px; text-align: center;"> TCA6507 7-Bits </div>
Serial	<ul style="list-style-type: none"> • LED Indicator • General Purpose 	<div style="border: 1px solid green; border-radius: 10px; padding: 5px; text-align: center;"> SN784LV8153 8-Bits </div>	
Linear	<ul style="list-style-type: none"> • General Purpose • Customer Solution • Desktop LED LAMP 	<div style="border: 1px solid green; border-radius: 10px; padding: 5px; text-align: center;"> TL4242 500-mA </div>	<div style="border: 1px solid yellow; border-radius: 10px; padding: 10px;"> <p>DC/DC</p> <ul style="list-style-type: none"> • MC33063/34063 (1.5A) • TL2575/HV (1A) </div>

Thanks for Your Time

Samuel Lin

Asia Marketing Development
Download Web

www.ti.com.tw/logicsystem