LED controllers

Voltage-switch drivers, constant-current drivers, and Flash LED drivers

NXP

LEDs are used in a wide range of applications, from low-end status indicators to high-end video displays. System designers often need the ability to control these LEDs, but can't afford to tie up the system processor to do so. NXP's LED controllers solve this problem, performing a variety of control tasks while offloading the system processor. Having sent instructions to the LED controller, the processor is free to engage in other tasks or go into a low-power state.

NXP's LED controllers offer a variety of features needed in LED-driving applications. Some of these features include:

▸ Blinking and dimming capability
▸ Pulse-width modulation (PWM) for LED control
▸ Color mixing capabilities
▸ Fast-mode Plus (Fm+) bi-directional communication channel with data transfer rate of up to 1 Mbps over the I²C-bus
▸ Ultra Fast-mode (UFm) uni-directional communication channel with data transfer rate of up to 5 Mbps over the I²C-bus
▸ SPI-compatible 3-wire serial uni-directional interface with data transfer rate of up to 25 Mbps over Serial Peripheral Interface (SPI)
▸ Different output drive types (push-pull, open-drain voltage switch or constant-current driver)
▸ Independent control of LEDs
▸ LED Open or Short status and fault reading
▸ Gradation control with programmable "breathing" effect
▸ Short-circuit protection
▸ Over-temperature protection

The devices are classified in three groups: voltage-switch drivers, constant-current drivers, and Flash LED drivers. These groups are discussed below.

Voltage-Switch Drivers

Voltage-switch output driver devices control the LED connected to the output pin by switching the connection to ground or supply on or off. A series resistor connected between the LED and the device limits the current that flows through the LED into the device.

Voltage-switch devices have the advantage of dissipating the heat outside the device, in the series resistor. Therefore the device is insensitive to heat dissipation and is good for driving multiple LEDs in series, with different forward-bias voltages (V_f), from the same supply.
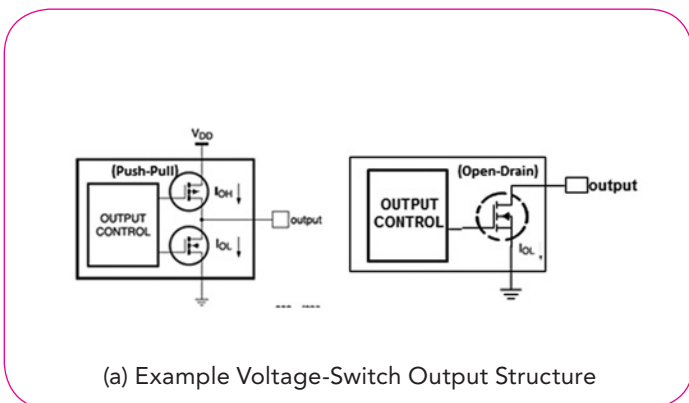
Constant-Current Drivers

A current-regulated LED driver results in the LED light remaining constant with the supply-voltage fluctuations. NXP constant-current LED drivers are used for low-current luminary lighting applications requiring accurate lighting control independent of supply voltage, temperature, and LED forward-bias voltage.

Flash LED Drivers

NXP Flash LED Drivers are high-efficiency, maximum-output, small footprint devices with touch capability and an indicator LED output feature. These devices are highly integrated with hardware and I²C interface modes.

(a) Example Voltage-Switch Output Structure

(b) Example Constant-Current Output Structure
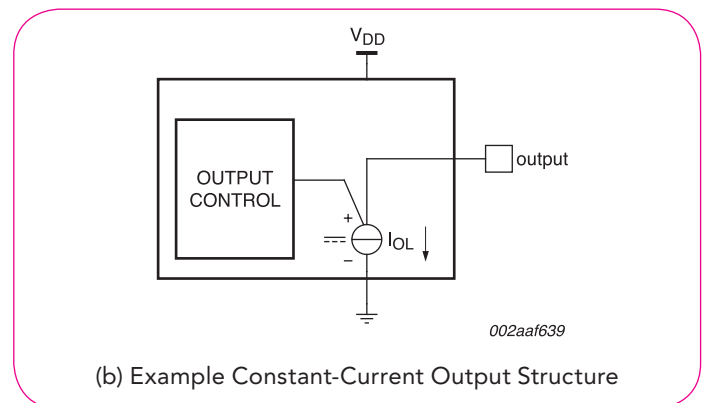
The LED controllers are supported by application boards and daughter cards, an established manufacturing infrastructure that supports high volumes, and several technical documents. NXP helps system designers make lighting affordable, in everything from indoor consumer electronics and appliances to outdoor decorative lighting.

LED Controllers Selection Guide

Device	Function	Number of LED Outputs	Operating Voltage Range	Standby Current [1]	Type of LED Drive	Max LED Drive Current	Max LED Drive Voltage	Output Type	LED Pin can be used as Input	Number of PWMs	Individual PWM Resolution (Steps)	Group PWM Resolution (Steps)	Individual Brightness Control	Group Brightness Control	Output Enable / PWM Control	Programmable Output Delay	LED Error Detection	Thermal Shutdown	Interface	Number of Device Addresses	Hardware Reset	Individual PWM Frequency	Group PWM Frequency	Status
PCA9550	Blinker	2	2.3 V - 5.5 V	1.9 µA	Voltage switch	25 mA	5 V	Open Drain (Sink)	Y	2	256	N/A	Y	N	N	N	N	N	I²C, Fm	2	Y	0.172 Hz - 44 Hz	N/A	In Production
PCA9553	Blinker	4	2.3 V - 5.5 V	1.9 µA	Voltage switch	25 mA	5 V	Open Drain (Sink)	Y	2	256	N/A	N	N	N	N	N	N	I²C, Fm	1	N	0.172 Hz - 44 Hz	N/A	In Production
PCA9551	Blinker	8	2.3 V - 5.5 V	1.9 µA	Voltage switch	25 mA	5 V	Open Drain (Sink)	Y	2	256	N/A	N	N	N	N	N	N	I²C, Fm	8	Y	0.172 Hz - 44 Hz	N/A	In Production
PCA9552	Blinker	16	2.3 V - 5.5 V	2.1 µA	Voltage switch	25 mA	5 V	Open Drain (Sink)	Y	2	256	N/A	N	N	N	N	N	N	I²C, Fm	8	Y	0.172 Hz - 44 Hz	N/A	In Production
PCA9530	Dimmer & Blinker	2	2.3 V - 5.5 V	1.9 µA	Voltage switch	25 mA	5 V	Open Drain (Sink)	Y	2	256	N/A	Y	N	N	N	N	N	I²C, Fm	2	Y	0.591 Hz - 152 Hz	N/A	In Production
PCA9533	Dimmer & Blinker	4	2.3 V - 5.5 V	1.9 µA	Voltage switch	25 mA	5 V	Open Drain (Sink)	Y	2	256	N/A	N	N	N	N	N	N	I²C, Fm	1	N	0.591 Hz - 152 Hz	N/A	In Production
PCA9531	Dimmer & Blinker	8	2.3 V - 5.5 V	1.9 µA	Voltage switch	25 mA	5 V	Open Drain (Sink)	Y	2	256	N/A	N	N	N	N	N	N	I²C, Fm	8	Y	0.591 Hz - 152 Hz	N/A	In Production
PCA9532	Dimmer & Blinker	16	2.3 V - 5.5 V	2.1 µA	Voltage switch	25 mA	5 V	Open Drain (Sink)	Y	2	256	N/A	N	N	N	N	N	N	I²C, Fm	8	Y	0.591 Hz - 152 Hz	N/A	In Production
PCA9632	Dimmer & Blinker	4	2.3 V - 5.5 V	0.005 µA	Voltage switch	-10 mA 25 mA	5 V	Push Pull (Configurable)	N	4 + 1	256	64	Y	Y	N	N	N	N	I²C, Fm+	1, 4	N	1.56 KHz	190 Hz (6.25 KHz)	In Production
PCA9633	Dimmer & Blinker	4	2.3 V - 5.5 V	3.8 µA	Voltage switch	-10 mA 25 mA	5 V	Push Pull (Configurable)	N	4 + 1	256	256	Y	Y	Y	N	N	N	I²C, Fm+	1, 4, 126	N	97 KHz	190 Hz (97 KHz)	In Production
PCA9634	Dimmer & Blinker	8	2.3 V - 5.5 V	3.8 µA	Voltage switch	-10 mA 25 mA	5 V	Push Pull (Configurable)	N	8 + 1	256	256	Y	Y	Y	N	N	N	I²C, Fm+	126	N	97 KHz	190 Hz (97 KHz)	In Production
PCA9635	Dimmer & Blinker	16	2.3 V - 5.5 V	3.8 µA	Voltage switch	-10 mA 25 mA	5 V	Push Pull (Configurable)	N	16 + 1	256	256	Y	Y	Y	N	N	N	I²C, Fm+	126	N	97 KHz	190 Hz (97 KHz)	In Production
PCA9685[2]	Dimmer	16	2.3 V - 5.5 V	2.2 µA	Voltage switch	-10 mA 25 mA	5 V	Push Pull (Configurable)	N	16	4096	N/A	Y	N	Y	Y	N	N	I²C, Fm+	62	N	24 Hz - 1526 Hz	N/A	In Production
PCA9624	Dimmer & Blinker	8	2.3 V - 5.5 V	2.1 µA	Voltage switch	100 mA	40 V	Open Drain (Sink)	N	8 + 1	256	256	Y	Y	Y	N	N	N	I²C, Fm+	126	N	97 KHz	190 Hz (97 KHz)	In Production
PCA9622	Dimmer & Blinker	16	2.3 V - 5.5 V	3.2 µA	Voltage switch	100 mA	40 V	Open Drain (Sink)	N	16 + 1	256	256	Y	Y	Y	N	N	N	I²C, Fm+	126	N	97 KHz	190 Hz (97 KHz)	In Production
PCA9626	Dimmer & Blinker	24	2.3 V - 5.5 V	6.0 µA	Voltage switch	100 mA	40 V	Open Drain (Sink)	N	24 + 1	256	256	Y	Y	Y	N	N	N	I²C, Fm+	126	N	97 KHz	190 Hz (97 KHz)	In Production
PCA9952[4]	Dimmer & Blinker	16	3.0 V - 5.5 V	100 µA	Constant Current	57 mA	40 V	Open Drain (Sink)	N	16 + 1	256	256	Y	Y	Y	Y	Y	Y	I²C, Fm+	8	Y	31.5 KHz	122 Hz	In Production
PCA9955[4]	Dimmer & Blinker	16	3.0 V - 5.5 V	100 µA	Constant Current	57 mA	40 V	Open Drain (Sink)	N	16 + 1	256	256	Y	Y	N	Y	Y	Y	I²C, Fm+	16	Y	31.5 KHz	122 Hz	In Production
PCA9955A[3]	Dimmer & Blinker	16	3.0 V - 5.5 V	170 µA	Constant Current	57 mA	20 V	Open Drain (Sink)	N	16 + 1	256	256	Y	Y	Y	Y	Y	Y	I²C, Fm+	125	Y	31.5 KHz	122 Hz	In Production
PCA9956A	Dimmer & Blinker	24	3.0 V - 5.5 V	100 µA	Constant Current	57 mA	20 V	Open Drain (Sink)	N	24 + 1	256	256	Y	Y	Y	Y	Y	Y	I²C, Fm+	125	Y	31.5 KHz	122 Hz	In Production
PCA9655A	Dimmer & Blinker	16	3.0 V - 5.5 V	170 µA	Voltage switch	100 mA	20 V	Open Drain (Sink)	N	16 + 1	256	256	Y	Y	Y	Y	N	Y	I²C, Fm+	125	Y	31.5 KHz	122 Hz	In Production (Q3, 2014)
PCA9755A[3]	Dimmer & Blinker	16	3.0 V - 5.5 V	100 µA	Constant Current	57 mA	20 V	Open Drain (Sink)	N	16 + 1	256	256	Y	Y	Y	Y	N	Y	SPI 25 MHz	25	Y	31.5 KHz	122 Hz	In Development
PCU9955A[3]	Dimmer & Blinker	16	3.0 V - 5.5 V	170 µA	Constant Current	57 mA	20 V	Open Drain (Sink)	N	16 + 1	256	256	Y	Y	Y	Y	N	Y	I²C, UFm	125	Y	31.5 KHz	122 Hz	In Production
PCU9956A	Dimmer & Blinker	24	3.0 V - 5.5 V	100 µA	Constant Current	57 mA	20 V	Open Drain (Sink)	N	24 + 1	256	256	Y	Y	Y	Y	N	Y	I²C, UFm	125	Y	31.5 KHz	122 Hz	In Production

[1] Typical value measured with VDD = 5.5 V, no load, VI = VDD or VSS and FSCL = 0 Hz
[2] External clock input option
[3] Build in Gradation control
[4] In Production AEC-Q100 compliant version only

LED Flash Drivers Selection Guide

Device	Function	Operating Voltage Range	Flash LED Output Drive Type	Flash LEDs Driven in Series	Maximum LED Drive Current				Fixed Switching Frequency	Integrated Diodes and Resistors	Inductor Broken Coil Detect	Interface Type	Number of Device Addresses	Max Timed Flash Operation	Assist Light	Status
					Flash (1 LED)	Flash (2 LEDs)	Touch	Indicator Output								
SSL3252	Synchronous boost converter	2.5 V - 5.5 V	High-side drive	1 or 2	500 mA	400 mA	160 mA	10 mA	2.0 MHz	Y	Y	I²C, Fm or direct	1	820 ms	Y	In Production

PCA9622 Voltage Switch LED Driver Application Example
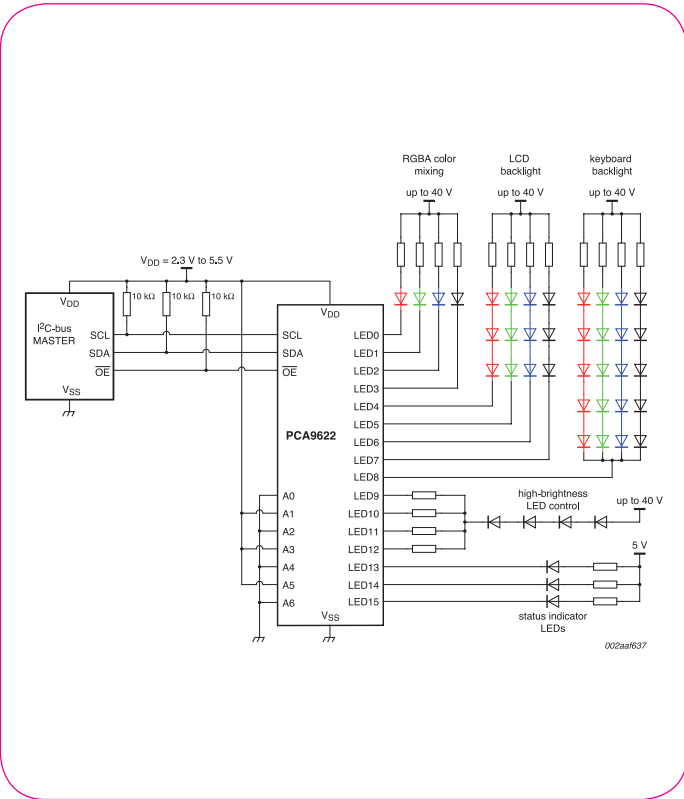
PCA9955A Constant Current LED driver Application Example
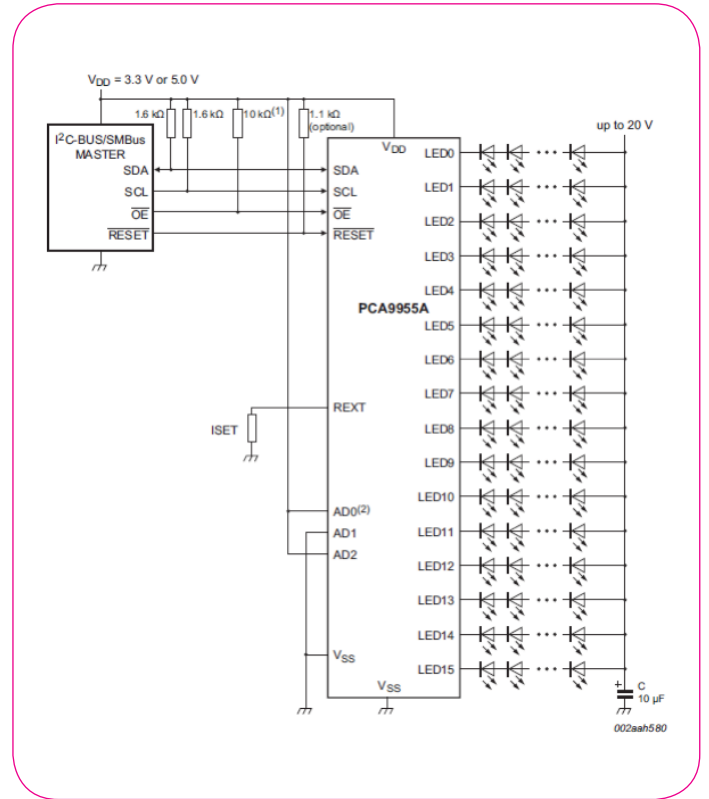
Architectural Lighting

Automotive Instrument Cluster

Mobile Phone Application Example

Car Radio Backlight

Application Support

For added application support, NXP offers the following application reports on the LED driver family devices:

▸ AN10579:   Driving LED light bars using NXP Solutions
              http://www.nxp.com/documents/application_note/AN10579.pdf

▸ AN10733:   Flash LED App. Note
              http://www.nxp.com/documents/application_note/AN10733.pdf

▸ AN264:   I²C Devices for LED Display Control App. Note
              http://www.nxp.com/documents/application_note/AN264.pdf

▸ AN10315:   LED Dimmer Board
              http://www.nxp.com/documents/application_note/AN10315.pdf

For more information, visit http://ics.nxp.com/products/led.drivers/

NXP offers evaluation modules and demo boards that can be used to develop software and evaluate the performance of the LED controllers and LED Flash drivers.

OM6275 – I²C 2005-1 Evaluation Board

Easy experimentation and training module. I²C-bus connects to LED controllers, other I²C peripherals, and daughter cards. USB Connection. GUI interface allows direct control of device without programming.
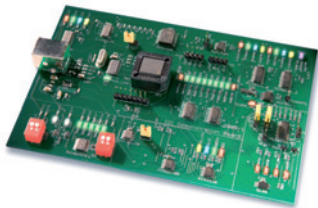

OM6276 – PCA9633 Demo Board

Evaluate LED dimming and blinking features of the PCA9633 4-bit (RGBA) PWM LED driver. RJ-45 jack allows series connection to multiple boards to evaluate long-distance Fm+ bus and P82B96.


OM6279 – LED Dimmer Demo Board

NXP LED controllers and GPIO in simulated mobile phone application showing RGB LED color mixing, LED blinking and dimming, and backlight LED control applications.
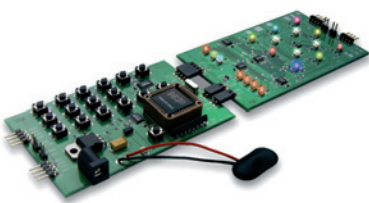
OM6281 – PCA9698 Daughter Card for I²C 2005-1

PCA9698 40-bit GPIO with easy access to all 40 I/O pins and several LEDs. Demonstrates using PCA9530 2-bit LED dimmer to dim and/or blink all 40 outputs using the /OE input of the PCA9698.
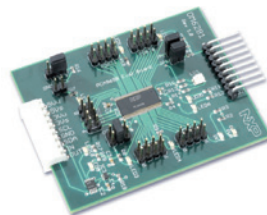
OM13483 – PCA9955A 16 channels LED demo board

The OM13483 is an add-on to 9-pin connector of NXP's I²C demo board 2005-1 or Fm+ I2C Bus development board. This daughter board makes it easy to test and design with the PCA9955A, a 16-channel Fast-mode Plus (Fm+) 57 mA constant current and outputs allow up to 20 V for LED supply.

OM13321 – PCA9956A 24 channels LED demo board

The OM13321 is an add-on to 9-pin connector of NXP's I²C demo board 2005-1 or Fm+ I²C Bus development board. This daughter board makes it easy to test and design with the PCA9956A, a 24-channel Fast-mode Plus (Fm+) 57 mA constant current and outputs allow up to 20 V for LED supply.

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