## **LED Solutions for LCD Backlighting**





# **LED Solutions for LCD Backlighting**



ST Position:

- #1 in Lighting Segment\*
- #2 in Power Management\*\*

# ST Expertise:

- System Solutions
- Technology Integration and Innovation
- Excellent Technical Support

\*STMicroelectronics, Datapoint and Darnell - 2008 \*\*iSupply - 2010

## Contents



- LED Solutions for LCD Backlighting
  - LED Array Driver Features/Benefits
    - Error Detection/Diagnostics
    - Auto Power Savings/Shutdown
    - PWM Dimming
    - External Synchronization Capability
  - System Evaluation Boards and Tools
    - LEDs Driver with Boost Converter for LCD Panels Backlight
    - White LED Controller in Boost topology
    - 6-row, 30 mA LED driver with Boost

# **LED Solutions for LCD Backlighting**



LCD backlighting applications:

- LED TVs
- PC monitors
- Notebooks
- Netbooks
- Mid to Large-sized LCDs

LED7706/07/08, STLA02, STLD40/41 PM6600 Topology and architecture flexibility

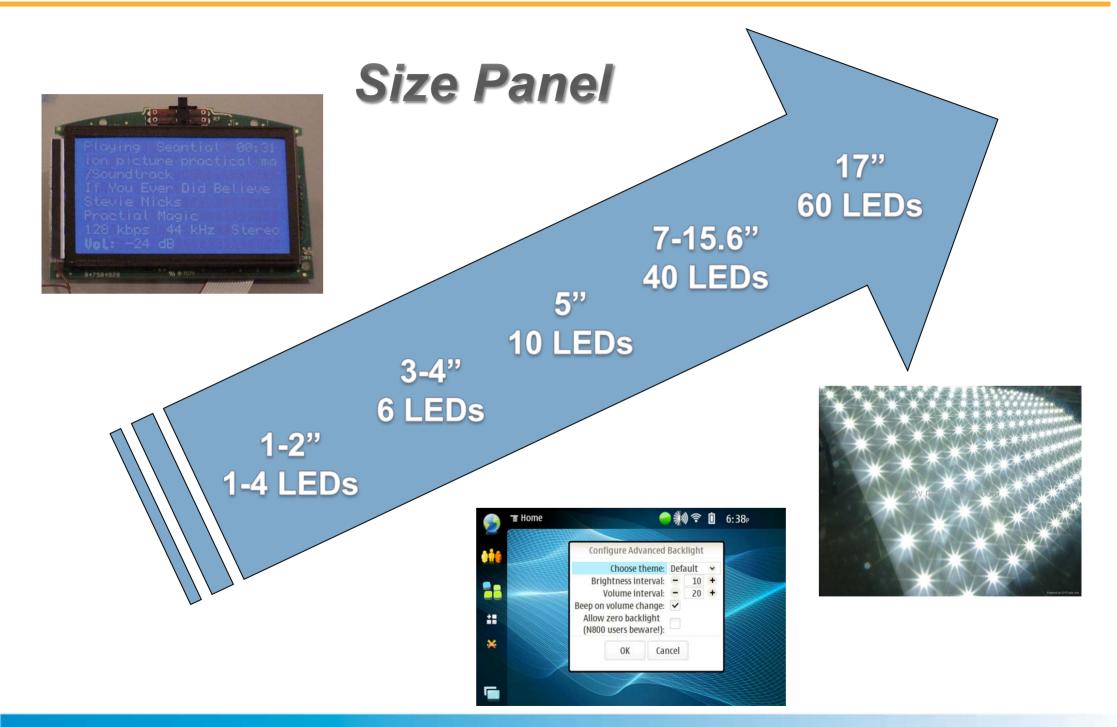
- Buck-Boost improved efficiency
- High side control in Boost topology for improved accuracy
- High Frequency (2MHz) operation with PWM control
- Chip scale packaging solutions
- Smallest application area





## **Lighting Management - Backlight**







Part Number	Drive (# of LEDs)	lout (mA)	Vin range (V)	Fsw (MHz)	Notes
STLA02	6	20	2.5-18	2.3	Synchronous, PWM Dimming
STLD40	10	20	3.0-5.5	0.5	Asynchronous, PWM Dimming
STLD41	40 (4 strings of 10)	120	3.0-21	1.8	Asynchronous, PWM Dimming
STLD25	10 (5 strings of 2)	25	2.3-5.5	2.5	Asynchronous, PWM Dimming
LED7706	60 (6 strings of 10)	30	4.5-36	0.2-1	Ext. Sync. Capability, PWM dimming
LED7707	60 (6 strings of 10)	85	4.5-36	0.2-1	Ext. Sync. Capability, PWM dimming
LED7708	160 (16 strings of 10)	85	3.6-36	0.25-1	Ext. Sync. Capability, PWM dimming
PM6600	60 (6 strings of 10)	32	4.7-28	0.2-1	Ext. Sync. Capability, PWM dimming

# Features: Appli

**STLA02 Boost Converter LED Driver** 

VIN

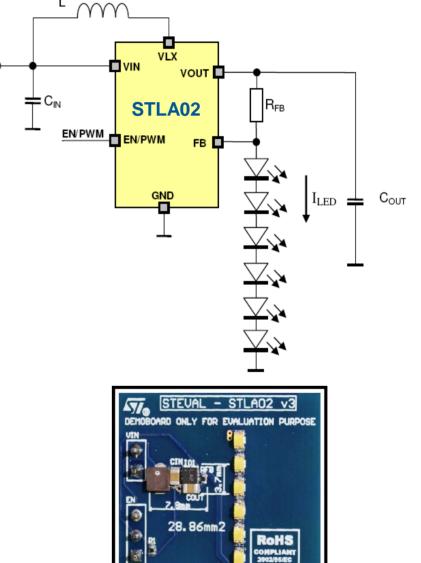
- Supply Input range 2.5V 18V
- Synchronous rectification
- Output voltage up to 27V
- Drivers up to 6 LEDs in series
- High side current sensing
- Simple Topology to connect LEDs
- LED current 20mA
- 2.3MHz Freq PWM control
- Enable and Dimming current (300:1) with dedicated Pin
- Soft Start
- Over Temperature and Voltage protections
- Package DNF6 2x2 mm

### ST advantages:

- High side configuration allows single layer PCB
- Synchronous rectification
- High switching frequency reduces size of external components
- Tiny package DFN2x2

## **STMicroelectronics**

### **Application schematic**



STLA02 EVAL Board See ST Sales team for availability



# **STLD40D W-LED Power Supply**



#### w/Evaluation board for Large Display Backlight L=4.7uH **Features:** Inductor switcher boost converter Cin=2.2uF Cout=100nF Vin range : 3.0Vdc to 5.5Vdc High efficiency >80% over wide range of Vin from 3-37V Can drive up to 10 white LEDs in series VOUT Output Current capability 20mA VIN Enable pin with possibility of PWM dimming control STLD40D N/C OVP and OVT protections with automatic restart EN PFM mode control Soft start with adjustable peak current limit Small external inductor GND RLED QFN 3x3 8 leads 1mm Height **Typical applications:** White Led supply for LCD backlight Mobile phone/smart phones PDA and organizers Handheld POS **Digital camera** MP3 Any handsets powered by Li-ion battery QFN8 (3mm x 3mm) STEVAL-TLL001V1

Part #	Evaluation Board	Vin	loutmax	Description	App Notes
STLD40D	STEVAL-TLL001V1	3.0-5.5V	20mA	White LED power supply for large display backlight	AN2333

# STLD41 – Single Channel WLED Driver



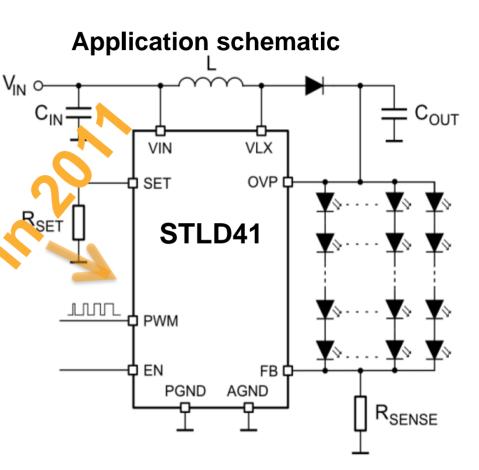
## White LED Power Supply

#### **Features:**

- White LED boost converter
- Drives up to 40 LEDs (4 strings of 10 LEDs)
   Vin range: 3.0Vdc to 21Vdc
- Operating Vout: ~38V
- Output Current capability 120mA adjustable by single resistor
- PWM/PFM Control Mode (1.8 MHz)
  - High efficiency w/2 or 3 Li+ cells
  - Adjustable peak current
- Separate PWM dimming and enable pinso
- Over voltage and over temperature protections
   Soft start
- Low shutdown current < 1µA.
- Package QFN 3x3-8 leads

#### ST advantages:

- Low cost solution
- LED configuration flexibility
- Few external components needed



### **APPLICATIONS:**

- Mid-size LCD backlight
  - Tablet
  - Mobile phone
  - PDAs



QFN8 (3mm x 3mm)

## STLD25 - 5 Channel WLED Driver



### Features:

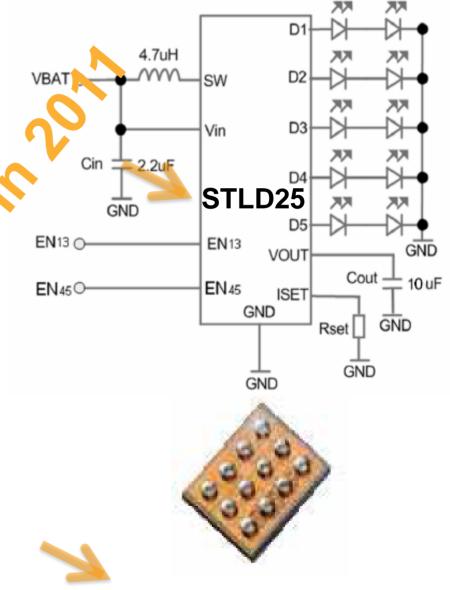
- Operating input voltage from 2.3V to 5.5V
  - <u>+</u> 7.5% LED current accuracy
  - Two LEDs in series, 5 channels to drive up to 10 LEDs
- High side current source
  Up to 125mA of total LEDs current
  90% efficiency at 100mA
- PWM Dimming with automatic shutdown time window
- 2.5MHz switching frequency
- CSP 12 bumps 0.4mm pitch 1.4x1.8mm

## Typical Applications.

- LCD backlight with up to 10 LEDs
- Cellular phones
- PDAs

## **STMicroelectronics**

### **Application schematic**



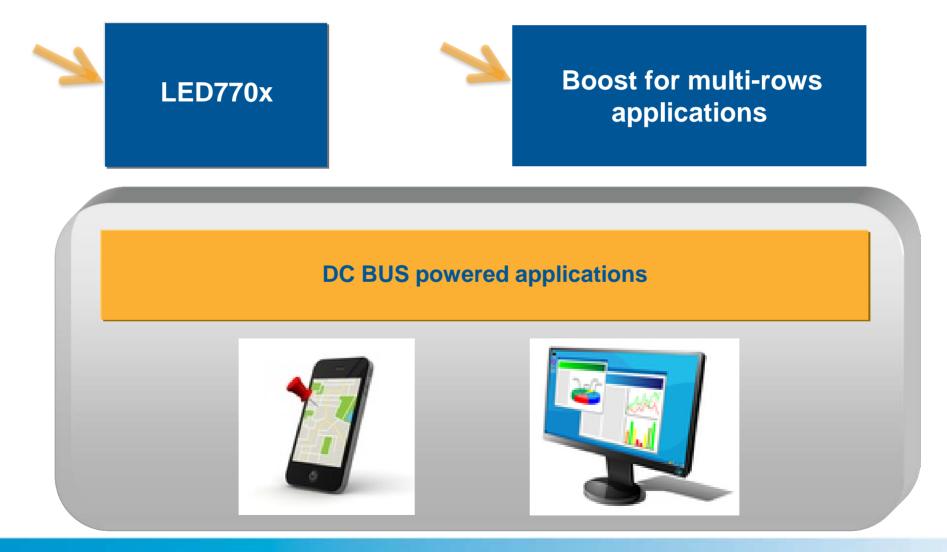
CSP 1.4x1.8 mm 12 bumps 0.4mm pitch

# **Using DC-DC Switching Regulators**



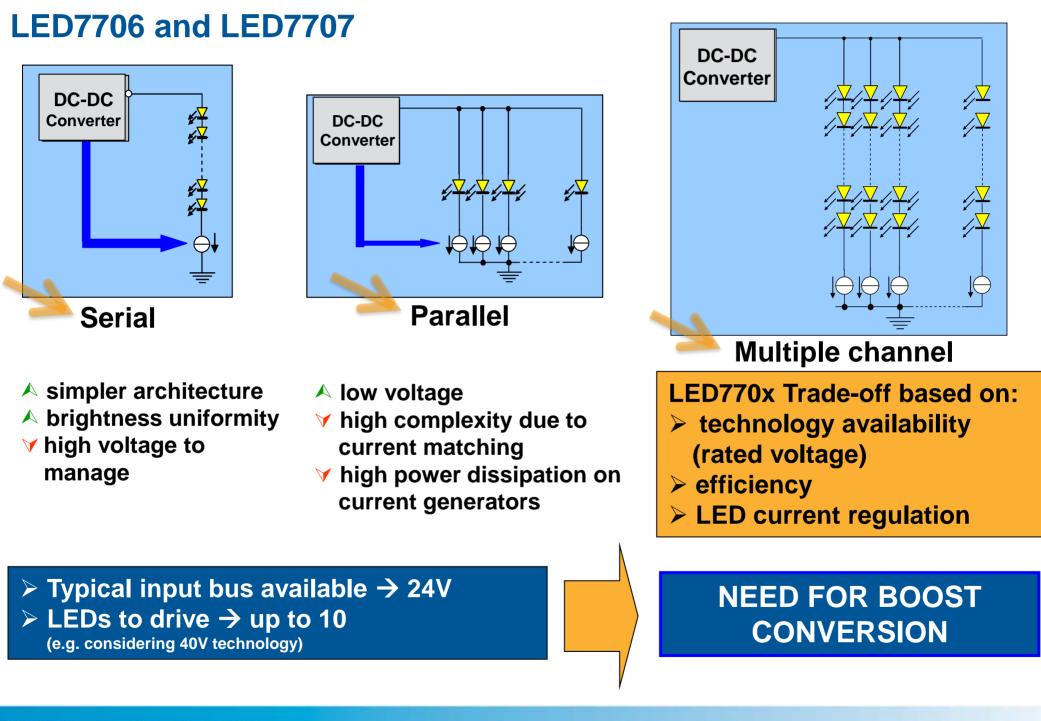
### **In Driving LEDs**

Monolithic solutions offer high efficiency and compactness, wide input voltage range, high current capability for a variety of applications, and high dimming performance for superior brightness uniformity.



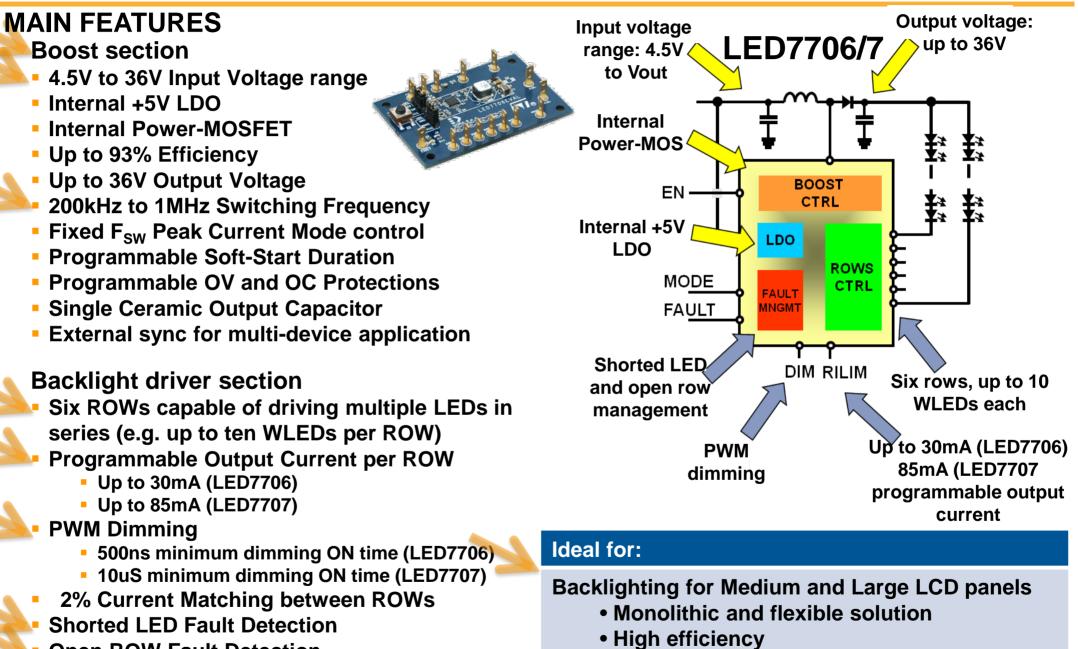
# **Optimized LED driving solution**





# LED7706/7: LED Controllers





• Open ROW Fault Detection

**STMicroelectronics** 

Capability to Disconnect Unused ROWs

#### Superior dimming capability

Complete and flexible fault management

## LED7708 LED Controller



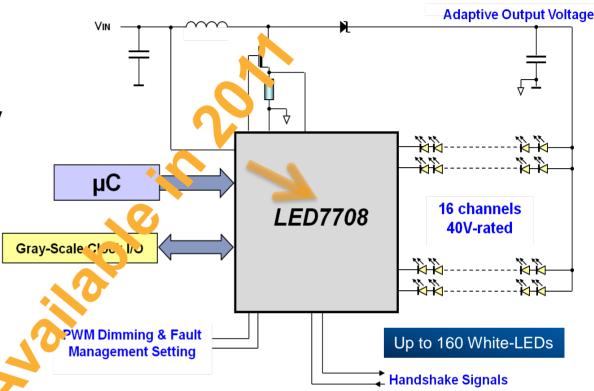
#### MAIN FEATURES

**Boost controller section** 

- 3.6V to 36V Input Voltage range
- Adaptive output voltage for high efficiency
- Internal +5V LDO for gate driver supply
- Internal +3.3V LDO for device supply
- High performance external MOSFET driver
- 250kHz to 1MHz Switching Frequency
- Fixed F<sub>sw</sub> Peak Current Mode control
- External sync for multi-device application
- Programmable OV and OC Protections
- Over-temp alert and thermal shutdown

#### LED array driver section

- 4-wire, 30MHz serial interface
- 16-channels with 85mA/ch current capability
- Selectable 12/16-bit gray-scale
- Programmable gray-scale latency
- Grouped or independent channel PWM control
- 1.5% max channel-t-channel current matching
- LED short-circuit and open-channel fault detection and management
- Serial data formats: 16x16 bits, 1x256bits or 1x192 bits

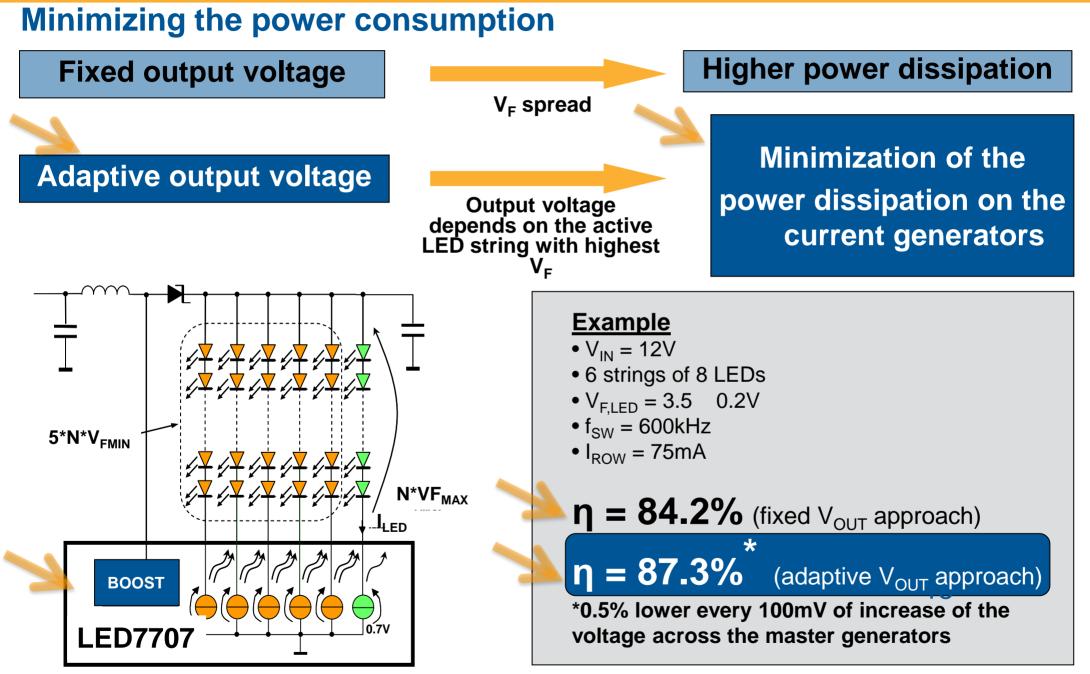


#### Ideal for:

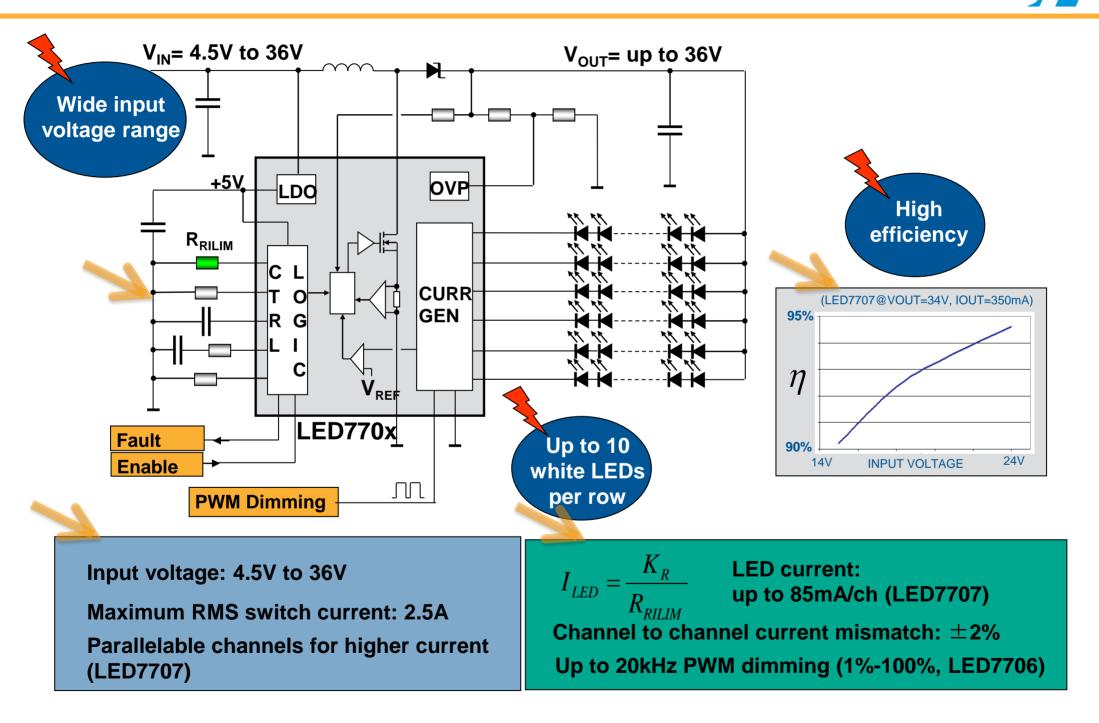
- **Backlighting for LCD TVs** 
  - Advanced local dimming performance
  - Adaptive LEDs voltage regulation
  - Flexible solution
  - High efficiency
  - Superior brightness control
  - Complete and smart fault management

# LED770x: Adaptive Output Voltage



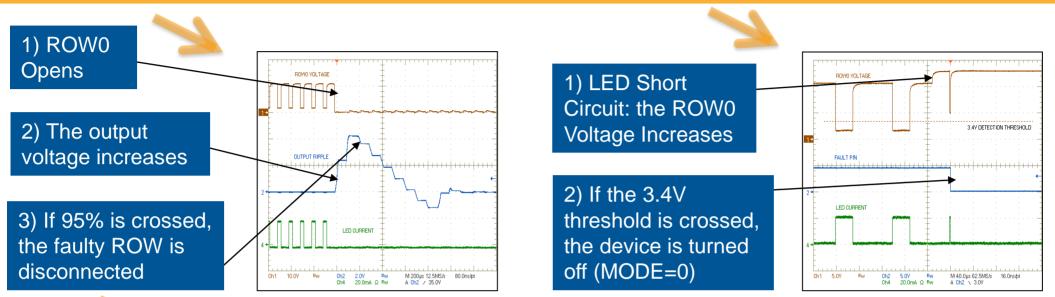


## LED770x: Boost topology

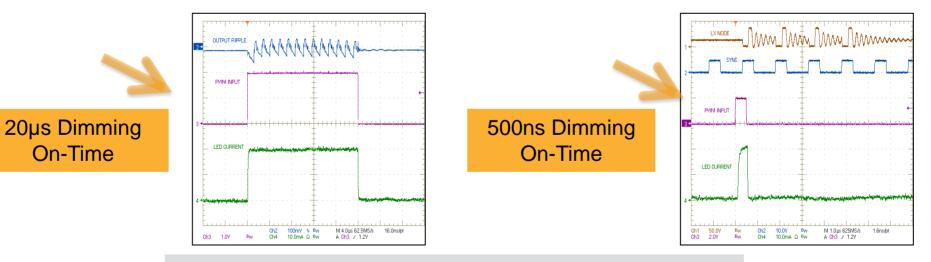


# **LED Faults & Dimming Waveforms**





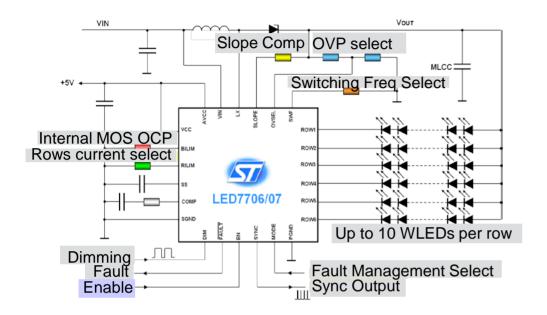
### Detecting and Managing Faults in LED7706/7/8



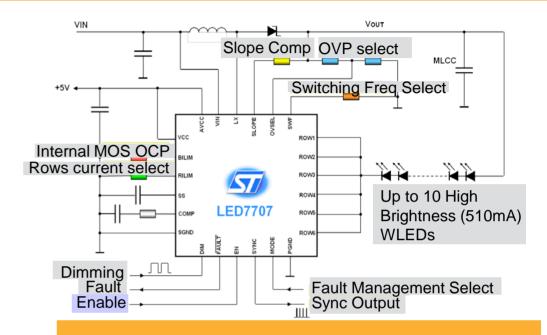
(f<sub>DIM</sub>=10kHz, D<sub>DIM</sub>=20%, f<sub>SW</sub>=630kHz, LED current=20mA)

Managing Dimming Waveforms in LED7706/7/8

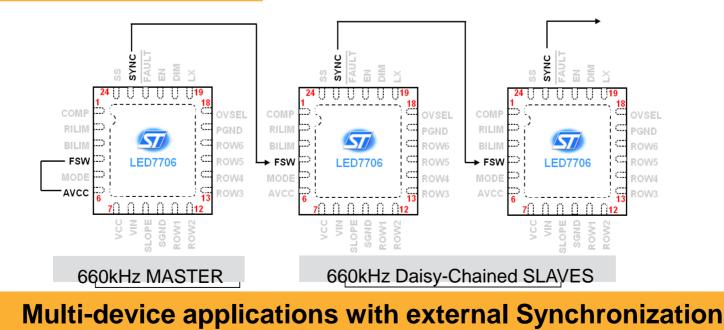
## **LED7706/7 LED Driver Application Examples**



#### **Typical application schematic**



#### **High-Brightness LED driving solution**



# LED7706/7 LED Driver w/Boost Converter

## **Evaluation Board Solution**

#### **Key Features:**

#### **Boost section**

- 4.5 V to 36 V input voltage range
- Internal power MOSFET
- Internal +5 V LDO for device supply
- Up to 36 V output voltage
- Constant frequency peak current-mode control
- 200/250 kHz to 1 MHz adjustable switching frequency (LED7706/7)
- External sync for multi-device application
- Pulse-skip power saving mode at light load
- Programmable soft-start
- Programmable OVP protection
- Single ceramic output capacitor
- Non-latched thermal shutdown

#### **Typical Applications:**

- LCD monitors & TV Panels
- PDAs Panel Backlight
- GPS Panel Backlight
- Emergency Lightning





#### STEVAL-ILL021V1

#### LED driver section

- Six rows with 30/85 mA maximum current capability (adjustable) LED7706 /7
- Up to 10 white LEDs per row
- Rows disable option
- Less than 500 ns minimum dimming time (1% minimum dimming duty-cycle at 20 kHz dimming frequency - LED7706,
- Less than 10 µs minimum dimming time at 1kHz dimming frequency - LED7707
- 2.0% current matching between rows
- LED failure (open and short circuit) detection

Part #	Evaluation Board	valuation Board Vin		Description	App Notes
LED7706	STEVAL-ILL020V1	4.5V to 36V	20mA /ch	LEDs Driver with Boost Converter	AN2809
LED7707	STEVAL-ILL021V1	4.5V to 36V	60mA/ch	LEDs Driver with Boost Converter	AN2810

# PM6600 LED Driver w/Boost Converter

## and Evaluation Board

#### **Key features**

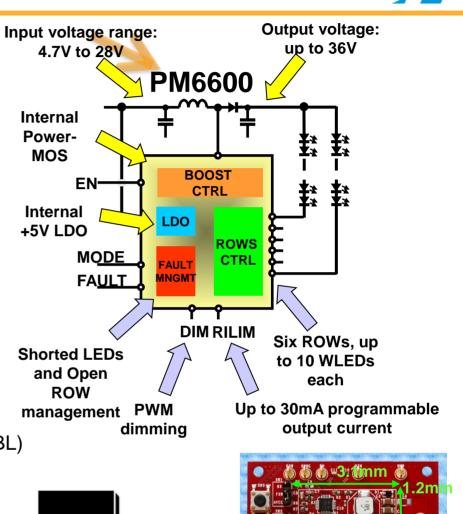
- 6 rows with up to 10 LEDs/row (60 LEDs) Monolithic solution up to 36V output voltage
- Programmable LED current up to 32 mA at highest precision/ matching accuracy
- Supports analog and digital dimming
- Boost Fsw from 200Khz to 1MHz and high efficiency at light load
- Pulse-skip power saving mode at light load
- LED failure (open and short circuit) detection
- Soft-start, programmable OVP protection, thermal shutdown
  Internal power MOSFET, reducing space and application cost
- Ceramic output capacitor supported

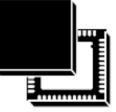
#### Key benefits

- Covers all mobile PC and netbook screen sizes (8" to 17")
- Superior brightness uniformity, with tight current matching
- Longer battery life with energy regulation compliancy (VESA-NEBL)
- Saves BOM cost, supporting MLCC output cap w/default values
- Space-saving monolithic solution in 24-pin QFN4x4

#### **Typical applications**

- Notebook panels, netbooks, and nettops
- Tablet PCs
- Battery/AC adapter supplied equipment





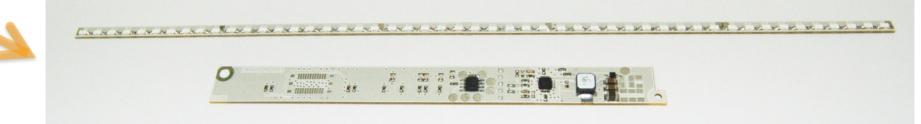
VFQFPN-24 4x4mm<sup>2</sup>

STEVAL-ISA056V1

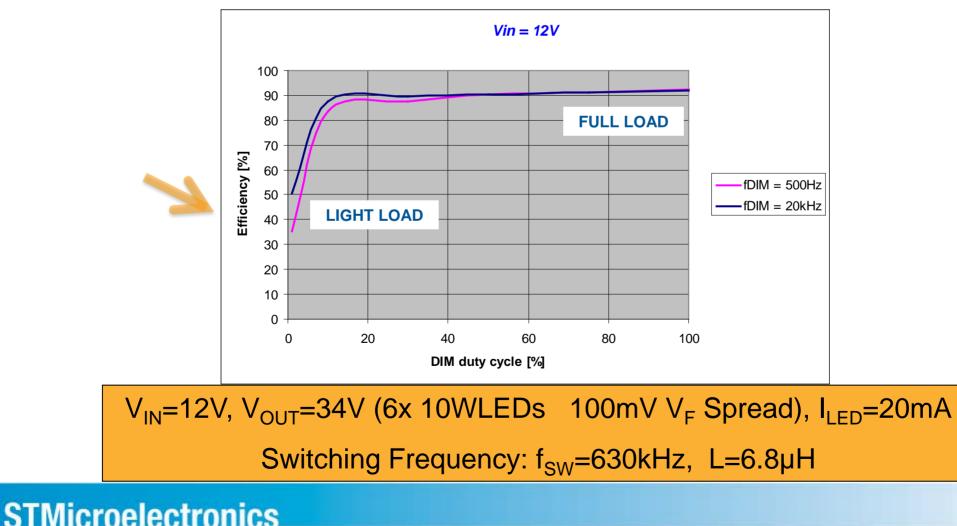
Part #	Evaluation Board	Vin	loutmax	Description
PM6600	STEVAL-ISA056V1	4.7 - 28V	32mA	6-row, 30 mA LED driver with boost

# PM6600: Higher Efficiency – up to 93%

### WLEDs board + PM6600 save board space



### Save Power in whole dimming range





### **Evaluation Boards Summary**

Part Number	Order Code	Order Code Vin		Comments	AN
LED7706	STEVAL-ILL020V1	4.5V to 32V	20mA per channel	LEDs Driver with Boost Converter for LCD Panels Backlight	AN2809
LED7707	STEVAL-ILL021V1	4.5V to 32V	60mA per channel	LEDs Driver with Boost Converter for LCD Panels Backlight	AN2810
STLD40D	STEVAL-TLL001V1	3V to 5.5V	up to 20mA	White LED Controller in Boost topology	AN2333
PM6600	STEVAL-ISA056V1	4.7 to 48V	32mA	6-row, 30 mA LED driver with Boost	TBD

# **LED Solutions for LCD Backlighting**



## on ST.COM

#### **LED Lighting Brochure**



#### LED Application web pages

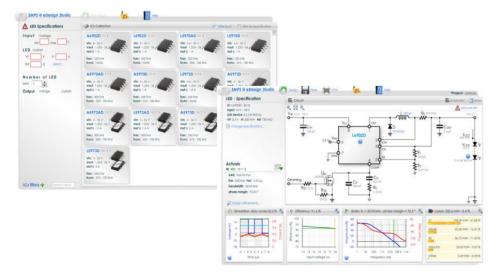


Lighting ST's lighting solutions are split into five main categories: dimmer, fluorescent, halogen, HID and LED.

http://www.st.com/internet/com/segment/4.jsp

http://www.st.com/internet/com/SALES\_AND\_MARKETING\_RESOURCES/ MARKETING\_COMMUNICATION/MARKETING\_BROCHURE/brlighting.pd

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## **STMicroelectronics**

### Add LCD Backlighting block diagram here



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