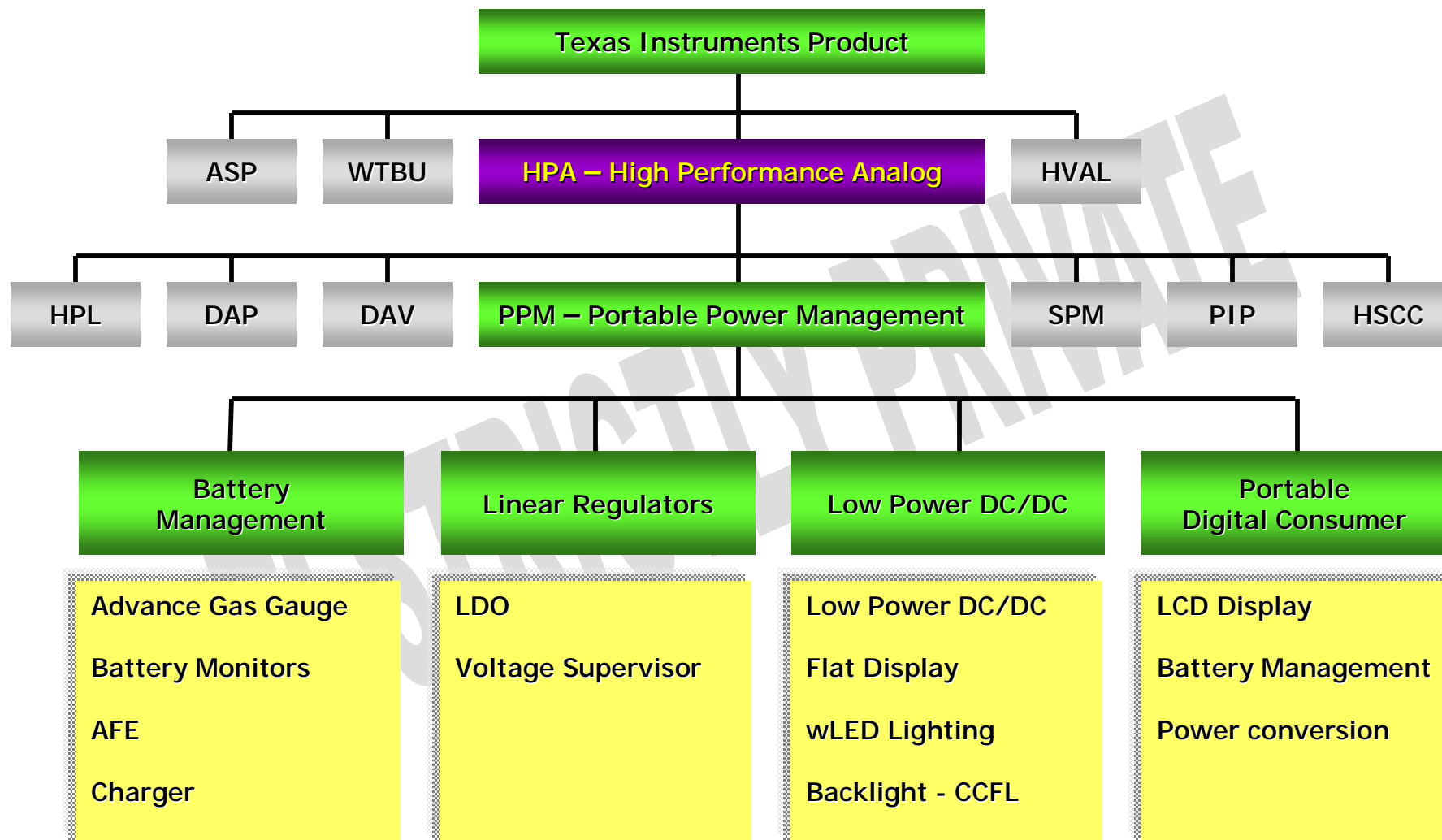


Mobile Display

- *wLED Backlight*
- *wLED Flashlight*
- *LCD Bias*
- *OLED Driver*

Silvan Ho
HPA/APR Mkt Dev
silvan_ho@ti.com
Dec 7, 2004

Organization Summary - Portable Power Management



HPA Socket in LCM



wLED Backlight Driver Supply

⌘ wLED Characteristic

ü Current drive device

ü Typical parameter

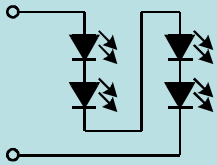
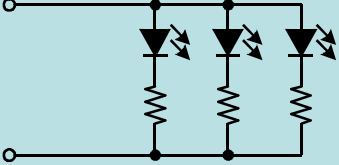
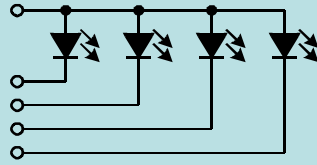
- $V_F = 3.5 \sim 4V$
- $I_{LED} = 20mA$
- $I_R = 10 \sim 100mA$

⌘ E/E requirement

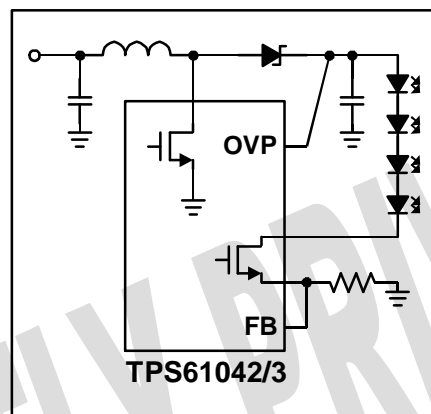
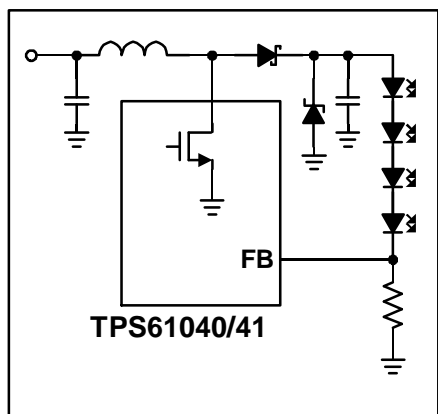
ü Mobile Phone : 2~3 pcs

ü DSC : 2~4 pcs

ü PDA : 4~6 pcs

Connection	Series	Parallel	Parallel
Example			
Voltage	16V~	4V~	4V~
Current	20mA~	80mA~	80mA~
Proper Topology	Boost	Charge Pump	Charge Pump
Current Balance	Good	Trade off	Good
Efficiency	High	Low	Medium
Wireless App	EMI issue	Good	Good
Cost	Medium	Low	High
Ti solution	TPS61040/1/2/3	REG71050 (3 wLED)	TPS60230/1 (5/3 wLEDs)

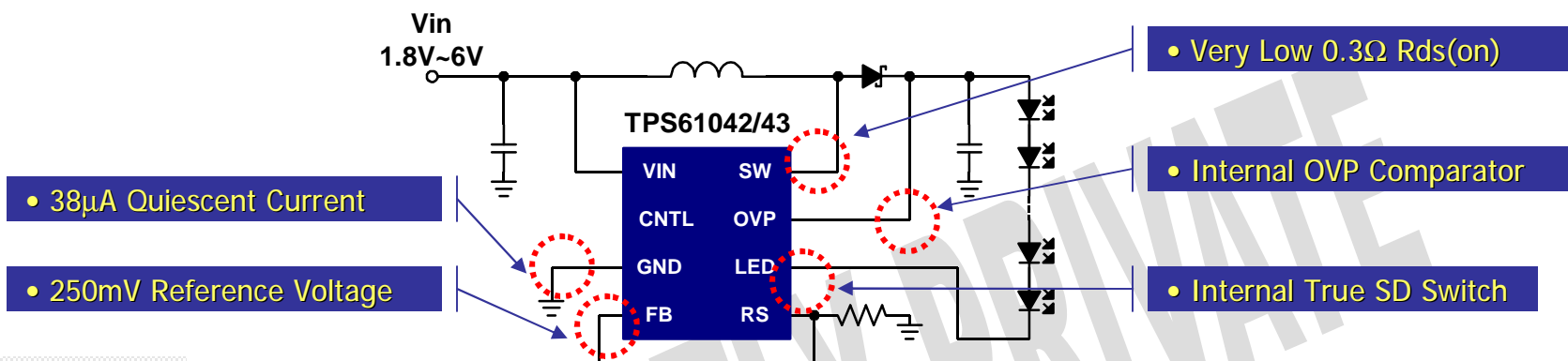
Boost wLED Driver Supply - TPS61040/1/2/3



Key Spec.	TPS61040/41	TPS61042/3	which means,
OVP	No	29V/18V	Save External Schottky Diode
Rds(on)	0.6W/0.75W	0.3W	Efficiency at backlight operation
Reference	1.233V	0.25V	Power loss on current sense resistor
Package	SOT23	3x3QFN	
Iq(mA)	28	38	Mobile phone standby time
True SD	No	Yes	Mobile phone standby time
Control Scheme	1MHz/PFM	1MHz/PFM	
wLEDs	6	6/4	Application

Key
Spec

TPS61042/43 - High Performance wLED Driver



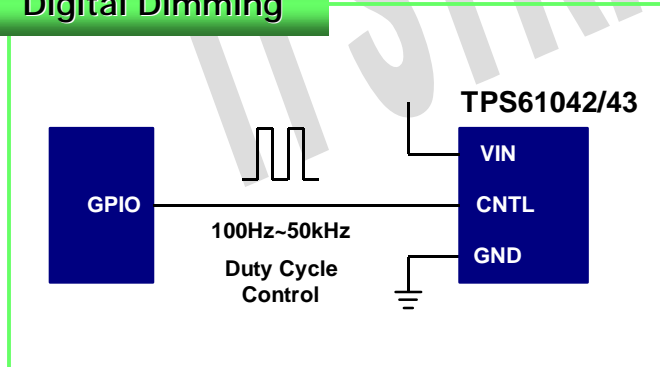
DS

Available

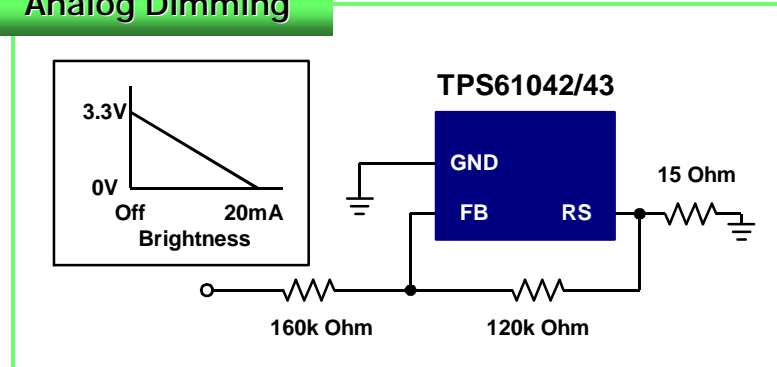
NEW

TPS61043 : Low Cost, p2p with TPS61042, Mobile Phone Application

Digital Dimming



Analog Dimming



TPS61060 - Sync Boost wLED Driver

Features

- Synchronous Boost Topology
- 1.2MHz Fixed Switching Frequency
- Internal 5 bit DAC, 16.7mV/Step
- CSP8, 3x3QFN8 Package

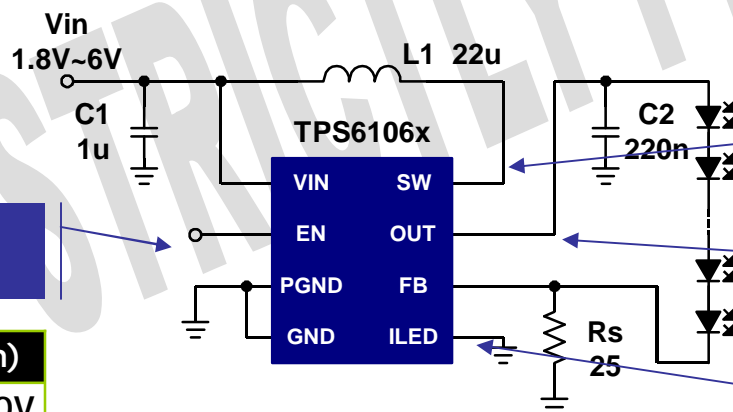
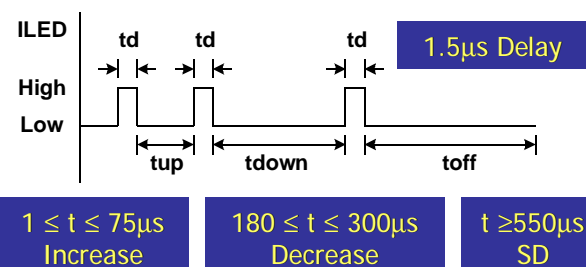
DS

Available

- Enable pin
- Up to 1kHz PWM dimming

Part Number	OVP (min)
TPS61060	14.0V
TPS61061	18.0V
TPS61062	22.75V

ILED Dimming



- 1.2MHz PWM
- Synchronous Boost

- Internal OVP
- LED disconnect at Shutdown

- High : 250mV Reference
- Low : 500mV Reference
- Digital Dimming
- 15.6mV/Step (32 Step)

wLED Driver Key Spec. Comparison

	TPS61041	LM2703	LT1615	LT1937	MPS1522	MPS1523	NCP5007
Max Vo (V)	28	20	34	36	25	28	22
Rds(on) Ω	0.75	0.7	0.25	350mV/250mA	0.5	0.5	1.7
Ref (V)	1.23	1.237	1.23	0.095	1.23	0.4	0.2
Iq(mA)	0.028	0.04	0.02	2.5	0.5	0.55	--
Package	SOT23	SOT23	TSOT23	TSOT23	QFN/SOT23	SOT23	SOT23
Control Scheme	PFM	PFM	PFM	PWM	PFM	PFM	PFM

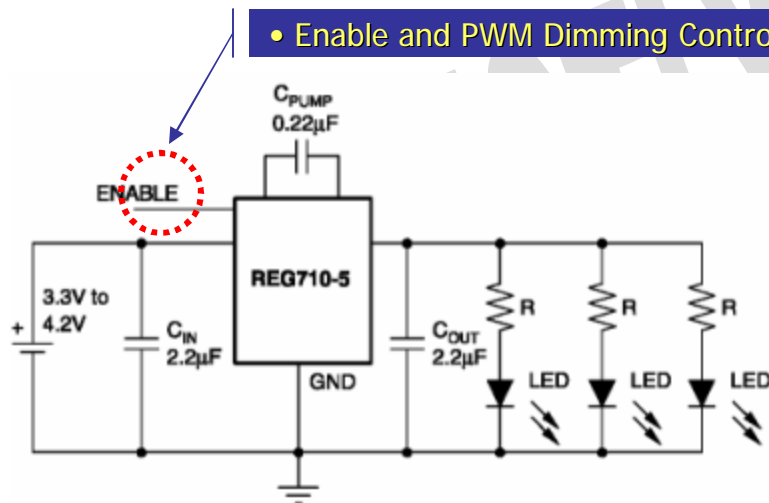
	TPS61060/1	TPS61042/43	MPS1518	FAN5606
OVP (V)	14/18	29/18	28	No
Max Vo (V)	25	28/16.9	25	18
Rds(on) Ω	0.5	0.3	0.5	?
Ref (V)	0.25/adj	0.25	0.104	1.22
Iq(mA)	1	0.038	0.75	?
Package	3x3 QFN/CSP	3x3 QFN	2x2QFN/TSOT23	3x3 QFN
True SD	yes	yes	No	no
Control Scheme	PWM	PFM	PWM	PFM
Co (μ F)	0.22	0.1	0.22	4.7

NOTE : PWM control usually consume more quiescent current

REG71050 – 60mA White LED Charge Pump

Features

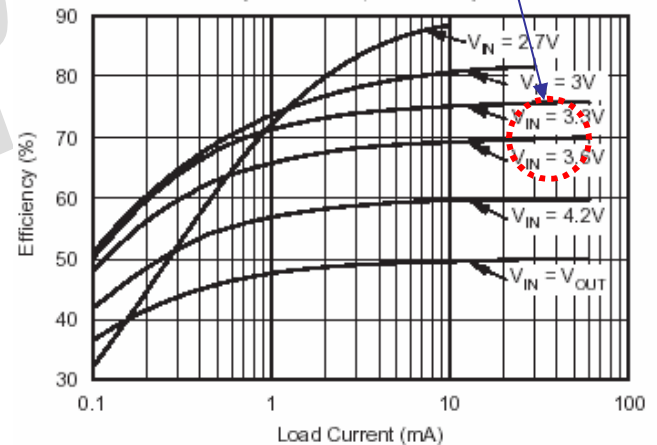
- Low Cost wLED Driver
- Ideal for Wireless application
- Simple Design and few external component
- SOT23-6 Package



3 Cap Only

wLED Operation

EFFICIENCY vs LOAD CURRENT
(REG710-5V, REG71050)



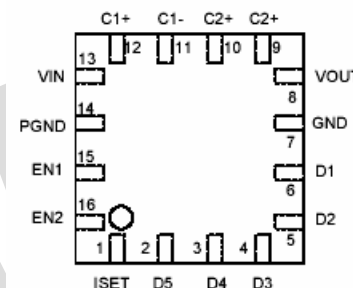
DS

Available

TPS60230/1 - White LED Charge Pump

Features

- ü PWM dimmable
- ü Only 5 small external components
- ü 1MHz oscillator frequency
- ü output current source for each LED
- ü 60mA quiescent current
- ü Thermal shutdown
- ü 3x3QFN16 package



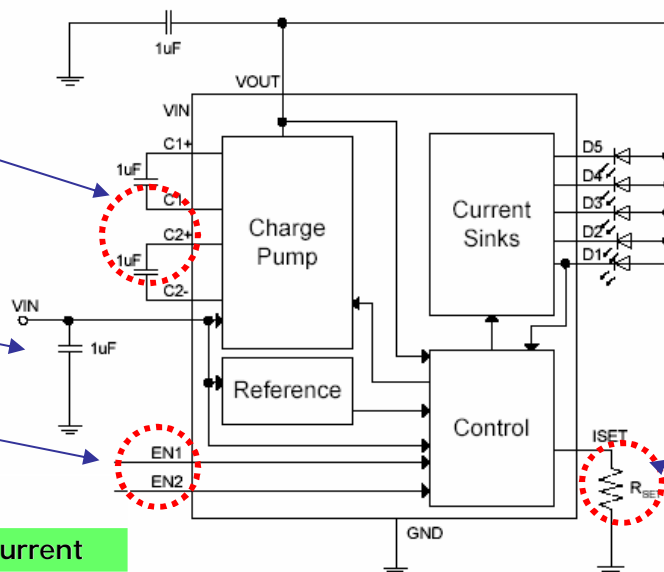
- High Efficiency by Fractional Conversion with 1x and 1.5x Modes

- 2.7V~6.5V Input Range

- LED Brightness control

LED Current Adjustment

EN2	EN1	Mode : V _{ISET}	LED Current
0	0	SD	0
0	1	200mV	1/3
1	0	400mV	2/3
1	1	600mV	Full



TPS60230

- 5 wLEDs x 25mA/CH
- TPS60231
- 3 wLEDs x 25mA/CH

- LED Current Setting

4C 1R Only

DS

Available

wLED Driver Key Spec. Comparison

	TPS60230	TPS60231	AAT3113	AAT3114
# of wLED	5	3	4	6
Mode Support	1x/1.5x	1x/1.5x	1x/1.5x	1x/1.5x
Fsw	1MHz	1MHz	600kHz	600kHz
Current Matching	0.3%	0.3%	0.3%	0.3%
Iout/CH	25mA	25mA	20mA	20mA
Package	3x3QFN	3x3QFN	4x4QFN	4x4QFN

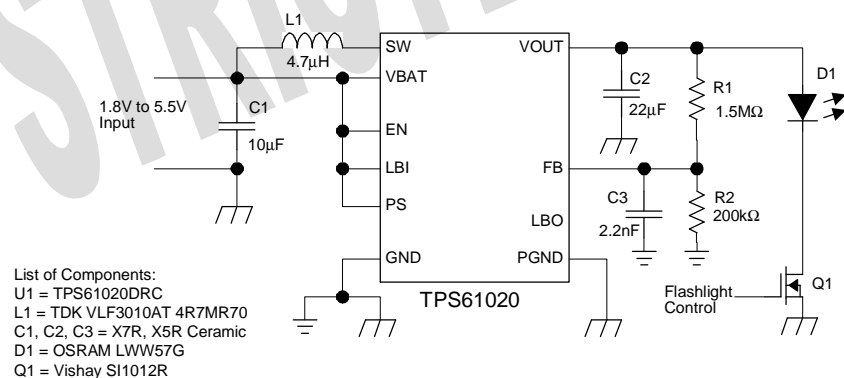
wLED Flash Light Power Supply Requirements

- ⌚ Efficiency is of secondary order

 - ü Flash light supply is turned off for most of the time
- ⌚ Fast turn off and turn on times are required

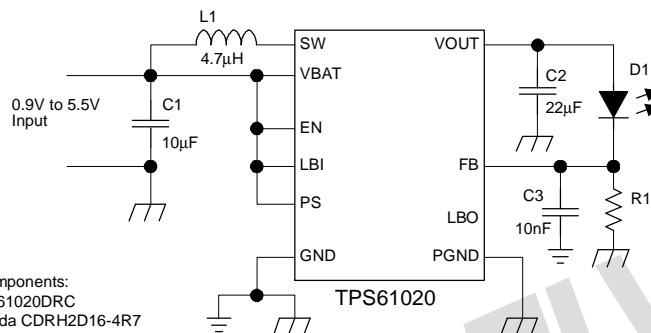
 - ü Time period for flash ranges from 30ms up to 200ms
 - ü Rise time of current needs to be in the μs range
 - ü Boost or charge pump must be powered up before the flash can be initiated
- ⌚ Storage capacitor and current limit might be required to avoid high input peak currents during flash

Flash-Light LED Driver with Fast Turn-On/Off Time



TPS61020 Flash-Light Driver

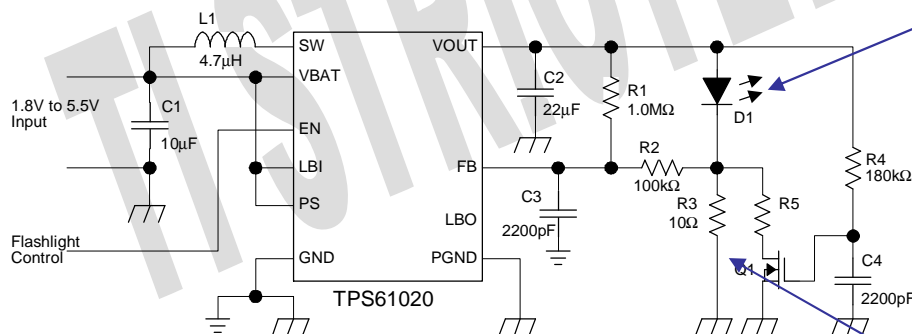
Flash-Light LED Controlled Current Source



List of Components:
U1 = TPS61020DRC
L1 = Sumida CDRH2D16-4R7
C1, C2, C3 = X7R, X5R Ceramic
D1 = White LED

Starts-up into 150-mA Flash-Light LED from 3.0V input voltage

High Current Flash-Light LED Controlled Current Source



List of Components:
U1 = TPS61020DRC
L1 = TDK VLF3010AT 4R7MR70
C1, C2, C3, C4 = X7R, X5R Ceramic
R5 = optional for LED current adjustment
D1 = OSRAM LWW57G
Q1 = Vishay SI1012R

Starts-up into 400-mA Flash-Light LED from 3.0V input voltage

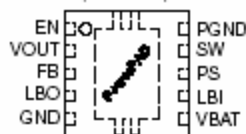
Movie Light: Possibility for Analog Current Regulation Adjustment

Converter for wLED Flashlight

TPS61020 – Sync. Boost

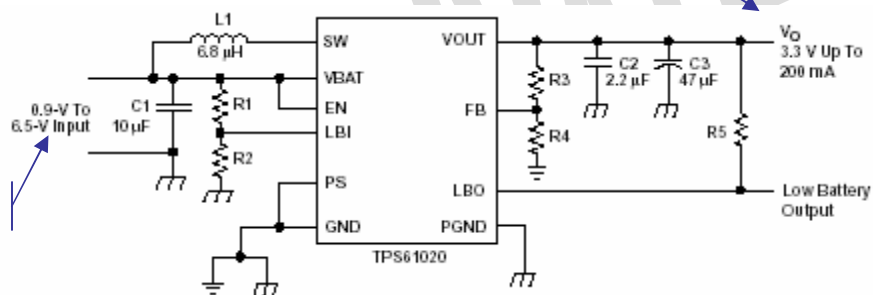
Features

- 1500mA switch current limit
- 600kHz switching frequency
- 25mA Quiescent Current
- 3x3 QFN10 package



• Input : 0.9V~6.5V

- $I_o : 200\text{mA}@0.9\text{V } V_{in}$
- $I_o : 500\text{mA}@1.8\text{V } V_{in}$



TPS61070 – Sync. Boost

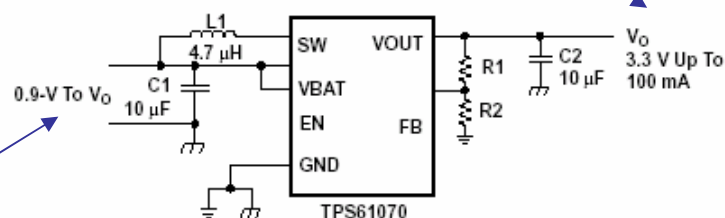
Features

- 600mA switch current limit
- 1.2MHz switching frequency
- 19mA Quiescent Current
- TSOT23-6 package



• Input : 0.9V~5.5V

- $I_o : 75\text{mA}@0.9\text{V } V_{in}$
- $I_o : 150\text{mA}@1.8\text{V } V_{in}$



TPS6511x – Triple Charge Pump for SFF LTPS LCD Bias

Features

ü 3CH Low Ripple Regulated Charge Pumps.

- V_{in} : 2.4V~5.5V
- V_{CC} =3.0V to 5.0V/16mA w/ 0.1V step(3.0~4.0V), 0.2V step(4.2~5.2V)
- V_{DD} =6.5V to 10V/ 2mA w/ 0.5V step
- V_{SS} =-2.4V to -4.5V/ 1mA w/ 0.3V step

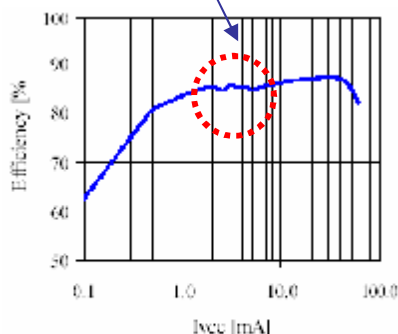
ü Charge Pump Topology (No inductor EMI issue)

ü Ultra Low Ripple (V_{CC} : 5mV@5mA)

ü Programmable Output Voltage w/I2C (EEPROM)

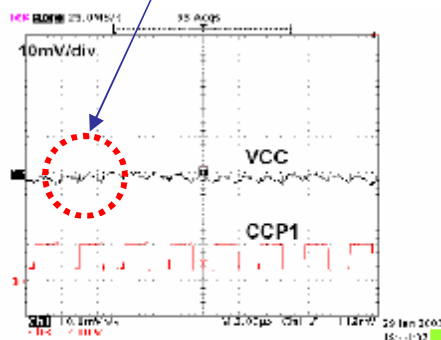
ü 4x4mm² QFN24 Package

85% Efficiency

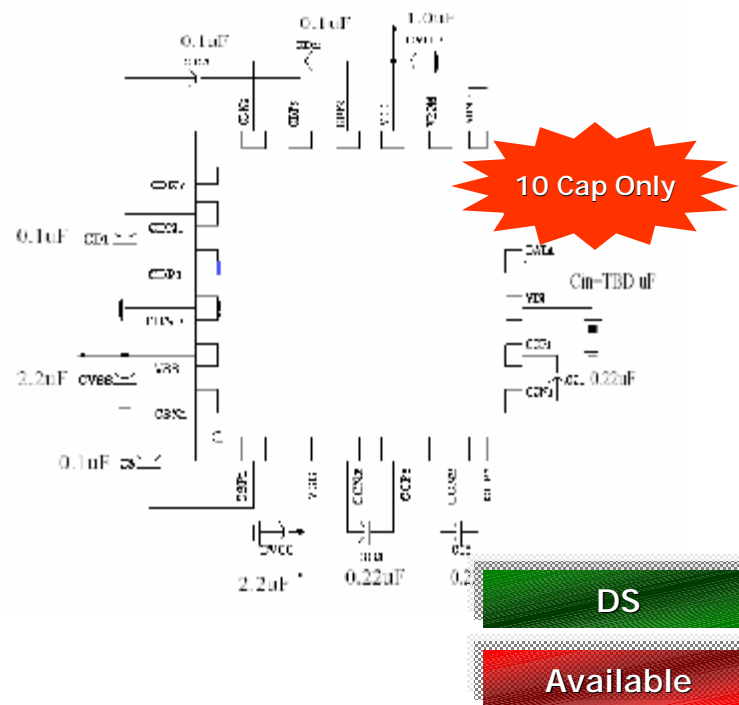


VCC Charge pump Efficiency
 $V_{in}=2.8V$, $V_{CC}=3.3V$

Ripple 5mV only



VCC Charge pump Output Ripple
 $V_{in}=2.8V$, $V_{CC}=3.3V$, $I_O=10mA$



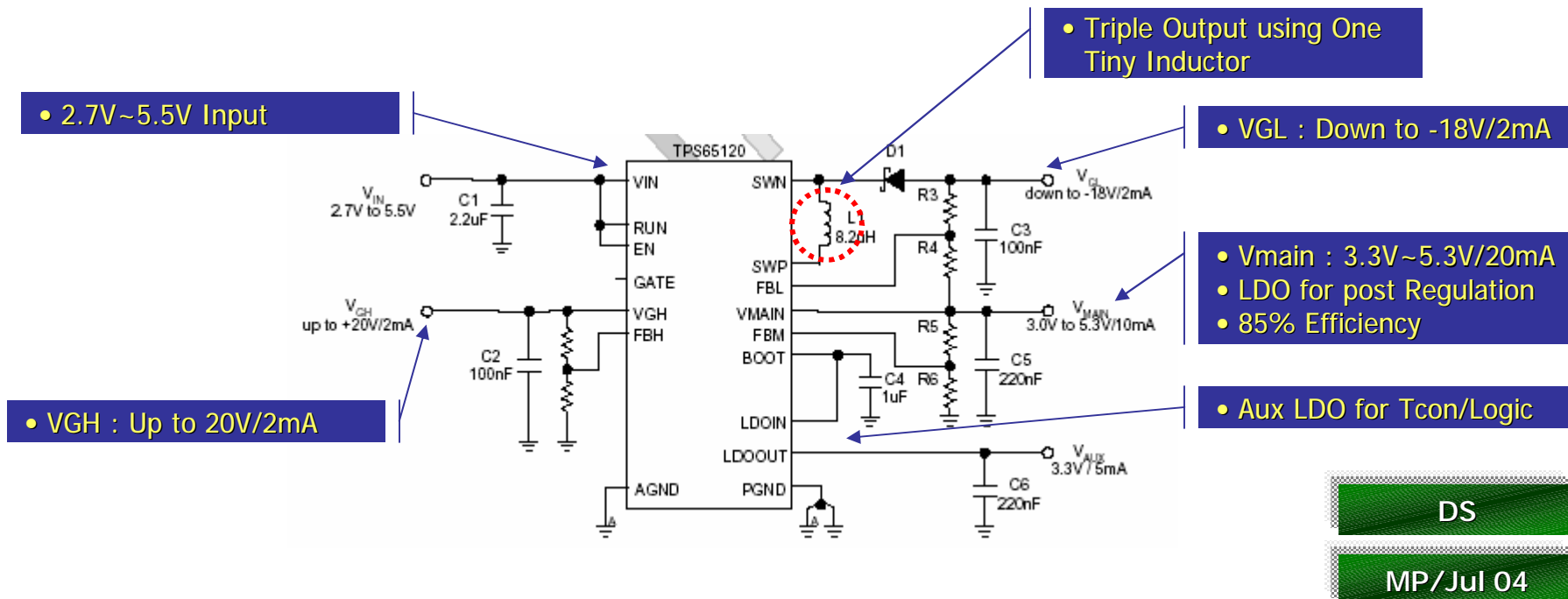
Device	VCC	VDD	VSS	PONS	POFS
TPS65110	3.3V	7.5V	-2.7V	$V_{CC} \oplus V_{SS} \oplus V_{DD}$	$V_{DD} \oplus V_{SS} \oplus V_{CC}$
TPS65111	5.0	9.0V	-3.0V	$V_{CC} \oplus V_{SS} \oplus V_{DD}$	$V_{DD} \oplus V_{SS} \oplus V_{CC}$

TPS65120 - SFF LCD Panel Bias w/ Inductor

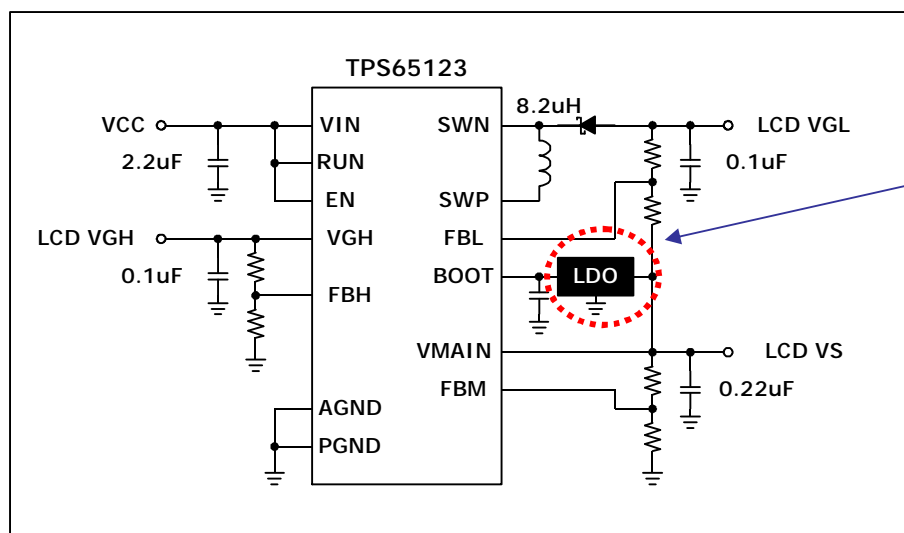
Features

- 4 Channel output
- Internal/External Sequencing
- Ultra-Small External Components
- Internal Softstart
- Output Short Circuit Protected
- 1mA Shutdown Current
- Ultra-Thin 16-Pin QFN Package (3x3mm/0.8mm max height)

Device	LDO	Sequencing
TPS65120	3.3V	Vmain® VGL® VGH
TPS65121	2.5V	Vmain® VGL® VGH
TPS65122	1.8V	Vmain® VGL® VGH
TPS65123	No	Vmain® VGL® VGH
TPS65124	No	Programmable



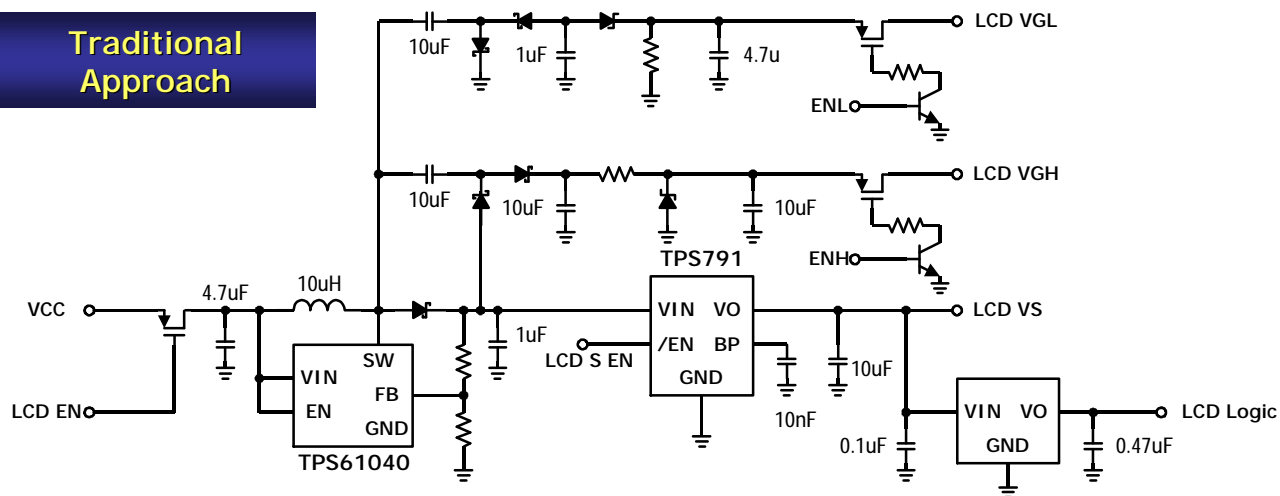
TPS65120 – Larger Vmain Output Current



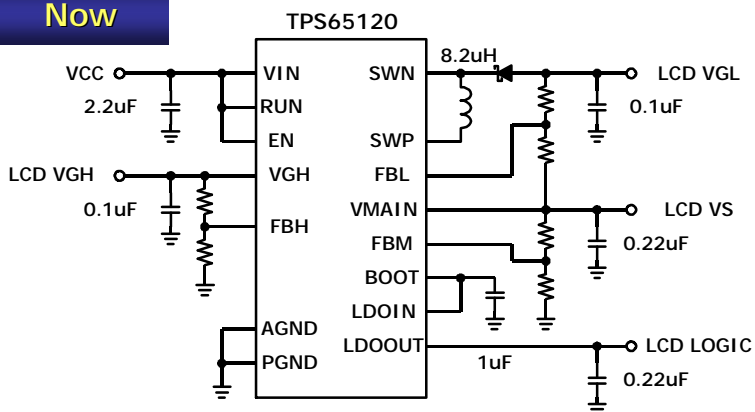
- External LDO for Output current >25mA
- TPS715, SC70, 50mA

TPS65120 Benefit

Traditional Approach



Now



Most Compact LCD Bias Solution in the Market

	Discrete	TPS65120
Component Count	31	14
Diode/FET	7/5	1/0
Device	3	1
Output Cap	Big	Small

OLED Power Supply

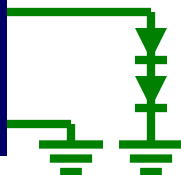
ρ OLED Power Supply

- ü Current Drive
- ü MP sub panel : Typ. 9~15V/30mA
- ü True Shutdown for extending OLED life cycle

ρ PMOLED (Passive Matrix OLED)

- ü Single Supply
- ü Typ. 9~15V/30mA
- ü Ti solution TPS61045/60

TPS61045/60
Boost
Regulator



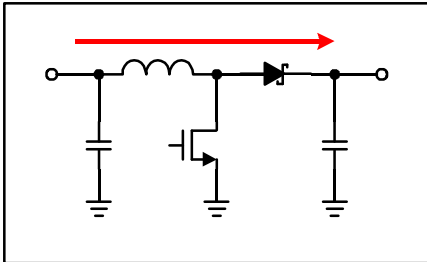
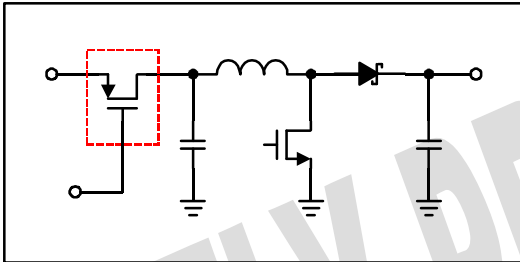
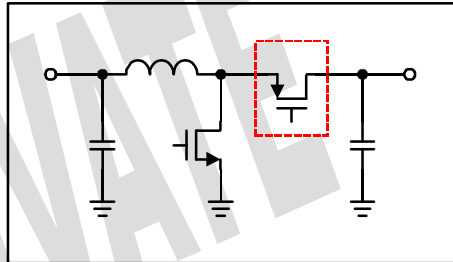
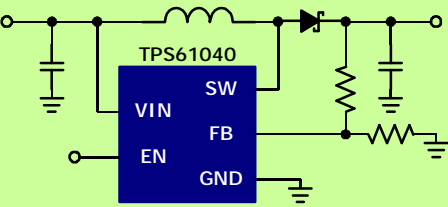
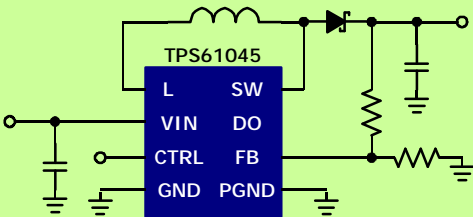
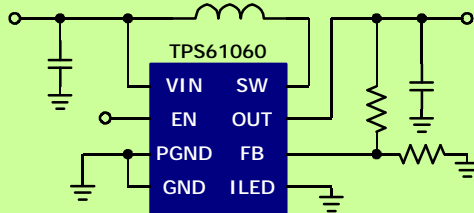
ρ AMOLED (Active Matrix OLED)

- ü Dual Supply
- ü Typ. $\pm(7 \sim 15)V/50mA$
- ü Ti solution : TPS65130

Dual Channel
DC/DC
Regulator



True Shutdown Implemented in Step Up Converter

Traditional Approach	Solution I	Solution II
		
<ul style="list-style-type: none"> - No True shutdown - Solution is Popular - Impact to OLED Life Cycle 	<ul style="list-style-type: none"> - Add Additional Switch - External P-FET and disable control - Additional space for external circuit 	<ul style="list-style-type: none"> - Sync. Boost Topology - Integrated Sync. Driver required - Enhance efficiency at the same time
TPS61040	TPS61045	TPS61060
SOT23-5	3x3 QFN	3x3 QFN/CSP
		

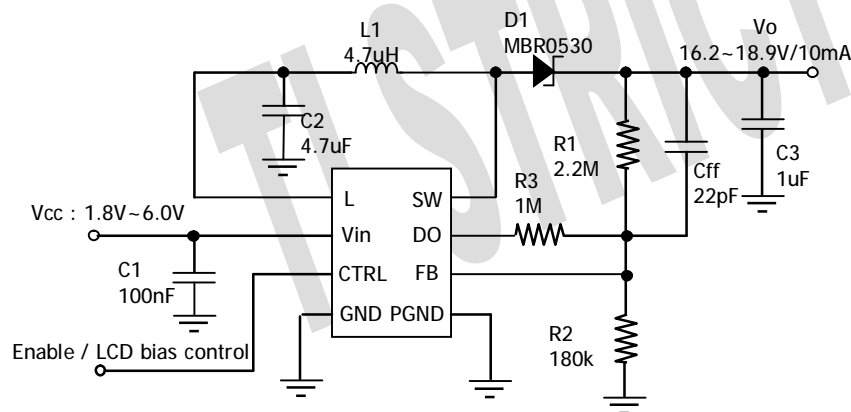
TPS61045 - True Shutdown Boost Converter

p Features

- ü 1.8V to 6.0V Input Voltage Range
- ü up to 80% efficiency
- ü Digital adjustable output voltage control
- ü Disconnects output from input during shutdown
- ü 40mA typical no load quiescent current

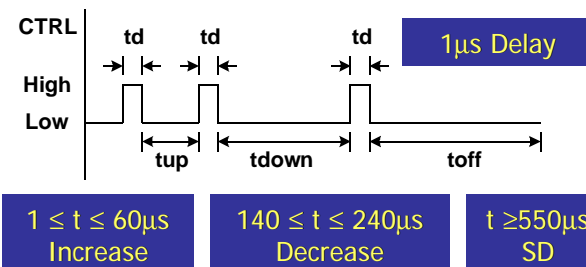
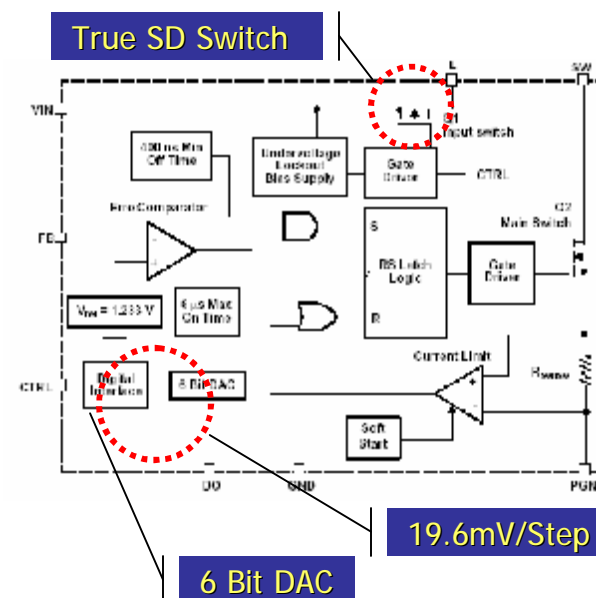
p Benefit

- True Shutdown, save one PFET
- Digital interface control output voltage
- 3x3mm² QFN8 Package



DS

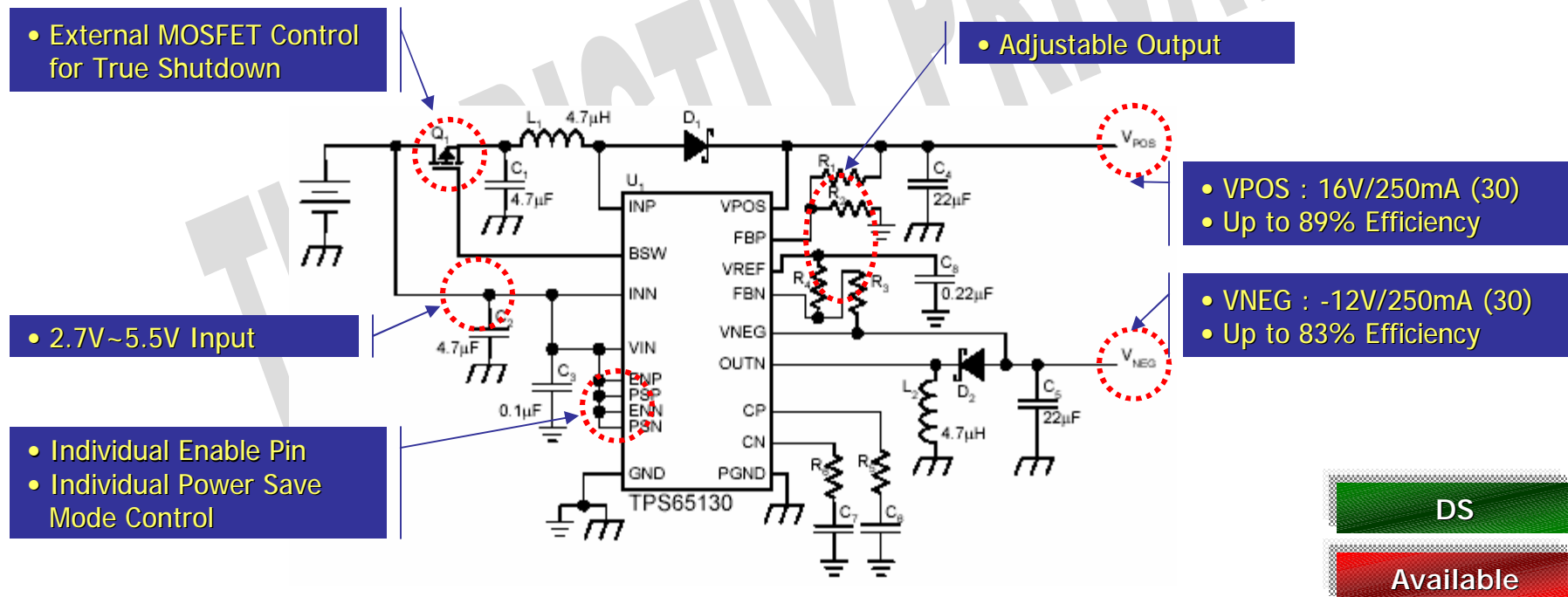
Available



TPS65130/1 - Dual Channel OLED Power Supply

Features

- 1.5MHz Fixed Frequency PWM Operation
- I_{switch} : TPS65130/31 : 800mA/1950mA
- 50mA Quiescent Current
- 1μA Shutdown Current
- Thermal Shutdown
- 4x4mm² QFN16 Package



New PMP Selection Guide - 20004Q4



<http://www-s.ti.com/sc/techlit/slv145.pdf>



The
POWER
Behind Your Designs

<http://power.ti.com>