AME, Inc.

AME5136

Integrated White LED Driver With Organic LED Display Power Supply

■ General Description

The AME5136 is a dual Boost DC/DC converter, designed to drive up to 4 white LEDs with a constant current and to power an organic LED display with a constant voltage. According to SEL pin status, the AME5136 can either regulates output current flowing through series connected LEDs or regulate output voltage applying to OLED.

A single external resistor is used to set the maximum LED current. The LED current can be adjusted by applying a PWM signal to the EN pin. Pulling the EN pin to GND disables the chip and reduces the supply current to less than 1uA. Additional features include a low-side NFET switch that can turn off the LED string with no DC current path to ground. Other features include OVP, OCP, UVP and OTP.

The AME5136 is available in a small DFN-10(3mmx3mmx0.85mm) package.

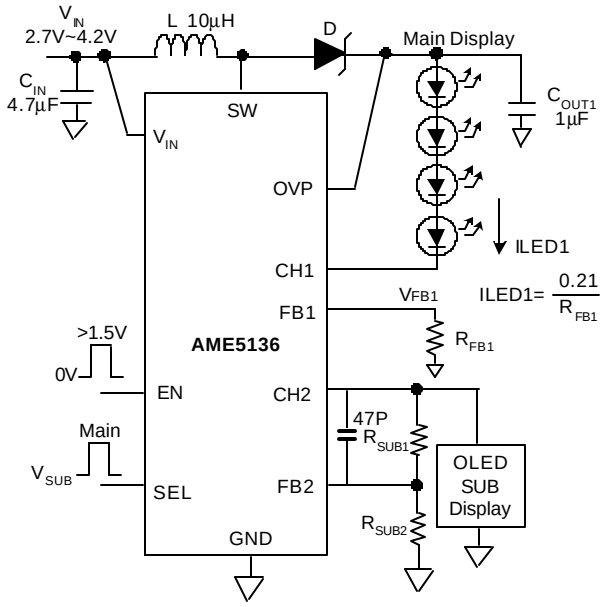
■ Features

- Integrated OLED and White-LED Driver
- Wide Input Voltage Range: 2.7V to 5.5V
- Adjustable output voltage up to 20V
- Complete Protection: OVP, OTP, UVP
- PWM Dimming Control
- Small External Components
- Cycle-By-Cycle Current Limit
- All AME's Lead Free Products Meet RoHS Standards

■ Applications

- White LED Back-Lighting
- Hand-held Devices
- Digital Cameras
- Flip-phones / Clam-shell Cellular Phones
- High-fashion cellular phones

■ Typical Application



$$V_{SUB} = \left(1 + \frac{R_{SUB1}}{R_{SUB2}}\right) \times 1.23$$

Figure 1. Main LEDs Display and OLED SUB Display

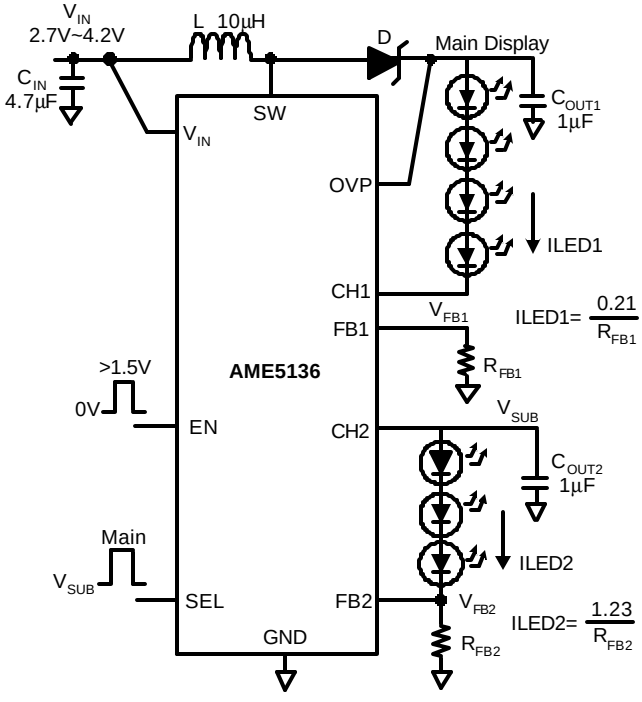


Figure 2. 4 LEDs for Main Panel and 3 LEDs for SUB Panel

■ Function Block Diagram

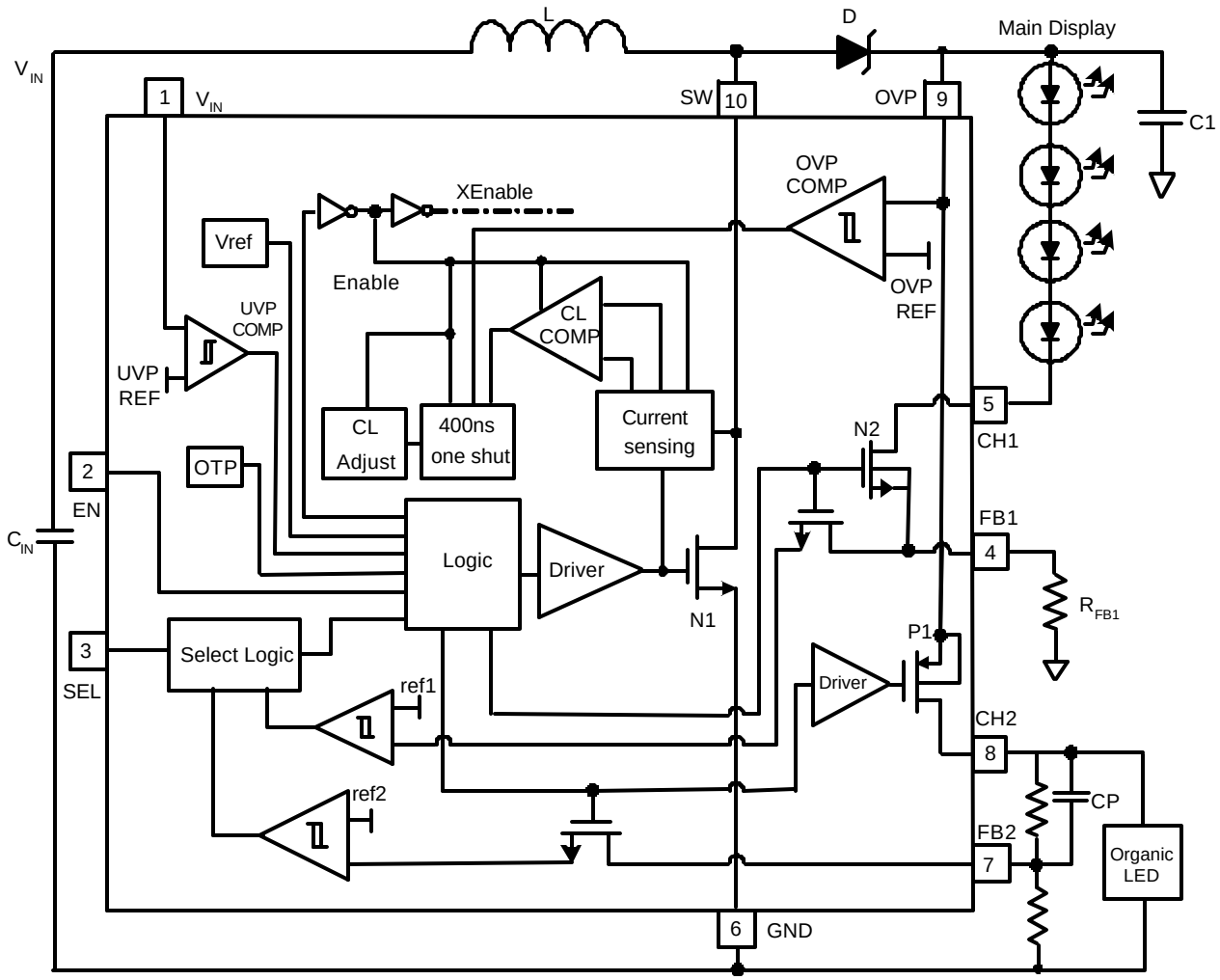
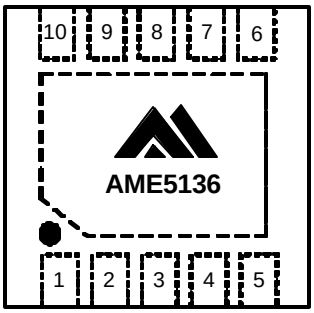


Figure 3. AME5136 Function Block Diagram

■ Pin Configuration

DFN-10
(3mmx3mmx0.85mm)
Top View



AME5136AEVB

1. V_{IN}
2. EN
3. SEL
4. FB1
5. CH1
6. GND
7. FB2
8. CH2
9. OVP
10. SW

*** Die Attach:**
Conductive Epoxy

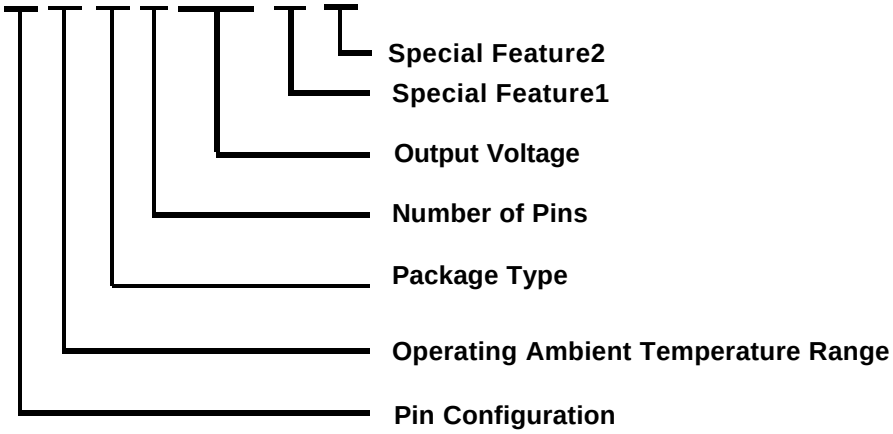
Note : The area enclosed by dashed line represents Exposed Pad and connect to GND.

■ Pin Description

Pin Number	Pin Name	Pin Description
1	V_{IN}	Input Voltage.
2	EN	Shutdown control input, active low. The shutdown pin is an active low control. Tie this pin above 1.5V to enable the device. Tie this pin below 0.4V to turn off the device.
3	SEL	Selection Pin. Internal MOSFET selection. Pull low to turn on the internal CH1. Pull high to turn on CH2.
4	FB1	Main Display Feedback.
5	CH1	Main Display Return Voltage
6	GND	Ground.
7	FB2	SUB Display Feedback.
8	CH2	SUB Display Power Supply Voltage. $V_{SUB} = \left(1 + \frac{R_{SUB1}}{R_{SUB2}}\right) \times 1.23$
9	OVP	Over Voltage Protection.
10	SW	This is the switch pin and is connected to the drain of the internal NMOS power switch N1.

■ Ordering Information

AME5136 x x x x xxx x- x



Pin Configuration	Operating Ambient Temperature Range	Package Type	Number of Pins	Output Voltage	Special Feature1	Special Feature2 (For DFN package only)
A (DFN-10) 1. V_{IN} 2. EN 3. SEL 4. FB1 5. CH1 6. GND 7. FB2 8. CH2 9. OVP 10. SW	E: -40°C to +85°C	V: DFN	B: 10	ADJ: Adjustable	Z: Lead free	3: 3x3x0.85(mm) (LxWxH)

■ Ordering Information

Part Number	Marking*	Output Voltage	Package	Operating Ambient Temperature Range
AME5136AEVBADJZ-3	BDZ yyww	ADJ	DFN-10 (3mmx3mmx0.85mm)	-40°C to +85°C

Note: ww represents the date code and pls refer to Date Code Rule page on Package Dimension.
* A line on top of the first letter represents lead free plating such as BDZ.
Please consult AME sales office or authorized Rep./Distributor for the availability of package type.

■ Absolute Maximum Ratings

Parameter	Symbol	Maximum	Unit
Input Supply Voltage	V_{IN}	6	V
EN, FB Voltages	V_{EN},V_{FB}	V_{IN}	
SW Voltage	V_{SW}	30	
ESD Classification	A*		

Caution: Stress above the listed absolute rating may cause permanent damage to the device.

* HBM A: 0V ~ 1999V

■ Recommended Operating Conditions

Parameter	Symbol	Rating	Unit
Input Supply Voltage	V_{IN}	2.7 to 5.5	V
Ambient Temperature Range	T_A	-40 to +85	^oC
Junction Temperature Range	T_J	-40 to +125	

■ Thermal Information

Parameter	Package	Die Attach	Symbol	Maximum	Unit
Thermal Resistance (Junction to Ambient)	DFN-10 (3x3x0.85)(mm)	Conductive Epoxy	θ_{JA}	48	^oC / W
Internal Power Dissipation			P_D	2	W
Maximum Junction Temperature				150	^oC
Solder Iron (10 Sec)**				350	^oC

* MIL-STD-202G 210F

■ Electrical Specifications

V_{IN}=3.6V, EN = $V_{IN,}$ T_A= 25ºC unless otherwise noted.

Parameter	Symbol	Test Condition		Min	Typ	Max	Units
Input Voltage Range	V_{IN}	T_A = -40°C to +85°C		2.7		5.5	V
Main Display Quiescent Current	I_Q(Main)	FB = 0.3 (Not Switch)	T_A = 25°C		150	200	μA
			T_A = -40 to 85°C			300	
		FB = 0.1 (Switching)	T_A = 25°C		150	250	
			T_A = -40 to 85°C			400	
SUB Display Quiescent Current	I_Q(SUB)	FB = 1.3V (Not Switch)	T_A = 25°C		150	200	μA
			T_A = -40 to 85°C			300	
		FB = 1.15V (Switching)	T_A = 25°C		150	250	
			T_A = -40 to 85°C			400	
Shutdown Current	I_{SD}	EN = 0V			0.05	2	μA
FB1 Feedback Voltage	V_{FB1}	T_A = -40 to 85°C		0.2	0.21	0.23	V
FB2 Feedback Voltage	V_{FB2}	T_A = -40 to 85°C		1.2	1.23	1.26	
Switch Current Limit	I_{CL}	T_A = 25°C		300	350	400	mA
		T_A = -40 to 85°C		280		400	
Main_Switch $R_{DSON,}$ N1	R_{DSON}	T_A = -40 to 85°C			0.6	1.6	Ω
PMOS Switch R_{DSON}, P1					8	10	
NMOS Switch R_{DSON}, N2					6	8	
Switch off time	t_{OFF}				400		ns
Input Under Voltage Lockout	UVP	T_A = -40 to 85°C		1.7	2	2.3	V
Output Over Voltage Protection	OVP	T_A = -40 to 85°C		21	22	23	
Over Temperature Protection	OTP				160		°C
Over Temperature Hysteresis	OTH				20		
Main Switch Leakage N1	I_{SW}	V_{SW} = 5V			0.1	2	μA
PMOS Switch Leakage P1					0.5	1	
NMOS Switch Leakage N2					0.5	1	
EN Input Threshold (Low) (Shutdown)	EN Threshold	T_A = -40 to 85°C				0.4	V
EN Input Threshold (High) (Enable the device)				1.5			
Sel Low Level Voltage Enable SUB Display Disable Main Display	SEL Threshold	T_A = -40 to 85°C				0.3	V
Sel High Level Voltage Enable Main Display Disable SUB Display				1.5			

■ Detailed Description

The AME5136 is designed for white LED & OLED backlighting in mobile phone applications. It has a main display loop which can drive up to 4 white LEDS in series and a SUB display loop which is designed to drive OLED up to 20V/10mA or 3 white LEDs.

The AME5136 operates at a wide input voltage range suitable for Li-ion battery and has a constant off time for smaller inductor and capacitors. The block diagram refers the operation circuit. By SEL pin, it can choose the different channel to turn on CH1 or CH2.

Current Limit Protection

The AME5136 has current limiting protection to prevent excessive stress on itself and external components during overload conditions. The internal current limit comparator will disable the NMOS power device at a typical switch peak current limit of 300mA.

Output Over-Voltage Protection

The AME5136 contains dedicated circuitry for monitoring the output voltage. In the event that the primary LED network is disconnected the output will increase and be limited to 22V(typ.). There is a ~1V hysteresis associated with this circuitry, which will turn the NMOS off when the output voltage is at 23V(max.) until the output voltage reach 21V(typ.) or lower. The 22V limit allows the use of 25V 1μF ceramic output capacitors creating an overall small solution for white LED applications.

Under Voltage Protection

The AME5136 has an UVP comparator to turn the NMOS power device off in case the input voltage or battery voltage is too low preventing an on state of the power device conducting large amounts of current.

■ Application Information

Inductor Selection

The recommended value of inductor for AME5136 applications is 10uH. Small size and better efficiency are the major concerns for portable device, such as AME5136 used for dual panel mobile phone. The inductor should have low DCR for better efficiency. To avoid inductor saturation, current rating should be at least 600mA. The in put range is 2.7V to 5.5V.

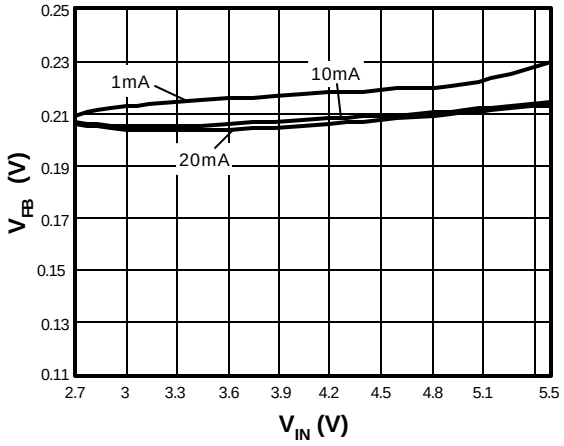
Capacitor Selection

4.7μF input capacitor can reduce input ripple. For better voltage stability, to increase the input capacitor value or using LC filter is feasible, especially in the Li-ion battery application. 1uF output capacitor is sufficient to reduce output voltage ripple. For better voltage filtering, ceramic capacitors with low ESR are recommended. X5R and X7R types are suitable because of their wider voltage and temperature ranges.

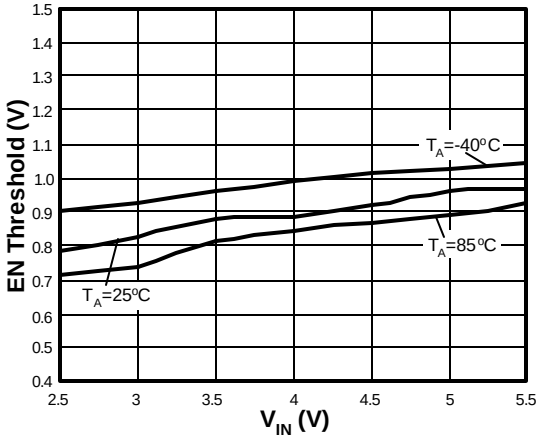
Diode Selection

Schottky diode is a good choice for AME5136 because of its lower forward voltage drop and faster reverse recovery. Using schottky diode can get better efficiency. The high speed rectification is also a good characteristic of schottky diode for high switching frequency. Current rating of the diode must meet the root mean square of the peak current and output average current multiplication.

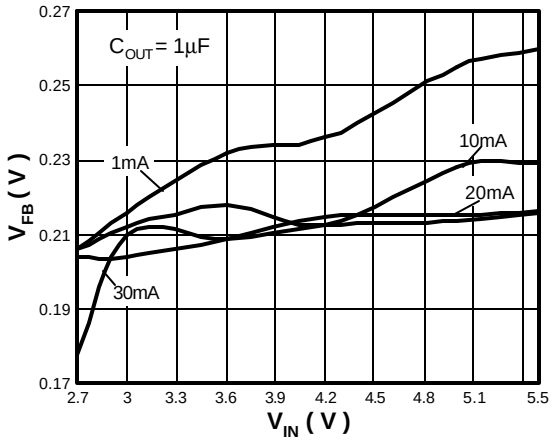
Feedback Voltage vs. V_{IN} (4LEDs)



EN Threshold vs. V_{IN}



Feedback Voltage vs. V_{IN} (3LEDs)



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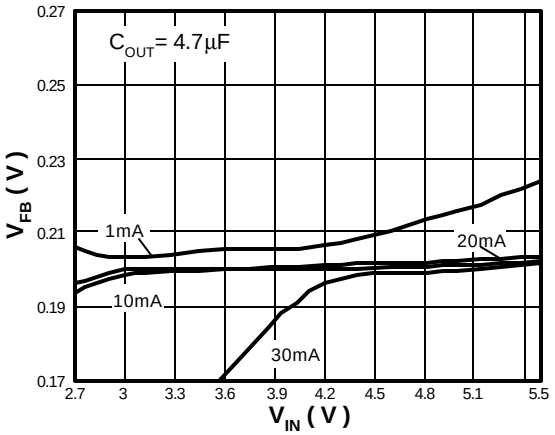
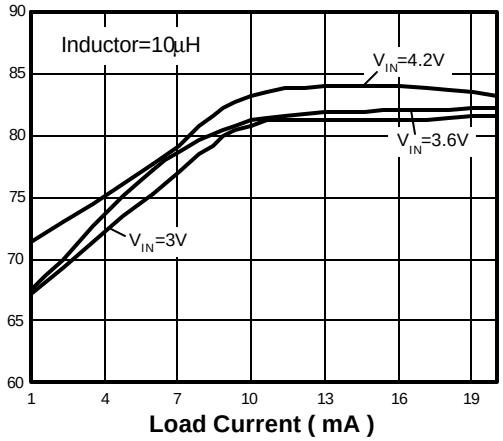
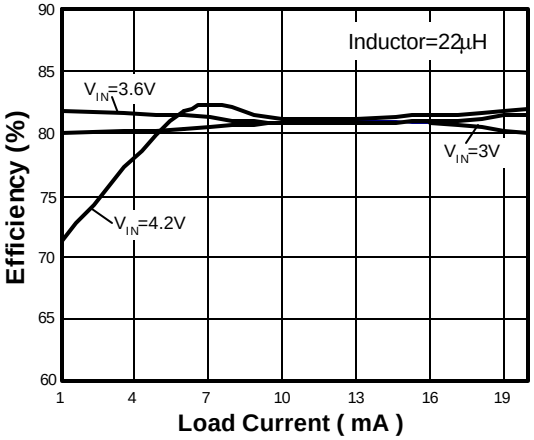


Main Display Efficiency (4LEDs)



Main Display Efficiency (4LEDs)



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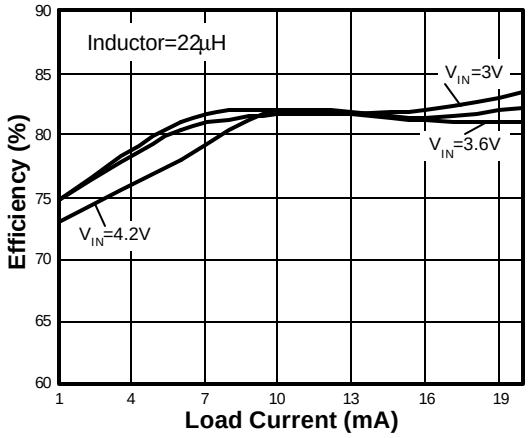

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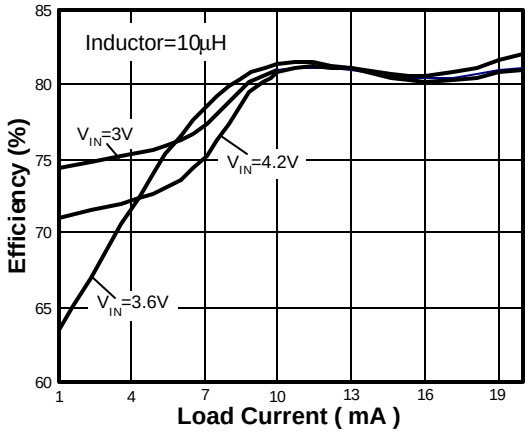
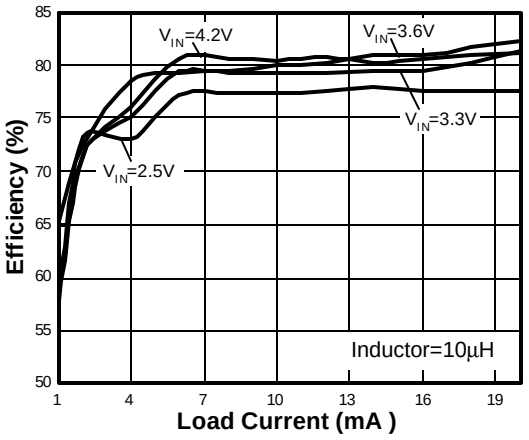
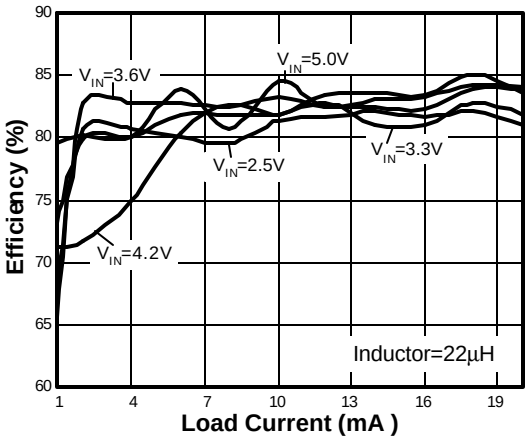


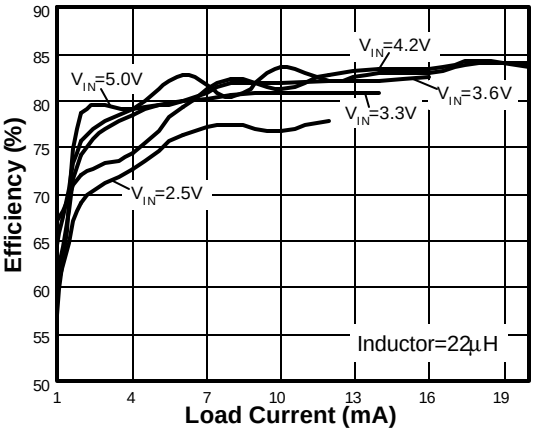
Sub Display Efficiency(V_{SUB}=12V)



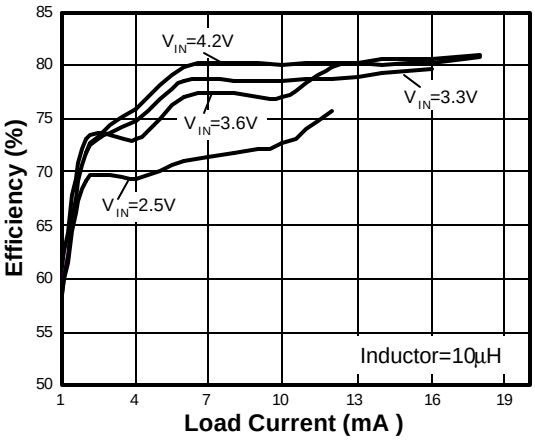
Sub Display Efficiency (V_{SUB}=12V)



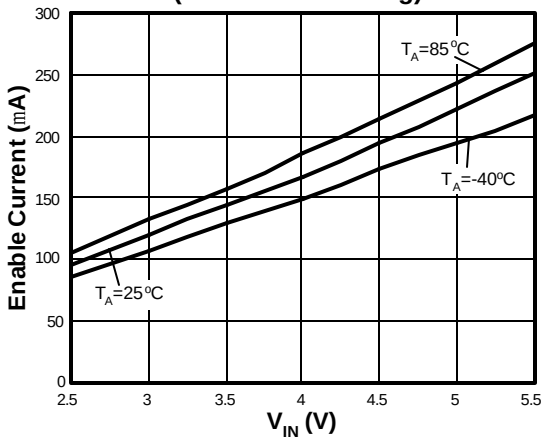
Sub Display Efficiency(V_{SUB}=20V)



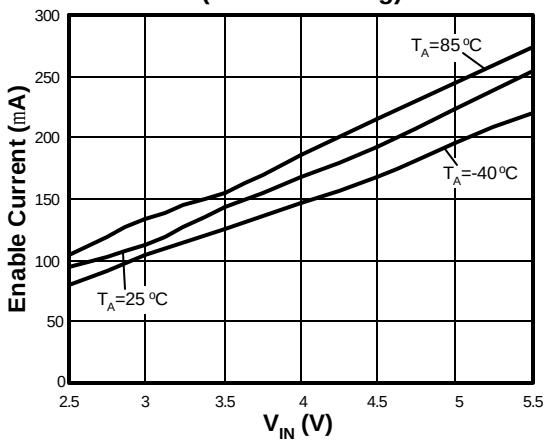
Sub Display Efficiency(V_{SUB}=20V)



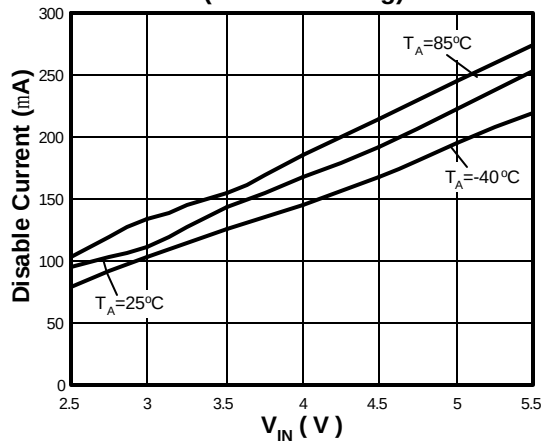
Sub Enable Current vs. V_{IN} (Part not Switching)



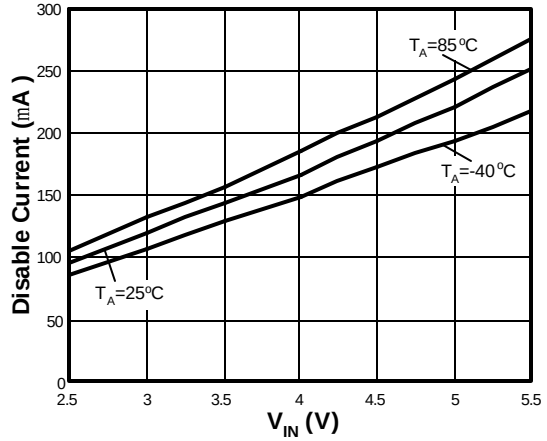
Main Enable Current vs. V_{IN} (Part Switching)



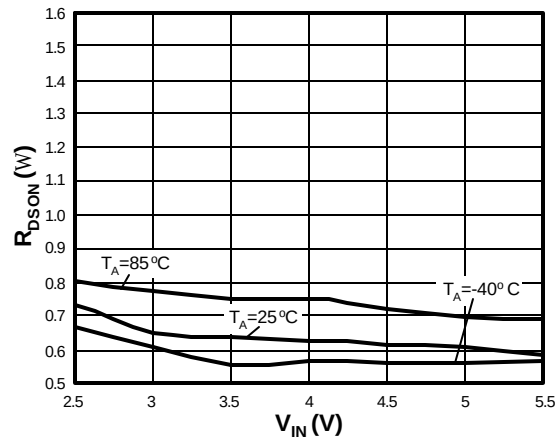
Main Disable Current vs. V_{IN} (Part Switching)



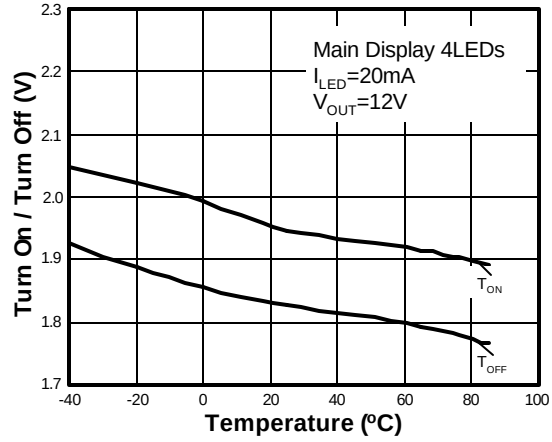
Sub Disable Current vs. V_{IN} (Part not Switching)



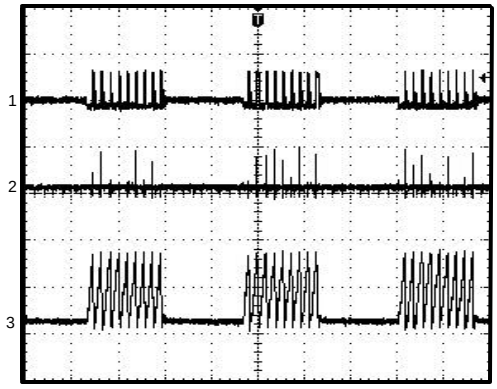
Switch R_{DSON} vs. V_{IN}



Input Under Voltage Lockout vs. Temp.

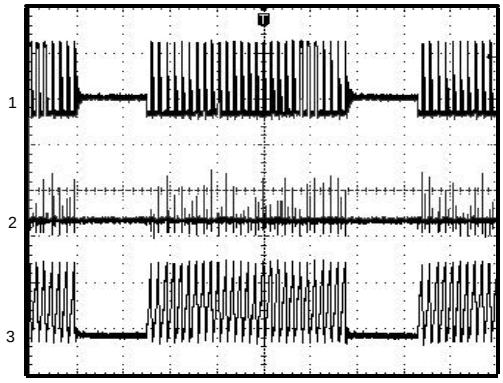


Typical Switching Waveform



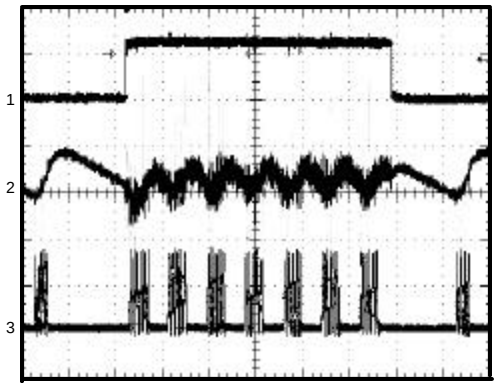
V_{OUT} =12V, V_{IN}=2.5V; 4LEDs
I_{OUT}=10mA (R_{FB1}=20 Ω)
1) V_{SW}= 20V/div,DC
2) V_{OUT} , 100mV / div,AC
3) Inductor Current, 200mA / div,DC
T= 10μS / div
Inductor=10μH, C_{OUT}=4.7μF

Typical Switching Waveform



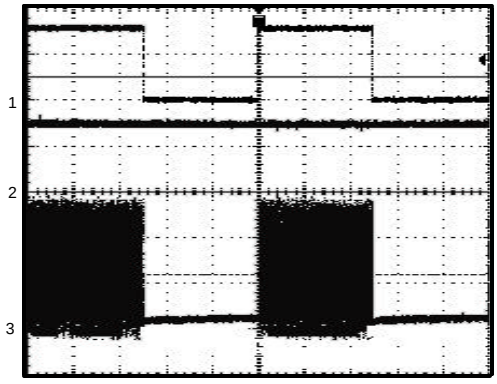
V_{OUT}=12V, V_{IN}=3.6V; 4LEDs
I_{OUT}=20mA (R_{FB1}=10Ω)
1) V_{SW}= 10V/div,DC
2) V_{OUT} , 100mV / div,AC
3) Inductor Current, 200mA / div,DC
T= 10μS / div
Inductor=10μH, C_{OUT}=4.7μF

Step Response



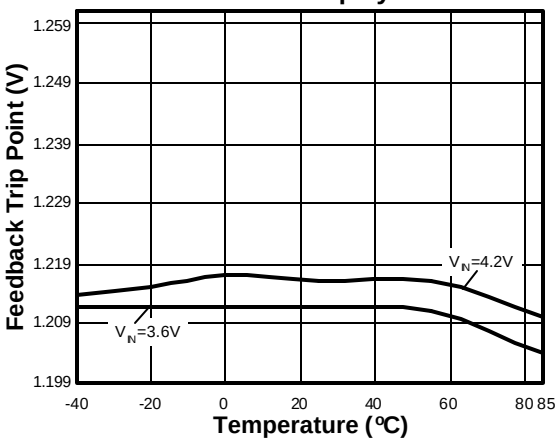
V_{OUT}= 12V , V_{IN}=3.6V
1) Load 2mA to 15mA to 2mA ,DC.
2) V_{OUT} , 100mA / div,AC
3) Inductor Current 200mA / div,DC
T= 20μS /div

Start-Up/Shutdown

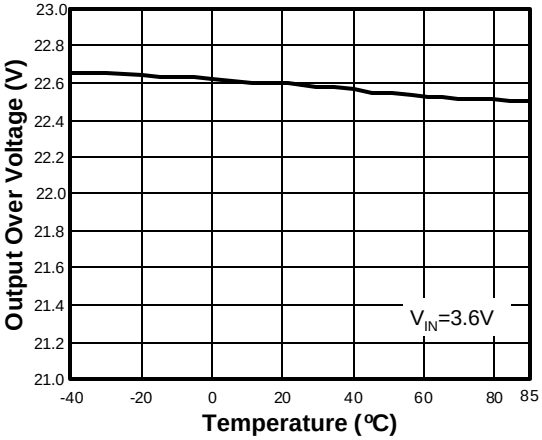


V_{OUT}=12V , V_{IN}=2.7V
1) EN , 1V/ div.DC
2) V_{OUT} , 10/div,DC
3) Inductor Current 100mA/div,DC
Load = 4LEDs, T=2ms/div

FB Trip Point vs Temperature
SUB Display



Output Over Voltage Protection vs. Temp.

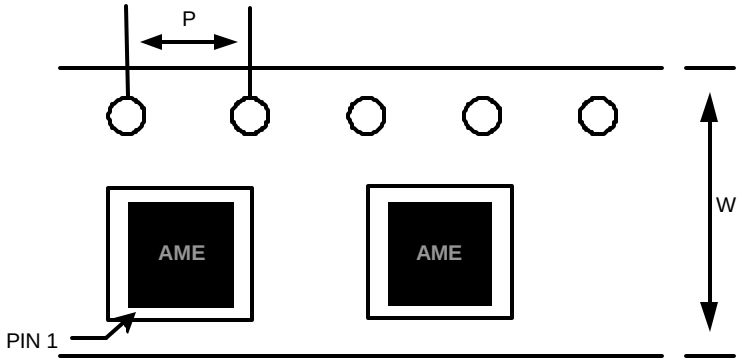


■ Date Code Rule

Marking			Date Code		Year
A	A	A	W	W	xxx0
A	A	A	W	W	xxx1
A	A	A	W	W	xxx2
A	A	A	W	W	xxx3
A	A	A	W	W	xxx4
A	A	A	W	W	xxx5
A	A	A	W	W	xxx6
A	A	A	W	W	xxx7
A	A	A	W	W	xxx8
A	A	A	W	W	xxx9

■ Tape and Reel Dimension

DFN-10
(3mmx3mmx0.85mm)

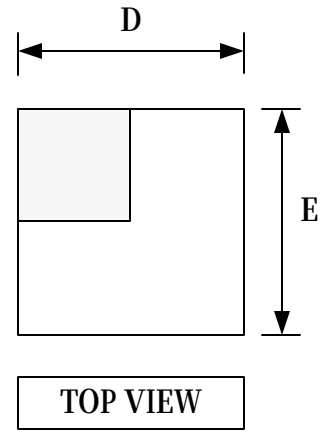


Carrier Tape, Number of Components Per Reel and Reel Size

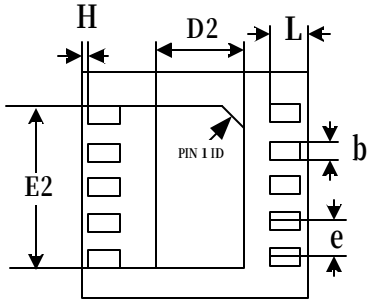
Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
DFN-10 (3mmx3mmx0.85mm)	8.0±0.1 mm	4.0±0.1 mm	1000pcs	180±1 mm

■ Package Dimension

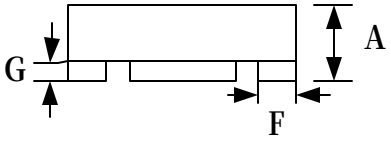
DFN-10
(3mmx3mmx0.85mm)



TOP VIEW



BOTTOM VIEW



SIDE VIEW

SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A		0.900		0.035
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
F	0.450 TYP.		0.017 TYP.	
e	0.450	0.550	0.018	0.022
D2	1.600 TYP.		0.063 TYP.	
E2	2.400 TYP.		0.094 TYP.	
b	0.150	0.250	0.0059	0.010
L	0.350	0.450	0.014	0.018
G	0.010	0.090	0.0004	0.004
H	0.000	0.050	0.000	0.002

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