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Lead-free Green

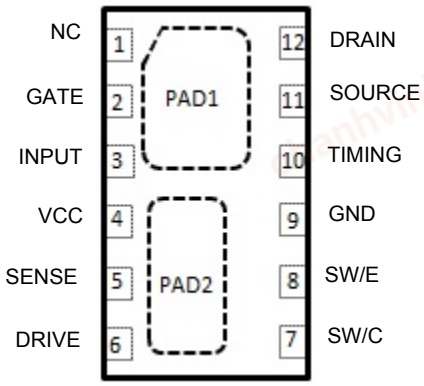
AL8812

BOOST/BUCK DC-DC CONVERTER FOR DIMMABLE MR16 LED LAMPS

Description

The AL8812 is a monolithic control circuit containing the primary functions required for DC-to-DC converters with MOSFET in one package. These devices consist of an internal temperature compensated reference, comparator, controlled duty cycle oscillator with an active current limit circuit, driver and high current output switch. Additionally a 60V, 3.6A MOSFET is integrated for reduced BOM cost and size. This series is specifically designed for buck and boost applications with a minimum number of external components.

Pin Assignments



U-DFN6040-12

Features

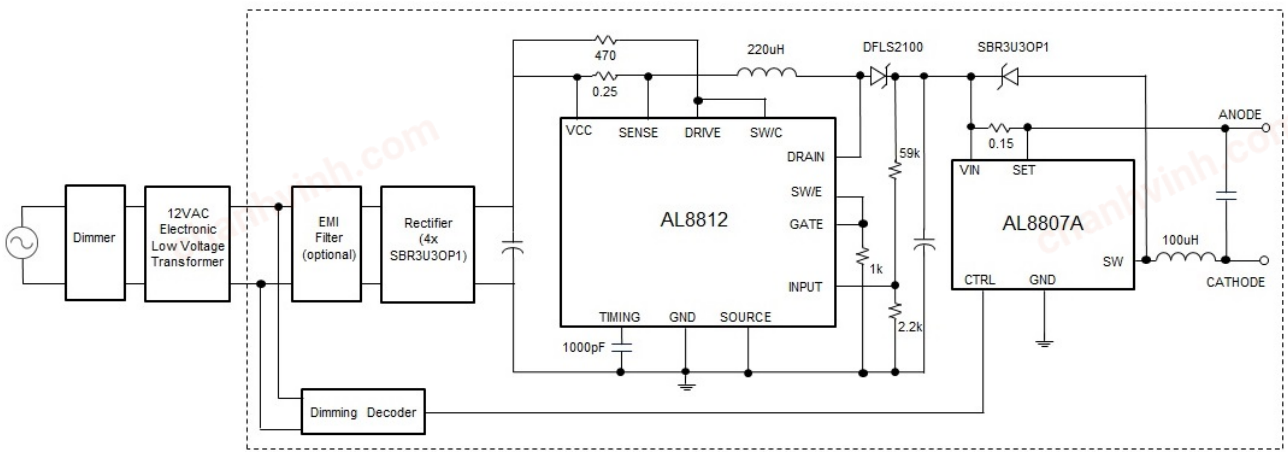
- Operation from 3.0V to 20V Input
- Integrated 60V, 3.6A MOSFET
- Low Standby Current
- Current Limiting
- Output Voltage Adjustable
- Frequency Operation to 100 kHz
- Precision 2% Reference
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Applications

- Low Voltage LED Lighting such as MR-16
- General Purpose DC-DC Converter

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Typical Applications Circuit



Dimmable MR-16 LED Driver System Diagram

(For detailed schematic please contact your Diodes Sales Representative)

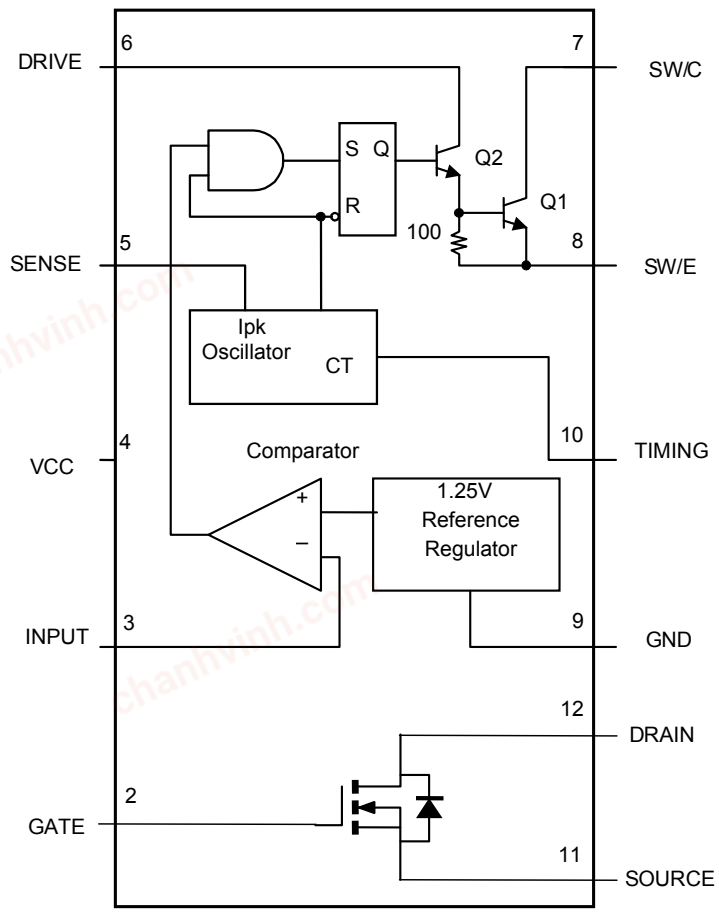
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Pin Descriptions

Pin Name	Pin Number (U-DFN6040-12)	Function
NC	1	No Connection
GATE	2	Gate connection of internal MOSFET.
INPUT	3	Feedback pin for inverting input of internal comparator
VCC	4	Supply voltage pin
SENSE	5	No Connection.
DRIVE	6	Current drive collector: Normally connected to V_{CC} directly or via a resistor.
SW/C	7	Internal switch transistor collector
SW/E	8	Internal switch transistor emitter
GND	9	Ground Connection
TIMING	10	Timing Capacitor to control the switching frequency.
SOURCE	11	Source connecton of internal MOSFET
DRAIN	12	Drain connection of internal MOSFET
Exposed PAD1		Exposed Pad of MOSFET Drain
Exposed PAD2		Exposed Pad of AL8812 and connect to PCB ground

Functional Diagram



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Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Value	Unit
V_{CC}	Power Supply Voltage	20	V
V_{IR}	Comparator Input Voltage Range	-0.3 to +36	V
SW/C	Switch Collector Voltage	36	V
SW/E	Switch Emitter Voltage (V_{Pin} 1 = 40V)	36	V
$V_{CE\ (switch)}$	Switch Collector to Emitter Voltage	36	V
DRIVE	Driver Collector Voltage	36	V
$I_{C\ (driver)}$	Driver Collector Current (Note 4)	100	mA
I_{SW}	Switch Current	1.6	A
V_{DS}	Maximum MOSFET Drain-Source voltage	60	V
V_{GS}	Maximum MOSFET Gate-Source voltage	+/-20	V
I_{SOURCE}	Maximum Continuous Source (Body Diode) Current	3.7	A
P_D	Continuous Power Dissipation (T_A = +25°C) (U-DFN6040-12 (derate 10mW/°C above +25°C)	1000	mW
θ_{JA}	Junction-to-Ambient Thermal Resistance	47.31	°C/W
θ_{JC}	Junction-to-Case Thermal Resistance	6.42	°C/W
T_{MJ}	Maximum Junction Temperature	+150	°C
T_{OP}	Operating Junction Temperature Range	0 to +105	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C
ESD HBM	Human Body Model ESD Protection	250	V
ESD MM	Machine Model ESD Protection	100	V

Note: 4. Maximum package power dissipation limits must be observed.

Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

Symbol	Characteristics	Min	Typ	Max	Unit
OSCILLATOR					
f_{osc}	Frequency (V_{PIN} 5 = 0V, C_T = 1.0nF, T_A = +25°C)	24	33	42	kHz
I_{chg}	Charge Current (V_{CC} = 5.0V to 40V, T_A = +25°C)	24	30	42	µA
I_{dischg}	Discharge Current (V_{CC} = 5.0V to 40V, T_A = +25°C)	140	200	260	µA
I_{dischg} / I_{chg}	Discharge to Charge Current Ratio (Pin 7 to V_{CC}, T_A = +25°C)	5.2	6.5	7.5	—
$V_{ipk\ (sense)}$	Current Limit Sense Voltage (I_{chg} = I_{dischg}, T_A = +25°C)	300	400	450	mV
OUTPUT SWITCH (Note 5)					
$V_{CE\ (sat)}$	Saturation Voltage, Darlington Connection (I_{SW} = 1.0A, Pins 1,8 connected)	—	1.0	1.3	V
$V_{CE\ (sat)}$	Saturation Voltage, Darlington Connection (I_{SW} = 1.0A, ID = 50mA, Forced ß ≈ 20)	—	0.45	0.7	V
h_{FE}	DC Current Gain (I_{SW} = 1.0A, V_{CE} = 5.0V, T_A = +25°C)	50	75	—	—
$I_{C\ (off)}$	Collector Off-State Current (V_{CE} = 40V)	-	0.01	100	µA
OUTPUT MOSFET					
$V_{GS(th)}$	MOSFET Gate Threshold voltage	1	—	2.2	V
V_{FD}	MOSFET Diodes forward voltage	—	.85	.95	V
$R_{DS(ON)}$	Drain-source on-resistance (VGS = 10V, ID = 2.5A) Drain-source on-resistance (VGS = 4.5V, ID = 2A)	—	—	120 180	mΩ mΩ
COMPARATOR					
V_{th}	Threshold Voltage	—	—	—	V
—	T_A = +25°C	1.225	1.25	1.275	—
—	T_A = 0°C to +70°C	1.21	—	1.29	—
Reg_{line}	Threshold Voltage Line Regulation (V_{CC} = 3.0V to 40V)	—	1.4	6.0	mV
TOTAL DEVICE					
I_{CC}	Supply Current (V_{CC} = 5.0V to 40V, C_T =1.0nF, Pin 7 = V_{CC}, $V_{Pin\ 5}$ > V_{th} Pin 2 = Gnd, remaining pins open)	—	—	3.5	mA

Note: 5. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.

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Performance Characteristics

Figure 1. Vce(sat) versus Ie

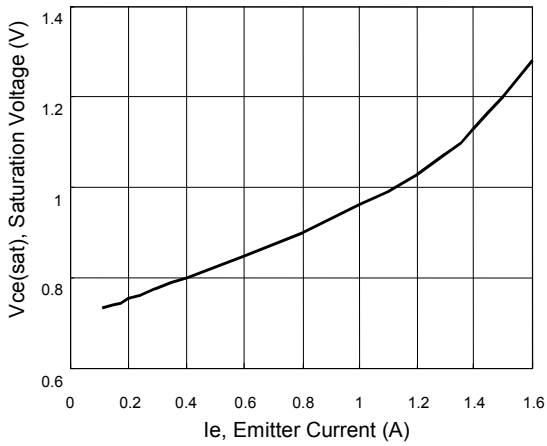


Figure 2. Reference Voltage versus Temp.

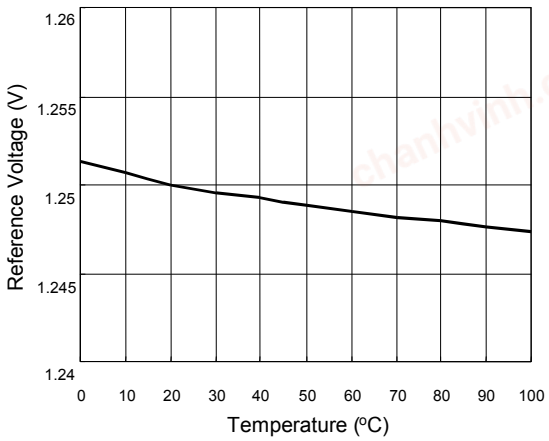


Figure 3. Current Limit Sense Voltage versus Temperature

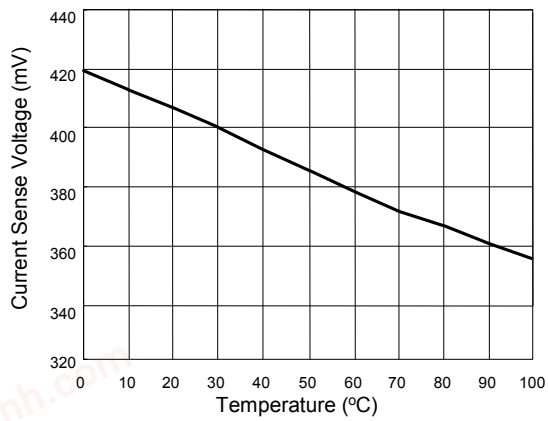


Figure 4. Standby Supply Current versus Supply Voltage

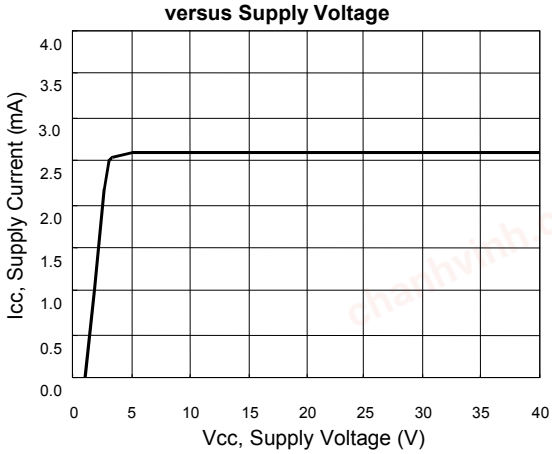


Figure 5. Emitter Follower Configuration Output Saturation Voltage vs. Emitter Current

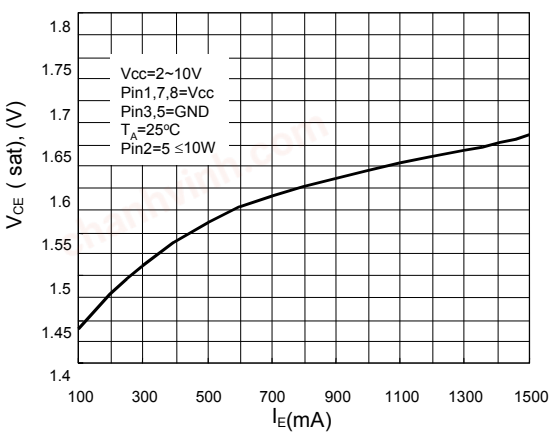
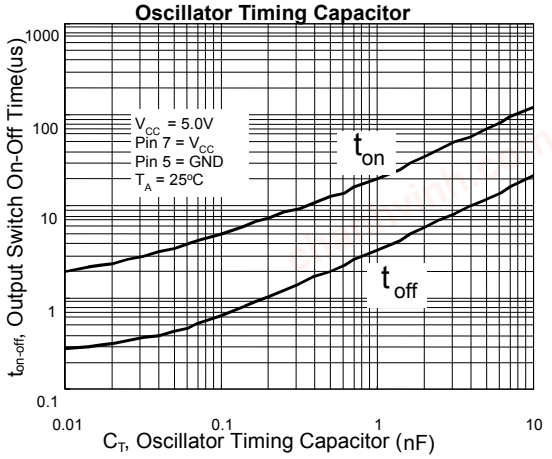
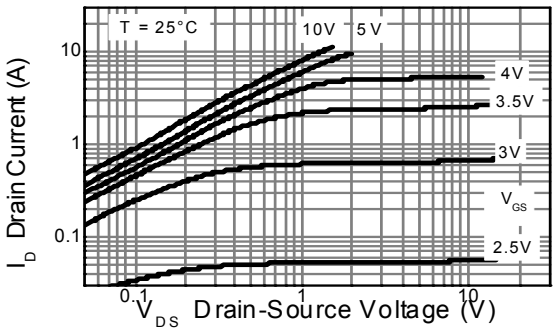


Figure 6.Output Switch On-Off Time versus Oscillator Timing Capacitor

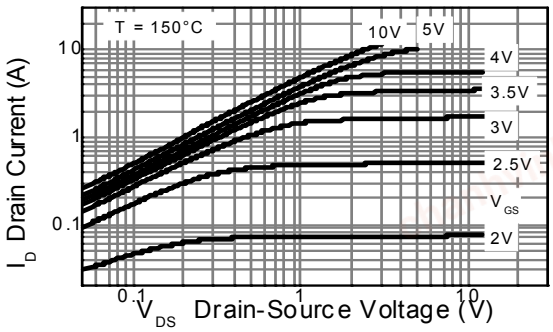


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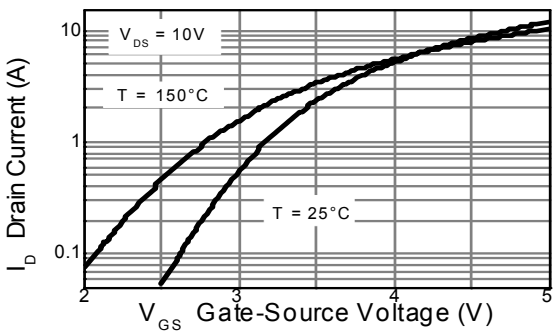
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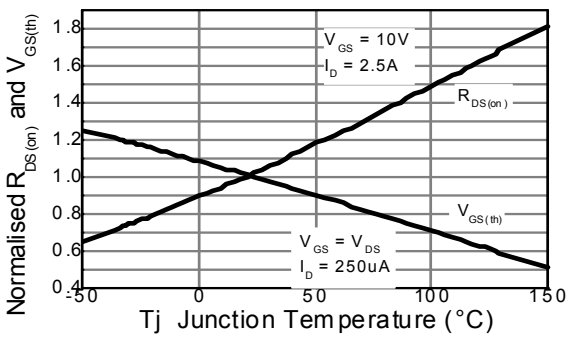
Output Characteristics



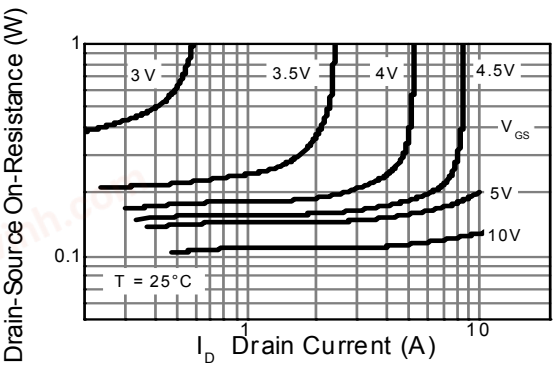
Output Characteristics



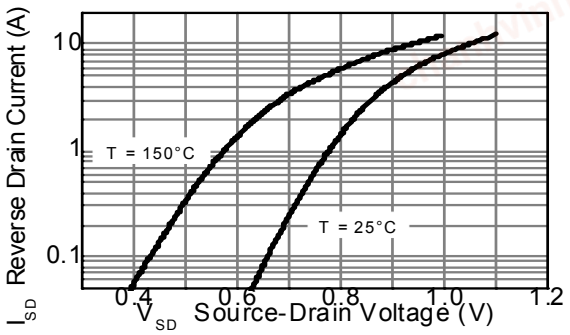
Typical Transfer Characteristics



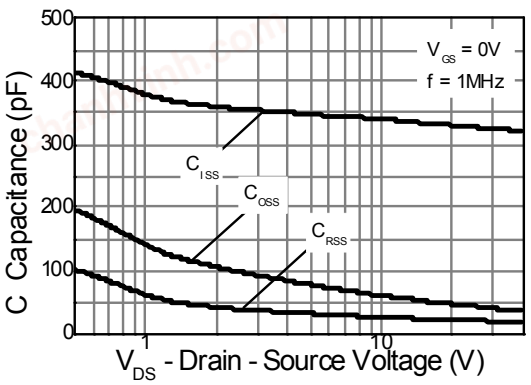
Normalised Curves v Temperature



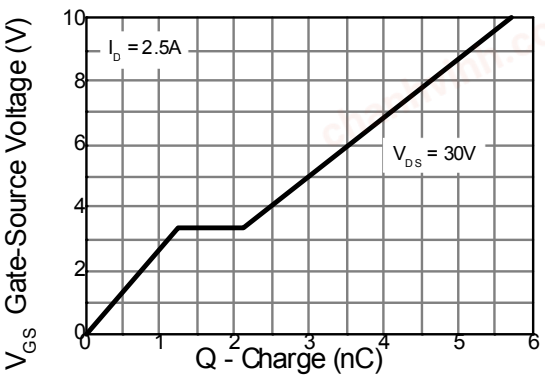
On-Resistance v Drain Current



Source-Drain Diode Forward Voltage



Capacitance v Drain-Source Voltage



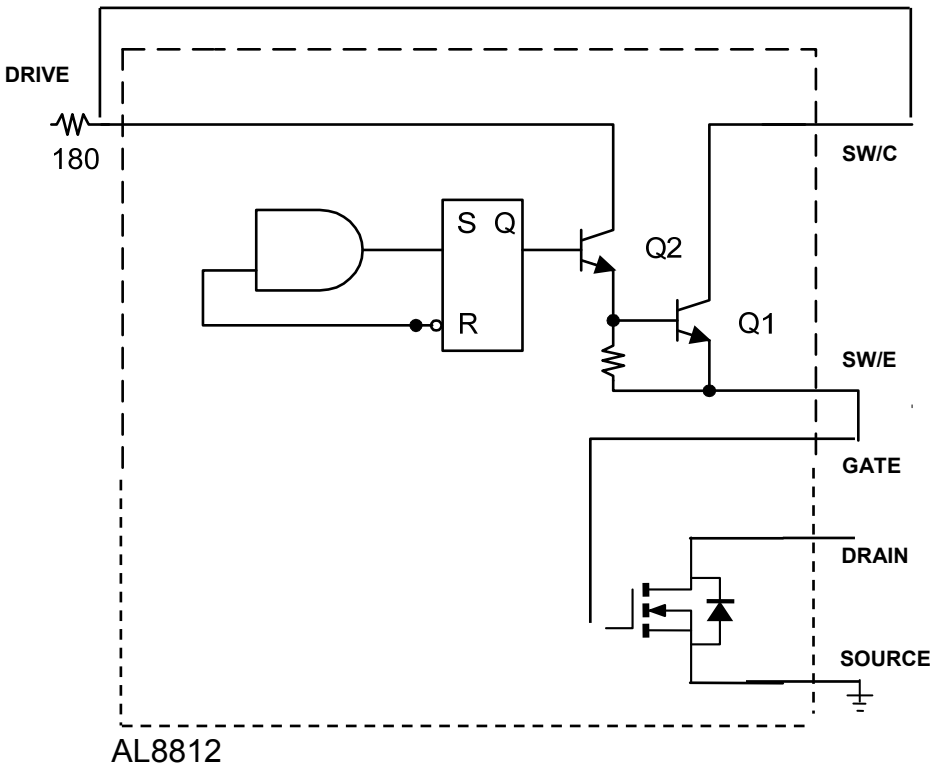
Gate-Source Voltage v Gate Charge

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Typical Application Circuits

Circuits shown below represent connections employed for different topologies. To use the integrated MOSFET the typical configuration below can be used.

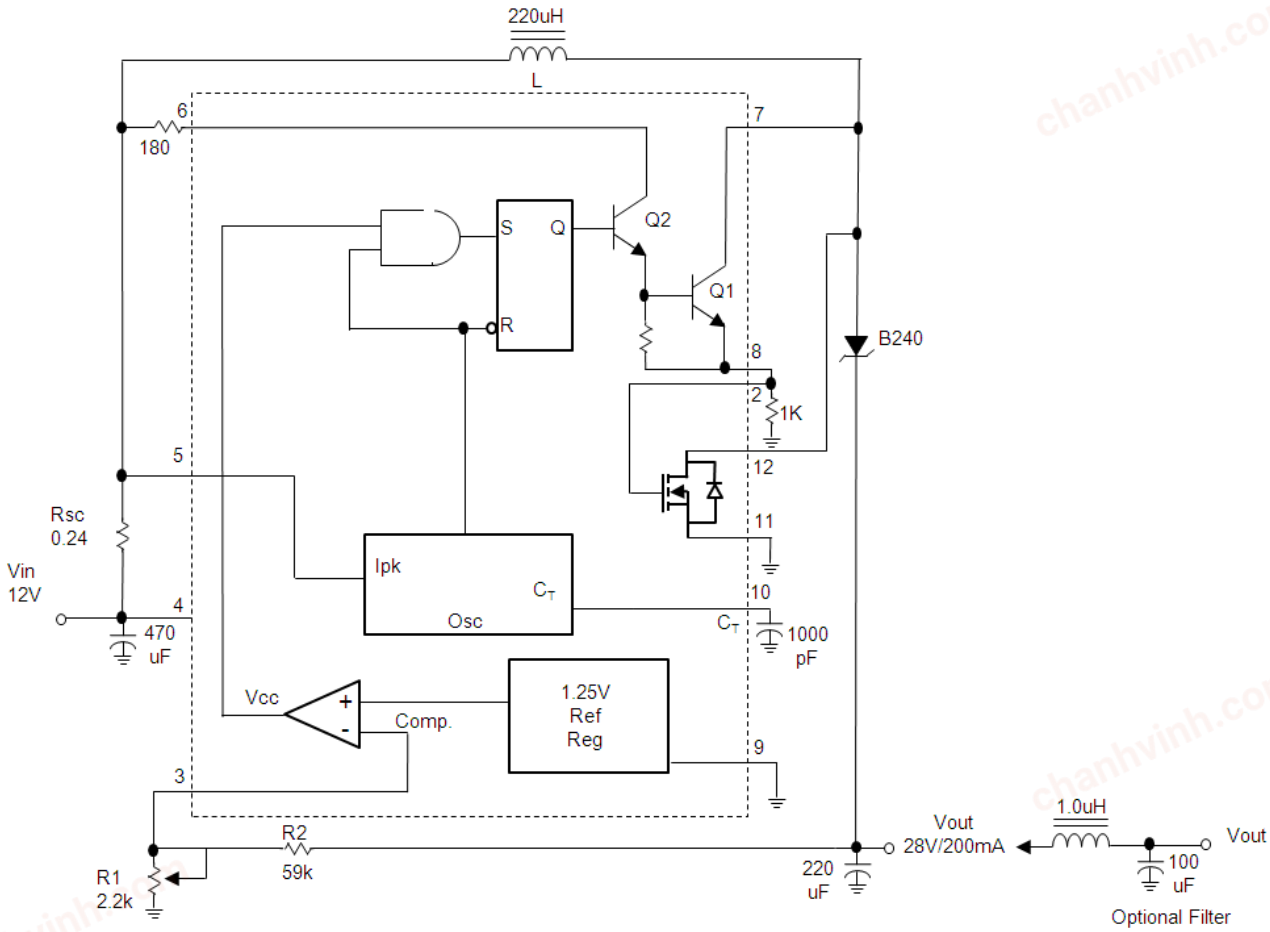


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Typical Application Circuits (cont.)

Boost Converter



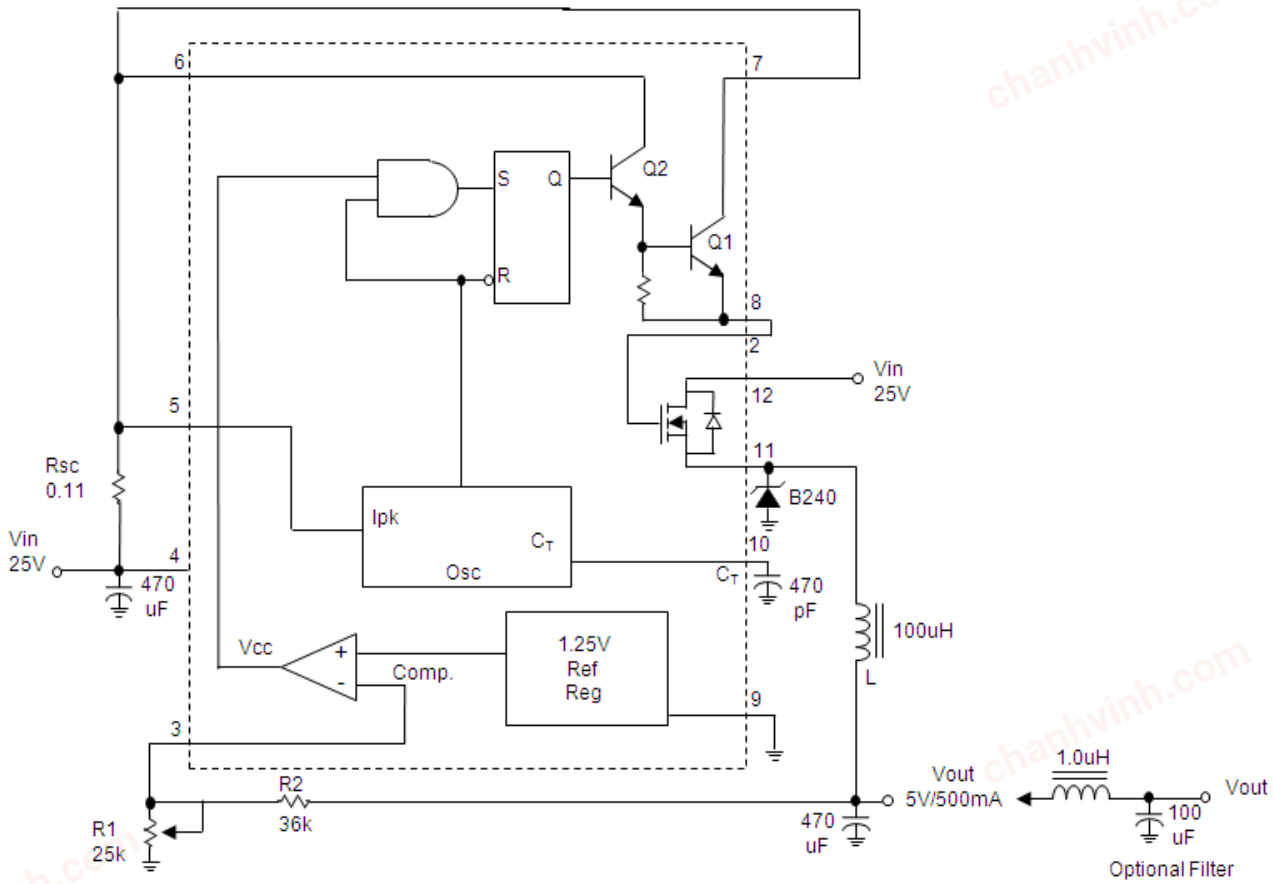
Test	Conditions	Results
Line Regulation	V_{in} = 9V to 12V, I_O = 200mA	20mV = ±0.035%
Load Regulation	V_{in} = 12V, I_O = 50mA to 200mA	15mV = ±0.035%
Output Ripple	V_{in} = 12V, I_O = 200mA	500mV_{PP}
Efficiency	V_{in} = 12V, I_O = 200mA	80%

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Typical Application Circuits (cont.)

Buck Converter



Test	Conditions	Results
Line Regulation	V_{in} = 12V to 24V, I_O = 500mA	20mV = ±0.2%
Load Regulation	V_{in} = 24V, I_O = 50mA to 500mA	5mV = ±0.05%
Output Ripple	V_{in} = 24V, I_O = 500mA	160mV_{PP}
Efficiency	V_{in} = 24V, I_O = 500mA	82%

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Design Formula Table

Calculation	Boost	Buck
t_{ON} / t_{off}	$V_{OUT} + V_F - V_{IN\ (min)}$	$V_{OUT} + v_F$
	$V_{IN\ (min)} - V_{sat}$	$V_{IN\ (min)} - V_{SAT} - V_{OUT}$
$(t_{ON} + t_{off})$	1/f	1/f
t_{off}	$t_{ON} + t_{OFF}$	$t_{ON} + t_{OFF}$
	$\frac{t_{ON}}{t_{OFF}} + 1$	$\frac{t_{ON}}{t_{OFF}} + 1$
t_{ON}	$(t_{ON} + t_{OFF}) - t_{OFF}$	$(t_{ON} + t_{OFF}) - t_{OFF}$
C_T	$4.0 \times 10^{-5} t_{ON}$	$4.0 \times 10^{-5} t_{ON}$
I_{pk} (switch)	$2I_{OUT\ (max)} (t_{ON} / t_{off} + 1)$	$2I_{OUT\ (max)}$
R_{sc}	$0.3 / I_{pk\ (switch)}$	$0.3 / I_{pk\ (switch)}$
$L_{(min)}$	$\frac{(V_{IN\ (min)} - V_{sat})}{I_{pk\ (switch)}} t_{on\ (max)}$	$\frac{(V_{IN\ (min)} - V_{SAT} - V_{OUT})}{I_{pk\ (switch)}}$ ON (max)
C_O	9 $\frac{I_{OUT}\ t_{ON}}{V_{ripple\ (pp)}}$	$\frac{I_{pk\ (switch)} (t_{OFF} + t_{ON})}{8V_{ripple\ (pp)}}$

V_{sat} = Saturation voltage of the output switch.
V_F = Forward voltage drop of the output rectifier.

The following power supply characteristics must be chosen:

V_{IN} - Nominal input voltage.
V_{OUT} - Desired output voltage, $|V_{OUT}| = 1.25 (1+R2/R1)$
I_{OUT} - Desired output current.
f_{min} - Minimum desired output switching frequency at the selected values of V_{in} and I_o.
$V_{ripple(pp)}$ - Desired peak-to-peak output ripple voltage. In practice, the calculated capacitor value will need to be increased due to its equivalent series resistance and board layout. The ripple voltage should be kept to a low value since it will directly affect the line and load regulation.

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Ordering Information

AL 8812 XX - X

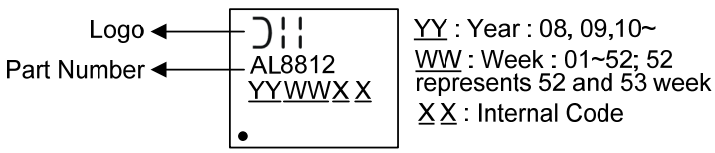
- XX → Package: FDF: U-DFN6040-12
- X → Packing: 13 : Tape & Reel

Part Number	Package Code	Packaging	Tube		13" Tape and Reel	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix
AL8812FDF-13	FDF	U-DFN6040-12	NA	NA	3000/Tape & Reel	-13

Marking Information

(1) U-DFN6040-12

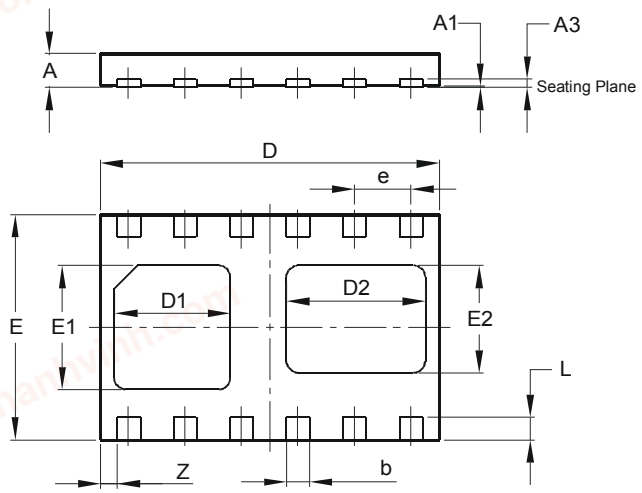
(Top View)



YY : Year : 08, 09,10~
WW : Week : 01~52; 52 represents 52 and 53 week
X X : Internal Code

Package Outline Dimensions (All dimensions in mm.)

Please see AP02002 at http://www.diodes.com/datasheets/ap02002.pdf for latest version.



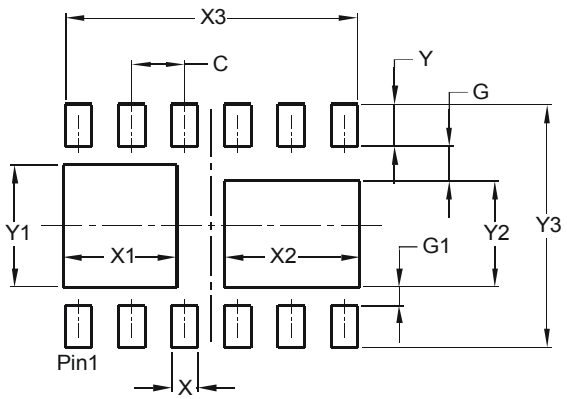
U-DFN6040-12			
Dim	Min	Max	Typ
A	0.55	0.65	0.60
A1	0	0.05	0.02
A3	-	-	0.15
b	0.35	0.45	0.40
D	5.95	6.05	6.00
D1	1.95	2.15	2.05
D2	2.35	2.55	2.45
e	-	-	1.00
E	3.95	4.05	4.00
E1	2.10	2.30	2.20
E2	1.80	2.00	1.90
L	0.35	0.45	0.40
Z	-	-	0.30
All Dimensions in mm			

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Suggested Pad Layout

Please see AP02001 at http://www.diodes.com/datasheets/ap02001.pdf for the latest version.



Dimensions	Value (in mm)
C	0.500
G	0.650
G1	0.350
X	0.250
X1	1.075
X2	1.275
X3	2.750
Y	0.400
Y1	1.150
Y2	1.000
Y3	2.300

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