

# SINGLE INPUT SUPPLY PWM CONTROLLER WITH LDO CONTROLLER

## PRODUCTION DATA SHEET

**Pb Free Product**

### DESCRIPTION

The LX2750 controller IC is a compact synchronous Buck controller IC with 16 lead MLPQ package designed for step-down DC to DC converter applications. Selectable feedforward voltage mode control or constant on time control provides fast dynamic response. Selectable diode emulation mode greatly improves the light load efficiency. The LX2750 controller is optimized to convert single supply 12V bus voltage to as low as 0.8V output voltage. An internal regulator converts bus voltage to 5V, which provides voltage supply to internal logic and driver circuit. The LX2750 employs programmable loss-less current limiting by sensing the R<sub>ds(on)</sub> of synchronous MOSFET followed by hiccup feature. Feedback under voltage also triggers hiccup. Internal UVLO keeps the controller off until the bus supply voltage exceeds 9V where internal digital soft starts get initiated to ramp up output. The LX2750 employs NMOS LDO controller. Other features include: 5V gate drive for HDRV signal, 12V gate drive for LDRV signal, programmable frequency, adaptive deadband control.

### FEATURES

- Single Input 12V Bus Voltage
- Excellent Dynamic Response with Selectable Feedforward Voltage Mode Control or Constant On Time Control
- Diode Emulation Mode Available
- Programmable Switching Frequency Up to 2MHz
- Internal Digital Soft Start Function
- Programmable Over Current Protection Triggers Hiccup
- NMOS LDO Controller Available
- FB UVLO Followed by Hiccup Feature in Both Controllers
- 5V High Side Driver and 12 V Low Side Driver
- Pb-free and RoHS Compliant

### APPLICATIONS

- Graphic Card on Board Converters
- On Board DC to DC such as 12V to 3.3V, 2.5V or 1.8V
- Set Top Box and LCD Display
- ASIC Power Supplies

### TYPICAL APPLICATION

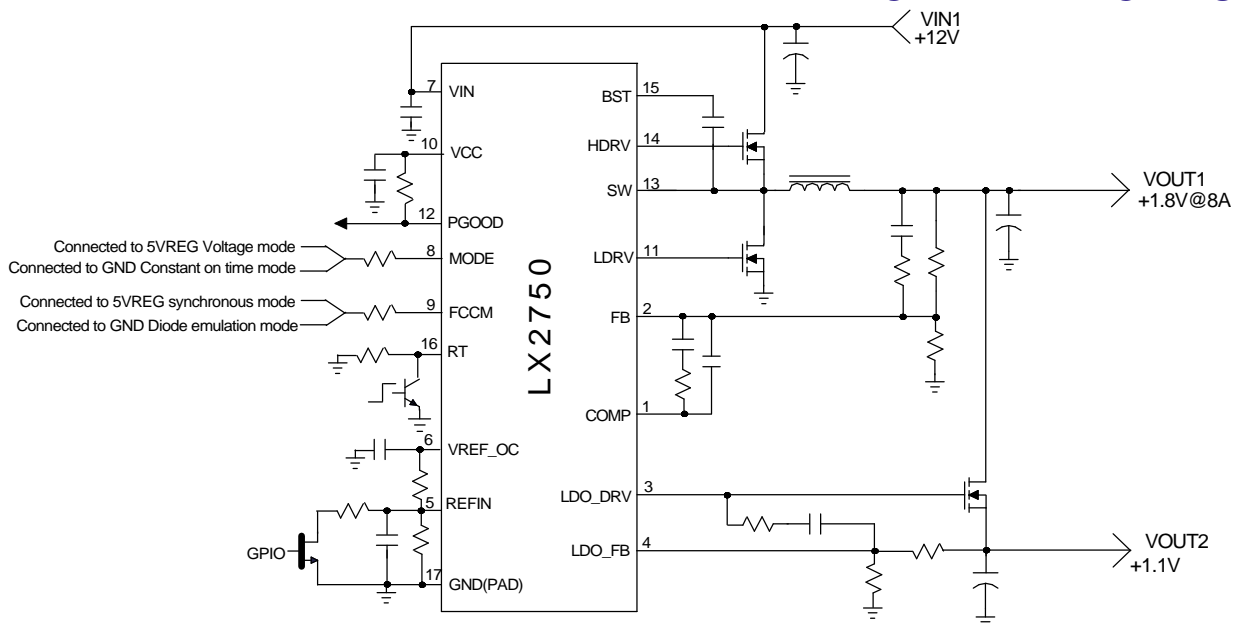


Figure1 - Typical application of LX2750

### ORDERING INFORMATION

Device	Temperature	Package	Frequency	Pb-Free
LX2750CLQ	0 to 70°C	3X3 MLPQ-16L	200kHz to 2MHz	Yes

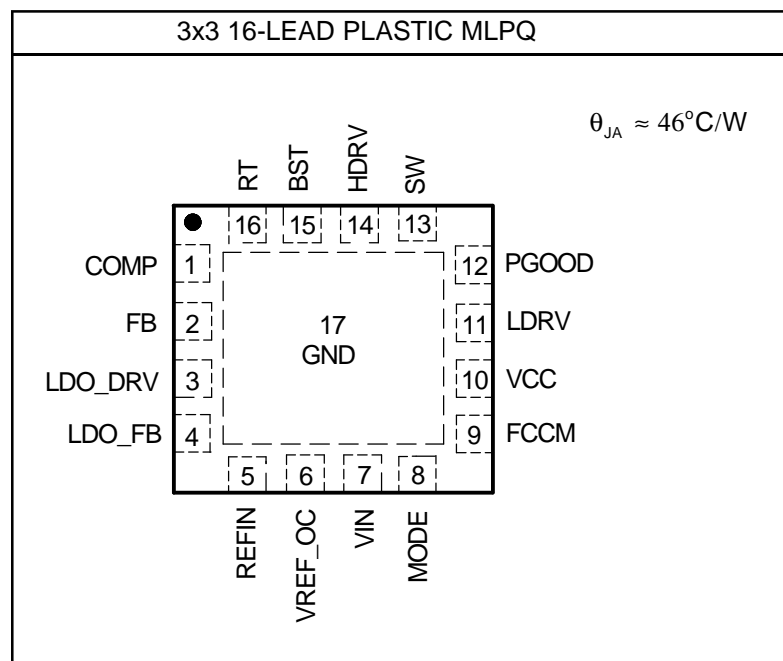
Note: Available in Tape & Reel. Append the letters "TR" to the part number. (i.e. LX2750CLQ-TR)

## ABSOLUTE MAXIMUM RATINGS

5VREG to GND & BST to SW voltage .....	-0.3V to 6V
VIN, LDO_DRV to GND .....	-0.3V to 16V
BST,HDRV to GND Voltage .....	-0.3V to 21V
SW to GND .....	-2V to 16V
LDRV to GND .....	-0.3V to VIN+0.3V
All other pins .....	-0.3V to VCC+0.3V
Storage Temperature Range .....	-65°C to 150°C
Operating Junction Temperature Range .....	-40°C to 125°C
ESD Susceptibility .....	1000V

CAUTION: Stresses above those listed in "ABSOLUTE MAXIMUM RATINGS", may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

## PACKAGE INFORMATION



## ELECTRICAL SPECIFICATIONS

Unless otherwise specified, these specifications apply over  $V_{IN}=12\text{V}$  and  $T_A = 0$  to  $70^{\circ}\text{C}$ . Typical values refer to  $T_A = 25^{\circ}\text{C}$ .

PARAMETER	SYM	Test Condition	Min	TYP	MAX	Units
REFOUT_OC Voltage						
REFOUT_OC Voltage	$V_{REF}$		2.45	2.5	2.55	V
Accuracy		$V_{IN}$ from 10V to 16V	-0.3		0.3	%
<b>Supply Voltage(Vin)</b>						
$V_{in}$ Voltage Range	$V_{in}$		10		16	V
Input Voltage Current(Static)		No switching,COMP=0.8V		7		mA
Input Voltage Current (Dynamic)		Switching with HDRV and LDRV open,COMP=1.8V		9		mA

PARAMETER	SYM	Test Condition	Min	TYP	MAX	Units
<b>VIN UVLO</b>						
V <sub>in</sub> -Threshold	V <sub>n-UVLO</sub>	V <sub>in</sub> Rising		9		V
V <sub>in</sub> -Hysteresis	V <sub>n-Hyst</sub>	V <sub>in</sub> Falling		8		V
<b>5V REG</b>						
5VREG Output		No switching		5.4		V
5VREG Max Current			30	50		mA
<b>SS</b>						
Soft Start time	T <sub>ss_pwm</sub>	F <sub>S</sub> =350kHz,MODE=5V		5.2		mS
	T <sub>ss_con</sub>	F <sub>S</sub> =350kHz,MODE=0V		1.3		mS
<b>Oscillator (Rt)</b>						
Frequency	F <sub>S</sub>	Rt=110k,MODE=5V	245	300	359	kHz
Ramp-feedforward gain	V <sub>RAMP</sub>			0.1		V/V
Ramp Offset				1		V
Max Duty Cycle		F <sub>S</sub> =300kHz		80		%
Min Off Time				560		nS
Min Controlable On Time				200		nS
Rt Disable threshold				0.3		V
<b>Error Amplifiers</b>						
Open Loop Gain (Note1)				80		dB
Gain Bandwidth (Note1)				10		MHz
Input Bias Current	I <sub>b</sub>			1	100	nA
Max Sourcing Current		FB=0.7V, comp>=3V		3		mA
Max Sinking Current		FB=0.9V, comp<=0.3V		0.4		mA
COMP High Voltage		FB=0.7V, source 80uA		4.4		V
COMP Low Voltage		FB=0.9V, sink 40uA		0.1		V
<b>SW zero cross comparator</b>						
Offset voltage				-2		mV
<b>High Side Driver</b>						
Output Impedance , Sourcing Current (Note1)	R <sub>source</sub> (Hdrv)	BST to SW=5V, I=200mA		1		ohm
Output Impedance , Sinking Current (Note1)	R <sub>sink</sub> (Hdrv)	BST to SW=5V, I=200mA		0.8		ohm
<b>Low Side Driver</b>						
Output Impedance, Sourcing Current (Note1)	R <sub>source</sub> (Ldrv)	PVCC=12V		6		ohm
Output Impedance, Sinking Current (Note1)	R <sub>sink</sub> (Ldrv)	PVCC=12V		2		ohm
<b>MODE,FCCM threshold</b>						
High Threshold			2			V
Low Threshold					0.8	V
<b>Internal Schottky Diode</b>						
Forward voltage drop		Forward current=20mA		450		mV
<b>Power Good</b>						
Threshold Voltage as % of Vref		FB ramping up		85		%
Hysteresis				5		%
<b>FBUVLO</b>						
Feedback UVLO threshold		percent of nominal		60		%

PARAMETER	SYM	Test Condition	Min	TYP	MAX	Units
<b>LDO Controller</b>						
Open Loop Gain(Note1)				100		dB
Gain Bandwidth(Note1)				2		MHz
FB Pin- Bias Current				1	100	nA
LDO FB Voltage			0.772	0.8	0.828	V
LDO FB UVLO		percent of nominal		60		%
High Output Voltage		VIN=12V,LDOFB=0.7V, source 1.4mA		11.5		V
Low Output Voltage		LDOFB=0.9V,sink 1.4mA		0.4		V
Max Sourcing Current		LDOFB=0.7V, LDODRV>8V		2		mA
Min Sinking Current		LDOFB=0.9V, LDODRV<1V		8		mA

Note1: Design Guaranteed.

## PIN DESCRIPTIONS

PIN SYMBOL	PIN DESCRIPTION
VCC	This pin is internal 5V regulator output and supplies the internal 5V bias circuit. A high freq 1uF ceramic capacitor is recommended to connect this pin to ground.
BST	This pin supplies voltage to high side FET driver. A high freq minimum 0.1uF ceramic capacitor is placed as close as possible to and connected to this pin and SW pin.
GND	Ground pin.
FB	This pin is the error amplifiers inverting input. This pin is connected via resistor divider to the output of the switching regulator to set the output DC voltage.
COMP	This pin is the output of the error amplifier and together with FB pin is used to compensate the voltage control feedback loop.
SW	This pin is connected to source of high side FETs and provide return path for the high side driver.
HDRV	High side gate driver output.
LDRV	Low side gate driver output.
VIN	Voltage supply for the internal 5V regulator, LDO controller and low side driver.
RT	Oscillator's frequency can be set by using an external resistor from this pin to GND. Pulling this pin down below 0.3V shuts down both controllers.
LDO_FB	LDO controller feedback input. This pin is connected via resistor divider to the output of the LDO to set the output DC voltage.
LDO_DRV	LDO controller output. This pin is controlling the gate of an external NCH MOSFET. The maximum rating of this pin is 16V.
MODE	Connecting this pin to 5VREG voltage control mode will be chosen. Connecting this pin to ground, constant on time control mode will be chosen.
FCCM	Connecting this pin to 5VREG, synchronous mode will be chosen. Connecting this pin to ground, diode emulation mode will be chosen, LDRV will be off when inductor current becomes negative current.
REFIN	Reference input voltage for error amplifier.
VREF_OC	2.5V external reference. OCP trigger level is set by connect resistor from this pin to ground.
PGOOD	PGOOD indicator for switching regulator. It requires a pull up resistor to Vcc or lower voltage. When FB pin reaches 85% of the reference voltage PGOOD transitions from LO to HI state.

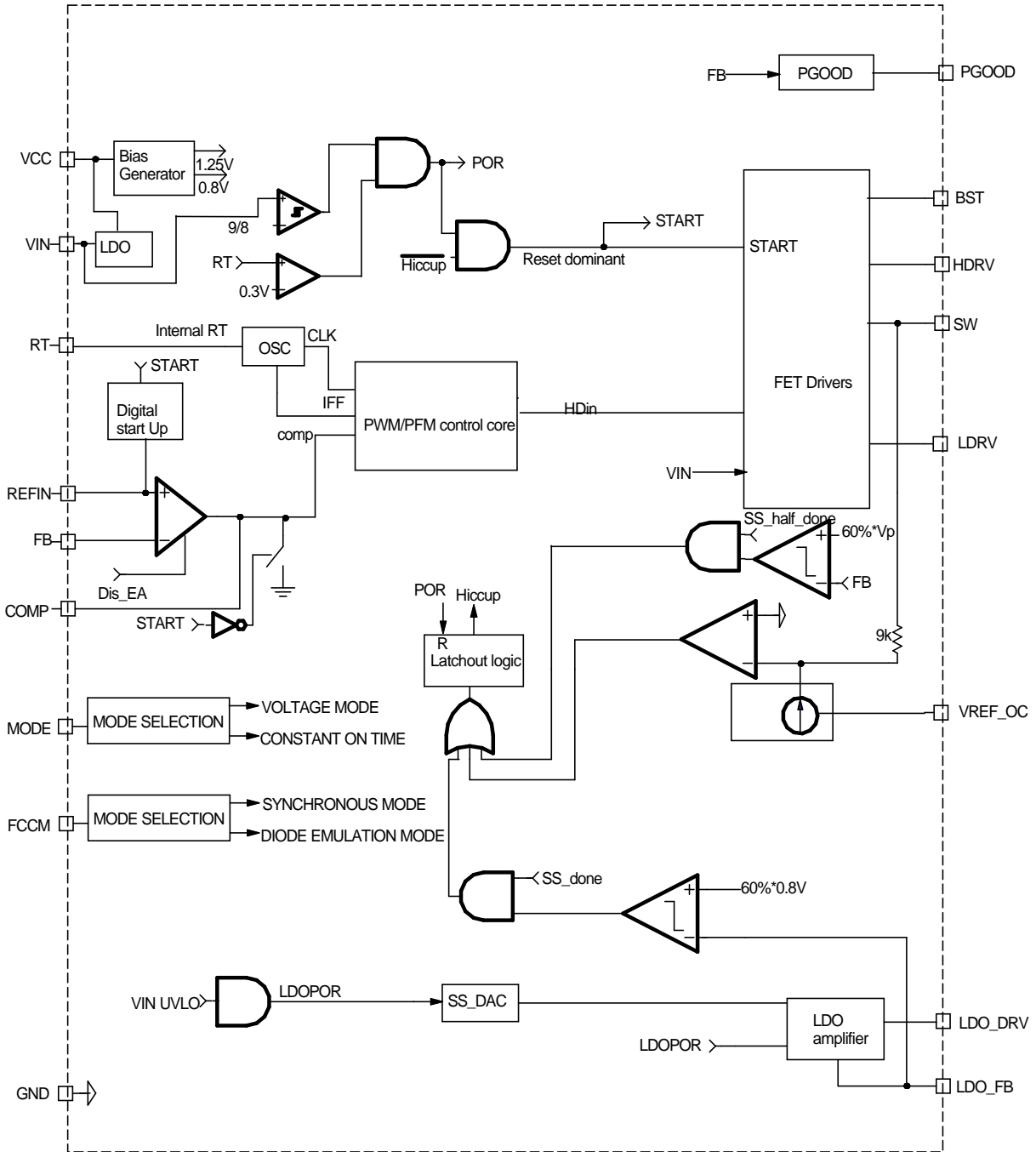
**BLOCK DIAGRAM**


Figure 2 - Simplified block diagram of the LX2750

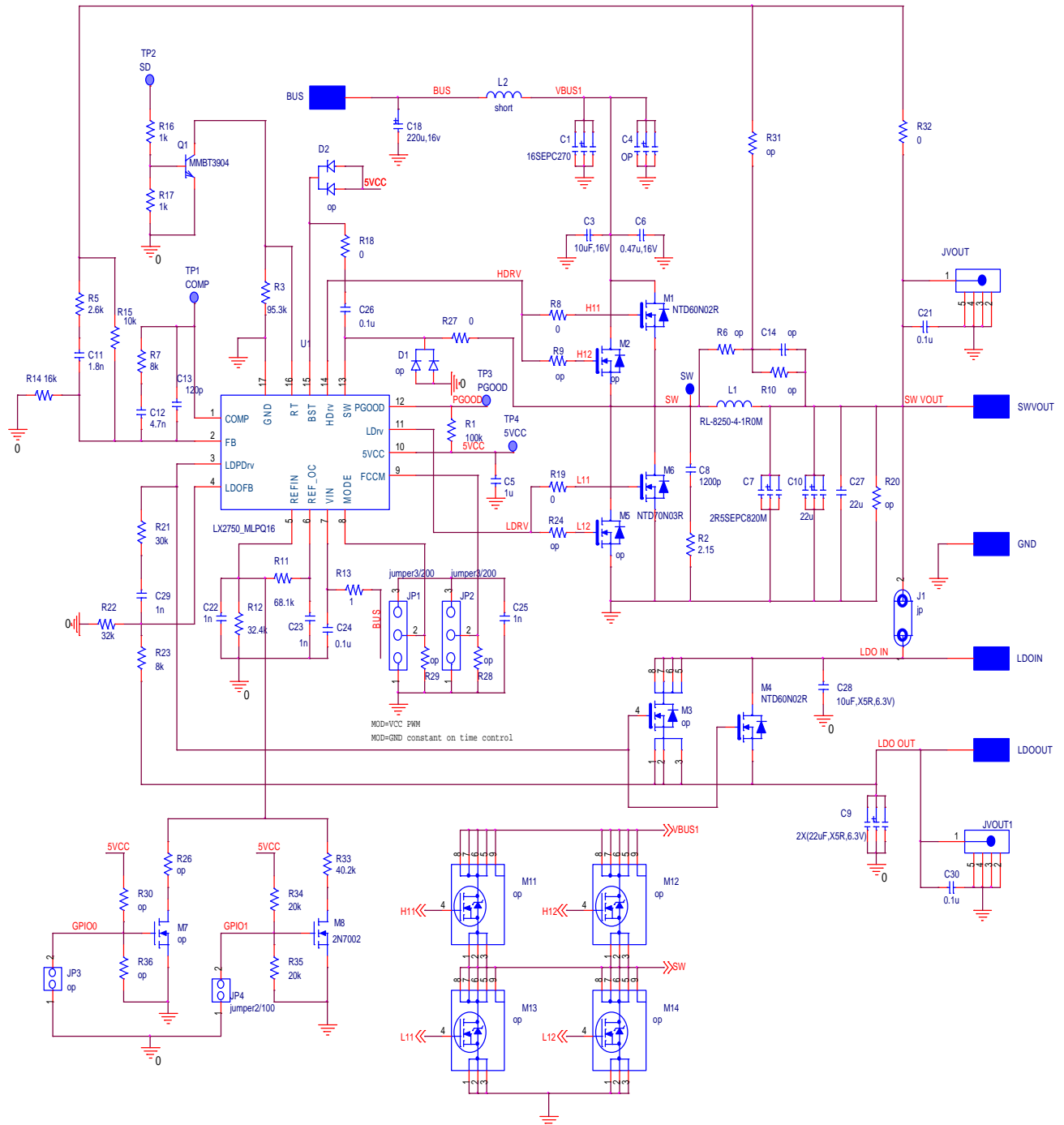


Figure 3 - Demo board schematic

**Bill of Materials**

Item	Quantity	Reference	Part
1	1	C1	16SEPC270
2	1	C3	10uF,16V
3	1	C5	1u
4	1	C6	0.47u,16V
5	1	C7	2R5SEPC820M
6	1	C8	1200p
7	2	C9	22uF,X5R,6.3V
8	2	C10,C27	22uF,X5R,6.3V
9	1	C11	1.8n
10	1	C12	4.7n
11	1	C13	120p
12	1	C18	220u,16V
13	4	C21,C24,C26,C30	0.1u
14	4	C22,C23,C25,C29	1n
15	1	C28	10uF,X5R,6.3V
16	1	L1	RL-8250-4-1R0M
17	2	M1,M4	NTD60N02R
18	1	M6	NTD70N03R
19	1	M8	2N7002
20	1	Q1	MMBT3904
21	1	R1	100k
22	1	R2	2.15
23	1	R3	95.3k
24	1	R5	2.6k
25	2	R7,R23	8k
26	5	R8,R18,R19,R27,R32	0
27	1	R11	68.1k
28	1	R12	32.4k
29	1	R13	1
30	1	R14	16k
31	1	R15	10k
32	2	R16,R17	1k
33	1	R21	30k
34	1	R22	32k
35	1	R33	40.2k
36	2	R34,R35	20k
37	1	U1	LX2750_MLPQ16



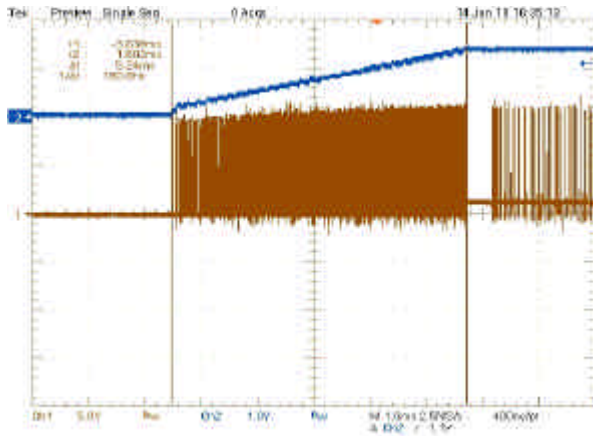
**Demoboard waveforms**


Fig.4 Startup when MODE=5V (CH1 SW 5V/DIV, CH2 SW VOUT 1V/DIV)

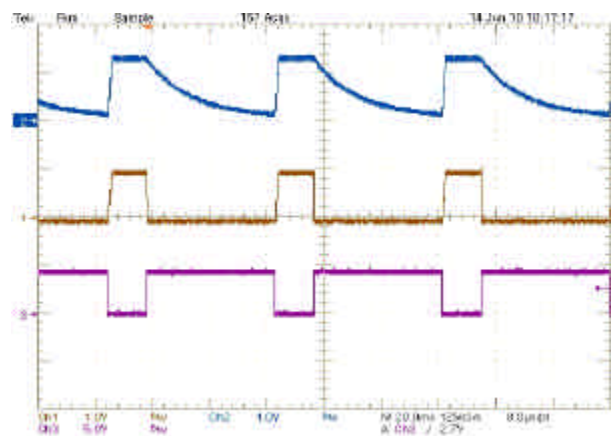


Fig.5 Use RT pin to turn on and off (CH1 LDO VOUT 1V/DIV, CH2 SW VOUT 1V/DIV, CH3 SIGNAL on TP2 5V/DIV)

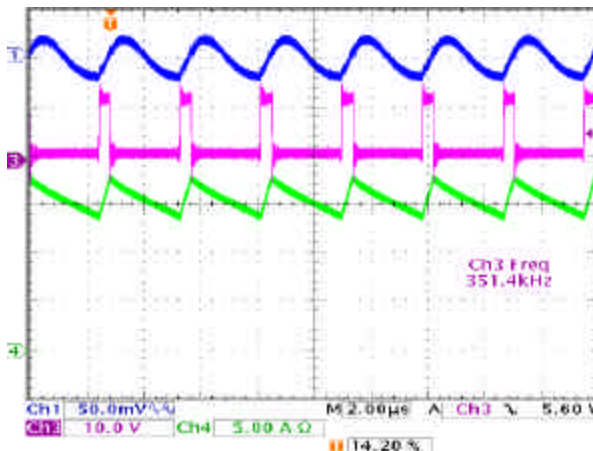


Fig.6 SW VOUT ripple when MODE=5V (CH1 SW VOUT RIPPLE 50mV/DIV, CH3 SW 10V/DIV, CH4 INDUCTOR CURRENT 5A/DIV)

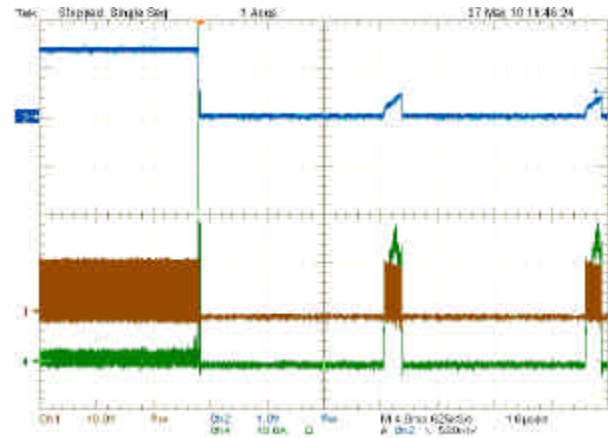


Fig.7 SW output short(CH1 SW 10V/DIV, CH2 SW VOUT 1V/DIV, CH4 INDUCTOR CURRENT 10A/DIV)

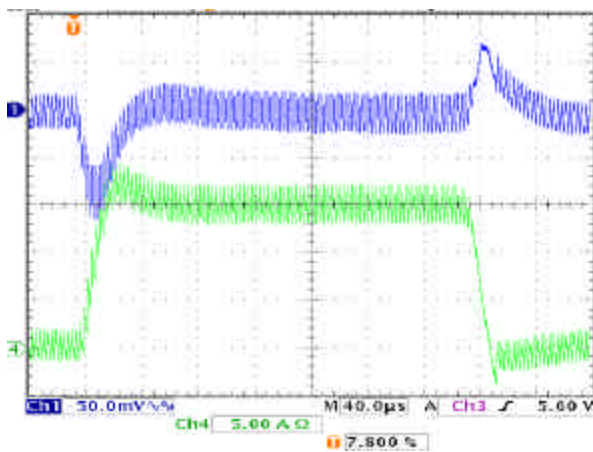


Fig. 8 SW dynamic response when MODE=5V,FCCM=5V(CH1 SW VOUT AC 50mV/DIV, CH4 INDUCTOR CURRENT 5A/DIV)

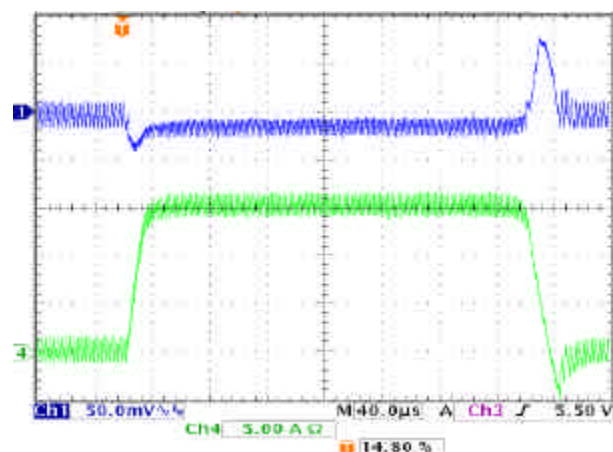


Fig. 9 SW dynamic response when MODE=0V,FCCM=5V(CH1 SW VOUT AC 50mV/DIV, CH4 INDUCTOR CURRENT 5A/DIV)

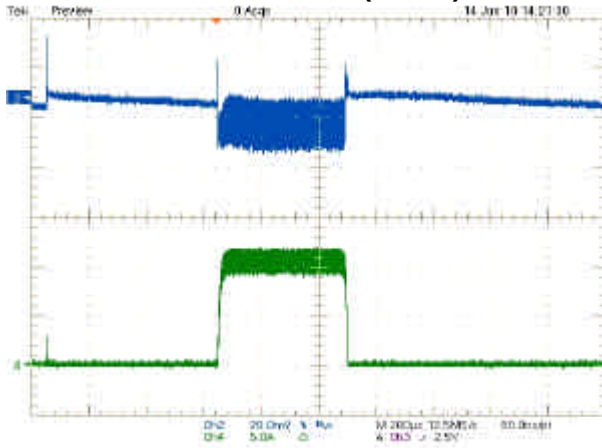
**Demoboard waveforms(Cont')**


Fig. 10 SW dynamic response when MODE=0V,FCCM=0V, load from 3mA to 10A(CH1 SW VOUT AC 20mV/DIV, CH4 INDUCTOR CURRENT 5A/DIV)

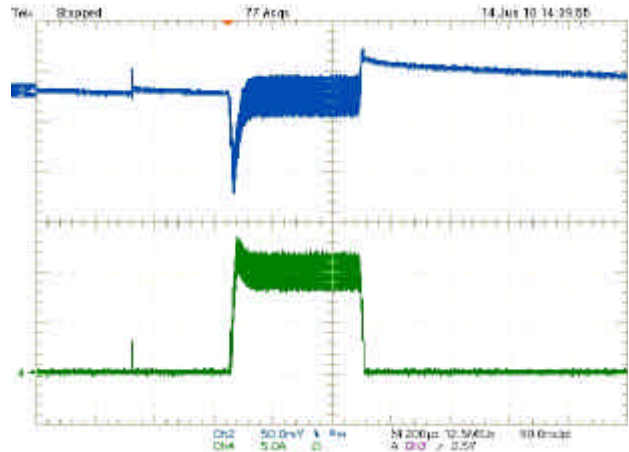


Fig. 11 SW dynamic response when MODE=5V,FCCM=0V, load from 8mA to 10A(CH1 SW VOUT AC 50mV/DIV, CH4 INDUCTOR CURRENT 5A/DIV)

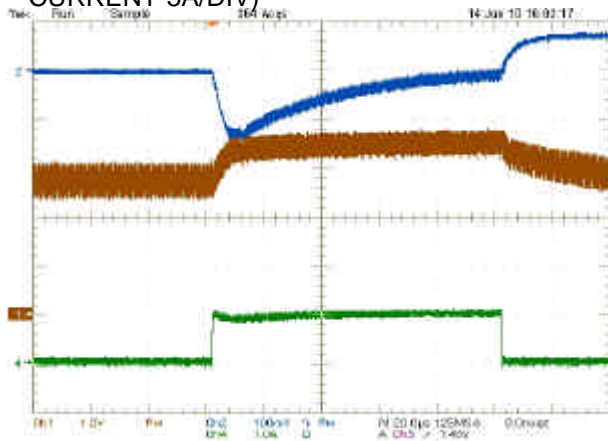


Fig. 12 LDO dynamic response when LDO load from 0.1A to 1A (CH1 LDODRV 1V/DIV, CH2 LDO VOUT AC 100mV/DIV, CH4 OUTPUT CURRENT 1A/DIV)

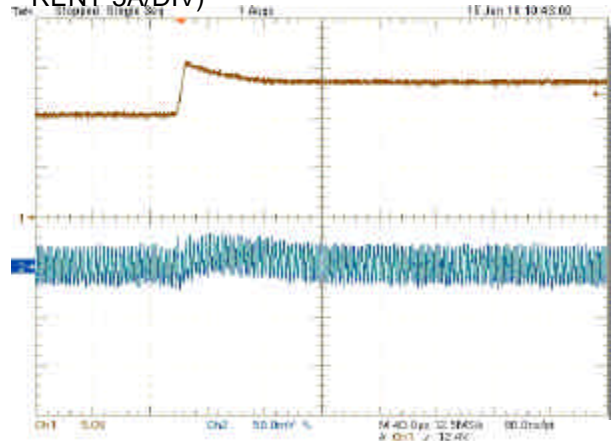


Fig. 13 Line transient when MODE=5V(CH1 VIN 5V/DIV, CH4 SW VOUT AC 50mV/DIV)

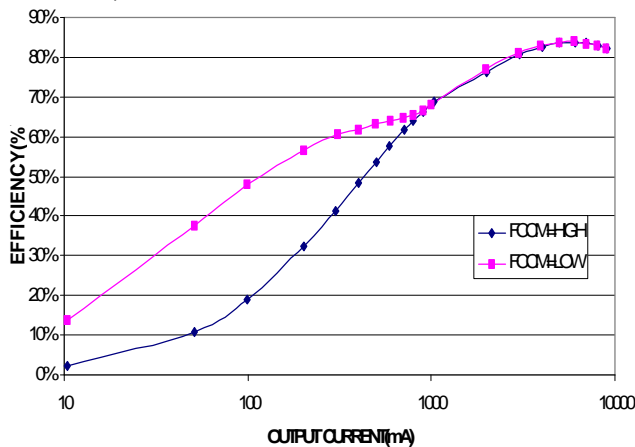


Fig. 14 Efficiency when MODE=5V

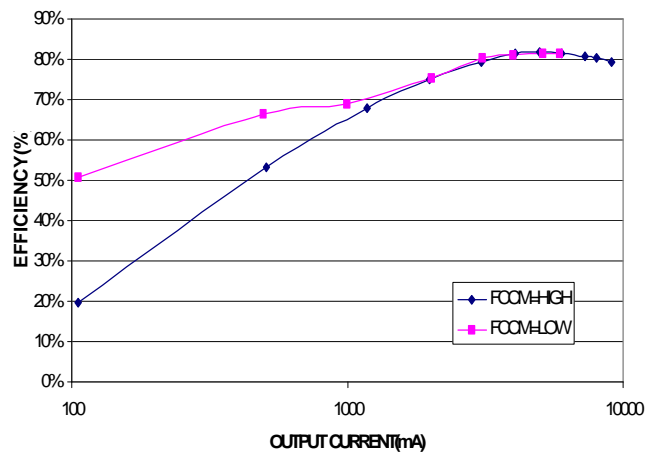
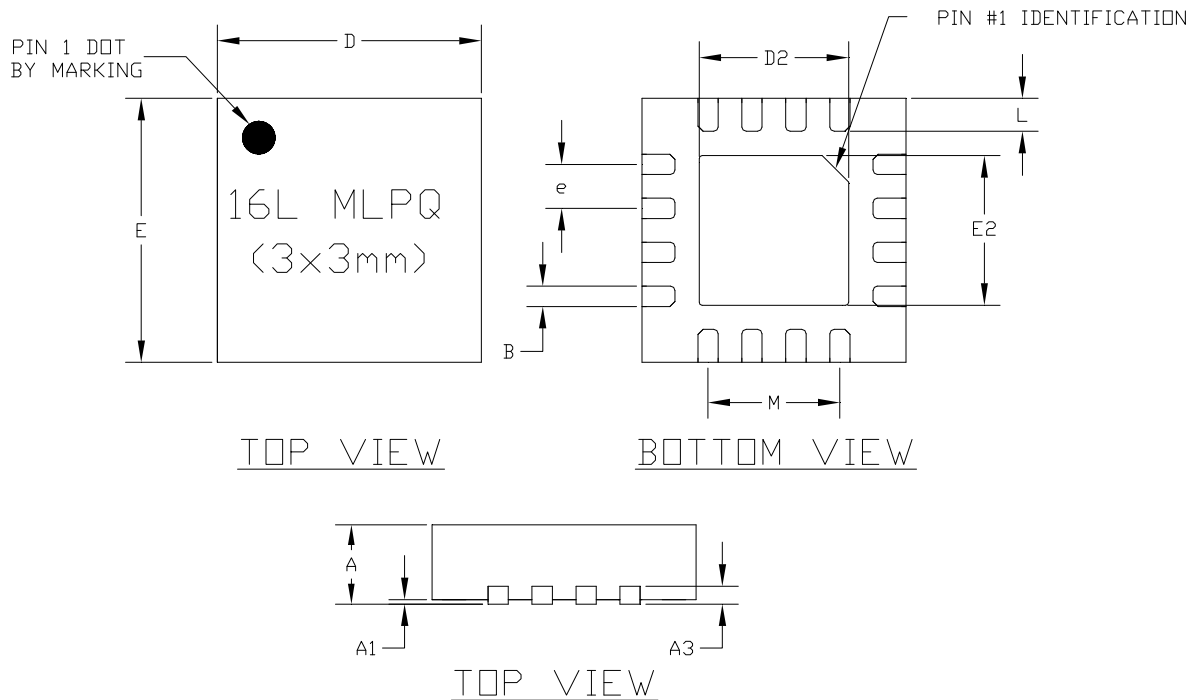


Fig. 15 Efficiency when MODE=0V

**MLPQ 16 PIN 3 x 3 PACKAGE OUTLINE DIMENSIONS**


SYMBOL NAME	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203REF		0.008REF	
B	0.180	0.300	0.007	0.012
D	2.950	3.050	0.116	0.120
D2	1.600	1.750	0.063	0.069
E	2.950	3.050	0.116	0.120
E2	1.600	1.750	0.063	0.069
e	0.50BSC		0.50BSC	
L	0.325	0.450	0.013	0.018
M	1.5REF		0.059REF	