

# LM5025 Reference Design - Active clamp forward converter with an input of 30-60V to 15V@1.5A isolated.

National Semiconductor  
LM5025  
Power Applications Design Center, Americas  
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## 1.0 Design Specifications

Inputs	Output #1
VinMin=30V	Vout1=15V
VinMax=60V	Iout1=1.5A

## 2.0 Design Description

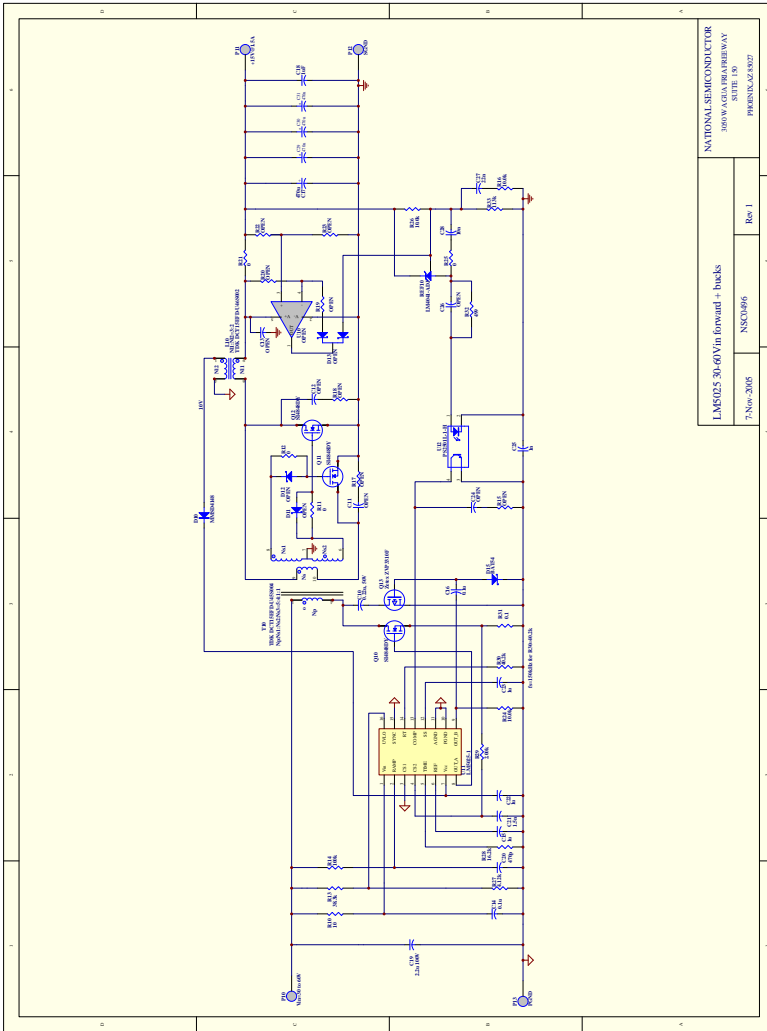
This circuit uses the LM5025 voltage mode PWM controller with complementary gate drives to implement a high-efficiency single-ended active clamp forward converter.

MOSFET Q10 is an n-channel main primary side FET while Q13 a P-channel clamp FET. Circuits around the LM5025 implements various necessary functions: R10 and C14 implement start-up at pin 1; R14 and C20 implement a voltage ramp with input voltage feedforward for the duty cycle comparator at pin 2; R31, R29 and C21 implement over current protection at pin 4; C23 implements soft-start at pin 12 and R30 sets the switching frequency at pin 14.

Self driven synchronous rectifiers Q11 and Q12 are used on the secondary side to improve efficiency. But because the voltages off the main secondary winding would be too great for the gates of the synchronous rectifiers, an auxiliary, lower voltage center-tapped secondary winding is used to drive the gates of these FETs. The feedback control circuit for regulation of the output voltage consists of the LM4041 reference/error amplifier REF10 with the opto-coupler U12 to transmit output voltage information to the primary side. The LM5025 has a direct opto-coupler interface at pin 13 that simplifies the feedback interface.

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isolated.  
LM5025

### 3.0 Schematic



schematic

FIGURE 1. Schematic

## 4.0 Bill of Materials

LM5025

## NSC0610 LM5025 30-60V to 15V@1.5A Active Clamp Forward Converter 11/07/2005

Designator	Part Type	Footprint	Description	Manufacturer
C10	0.22u, 50V	1210	Capacitor Ceramic X7R	TDK/C3225X5R1C224K
C11	OPEN	805		
C12	OPEN	805		
C13	OPEN	805		
C14	0.1u	805	Capacitor Ceramic	Vitramon/VJ0805
C15	1u	805	Capacitor Ceramic X7R	TDK/C2012X5R1C105K
C16	0.1u	805	Capacitor Ceramic	Vitramon/VJ0805
C17	470u		Capacitor electrolytic	470u,25V
C18	1uF	805	Capacitor Ceramic X7R	TDK/C2012X5R1C105K
C19	2.2u 100V	1812	Capacitor Ceramic X7R	TDK/C4532X7R2A225
C20	470p	805	Capacitor Ceramic	Vitramon/VJ0805
C21	1.5n	805	Capacitor Ceramic	Vitramon/VJ0805
C22	1u	805	Capacitor Ceramic X7R	TDK/C2012X5R1C105K
C23	1u	805	Capacitor Ceramic X7R	TDK/C2012X5R1C105K
C24	OPEN	805		
C25	1n, 250Vac	1808	Y3 Capacitor Ceramic	Syfer/1808JA250102KXBSY2
C26	OPEN	805		
C27	22n	805	Capacitor Ceramic	Vitramon/VJ0805
C28	10n	805	Capacitor Ceramic	Vitramon/VJ0805
C29	470u		Capacitor electrolytic	470u,25V
C30	470u		Capacitor electrolytic	470u,25V
C31	470u		Capacitor electrolytic	470u,25V
D10	MMSD4148	sod-123	Small signal diode	Vishay/MMSD4148
D11	OPEN	SOT-23		
D12	OPEN	SOT-23		
D13	OPEN	SOT-23		
D15	BAT54	SOD-123	Small signal schottky diode	Vishay/BAT54
L10	DCT15EFD-U46S002	EFD15	Surface mount power inductor	TDK/DCT15EFD-U46S002
Q10	SI4848DY	so-8	N-channel power MOSFET	Vishay/SI4848DY
Q11	SI4848DY	so-8	N-channel power MOSFET	Vishay/SI4848DY
Q12	SI4848DY	so-8	N-channel power MOSFET	Vishay/SI4848DY
Q13	Zetex ZVP3310F	SOT-23	P-channel power MOSFET	Zetex/ZVP3310F
R10	10	805	1% Thick Film	DALE CRCW0805
R11	0	805	1% Thick Film	DALE CRCW0805
R12	0	805	1% Thick Film	DALE CRCW0805
R13	38.3k	805	1% Thick Film	DALE CRCW0805
R14	100k	805	1% Thick Film	DALE CRCW0805
R15	OPEN	805		
R16	10.0k	805	1% Thick Film	DALE CRCW0805
R17	OPEN	805		
R18	OPEN	805		
R19	OPEN	805		
R20	OPEN	805		
R21	0	805	1% Thick Film	DALE CRCW0805
R22	OPEN	805		
R23	OPEN	805		
R24	10.0k	805	1% Thick Film	DALE CRCW0805
R25	0	805	1% Thick Film	DALE CRCW0805
R26	10.0k	805	1% Thick Film	DALE CRCW0805
R27	4.12k	805	1% Thick Film	DALE CRCW0805
R28	16.2k	805	1% Thick Film	DALE CRCW0805
R29	2.00k	805	1% Thick Film	DALE CRCW0805
R30	40.2k	805	1% Thick Film	DALE CRCW0805
R31	0.1	0805	1% power metal strip	

bom3

FIGURE 2. Bill of materials, page 1

R32	499	805	1% Thick Film	DALE CRCW0805
R33	113k	805	1% Thick Film	DALE CRCW0805
REF10	LM4041-ADJ	SOT-23	Precision micropower shunt voltage reference	National/LM4041-ADJ
T10	DCT15EFD-U45S004	EFD15	Surface mount power transformer	TDK/DCT15EFD-U45S004
U10	OPEN			
U11	LM5025-1	tssop16	Active clamp voltage mode PWM cor	National/LM5025
U12	PS2501L-1-H	dip4-smt	Surface mount opto-coupler	NEC/PS2501L-1-H

\*\*Specified by customer

bom4

**FIGURE 3. Bill of materials, page 2**

## 5.0 Other Operating Values

Operating Values

Description	Parameter	Value	Unit
Modulation Frequency	Frequency	150	KHz
Total output power	Pout	20	W
Steady State Efficiency, Vin = 45V @ 1.5A	Efficiency	92	%
Peak-to-peak ripple voltage, Vin = 36 @ 1.5A	Vout p-p	120	mV
Dynamic load regulation, Vin = 36V, step response .5A to 1A	Dynamic load	125	mV

## 6.0 Layouts

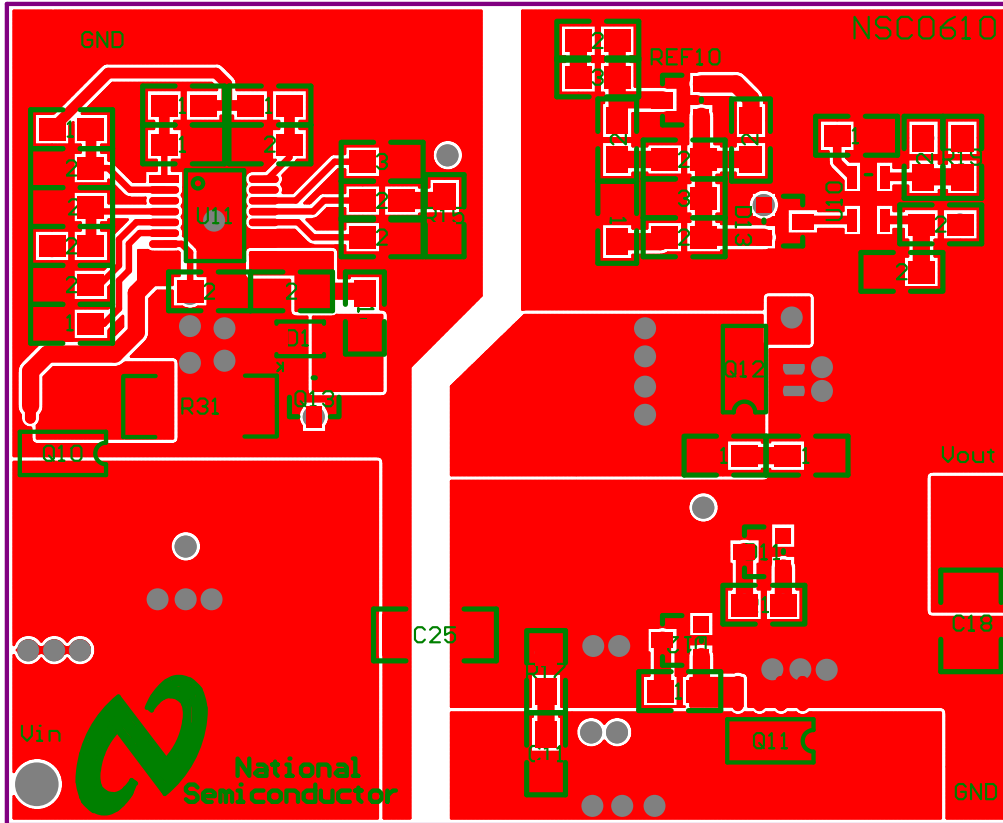


FIGURE 4. Top Layer

layout4

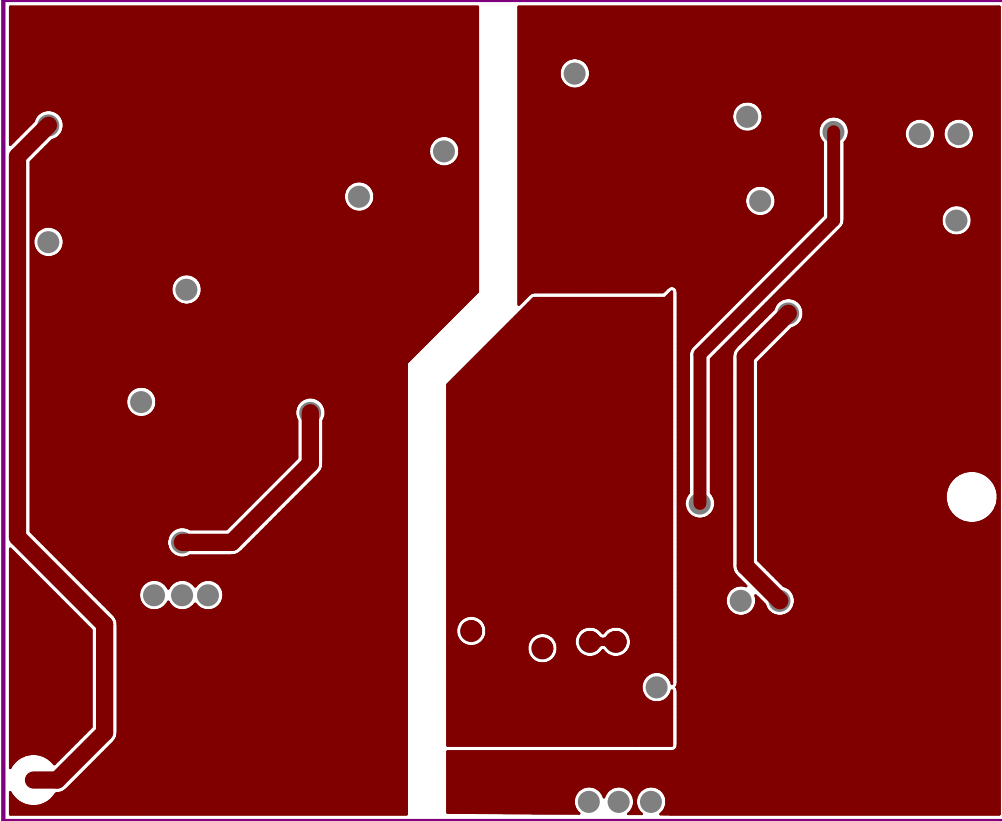


FIGURE 5. Middle Layer 1

layout5



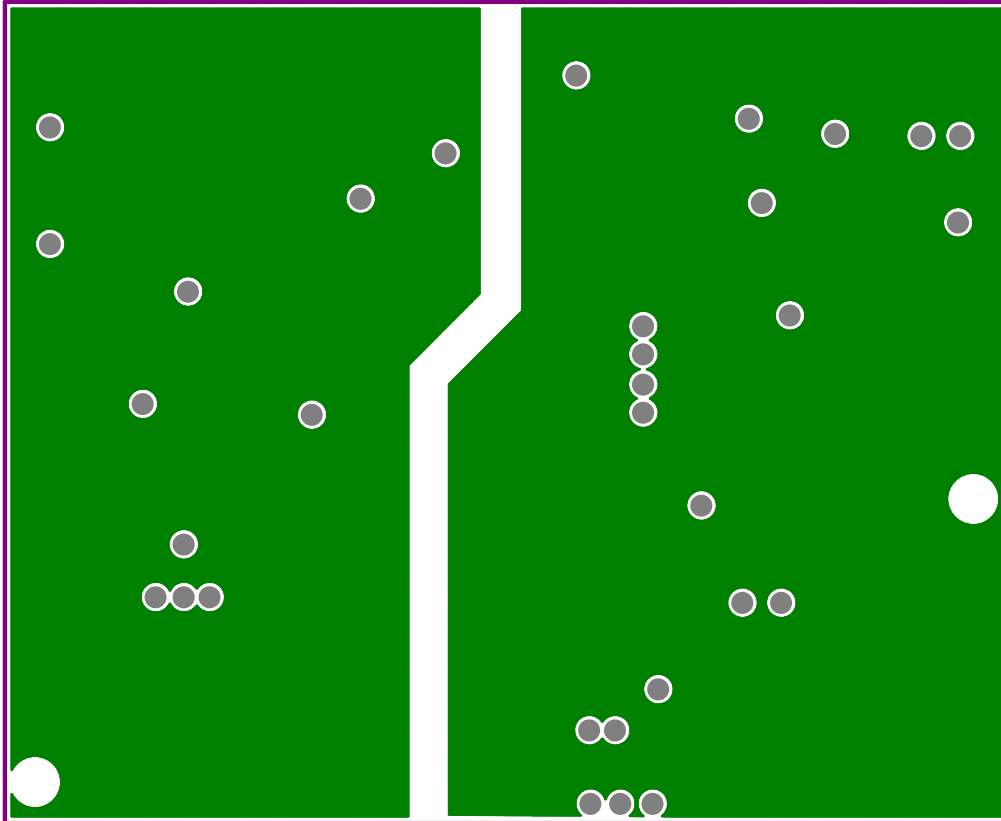


FIGURE 6. Middle Layer 2

layout6

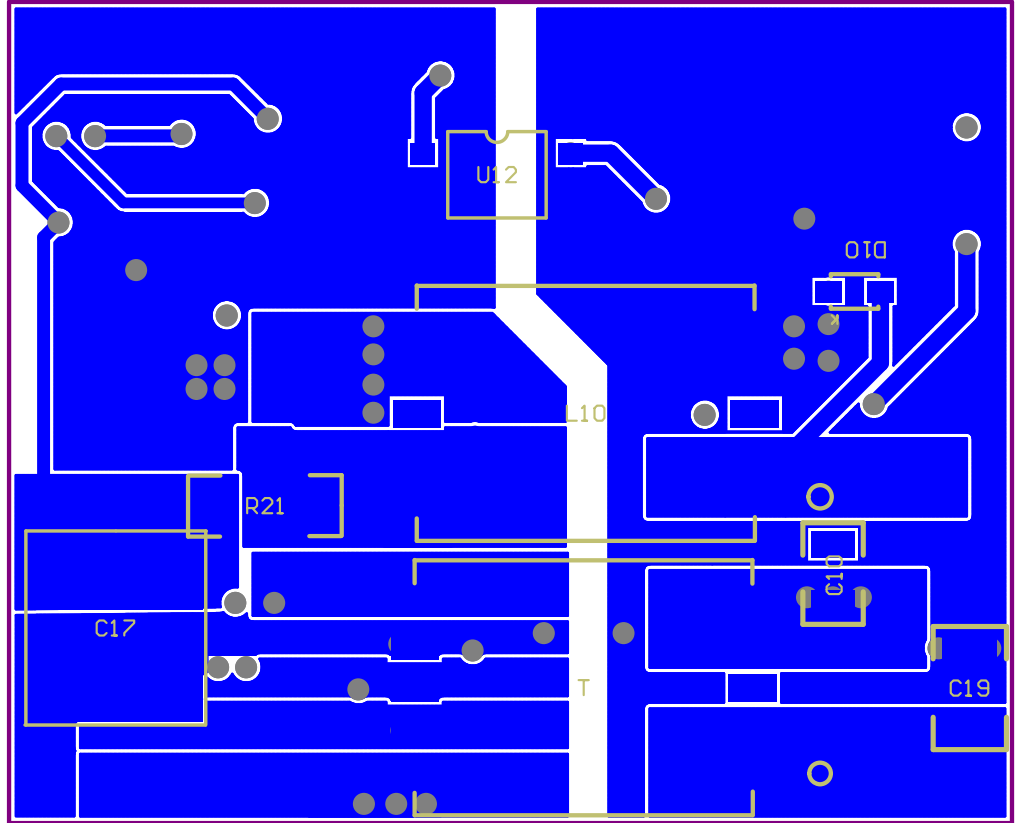


FIGURE 7. Bottom Layer

layout7

## 7.0 Waveforms



waveform2

FIGURE 8. Output ripple,  $V_{in} = 36V$  with full load



waveform3

FIGURE 9. Transient response, Vin = 36V with a step response of .5A to 1A

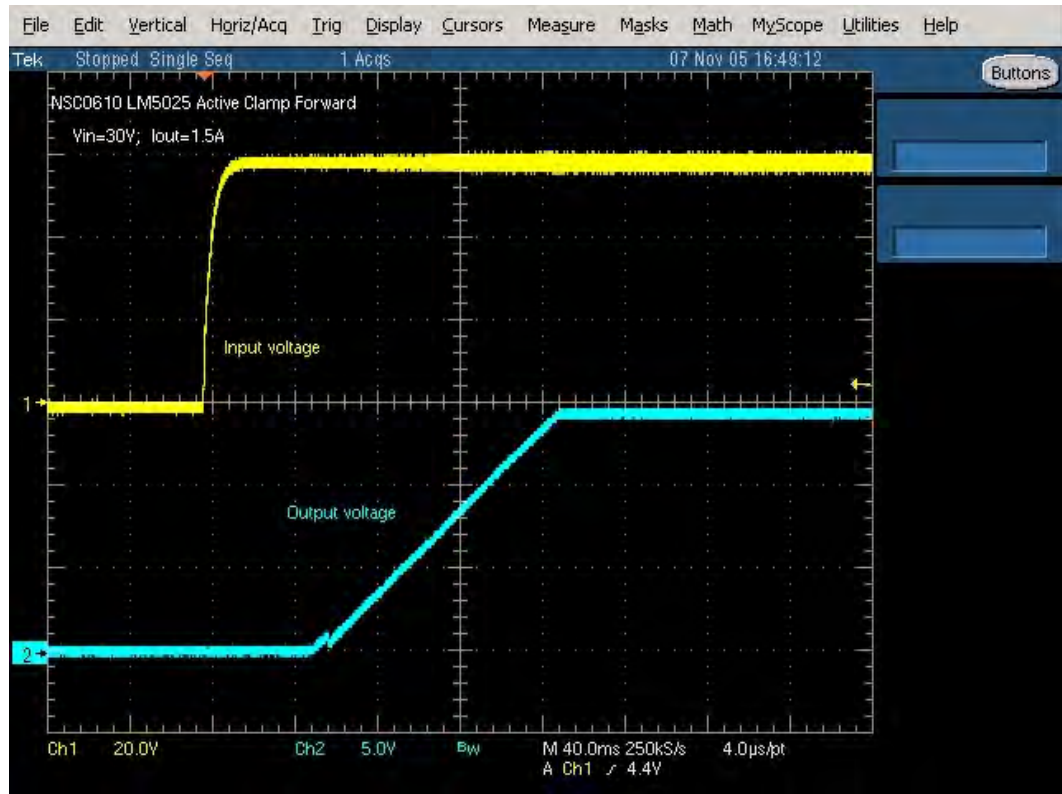


FIGURE 10. Start-up waveforms  $V_{in}=36V$ ,  $I_{out}=1.5A$

waveform4

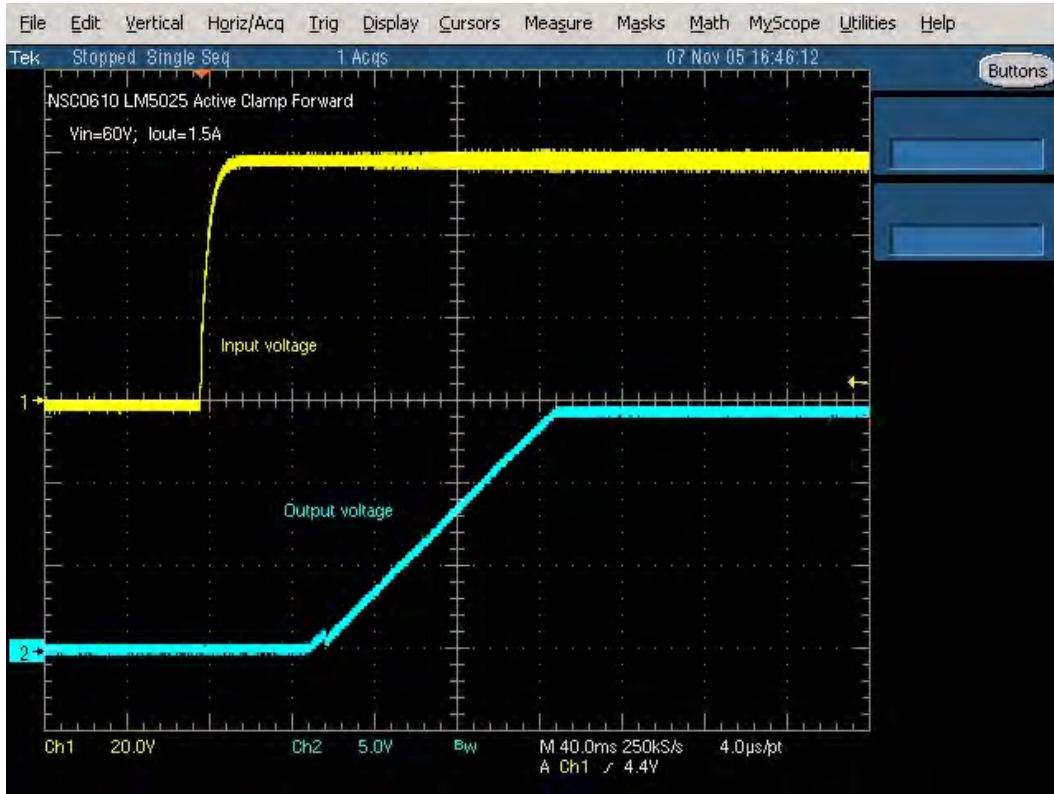


FIGURE 11. Start-up waveforms  $V_{in}=60V$ ,  $I_{out}=1.5A$

waveform5

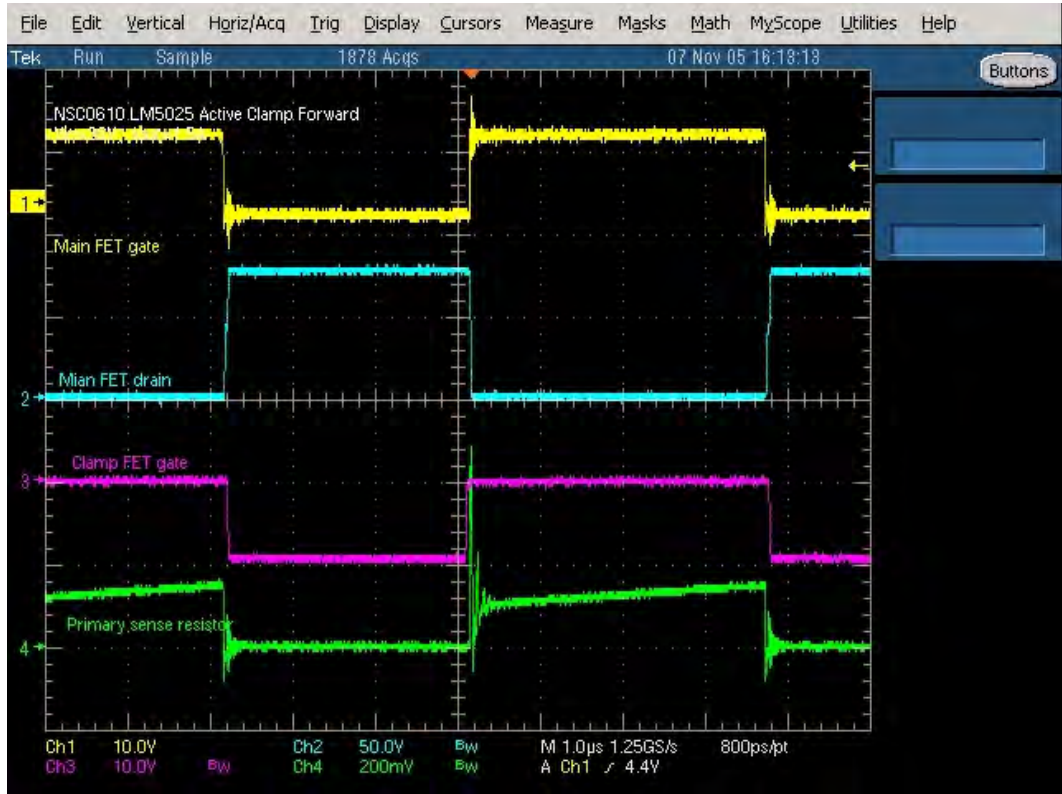


FIGURE 12. Switching waveforms  $V_{in}=36V$ ,  $I_{out}=1.5A$

waveform6

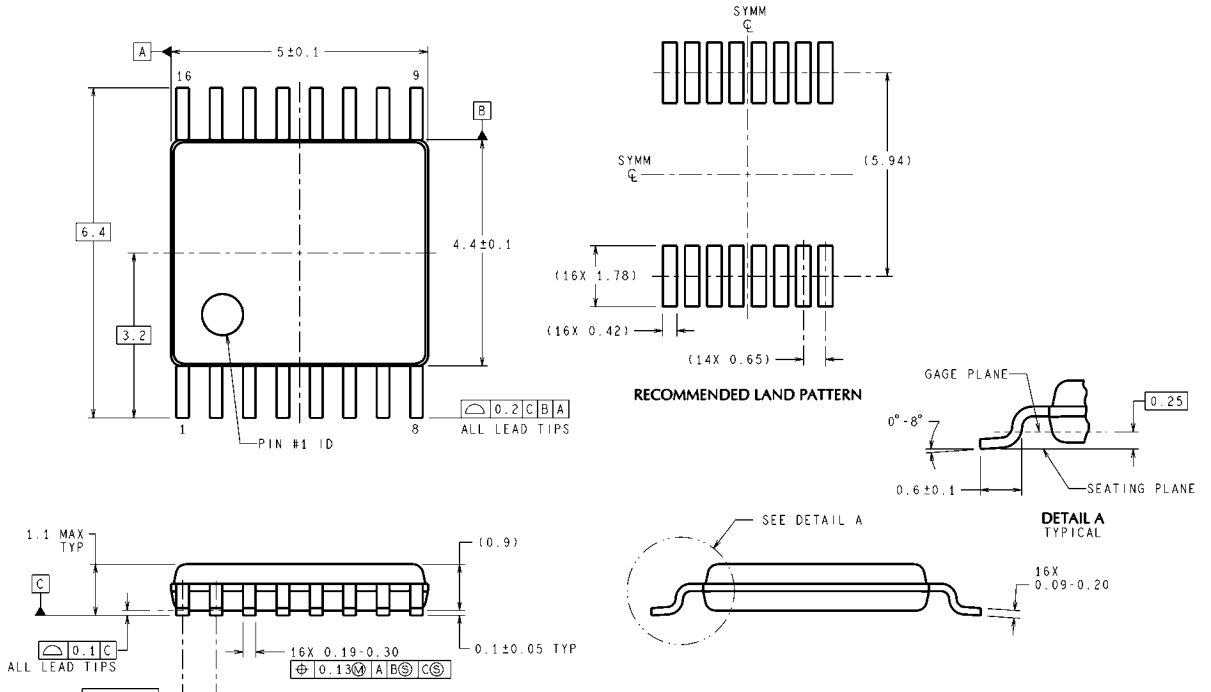




FIGURE 13. Switching waveforms  $V_{in}=60V$ ,  $I_{out}=1.5A$

waveform7

# 8.0 Physical Dimensions inches (millimeters) unless otherwise noted



DIMENSIONS ARE IN MILLIMETERS  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

MTC16 (Rev D)

# Notes

LM5025

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