

AN-1280 LM2731/LM2733 Evaluation Board

1 Introduction

The LM2731 and LM2733 are high frequency switching boost regulators that offer small size and high power conversion efficiency. The "X" version of the part operates at 1.6MHz switching frequency and the "Y" version at 600kHz. The primary difference between the LM2731 and LM2733 is that the LM2731 has a higher current internal switch FET (with lower breakdown voltage), while the LM2733 has a higher voltage FET that handles less current. The LM2733 targets applications with higher output voltages, while the LM2731 is intended for applications requiring higher load currents at lower output voltages. This user's guide will describe the evaluation board supplied to demonstrate the operation of these parts and give information on its usage.

2 Basic Application Circuit

The basic application circuit shown in [Figure 1](#) provides the component designators used on the evaluation board.

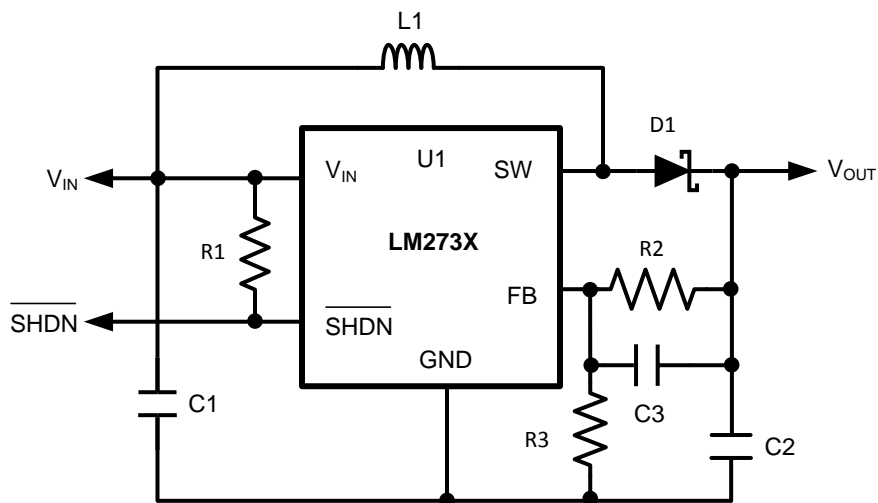


Figure 1. Evaluation Board Basic Application Circuit

3 Component Layout

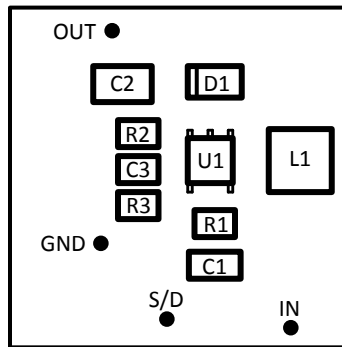


Figure 2. Evaluation Board Component Layout

4 Basic Application Circuit - LM2733Y

Table 1. LM2733Y Bill of Materials ($V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 250mA$)

Designation	Description	Size	Manufacturer Part #	Vendor
C1	Cap 2.2 μ F 16V	1206	EMK316BJ225ML	Taiyo Yuden
C2	Cap 4.7 μ F 16V	1812	EMK432BJ475ML	Taiyo Yuden
C3	Cap 220pF 50V	0805	VJ0805A221JXACW1BC	Vishay
R1	RES, 51k Ohm, 5%, 0.1W	0805	CRCW080551K0JNEA	Vishay
R2	RES, 118k Ohm, 1%, 0.1W	0805	CRCW0805118KFKEA	Vishay
R3	RES, 13.3k Ohm, 1%, 0.1W	0805	CRCW080513K3FKEA	Vishay
L1	Shielded Inductor 10 μ H 4A		CDRH125-100MC	Sumida
D1	Diode 20V 0.5A	SOT23	MBR0520	International Rectifier
U1	IC LM2733YMF			Texas Instruments

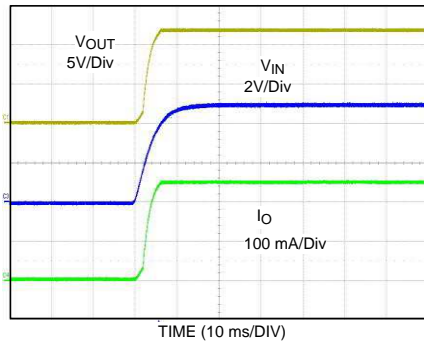


Figure 3. Start Up
 $V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 250mA$

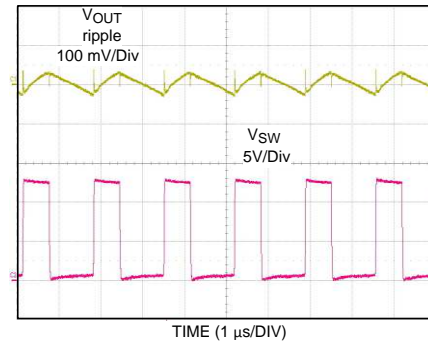


Figure 4. Switching Waveform and Output Voltage Ripple
 $V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 250mA$

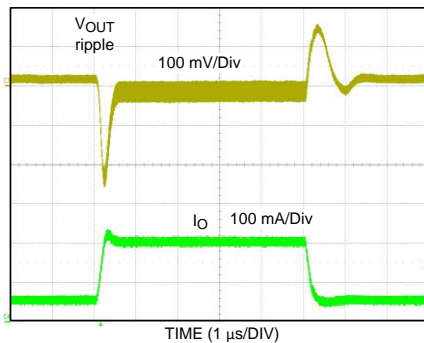


Figure 5. Load Transient
 $V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 50mA$ to $200mA$

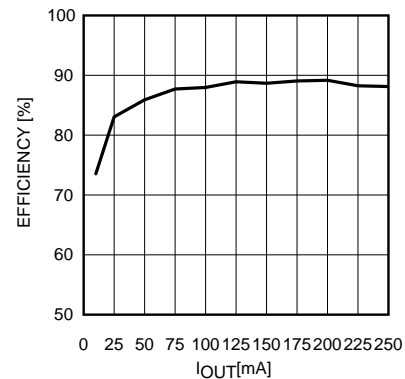


Figure 6. Efficiency
 $V_{IN} = 5V$, $V_{OUT} = 12V$

5 Basic Application Circuit - LM2733X

Table 2. LM2733X Bill of Materials ($V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 250mA$)

Designation	Description	Size	Manufacturer Part #	Vendor
C1	Cap 2.2 μ F 16V	1206	EMK316BJ225ML	Taiyo Yuden
C2	Cap 4.7 μ F 16V	1812	EMK432BJ475ML	Taiyo Yuden
C3	Cap 220pF 50V	0805	VJ0805A221JXACW1BC	Vishay
R1	RES, 51k Ohm, 5%, 0.1W	0805	CRCW080551K0JNEA	Vishay
R2	RES, 118k Ohm, 1%, 0.1W	0805	CRCW0805118KFKEA	Vishay
R3	RES, 13.3k Ohm, 1%, 0.1W	0805	CRCW080513K3FKEA	Vishay
L1	Shielded Inductor 10 μ H 4A		CDRH125-100MC	Sumida
D1	Diode 20V 0.5A	SOT23	MBR0520	International Rectifier
U1	IC LM2733XMF			Texas Instruments

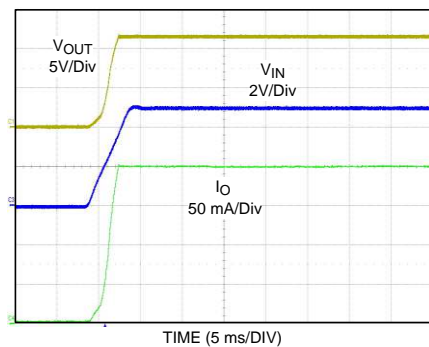


Figure 7. Start Up
 $V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 250mA$

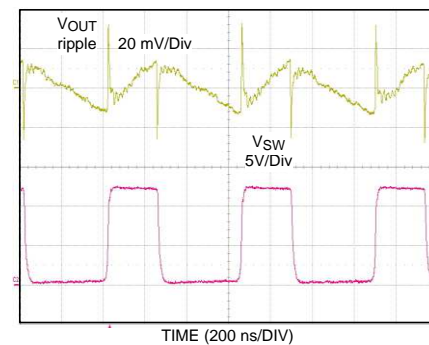


Figure 8. Switching Waveform and Output Voltage Ripple
 $V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 250mA$

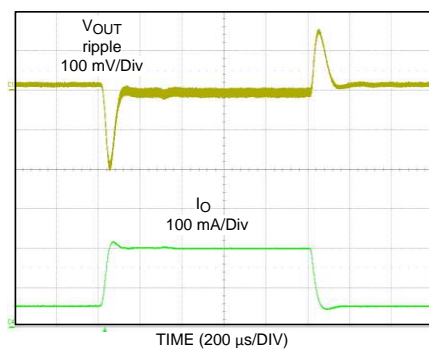


Figure 9. Load Transient
 $V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 50mA$ to $200mA$

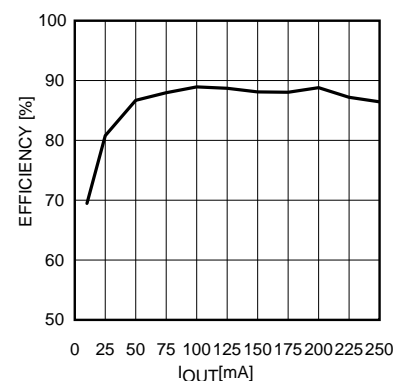


Figure 10. Efficiency
 $V_{IN} = 5V$, $V_{OUT} = 12V$

6 Basic Application Circuit - LM2731Y

Table 3. LM2731Y Bill of Materials ($V_{IN} = 3.3V$, $V_{OUT} = 5V$, $I_{OUT} = 500mA$)

Designation	Description	Size	Manufacturer Part #	Vendor
C1	Cap 2.2 μ F 16V	1206	EMK316BJ225ML	Taiyo Yuden
C2	Cap 22 μ F 16V	1812	EMK432BJ226ML	Taiyo Yuden
C3	Cap 470pF 50V	0805	VJ0805A471JXAMX	Vishay
R1	RES, 51k Ohm, 5%, 0.1W	0805	CRCW080551K0JNEA	Vishay
R2	RES, 40.2k Ohm, 1%, 0.1W	0805	CRCW08054022F	Vishay
R3	RES, 13.3k Ohm, 1%, 0.1W	0805	CRCW080513K3FKEA	Vishay
L1	Shielded Inductor 4.7 μ H 1.68A		NRS6012T6R8MMGJ	Taiyo Yuden
D1	Diode 20V 0.5A	SOT23	MBR0520	International Rectifier
U1	IC LM2731YMF			Texas Instruments

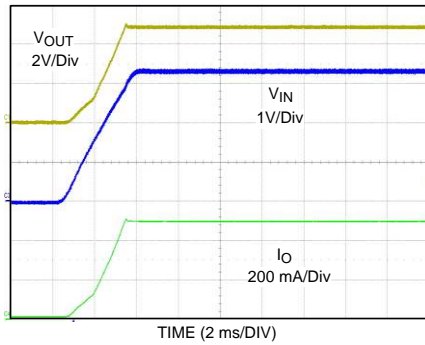


Figure 11. Start Up
 $V_{IN} = 3.3V$, $V_{OUT} = 5V$, $I_{OUT} = 500mA$

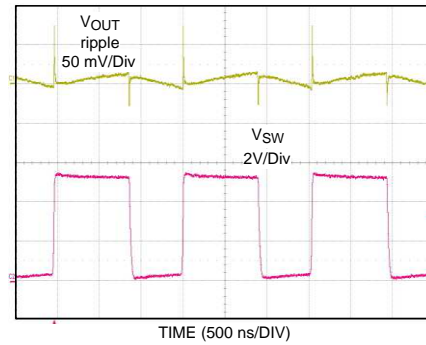


Figure 12. Switching Waveform and Output Voltage Ripple
 $V_{IN} = 3.3V$, $V_{OUT} = 5V$, $I_{OUT} = 500mA$

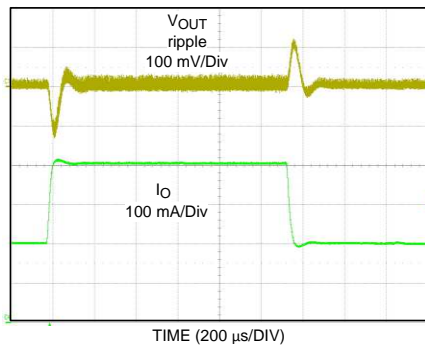


Figure 13. Load Transient
 $V_{IN} = 3.3V$, $V_{OUT} = 5V$, $I_{OUT} = 200mA$ to $400mA$

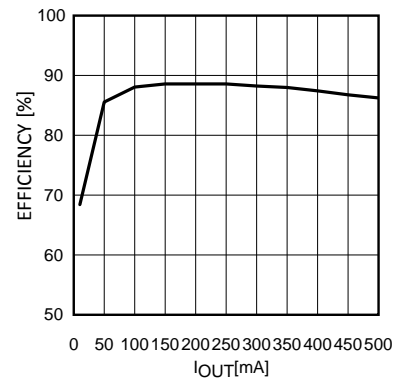
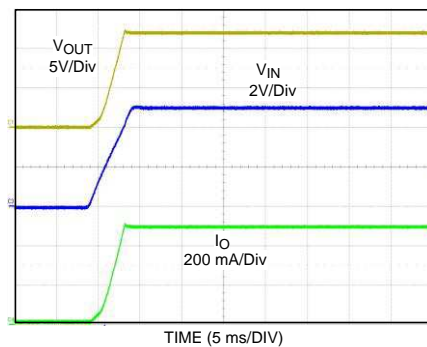
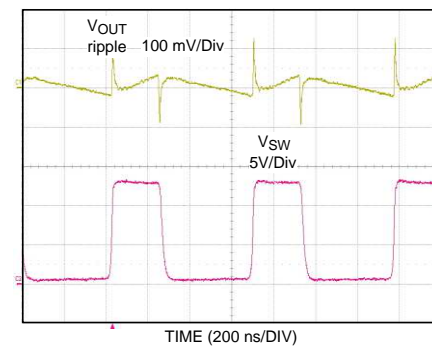
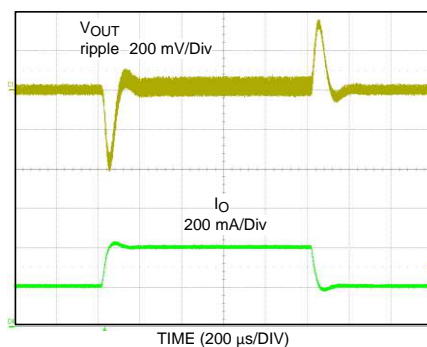
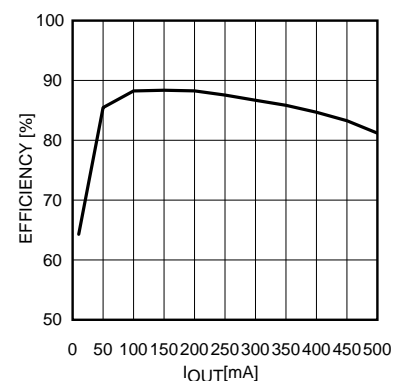


Figure 14. Efficiency
 $V_{IN} = 3.3V$, $V_{OUT} = 5V$

7 Basic Application Circuit - LM2731X

Table 4. LM2731X Bill of Materials ($V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 500mA$)

Designation	Description	Size	Manufacturer Part #	Vendor
C1	Cap 2.2 μ F 16V	1206	EMK316BJ225ML	Taiyo Yuden
C2	Cap 4.7 μ F 16V	1812	EMK432BJ475ML	Taiyo Yuden
C3	Cap 220pF 50V	0805	VJ0805A221JXACW1BC	Vishay
R1	RES, 51k Ohm, 5%, 0.1W	0805	CRCW080551K0JNEA	Vishay
R2	RES, 118k Ohm, 1%, 0.1W	0805	CRCW0805118KFKEA	Vishay
R3	RES, 13.3k Ohm, 1%, 0.1W	0805	CRCW080513K3FKEA	Vishay
L1	Shielded Inductor 10 μ H 4A		CDH53-4R7MC	Sumida
D1	Diode 20V 0.5A	SOT23	MBR0520	International Rectifier
U1	IC LM2731XMF			Texas Instruments


Figure 15. Start Up
 $V_{IN}=5V$, $V_{OUT}=12V$, $I_{OUT}=500mA$

Figure 16. Switching Waveform and Output Voltage Ripple
 $V_{IN}=5V$, $V_{OUT}=12V$, $I_{OUT}=500mA$

Figure 17. Load Transient
 $V_{IN}=5V$, $V_{OUT}=12V$, $I_{OUT}= 200mA$ to $400mA$

Figure 18. Efficiency
 $V_{IN}=5V$, $V_{OUT}=12V$

8 Adjusting the Output Voltage

The output voltage is set using R2 and R3 as given by the formula:

$$V_{OUT} = 1.23 (R2/R3) + 1.23 \quad (1)$$

Solved for R2:

$$R2 = (V_{OUT} - 1.23) / 1.23 \times R3 \quad (2)$$

The evaluation board as shipped has a 13.3k resistor installed at R3. The appropriate value for R2 for any output may be calculated from the above formula.

9 Feedforward Compensation

The feedforward capacitor C3 should be selected to set the compensation zero at approximately 8 kHz. The value of C3 is calculated using:

$$C3 = 1 / (2 \times \pi \times 8k \times R2) \quad (3)$$

The value of C3 is calculated after R2 is selected for the output voltage needed for the specific application.

10 Guidelines for Component Selection

Since it is assumed that some of the eval boards will be modified to be used in different voltage and current configurations, some guidelines are given to help select components which are likely to be changed.

INDUCTOR L1: The amount of inductance required depends on switching frequency, duty cycle and amount of allowable ripple current. 10 μ H is a good choice for most applications. At low boost ratios such as 3.3V to 5V, the LM2731 loop stability requires that the inductance not exceed 6.8 μ H. Smaller inductors may be used in applications with less output current. Higher ripple current resulting from a smaller inductor means the maximum average current (and power) will be less. Duty cycle also affects ripple current, since the time the switch is ON determines the length of time that the current has to ramp up. Any design must be verified for maximum load current over the full temperature range of the application to make sure the inductance is sufficient.

Smaller inductors can be used (and make more sense economically) if the load current is fairly light. The part may operate in discontinuous mode (where inductor current drops to zero during each switching cycle) using less inductance, but this is harmless and actually increases stability (phase margin) compared to continuous operation.

DIODE D1: Because of the fast switching speeds, a Schottky diode must be used for D1. The voltage rating (minimum) should be at least 5V higher than the output voltage for safe design margin. The average current rating of the diode should be at least 50% more than the maximum output load current of the application.

OUTPUT CAPACITOR C2: The output capacitor(s) used on the LM273X must be good quality ceramics of the X7R or X5R type. Z5U or Z5F types will not give sufficient capacitance because of the applied voltage reducing effective capacitance.

The output capacitor is also critical for stability. As a basic guideline, it is recommended for the LM2733: 4.7 μ F minimum, at output voltages of 10V or above. At lower output voltages, use 10-22 μ F. In general, the higher the load current, the more output capacitance is required for stability. For the LM2731: use at least 10 μ F in 5V to 12V applications, and use 22 μ F at lower boost ratios (such as 3.3 to 5V).

Stability of the specific application should be verified over the full operating temperature range by load step testing, where the load current is increased from no load to full load abruptly. This can be done simply by tapping the lead from the load box onto the output terminal. The amount of ringing seen on the output voltage waveform will define the stability of the design.

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