LM2733 0.6/1.6 MHz Boost Converters With 40V Internal FET Switch in SOT-23

Check for Samples: LM2733

FEATURES

- **40V DMOS FET Switch**
- **1.6 MHz (“X”), 0.6 MHz (“Y”) Switching Frequency**
- **Low R_{DS}(ON) DMOS FET**
- **Switch Current up to 1A**
- **Wide Input Voltage Range (2.7V–14V)**
- **Low Shutdown Current (<1 µA)**
- **5-Lead SOT-23 Package**
- **Uses Tiny Capacitors and Inductors**
- **Cycle-by-Cycle Current Limiting**
- **Internally Compensated**

APPLICATIONS

- **White LED Current Source**
- **PDA’s and Palm-Top Computers**
- **Digital Cameras**
- **Portable Phones and Games**
- **Local Boost Regulator**

DESCRIPTION

The LM2733 switching regulators are current-mode boost converters operating fixed frequency of 1.6 MHz (“X” option) and 600 kHz (“Y” option).

The use of SOT-23 package, made possible by the minimal power loss of the internal 1A switch, and use of small inductors and capacitors result in the industry's highest power density. The 40V internal switch makes these solutions perfect for boosting to voltages of 16V or greater.

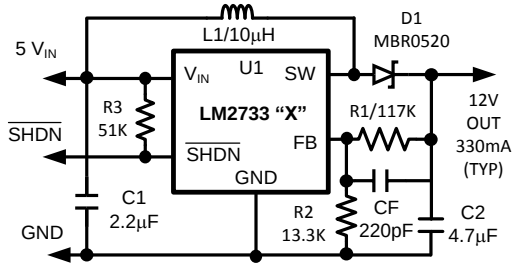
These parts have a logic-level shutdown pin that can be used to reduce quiescent current and extend battery life.

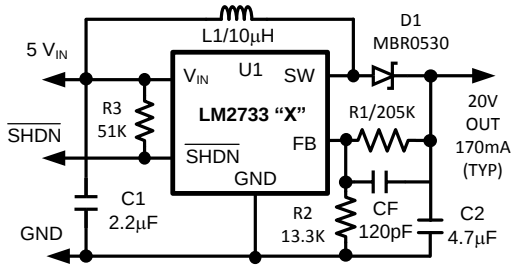
Protection is provided through cycle-by-cycle current limiting and thermal shutdown. Internal compensation simplifies design and reduces component count.

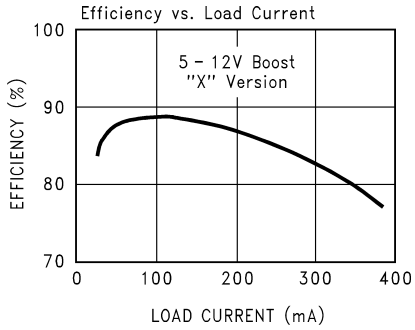
Table 1. Switch Frequency

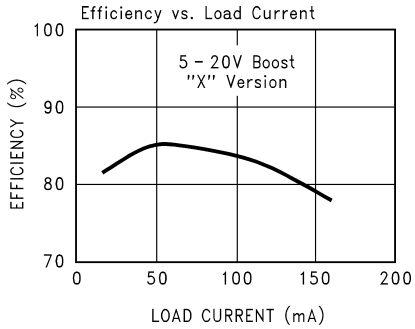
X	Y
1.6 MHz	0.6 MHz

Typical Application Circuit







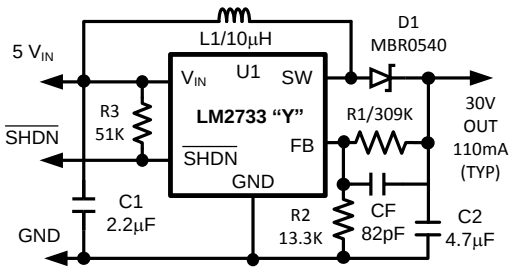


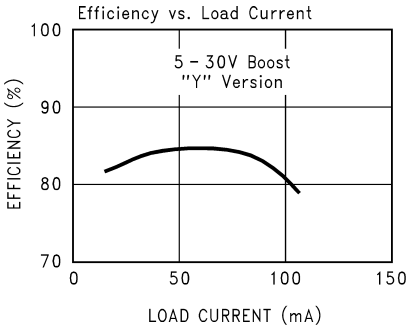
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 2004–2010, Texas Instruments Incorporated





Connection Diagram

Top View

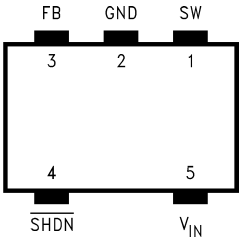


Figure 1. 5-Lead SOT-23 Package
See Package Number DBV (R-PDSO-G5)

PIN DESCRIPTIONS

Pin	Name	Function
1	SW	Drain of the internal FET switch.
2	GND	Analog and power ground.
3	FB	Feedback point that connects to external resistive divider.
4	$\overline{SHDN}$	Shutdown control input. Connect to V_{IN} if this feature is not used.
5	V_{IN}	Analog and power input.

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Copyright © 2004–2010, Texas Instruments Incorporated

Absolute Maximum Ratings[1][2]

Storage Temperature Range		−65°C to +150°C
Operating Junction Temperature Range		−40°C to +125°C
Lead Temp. (Soldering, 5 sec.)		300°C
Power Dissipation[3]		Internally Limited
FB Pin Voltage		−0.4V to +6V
SW Pin Voltage		−0.4V to +40V
Input Supply Voltage		−0.4V to +14.5V
$\overline{SHDN}$ Pin Voltage		−0.4V to VIN + 0.3V
θ_{J-A} (SOT-23)		265°C/W
ESD Rating[4]	Human Body Model	2 kV
	Machine Model	200V

(1) Absolute Maximum Ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of the limits set forth under the operating ratings which specify the intended range of operating conditions.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
(3) The maximum power dissipation which can be safely dissipated for any application is a function of the maximum junction temperature, $T_J(MAX)$ = 125°C, the junction-to-ambient thermal resistance for the SOT-23 package, θ_{J-A} = 265°C/W, and the ambient temperature, T_A. The maximum allowable power dissipation at any ambient temperature for designs using this device can be calculated using the formula: $P(MAX) = \frac{T_J(MAX) - T_A}{\theta_{J-A}} = \frac{125 - T_A}{265}$ If power dissipation exceeds the maximum specified above, the internal thermal protection circuitry will protect the device by reducing the output voltage as required to maintain a safe junction temperature.
(4) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin. The machine model is a 200 pF capacitor discharged directly into each pin.

Electrical Characteristics

Limits in standard typeface are for T_J = 25°C, and limits in **boldface type** apply over the full operating temperature range (−40°C ≤ T_J ≤ +125°C). Unless otherwise specified: V_{IN} = 5V, V_{SHDN} = 5V, I_L = 0A.

Symbol	Parameter	Conditions	Min[1]	Typical[2]	Max[1]	Units
V_{IN}	Input Voltage		**2.7**		**14**	V
I_{SW}	Switch Current Limit	See[3]	1.0	1.5		A
$R_{DS}(ON)$	Switch ON Resistance	I_{SW} = 100 mA		500	650	mΩ
$SHDN_{TH}$	Shutdown Threshold	Device ON	**1.5**			V
		Device OFF			**0.50**	
I_{SHDN}	Shutdown Pin Bias Current	V_{SHDN} = 0		0		µA
		V_{SHDN} = 5V		0	**2**	
V_{FB}	Feedback Pin Reference Voltage	V_{IN} = 3V	**1.205**	1.230	**1.255**	V
I_{FB}	Feedback Pin Bias Current	V_{FB} = 1.23V		60		nA
I_Q	Quiescent Current	V_{SHDN} = 5V, Switching "X"		2.1	**3.0**	mA
		V_{SHDN} = 5V, Switching "Y"		1.1	**2**	
		V_{SHDN} = 5V, Not Switching		400	**500**	µA
		V_{SHDN} = 0		0.024	1	
$\Delta V_{FB}/\Delta V_{IN}$	FB Voltage Line Regulation	2.7V ≤ V_{IN} ≤ 14V		0.02		%/V
F_{SW}	Switching Frequency	“X” Option	**1.15**	1.6	**1.85**	MHz
		“Y” Option	**0.40**	0.60	**0.8**	
D_{MAX}	Maximum Duty Cycle	“X” Option	**87**	93		%
		“Y” Option	**93**	96		
I_L	Switch Leakage	Not Switching V_{SW} = 5V			1	µA

(1) Limits are specified by testing, statistical correlation, or design.
(2) Typical values are derived from the mean value of a large quantity of samples tested during characterization and represent the most likely expected value of the parameter at room temperature.
(3) Switch current limit is dependent on duty cycle (see Typical Performance Characteristics). Limits shown are for duty cycles ≤ 50%.

Copyright © 2004–2010, Texas Instruments Incorporated

Typical Performance Characteristics

Unless otherwise specified: V_{IN} = 5V, $\overline{SHDN}$ pin is tied to V_{IN}.

Iq V_{IN} (Active) vs Temperature - "X"

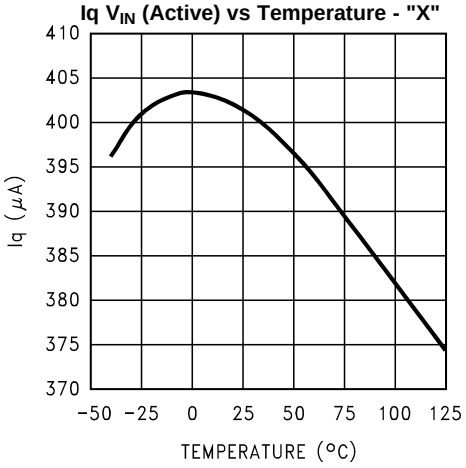


Figure 2.

Iq V_{IN} (Active) vs Temperature - "Y"

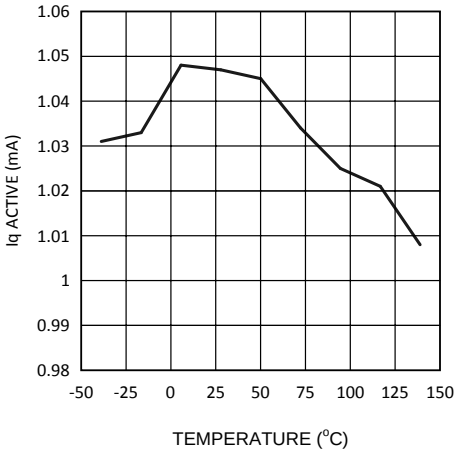


Figure 3.

Oscillator Frequency vs Temperature - "X"

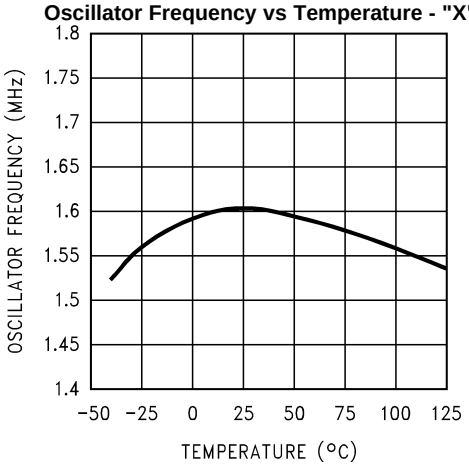


Figure 4.

Oscillator Frequency vs Temperature - "Y"

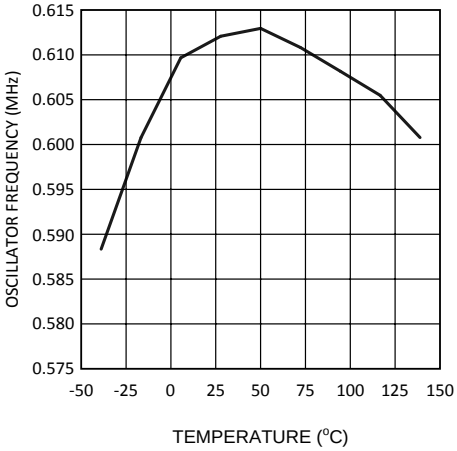


Figure 5.

Max. Duty Cycle vs Temperature - "X"

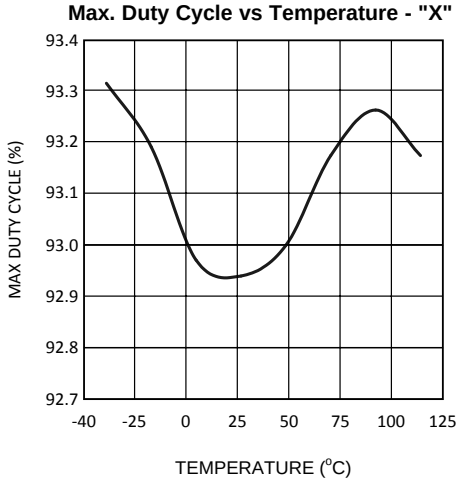


Figure 6.

Max. Duty Cycle vs Temperature - "Y"

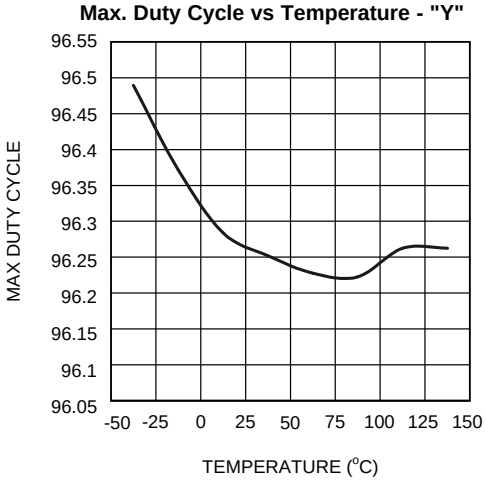


Figure 7.

Copyright © 2004–2010, Texas Instruments Incorporated

Typical Performance Characteristics (continued)

Unless otherwise specified: V_{IN} = 5V, $\overline{SHDN}$ pin is tied to V_{IN}.

Feedback Voltage vs Temperature

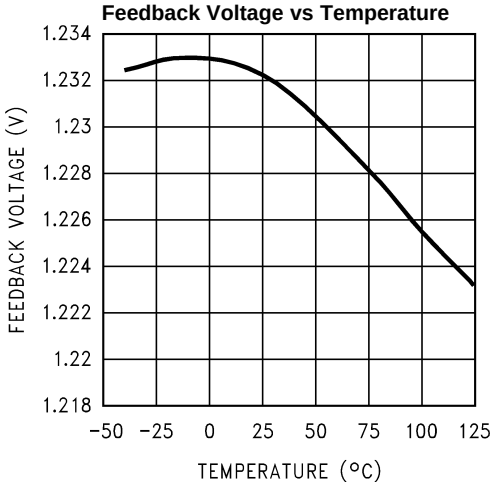


Figure 8.

R_{DS}(ON) vs Temperature

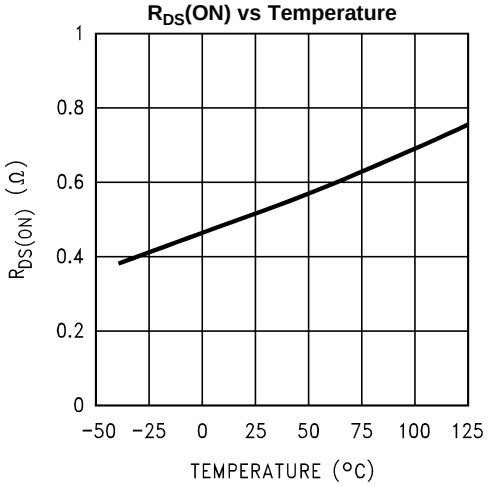


Figure 9.

Current Limit vs Temperature

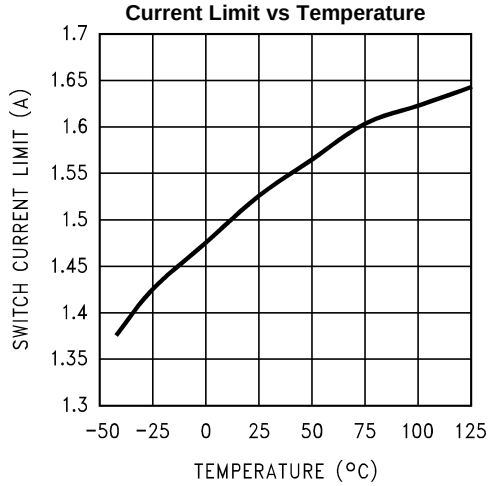


Figure 10.

$R_{DS(ON)}$ vs V_{IN}

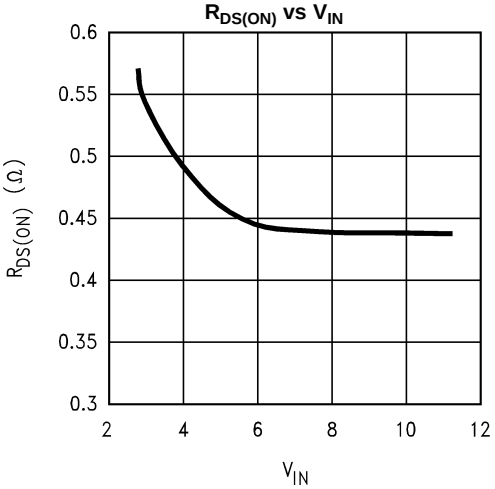


Figure 11.

Efficiency vs Load Current (V_{OUT} = 12V) - "X"

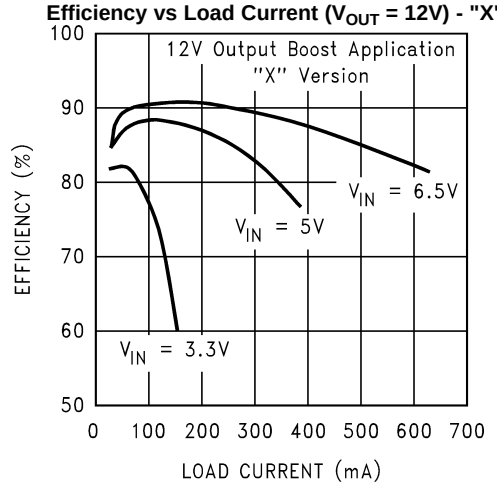


Figure 12.

Efficiency vs Load Current (V_{OUT} = 15V) - "X"

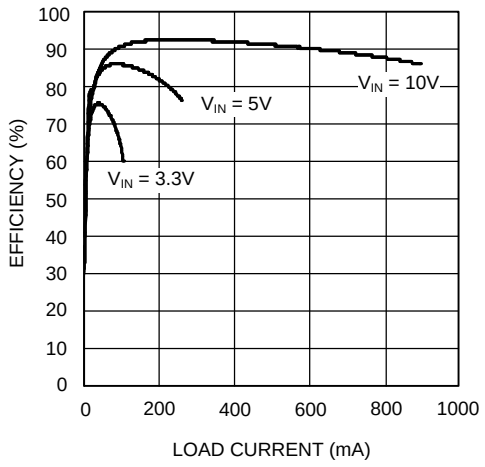


Figure 13.

Copyright © 2004–2010, Texas Instruments Incorporated

Typical Performance Characteristics (continued)

Unless otherwise specified: V_{IN} = 5V, $\overline{SHDN}$ pin is tied to V_{IN}.

Efficiency vs Load Current (V_{OUT} = 20V) - "X"

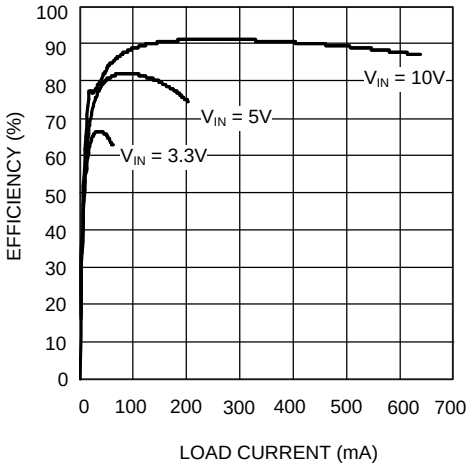


Figure 14.

Efficiency vs Load Current (V_{OUT} = 25V) - "X"

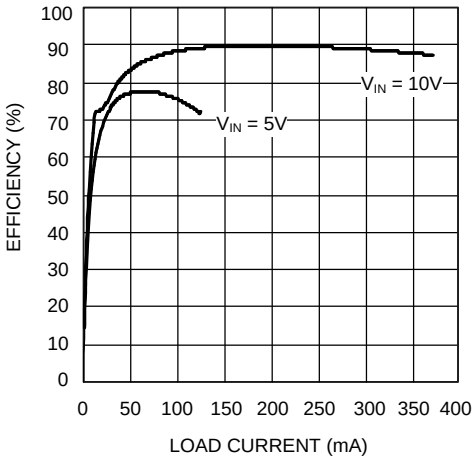


Figure 15.

Efficiency vs Load Current (V_{OUT} = 30V) - "X"

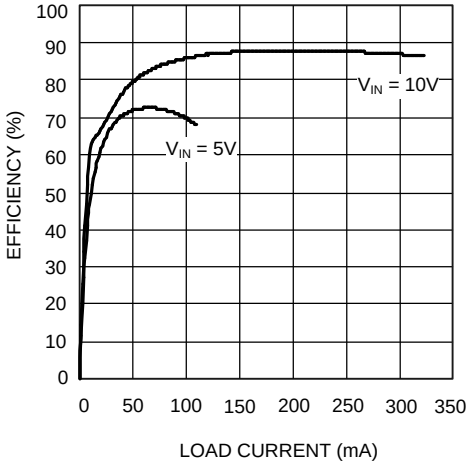


Figure 16.

Efficiency vs Load Current (V_{OUT} = 35V) - "X"

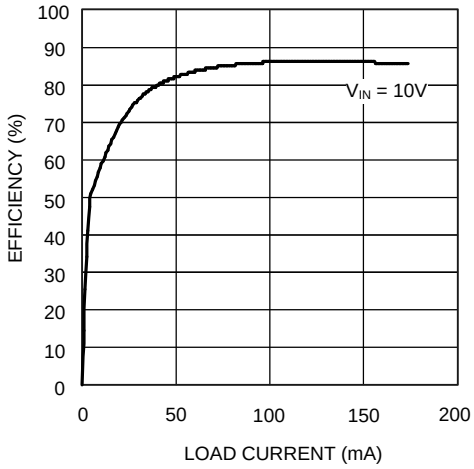


Figure 17.

Efficiency vs Load Current (V_{OUT} = 40V) - "X"

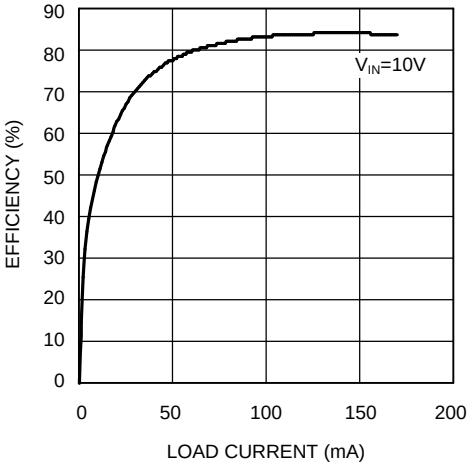


Figure 18.

Efficiency vs Load (V_{OUT} = 15V) - "Y"

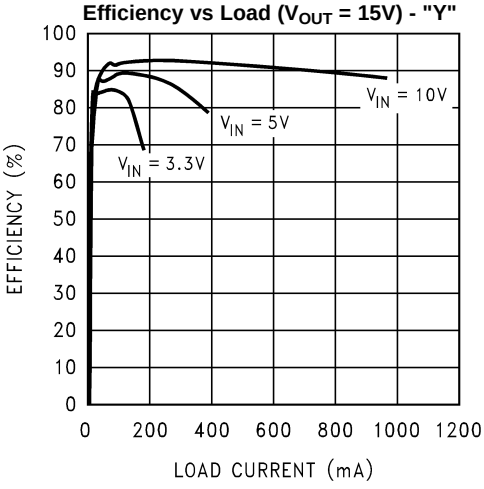


Figure 19.

Copyright © 2004–2010, Texas Instruments Incorporated

Typical Performance Characteristics (continued)

Unless otherwise specified: V_{IN} = 5V, $\overline{SHDN}$ pin is tied to V_{IN}.

Efficiency vs Load (V_{OUT} = 20V) - "Y"

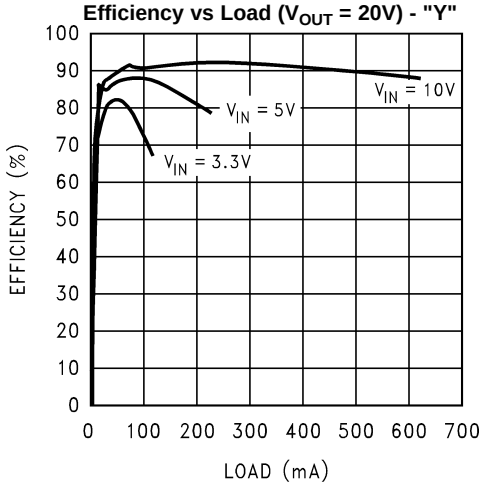


Figure 20.

Efficiency vs Load (V_{OUT} = 25V) - "Y"

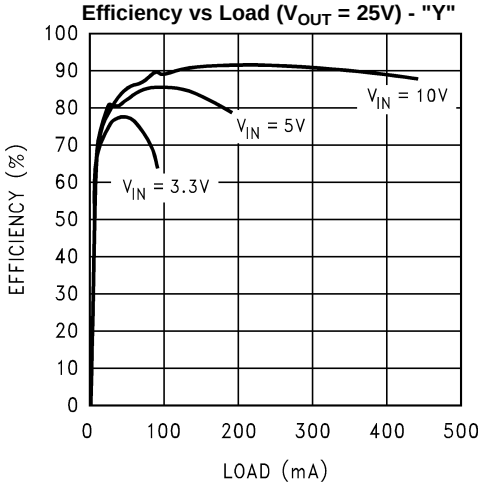


Figure 21.

Efficiency vs Load (V_{OUT} = 30V) - "Y"

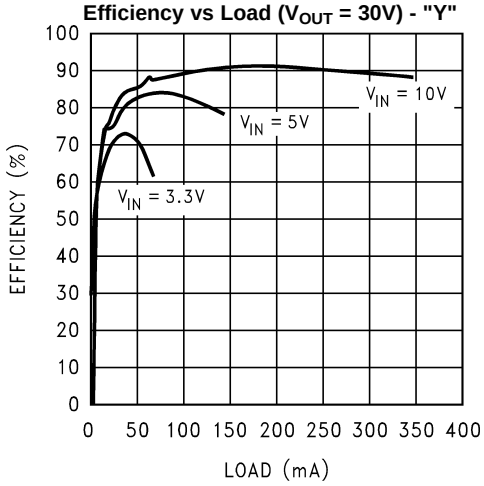


Figure 22.

Efficiency vs Load (V_{OUT} = 35V) - "Y"

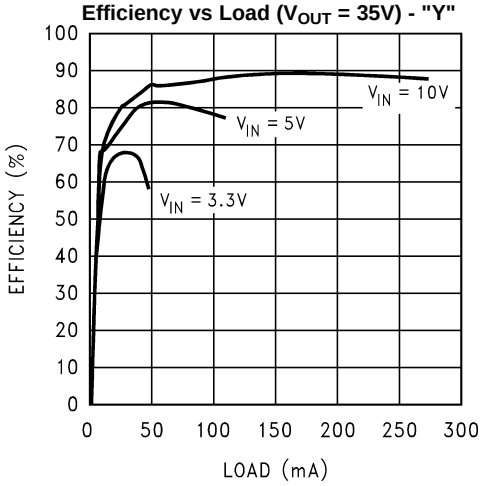


Figure 23.

Efficiency vs Load (V_{OUT} = 40V) - "Y"

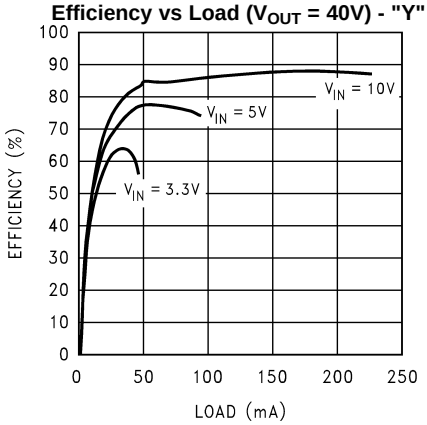
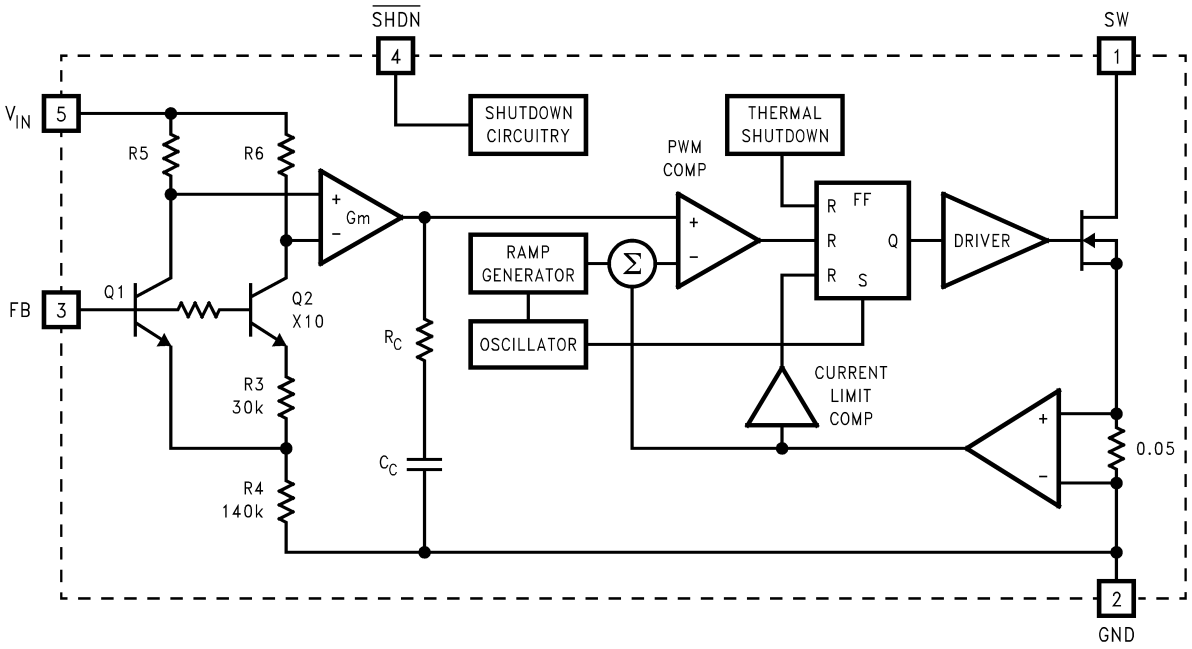


Figure 24.

Copyright © 2004–2010, Texas Instruments Incorporated

Block Diagram



THEORY OF OPERATION

The LM2733 is a switching converter IC that operates at a fixed frequency (0.6 or 1.6 MHz) using current-mode control for fast transient response over a wide input voltage range and incorporate pulse-by-pulse current limiting protection. Because this is current mode control, a 50 mΩ sense resistor in series with the switch FET is used to provide a voltage (which is proportional to the FET current) to both the input of the pulse width modulation (PWM) comparator and the current limit amplifier.

At the beginning of each cycle, the S-R latch turns on the FET. As the current through the FET increases, a voltage (proportional to this current) is summed with the ramp coming from the ramp generator and then fed into the input of the PWM comparator. When this voltage exceeds the voltage on the other input (coming from the Gm amplifier), the latch resets and turns the FET off. Since the signal coming from the Gm amplifier is derived from the feedback (which samples the voltage at the output), the action of the PWM comparator constantly sets the correct peak current through the FET to keep the output volatge in regulation.

Q1 and Q2 along with R3 - R6 form a bandgap voltage reference used by the IC to hold the output in regulation. The currents flowing through Q1 and Q2 will be equal, and the feedback loop will adjust the regulated output to maintain this. Because of this, the regulated output is always maintained at a voltage level equal to the voltage at the FB node "multiplied up" by the ratio of the output resistive divider.

The current limit comparator feeds directly into the flip-flop, that drives the switch FET. If the FET current reaches the limit threshold, the FET is turned off and the cycle terminated until the next clock pulse. The current limit input terminates the pulse regardless of the status of the output of the PWM comparator.

Copyright © 2004–2010, Texas Instruments Incorporated

Application Hints

SELECTING THE EXTERNAL CAPACITORS

The best capacitors for use with the LM2733 are multi-layer ceramic capacitors. They have the lowest ESR (equivalent series resistance) and highest resonance frequency which makes them optimum for use with high frequency switching converters.

When selecting a ceramic capacitor, only X5R and X7R dielectric types should be used. Other types such as Z5U and Y5F have such severe loss of capacitance due to effects of temperature variation and applied voltage, they may provide as little as 20% of rated capacitance in many typical applications. Always consult capacitor manufacturer's data curves before selecting a capacitor. High-quality ceramic capacitors can be obtained from Taiyo-Yuden, AVX, and Murata.

SELECTING THE OUTPUT CAPACITOR

A single ceramic capacitor of value 4.7 µF to 10 µF will provide sufficient output capacitance for most applications. For output voltages below 10V, a 10 µF capacitance is required. If larger amounts of capacitance are desired for improved line support and transient response, tantalum capacitors can be used in parallel with the ceramics. Aluminum electrolytics with ultra low ESR such as Sanyo Oscon can be used, but are usually prohibitively expensive. Typical AI electrolytic capacitors are not suitable for switching frequencies above 500 kHz due to significant ringing and temperature rise due to self-heating from ripple current. An output capacitor with excessive ESR can also reduce phase margin and cause instability.

SELECTING THE INPUT CAPACITOR

An input capacitor is required to serve as an energy reservoir for the current which must flow into the coil each time the switch turns ON. This capacitor must have extremely low ESR, so ceramic is the best choice. We recommend a nominal value of 2.2 µF, but larger values can be used. Since this capacitor reduces the amount of voltage ripple seen at the input pin, it also reduces the amount of EMI passed back along that line to other circuitry.

FEED-FORWARD COMPENSATION

Although internally compensated, the feed-forward capacitor Cf is required for stability (see Figure 26). Adding this capacitor puts a zero in the loop response of the converter. Without it, the regulator loop can oscillate. The recommended frequency for the zero fz should be approximately 8 kHz. Cf can be calculated using the formula:

$$Cf = 1 / (2 \times \pi \times R1 \times fz) \quad (1)$$

SELECTING DIODES

The external diode used in the typical application should be a Schottky diode. If the switch voltage is less than 15V, a 20V diode such as the MBR0520 is recommended. If the switch voltage is between 15V and 25V, a 30V diode such as the MBR0530 is recommended. If the switch voltage exceeds 25V, a 40V diode such as the MBR0540 should be used.

The MBR05XX series of diodes are designed to handle a maximum average current of 0.5A. For applications exceeding 0.5A average but less than 1A, a Microsemi UPS5817 can be used.

LAYOUT HINTS

High frequency switching regulators require very careful layout of components in order to get stable operation and low noise. All components must be as close as possible to the LM2733 device. It is recommended that a 4-layer PCB be used so that internal ground planes are available.

As an example, a recommended layout of components is shown:

Copyright © 2004–2010, Texas Instruments Incorporated

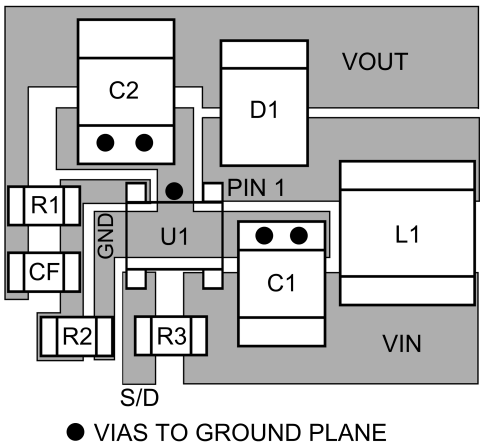


Figure 25. Recommended PCB Component Layout

Some additional guidelines to be observed:

1. Keep the path between L1, D1, and C2 extremely short. Parasitic trace inductance in series with D1 and C2 will increase noise and ringing.
2. The feedback components R1, R2 and CF must be kept close to the FB pin of U1 to prevent noise injection on the FB pin trace.
3. If internal ground planes are available (recommended) use vias to connect directly to ground at pin 2 of U1, as well as the negative sides of capacitors C1 and C2.

SETTING THE OUTPUT VOLTAGE

The output voltage is set using the external resistors R1 and R2 (see Figure 26). A value of approximately 13.3 kΩ is recommended for R2 to establish a divider current of approximately 92 µA. R1 is calculated using the formula:

$$R1 = R2 \times (V_{OUT}/1.23 - 1) \quad (2)$$

SWITCHING FREQUENCY

The LM2733 is provided with two switching frequencies: the “X” version is typically 1.6 MHz, while the “Y” version is typically 600 kHz. The best frequency for a specific application must be determined based on the tradeoffs involved:

Higher switching frequency means the inductors and capacitors can be made smaller and cheaper for a given output voltage and current. The down side is that efficiency is slightly lower because the fixed switching losses occur more frequently and become a larger percentage of total power loss. EMI is typically worse at higher switching frequencies because more EMI energy will be seen in the higher frequency spectrum where most circuits are more sensitive to such interference.

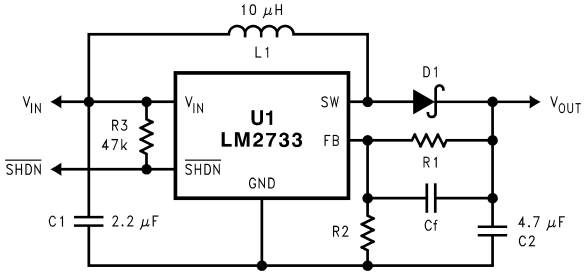


Figure 26. Basic Application Circuit

Copyright © 2004–2010, Texas Instruments Incorporated

DUTY CYCLE

The maximum duty cycle of the switching regulator determines the maximum boost ratio of output-to-input voltage that the converter can attain in continuous mode of operation. The duty cycle for a given boost application is defined as:

$$\text{Duty Cycle} = \frac{V_{OUT} + V_{DIODE} - V_{IN}}{V_{OUT} + V_{DIODE} - V_{SW}} \quad (3)$$

This applies for continuous mode operation.

The equation shown for calculating duty cycle incorporates terms for the FET switch voltage and diode forward voltage. The actual duty cycle measured in operation will also be affected slightly by other power losses in the circuit such as wire losses in the inductor, switching losses, and capacitor ripple current losses from self-heating. Therefore, the actual (effective) duty cycle measured may be slightly higher than calculated to compensate for these power losses. A good approximation for effctive duty cycle is :

$$DC\ (eff) = (1 - Efficiency \times (V_{IN}/V_{OUT})) \quad (4)$$

Where the efficiency can be approximated from the curves provided.

INDUCTANCE VALUE

The first question we are usually asked is: “How small can I make the inductor?” (because they are the largest sized component and usually the most costly). The answer is not simple and involves tradeoffs in performance. Larger inductors mean less inductor ripple current, which typically means less output voltage ripple (for a given size of output capacitor). Larger inductors also mean more load power can be delivered because the energy stored during each switching cycle is:

$$E = L/2 \times (Ip)^2 \quad (5)$$

Where “Ip” is the peak inductor current. An important point to observe is that the LM2733 will limit its switch current based on peak current. This means that since Ip(max) is fixed, increasing L will increase the maximum amount of power available to the load. Conversely, using too little inductance may limit the amount of load current which can be drawn from the output.

Best performance is usually obtained when the converter is operated in “continuous” mode at the load current range of interest, typically giving better load regulation and less output ripple. Continuous operation is defined as not allowing the inductor current to drop to zero during the cycle. It should be noted that all boost converters shift over to discontinuous operation as the output load is reduced far enough, but a larger inductor stays “continuous” over a wider load current range.

To better understand these tradeoffs, a typical application circuit (5V to 12V boost with a 10 µH inductor) will be analyzed. We will assume:

V_{IN} = 5V, V_{OUT} = 12V, V_{DIODE} = 0.5V, V_{SW} = 0.5V

Since the frequency is 1.6 MHz (nominal), the period is approximately 0.625 µs. The duty cycle will be 62.5%, which means the ON time of the switch is 0.390 µs. It should be noted that when the switch is ON, the voltage across the inductor is approximately 4.5V.

Using the equation:

$$V = L\ (di/dt) \quad (6)$$

We can then calculate the di/dt rate of the inductor which is found to be 0.45 A/µs during the ON time. Using these facts, we can then show what the inductor current will look like during operation:

Copyright © 2004–2010, Texas Instruments Incorporated

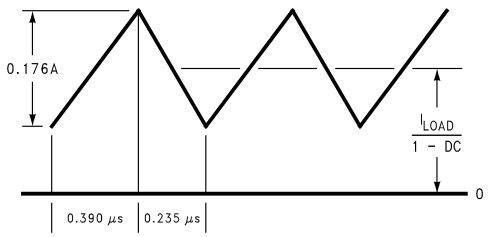


Figure 27. 10 µH Inductor Current, 5V–12V Boost (LM2733X)

During the 0.390 µs ON time, the inductor current ramps up 0.176A and ramps down an equal amount during the OFF time. This is defined as the inductor “ripple current”. It can also be seen that if the load current drops to about 33 mA, the inductor current will begin touching the zero axis which means it will be in discontinuous mode. A similar analysis can be performed on any boost converter, to make sure the ripple current is reasonable and continuous operation will be maintained at the typical load current values.

MAXIMUM SWITCH CURRENT

The maximum FET swtch current available before the current limiter cuts in is dependent on duty cycle of the application. This is illustrated in the graphs below which show both the typical and specified values of switch current for both the "X" and "Y" versions as a function of effective (actual) duty cycle:

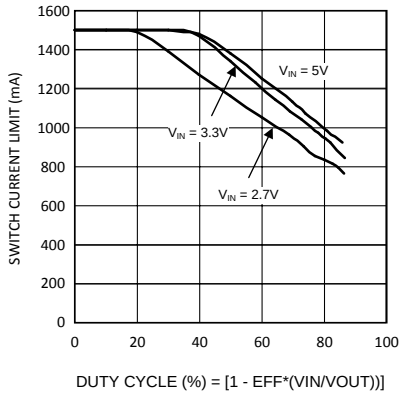


Figure 28. Switch Current Limit vs Duty Cycle - "X"

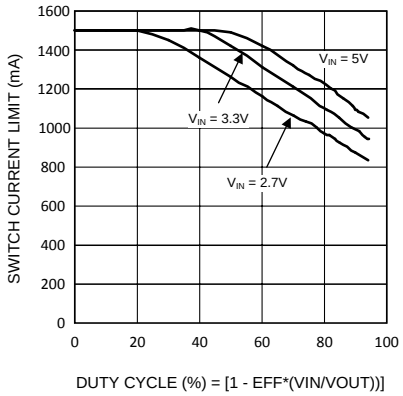


Figure 29. Switch Current Limit vs Duty Cycle - "Y"

Copyright © 2004–2010, Texas Instruments Incorporated

CALCULATING LOAD CURRENT

As shown in the figure which depicts inductor current, the load current is related to the average inductor current by the relation:

$$I_{LOAD} = I_{IND}(AVG) \times (1 - DC) \quad (7)$$

Where "DC" is the duty cycle of the application. The switch current can be found by:

$$I_{SW} = I_{IND}(AVG) + ½ (I_{RIPPLE}) \quad (8)$$

Inductor ripple current is dependent on inductance, duty cycle, input voltage and frequency:

$$I_{RIPPLE} = DC \times (V_{IN}-V_{SW}) / (f \times L) \quad (9)$$

combining all terms, we can develop an expression which allows the maximum available load current to be calculated:

$$I_{LOAD}(max) = (1 - DC) \times \left(I_{SW}(max) - \frac{DC\,(V_{IN} - V_{SW})}{2fL}\right) \quad (10)$$

The equation shown to calculate maximum load current takes into account the losses in the inductor or turn-OFF switching losses of the FET and diode. For actual load current in typical applications, we took bench data for various input and output voltages for both the "X" and "Y" versions of the LM2733 and displayed the maximum load current available for a typical device in graph form:

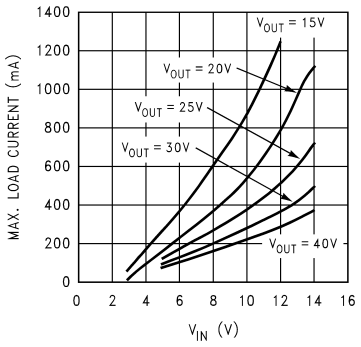


Figure 30. Max. Load Current vs V_{IN} - "X"

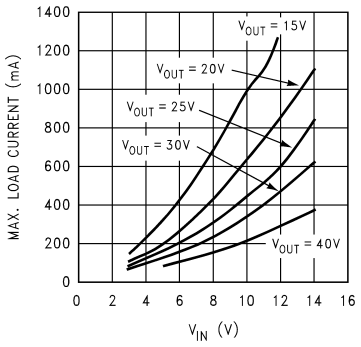


Figure 31. Max. Load Current vs V_{IN} - "Y"

DESIGN PARAMETERS V_{SW} AND I_{SW}

The value of the FET "ON" voltage (referred to as V_{SW} in the equations) is dependent on load current. A good approximation can be obtained by multiplying the "ON Resistance" of the FET times the average inductor current.

FET on resistance increases at V_{IN} values below 5V, since the internal N-FET has less gate voltage in this input voltage range (see Typical Performance Characteristics curves). Above V_{IN} = 5V, the FET gate voltage is internally clamped to 5V.

Copyright © 2004–2010, Texas Instruments Incorporated

The maximum peak switch current the device can deliver is dependent on duty cycle. The minimum value is specified to be > 1A at duty cycle below 50%. For higher duty cycles, see Typical performance Characteristics curves.

THERMAL CONSIDERATIONS

At higher duty cycles, the increased ON time of the FET means the maximum output current will be determined by power dissipation within the LM2733 FET switch. The switch power dissipation from ON-state conduction is calculated by:

$$P_{(SW)} = DC \times I_{IND}(AVE)^2 \times R_{DS}ON \quad (11)$$

There will be some switching losses as well, so some derating needs to be applied when calculating IC power dissipation.

MINIMUM INDUCTANCE

In some applications where the maximum load current is relatively small, it may be advantageous to use the smallest possible inductance value for cost and size savings. The converter will operate in discontinuous mode in such a case.

The minimum inductance should be selected such that the inductor (switch) current peak on each cycle does not reach the 1A current limit maximum. To understand how to do this, an example will be presented.

In the example, the LM2733X will be used (nominal switching frequency 1.6 MHz, minimum switching frequency 1.15 MHz). This means the maximum cycle period is the reciprocal of the minimum frequency:

$$T_{ON(max)} = 1/1.15M = 0.870\ \mu s \quad (12)$$

We will assume the input voltage is 5V, V_{OUT} = 12V, V_{SW} = 0.2V, V_{DIODE} = 0.3V. The duty cycle is:

Duty Cycle = 60.3%

Therefore, the maximum switch ON time is 0.524 µs. An inductor should be selected with enough inductance to prevent the switch current from reaching 1A in the 0.524 µs ON time interval (see below):

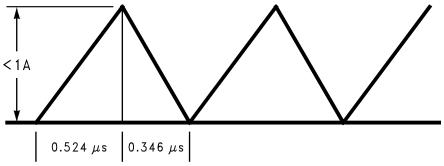


Figure 32. Discontinuous Design, 5V–12V Boost (LM2733X)

The voltage across the inductor during ON time is 4.8V. Minimum inductance value is found by:

$$V = L \times dI/dt,\ L = V \times (dt/dI) = 4.8\ (0.524\mu/1) = 2.5\ \mu H \quad (13)$$

In this case, a 2.7 µH inductor could be used assuming it provided at least that much inductance up to the 1A current value. This same analysis can be used to find the minimum inductance for any boost application. Using the slower switching “Y” version requires a higher amount of minimum inductance because of the longer switching period.

INDUCTOR SUPPLIERS

Some of the recommended suppliers of inductors for this product include, but not limited to are Sumida, Coilcraft, Panasonic, TDK and Murata. When selecting an inductor, make certain that the continuous current rating is high enough to avoid saturation at peak currents. A suitable core type must be used to minimize core (switching) losses, and wire power losses must be considered when selecting the current rating.

SHUTDOWN PIN OPERATION

The device is turned off by pulling the shutdown pin low. If this function is not going to be used, the pin should be tied directly to V_{IN}. If the SHDN function will be needed, a pull-up resistor must be used to V_{IN} (approximately 50k-100kΩ recommended). The SHDN pin must not be left unterminated.

Copyright © 2004–2010, Texas Instruments Incorporated

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM2733XMF	ACTIVE	SOT-23	DBV	5	1000	TBD	Call TI	Call TI	-40 to 125	S52A	Samples
LM2733XMF/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	SN	Level-1-260C-UNLIM	-40 to 125	S52A	Samples
LM2733XMFX	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125	S52A	Samples
LM2733XMFX/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	SN	Level-1-260C-UNLIM	-40 to 125	S52A	Samples
LM2733YMF	ACTIVE	SOT-23	DBV	5	1000	TBD	Call TI	Call TI	-40 to 125	S52B	Samples
LM2733YMF/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	S52B	Samples
LM2733YMFX	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 125	S52B	Samples
LM2733YMFX/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	S52B	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

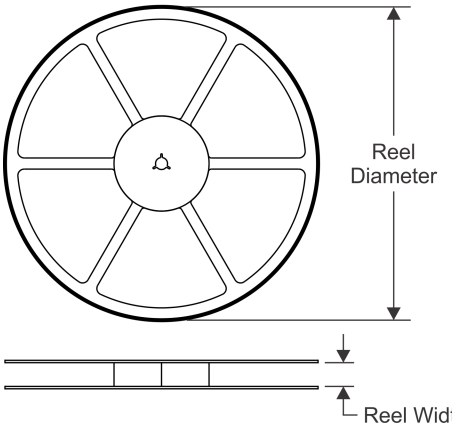
(4) Only one of markings shown within the brackets will appear on the physical device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

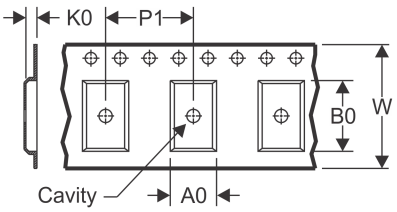
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

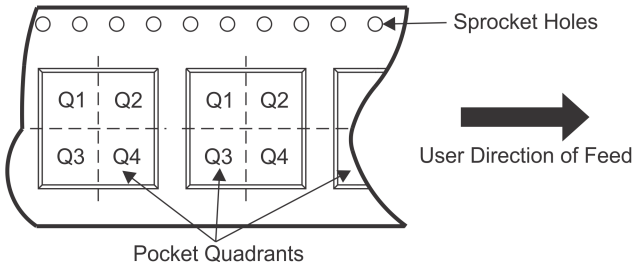


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

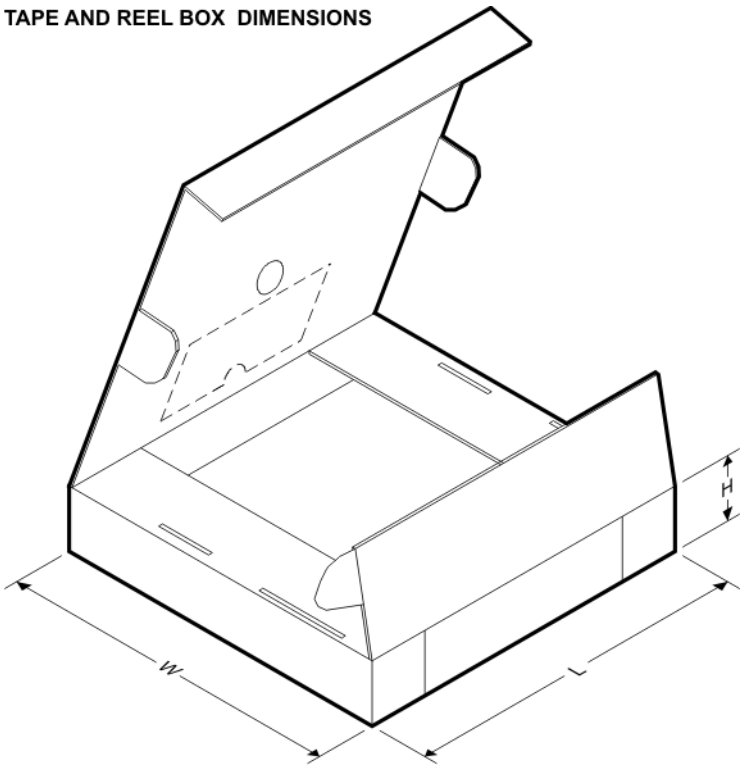
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM2733XMF	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2733XMF/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2733XMFX	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2733XMFX/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2733YMF	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2733YMF/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2733YMFX	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2733YMFX/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

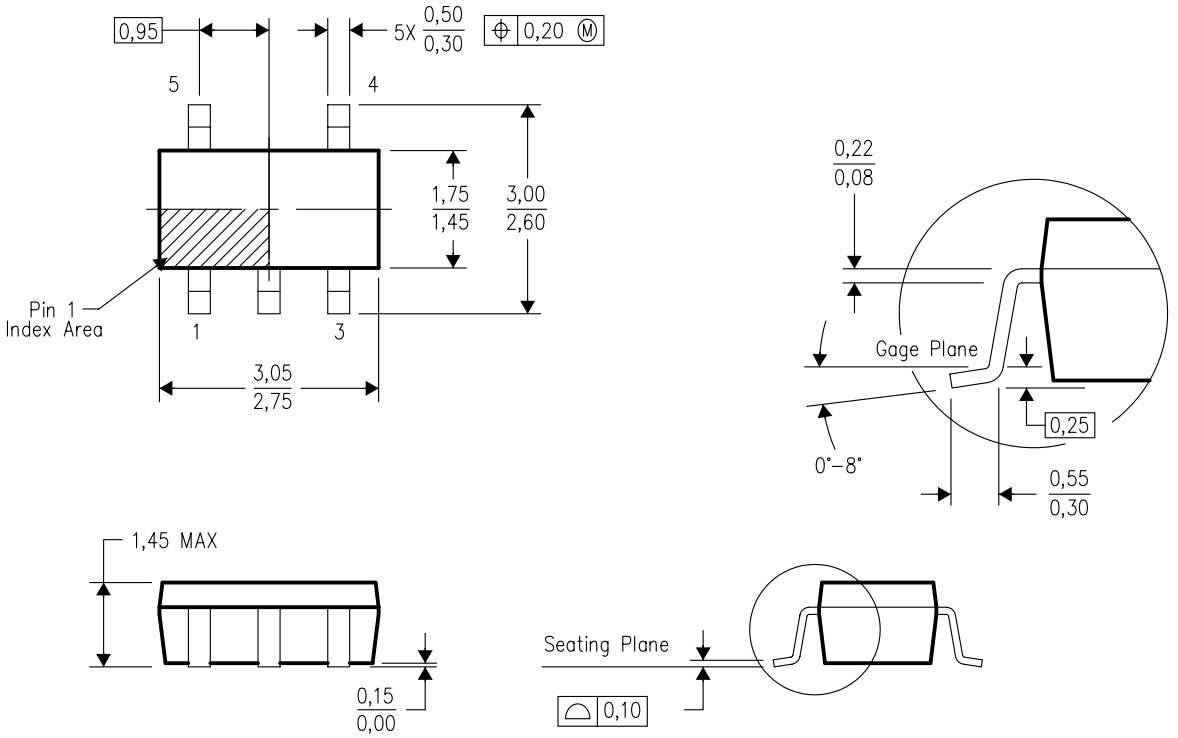
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2733XMF	SOT-23	DBV	5	1000	210.0	185.0	35.0
LM2733XMF/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LM2733XMFX	SOT-23	DBV	5	3000	210.0	185.0	35.0
LM2733XMFX/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0
LM2733YMF	SOT-23	DBV	5	1000	210.0	185.0	35.0
LM2733YMF/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LM2733YMFX	SOT-23	DBV	5	3000	210.0	185.0	35.0
LM2733YMFX/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0

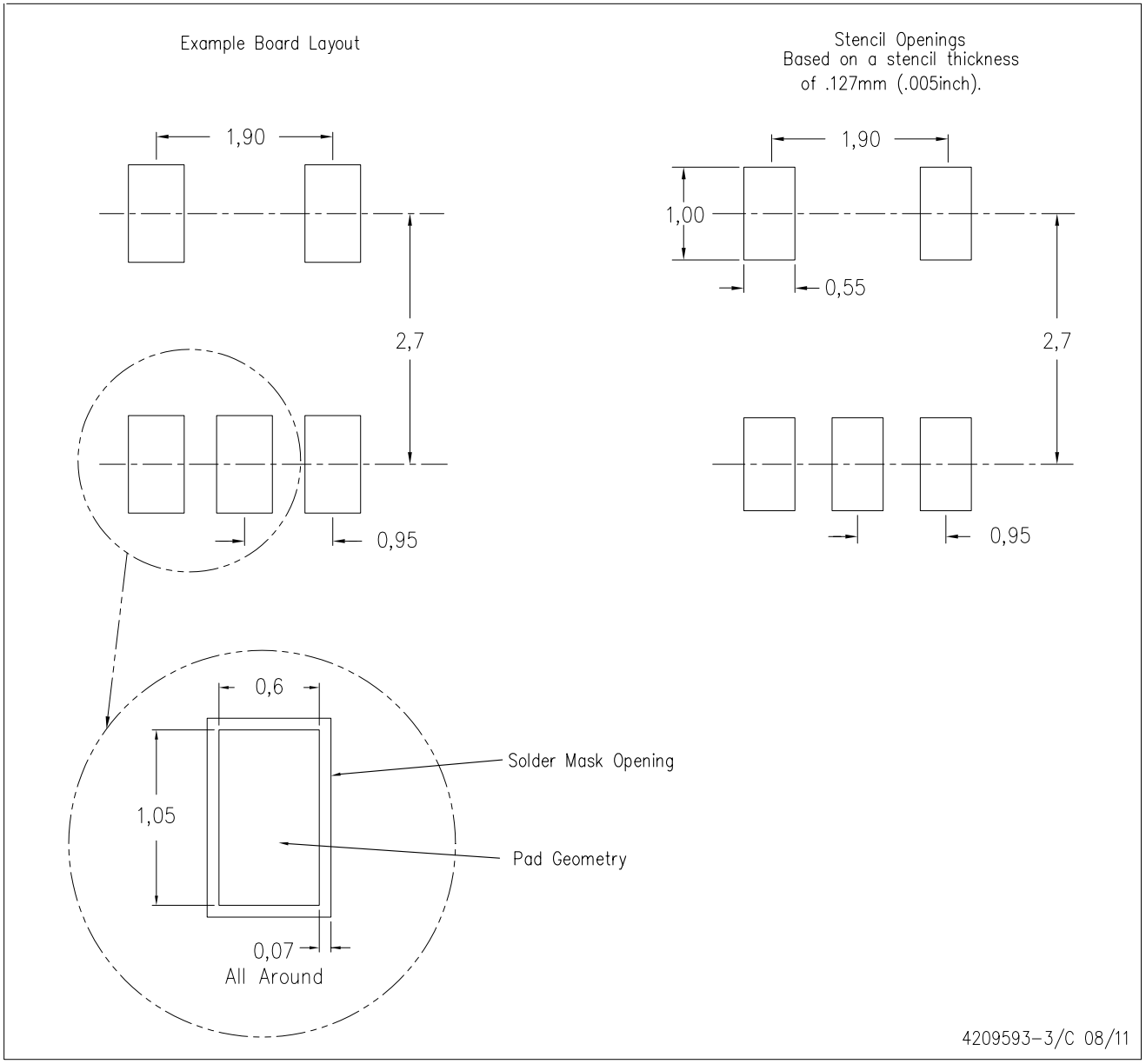
DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



4073253–4/K 03/2006

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–178 Variation AA.

DBV (R–PDSO–G5) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2013, Texas Instruments Incorporated

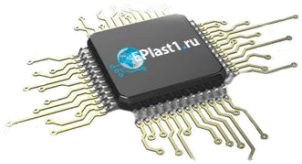
Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)
Факс: 8 (812) 320-02-42
Электронная почта: org@eplast1.ru
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.