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产品规格说明书

Product Data Sheet

LM2576S-12

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电源管理IC



通信接口芯片



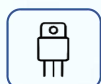
二三极管



LDO稳压器



逻辑器件



MOSFETs



运算放大器



显示驱动



MCU单片机



光电器件

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DC-DC Power Chip



General Description

The LM2576 series of regulators are monolithic integrated circuit that provides all the active functions for a step-down (buck) switching regulator, capable of driving 3A load with excellent line and load regulation. The LM2576HV available in fixed output voltages of 3.3V, 5V, 12V and an adjustable output version.

Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation and a fixed-frequency oscillator.

The LM2576 series offers a high-efficiency replacement for popular three-terminal linear regulators. It substantially reduces the size of the heat sink, and in some cases no heat sink is required. A standard series of inductors optimized for use with the LM2576HV are available from several different manufacturers. This feature greatly simplifies the design of switch-mode power supplies.

Other features include a guaranteed $\pm 4\%$ tolerance on output voltage within specified input voltages and output load conditions, and $\pm 10\%$ on the oscillator frequency. External shutdown is included, featuring 50 μA (typical) standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

The LM2576 is available in TO220-5 and TO263-5 package.

Features

- 3.3V, 5V, 12V and adjustable output versions
- High efficiency
- Guaranteed 3A output current
- Requires only 4 external components
- 52 kHz fixed frequency internal oscillator
- TTL shutdown capability, low power standby mode
- Uses readily available standard inductors
- Thermal shutdown and current limit protection
- Adjustable version output voltage range, 1.23V to 57V $\pm 4\%$ max over line and load conditions



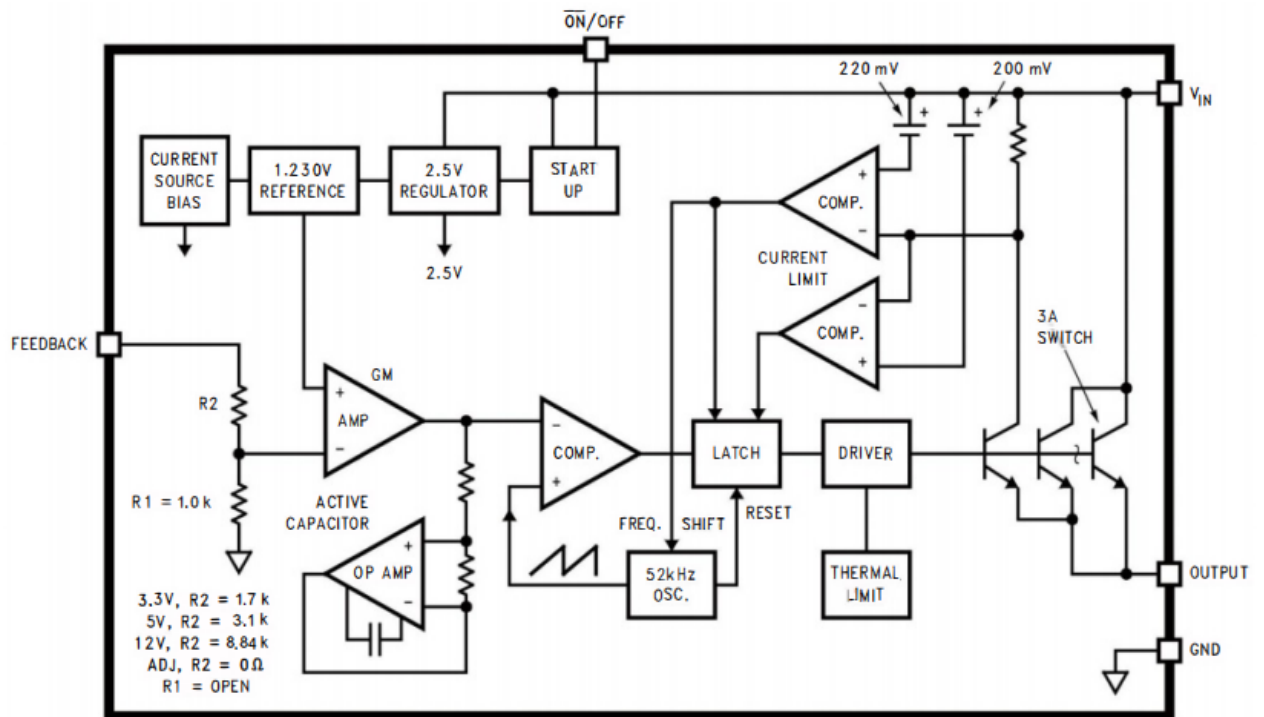
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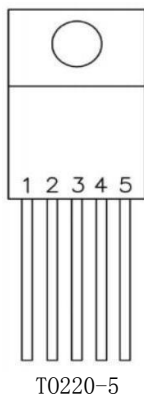
Application

- Simple high-efficiency step-down (buck) regulator
- Efficient pre-regulator for linear regulators
- On-card switching regulators
- Positive to negative converter (Buck-Boost)

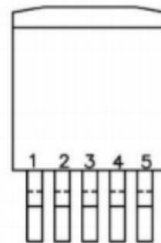
Functional Block Diagram



Pin Configuration



T0220-5



T0263-5



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Pin Description

| Pin Number | Pin Name | Function Description |
|------------|----------|--|
| 1 | VIN | This is the positive input supply for the IC switching regulator. A suitable input bypass capacitor must be present at this pin to minimize voltage transients and to supply the switching currents needed by the regulator. |
| 2 | OUTPUT | Internal switch, the voltage at this pin switches between $(+V_{IN}, V_{SAT})$ and approximately -0.5V. To minimize coupling to sensitive circuitry, the PCB boad copper area connected to this pin should be kept to a minimum. |
| 3 | GND | Circuit Ground. |
| 4 | FEEDBACK | Senses the regulated output voltage to complete the feedback loop. |
| 5 | ON/OFF | Allows the switching regulator circuit to be shut down using logic level signals. |

Absolute Maximum Ratings

| Parameter Name | Symbol | Value | Unit |
|---|------------|----------------------------|------|
| Maximum Supply Voltage | V_{IN} | 45 | V |
| ON/OFF Pin Input Voltage | ON/OFF | $-0.3 \leq V \leq +V_{IN}$ | V |
| Output Voltage to Ground (steady state) | V_{OUT} | -1 | V |
| Power Dissipation | P_{DMAX} | Internally Limited | |
| Storage Temperature Range | Tstg | -65~+150 | |
| Maximum Junction Temperature | T_{JA} | 150 | |
| ESD Susceptibility (Human Body Model) | ESD | 2 | kV |
| Lead Temperature (Soldering, 10 Second) | T_L | 260 | |

Recommended Operating Conditions

| Parameter Name | Symbol | Value | Unit |
|-----------------------------|----------|----------|------|
| Supply Voltage | V_{IN} | 6~60 | V |
| Operating temperature range | Topr | -40~+125 | |



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Electro-Optical Characteristics

(unless otherwise specified: $T_J=25^\circ\text{C}$)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|------------------------------|------------|---------------------------------------|-----|-----|-----|---------|
| Device Parameters | | | | | | |
| Feedback Bias Current | I_b | Adjustable version only, $V_{OUT}=5V$ | | 50 | 100 | nA |
| Oscillator Frequency | f_o | (Note1) | 47 | 52 | 58 | kHz |
| V_{SAT} Saturation Voltage | V_{SAT} | $I_{OUT}=3A$ | | 1.4 | 1.8 | V |
| Max.Duty Cycle(ON) | DC | | 93 | 98 | | % |
| Current Limit | I_{CL} | (Note1) | 4.2 | 5.8 | 6.9 | A |
| Output Leakage Current | I_L | Output=0V | | | 2 | mA |
| | | Output=-1V | | 7.5 | 30 | mA |
| Quiescent Current | I_Q | | | 5 | 10 | mA |
| Standby Quiescent Current | I_{STBY} | ON/OFF | | 50 | 200 | μA |
| ON/OFF Control | | | | | | |
| ON/OFF Pin Logic Input Level | V_{IH} | $V_{OUT}=0V$ | 2.0 | | | V |
| | V_{IL} | V_{OUT} =nominal output voltage | | | 0.8 | V |
| ON/OFF Pin Input Current | I_{IH} | ON/OFF pin=5V (OFF) | | 12 | 30 | μA |
| | I_{IL} | ON/OFF pin=0V (ON) | | 0 | 10 | μA |

Note1: The oscillator frequency reduces to approximately 11 kHz in the event of an output short or an overload which causes the regulated output voltage to drop approximately 40% from the nominal output voltage. This self protection feature lowers the average power dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%. Output pin sourcing current. No diode, inductor or capacitor connected to output.



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Product Specification

| ParameterName | Symbol | Test Conditions | Min | Typ | Max | Units |
|----------------|-----------|---|-------|-------|-------|-------|
| LM2576HV-3.3V | | | | | | |
| Output Voltage | V_{OUT} | $V_{IN}=12V, I_O=500mA$ | 3.234 | 3.3 | 3.366 | V |
| | | $6V \leq V_{IN} \leq 40V$ $0.5A \leq I_{LOAD} \leq 3A$ | 3.168 | 3.3 | 3.450 | V |
| Efficiency | η | $V_{IN}=12V, I_{LOAD}=3A$ | | 75 | | % |
| LM2586HV-5.0V | | | | | | |
| Output Voltage | V_{OUT} | $V_{IN}=12V, I_O=500mA$ | 4.90 | 5.00 | 5.10 | V |
| | | $8V \leq V_{IN} \leq 40V$ $0.5A \leq I_{LOAD} \leq 3A$ | 4.80 | 5.00 | 5.20 | V |
| Efficiency | η | $V_{IN}=12V, I_{LOAD}=3A$ | | 77 | | % |
| LM2576HV-12V | | | | | | |
| Output Voltage | V_{OUT} | $V_{IN}=25V, I_O=500mA$ | 11.76 | 12.00 | 12.24 | V |
| | | $15V \leq V_{IN} \leq 40V$ $0.5A \leq I_{LOAD} \leq 3A$ | 11.52 | 12.00 | 12.48 | V |
| Efficiency | η | $V_{IN}=25V, I_{LOAD}=3A$ | | 88 | | % |
| LM2576HV-ADJ | | | | | | |
| Output Voltage | V_{OUT} | $V_{IN}=12V, I_O=500mA,$ $V_{OUT}=5V$ | 1.217 | 1.230 | 1.243 | V |
| | | $6V \leq V_{IN} \leq 40V, V_{OUT}=5V$ $0.5A \leq I_{LOAD} \leq 3A$ | 1.193 | 1.230 | 1.267 | V |
| Efficiency | η | $V_{IN}=12V, I_{LOAD}=3A, V_{OUT}=5V$ | | 77 | | % |



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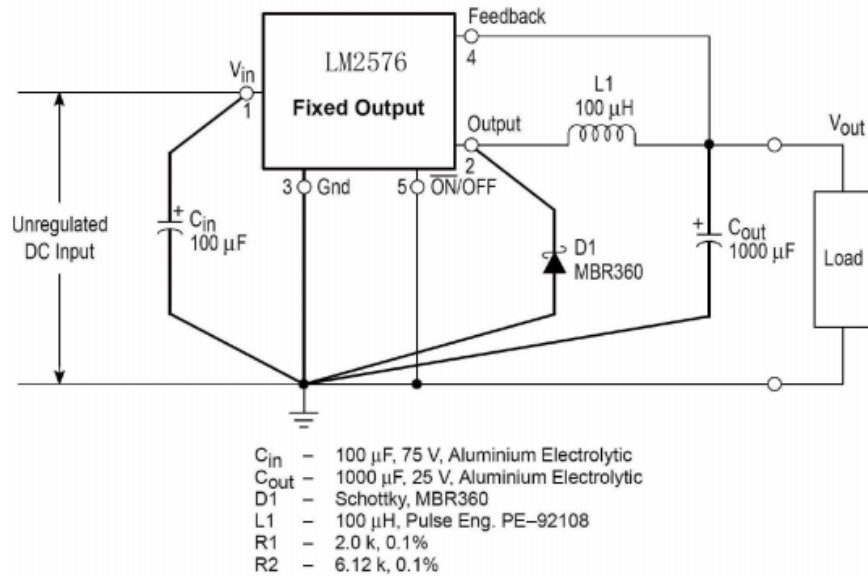
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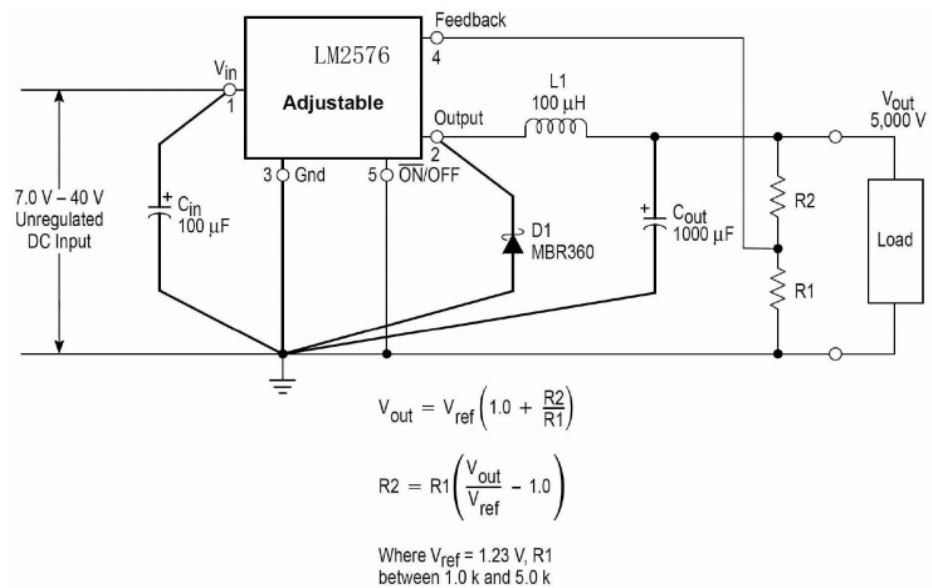
Data Sheet

Test Circuit

Fixed Output Voltage Versions



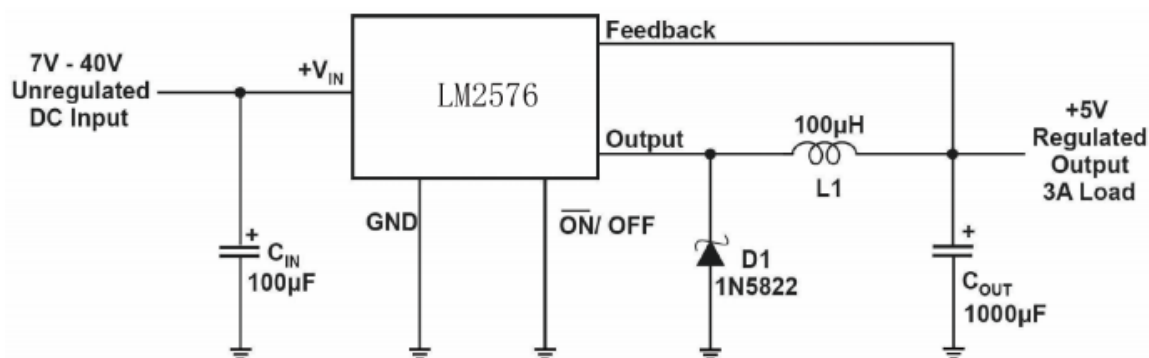
Adjustable output voltage versions



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Typical Application



Application Information

Input Capacitor(C_{IN})

To maintain stability, the regulator input pin must be bypassed with at least a 100 uF electrolytic capacitor.

The capacitor's leads must be kept short, and located near the regulator. If the operating temperature range includes temperatures below -25°C, the input capacitor value may need to be larger. With most electrolytic capacitors, the capacitance value decreases and the ESR increases with lower temperatures and age. Paralleling a ceramic or solid tantalum capacitor will increase the regulator stability at cold temperatures. For maximum capacitor operating lifetime, the capacitor's RMS ripple current rating should be greater than

$$1.2 \times \left(\frac{t_{ON}}{T} \right) \times I_{LOAD}$$

Where $\frac{t_{ON}}{T} = \frac{V_{OUT}}{V_{IN}}$ for a buck regulator

and $\frac{t_{ON}}{T} = \frac{|V_{OUT}|}{|V_{OUT}| + V_{IN}}$ for a buck-boost regulator.



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Inductor Selection

All switching regulators have two basic modes of operation: continuous and discontinuous. The difference between the two types relates to the inductor current, whether it is flowing continuously, or if it drops to zero for a period of time in the normal switching cycle. Each mode has distinctively different operating characteristics, which can affect the regulator performance and requirements. The LM2576 can be used for both continuous and discontinuous modes of operation. When using inductor values shown in the inductor selection guide, the peak-to-peak inductor ripple current will be approximately 20% to 30% of the maximum DC current. With relatively heavy load currents, the circuit operates in the continuous mode (inductor current always flowing), but under light load conditions, the circuit will be forced to the discontinuous mode (inductor current falls to zero for a period of time). This discontinuous mode of operation is perfectly acceptable. For light loads (less than approximately 300mA) it may be desirable to operate the regulator in the discontinuous mode, primarily because of the lower inductor values required for the discontinuous mode. The selection guide chooses inductor values suitable for continuous mode operation, but if the inductor value chosen is prohibitively high, the designer should investigate the possibility of discontinuous operation.

Inductors are available in different styles such as pot core, toroid, E-frame, bobbin core, etc., as well as different core materials, such as ferrites and powdered iron. The least expensive, the bobbin core type, consists of wire wrapped on a ferrite rod core. This type of construction makes for an inexpensive inductor, but since the magnetic flux is not completely contained within the core, it generates more electromagnetic interference (EMI).

This EMI can cause problems in sensitive circuits or can give incorrect scope readings because of induced voltages in the scope probe. The inductors listed in the selection chart include ferrite pot core construction for AIE, powdered iron toroid for Pulse Engineering, and ferrite bobbin core for Renco.

An inductor should not be operated beyond its maximum rated current because it may saturate. When an inductor begins to saturate, the inductance decreases rapidly and the inductor begins to look mainly resistive (the DC resistance of the winding). This will cause the switch current to rise very rapidly. Different inductor types have different saturation characteristics and this should be kept in mind when selecting an inductor.



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The inductor manufacturer's data sheets include current and energy limits to avoid inductor saturation.

Inductor Ripple Current

When the switcher is operating in the continuous mode, the inductor current waveform ranges from a triangular to a sawtooth type of waveform (depending on the input voltage). For a given input voltage and output voltage, the peak-to-peak amplitude of this inductor current waveform remains constant. As the load current rises or falls, the entire sawtooth current waveform also rises or falls. The average DC value of this waveform is equal to the DC load current (in the buck regulator configuration). If the load current drops to a low enough level, the bottom of the sawtooth current waveform will reach zero, and the switcher will change to a discontinuous mode of operation. This is a perfectly acceptable mode of operation. Any buck switching regulator (no matter how large the inductor value is) will be forced to run discontinuous if the load current is light enough.

Catch Diode

Buck regulators require a diode to provide a return path for the inductor current when the switch is off. This diode should be located close to the LM2576 using short leads and short printed circuit traces.

Because of their fastswitching speed and low forward voltage drop, Schottky diodes provide the best efficiency, especially in low output voltage switching regulators (less than 5V). Fast-Recovery, High-Efficiency, or Ultra-Fast Recovery diodes are also suitable, but some types with an abrupt turn-off characteristic may cause instability and EMI problems. A fast-recovery diode with soft recovery characteristics is a better choice. Standard 60 Hz diodes (e.g., IN4001 or IN5400, etc.) are also not suitable.

Output Capacitor

An output capacitor is required to filter the output voltage and is needed for loop stability. The capacitor should be located near the LM2576 using short pc board traces. Standard aluminum electrolytics are usually adequate, but low ESR types are recommended for low output ripple voltage and good stability. The ESR of a capacitor depends on many factors, some which are: the value, the voltage rating, physical size and the type of construction. In general, low value or low voltage (less than 12V) electrolytic capacitors usually have higher ESR numbers.

The amount of output ripple voltage is primarily a function of the ESR (Equivalent Series Resistance) of the output capacitor and the amplitude of the inductor ripple current (ΔI_{in}). See the section on inductor ripple current in Application Hints. The lower capacitor values (220 μ F-1000 μ F) will allow typically 50 mV to 150 mV of output ripple voltage, while larger-value capacitors will reduce the ripple to approximately 20 mV to 50 mV. Output Ripple Voltage = (ΔI_{in}) (ESR of Cap). To further reduce the output ripple voltage, several standard electrolytic capacitors may be paralleled, or a higher-grade capacitor may be used. Such capacitors are often called



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" high-frequency" " low-inductance" or " low-ESR" These will reduce the output ripple to 10 mV or 20 mV. However, when operating in the continuous mode, reducing the ESR below 0.032 can cause instability in the regulator.

Tantalum capacitors can have a very low ESR, and should be carefully evaluated if it is the only output capacitor. Because of their good low temperature characteristics, a tantalum can be used in parallel with aluminum electrolytics, with the tantalum making up 10% or 20% of the total capacitance. The capacitor's ripple current rating at 52 kHz should be at least 50% higher than the peak-to-peak inductor ripple current.

Output Voltage Ripple and Transients

The output voltage of a switching power supply will contain a sawtooth ripple voltage at the switcher frequency, typically about 1% of the output voltage, and may also contain short voltage spikes at the peaks of the sawtooth waveform. The output ripple voltage is due mainly to the inductor sawtooth ripple current multiplied by the ESR of the output capacitor. The voltage spikes are present because of the fast switching action of the output switch, and the parasitic inductance of the output filter capacitor. To minimize these voltage spikes, special low inductance capacitors can be used, and their lead lengths must be kept short. Wiring inductance, stray capacitance, as well as the scope probe used to evaluate these transients, all contribute to the amplitude of these spikes. An additional small LC filter (20 μ H & 100 μ F) can be added to the output to further reduce the amount of output ripple and transients. A 10 x reduction in output ripple voltage and transients is possible with this filter.

Feedback Connection

The LM2576(fixed voltage versions) feedback pin must be wired to the output voltage point of the switching power supply. When using the adjustable version, physically locate both output voltage programming resistors near the LM2576 to avoid picking up unwanted noise. Avoid using resistors greater than 100k because of the increased chance of noise pickup. **ON/OFF Input**

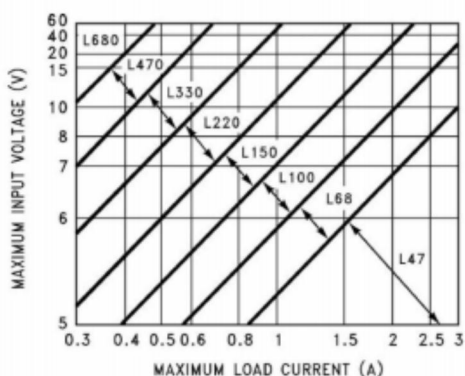
For normal operation, the ON /OFF pin should be grounded or driven with a low-level TTL voltage (typically below 1.6V). To put the regulator into standby mode, drive this pin with a high-level TTL or CMOS signal. The ON/OFF pin can be safely pulled up to +V_{in} without a resistor in series with it. The ON/OFF pin should not be left open.



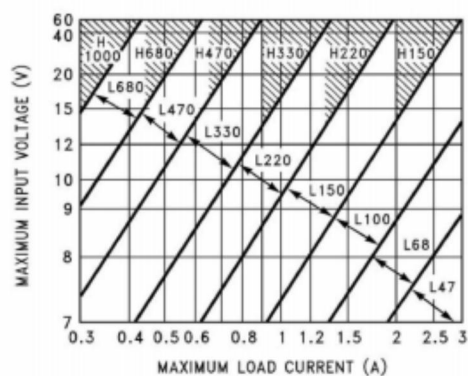
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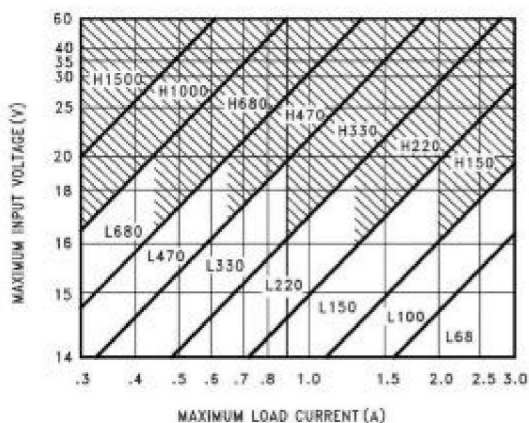
Inductor Value Selection Guides (For Continuous Mode Operation)



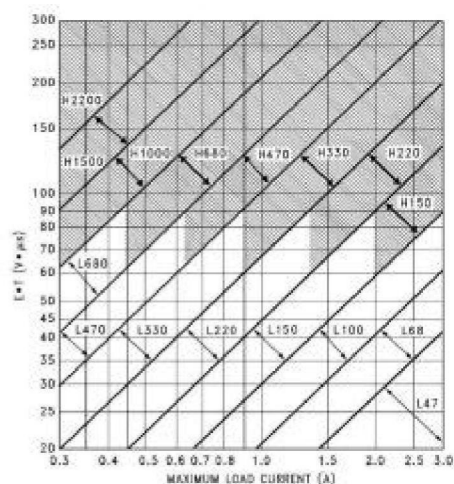
LM2576HV-3.3



LM2576HV-5.0



LM2576HV-12



LM2576HV-ADJ



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| Inductor Code | Inductor Value | Schott | PulseEng. | Renco |
|---------------|----------------|----------|-----------|--------|
| L47 | 47 μ H | 67126980 | PE-53112 | RL2442 |
| L48 | 68 μ H | 67126990 | PE-92114 | RL2443 |
| L100 | 100 μ H | 67127000 | PE-92108 | RL2444 |
| L150 | 150 μ H | 67127010 | PE-53113 | RL1954 |
| L220 | 220 μ H | 67127020 | PE-52626 | RL1953 |
| L330 | 330 μ H | 67127030 | PE-52627 | RL1952 |
| L470 | 470 μ H | 67127040 | PE-53114 | RL1951 |
| L680 | 680 μ H | 67127050 | PE-52629 | RL1950 |
| H150 | 150 μ H | 67127060 | PE-53115 | RL2245 |
| H220 | 220 μ H | 67127070 | PE-53116 | RL2446 |
| H330 | 330 μ H | 67127080 | PE-53117 | RL2447 |
| H470 | 470 μ H | 67127090 | PE-53118 | RL1961 |
| H680 | 680 μ H | 67127100 | PE-53119 | RL1960 |
| H1000 | 1000 μ H | 67127110 | PE-53120 | RL1959 |
| H1500 | 1500 μ H | 67127120 | PE-53121 | RL1958 |
| H2200 | 2200 μ H | 67127130 | PE-53122 | RL2448 |

Inductor Selection Guide



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DC-DC Power Chip

Product Specification

| VR | Schootky | | FastRecovery | |
|-----|-------------------------------------|------------------------|--|--|
| | 3A | 4A-6A | 3A | 4A-6A |
| 20V | 1N5820 MBR320P SR302 | 1N5823 | The following diodes are all rated to 100V 31DF1 HER302 | The following diodes are all rated to 100V 50WF10 MUR410 HER602 |
| 30V | 1N5821 MBR330 31DQ03 SR303 | 50WQ03 1N5824 | | |
| 40V | 1N5822 MBR340 31DQ04 SR304 | MBR34050WQ04 1N5825 | | |
| 50V | MBR350 31DQ05 SR305 | 50WQ05 | | |
| 60V | MBR360 DQ06 SR306 | 50WR0650SQ060 | | |

Diode selection Guide



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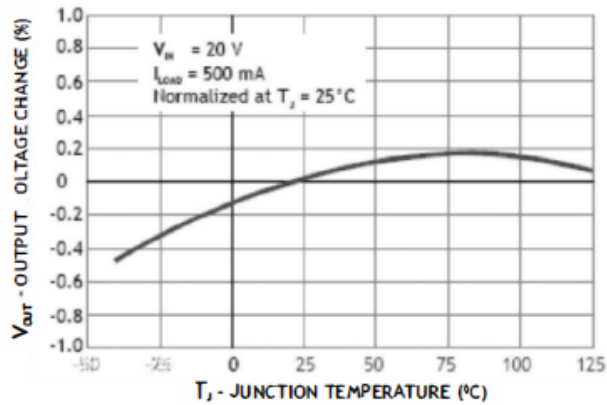
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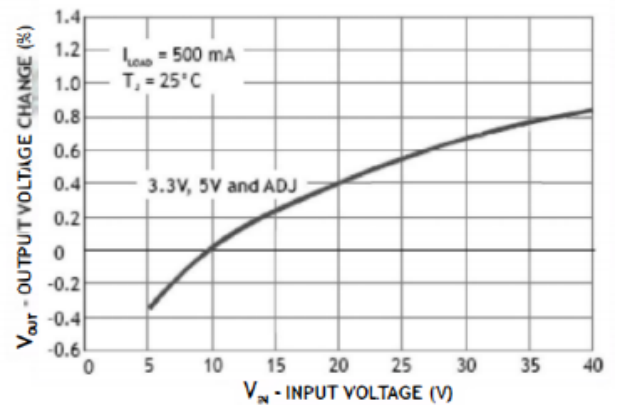
Data Sheet

Characteristic Curves

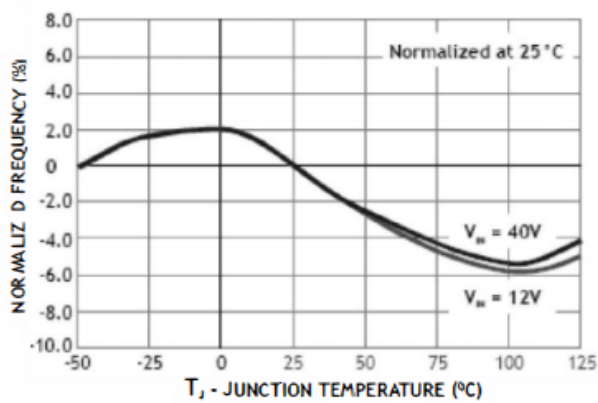
NORMALIZED OUTPUT VOLTAGE



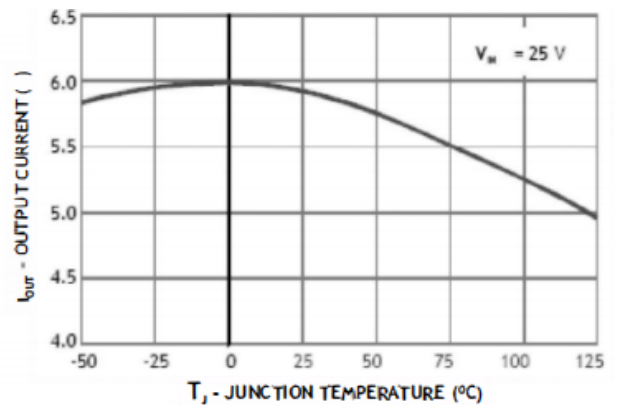
LINE REGULATION



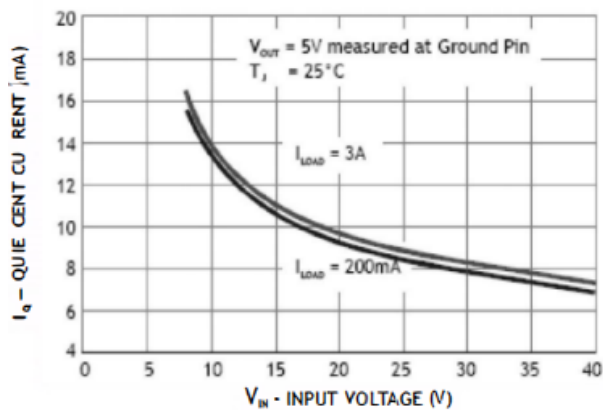
OSCILLATOR FREQUENCY



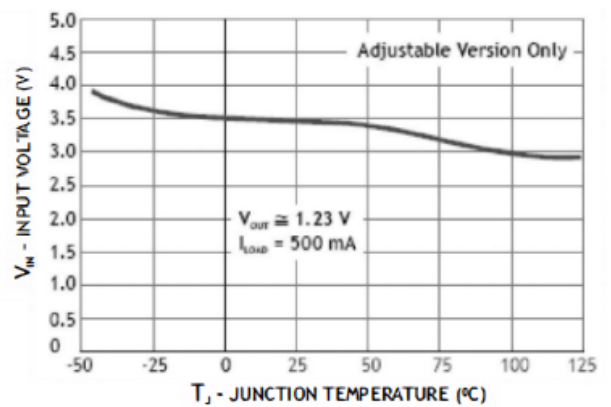
CURRENT LIMIT



QUIESCENT CURRENT



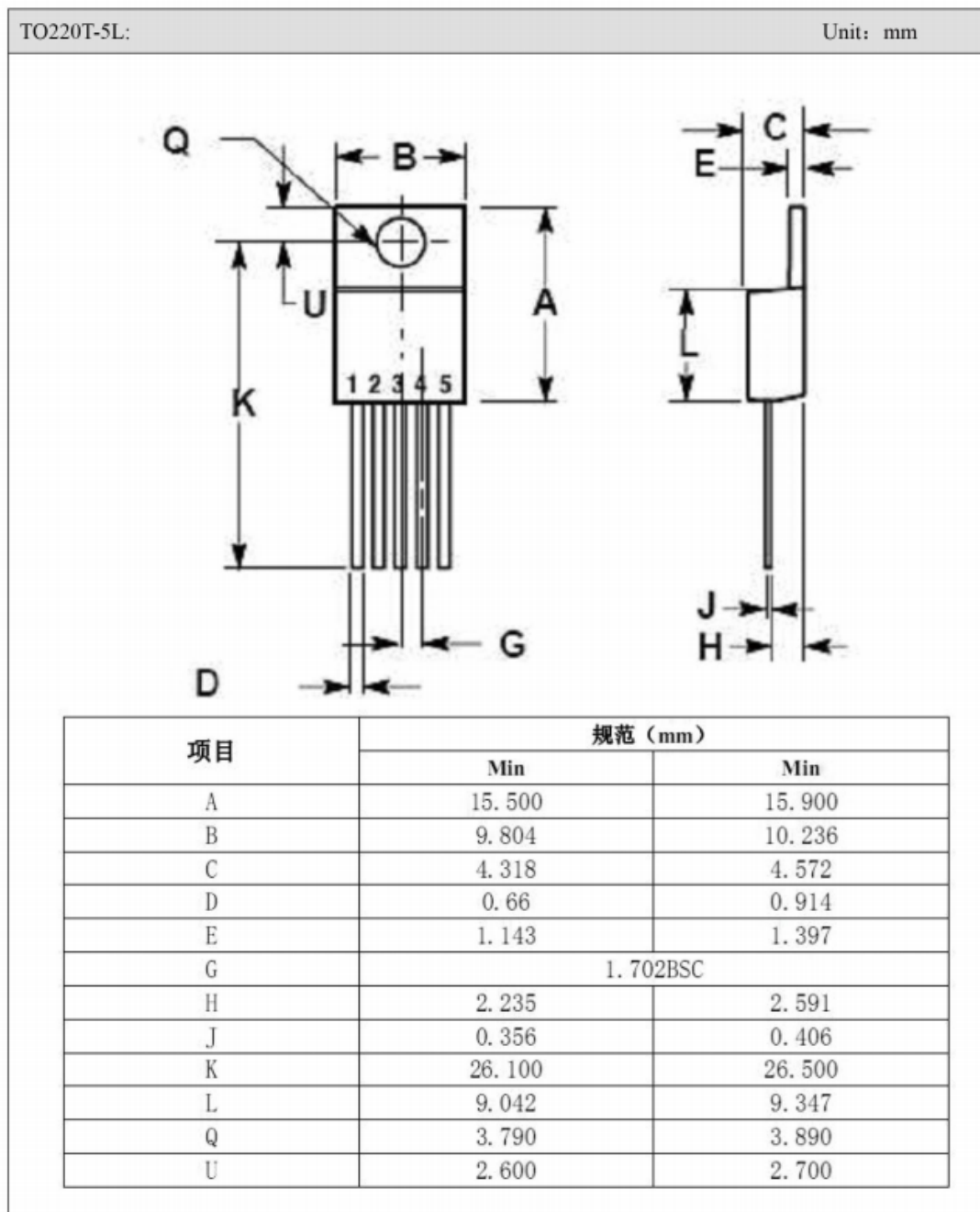
MINIMUM OPERATING VOLTAGE



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Outline Dimensions



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