7.5A ULTRA LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR WITH SHUTDOWN INPUT

PRELIMINARY DATASHEET

FEATURES

- Guaranteed **<TBDV Dropout at 7.5A**
- Fast Transient Response
- **1%** Voltage Reference Initial Accuracy
- Built-in Thermal Shutdown

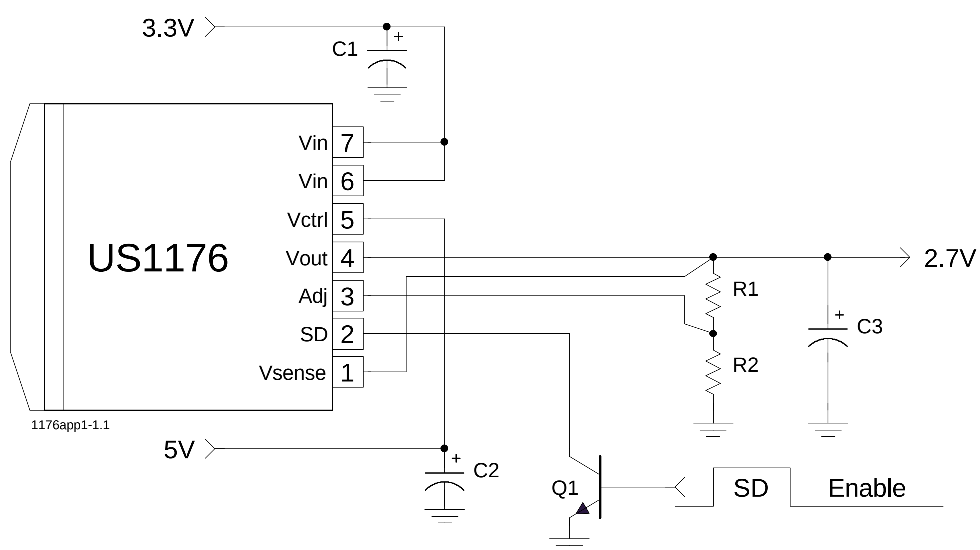
APPLICATIONS

- **3.3V to 2.7V Intel I740 chip set.**

DESCRIPTION

The US1176 product is a **7.5A regulator with extremely low dropout voltage using a proprietary Bipolar process that achieves comparable equivalent on resistance to that of discrete MOSFETs**. The US1176 also provides a convenient Shutdown pin that allows the regulator to be shutdown and reduce the input current consumption. Unlike the PNP type regulators this device does not have high quiecent current during the start up mode making it ideal for applications where there is limited current capability such operation from the 5V Standby supply of the computer power supply.One application is the new generation of the RDRAM memory that needs to provide 2.5V from 3.3V input and be able to operate from 5VSB as well.

TYPICAL APPLICATION



Typical application of US1176 .

PACKAGE ORDER INFORMATION

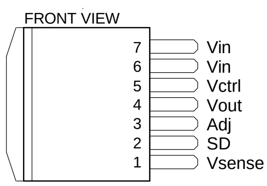
Tj (°C)	7 PIN PLASTIC TO263 (M)	7 PIN PLASTIC POWER FLEX (P)
0 TO 125	US1176CM	US1176CP

ABSOLUTE MAXIMUM RATINGS

Input Voltage (Vin) 7V
Control Input Voltage (Vctrl) 14V
Power Dissipation... Internally Limited
Storage Temperature Range .... -65°C TO 150°C
Operating Junction Temperature Range .... 0°C TO 150°C

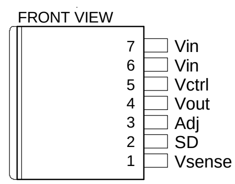
PACKAGE INFORMATION

7 PIN PLASTIC TO263 (M)



θ_{JA}=35°C/W for 0.5" square pad

7 PIN PLASTIC POWER FLEX (P)



θ_{JA}=35°C/W for 0.5" square pad

ELECTRICAL SPECIFICATIONS

Unless otherwise specified ,these specifications apply over ,Cin=1uF,Cout=10uF, and Tj=0 to 125°C.Typical values refer to Tj=25°C. Vout=Vsense.

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Reference Voltage	Vref	Vctrl=2.75V,Vin=2V,Io=10mA Tj=25,Vadj=0V	1.243	1.250	1.257	V
		Vctrl=2.7to12V,Vin=2.05V to 5.5V, Io=10mA to 7.5A,Vadj=0V	1.237	1.250	1.263	
Line Regulation		Vctrl=2.5Vto7V,Vin=1.75Vto5.5V ,Io=10mA ,Vadj=0V		0.5		mV
Load Regulation (note 1)		Vctrl=2.75V,Vin=2.1V,Io=10mA to 7.5A,Vadj=0V		5		mV
Dropout Voltage (note 2) (Vctrl - Vout)		Vadj=0V for all conditions below.				
		Vin=2.05V,Io=1.5A		0.95		V
		Vin=2.05V,Io=3A		1.00		
		Vin=2.05V,Io=4A		1.05		
		Vin=2.05V,Io=7.5A		1.15		
Dropout Voltage (note 2) (Vin - Vout)		Vadj=0V for all conditions below.				
		Vctrl=2.75V,Io=1.5A		0.075		V
		Vctrl=2.75V,Io=3A		0.150		
		Vctrl=2.75V,Io=4A		0.200		
		Vctrl=2.75V,Io=7.5A		0.375		
Current Limit		Vctrl=2.75V,Vin=2.05V, dVo=100mV Vadj=0V	7.7	9		A
Minimum Load Current (note 3)		Vctrl=5V,Vin=3.3V,Vadj=0V,		5	10	mA
Thermal Regulation		30 mS Pulse		0.01	0.02	%/W
Ripple Rejection		Vctrl=5V,Vin=5V,Io=4A,Vadj=0V Tj=25,Vripple=1Vpp at 120Hz	60	70		dB
S.D Threshold Voltage				Vctrl - 1.4	Vctrl - 2.2	V
S.D Input Current		Vctrl=5V, S.D=0V		94	130	uA

ELECTRICAL SPECIFICATIONS

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Control Pin Current		Vadj=0V for all below conditions. Vctrl=2.75V,Vin=2.05V,Io=1.5A Vctrl=2.75V,Vin=2.05V,Io=3A Vctrl=2.75V,Vin=2.05V,Io=4A Vctrl=2.75V,Vin=2.05V,Io=7.5A				mA
Adjust Pin Current	Iadj	Vctrl=2.75V,Vin=2.05V,Vadj=0V,		50	120	uA

Note 1 : Low duty cycle pulse testing with Kelvin connections are required in order to maintain accurate data.
Note 2 : Drop-out voltage is defined as the minimum differential between Vin and Vout required to maintain regulation at Vout. It is measured when the output voltage drops 1% below its nominal value.
Note 3 : Minimum load current is defined as the minimum current required at the output in order for the output voltage to maintain regulation. Typically the resistor dividers are selected such that it automatically maintains this current.

PIN DESCRIPTIONS

PIN #	PIN SYMBOL	PIN DESCRIPTION
1	Vsense	This pin is the positive side of the reference which allows remote load sensing to achieve excellent load regulation.
2	S.D	When this pin is pulled lower than 1.4V with respect to the Vctrl pin the device is shutdown. To enable the operation leave this pin open. Internal to device, there is a pull up resistor.
3	Adj	A resistor divider from this pin to the Vout pin and ground sets the output voltage.
4	Vout	The output of the regulator. A minimum of 10uF capacitor must be connected from this pin to ground to insure stability.
5	Vctrl	This pin is the supply pin for the internal control circuitry as well as the base drive for the pass transistor.This pin must always be higher than the Vout pin in order for the device to regulate.(see specifications)
6,7	Vin	The input pin of the regulator. Typically a large storage capacitor is connected from this pin to ground to insure that the input voltage does not sag below the minimum drop out voltage during the load transient response. This pin must always be higher than Vout in order for the device to regulate.(see specifications)

BLOCK DIAGRAM

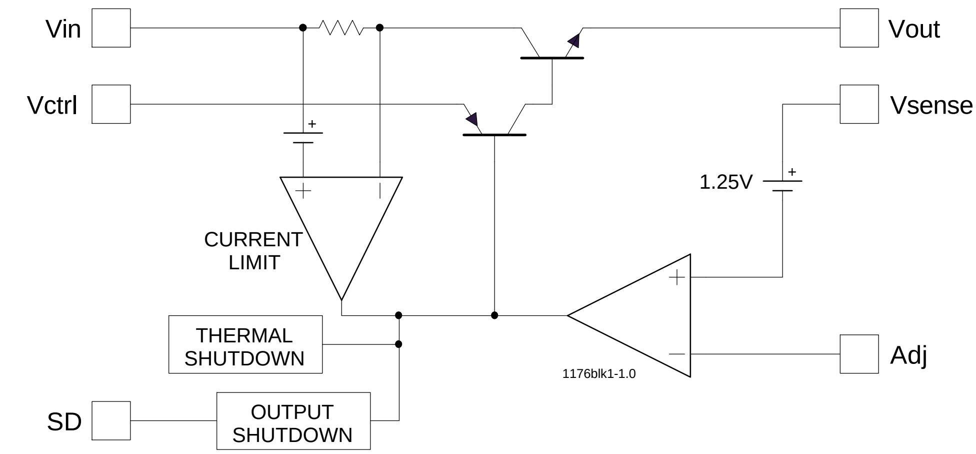


Figure 1 - Simplified block diagram of the US1176

APPLICATION INFORMATION

Introduction

The US1176 adjustable regulator is a 5 terminal device designed specificaly to provide extremely low dropout voltages comparable to the PNP type without the disadvantage of the extra power dissipation due to the base current associated with PNP regulators.This is done by bringinging out the control pin of the regulator that provides the base current to the power NPN and connecting it to a voltage that is grater than the voltage present at the Vin pin.This flexebility makes the US1176 ideal for applications where dual inputs are available such as a computer motherboard with an ATX style power supply that provides 5V and 3.3V to the board.One such application is the new graphic chip sets that require anywhere from 2.4V to 2.7V supply such as the Intel I740 chip set. The US1176 can easily be programmed with the addition of two external resistors to any voltages within the range of 1.25 to 5.5 V. Another major requirement of these graphic chips is the need to switch the load current from zero to several amps in tens of nanoseconds at the processor pins ,which translates to an approximately 300 to 500 nS of current step at the regulator . In addition, the output voltage tolerances are also extremely tight and they include the transient response as part of the specification.

The US1176 is specifically designed to meet the fast current transient needs as well as providing an accurate initial voltage , reducing the overall system cost with the need for fewer number of output capacitors.Another feature of the device is its true remote sensing capability which allows accurate voltage setting at the load rather than at the device.

Output Voltage Setting

The US1176 can be programmed to any voltages in the range of 1.25V to 5.5V with the addition of R1 and R2 external resistors according to the following formula:

$$V_{OUT} = V_{REF}\left(1+\frac{R_2}{R_1}\right) + I_{ADJ} \times R_2$$

Wehre : V_{REF}=125V Typically

I_{ADJ}=50 uA Typically

R_1 & R_2 as shown in figure 2

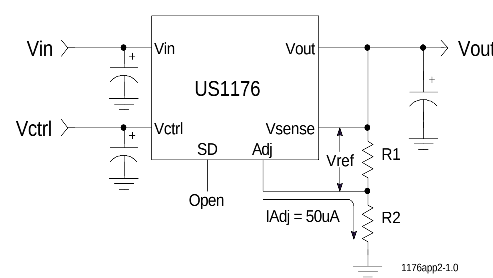


Figure 2 - Typical application of the US1176 for programming the output voltage.

Rev. 1.1
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The US1176 keeps a constant 1.25V between the Vsense pin and the Vadj pin. By placing a resistor R1 across these two pins and connecting the Vsense and Vout pin together , a constant current flows through R1, adding to the Iadj current and into the R2 resistor producing a voltage equal to the (1.25/R1)*R2 + Iadj*R2 .This voltage is then added to the 1.25V to set the output voltage. This is summarized in the above equation. Since the minimum load current requirement of the US1176 is 10 mA , R1 is typically selected to be a 121Ω resistor so that it automatically satisfies this condition. Notice that since the Iadj is typically in the range of 50uA it only adds a small error to the output voltage and should be considered when very precise output voltage setting is required.

Load Regulation

Since the US1176 has separate pins for the output (Vout) and the sense (Vsense), it is ideal for providing true remote sensing of the output voltage at the load.This means that the voltage drops due to parasitic resistance such as PCB traces between the regulator and the load are compensated for using remote sensing. Figure 3 shows a typical application of the US1176 with remote sensing.

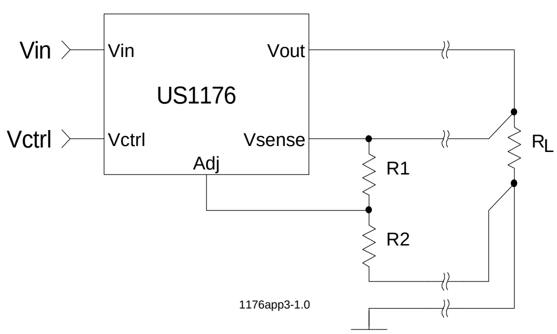

Figure 3 - Schematic showing connection for best load regulation

Stability

The US1176 requires the use of an output capacitor as part of the frequency compensation in order to make the regulator stable. Typical designs for the microprocessor applications use standard electrolytic capacitors with typical ESR in the range of 50 to 100 mΩ and an output capacitance of 500 to 1000uF. Fortunately as the capacitance increases, the ESR decreases resulting in a fixed RC time constant. The US1176 takes advantage of this phenomena in making the overall regulator loop stable.

For most applications a minimum of 100uF aluminum electrolytic capacitor such as Sanyo, MVGX series ,Panasonic FA series as well as the Nichicon PL series insures both stability and good transient response.

Shutdown Operation

The US1176 can be disabled by pulling the S.D pin low using an open collector device such as a low cost 2N3904 general purpose transistor as shown in the application circuit. The current sink of the pin is equal to:
Isink=(Vctrl-1.4)/R where, R=50 kΩ typ.

Thermal Design

The US1176 incorporates an internal thermal shutdown that protects the device when the junction temperature exceeds the allowable maximum junction temperature. Although this device can operate with junction temperatures in the range of 150°C ,it is recommended that the selected heat sink be chosen such that during maximum continuos load operation the junction temperature is kept below this number. The example below shows the steps in selecting the proper surface mount package.

Assuming, the following conditions:
Vout=2.7V
Vin=3.3V
Vctrl=5V
Iout=2A DC Avg

Calculate the maximum power dissipation using the following equation:

Pd=Iout*(Vin-Vout) + (Iout/60)*(Vctrl - Vout)
Pd=2*(3.3-2.7) + (2/60)*(5-2.7)=1.28 W

Using table below select the proper package and the amount of copper board needed.

Pkg	Copper Area	θ_{JA}(°C/W)	Max Pd (Ta=25°C)	Max Pd (Ta=45°C)
M or P	1.4"X1.4"	25	4.4W	3.6W
M or P	1.0"X1.0"	30	3.7W	3.0W
M or P	0.7"X0.7"	35	3.1W	2.6W
M or P	Pad Size	45	2.4W	2.0W

Note: Above table is based on the maximum junction temperature of 135°C.
As shown in the above table, any of the two packages will do the job. For lower cost applications the Power Flex package is recommended.