

**700mA Low Dropout Voltage Regulators
With Shutdown**
(PRELIMINARY INFORMATION)

FEATURES

- Output Current 700mA at 3.3V and 5V
- Internal Short Circuit Current Limit
- Dropout Voltage 0.5V at 700mA Output
- Extremely Tight Load and Line Regulation
- Very Low Temperature Coefficient
- Mirror Image Insertion Protection
- Unregulated DC Input Can Withstand -20V Reverse Battery and +60V Positive Transients
- Direct Replacement For LM2937 Socket

APPLICATIONS

- Battery Powered Systems
- Cordless Telephones
- Automotive Electronics
- Portable/ Palm Top / Notebook Computers
- Portable Consumer Equipment
- Portable Instrumentation
- SMPS Post-Regulator
- Voltage Reference

PRODUCT DESCRIPTION

The ALPHA Semiconductor AS2700/01/02 are a low power positive voltage regulators. The AS2700/01/02 offers 700mA output current with a dropout voltage of only 0.5V and over temperature dropout is up to 1V. The quiescent current is 10mA at differential output of 5V and output current of 700mA. A higher quiescent current can exist when the device is in dropout mode ($V_{IN} - V_{OUT} \leq 3V$).

The regulator will automatically shut down to protect both the internal circuits and the load. This device also features short circuit and thermal overload protection.

The AS2700/01/02 is offered in 3 and 5 pin TO-220, TO-263 and 3-pin SOT-223 packages compatible with other 5V and 3.3V regulators, TO-263 and 3-pin SOT-223. The device is offered in standard output voltages of 5V and 3.3V as well as in adjustable output regulator.

ORDERING INFORMATION

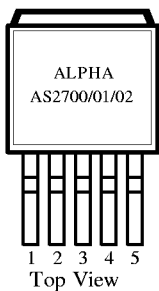
TO-220 3 / 5-PIN	TO-263 3 / 5-PIN	SOT-223 3-PIN	OPER. TEMP. RANGE
AS2700/01/02YU-X	AS2700/01/02YT-X	AS2700YM3-X	-40 °C to +125°C

X= Output Voltage (X = 3.3V, 5.0V)

Y = A or Blank for adjustable).

PIN CONNECTIONS

TO-263-5 Package



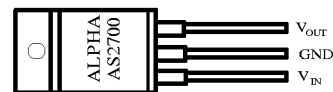
Five Lead Package Pin Functions:

AS2701	AS2702
1) ERROR	ADJUST
2) INPUT	SHUTDOWN
3) GND	GND
4) OUTPUT	INPUT
5) SHUTDOWN	OUTPUT

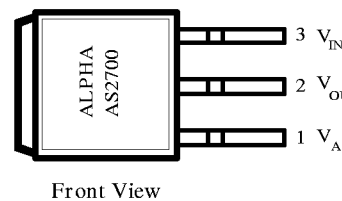
TO-220-5 Package



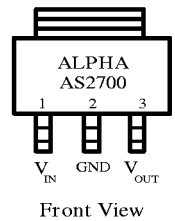
TO-220 Package



TO-263-3 Package



SOT-223 Package



ABSOLUTE MAXIMUM RATINGS

Power Dissipation.....Internally Limited
 Lead Temp. (Soldering, 10 Seconds)260°C
 Feedback Input Voltage -1.5V to +30V
 Shutdown Input Voltage -0.3V to +30V
 Error Comparator Output -0.3V to +30V

Input Supply Voltage Continuous+30V
 Transient -20V to +60V
 Storage Temperature Range -65° to +150°C
 Operating Junction Temperature Range ... -40°C to +125°C
 ESD Rating2KV Min

ELECTRICAL CHARACTERISTICS at $V_{IN} = V_O + 5V$, $I_O = 700mA$, $C_O = 10 \mu F$, unless otherwise specified. Limits in Boldface type apply over the entire operating temperature range. All other specifications are $T_A = 25^\circ C$.

Parameter	Conditions (Note 2)	Typ.	AS2700/01/02A		AS2700/01/02B		Units
			Min	Max	Min	Max	
3.3V Version							
Output Voltage	$-40^\circ C \leq T_J \leq +125^\circ C$ $1mA \leq I_L \leq 500mA$	3.3	3.267	3.333	3.234	3.366	V
		3.3	3.217	3.382	3.185	3.415	
5V Version							
Output Voltage	$-40^\circ C \leq T_J \leq +125^\circ C$ $1mA \leq I_L \leq 700mA$	5.0	4.950	5.050	4.900	5.100	V
		5.0	4.880	5.120	4.870	5.130	
All Voltage Options							
Output Voltage Temperature Coefficient	(Note1)	20		100		150	ppm/°C
Line Regulation (Note 3)	$6V \leq V_{IN} \leq 30V$ (Note4)	0.03		0.1 0.40		0.20 0.80	%max
Load Regulation (Note 3)	$I_L = 1$ to 700 $I_L = 0.1$ to 1mA	0.04		0.20 0.30		0.30 0.50	%max
Dropout Voltage (Note 5)	$I_L = 1mA$ $I_L = 700mA$	60		100 150		100 150	mV
		375		400 500		400 500	
Ground Current	$I_L = 1mA$ $I_L = 700mA$	100		150 180		150 180	μA
		4.5		2		2	mA
		15		2.5 14		2.5 14	
		20		16 20 22		16 20 22	
Current Limit	$V_{OUT} = 0$			700 800		700 800	mA
Thermal Regulation		0.05		0.2		0.2	%/w
Output Noise, 10Hz to 100kHz $I_L = 100mA$	$C_L = 2.2\mu F$ $C_L = 33\mu F$	400	1.0	0.60	1.0	0.60	μV
		200					Vrms
Adjustable Versions Only							
Reference Voltage	Over Temperature (Note 6)	1.235	1.210	1.260	1.200	1.270	V
			1.200	1.270	1.980	1.272	
			1.185	1.285	1.185	1.285	
Feedback Pin Bias Current		20		40 60		60 80	nA
Reference Voltage Temperature Coefficient	(Note 7)	50					ppm/°C
Feedback Pin Bias Current Temperature Coefficient		0.1					NA/°C

ELECTRICAL CHARACTERISTICS at $V_{IN} = V_O + 5V$, $I_O = 700mA$, $C_O = 22 \mu F$, unless otherwise specified. Limits in Boldface type apply over the entire operating temperature range. All other specifications are $T_A = 25^\circ C$.

Parameter	Conditions	Typ.	AS2700/01/02A		AS2700/01/02B		Units
			Min	Max	Min	Max	
Error Comparator							
Output Leakage Current	$V_{OH} = 30V$	0.01		1.00 2.00		1.00 2.00	μA
Output Low Voltage	$V_{IN} = 4.5V$ $I_{OL} = 400\mu A$	150		250 400		250 400	mV
Upper Threshold Voltage	(Note 8)	60	40 25		40 25		mV
Lower Threshold Voltage	(Note 8)	75		95 140		95 140	mV
Hysteresis	(Note 8)	15					mV
Shutdown Input							
Input Logic Voltage	Low (Regulator ON) High (Regulator OFF)	1.3	2.0	0.7	2.0	0.7	V
Shutdown Pin Input Current	$V_S = 2.4V$	30		50 100 600 750		90 150 800 1000	μA
	$V_S = 30V$	450					
Regulator Output Current In Shutdown		3	10 20			15 25	μA

Note 1: Output or reference voltage temperature coefficients defined as the worst case voltage change divided by the total temperature range.

Note 2: Unless otherwise specified all limits are guaranteed for $T_j = 25^\circ C$, $V_{IN} = 6V$, $I_L = 100\mu A$ and $C_L = 1\mu F$. Additional conditions for the 8-pin versions are feedback tied to 5V tap and output tied to output sense ($V_{OUT} = 5V$) and $V_{SHUTDOWN} \leq 0.8V$.

Note 3: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 4: Line regulation for the AS2700/01/02 is tested at $150^\circ C$ for $I_L = 1 mA$. For $I_L = 100\mu A$ and $T_j = 125^\circ C$, line regulation is guaranteed by design to 0.2%. See typical performance characteristics for line regulation versus temperature and load current.

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential at very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

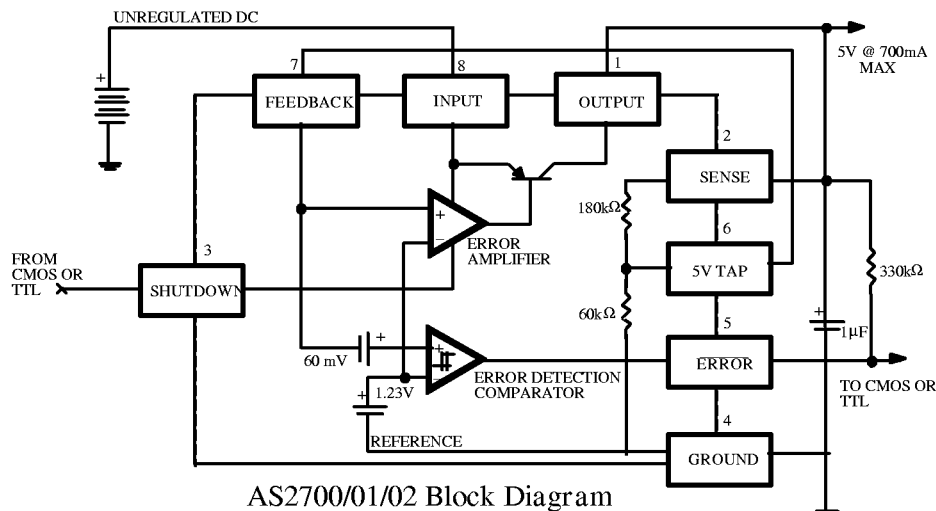
Note 6: $V_{REF} \leq V_{OUT} \leq (V_{in} - 1V)$, $2.3 \leq V_{in} \leq 30V$, $100\mu A \leq I_L \leq 250 mA$, $T_j \leq T_{jMAX}$.

Note 7: Comparator thresholds are expressed in terms of a voltage differential at the feedback terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = $V_{OUT}/V_{REF} = (R1 + R2)/R2$. For example, at a programmed output voltage of 5V, the Error output is guaranteed to go low when the output drops by $95 mV \times 5V/1.235 = 384 mV$. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

Note 8: $V_{SHUTDOWN} \geq 2V$, $V_{IN} \leq 30V$, $V_{OUT} = 0$, Feedback pin tied to 5V Tap.

Note 9: The junction -to-ambient thermal resistance of the TO-92 package is $180^\circ C/W$ with 0.4" leads and $160^\circ C/W$ with 0.25" leads to a PC board.

The thermal resistance of the 8-Pin DIP package is $105^\circ C/W$ junction-to-ambient when soldered directly to a PC board. Junction-to-ambient thermal resistance for the SOIC (S) package is $160^\circ C/W$.



APPLICATION HINTS

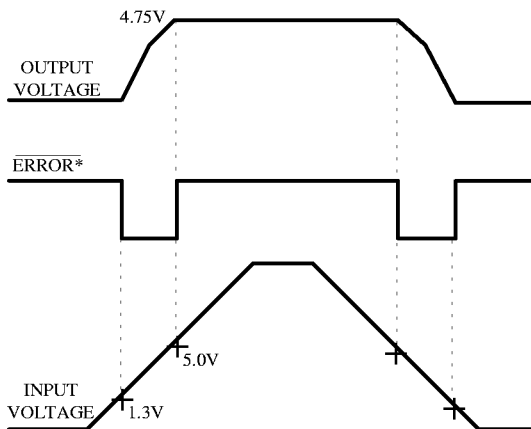
EXTERNAL CAPACITORS

The stability of the AS2700/01/02 requires a 10 μ F or greater capacitor between output and ground. Oscillation could occur without this capacitor. Most types of tantalum or aluminum electrolytic works fine here. For operations below -25°C solid tantalum is recommended since the many aluminum types have electrolytes that freeze at about -30°C. The ESR of about 5 Ω or less and resonant frequency above 500 kHz are the most important parameters in the value of the capacitor. The capacitor value may be increased without limit.

At lower values of output current, less output capacitance is required for stability. For the currents below 10mA the value of the capacitor can be reduced to 22 μ F and 0.15 μ F for 1mA. More output capacitance is needed for the 8-pin version at voltages below 5V since it runs the error amplifier at lower gain. At worst case 22 μ F or greater must be used for the condition of 750mA load at 1.23V output.

The AS2700/01/02, unlike other low dropout regulators will remain stable and in regulation with no load in addition to the internal voltage divider. This feature is especially important in applications like CMOS RAM keep-alive. When setting the output voltage of the AS2700/01/02 version with external resistors, a minimum load of 5mA is recommended. If there is more than 10 inches of wire between the input and the AC filter capacitor or if a battery is used as the input then a 1 μ A tantalum or aluminum electrolytic capacitor should be placed from the input to the ground.

ERROR DETECTION COMPARATOR OUTPUT



* See Application Info.

Figure 1. ERROR Output Timing

The Comparator produces a logic low output whenever the AS2700/01/02 output falls out of regulation by more than around 5%. This is around 75mV offset divided by the 1.235 reference voltage. This trip level remains 5% below normal regardless of the programmed output voltage of the regulator. Figure 1 shows the timing diagram depicting the ERROR signal and the regulator output voltage as the AS2700/01/02 input is ramped up and down. The ERROR signal becomes low at around 1.3V input, and goes

high around 5V input (input voltage at which $V_{out} = 4.75$). Since the AS2700/01/02's dropout voltage is load dependent, the input voltage trip point (around 5V) will vary with the load current. The output voltage trip point (approx. 4.75V) does not vary with load. The error comparator has an open-collector output, which requires an external pull-up resistor. Depending on the system requirements the resistor may be returned to 5V output or other supply voltage. In determining the value of this resistor, note that the output is rated to sink 250 μ A, this value adds to battery drain in a low battery condition. Suggested values range from 100K to 1M Ω . If the output is unused this resistor is not required.

PROGRAMMING THE OUTPUT VOLTAGE OF AS2700/01/02

The AS2700/01/02 may be programmed for any output voltage between its 1.235V reference and its 30V maximum rating. As seen in Figure 2, an external pair of resistors is required. Refer to the below equation for the programming of the output voltage:

$$V_{OUT} = V_{REF} \times (1 + R_1/R_2) + I_{FB}R_1$$

The V_{REF} is 1.235 and I_{FB} is the feedback bias current, nominally -20 nA. The minimum recommended load current of 1 μ A forces an upper limit of 1.2 M Ω on value of R_2 . If no load is presented the I_{FB} produces an error of typically 2% in V_{OUT} , which may be eliminated at room temperature by trimming R_1 . To improve the accuracy choose the value of $R_2 = 100k$ this reduces the error by 0.17% and increases the resistor program current by 12 μ A. Since the AS2700/01/02 typically draws 100 μ A at no load with SHUTDOWN open-circuited this is a small price to pay

REDUCING OUTPUT NOISE

It may be an advantage to reduce the AC noise present at the output. One way is to reduce the regulator bandwidth by increasing the size of the output capacitor. This is the only way that noise can be reduced on the 3 lead AS2700/01/02 but is relatively inefficient, as increasing the capacitor from 1 μ F to 220 μ F only decreases the noise from 430 μ V to 160 μ V_{RMS} for a 100 kHz bandwidth at 5V output. Noise could also be reduced fourfold by a bypass capacitor across R_1 , since it reduces the high frequency gain from 4 to unity. Pick

$$C_{BYPASS} \cong 1 / 2\pi R_1 \times 200 \text{ Hz}$$

or choose 0.01 μ F. When doing this, the output capacitor must be increased to 3.3 μ F to maintain stability. These changes reduce the output noise from 430 μ V to 100 μ V_{RMS} for a 100 kHz bandwidth at 5V output. With the bypass capacitor added, noise no longer scales with output voltage so that improvements are more dramatic at higher output voltages.

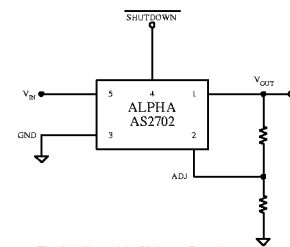


Fig.2 Adjustable Voltage Regulator