ALPHA
SEMICONDUCTOR
Excellence in Analog Power Products

AS2940

1A Low Dropout Voltage Regulators

(PRELIMINARY INFORMATION)

FEATURES

- Output Current 1A
- Internal Short Circuit Current Limit
- Dropout Voltage 0.5V at 1A 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 LM2940 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 AS2940 is a low powered positive voltage regulator. The AS2940 offers 1A output current with dropout voltage of only 0.5V and over temperature dropout is up to 1V. The quiescent current is 30mA at differential output of 5V and output current of 1A. The higher quiescent current can be exist when the device is in dropout mode ($V_{IN} - V_{OUT} \leq 3V$).

Other key additional features of this device includes higher output current, positive transient protection up to 60V (load dump), and ability to survive an unregulated input voltage transient of -20V below ground (reverse battery). 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 AS2940 is offered in a 3-pin TO-220 and TO-263 package compatible with other 5V regulators. This device offers a variety of output voltages; 5V, 8V, 9V, 10V, 12V, and 15V. AS2940 is direct replacement to LM2940.

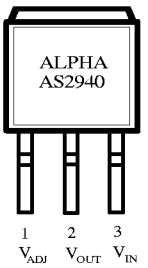
ORDERING INFORMATION

TO-263 3-PIN	TO-220 3-PIN	Oper. Temp. Range
AS2940T-X	AS2940U-X	-40°C to +125°C

X= Output Voltage (X = 5.0V, 8.0V, 9.0V, 10V, 12V or 15V)
Consult factory for other fixed voltages.

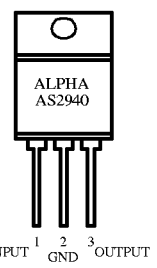
PIN CONNECTIONS

TO-263-3 Package



Front View

TO-220 Package



Front View

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Rev. 10/18/98

ABSOLUTE MAXIMUM RATINGS

Power Dissipation (Note 1) ..... Internally Limited
Lead Temperature (Soldering, 5 seconds) ..... 260°C
Storage Temperature Range ..... -65°C to +150°C
Operating Junction Temperature Range ... -40°C to +125°C
TO-220 θ_{JC} ..... 2 °C/W
TO-263 θ_{JC} ..... 2 °C/W

Input Supply voltage ..... -26V to +60V
Operating Input Supply voltage ..... +2V to 12V
Shutdown Input Voltage ..... -0.3V to +30V
Error Comparator Output Voltage ..... -0.3 to +30V

ELECTRICAL CHARACTERISTICS

$V_{IN} = V_O + 5V$, $I_O = 1A$, $C_O = 22\ \mu F$, unless otherwise specified. Boldface applies over the entire operating temperature range of the indicated device. All other specifications apply for $T_A = T_J = 25°C$.

Output Voltage (V_O)		5V			8V			Units
Parameter	Conditions	Typ	AS2940 Limit (Note 5)	AS2940/883 Limit (Note 6)	Typ	AS2940 Limit (Note 5)	AS2940/833 Limit (Note 6)	
		6.25V ≤ V_{IN} ≤ 26V			9.4V ≤ V_{IN} ≤ 26V			
Output Voltage	5 mA ≤ I_O ≤ 1A	5.00	4.85/4.75 5.15/5.25	4.85/4.75 5.15/5.25	8.00	7.76/7.60 8.24/8.40	7.76/7.60 8.24/8.40	V V
Line Regulation	V_O + 2V ≤ V_{IN} ≤ 26V, I_O = 5 mA	20	50	40/50	20	80	50/80	mV
Load Regulation	50 mA ≤ I_O ≤ 1A AS2940, AS2940/833 AS2940C	 35 35	 50/80 50	 50/100	 55 55	 80/130 80	 80/130	 mV
Output Impedance	100 mADC and 20 mArms, f_O = 120 Hz	35		1000/1000	55		1000/1000	mΩ
Quiescent Current	V_O + 2V ≤ V_{IN} ≤ 26V, I_O = 5 mA AS2940, AS2940/833 AS2940C	 10 10	 15/20 15	 15/20	 10	 15/20	 15/20	 mA
	V_{IN} = V_O + 5V, I_O = 1A	30	45/60	50/60	30	45/60	50/60	mA
Output Noise Voltage	10 Hz - 100 kHz, I_O = 5 mA	150		700/700	240		1000/1000	μV_{RMS}
Ripple Rejection	f_O = 120 Hz, 1 V_{RMS}, I_O = 100 ma AS2940 AS2940C	 72 72	 60/54 60		 66 66	 54/48 54		 dB_{MIN}
	f_O = 1 kHz, 1 V_{RMS}, I_O = 5 mA			60/50			54/48	dB_{MIN}
Long Term Stability		20			32			mV/ 1000 Hr
Dropout Voltage	I_O = 1A	0.5	0.8/1.0	0.7/1.0	0.5	0.8/1.0	0.7/1.0	V_{MAX}
	I_O = 100 mA	110	150/200	150/200	110	150/200	150/200	mV_{MAX}

ELECTRICAL CHARACTERISTICS $V_{IN} = V_O + 5V$, $I_O = 1A$, $C_O = 22\ \mu F$, unless otherwise specified. Boldface limits apply over the entire operating temperature range of the indicated device. All other specifications apply for $T_A = T_J = 25°C$. (Continued)

Output Voltage (V_O)		5V			8V			Units
Parameter	Conditions	Typ	AS2940 Limit (Note 5)	AS2940/883 Limit (Note 6)	Typ	AS2940 Limit (Note 5)	AS2940/833 Limit (Note 6)	
		6.25V ≤ V_{IN} ≤ 26V			9.4 ≤ V_{IN} ≤ 26V			
Short Circuit Current	(Note 7)	1.9	1.6	1.5/1.3	1.9	1.6	1.6/1.3	A
Maximum Line Transient	$R_O = 100\Omega$ AS2940, T ≤ 100 ms AS2940/833, T ≤ 20 ms AS2940C, T ≤ 1 ms	75 55	60/60 45	40/40	75 55	60/60 45	40/40	V
Reverse Polarity DC Input Voltage	$R_O = 100\Omega$ AS2940/833, T ≤ 20 ms AS2940C	-30 -30	-15/-15 -15	-15/-15	-30 -30	-15/-15 -15	-15/-15	V
Reverse Polarity Transient Input Voltage	$R_O = 100\Omega$ AS2940, T ≤ 100 ms AS2940/833, T ≤ 20 ms AS2940C, T ≤ 1 ms	-75 -55	-50/-50 -45/-45	-45/-45	-75	-50/-50	-45/-45	V

ELECTRICAL CHARACTERISTICS $V_{IN} = V_O + 5V$, $I_O = 1A$, $C_O = 22\ \mu F$, unless otherwise specified. Boldface limits apply over the entire operating temperature range of the indicated device. All other specifications apply for $T_A = T_J = 25°C$. (Continued)

Output Voltage (V_O)		9V		10V		Units
Parameter	Conditions	Typ	AS2940 Limit (Note 5)	Typ	AS2940 Limit (Note 5)	
		10.5V ≤ V_{IN} ≤ 26V		11.5V ≤ V_{IN} ≤ 26V		
Output Voltage	5 mA ≤ I_O ≤ 1A	9.00	8.73/8.55 9.27/9.45	10.00	9.70/9.50 10.30/10.50	V V
Line Regulation	$V_O + 2V \le V_{IN} \le 26V$, $I_O = 5$ mA	20	90	20	100	mV
Load Regulation	50 mA ≤ I_O ≤ 1A AS2940 AS2940C	 60 60	 90/150 90	 65	 100/165	mV
Output Impedance	100 mADC and 20 mArms, $f_O = 120$ Hz	60		65		mΩ
Quiescent Current	$V_O + 2V \le V_{IN} \le 26V$, $I_O = 5$ mA AS2940 AS2940C	 10 10	 15/20 15	 10	 15/20	mA
	$V_{IN} = V_O + 5V$, 1A	30	45/60	30	45/60	mA
Output Noise Voltage	10 Hz - 100 kHz, $I_O = 5$ mA	270		300		μV_{RMS}

ELECTRICAL CHARACTERISTICS $V_{IN} = V_O + 5V$, $I_O = 1A$, $C_O = 22\ \mu F$, unless otherwise specified. Boldface limits apply over the entire operating temperature range of the indicated device. All other specifications apply for $T_A = T_J = 25°C$. (Continued)

Output Voltage (V_O)		9V		10V		Units
Parameter	Conditions	Typ	AS2940 Limit (Note 5)	Typ	AS2940 Limit (Note 5)	
Ripple Rejection		10.5V ≤ V_{IN} ≤ 26V		11.5V ≤ V_{IN} ≤ 26V		
	f_O = 120 Hz, 1 V_{RMS}, I_O = 100 mA AS2940 AS2940C	 64 64	 52/46 52	 63	 51/45	dB
Long Term Stability		34		36		mV/ 1000 Hr
Dropout Voltage	I_O = 1A	0.5	0.8/1.0	0.5	0.8/1.0	V
	I_O = 100 mA	110	150/200	110	150/200	mV
Short Circuit Current	(Note 7)	1.9	1.6	1.9	1.6	A
Maximum Line Transient	R_O = 100Ω T ≤ 100 ms AS2940 AS2940C	 75 55	 60/60 45	 75	 60/60	V
Reverse Polarity DC Input Voltage	R_O = 100Ω AS2940 AS2940C	 -30 -30	 -15/-15 -15	 -30	 -15/-15	V
Reverse Polarity Transient Input Voltage	R_O = 100Ω T ≤ 100 ms AS2940 AS2940C	 -75 -55	 -50/-50 -45/-45	 -75	 -50/-50	V

ELECTRICAL CHARACTERISTICS $V_{IN} = V_O + 5V$, $I_O = 1A$, $C_O = 22\ \mu F$, unless otherwise specified. Boldface limits apply over the entire operating temperature range of the indicated device. All other specifications apply for $T_A = T_J = 25°C$. (Continued)

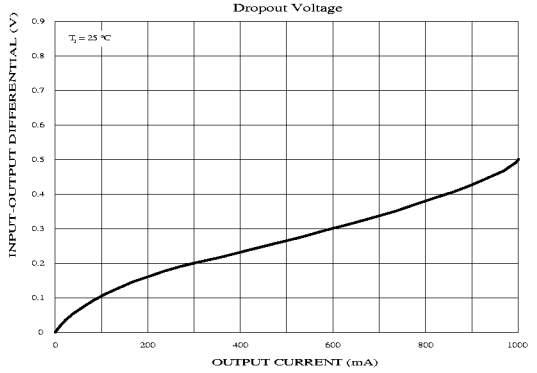
Output Voltage (V_O)		12V			15V			Units
Parameter	Conditions	Typ	AS2940 Limit (Note 5)	AS2940/883 Limit (Note 6)	Typ	AS2940 Limit (Note 5)	AS2940/833 Limit (Note 6)	
Output Voltage	5 mA ≤ I_O ≤ 1A	13.6V ≤ V_{IN} ≤ 26V			16.75 ≤ V_{IN} ≤ 26V			
		12.00	11.64/11.40 12.36/12.60	11.64/11.40 12.36/12.60	15.00	14.55/1 4.25 15.45/1 5.75	14.55/14.25 15.45/15.75	V V
Line Regulation	V_O + 2V ≤ V_{IN} ≤ 26V, I_O = 5 mA	20	120	75/120	20	150	95/150	mV
Load Regulation	50 mA ≤ I_O ≤ 1A AS2940, AS2940/833 AS2940C	 55 55	 120/200 120	 120/190	 70	 150	 150/240	 mV

ELECTRICAL CHARACTERISTICS $V_{IN} = V_O + 5V$, $I_O = 1A$, $C_O = 22\ \mu F$, unless otherwise specified. Boldface limits apply over the entire operating temperature range of the indicated device. All other specifications apply for $T_A = T_J = 25°C$. (Continued)

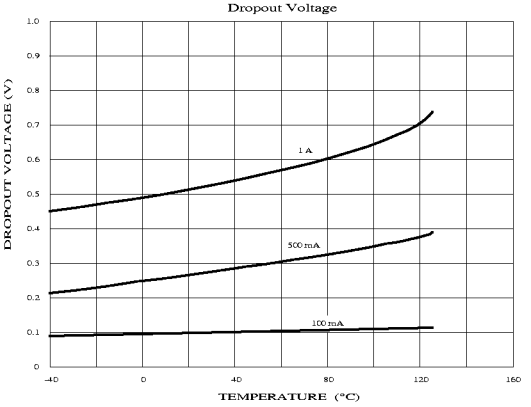
Output Voltage (V_O)		12V			15V			Units
Parameter	Conditions	Typ	AS2940 Limit (Note 5)	AS2940/833 Limit (Note 6)	Typ	AS2940 Limit (Note 5)	AS2940/833 Limit (Note 6)	
		13.6V ≤ V_{IN} ≤ 26V			16.75 ≤ V_{IN} ≤ 26V			
Output Impedance	100 mADC and 20 mArms, f_O = 120 Hz	80		1000/1000	100		1000/1000	mΩ
Quiescent Current	V_O +2V ≤ V_{IN} ≤ 26V, I_O = 5 mA AS2940, AS2940/883 AS2940C	 10 10	 15/20 15	 15/20	 10	 15	 15/20	mA
	$V_{IN} = V_O + 5V$, $I_O = 1A$	30	45/60	50/60	30	45/60	50/60	mA
Output Noise Voltage	10 Hz - 100 kHz, I_O = 5 mA	360		1000/1000	450		1000/1000	μV_{RMS}
Ripple Rejection	f_O = 120 Hz, 1 V_{RMS}, I_O = 100 mA AS2940 AS2940C	 66 66	 54/48 54		 64	 52		dB
	f_O = 1 kHz, 1 V_{rms}, I_O = 5 mA			52/46			48/42	dB
Long Term Stability		48			60			mV/ 1000 Hr
Dropout Voltage	I_O = 1A	0.5	0.8/1.0	0.7/1.0	0.5	0.8/1.0	0.7/1.0	V
	I_O = 100 mA	110	150/200	150/200	110	150/200	150/200	mV
Short Circuit Current	(Note 7)	1.9	1.6	1.6/1.3	1.9	1.6	1.6/1.3	A
Maximum Line Transient	R_O = 100Ω AS2940, T ≤ 100 ms AS2940/883, T ≤ 20 ms AS2940C, T ≤ 1 ms	 75 55	 60/60 45	 40/40	 55	 45	 40/40	V
Reverse Polarity DC Input Voltage	R_O = 100Ω AS2940, AS2940/883 AS2940C	 -30 -30	 -15/-15 -15	 -15/-15	 -30	 -15	 -15/-15	V
Reverse Polarity Transient Input Voltage	R_O = 100Ω AS2940, T ≤ 100 ms AS2940/883, T ≤ 20 ms AS2940C, T ≤ 1 ms	 -75 -55	 -50/-50 -45/-45	 -45/-45	 -55	 -45/-45	 -45/-45	V

ELECTRICAL CHARACTERISTICS $V_{IN} = V_O + 5V$, I_O =1A, C_O = 22 µF, unless otherwise specified.

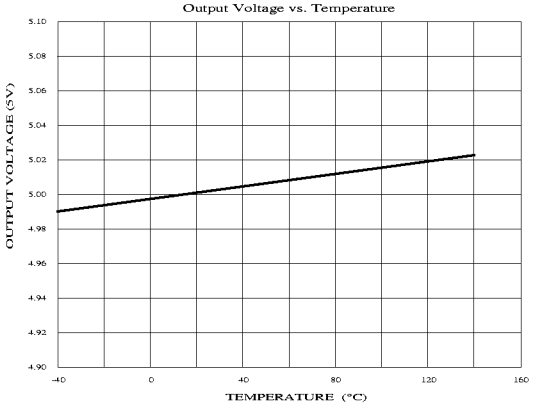
Dropout Voltage



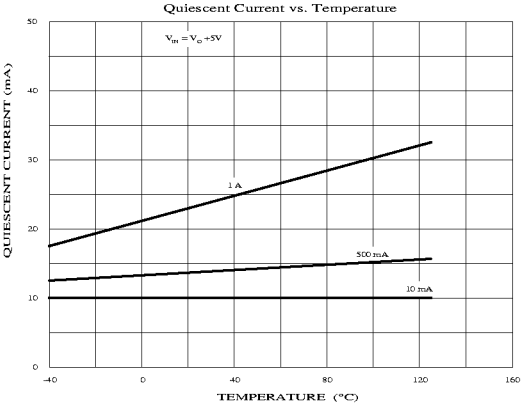
Dropout Voltage



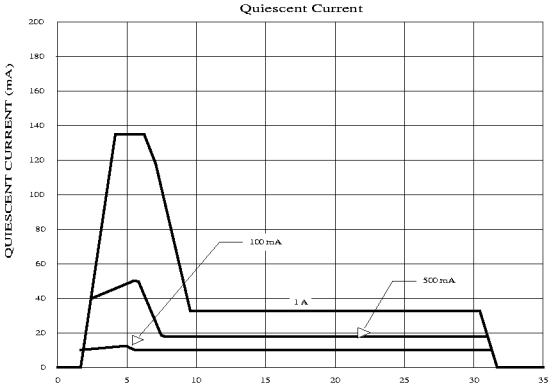
Output Voltage vs. Temperature



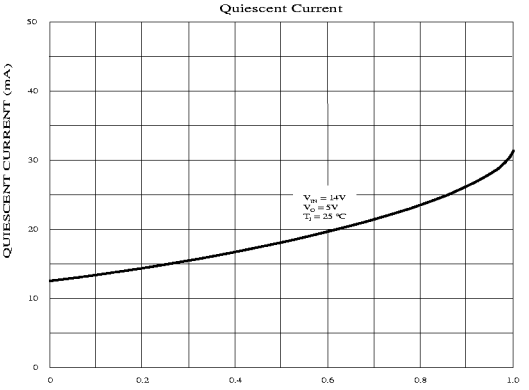
Quiescent Current vs. Temperature



Quiescent Current

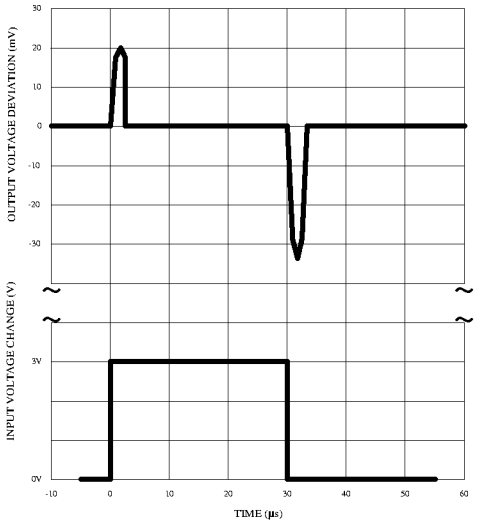


Quiescent Current

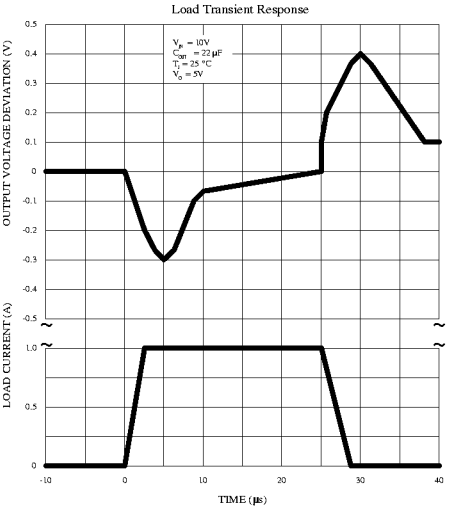


ELECTRICAL CHARACTERISTICS $V_{IN} = V_O + 5V$, $I_O = 1A$, $C_O = 22\ \mu F$, unless otherwise specified.

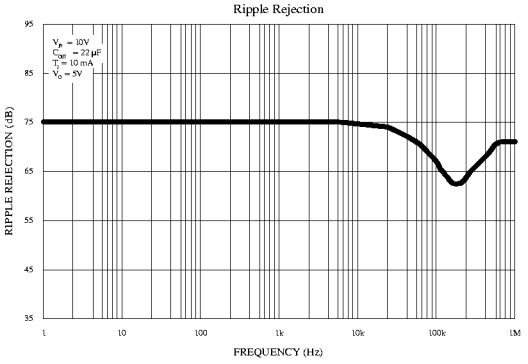
Quiescent Current



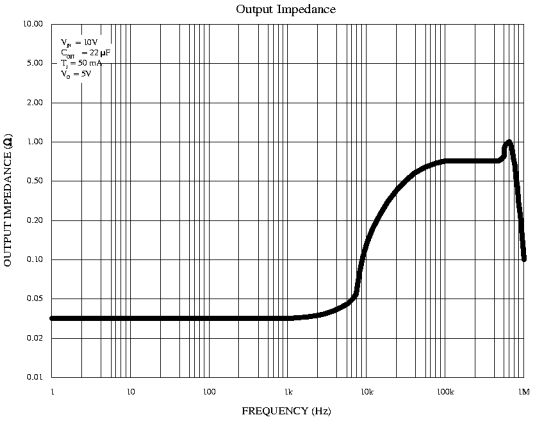
Load Transient Response



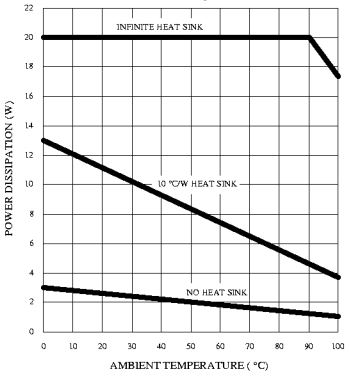
Ripple Rejection



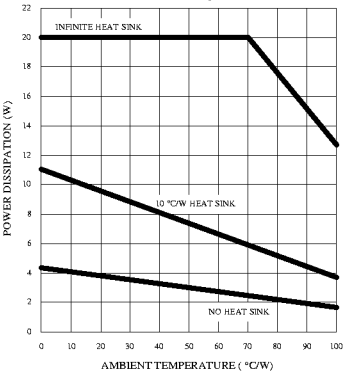
Output Impedance



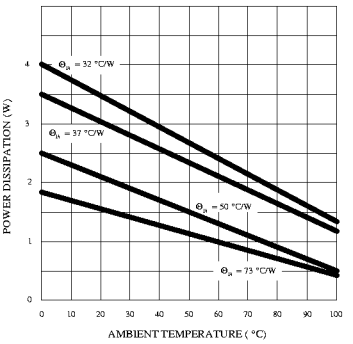
Maximum Power Dissipation (TO-220)



Maximum Power Dissipation (TO-3)

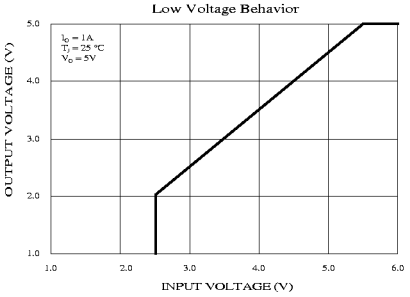


Maximum Power Dissipation (TO-263) (See Note 3)

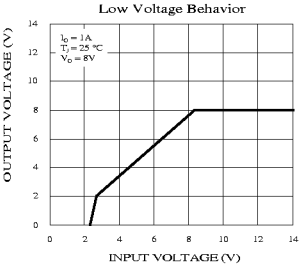


ELECTRICAL CHARACTERISTICS $V_{IN} = V_O + 5V$, I_O =1A, C_O = 22 µF, unless otherwise specified.

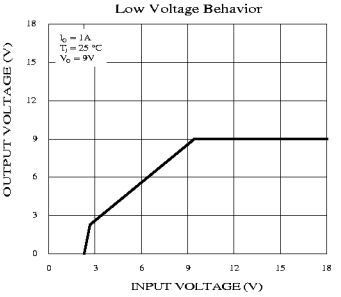
Low Voltage Behavior



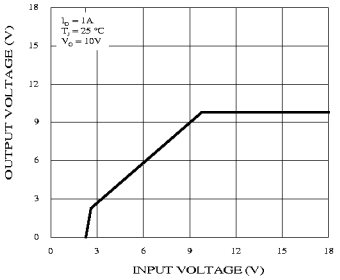
Low Voltage Behavior



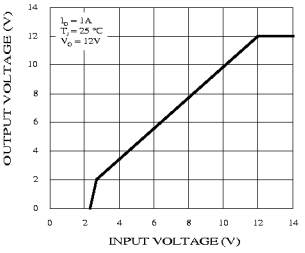
Low Voltage Behavior



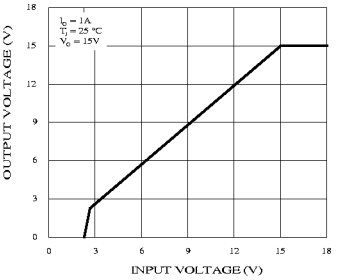
Low Voltage Behavior



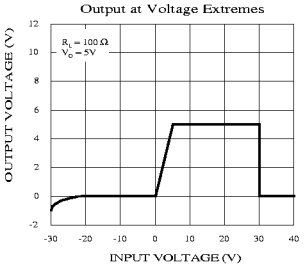
Low Voltage Behavior



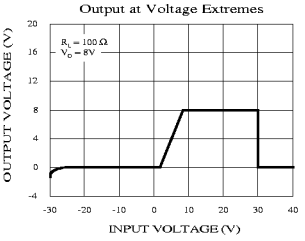
Low Voltage Behavior



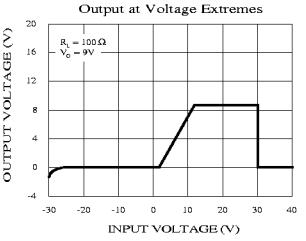
Output at Voltage Extremes



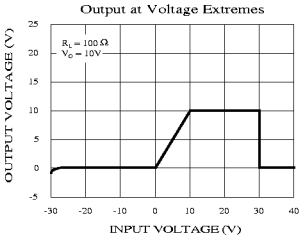
Output at Voltage Extremes



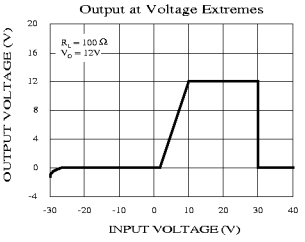
Output at Voltage Extremes



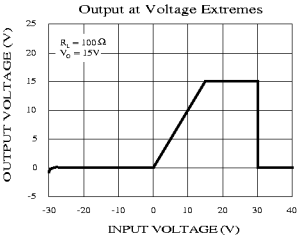
Output at Voltage Extremes



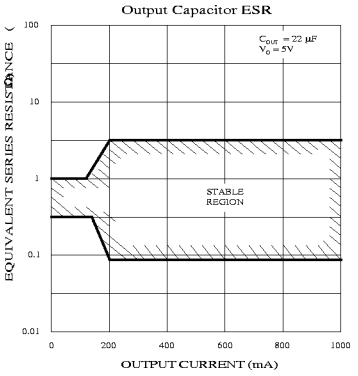
Output at Voltage Extremes



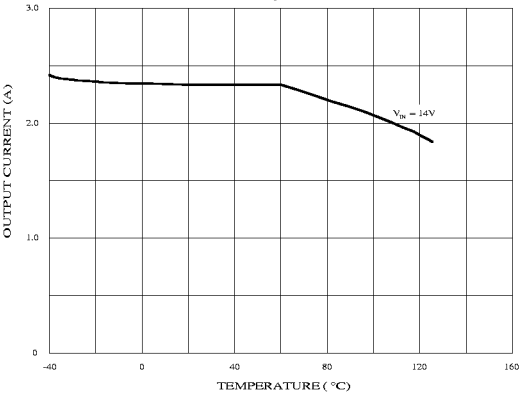
Output at Voltage Extremes



Output Capacitor ESR

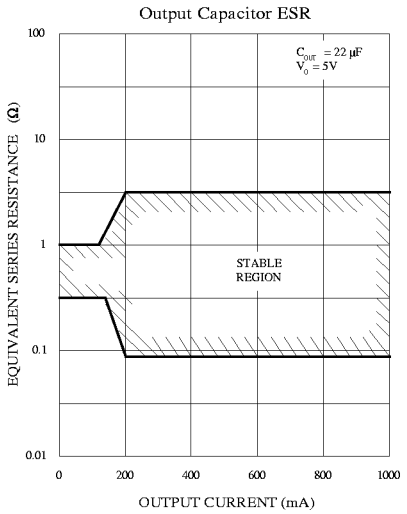


Peak Output Current



APPLICATION HINTS
External Capacitors

A minimum capacitance of 22µF and conditions on ESR (Equivalent Series Resistance) must be met. The minimum value for the capacitance is 22µF and can be increased without limit. However the ESR may cause loop instability if it is too high or too low. The following graph shows the acceptable range for the ESR.



If the capacitor does not meet these requirements oscillation can result.

ESR is specified only at room temperature. Therefore the designer must ensure the proper behavior of the ESR over the temperature range. ESR, for electrolytic capacitor, will increase by about 30X as the temperature is reduced from 25°C to -40°C. Aluminum electrolytic capacitors are not well suited for low temperature operation.
Solid tantalum capacitors' ESR are more stable over temperature, but expensive. A cost-effective approach is then to put in parallel a solid tantalum and a aluminum electrolytic capacitors in the ratio25/75%.

Thermal Consideration

Although the AS2940 offers some limiting circuitry for overload conditions, it is necessary not to exceed the maximum junction temperature, and therefore to be careful about thermal resistance. The heat flow will follow the lowest resistance path, which is the Junction-to-case thermal resistance. In order to insure the best thermal flow of the component, a proper mounting is required. Note that the case of the device is electrically connected to the output. In case the case has to be electrically isolated, a thermally conductive spacer can be used. However do not forget to consider its contribution to thermal resistance.

Formulas for calculating the power dissipated in the regulator are the following:

$I_{IN} = I_L + I_G$

$P_D = (V_{IN} + V_{OUT}) * I_L + V_{IN} * I_G$

Where I_{IN} is the input current, I_L is the load current, I_G is the ground current, P_D is the power dissipated, V_{IN} is the input voltage and V_{OUT} is the output voltage.