

LM2990 Negative Low Dropout Regulator

Check for Samples: [LM2990](#)

FEATURES

- 5% output accuracy over entire operating range
- Output current in excess of 1A
- Dropout voltage typically 0.6V at 1A load
- Low quiescent current
- Internal short circuit current limit

- Internal thermal shutdown with hysteresis
- Functional complement to the LM2940 series

APPLICATIONS

- Post switcher regulator
- Local, on-card, regulation
- Battery operated equipment

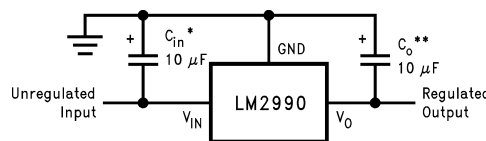
DESCRIPTION

The LM2990 is a three-terminal, low dropout, 1 ampere negative voltage regulator available with fixed output voltages of -5, -5.2, -12, and -15V.

The LM2990 uses new circuit design techniques to provide low dropout and low quiescent current. The dropout voltage at 1A load current is typically 0.6V and a guaranteed worst-case maximum of 1V over the entire operating temperature range. The quiescent current is typically 1 mA with 1A load current and an input-output voltage differential greater than 3V. A unique circuit design of the internal bias supply limits the quiescent current to only 9 mA (typical) when the regulator is in the dropout mode ($V_{OUT} - V_{IN} \leq 3V$). Output voltage accuracy is guaranteed to $\pm 5\%$ over load, and temperature extremes.

The LM2990 is short-circuit proof, and thermal shutdown includes hysteresis to enhance the reliability of the device when overloaded for an extended period of time. The LM2990 is available in a 3-lead package and is rated for operation over the automotive temperature range of -40°C to $+125^{\circ}\text{C}$.

Typical Application



*Required if the regulator is located further than 6 inches from the power supply filter capacitors. A 1 μF solid tantalum or a 10 μF aluminum electrolytic capacitor is recommended.

**Required for stability. Must be at least a 10 μF aluminum electrolytic or a 1 μF solid tantalum to maintain stability. May be increased without bound to maintain regulation during transients. Locate the capacitor as close as possible to the regulator. The equivalent series resistance (ESR) is critical, and should be less than 10 Ω over the same operating temperature range as the regulator.

Connection Diagrams

3-Lead Package

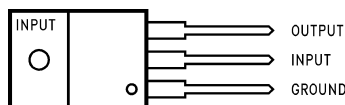


Figure 1. Front View

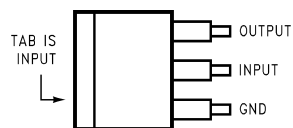
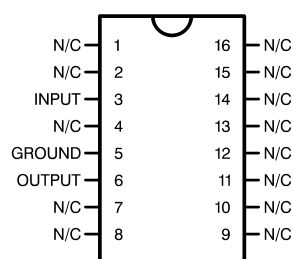
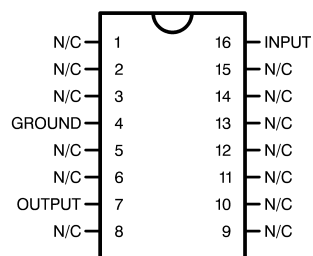


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Surface-Mount Package**Figure 2. Top View****Figure 3. Side View****16-Lead Package****Figure 4. Top View****16-Lead Package****Figure 5. Top View**



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.

Absolute Maximum Ratings ⁽¹⁾

Input Voltage	–26V to +0.3V
ESD Susceptibility ⁽²⁾	2 kV
Power Dissipation ⁽³⁾	Internally Limited
Junction Temperature (T_{Jmax})	125°C
Storage Temperature	–65°C to +150°C
Soldering Temperature	
TO-220 (T), Wave	260°C, 10 sec
TO-263 (S)	235°C, 30 sec

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.
- (2) Human body model, 100 pF discharged through a 1.5 kΩ resistor.
- (3) The maximum power dissipation is a function of T_{Jmax} , θ_{JA} , and T_A . The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{Jmax} - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 125°C, and the LM2990 will eventually go into thermal shutdown at a T_J of approximately 160°C. For the LM2990, the junction-to-ambient thermal resistance, is 53°C/W, 73°C/W for the TO-263, and the junction-to-case thermal resistance is 3°C. If the TO-263 package is used, the thermal resistance can be reduced by increasing the P.C. board copper area thermally connected to the package. Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 37°C/W; and with 1.6 or more square inches of copper area, θ_{JA} is 32°C/W.

Operating Ratings ⁽¹⁾

Junction Temperature Range (T_J)	–40°C to +125°C
Maximum Input Voltage (Operational)	–26V

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

Electrical Characteristics

$V_{IN} = -5V + V_{O(NOM)}^{(1)}$, $I_O = 1A$, $C_O = 47 \mu F$, unless otherwise specified. **Boldface** limits apply over the entire operating temperature range, $-40^\circ C \leq T_J \leq 125^\circ C$, all other limits apply for $T_J = 25^\circ C$.

Parameter	Conditions	LM2990-5.0		LM2990-5.2		Units (Limit)
		Typ (2)	Limit (3)	Typ (2)	Limit (3)	
Output Voltage (V_O)	$5 mA \leq I_O \leq 1A$	-5	-4.90	-5.2	-5.10	V (max)
			-5.10		-5.30	mV (min)
						V
	$5 mA \leq I_O \leq 1A$		-4.75		-4.94	V (max)
			-5.25		-5.46	V (min)
Line Regulation	$I_O = 5 mA$, $V_{O(NOM)} -1V > V_{IN} > -26V$	4	40	4	40	mV (max)
Load Regulation	$50 mA \leq I_O \leq 1A$	1	40	1	40	mV (max)
Dropout Voltage	$I_O = 0.1A$, $\Delta V_O \leq 100 mV$	0.1	0.3	0.1	0.3	V (max)
	$I_O = 1A$, $\Delta V_O \leq 100 mV$	0.6	1	0.6	1	V (max)
Quiescent Current (I_q)	$I_O \leq 1A$	1	5	1	5	mA (max)
	$I_O = 1A$, $V_{IN} = V_{O(NOM)}$	9	50	9	50	mA (max)
Short Circuit Current	$R_L = 1\Omega$ ⁽⁴⁾	1.8	1.5	1.8	1.5	A (min)
Maximum Output Current	⁽⁴⁾	1.8	1.5	1.8	1.5	A (min)
Ripple Rejection	$V_{ripple} = 1 V_{rms}$	58	50	58	50	dB (min)
	$f_{ripple} = 1 kHz$, $I_O = 5 mA$					
Output Noise Voltage	10 Hz–100 kHz, $I_O = 5 mA$	250	750	250	750	μV (max)
Long Term Stability	1000 Hours	2000		2000		ppm

(1) $V_{O(NOM)}$ is the nominal (typical) regulator output voltage, -5V, -5.2V, -12V or -15V.

(2) Typicals are at $T_J = 25^\circ C$ and represent the most likely parametric norm.

(3) Limits are guaranteed and 100% production tested.

(4) The short circuit current is less than the maximum output current with the -12V and -15V versions due to internal foldback current limiting. The -5V and -5.2V versions, tested with a lower input voltage, does not reach the foldback current limit and therefore conducts a higher short circuit current level. If the LM2990 output is pulled above ground, the maximum allowed current sunk back into the LM2990 is 1.5A.

Electrical Characteristics

$V_{IN} = -5V + V_{O(NOM)}^{(1)}$, $I_O = 1A$, $C_O = 47 \mu F$, unless otherwise specified. **Boldface** limits apply over the entire operating temperature range, $-40^\circ C \leq T_J \leq 125^\circ C$, all other limits apply for $T_J = 25^\circ C$.

Parameter	Conditions	LM2990-12		LM2990-15		Units (Limit)
		Typ (2)	Limit (3)	Typ (2)	Limit (3)	
Output Voltage (V_O)	$5 mA \leq I_O \leq 1A$	-12	-11.76	-15	-14.70	V (max)
			-12.24		-15.30	V (min)
						V
	$5 mA \leq I_O \leq 1A$		-11.40		-14.25	V (max)
			-12.60		-15.75	V (min)
Line Regulation	$I_O = 5 mA$, $V_{O(NOM)} -1V > V_{IN} > -26V$	6	60	6	60	mV (max)
Load Regulation	$50 mA \leq I_O \leq 1A$	3	50	3	50	mV (max)
Dropout Voltage	$I_O = 0.1A$, $\Delta V_O \leq 100 mV$	0.1	0.3	0.1	0.3	V (max)
	$I_O = 1A$, $\Delta V_O \leq 100 mV$	0.6	1	0.6	1	V (max)
Quiescent Current (I_q)	$I_O \leq 1A$	1	5	1	5	mA (max)
	$I_O = 1A$, $V_{IN} = V_{O(NOM)}$	9	50	9	50	mA (max)
Short Circuit Current	$R_L = 1\Omega^{(4)}$	1.2	0.9	1.0	0.75	A (min)
Maximum Output Current	$^{(4)}$	1.8	1.4	1.8	1.4	A (min)
Ripple Rejection	$V_{ripple} = 1 V_{rms}$	52	42	52	42	dB (min)
	$f_{ripple} = 1 kHz$, $I_O = 5 mA$					
Output Noise Voltage	10 Hz–100 kHz, $I_O = 5 mA$	500	1500	600	1800	μV (max)
Long Term Stability	1000 Hours	2000		2000		ppm

(1) $V_{O(NOM)}$ is the nominal (typical) regulator output voltage, -5V, -5.2V, -12V or -15V.

(2) Typicals are at $T_J = 25^\circ C$ and represent the most likely parametric norm.

(3) Limits are guaranteed and 100% production tested.

(4) The short circuit current is less than the maximum output current with the -12V and -15V versions due to internal foldback current limiting. The -5V and -5.2V versions, tested with a lower input voltage, does not reach the foldback current limit and therefore conducts a higher short circuit current level. If the LM2990 output is pulled above ground, the maximum allowed current sunk back into the LM2990 is 1.5A.

Definition of Terms

Dropout Voltage: The input-output voltage differential at which the circuit ceases to regulate against further reduction in input voltage. Measured when the output voltage has dropped 100 mV from the nominal value obtained at ($V_O + 5V$) input, dropout voltage is dependent upon load current and junction temperature.

Input Voltage: The DC voltage applied to the input terminals with respect to ground.

Input-Output Differential: The voltage difference between the unregulated input voltage and the regulated output voltage for which the regulator will operate.

Line Regulation: The change in output voltage for a change in the input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that the average chip temperature is not significantly affected.

Load Regulation: The change in output voltage for a change in load current at constant chip temperature.

Long Term Stability: Output voltage stability under accelerated life-test conditions after 1000 hours with maximum rated voltage and junction temperature.

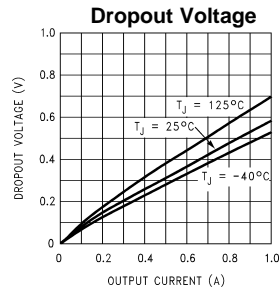
Output Noise Voltage: The rms AC voltage at the output, with constant load and no input ripple, measured over a specified frequency range.

Quiescent Current: That part of the positive input current that does not contribute to the positive load current. The regulator ground lead current.

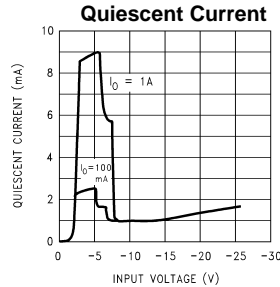
Ripple Rejection: The ratio of the peak-to-peak input ripple voltage to the peak-to-peak output ripple voltage.

Temperature Stability of V_O : The percentage change in output voltage for a thermal variation from room temperature to either temperature extreme.

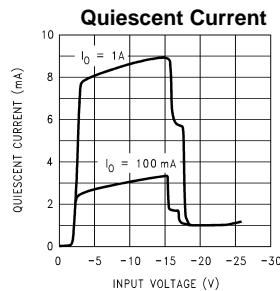
Typical Performance Characteristics



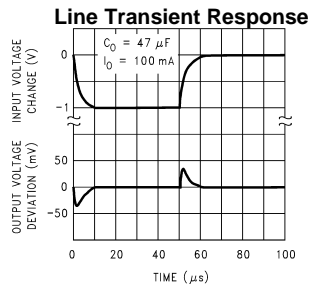
LM2990-5.0 and LM2990-5.2



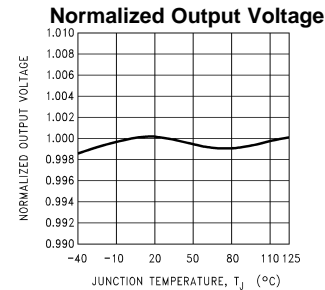
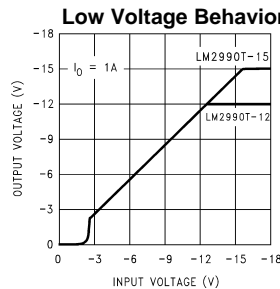
LM2990-15



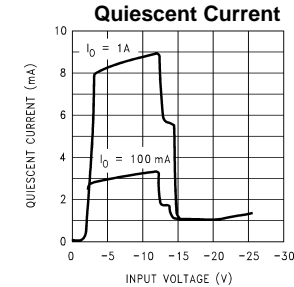
LM2990-5 and LM2990-5.2



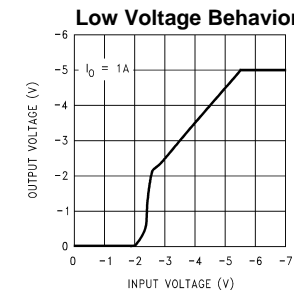
LM2990-12 and LM2990-15



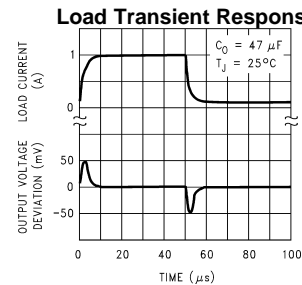
LM2990-12



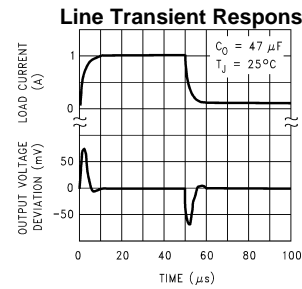
LM2990-5 and LM2990-5.2



LM2990-5 and LM2990-5.2

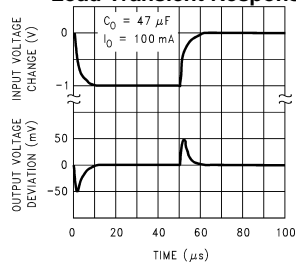


LM2990-12 and LM2990-15

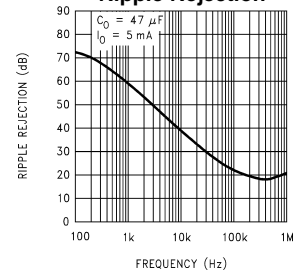


Typical Performance Characteristics (continued)

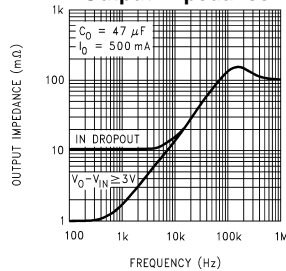
LM2990-12 and LM2990-15
Load Transient Response



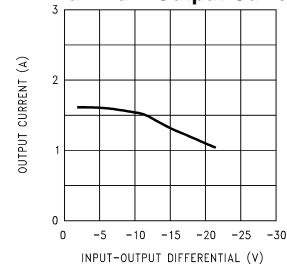
LM2990-5 and LM2990-5.2
Ripple Rejection



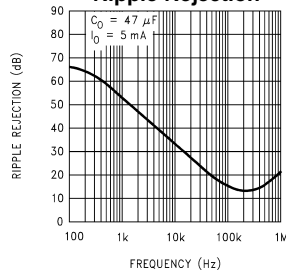
LM2990-5 and LM2990-5.2
Output Impedance



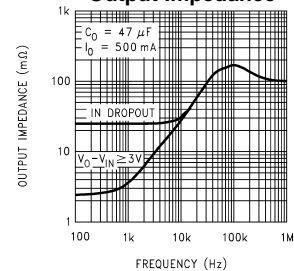
Maximum Output Current



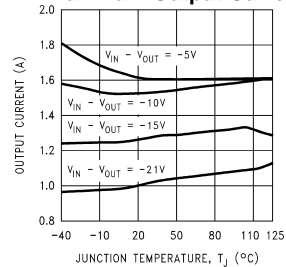
LM2990-12 and LM2990-15
Ripple Rejection



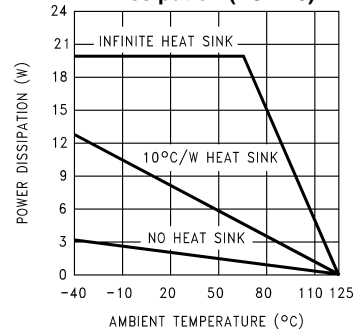
LM2990-12 and LM2990-15
Output Impedance



Maximum Output Current

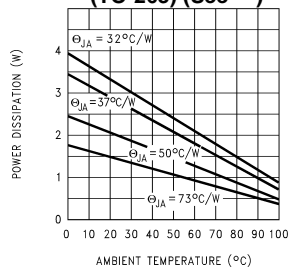


**Maximum Power
Dissipation (TO-220)**



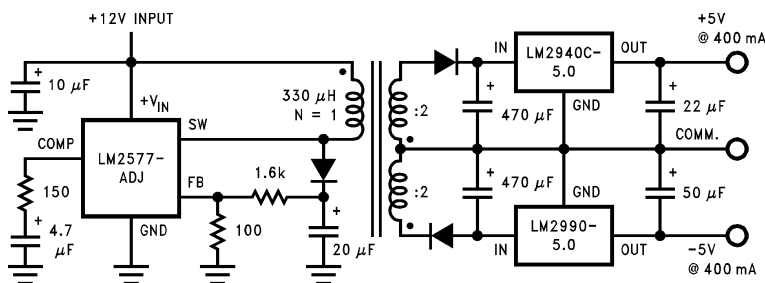
Typical Performance Characteristics (continued)

Maximum Power Dissipation
(TO-263) (See ⁽¹⁾)



Typical Applications

Figure 6. Post Regulator for an Isolated Switching Power Supply



The LM2940 is a positive 1A low dropout regulator; refer to its datasheet for further information.

Figure 7. Fixed Current Sink

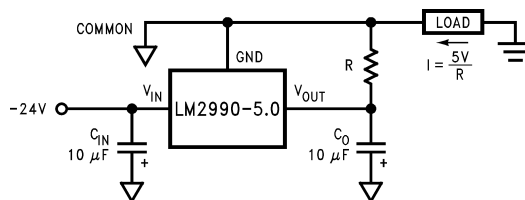
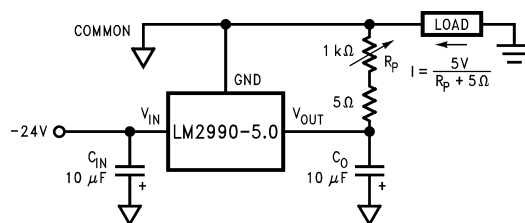


Figure 8. Adjustable Current Sink



- (1) The maximum power dissipation is a function of T_{Jmax}, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is P_D = (T_{Jmax} - T_A)/θ_{JA}. If this dissipation is exceeded, the die temperature will rise above 125°C, and the LM2990 will eventually go into thermal shutdown at a T_J of approximately 160°C. For the LM2990, the junction-to-ambient thermal resistance, is 53°C/W, 73°C/W for the TO-263, and the junction-to-case thermal resistance is 3°C. If the TO-263 package is used, the thermal resistance can be reduced by increasing the P.C. board copper area thermally connected to the package. Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 37°C/W; and with 1.6 or more square inches of copper area, θ_{JA} is 32°C/W.

Application Hints

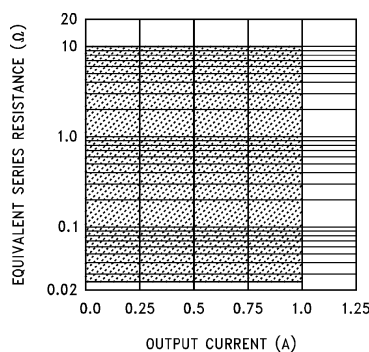
EXTERNAL CAPACITORS

The LM2990 regulator requires an output capacitor to maintain stability. The capacitor must be at least 10 μF aluminum electrolytic or 1 μF solid tantalum. The output capacitor's ESR must be less than 10Ω , or the zero added to the regulator frequency response by the ESR could reduce the phase margin, creating oscillations (refer to the graph on the right). An input capacitor, of at least 1 μF solid tantalum or 10 μF aluminum electrolytic, is also needed if the regulator is situated more than 6" from the input power supply filter.

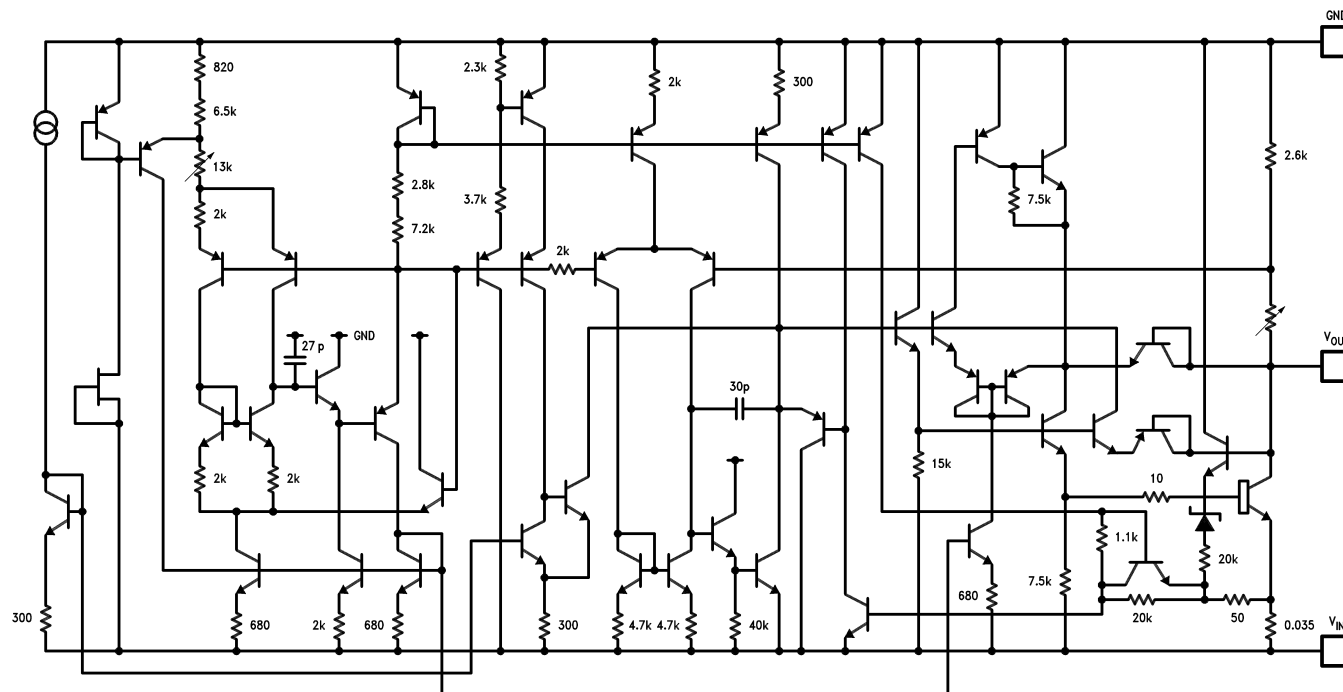
FORCING THE OUTPUT POSITIVE

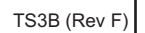
Due to an internal clamp circuit, the LM2990 can withstand positive voltages on its output. If the voltage source pulling the output positive is DC, the current must be limited to 1.5A. A current over 1.5A fed back into the LM2990 could damage the device. The LM2990 output can also withstand fast positive voltage transients up to 26V, without any current limiting of the source. However, if the transients have a duration of over 1 ms, the output should be clamped with a Schottky diode to ground.

Figure 9. Output Capacitor ESR



Equivalent Schematic





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
LM2990S-12	ACTIVE	DDPAK/ TO-263	KTT	3	45	TBD	Call TI	Call TI	-40 to 125	LM2990S -12 P+	Samples
LM2990S-12/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125	LM2990S -12 P+	Samples
LM2990S-15	ACTIVE	DDPAK/ TO-263	KTT	3	45	TBD	Call TI	Call TI	-40 to 125	LM2990S -15 P+	Samples
LM2990S-15/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125	LM2990S -15 P+	Samples
LM2990S-5.0	ACTIVE	DDPAK/ TO-263	KTT	3	45	TBD	Call TI	Call TI	-40 to 125	LM2990S -5.0 P+	Samples
LM2990S-5.0/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125	LM2990S -5.0 P+	Samples
LM2990SX-12	ACTIVE	DDPAK/ TO-263	KTT	3	500	TBD	Call TI	Call TI	-40 to 125	LM2990S -12 P+	Samples
LM2990SX-12/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125	LM2990S -12 P+	Samples
LM2990SX-15	ACTIVE	DDPAK/ TO-263	KTT	3	500	TBD	Call TI	Call TI	-40 to 125	LM2990S -15 P+	Samples
LM2990SX-15/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125	LM2990S -15 P+	Samples
LM2990SX-5.0	ACTIVE	DDPAK/ TO-263	KTT	3	500	TBD	Call TI	Call TI	-40 to 125	LM2990S -5.0 P+	Samples
LM2990SX-5.0/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125	LM2990S -5.0 P+	Samples
LM2990T-12	ACTIVE	TO-220	NDE	3	45	TBD	Call TI	Call TI	-40 to 125	LM2990T -12 P+	Samples
LM2990T-12/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	-40 to 125	LM2990T -12 P+	Samples
LM2990T-15	ACTIVE	TO-220	NDE	3	45	TBD	Call TI	Call TI	-40 to 125	LM2990T -15 P+	Samples
LM2990T-15/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	-40 to 125	LM2990T -15 P+	Samples
LM2990T-5.0	ACTIVE	TO-220	NDE	3	45	TBD	Call TI	Call TI	-40 to 125	LM2990T -5.0 P+	Samples

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
LM2990T-5.0/NOPB	ACTIVE	TO-220	NDE	3	45	Pb-Free (RoHS Exempt)	CU SN	Level-1-NA-UNLIM	-40 to 125	LM2990T -5.0 P+	Samples
LM2990T-5.2	ACTIVE	TO-220	NDE	3	45	TBD	Call TI	Call TI	-40 to 125	LM2990T -5.2 P+	Samples
LM2990T-5.2/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	-40 to 125	LM2990T -5.2 P+	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.

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TAPE AND REEL INFORMATION


*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
LM2990SX-12	DDPAK/TO-263	KTT	3	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2990SX-12/NOPB	DDPAK/TO-263	KTT	3	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2990SX-15	DDPAK/TO-263	KTT	3	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2990SX-15/NOPB	DDPAK/TO-263	KTT	3	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2990SX-5.0	DDPAK/TO-263	KTT	3	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2990SX-5.0/NOPB	DDPAK/TO-263	KTT	3	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2990SX-12	DDPAK/TO-263	KTT	3	500	358.0	343.0	63.0
LM2990SX-12/NOPB	DDPAK/TO-263	KTT	3	500	358.0	343.0	63.0
LM2990SX-15	DDPAK/TO-263	KTT	3	500	358.0	343.0	63.0
LM2990SX-15/NOPB	DDPAK/TO-263	KTT	3	500	358.0	343.0	63.0
LM2990SX-5.0	DDPAK/TO-263	KTT	3	500	358.0	343.0	63.0
LM2990SX-5.0/NOPB	DDPAK/TO-263	KTT	3	500	358.0	343.0	63.0



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