SLVS021D – JANUARY 1988 – REVISED AUGUST 1995

- **Very Low Dropout Voltage, Less Than 0.6 V at 750 mA**
- **Low Quiescent Current**
- **TTL- and CMOS-Compatible Enable on TL751M Series**
- **60-V Load-Dump Protection**
- **Overvoltage Protection**
- **Internal Thermal Overload Protection**
- **Internal Overcurrent Limiting Circuitry**

description

The TL750M and TL751M series are low-dropout positive voltage regulators specifically designed for battery-powered systems. The TL750M and TL751M incorporate on-board overvoltage and current-limit protection circuitry to protect both themselves and the regulated system. Both series are fully protected against 60-V load-dump and reverse battery conditions. Extremely low quiescent current, even during full-load conditions, makes the TL750M and TL751M series ideal for standby power systems.

The TL750M series of fixed-output voltage regulators offer 5-V, 8-V, 10-V, and 12-V options available in 3-lead KC (TO-220AB) and KTE plastic packages.

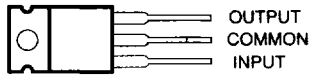
The TL751M series of fixed-output voltage regulators also offer 5-V, 8-V, 10-V, and 12-V options with the addition of an enable input. The enable input gives the designer complete control over power up, allowing sequential power up or emergency shutdown. When taken high, the enable input places the regulator output in a high-impedance state. It is completely TTL- and CMOS-compatible. The TL751M series is offered in 5-lead KC and KTG plastic packages.

The TL750MxxC and TL751MxxC are characterized for operation from 0°C to 125°C virtual junction temperature, and the TL750MxxQ and TL751MxxQ series are characterized for operation from –40°C to 125°C virtual junction temperature.

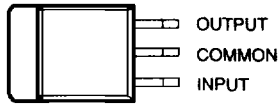
AVAILABLE OPTIONS

T_J	V_OTYP (V)	PACKAGED DEVICES				CHIP FORM (Y)
		HEAT-SINK MOUNTED (3-PIN) (KC)	HEAT-SINK MOUNTED (5-PIN) (KC)	PLASTIC FLANGE-MOUNT (KTE)	PLASTIC FLANGE-MOUNT (KTG)	
0°C to 125°C	5	TL750M05CKC	TL751M05CKC	TL750M05CKTG	TL751M05CKTG	TL750M05Y
	8	TL750M08CKC	TL751M08CKC	TL750M08CKTG	TL751M08CKTG	TL750M08Y
	10	TL750M10CKC	TL751M10CKC	TL750M10CKTG	TL751M10CKTG	TL750M10Y
	12	TL750M12CKC	TL751M12CKC	TL750M12CKTG	TL751M12CKTG	TL750M12Y
–40°C to 125°C	5	TL750M05QKC	TL751M05QKC	TL750M05QKTG	TL751M05QKTG	—
	8	TL750M08QKC	TL751M08QKC	TL750M08QKTG	TL751M08QKTG	—
	10	TL750M10QKC	TL751M10QKC	TL750M10QKTG	TL751M10QKTG	—
	12	TL750M12QKC	TL751M12QKC	TL750M12QKTG	TL751M12QKTG	—

TL750M . . . 3-LEAD KC PACKAGE
(TOP VIEW)

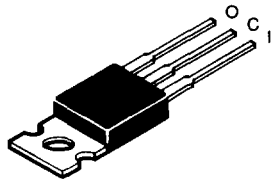


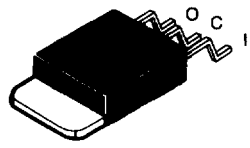
TL750M . . . 3-LEAD KTE PACKAGE
(TOP VIEW)



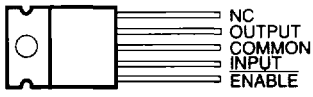
NOTE A: The common terminal is in electrical contact with the mounting base.

TO-200AB

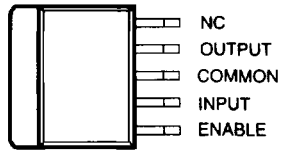




TL751M . . . 5-LEAD KC PACKAGE
(TOP VIEW)

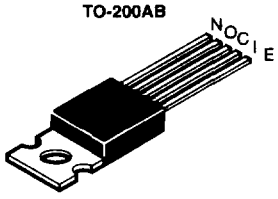


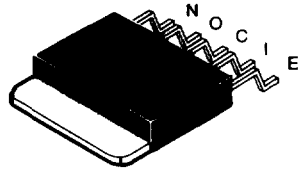
TL750M . . . 5-LEAD KTG PACKAGE
(TOP VIEW)



NOTE A: The common terminal is in electrical contact with the mounting base.

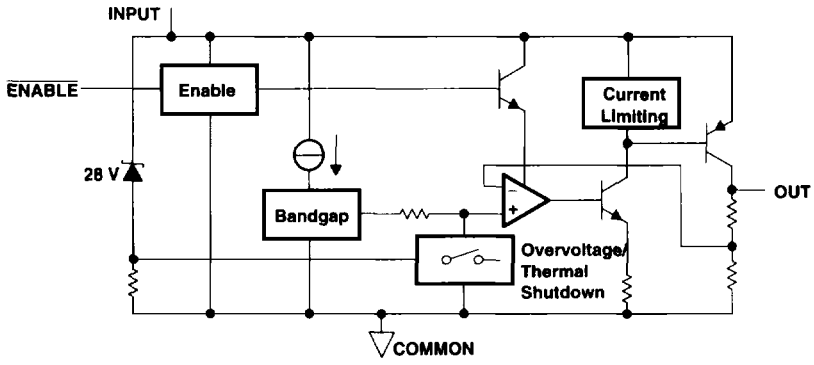
TO-200AB





NC – No internal connection

TL751Mxx functional block diagram

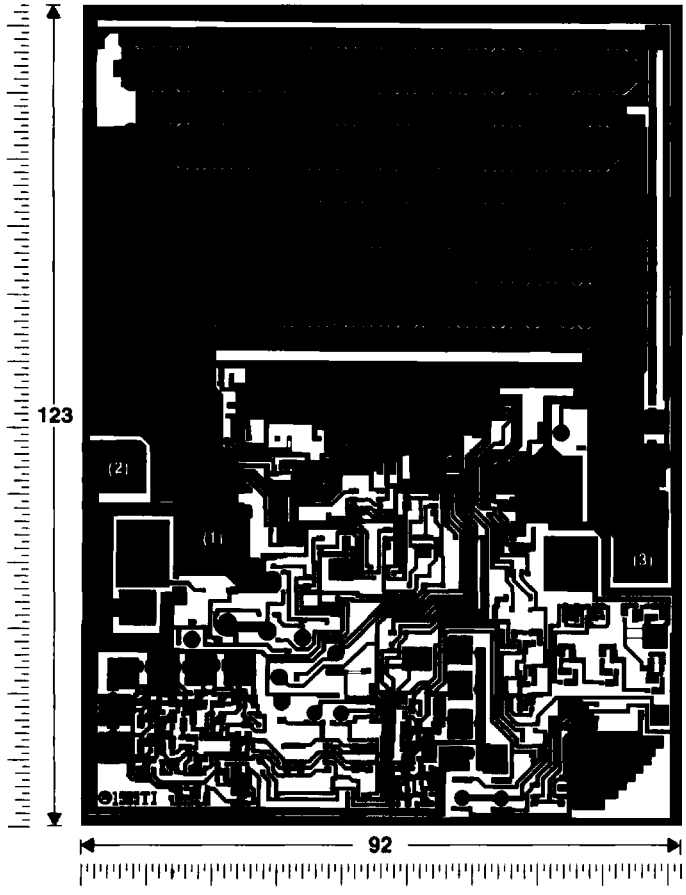


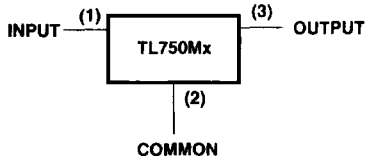
ACTUAL DEVICE COMPONENT COUNT	
Transistors	46
Diodes	14
Resistors	44
Capacitors	4
JFET	1
Tunnels (emitter R)	2

TL750MxxY chip information

This chip, when properly assembled, displays characteristics similar to the TL750MxxC. Thermal compression or ultrasonic bonding can be used on the doped aluminum bonding pads. The chip can be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 11 MILS TYPICAL
BONDING PADS: 7 X 7 MILS MINIMUM
$T_J$max = 150°C
TOLERANCES ARE ±10%
ALL DIMENSIONS ARE IN MILS

absolute maximum ratings over virtual junction temperature range (unless otherwise noted)†

Continuous input voltage	26 V
Transient input voltage (see Figure 5)	60 V
Continuous reverse input voltage	−15 V
Transient reverse input voltage: t = 100 ms	−50 V
Continuous total power dissipation at (or below) 25°C free-air temperature (see Note 1)	2 W
Continuous total power dissipation at (or below) 40°C case temperature (see Note 1)	20 W
Operating free-air, T_A, case, T_C, or virtual junction, T_J, temperature range	−40°C to 150°C
Storage temperature range, T_{stg}	−65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: For operation above T_A = 25°C and T_C = 40°C, refer to Figures 1 and 2. To avoid exceeding the design maximum virtual junction temperature, these ratings should not be exceeded. Due to variation in individual device electrical characteristics and thermal resistance, the built-in thermal overload protection may be activated at power levels slightly above or below the rated dissipation.

FREE-AIR TEMPERATURE DISSIPATION DERATING CURVE

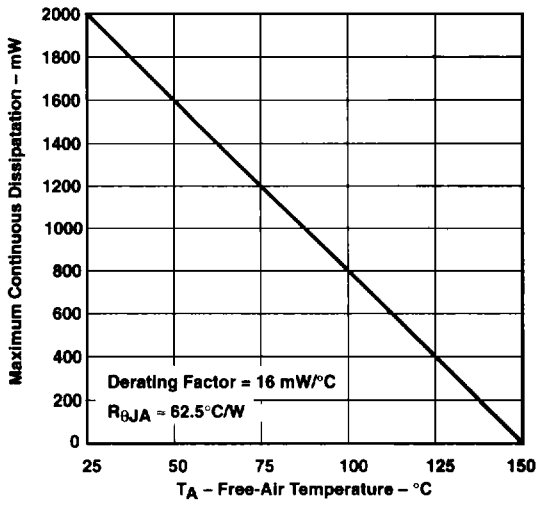


Figure 1

CASE TEMPERATURE DISSIPATION DERATING CURVE

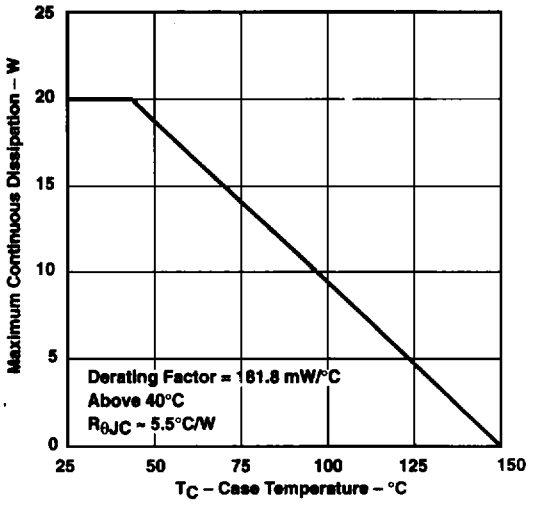


Figure 2

recommended operating conditions over recommended virtual junction temperature range

		MIN	MAX	UNIT
Input voltage range, V_I	TL75xM05	6	26	V
	TL75xM08	9	26	
	TL75xM10	11	26	
	TL75xM12	13	26	
High-level $\overline{\text{ENABLE}}$ input voltage, V_{IH}	TL751Mxx	2	15	V
Low-level $\overline{\text{ENABLE}}$ input voltage, V_{IL}	TL751Mxx	0	0.8	
Output current range, I_O			750	mA
Operating virtual junction temperature range, T_J	TL75xMxxC	0	125	°C
	TL75xMxxQ	−40	125	

electrical characteristics, V_I = 14 V, I_O = 300 mA, $\overline{\text{ENABLE}}$ at 0 V for TL751M05, T_J = 25°C (unless otherwise noted) (see Note 2)

PARAMETER	TEST CONDITIONS			TL750M05, TL751M05			UNIT
				MIN	TYP	MAX	
Output voltage	V_I = 6 V to 26 V,	I_O = 0 mA to 750 mA	T_J = 25°C	4.9	5	5.1	V
			T_J = MIN to MAX†	4.9		5.1	
Input voltage regulation	V_I = 9 V to 16 V,	I_O = 250 mA			10	25	mV
	V_I = 6 V to 26 V,	I_O = 250 mA			12	50	
Ripple rejection	V_I = 8 V to 18 V,	f = 120 Hz		50	55		dB
Output voltage regulation	I_O = 5 mA to 750 mA				20	50	mV
Dropout voltage	I_O = 500 mA					0.5	V
	I_O = 750 mA					0.6	
Output noise voltage	f = 10 Hz to 100 kHz				500		μV
Bias current	I_O = 750 mA				60	75	mA
	I_O = 10 mA					5	
Bias current (TL751Mxx only)	$\overline{\text{ENABLE}}$ V_{IH} ≥ 2 V					200	μA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

NOTE 2: Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-μF capacitor across the input and a 10-μF tantalum capacitor on the output with equivalent series resistance within the guidelines shown in Figure 3.

electrical characteristics, V_I = 14 V, I_O = 300 mA, $\overline{\text{ENABLE}}$ at 0 V for TL751M08, T_J = 25°C (unless otherwise noted) (see Note 2)

PARAMETER	TEST CONDITIONS			TL750M08, TL751M08			UNIT
				MIN	TYP	MAX	
Output voltage	V_I = 9 V to 26 V,	I_O = 0 mA to 750 mA	T_J = 25°C	7.84	8	8.16	V
			T_J = MIN to MAX†	7.84		8.16	
Input voltage regulation	V_I = 10 V to 17 V,	I_O = 250 mA			12	40	mV
	V_I = 9 V to 26 V,	I_O = 250 mA			15	68	
Ripple rejection	V_I = 11 V to 21 V,	f = 120 Hz		50	55		dB
Output voltage regulation	I_O = 5 mA to 750 mA				24	80	mV
Dropout voltage	I_O = 500 mA					0.5	V
	I_O = 750 mA					0.6	
Output noise voltage	f = 10 Hz to 100 kHz				500		μV
Bias current	I_O = 750 mA				60	75	mA
	I_O = 10 mA					5	
Bias current (TL751Mxx only)	$\overline{\text{ENABLE}}$ V_{IH} ≥ 2 V					200	μA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

NOTE 2: Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-μF capacitor across the input and a 10-μF tantalum capacitor on the output with equivalent series resistance within the guidelines shown in Figure 3.

electrical characteristics, V_I = 14 V, I_O = 300 mA, $\overline{\text{ENABLE}}$ at 0 V for TL751M10, T_J = 25°C (unless otherwise noted) (see Note 2)

PARAMETER	TEST CONDITIONS			TL750M10, TL751M10			UNIT
				MIN	TYP	MAX	
Output voltage	V_I = 11 V to 26 V,	I_O = 0 mA to 750 mA	T_J = 25°C	9.8	10	10.2	V
			T_J = MIN to MAX†	9.8		10.2	
Input voltage regulation	V_I = 12 V to 18 V,	I_O = 250 mA			15	43	mV
	V_I = 11 V to 26 V,	I_O = 250 mA			20	75	
Ripple rejection	V_I = 13 V to 23 V,	f = 120 Hz		50	55		dB
Output voltage regulation	I_O = 5 mA to 750 mA				30	100	mV
Dropout voltage	I_O = 500 mA					0.5	V
	I_O = 750 mA					0.6	
Output noise voltage	f = 10 Hz to 100 kHz				1000		μV
Bias current	I_O = 750 mA				60	75	mA
	I_O = 10 mA					5	
Bias current (TL751Mxx only)	$\overline{\text{ENABLE}}$ V_{IH} ≥ 2 V					200	μA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

NOTE 2: Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-μF capacitor across the input and a 10-μF tantalum capacitor on the output with equivalent series resistance within the guidelines shown in Figure 3.

electrical characteristics, V_I = 14 V, I_O = 300 mA, $\overline{\text{ENABLE}}$ at 0 V for TL751M12, T_J = 25°C (unless otherwise noted) (see Note 2)

PARAMETER	TEST CONDITIONS			TL750M12, TL751M12			UNIT
				MIN	TYP	MAX	
Output voltage	V_I = 13 V to 26 V,	I_O = 0 mA to 750 mA	T_J = 25°C	11.76	12	12.24	V
			T_J = MIN to MAX†	11.76		12.24	
Input voltage regulation	V_I = 14 V to 19 V,	I_O = 250 mA			15	43	mV
	V_I = 13 V to 26 V,	I_O = 250 mA			20	78	
Ripple rejection	V_I = 13 V to 23 V,	f = 120 Hz		50	55		dB
Output voltage regulation	I_O = 5 mA to 750 mA				30	120	mV
Dropout voltage	I_O = 500 mA					0.5	V
	I_O = 750 mA					0.6	
Output noise voltage	f = 10 Hz to 100 kHz				1000		μV
Bias current	I_O = 750 mA				60	75	mA
	I_O = 10 mA					5	
Bias current (TL751Mxx only)	$\overline{\text{ENABLE}}$ V_{IH} ≥ 2 V					200	μA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

NOTE 2: Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-μF capacitor across the input and a 10-μF tantalum capacitor on the output with equivalent series resistance within the guidelines shown in Figure 3.

electrical characteristics, V_I = 14 V, I_O = 300 mA, T_J = 25°C

PARAMETER	TL751Mxx			UNIT
	MIN	TYP	MAX	
Response time, $\overline{\text{ENABLE}}$ to output		50		μs

electrical characteristics, V_I = 14 V, I_O = 300 mA, $\overline{\text{ENABLE}}$ at 0 V, T_J = 25°C (unless otherwise noted) (see Note 2)

PARAMETER	TEST CONDITIONS		TL750M05Y			UNIT
			MIN	TYP	MAX	
Output voltage	V_I = 6 V to 26 V,	I_O = 0 mA to 750 mA,		5		V
Input voltage regulation	V_I = 9 V to 16 V,	I_O = 250 mA		10		mV
	V_I = 6 V to 26 V,	I_O = 250 mA		12		
Ripple rejection	V_I = 8 V to 18 V,	f = 120 Hz		55		dB
Output voltage regulation	I_O = 5 mA to 750 mA			20		mV
Output noise voltage	f = 10 Hz to 100 kHz			500		μV
Bias current	I_O = 750 mA			60		mA

NOTE 2: Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-μF capacitor across the input and a 10-μF tantalum capacitor on the output with equivalent series resistance within the guidelines shown in Figure 3.

electrical characteristics, V_I = 14 V, I_O = 300 mA, $\overline{\text{ENABLE}}$ at 0 V, T_J = 25°C (unless otherwise noted) (see Note 2)

PARAMETER	TEST CONDITIONS		TL750M08Y			UNIT
			MIN	TYP	MAX	
Output voltage	V_I = 9 V to 26 V,	I_O = 0 mA to 750 mA,		8		V
Input voltage regulation	V_I = 10 V to 17 V,	I_O = 250 mA		12		mV
	V_I = 9 V to 26 V,	I_O = 250 mA		15		
Ripple rejection	V_I = 11 V to 21 V,	f = 120 Hz		55		dB
Output voltage regulation	I_O = 5 mA to 750 mA			24		mV
Output noise voltage	f = 10 Hz to 100 kHz			500		μV
Bias current	I_O = 750 mA			60		mA

NOTE 2: Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-μF capacitor across the input and a 10-μF tantalum capacitor on the output with equivalent series resistance within the guidelines shown in Figure 3.

electrical characteristics, V_I = 14 V, I_O = 300 mA, $\overline{\text{ENABLE}}$ at 0 V, T_J = 25°C (unless otherwise noted) (see Note 2)

PARAMETER	TEST CONDITIONS		TL750M10Y			UNIT
			MIN	TYP	MAX	
Output voltage	V_I = 11 V to 26 V,	I_O = 0 mA to 750 mA,		10		V
Input voltage regulation	V_I = 12 V to 18 V,	I_O = 250 mA		15		mV
	V_I = 11 V to 26 V,	I_O = 250 mA		20		
Ripple rejection	V_I = 13 V to 23 V,	f = 120 Hz		55		dB
Output voltage regulation	I_O = 5 mA to 750 mA			30		mV
Output noise voltage	f = 10 Hz to 100 kHz			1000		μV
Bias current	I_O = 750 mA			60		mA

NOTE 2: Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-μF capacitor across the input and a 10-μF tantalum capacitor on the output with equivalent series resistance within the guidelines shown in Figure 3.

TL751M12Y electrical characteristics, V_I = 14 V, I_O = 300 mA, $\overline{\text{ENABLE}}$ at 0 V, T_J = 25°C (unless otherwise noted) (see Note 2)

PARAMETER	TEST CONDITIONS		TL750M12Y			UNIT
			MIN	TYP	MAX	
Output voltage	V_I = 13 V to 26 V,	I_O = 0 mA to 750 mA,		12		V
Input voltage regulation	V_I = 14 V to 19 V,	I_O = 250 mA		15		mV
	V_I = 13 V to 26 V,	I_O = 250 mA		20		
Ripple rejection	V_I = 13 V to 23 V,	f = 120 Hz		55		dB
Output voltage regulation	I_O = 5 mA to 750 mA			30		mV
Output noise voltage	f = 10 Hz to 100 kHz			1000		μV
Bias current	I_O = 750 mA			60		mA

NOTE 2: Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-μF capacitor across the input and a 10-μF tantalum capacitor on the output with equivalent series resistance within the guidelines shown in Figure 3.

PARAMETER MEASUREMENT INFORMATION

The TL751Mxx is a low-dropout regulator. This means that the capacitance loading is important to the performance of the regulator because it is a vital part of the control loop. The capacitor value and the equivalent series resistance (ESR) both affect the control loop and must be defined for the load range and the temperature range. Figures 3 and 4 can establish the capacitance value and ESR range for best regulator performance.

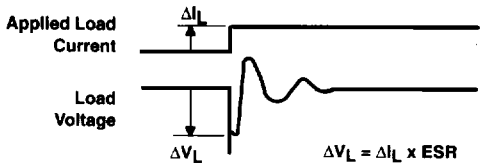
Figure 3 shows the recommended range of ESR for a given load with a 10-μF capacitor on the output. This figure also shows a maximum ESR limit of 2 Ω and a load-dependent minimum ESR limit.

For applications with varying loads, the lightest load condition should be chosen since it is the worst case. Figure 4 shows the relationship of the reciprocal of ESR to the square root of the capacitance with a minimum capacitance limit of 10 μF and a maximum ESR limit of 2 Ω. This figure establishes the amount that the minimum ESR limit shown in Figure 3 can be adjusted for different capacitor values. For example, if the minimum load needed is 200 mA, Figure 4 suggests an ESR range of 0.8 Ω to 2 Ω for 10 μF. Figure 4 shows that changing the capacitor from 10 μF to 400 μF can change the ESR minimum by greater than 3/0.5 (or 6). Therefore, the new minimum ESR value is 0.8/6 (or 0.13 Ω). This now allows an ESR range of 0.13 Ω to 2 Ω , achieving an expanded ESR range by using a larger capacitor at the output. [For better stability in low-current applications, a small resistance placed in series with the capacitor (see Table 1) is recommended, so that ESRs better approximate those shown in Figures 3 and 4.]

PARAMETER MEASUREMENT INFORMATION

Table 1. Compensations for Increased Stability at Low Currents

MANUFACTURER	CAPACITANCE	ESR TYP	PART NUMBER	ADDITIONAL RESISTANCE
AVX	15 μF	0.9 Ω	TAJB156M010S	1 Ω
KEMET	33 μF	0.6 Ω	T491D336M010AS	0.5 Ω



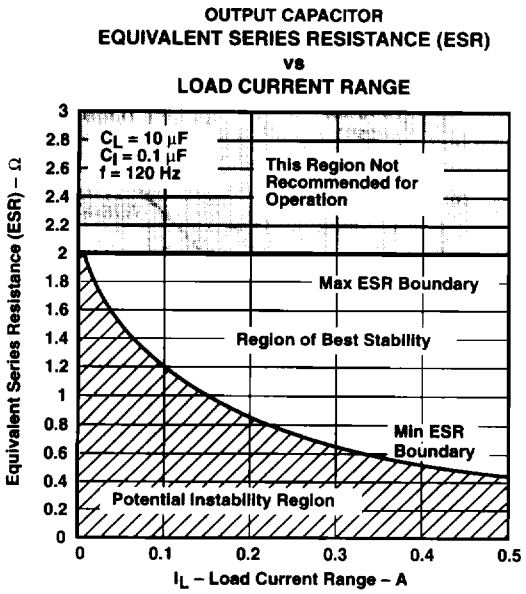


Figure 3

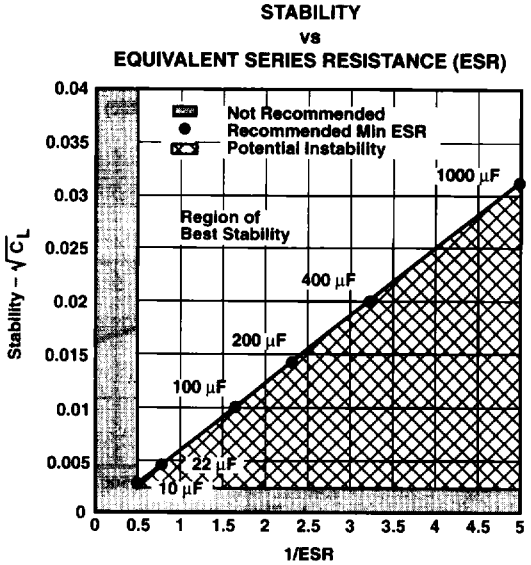


Figure 4

TYPICAL CHARACTERISTICS

table of graphs

			FIGURE
Transient input voltage		vs Time	5
Output voltage		vs Input voltage	6
Input current	I_O = 10 mA	vs Input voltage	7
	I_O = 100 mA	vs Input voltage	8
Dropout voltage		vs Output current	9
Quiescent current		vs Output current	10
Load transient response			11
Line transient response			12

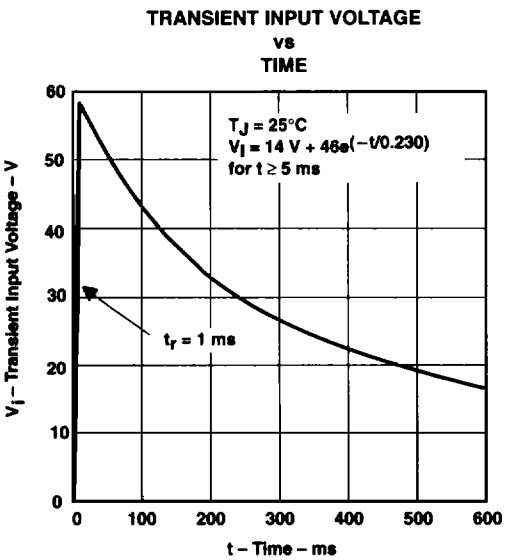


Figure 5

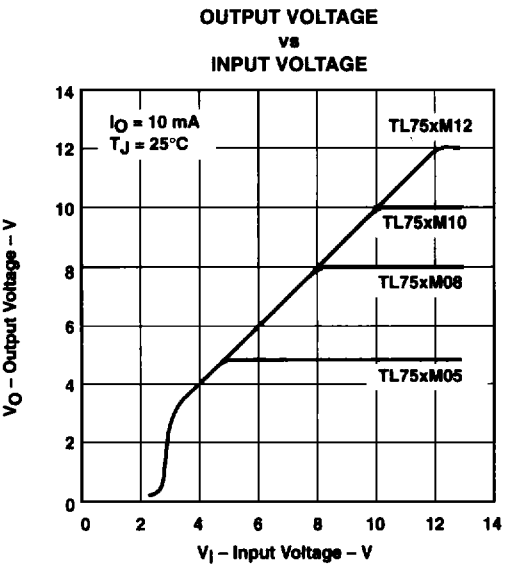


Figure 6

TYPICAL CHARACTERISTICS

INPUT CURRENT vs INPUT VOLTAGE

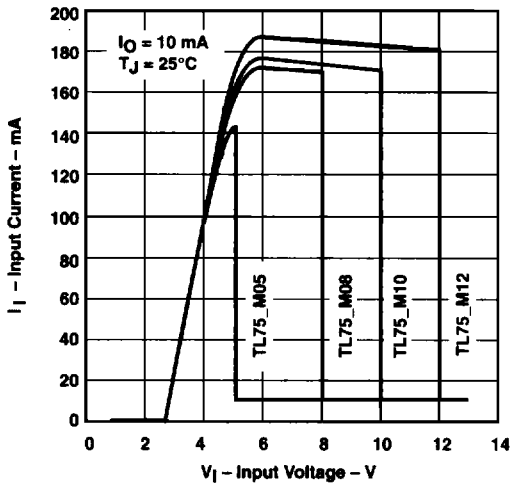


Figure 7

INPUT CURRENT vs INPUT VOLTAGE

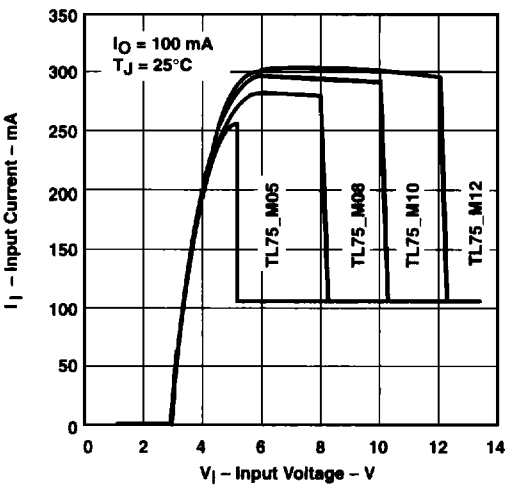


Figure 8

DROPOUT VOLTAGE vs OUTPUT CURRENT

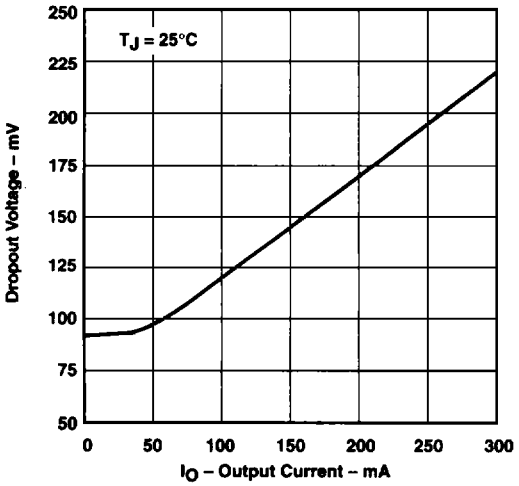


Figure 9

QUIESCENT CURRENT vs OUTPUT CURRENT

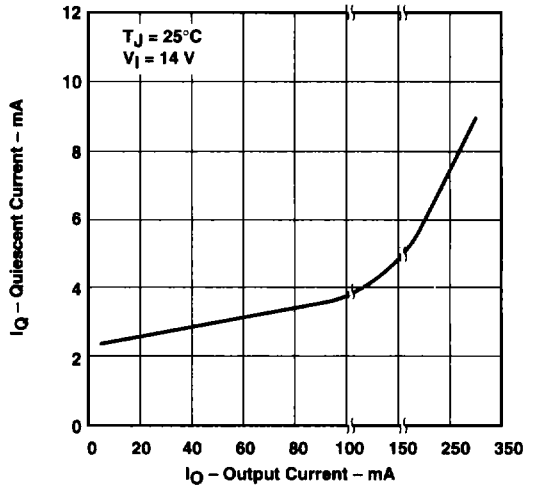


Figure 10

TYPICAL CHARACTERISTICS

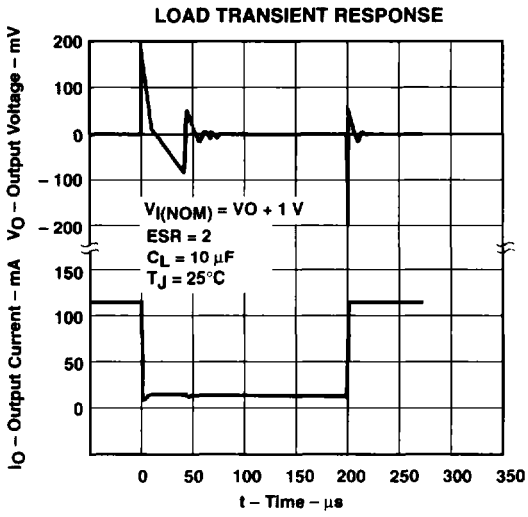


Figure 11

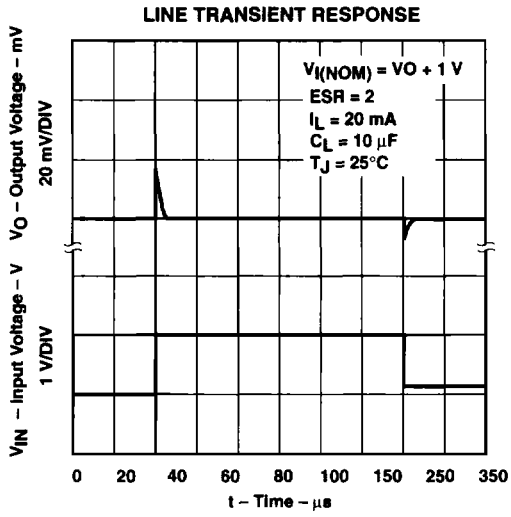


Figure 12