

TL750M, TL751M SERIES LOW-DROPOUT VOLTAGE REGULATORS

SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

- 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 series incorporate onboard overvoltage and current-limiting protection circuitry to protect the devices 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 and TL751M series offers 5-V, 8-V, 10-V, and 12-V options. The TL751M series has the addition of an enable (ENABLE) input. The ENABLE input gives the designer complete control over power up, allowing sequential power up or emergency shutdown. When ENABLE is high, the regulator output is placed in the high-impedance state. The ENABLE input is TTL- and CMOS-compatible.

The TL750MxxC and TL751MxxC are characterized for operation over the virtual junction temperature range 0°C to 125°C.

AVAILABLE OPTIONS

T _J	V _O TYP (V)	PACKAGED DEVICES				CHIP FORM (Y)
		HEAT-SINK MOUNTED (3-PIN) (KC)	PLASTIC FLANGE MOUNT (KTE)	PLASTIC FLANGE MOUNT (KTG)	PLASTIC FLANGE MOUNT (KTP)	
0°C to 125°C	5	TL750M05CKC	TL750M05CKTE	TL751M05CKTG	TL750M05CKTPR	TL750M05Y
	8	TL750M08CKC	TL750M08CKTE	TL751M08CKTG	TL750M08CKTPR	TL750M08Y
	10	TL750M10CKC	TL750M10CKTE	TL751M10CKTG	TL750M10CKTPR	TL750M10Y
	12	TL750M12CKC	TL750M12CKTE	TL751M12CKTG	TL750M12CKTPR	TL750M12Y

The KTE and KTG packages are available taped and reeled. The KTP is only available taped and reeled. Add the suffix R to device type (e.g., TL750M05CKTER). Chip forms are tested at 25°C.



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

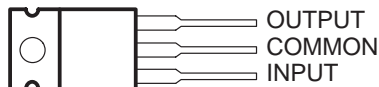
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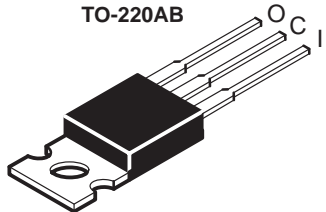
TL750M, TL751M SERIES

SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

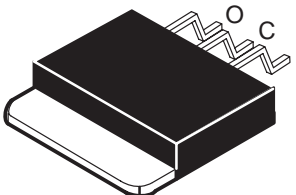
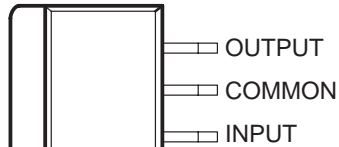
**TL750M . . . KC PACKAGE†
(TOP VIEW)**



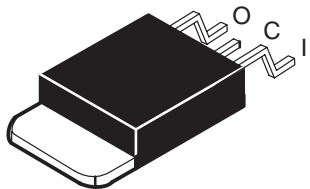
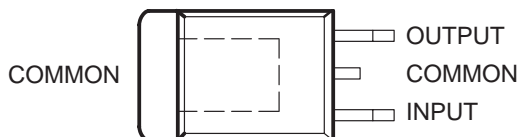
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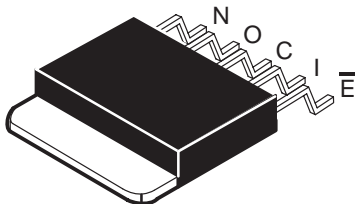
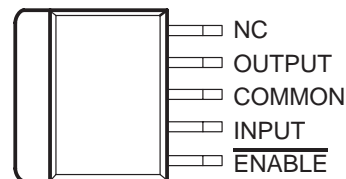
**TL750M . . . KTE PACKAGE†
(TOP VIEW)**



**TL750M . . . KTP PACKAGE†
(TOP VIEW)**



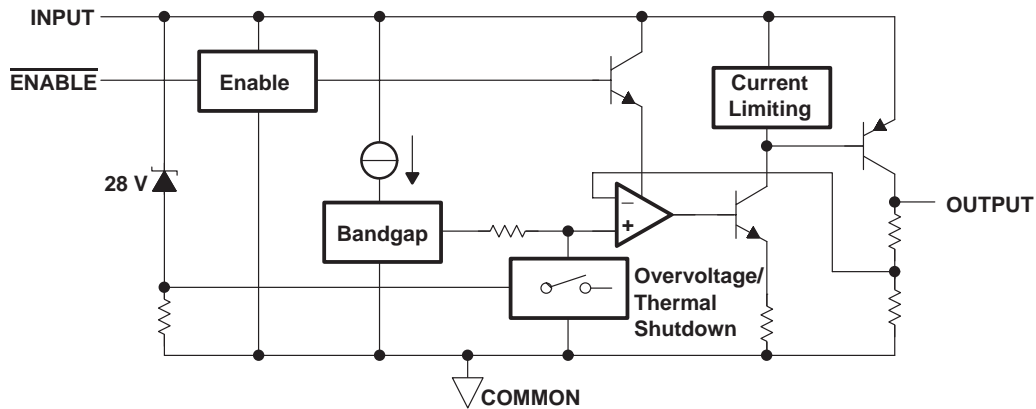
**TL751M... KTG PACKAGE†
(TOP VIEW)**



† The common terminal is in electrical contact with the mounting base.

NC – No internal connection

TL751Mxx functional block diagram



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

TL750M, TL751M SERIES LOW-DROPOUT VOLTAGE REGULATORS

SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

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

Continuous input voltage	26 V
Transient input voltage (see Figure 3)	60 V
Continuous reverse input voltage	–15 V
Transient reverse input voltage: t = 100 ms	–50 V
Package thermal impedance, θ_{JA} (see Notes 1 and 2):	
KC package	22°C/W
KTE package	23°C/W
KTG package	23°C/W
KTP package	28°C/W
Virtual junction temperature range, T_J	0°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C
Storage temperature range, T_{stg}	–65°C to 150°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.

- NOTES: 1. Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can impact reliability. 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.
2. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions

		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	V
Output current range, I_O	TL75xMxxC		750	mA
Operating virtual junction temperature range, T_J	TL75xMxxC	0	125	°C

electrical characteristics, $V_I = 14$ V, $I_O = 300$ mA, $T_J = 25^\circ\text{C}$

PARAMETER	TL751MXXX			UNIT
	MIN	TYP	MAX	
Response time, $\overline{\text{ENABLE}}$ to output		50		μs



TL750M, TL751M SERIES LOW-DROPOUT VOLTAGE REGULATORS

SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

electrical characteristics, $V_I = 14\text{ V}$, $I_O = 300\text{ mA}$, $\overline{\text{ENABLE}}$ at 0 V for TL751M05, $T_J = 25^\circ\text{C}$ (unless otherwise noted) (see Note 3)

PARAMETER	TEST CONDITIONS	TL750M05C TL751M05C			UNIT
		MIN	TYP	MAX	
Output voltage		4.95	5	5.05	V
	$T_J = 0^\circ\text{C to } 125^\circ\text{C}$	4.9		5.1	
Input voltage regulation	$V_I = 9\text{ V to } 16\text{ V}$, $I_O = 250\text{ mA}$		10	25	mV
	$V_I = 6\text{ V to } 26\text{ V}$, $I_O = 250\text{ mA}$		12	50	
Ripple rejection	$V_I = 8\text{ V to } 18\text{ V}$, $f = 120\text{ Hz}$	50	55		dB
Output voltage regulation	$I_O = 5\text{ mA to } 750\text{ mA}$		20	50	mV
Dropout voltage	$I_O = 500\text{ mA}$			0.5	V
	$I_O = 750\text{ mA}$			0.6	
Output noise voltage	$f = 10\text{ Hz to } 100\text{ kHz}$		500		μV
Bias current	$I_O = 750\text{ mA}$		60	75	mA
	$I_O = 10\text{ mA}$			5	
Bias current (TL751M05C and TL751M05Q only)	$\overline{\text{ENABLE}} V_{IH} \geq 2\text{ V}$			200	μA

NOTE 3: 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, $V_I = 14\text{ V}$, $I_O = 300\text{ mA}$, $\overline{\text{ENABLE}}$ at 0 V for TL751M08, $T_J = 25^\circ\text{C}$ (unless otherwise noted) (see Note 3)

PARAMETER	TEST CONDITIONS	TL750M08C TL751M08C			UNIT
		MIN	TYP	MAX	
Output voltage		7.92	8	8.08	V
	$T_J = 0^\circ\text{C to } 125^\circ\text{C}$	7.84		8.16	
Input voltage regulation	$V_I = 10\text{ V to } 17\text{ V}$, $I_O = 250\text{ mA}$		12	40	mV
	$V_I = 9\text{ V to } 26\text{ V}$, $I_O = 250\text{ mA}$		15	68	
Ripple rejection	$V_I = 11\text{ V to } 21\text{ V}$, $f = 120\text{ Hz}$	50	55		dB
Output voltage regulation	$I_O = 5\text{ mA to } 750\text{ mA}$		24	80	mV
Dropout voltage	$I_O = 500\text{ mA}$			0.5	V
	$I_O = 750\text{ mA}$			0.6	
Output noise voltage	$f = 10\text{ Hz to } 100\text{ kHz}$		500		μV
Bias current	$I_O = 750\text{ mA}$		60	75	mA
	$I_O = 10\text{ mA}$			5	
Bias current (TL751Mxx only)	$\overline{\text{ENABLE}} V_{IH} \geq 2\text{ V}$			200	μA

NOTE 3: 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.



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TL750M, TL751M SERIES LOW-DROPOUT VOLTAGE REGULATORS

SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

electrical characteristics, $V_I = 14\text{ V}$, $I_O = 300\text{ mA}$, $\overline{\text{ENABLE}}$ at 0 V for TL751M10, $T_J = 25^\circ\text{C}$ (unless otherwise noted) (see Note 3)

PARAMETER	TEST CONDITIONS	TL750M10C TL751M10C			UNIT
		MIN	TYP	MAX	
Output voltage		9.9	10	10.1	V
	$T_J = 0^\circ\text{C to } 125^\circ\text{C}$	9.8		10.2	
Input voltage regulation	$V_I = 12\text{ V to } 18\text{ V}$, $I_O = 250\text{ mA}$		15	43	mV
	$V_I = 11\text{ V to } 26\text{ V}$, $I_O = 250\text{ mA}$		20	75	
Ripple rejection	$V_I = 13\text{ V to } 23\text{ V}$, $f = 120\text{ Hz}$	50	55		dB
Output voltage regulation	$I_O = 5\text{ mA to } 750\text{ mA}$		30	100	mV
Dropout voltage	$I_O = 500\text{ mA}$			0.5	V
	$I_O = 750\text{ mA}$			0.6	
Output noise voltage	$f = 10\text{ Hz to } 100\text{ kHz}$		1000		μV
Bias current	$I_O = 750\text{ mA}$		60	75	mA
	$I_O = 10\text{ mA}$			5	
Bias current (TL751Mxx only)	$\overline{\text{ENABLE}} V_{IH} \geq 2\text{ V}$			200	μA

NOTE 3: 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, $V_I = 14\text{ V}$, $I_O = 300\text{ mA}$, $\overline{\text{ENABLE}}$ at 0 V for TL751M12, $T_J = 25^\circ\text{C}$ (unless otherwise noted) (see Note 3)

PARAMETER	TEST CONDITIONS	TL750M12C TL751M12C			UNIT
		MIN	TYP	MAX	
Output voltage		11.88	12	12.12	V
	$T_J = 0^\circ\text{C to } 125^\circ\text{C}$	11.76		12.24	
Input voltage regulation	$V_I = 14\text{ V to } 19\text{ V}$, $I_O = 250\text{ mA}$		15	43	mV
	$V_I = 13\text{ V to } 26\text{ V}$, $I_O = 250\text{ mA}$		20	78	
Ripple rejection	$V_I = 13\text{ V to } 23\text{ V}$, $f = 120\text{ Hz}$	50	55		dB
Output voltage regulation	$I_O = 5\text{ mA to } 750\text{ mA}$		30	120	mV
Dropout voltage	$I_O = 500\text{ mA}$			0.5	V
	$I_O = 750\text{ mA}$			0.6	
Output noise voltage	$f = 10\text{ Hz to } 100\text{ kHz}$		1000		μV
Bias current	$I_O = 750\text{ mA}$		60	75	mA
	$I_O = 10\text{ mA}$			5	
Bias current (TL751Mxx only)	$\overline{\text{ENABLE}} V_{IH} \geq 2\text{ V}$			200	μA

NOTE 3: 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.



TL750M, TL751M SERIES

LOW-DROPOUT VOLTAGE REGULATORS

SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

electrical characteristics, $V_I = 14\text{ V}$, $I_O = 300\text{ mA}$, $\overline{\text{ENABLE}}$ at 0 V , $T_J = 25^\circ\text{C}$ (unless otherwise noted) (see Note 3)

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

NOTE 3: 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 $0.1\text{-}\mu\text{F}$ capacitor across the input and a $10\text{-}\mu\text{F}$ tantalum capacitor on the output, with equivalent series resistance within the guidelines shown in Figure 3.

electrical characteristics, $V_I = 14\text{ V}$, $I_O = 300\text{ mA}$, $\overline{\text{ENABLE}}$ at 0 V , $T_J = 25^\circ\text{C}$ (unless otherwise noted) (see Note 3)

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

NOTE 3: 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 $0.1\text{-}\mu\text{F}$ capacitor across the input and a $10\text{-}\mu\text{F}$ tantalum capacitor on the output, with equivalent series resistance within the guidelines shown in Figure 3.

electrical characteristics, $V_I = 14\text{ V}$, $I_O = 300\text{ mA}$, $\overline{\text{ENABLE}}$ at 0 V , $T_J = 25^\circ\text{C}$ (unless otherwise noted) (see Note 3)

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

NOTE 3: 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 $0.1\text{-}\mu\text{F}$ capacitor across the input and a $10\text{-}\mu\text{F}$ tantalum capacitor on the output, with equivalent series resistance within the guidelines shown in Figure 3.



TL750M, TL751M SERIES LOW-DROPOUT VOLTAGE REGULATORS

SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

TL751M12Y electrical characteristics, $V_I = 14\text{ V}$, $I_O = 300\text{ mA}$, $\overline{\text{ENABLE}}$ at 0 V , $T_J = 25^\circ\text{C}$ (unless otherwise noted) (see Note 3)

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

NOTE 3: 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 $0.1\text{-}\mu\text{F}$ capacitor across the input and a $10\text{-}\mu\text{F}$ 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 1 and 2 can establish the capacitance value and ESR range for the best regulator performance.

Figure 1 shows the recommended range of ESR for a given load with a $10\text{-}\mu\text{F}$ capacitor on the output. This figure also shows a maximum ESR limit of $2\ \Omega$ and a load-dependent minimum ESR limit.

For applications with varying loads, the lightest load condition should be chosen because it is the worst case. Figure 2 shows the relationship of the reciprocal of ESR to the square root of the capacitance with a minimum capacitance limit of $10\ \mu\text{F}$ and a maximum ESR limit of $2\ \Omega$. This figure establishes the amount that the minimum ESR limit shown in Figure 1 can be adjusted for different capacitor values. For example, where the minimum load needed is 200 mA , Figure 2 suggests an ESR range of $0.8\ \Omega$ to $2\ \Omega$ for $10\ \mu\text{F}$. Figure 2 shows that changing the capacitor from $10\ \mu\text{F}$ to $400\ \mu\text{F}$ can change the ESR minimum by greater than $3/0.5$ (or 6). Therefore, the new minimum ESR value is $0.8/6$ (or $0.13\ \Omega$). This allows an ESR range of $0.13\ \Omega$ to $2\ \Omega$, 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 1 and 2.

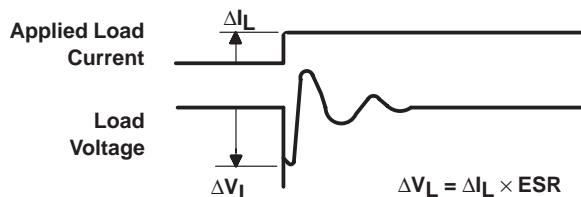
TL750M, TL751M SERIES LOW-DROPOUT VOLTAGE REGULATORS

SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

PARAMETER MEASUREMENT INFORMATION

Table 1. Compensation 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



OUTPUT CAPACITOR
EQUIVALENT SERIES RESISTANCE (ESR)
vs
LOAD CURRENT RANGE

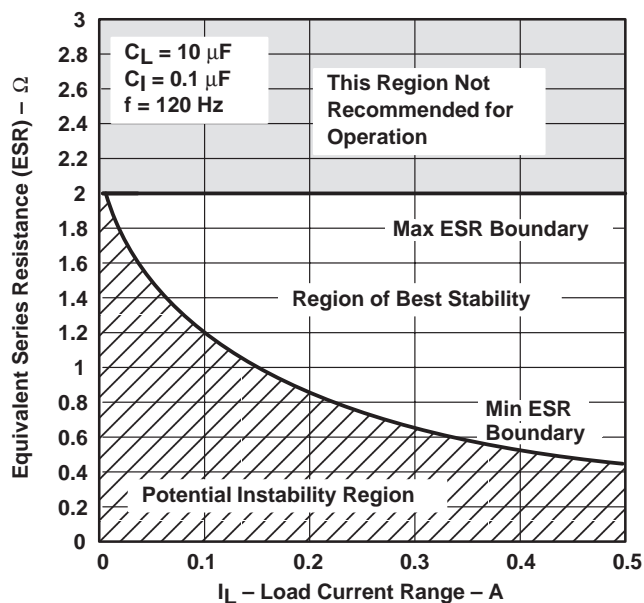


Figure 1

STABILITY
vs
EQUIVALENT SERIES RESISTANCE (ESR)

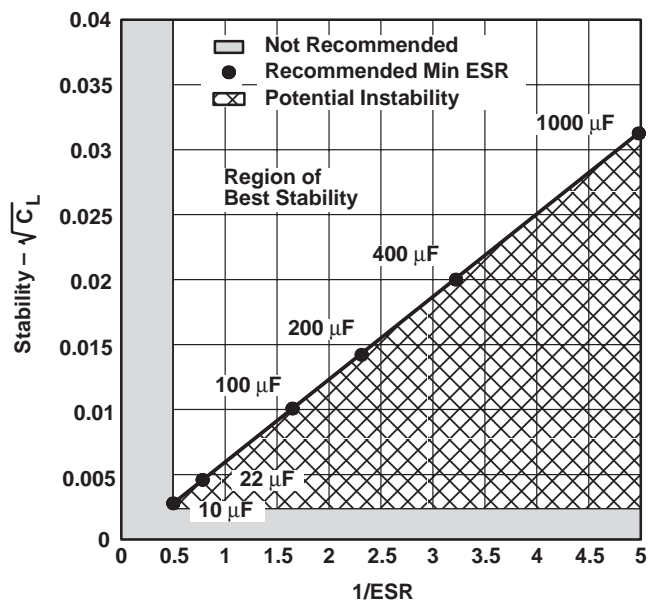


Figure 2

TYPICAL CHARACTERISTICS

Table of Graphs

		FIGURE
Transient input voltage vs Time		3
Output voltage vs Input voltage		4
Input current vs Input voltage	$I_O = 10 \text{ mA}$	5
	$I_O = 100 \text{ mA}$	6
Dropout voltage vs Output current		7
Quiescent current vs Output current		8
Load transient response		9
Line transient response		10

TRANSIENT INPUT VOLTAGE
vs
TIME

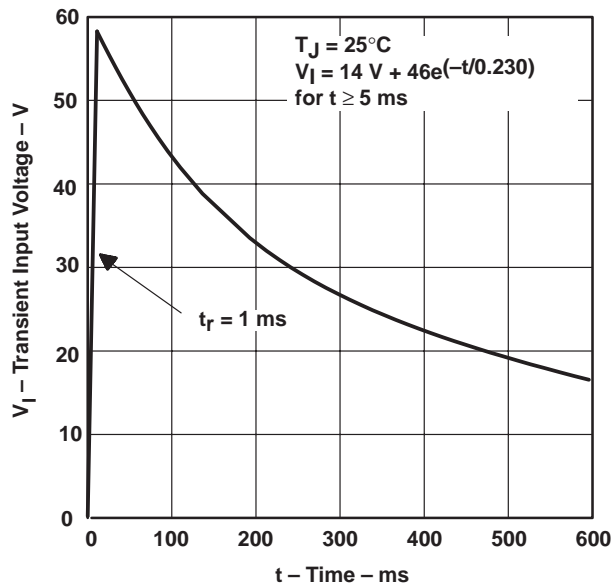


Figure 3

OUTPUT VOLTAGE
vs
INPUT VOLTAGE

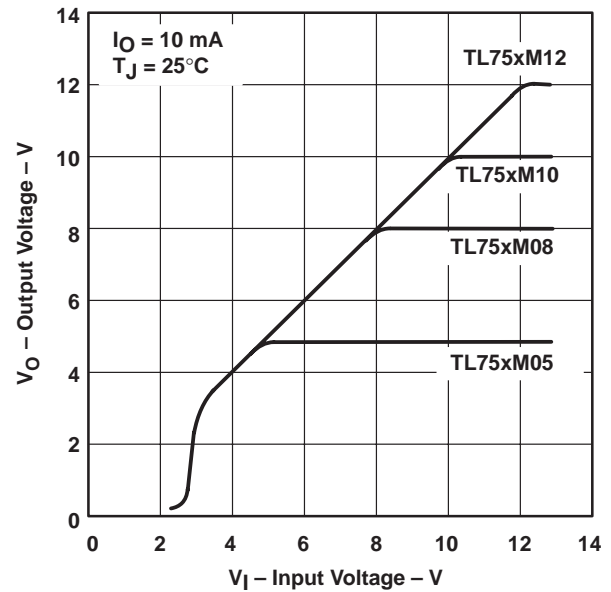


Figure 4

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SLVS021H – JANUARY 1988 – REVISED JANUARY 2000

TYPICAL CHARACTERISTICS

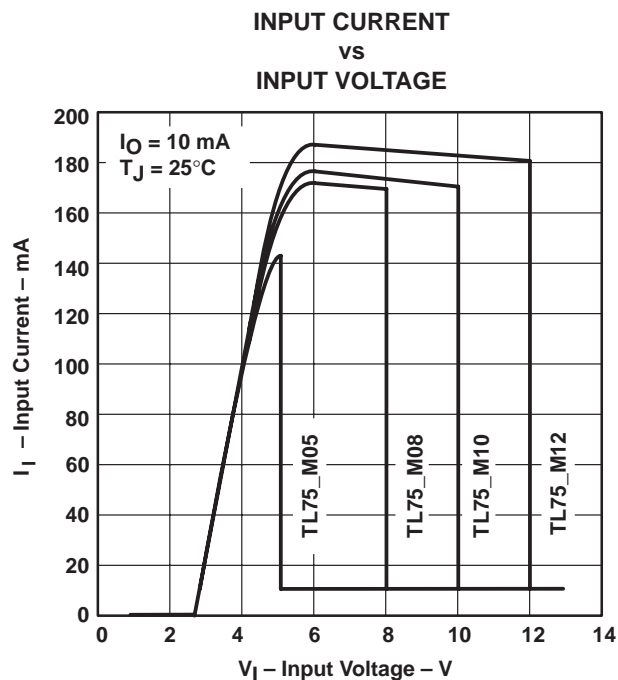


Figure 5

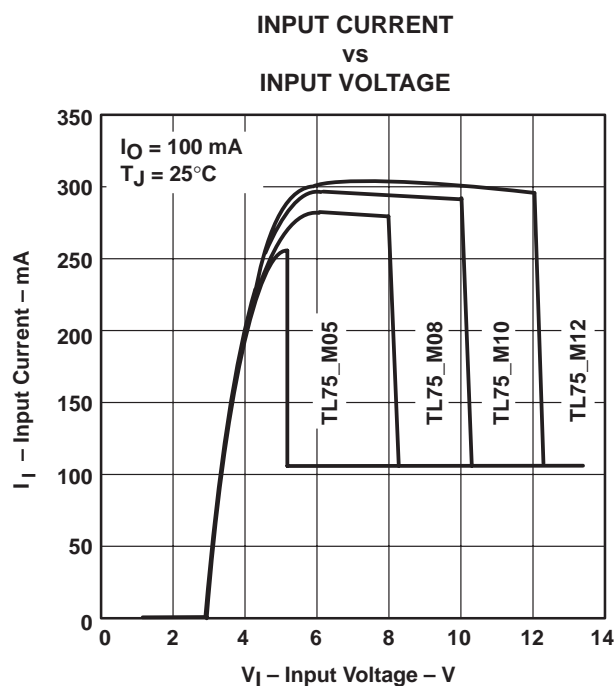


Figure 6

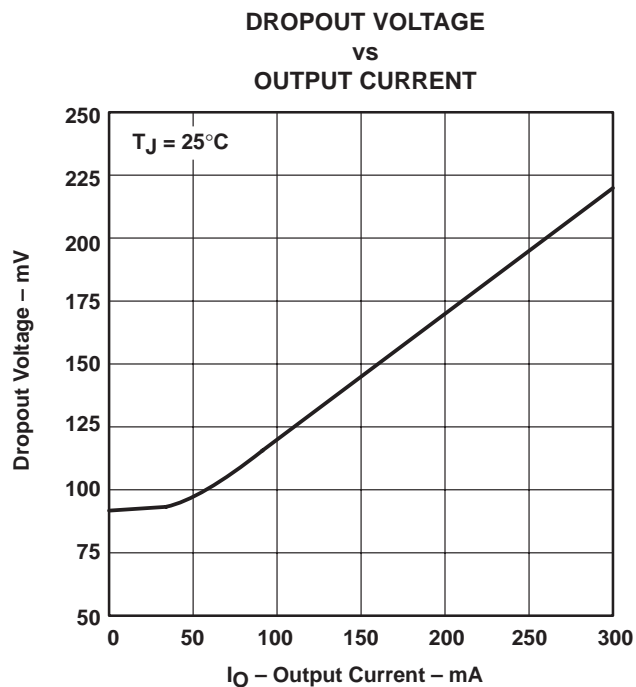


Figure 7

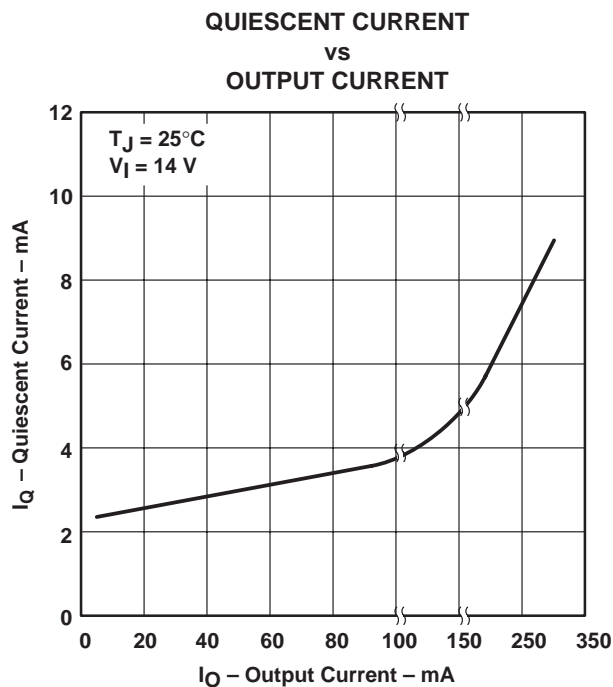


Figure 8

TYPICAL CHARACTERISTICS

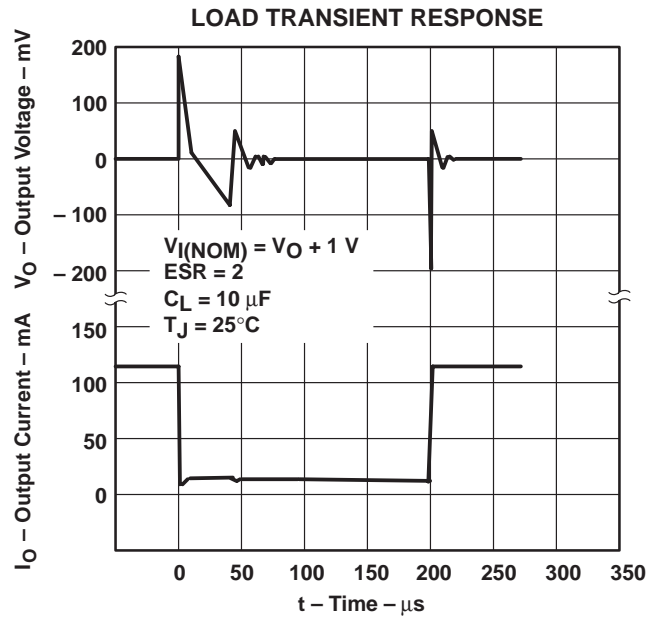


Figure 9

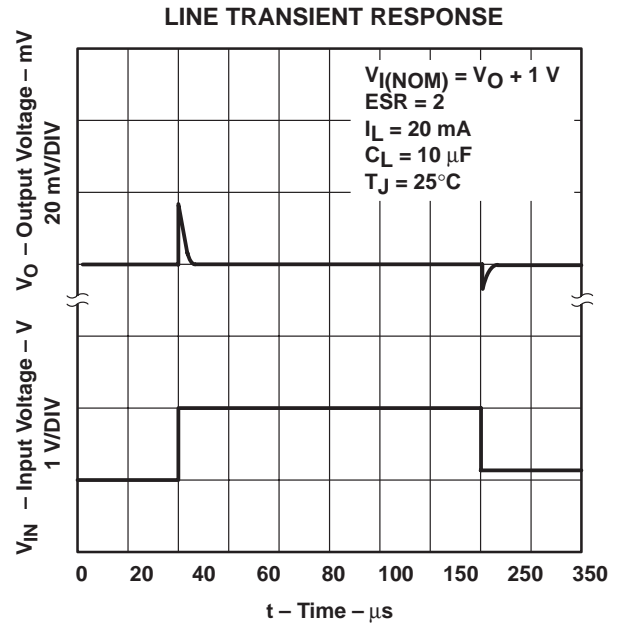


Figure 10

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TL750M05CKC	ACTIVE	TO-220	KC	3	50	None	Call TI	Level-1-220C-UNLIM
TL750M05CKTER	ACTIVE	PFM	KTE	3	2000	None	Call TI	Level-1-220C-UNLIM
TL750M05CKTPR	ACTIVE	PFM	KTP	2	3000	None	Call TI	Level-1-220C-UNLIM
TL750M10CKC	PREVIEW	TO-220	KC	3	50	None	Call TI	Level-1-220C-UNLIM
TL750M12CKC	PREVIEW	TO-220	KC	3	50	None	Call TI	Call TI
TL751M05CKTGR	PREVIEW	PFM	KTG	5	2000	None	Call TI	Level-1-220C-UNLIM

⁽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 - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

None: Not yet available Lead (Pb-Free).

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.

Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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