

LM125/LM325/LM325A, LM126/LM326 Voltage Regulators

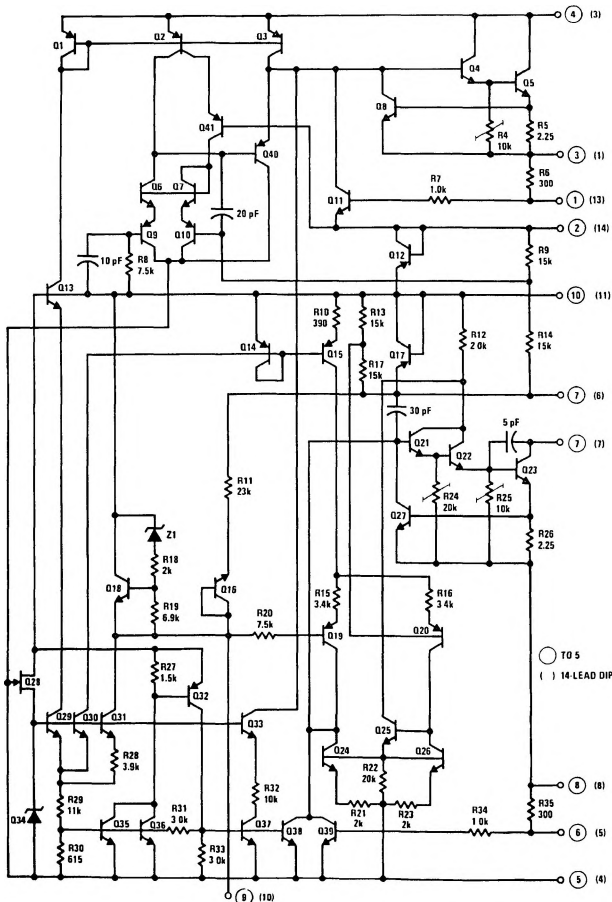
General Description

These are dual polarity tracking regulators designed to provide balanced positive and negative output voltages at current up to 100 mA, the devices are set for $\pm 15\text{V}$ and $\pm 12\text{V}$ outputs respectively. Input voltages up to $\pm 30\text{V}$ can be used and there is provision for adjustable current limiting. These devices are available in three package types to accommodate various power requirements and temperature ranges.

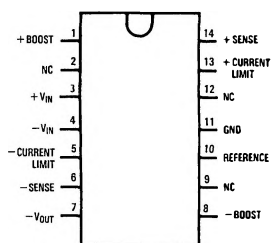
Features

- $\pm 15\text{V}$ and $\pm 12\text{V}$ tracking outputs
- Output current to 100 mA
- Output voltage balanced to within 1% (LM125, LM126, LM325A)
- Line and load regulation of 0.06%
- Internal thermal overload protection
- Standby current drain of 3 mA
- Externally adjustable current limit
- Internal current limit

Schematic and Connection Diagrams



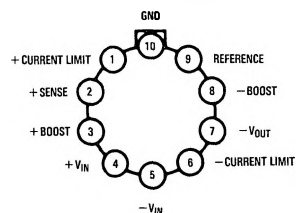
Dual-In-Line Package



Top View

Order Number LM325AN,
LM325N or LM326N
See NS Package Number N14A

Metal Can Package



Case connected to $-V_{IN}$ TL/H/7776-3

Top View

Order Number LM125H,
LM325H, LM126H or LM326H
See NS Package Number H10C

TL/H/7776-1

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/Distributors for availability and specifications.

(Note 5)

Input Voltage	±30V
Forced V_{O+} (Min) (Note 1)	−0.5V
Forced V_{O-} (Max) (Note 1)	+0.5V
Power Dissipation (Note 2)	P_{MAX}
Output Short-Circuit Duration (Note 3)	Indefinite

Operating Conditions

Operating Free Temperature Range	
LM125	−55°C to +125°C
LM325, LM325A	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	300°C

Electrical Characteristics LM125/LM325/LM325A (Note 2)

Parameter	Conditions	Min	Typ	Max	Units
Output Voltage LM125/LM325A LM325	$T_j = 25^\circ\text{C}$	14.8 14.5	15 15	15.2 15.5	V V
Input-Output Differential		2.0			V
Line Regulation	$V_{IN} = 18\text{V to } 30\text{V}$, $I_L = 20\text{ mA}$, $T_j = 25^\circ\text{C}$		2.0	10	mV
Line Regulation Over Temperature Range	$V_{IN} = 18\text{V to } 30\text{V}$, $I_L = 20\text{ mA}$,		2.0	20	mV
Load Regulation V_{O+} V_{O-}	$I_L = 0\text{ to } 50\text{ mA}$, $V_{IN} = \pm 30\text{V}$, $T_j = 25^\circ\text{C}$		3.0 5.0	10 10	mV mV
Load Regulation Over Temperature Range V_{O+} V_{O-}	$I_L = 0\text{ to } 50\text{ mA}$, $V_{IN} = \pm 30\text{V}$		4.0 7.0	20 20	mV mV
Output Voltage Balance LM125, LM325A LM325	$T_j = 25^\circ\text{C}$			±150 ±300	mV mV
Output Voltage Over Temperature Range LM125, LM325A LM325	$P \leq P_{MAX}$, $0 \leq I_O \leq 50\text{ mA}$, $18\text{V} \leq V_{IN} \leq 30$	14.65 14.27		15.35 15.73	V V
Temperature Stability of V_O			±0.3		%
Short Circuit Current Limit	$T_j = 25^\circ\text{C}$		260		mA
Output Noise Voltage	$T_j = 25^\circ\text{C}$, BW = 100 – 10 kHz		150		μVrms
Positive Standby Current	$T_j = 25^\circ\text{C}$		1.75	3.0	mA
Negative Standby Current	$T_j = 25^\circ\text{C}$		3.1	5.0	mA
Long Term Stability			0.2		%/kHr
Thermal Resistance Junction to Case (Note 4) LM125H, LM325H Junction to Ambient Junction to Ambient	(Still Air) (400 Lf/min Air Flow)		20 215 82		°C/W °C/W °C/W
Junction to Ambient LM325AN, LM325N	(Still Air)		90		°C/W

Note 1: That voltage to which the output may be forced without damage to the device.

Note 2: Unless otherwise specified these specifications apply for $T_j = 55^\circ\text{C}$ to $+150^\circ\text{C}$ on LM125, $T_j = 0^\circ\text{C}$ to $+125^\circ\text{C}$ on LM325A, $T_j = 0^\circ\text{C}$ to $+125^\circ\text{C}$ on LM325, $V_{IN} = \pm 20\text{V}$, $I_L = 0\text{ mA}$, $I_{MAX} = 100\text{ mA}$, $P_{MAX} = 2.0\text{W}$ for the TO-5 H Package. $I_{MAX} = 100\text{ mA}$, $P_{MAX} = 1.0\text{W}$ for the DIP N Package.

Note 3: If the junction temperature exceeds 150°C , the output short circuit duration is 60 seconds.

Note 4: Without a heat sink, the thermal resistance junction to ambient of the TO-5 Package is about 215°C/W . With a heat sink, the effective thermal resistance can only approach the junction to case values specified, depending on the efficiency of the sink.

Note 5: Refer to RETS125X drawing for military specification of LM125.

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/Distributors for availability and specifications.

(Note 5)

Input Voltage	± 30V
Forced V_{O+} (Min) (Note 1)	− 0.5V
Forced V_{O-} (Max) (Note 1)	+ 0.5V
Power Dissipation (Note 2)	Internally Limited
Output Short-Circuit Duration (Note 3)	Indefinite

Operating Conditions

Operating Free Temperature Range

LM126

− 55°C to + 125°C

LM326

0°C to + 70°C

Storage Temperature Range

− 65°C to + 150°C

Lead Temperature (Soldering, 10 sec.)

300°C

Electrical Characteristics LM126/LM326 (Note 2)

Parameter	Conditions	Min	Typ	Max	Units
Output Voltage LM126/LM326	$T_j = 25^\circ\text{C}$	11.8 11.5	12	12.2 12.5	V V
Input-Output Differential		2.0			V
Line Regulation	$V_{IN} = 15\text{V to } 30\text{V}$ $I_L = 20\text{ mA}, T_j = 25^\circ\text{C}$		2.0	10	mV
Line Regulation Over Temperature Range	$V_{IN} = 15\text{V to } 30\text{V}, I_L = 20\text{ mA}$		2.0	20	mV
Load Regulation V_{O+} V_{O-}	$I_L = 0\text{ to } 50\text{ mA}, V_{IN} = \pm 30\text{V},$ $T_j = 25^\circ\text{C}$		3.0 5.0	10 10	mV mV
Load Regulation Over Temperature Range V_{O+} V_{O-}	$I_L = 0\text{ to } 50\text{ mA}, V_{IN} = \pm 30\text{V}$		4.0 7.0	20 20	mV mV
Output Voltage Balance LM126, LM326	$T_j = 25^\circ\text{C}$			± 125 ± 250	mV mV
Output Voltage Over Temperature Range LM126 LM326	$P \leq P_{MAX}, 0 \leq I_O \leq 50\text{ mA},$ $15\text{V} \leq V_{IN} \leq 30$	11.68 11.32		12.32 12.68	V V
Temperature Stability of V_O			± 0.3		%
Short Circuit Current Limit	$T_j = 25^\circ\text{C}$		260		mA
Output Noise Voltage	$T_j = 25^\circ\text{C}, BW = 100 - 10\text{ kHz}$		100		μVrms
Positive Standby Current	$T_j = 25^\circ\text{C}, I_L = 0$		1.75	3.0	mA
Negative Standby Current	$T_j = 25^\circ\text{C}, I_L = 0$		3.1	5.0	mA
Long Term Stability			0.2		%/kHr
Thermal Resistance Junction to Case (Note 4) LM126H, LM326H Junction to Ambient Junction to Ambient	(Still Air) (400 Lf/min Air Flow)		20 215 82		°C/W °C/W °C/W
Junction to Ambient LM326N			150		°C/W

Note 1: That voltage to which the output may be forced without damage to the device.

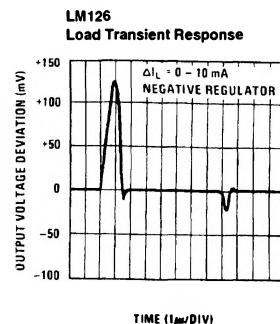
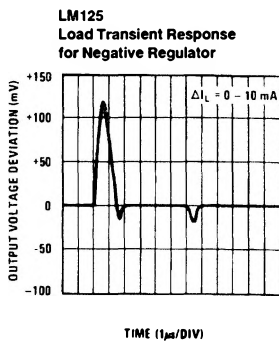
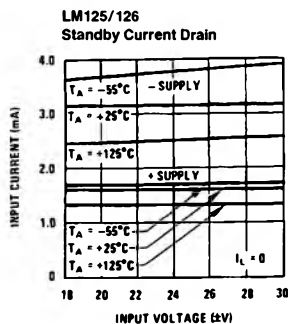
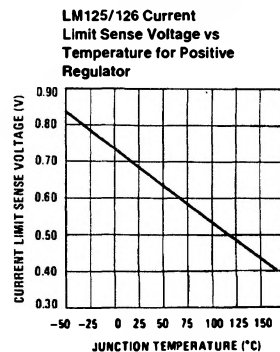
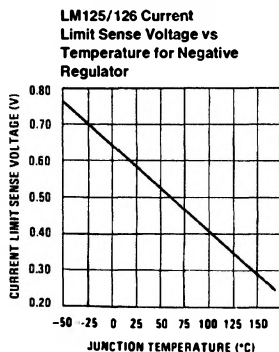
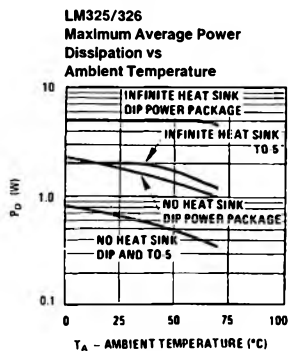
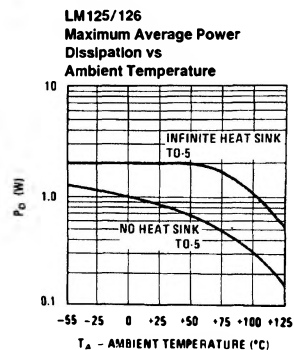
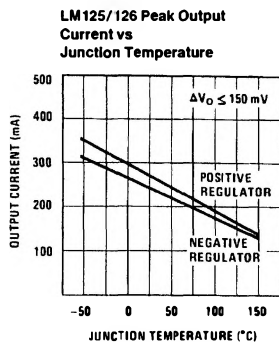
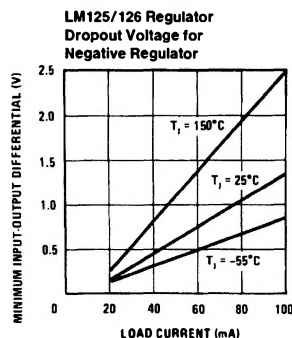
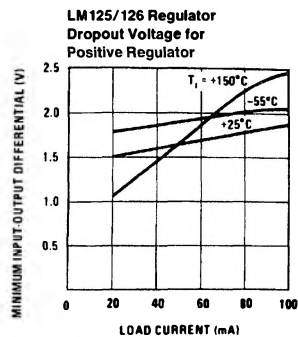
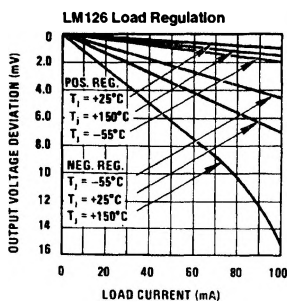
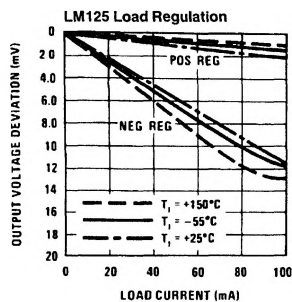
Note 2: Unless otherwise specified these specifications apply for $T_j = 55^\circ\text{C}$ to + 150°C on LM126, $T_j = 0^\circ\text{C}$ to + 125°C on LM326, $V_{IN} = \pm 20\text{V}$, $I_L = 0\text{ mA}$, $I_{MAX} = 100\text{ mA}$, $P_{MAX} = 2.0\text{W}$ for the TO-5 H Package, $I_{MAX} = 100\text{ mA}$, $P_{MAX} = 1.0\text{W}$ for the DIP N Package.

Note 3: If the junction temperature exceeds 150°C, the output short circuit duration is 60 seconds.

Note 4: Without a heat sink, the thermal resistance junction to ambient of the TO-5 Package is about 215°C/W. With a heat sink, the effective thermal resistance can only approach the junction to case values specified, depending on the efficiency of the sink.

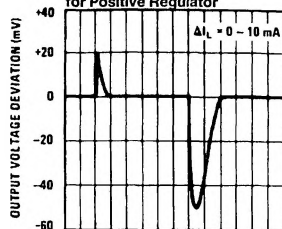
Note 5: Refer to RETS126X drawing for military specification of LM126.

Typical Performance Characteristics

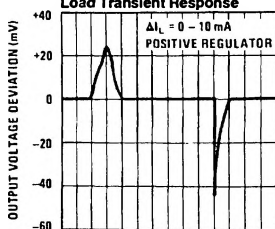


Typical Performance Characteristics (Continued)

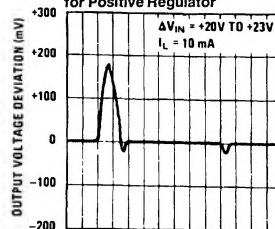
LM125
Load Transient Response
for Positive Regulator

TIME (1 μ s/DIV)

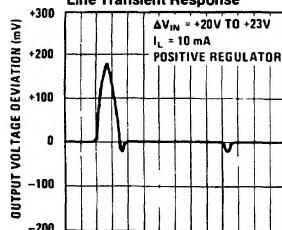
LM126
Load Transient Response

TIME (2 μ s/DIV)

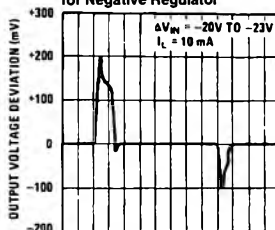
LM125
Line Transient Response
for Positive Regulator

TIME (2 μ s/DIV)

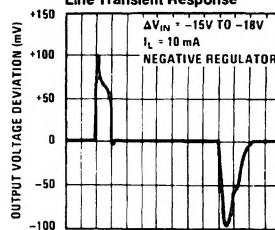
LM126
Line Transient Response

TIME (2 μ s/DIV)

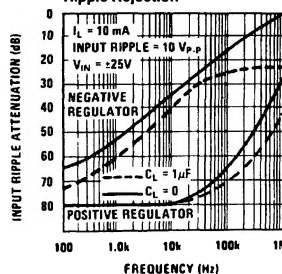
LM125
Line Transient Response
for Negative Regulator

TIME (10 μ s/DIV)

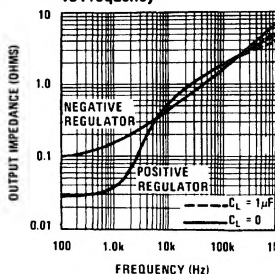
LM126
Line Transient Response

TIME (15 μ s/DIV)

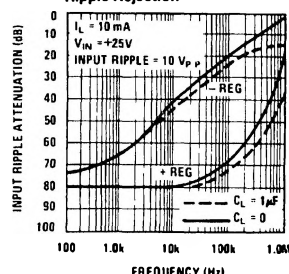
LM125
Ripple Rejection



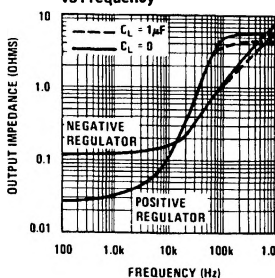
LM126
Output Impedance
vs Frequency



LM126
Ripple Rejection



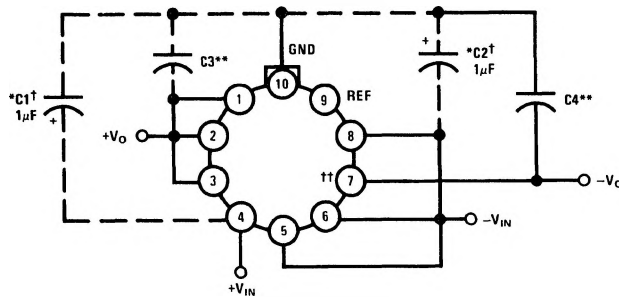
LM126
Output Impedance
vs Frequency



TL/H/7776-5

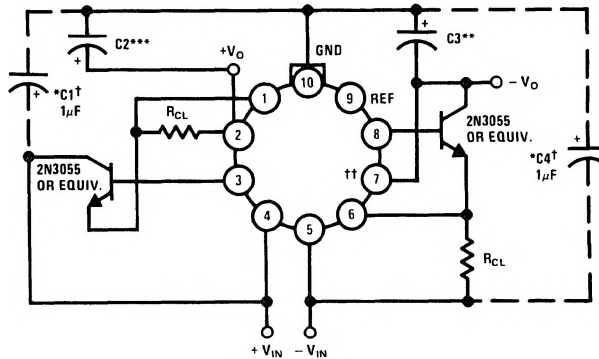
Typical Applications

Basic Regulator†††



TL/H/7776-6

2.0 Amp Boosted Regulator With Current Limit



TL/H/7776-7

Note: Metal can (H) packages shown.

$$I_{CL} = \frac{\text{Current Limit Sense Voltage (See Curve)}}{R_{CL}}$$

†Solid tantalum

††Short pins 6 and 7 on dip

††† R_{CL} can be added to the basic regulator between pins 6 and 5, 1 and 2 to reduce current limit.

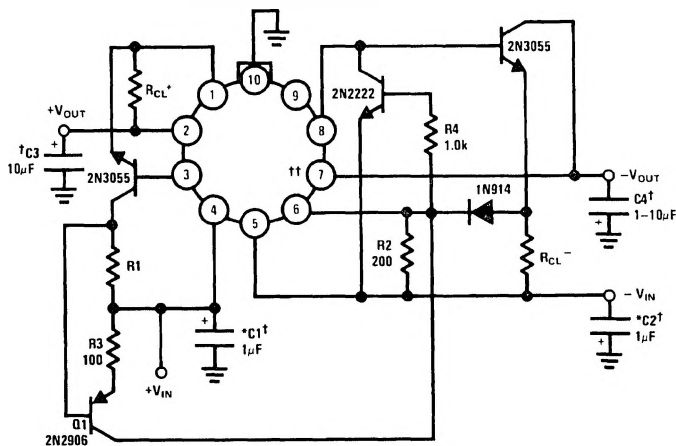
*Required if regulator is located an appreciable distance from power supply filter.

**Although no capacitor is needed for stability, it does help transient response. (If needed use 1 μ F electrolytic).

***Although no capacitor is needed for stability, it does help transient response. (If needed use 10 μ F electrolytic).

Typical Applications (Continued)

Positive Current Dependent Simultaneous Current Limiting



TL/H/7776-8

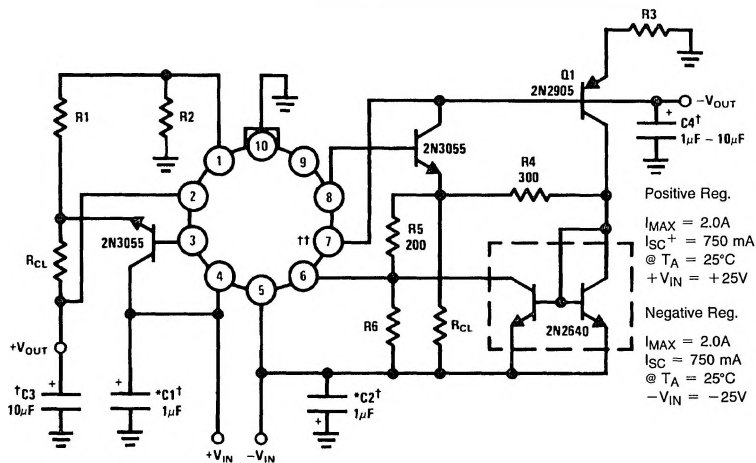
$$I_{CL}^+ = \frac{\frac{V_{SENSE\ NEG}}{2} + V_{BEQ1}}{R1}$$

$$I_{CL}^+ = \frac{V_{SENSE\ NEG} + V_{DIODE}}{R_{CL}^-}$$

I_{CL}^+ Controls Both Sides of the Regulator.

$$R_{CL}^+ = \frac{V_{SENSE}^+}{1.1 I_{CL}^+}$$

Boosted Regulator With Foldback Current Limit



Resistor Values

	125	126
R1	18	20
R2	310	180
R3	2.4k	1.35k
R6	300	290
RCL	0.7	0.9

Positive Reg.

$I_{MAX} = 2.0A$
 $I_{SC}^+ = 750\text{ mA}$
 @ $T_A = 25^\circ C$
 $+V_{IN} = +25V$

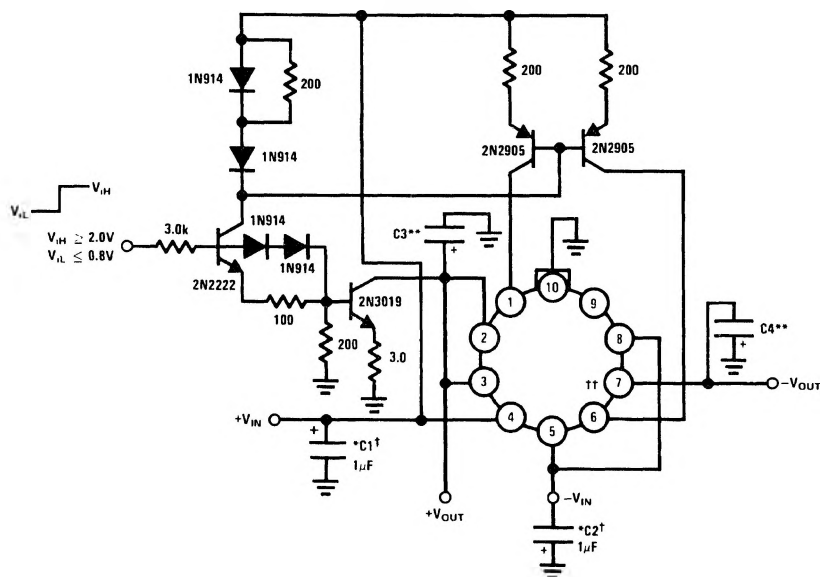
Negative Reg.

$I_{MAX} = 2.0A$
 $I_{SC} = 750\text{ mA}$
 @ $T_A = 25^\circ C$
 $-V_{IN} = -25V$

TL/H/7776-9

Typical Applications (Continued)

Electric Shutdown



TL/H/7776-10

†Solid tantalum

††Short pins 6 and 7 on dip

*Required if regulator is located an appreciable distance from power supply filter.

****Although no capacitor is needed for stability, it does help transient response. (If needed use 1 μ F electrolytic).**