

LM105/LM305/LM305A Voltage Regulators

General Description

The LM105 series are positive voltage regulators similar to the LM100, except that an extra gain stage has been added for improved regulation. A redesign of the biasing circuitry removes any minimum load current requirement and at the same time reduces standby current drain, permitting higher voltage operation. They are direct, plug-in replacements for the LM100 in both linear and switching regulator circuits with output voltages greater than 4.5V. Important characteristics of the circuits are:

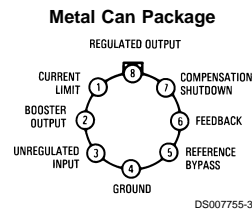
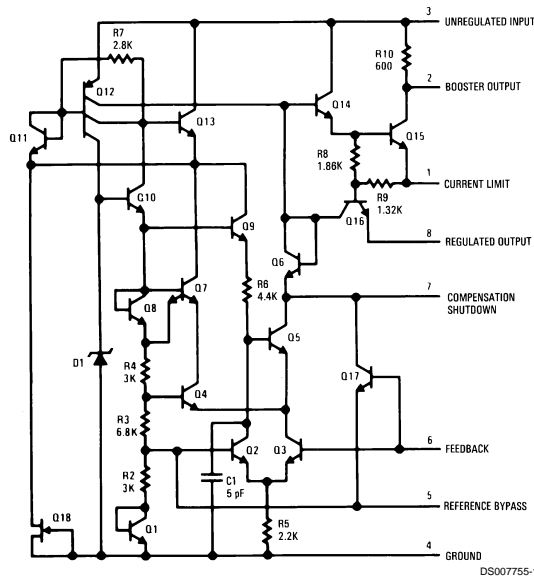
- Output voltage adjustable from 4.5V to 40V
- Output currents in excess of 10A possible by adding external transistors
- Load regulation better than 0.1%, full load with current limiting

- DC line regulation guaranteed at 0.03%/V
- Ripple rejection on 0.01%V
- 45 mA output current without external pass transistor (LM305A)

Like the LM100, they also feature fast response to both load and line transients, freedom from oscillations with varying resistive and reactive loads and the ability to start reliably on any load within rating. The circuits are built on a single silicon chip and are supplied in a TO-99 metal can.

The LM105 is specified for operation for $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$, and the LM305/LM305A is specified for $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$.

Schematic and Connection Diagrams



Top View
Order Number LM105H, LM105H/883,
SMD #5962-8958801, LM305H or LM305AH
See NS Package Number H08C

Absolute Maximum Ratings (Note 1)

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

(Note 5)

| | LM105 | LM305 | LM305A |
|--|-----------------|----------------|-----------------|
| Input Voltage | 50V | 40V | 50V |
| Input-Output Differential | 40V | 40V | 40V |
| Power Dissipation (Note 1) | 800 mW | 800 mW | 800 mW |
| Operating Temperature Range | -55°C to +125°C | 0°C to +70°C | 0°C to +70°C |
| Storage Temperature Range | -65°C to +150°C | 65°C to +150°C | -65°C to +150°C |
| Lead Temperature (Soldering, 10 seconds) | 300°C | 300°C | 300°C |

Electrical Characteristics (Note 2)

| Parameter | Conditions | LM105 | | | LM305 | | | LM305A | | | Units | |
|-----------------------------------|--|--|-------|------|-------|---------------------------------|------|---------------------------------|-------|------|-------|---|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | | |
| Input Voltage Range | | 8.5 | | 50 | 8.5 | | 40 | 8.5 | | 50 | V | |
| Output Voltage Range | | 4.5 | | 40 | 4.5 | | 30 | 4.5 | | 40 | V | |
| Input-Output Voltage Differential | | 3.0 | | 30 | 3.0 | | 30 | 3.0 | | 30 | V | |
| Load Regulation (Note 3) | $R_{SC} = 10\Omega, T_A = 25^\circ\text{C}$ | | 0.02 | 0.05 | | 0.02 | 0.05 | | | | % | |
| | $R_{SC} = 10\Omega, T_A = T_{A(\text{MAX})}$ | | 0.03 | 0.1 | | 0.03 | 0.1 | | | | % | |
| | $R_{SC} = 10\Omega, T_A = T_{A(\text{MIN})}$ | | 0.03 | 0.1 | | 0.03 | 0.1 | | | | % | |
| | | $0 \leq I_O \leq 12 \text{ mA}$ | | | | $0 \leq I_O \leq 12 \text{ mA}$ | | | | | | |
| | | $R_{SC} = 0\Omega, T_A = 25^\circ\text{C}$ | | | | | | | 0.02 | 0.2 | | % |
| | | $R_{SC} = 0\Omega, T_A = 70^\circ\text{C}$ | | | | | | | 0.03 | 0.4 | | % |
| | | $R_{SC} = 0\Omega, T_A = 0^\circ\text{C}$ | | | | | | | 0.03 | 0.4 | | % |
| | | | | | | | | $0 \leq I_O \leq 45 \text{ mA}$ | | | | |
| Line Regulation | $T_A = 25^\circ\text{C}$ | | | | | | | | | | %/V | |
| | $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ | | | | | | | | | | %/V | |
| | $V_{IN} - V_{OUT} \leq 5\text{V}, T_A = 25^\circ\text{C}$ | | 0.025 | 0.06 | | 0.025 | 0.06 | | 0.025 | 0.06 | %/V | |
| | $V_{IN} - V_{OUT} \geq 5\text{V}, T_A = 25^\circ\text{C}$ | | 0.015 | 0.03 | | 0.015 | 0.03 | | 0.015 | 0.03 | %/V | |
| Temperature Stability | $T_{A(\text{MIN})} \leq T_A \leq T_{A(\text{MAX})}$ | | 0.3 | 1.0 | | 0.3 | 1.0 | | 0.3 | 1.0 | % | |
| Feedback Sense Voltage | | 1.63 | 1.7 | 1.81 | 1.63 | 1.7 | 1.81 | 1.55 | 1.7 | 1.85 | V | |
| Output Noise Voltage | $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$ | | | | | | | | | | | |
| | $C_{REF} = 0$ | | 0.005 | | | 0.005 | | | 0.005 | | % | |
| | $C_{REF} = 0.1 \mu\text{F}$ | | 0.002 | | | 0.002 | | | 0.002 | | % | |
| Standby Current Drain | $V_{IN} = 30\text{V}, T_A = 25^\circ\text{C}$ | | | | | | | | | | mA | |
| | $V_{IN} = 40\text{V}$ | | | | | 0.8 | 2.0 | | | | mA | |
| | $V_{IN} = 50\text{V}$ | | 0.8 | 2.0 | | | | | 0.8 | 2.0 | mA | |
| Current Limit Sense Voltage | $T_A = 25^\circ\text{C}, R_{SC} = 10\Omega, V_{OUT} = 0\text{V}, (\text{Note } 4)$ | 225 | 300 | 375 | 225 | 300 | 375 | 225 | 300 | 375 | mV | |
| Long Term Stability | | | 0.1 | | | 0.1 | | | 0.1 | | % | |
| Ripple Rejection | $C_{REF} = 10 \mu\text{F}, f = 120 \text{ Hz}$ | | 0.003 | | | 0.003 | | | 0.003 | | %/V | |
| θ_{JA} | TO-99 Board Mount in Still Air | | 230 | | | 230 | | | 230 | | °C/W | |
| θ_{JA} | TO-99 Board Mount in 400 LF/Min Air Flow | | 92 | | | 92 | | | 92 | | °C/W | |
| θ_{JC} | TO-99 | | 25 | | | 25 | | | 25 | | °C/W | |

Electrical Characteristics (Note 2) (Continued)

Note 1: The maximum junction temperature of the LM105 and LM305A is 150°C, and the LM305 is 85°C. For operation at elevated temperatures, devices in the H08C package must be derated based on a thermal resistance of 168°C/W junction to ambient, or 25°C/W junction to case. Peak dissipations of 1W are allowable providing the dissipation rating is not exceeded with the power average over a five second interval for the LM105 and averaged over a two second interval for the LM305.

Note 2: Unless otherwise specified, these specifications apply for temperatures within the operating temperature range, for input and output voltages within the range given, and for a divider impedance seen by the feedback terminal of 2 kΩ. Load and line regulation specifications are for a constant junction temperature. Temperature drift effects must be taken into account separately when the unit is operating under conditions of high dissipation.

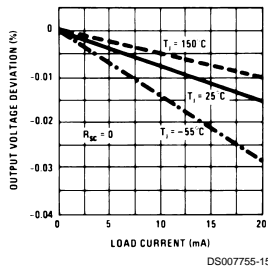
Note 3: The output currents given, as well as the load regulation, can be increased by the addition of external transistors. The improvement factor will be roughly equal to the composite current gain of the added transistors.

Note 4: With no external pass transistor.

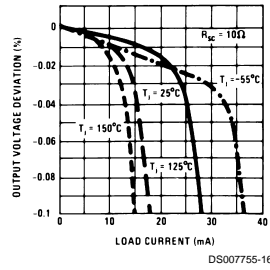
Note 5: Refer to RETS105X Drawing for military specifications for the LM105.

Typical Performance Characteristics

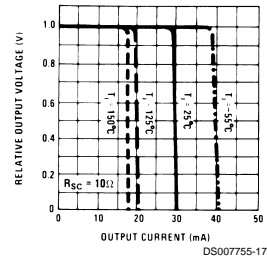
Load Regulation



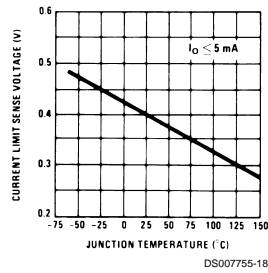
Load Regulation



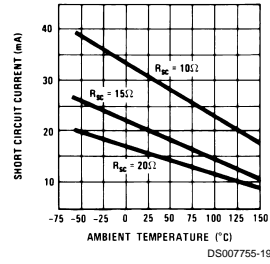
Current Limiting Characteristics



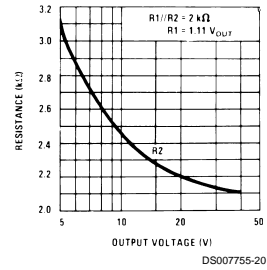
Current Limit Sense Voltage



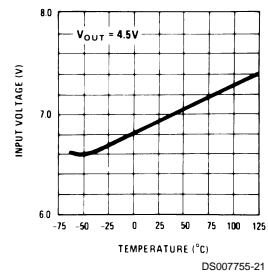
Short Circuit Current



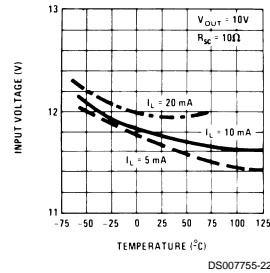
Optimum Divider Resistance Values



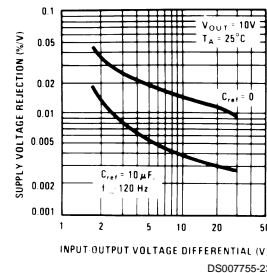
Minimum Input Voltage



Regulator Dropout Voltage

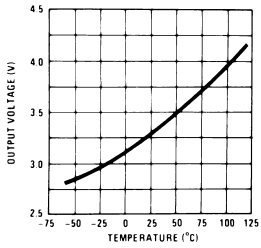


Supply Voltage Rejection



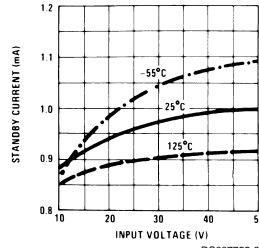
Typical Performance Characteristics (Continued)

Minimum Output Voltage



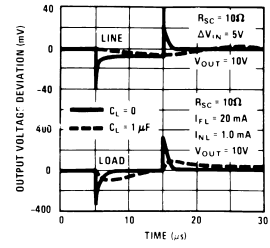
DS007755-24

Standby Current Drain



DS007755-25

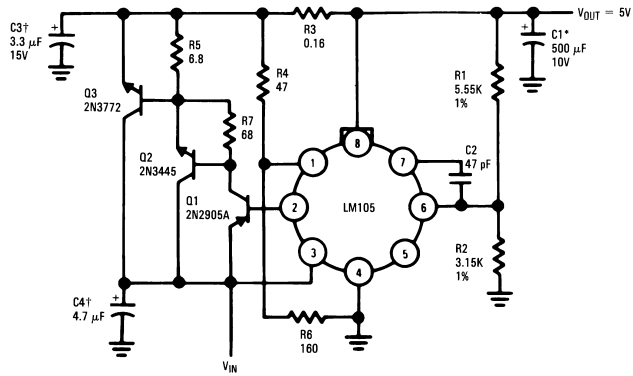
Transient Response



DS007755-26

Typical Applications

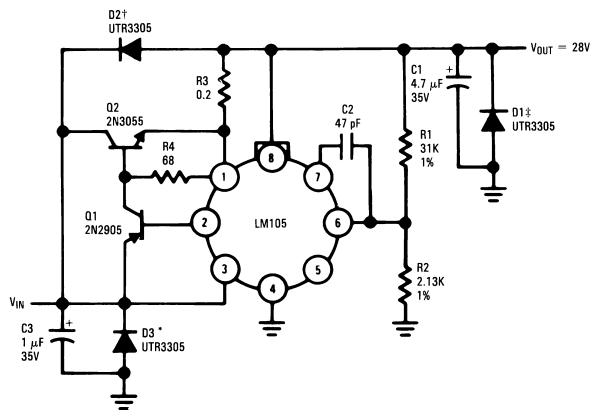
10A Regulator with Foldback Current Limiting



DS007755-4

†Solid tantalum.
*Electrolytic

1.0A Regulator with Protective Diodes

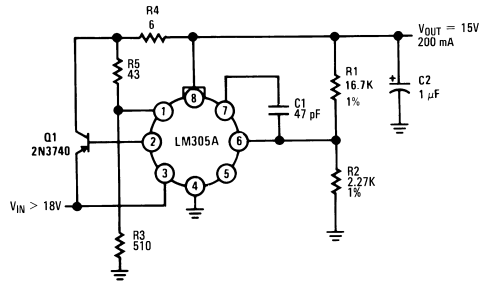


DS007755-5

†Protects against shorted input or inductive leads on unregulated supply.
*Protects against input voltage reversal.
††Protects against output voltage reversal.

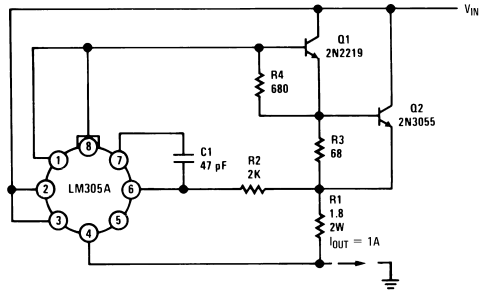
Typical Applications (Continued)

Linear Regulator with Foldback Current Limiting



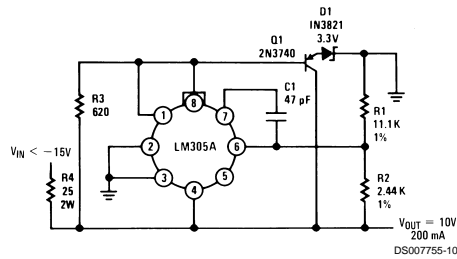
DS007755-8

Current Regulator



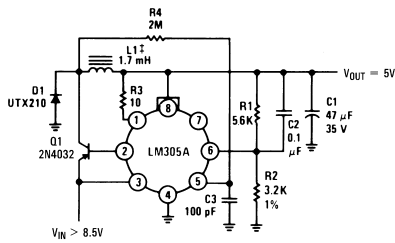
DS007755-9

Shunt Regulator



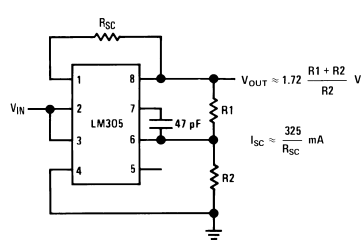
DS007755-10

Switching Regulator



DS007755-11

Basic Positive Regulator with Current Limiting



DS007755-12

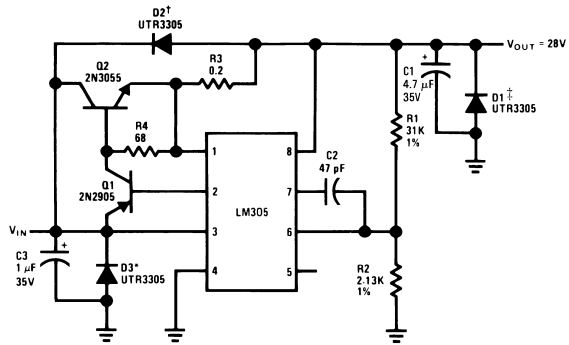
†Solid tantalum.

††125 turns = 22 on Arnold

Engineering A262123-2 molybdenum permally core.

Typical Applications (Continued)

1.0A Regulator with Protective Diodes



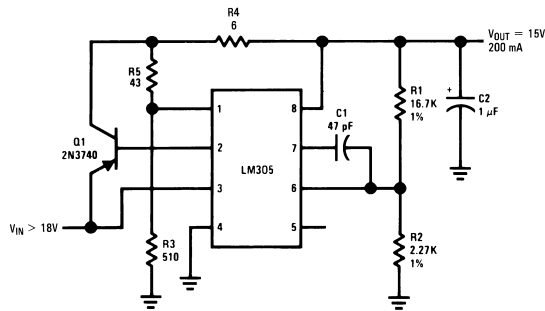
DS007755-13

†Protects against shorted input or inductive loads on unregulated supply.

*Protects against input voltage reversal.

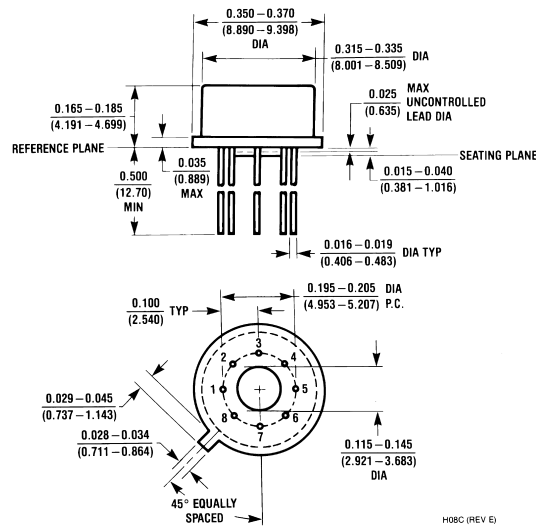
††Protects against output voltage reversal.

Linear Regulator with Foldback Current Limiting



DS007755-14

Physical Dimensions inches (millimeters) unless otherwise noted



Metal Can Package (H)
Order Number LM105H, LM105H/883, SMD #5962-8958801, LM305H or LM305AH
NS Package Number H08C

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