

## LM105/LM205/LM305/LM305A, LM376 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:

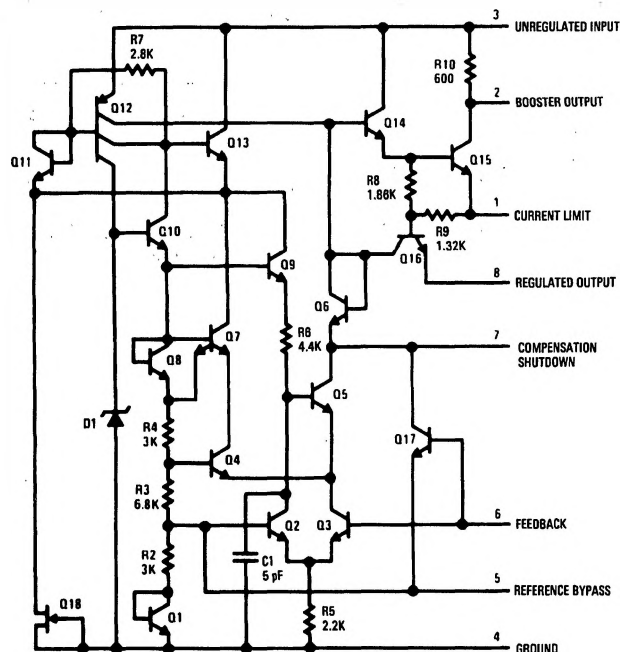
- Output voltage adjustable from 4.5V to 40V
- Output currents in excess of 10A possible by adding external transistors
- Load regulation better than 0.1%, full load with current limiting

- 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.

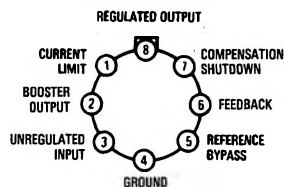
The LM105 is specified for operation for  $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ , and the LM305/LM305A is specified for  $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ .

### Schematic and Connection Diagrams



TL/H/7755-1

#### Metal Can Package



TL/H/7755-3

#### Top View

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

## Absolute Maximum Ratings

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<br>(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  | %     |
| Line Regulation                   |                                                           |       |       |      |                                 |       |      | $0 \leq I_O \leq 45 \text{ mA}$ |       |      |       |
|                                   | $T_A = 25^\circ\text{C}$                                  |       |       |      |                                 |       |      |                                 |       |      | %/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  | %     |

# Electrical Characteristics (Note 2) (Continued)

| Parameter                   | Conditions                                                    | LM105 |       |      | LM305 |       |      | LM305A |       |      | Units        |
|-----------------------------|---------------------------------------------------------------|-------|-------|------|-------|-------|------|--------|-------|------|--------------|
|                             |                                                               | Min   | Typ   | Max  | Min   | Typ   | Max  | Min    | Typ   | Max  |              |
| 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 Hz $\leq f \leq$ 10 kHz                                    |       |       |      |       |       |      |        |       |      |              |
|                             | $C_{REF} = 0$                                                 |       | 0.005 |      |       | 0.005 |      |        | 0.005 |      | %            |
|                             | $C_{REF} = 0.1 \mu F$                                         |       | 0.002 |      |       | 0.002 |      |        | 0.002 |      | %            |
| Standby Current Drain       | $V_{IN} = 30V, T_A = 25^\circ C$                              |       |       |      |       |       |      |        |       |      | mA           |
|                             | $V_{IN} = 40V$                                                |       |       |      |       | 0.8   | 2.0  |        |       |      | mA           |
|                             | $V_{IN} = 50V$                                                |       | 0.8   | 2.0  |       |       |      |        | 0.8   | 2.0  | mA           |
| Current Limit Sense Voltage | $T_A = 25^\circ C, R_{SC} = 10\Omega, V_{OUT} = 0V, (Note 4)$ | 225   | 300   | 375  | 225   | 300   | 375  | 225    | 300   | 375  | mV           |
| Long Term Stability         |                                                               |       | 0.1   |      |       | 0.1   |      |        | 0.1   |      | %            |
| Ripple Rejection            | $C_{REF} = 10 \mu F, f = 120 Hz$                              |       | 0.003 |      |       | 0.003 |      |        | 0.003 |      | %/V          |
| $\theta_{JA}$               | TO-99 Board Mount in Still Air                                |       | 230   |      |       | 230   |      |        | 230   |      | $^\circ C/W$ |
| $\theta_{JA}$               | TO-99 Board Mount in 400 LF/Min Air Flow                      |       | 92    |      |       | 92    |      |        | 92    |      | $^\circ C/W$ |
| $\theta_{JC}$               | TO-99                                                         |       | 25    |      |       | 25    |      |        | 25    |      | $^\circ C/W$ |

**Note 1:** The maximum junction temperature of the LM105 and LM305A is  $150^\circ C$ , and the LM305 is  $85^\circ C$ . For operation at elevated temperatures, devices in the H08C package must be derated based on a thermal resistance of  $168^\circ C/W$  junction to ambient, or  $25^\circ C/W$  junction to case. Peak dissipations to 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.

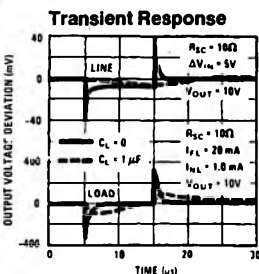
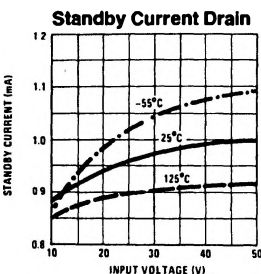
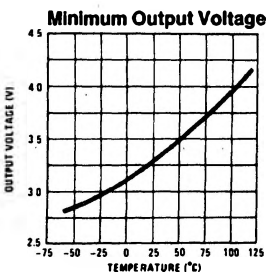
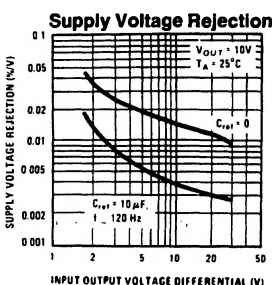
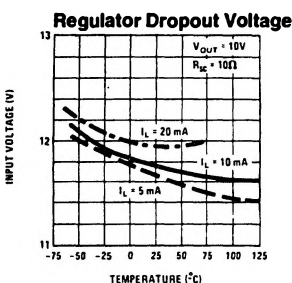
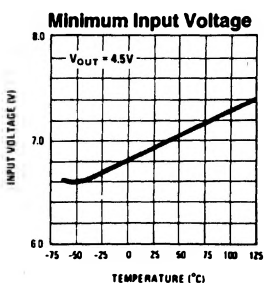
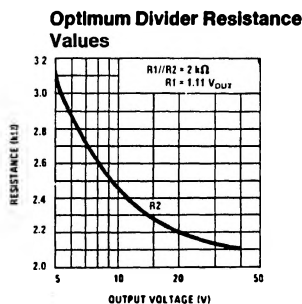
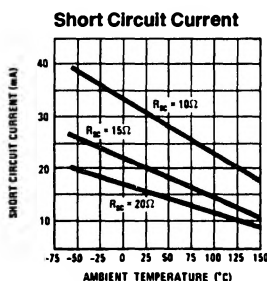
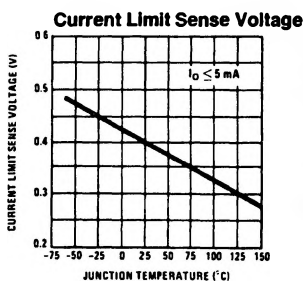
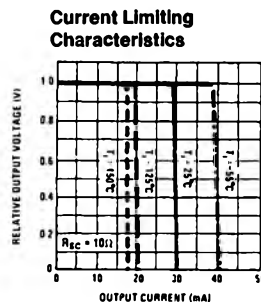
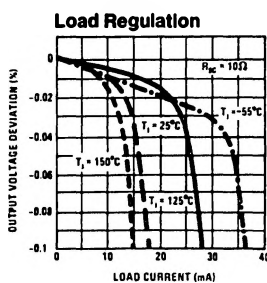
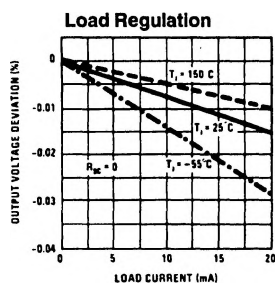
**Note 2:** Unless otherwise specified, these specifications apply for temperatures within the operating temperature range, for input and output voltages within the range given, and for a divider impedance seen by the feedback terminal of  $2 k\Omega$ . Load and line regulation specifications are for 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.

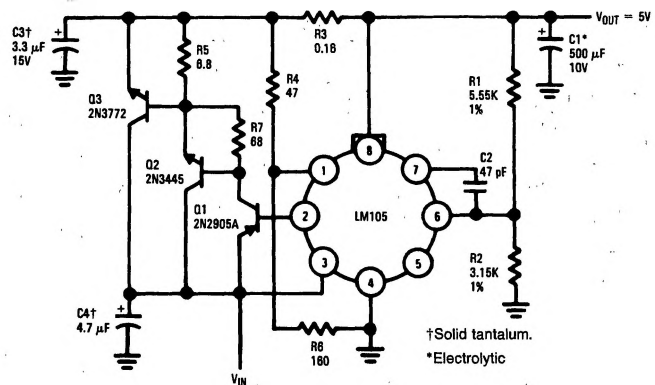
# Typical Performance Characteristics LM105/LM305/LM305A



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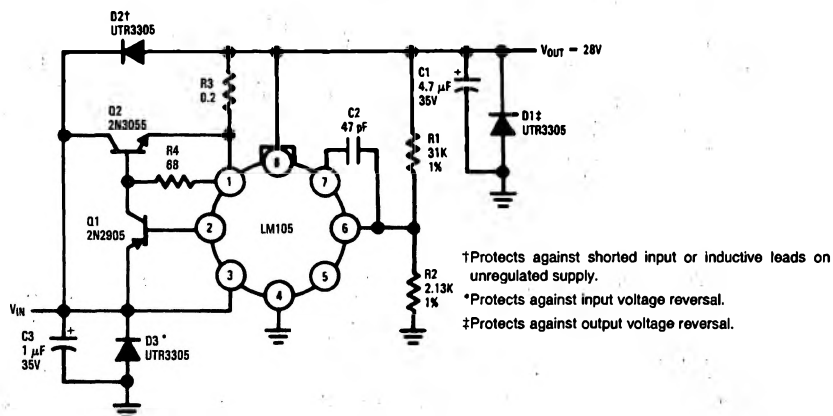
## Typical Applications

### 10A Regulator with Foldback Current Limiting



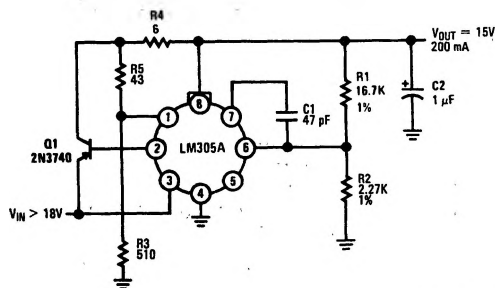
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### 1.0A Regulator with Protective Diodes



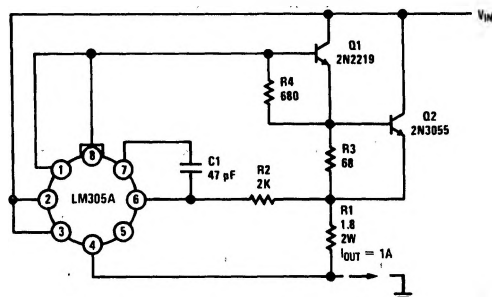
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### Linear Regulator with Foldback Current Limiting



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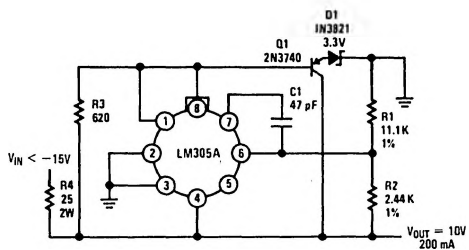
### Current Regulator



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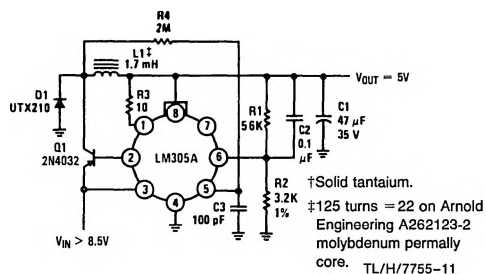
## Typical Applications (Continued)

## Shunt Regulator



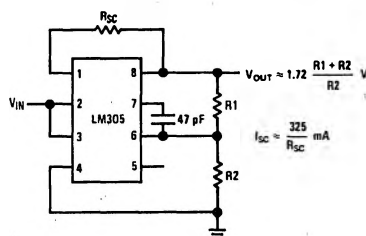
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## Switching Regulator



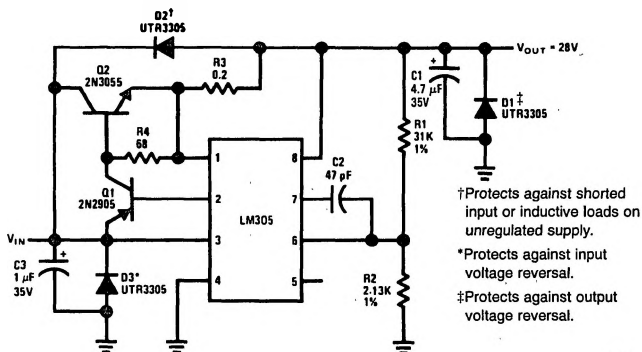
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## Basic Positive Regulator with Current Limiting



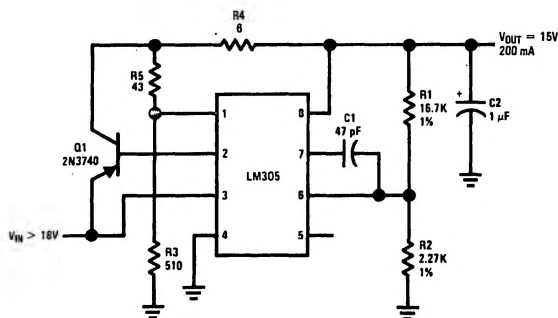
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## 1.0A Regulator with Protective Diodes



TL/H/7755-13

## Linear Regulator with Foldback Current Limiting



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