

# SH323 • SH223 • SH123 5 A, 3 V Voltage Regulator

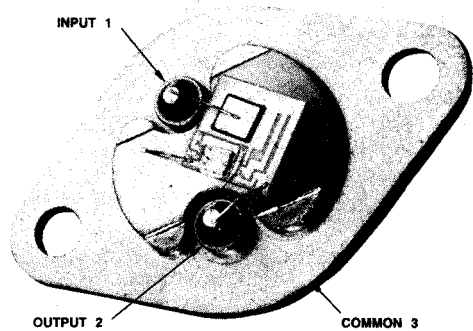
Hybrid Products

### Description

The SH232 is a hybrid regulator with 5.0 V fixed output and 3.0 A output capability. It has the inherent characteristics of the monolithic 3-terminal regulators, i.e., full thermal overload, short circuit and safe area protection. All devices are packaged in hermetically sealed TO-3s providing 50 W power dissipation. If the safe operating area is exceeded, the device shuts down rather than failing or damaging other system components (Note 1). This feature eliminates costly output circuitry and overly conservative heat sinks typical of high-current regulators built from discrete components.

- 3.0 A OUTPUT CURRENT
- INTERNAL CURRENT AND THERMAL OVERLOAD PROTECTION
- INTERNAL SHORT CIRCUIT PROTECTION
- LOW DROPOUT VOLTAGE (TYPICALLY 2.0 V @ 3.0 A)
- 50 W POWER DISSIPATION
- STEEL TO-3 PACKAGE
- ALL PIN-FOR-PIN COMPATIBLE WITH THE LM323, SG323

### Connection Diagram 2-Pin Metal Package

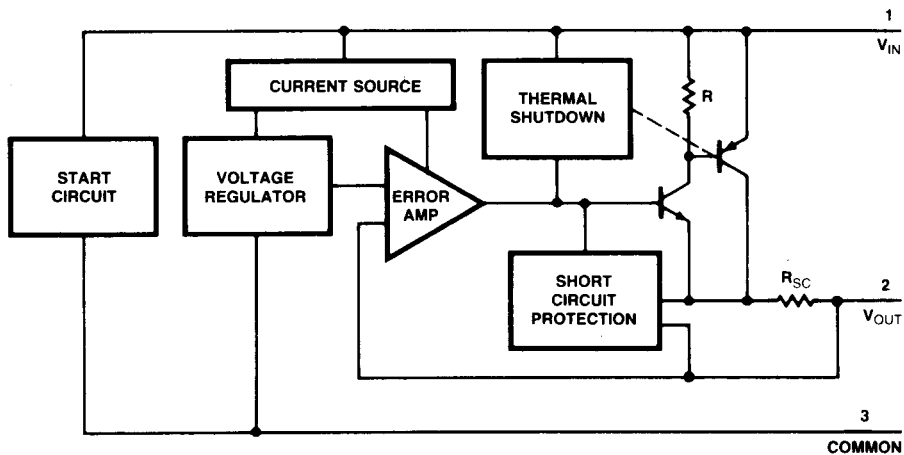


(Top View)

### Order Information

| Type  | Package | Code | Part No. |
|-------|---------|------|----------|
| SH323 | Metal   | GN   | SH323SC  |
| SH223 | Metal   | GN   | SH223SV  |
| SH123 | Metal   | GN   | SH123SM  |

### Block Diagram



## Absolute Maximum Ratings

|                                |                  |                              |                 |
|--------------------------------|------------------|------------------------------|-----------------|
| Input Voltage                  | 40 V             | Military Temperature Range   |                 |
| Input-to-Output Voltage        |                  | SH123SM                      | -55°C to +150°C |
| Differential                   |                  | Commercial Temperature Range |                 |
| Output Short Circuited         | 35 V             | SH323SC                      | 0°C to +150°C   |
| Internal Power Dissipation     | 50 W @ 25°C Case | Storage Temperature Range    | -55°C to +150°C |
| Operating Junction Temperature | 150°C            | Pin Temperature              |                 |
| Industrial Temperature Range   |                  | (Soldering, 60 s)            | 300°C           |
| SH223SV                        | -25°C to +150°C  |                              |                 |

**Electrical Characteristics**  $T_J = 25^\circ\text{C}$ ,  $V_{IN} = 10\text{ V}$ ,  $I_{OUT} = 2.0\text{ A}$  unless otherwise specified.

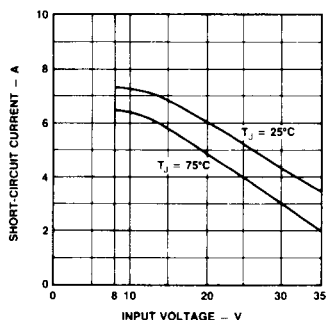
| Symbol           | Characteristic              | Limits |     |      | Unit                | Condition   |
|------------------|-----------------------------|--------|-----|------|---------------------|---|
|                  |                             | Min    | Typ | Max  |                     |   |
| $V_{OUT}$        | Output Voltage              | 4.85   | 5.0 | 5.25 | V                   | $I_{OUT} = 2.0\text{ A}$  |
| $\Delta V_{OUT}$ | Line Regulation (Note 2)    |        | 10  | 25   | mV                  | $V_{IN} = 7.5\text{ to }25\text{ V}$                                    |
| $\Delta V_{OUT}$ | Load Regulation (Note 2)    |        | 10  | 50   | mV                  | $10\text{ mA} \leq I_{OUT} \leq 3.0\text{ A}$                           |
| $I_Q$            | Quiescent Current           |        | 3.0 | 10   | mA                  | $I_{OUT} = 0$   |
| RR               | Ripple Rejection            | 60     |     |      | dB                  | $I_{OUT} = 1.0\text{ A}$ , $f = 120\text{ Hz}$ , $5.0\text{ V}_{pk-pk}$ |
| $V_n$            | Output Noise                |        | 40  |      | $\mu\text{V}_{RMS}$ | $10\text{ Hz} \leq f \leq 100\text{ kHz}$ , $V_{IN} = 10\text{ V}$      |
| $V_{DD}$         | Dropout Voltage (Note 3)    |        | 2.0 | 2.3  | V                   | $I_{OUT} = 3\text{ A}$  |
| $I_{OS}$         | Short Circuit Current Limit |        | 7.0 | 12.0 | $A_{pk}$            | $V_{IN} = 10\text{ V}$  |

## Notes

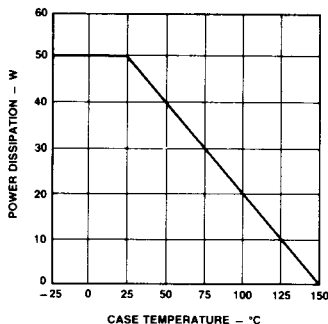
1. This voltage regulator offers output transistor safe area protection. However, to maintain full protection, the device must be operated within the maximum input-to-output voltage differential ratings, as listed on this data sheet under "Absolute Maximum Ratings." For applications violating these limits, device will not be fully protected.
2. Load and line regulation are specified at constant junction temperature. Pulse testing is required with a pulse width  $\leq 1\text{ ms}$  and a duty cycle  $\leq 5\%$ . Full Kelvin connection methods must be used to measure these parameters.
3. Dropout Voltage is the input-output voltage differential that causes the output voltage to decrease by 5% of its initial value.

## Typical Performance Curves

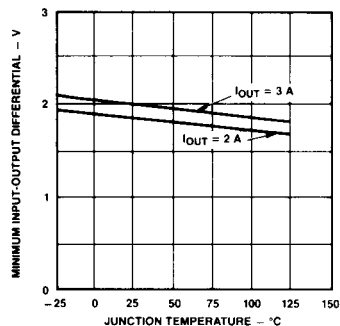
### Short Circuit Current



### Maximum Power Dissipation

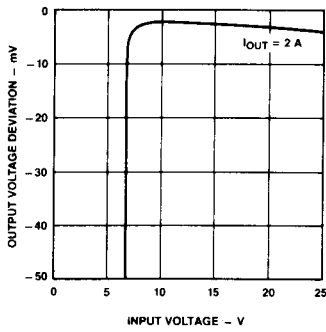


### Dropout Voltage

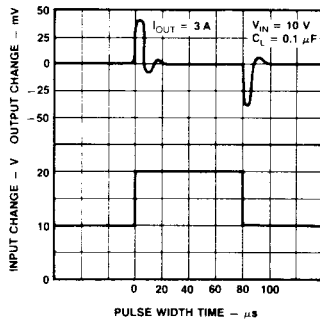


Typical Performance Curves (Cont.)

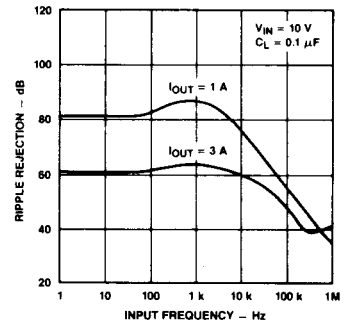
Line Regulation



Line Transient Response

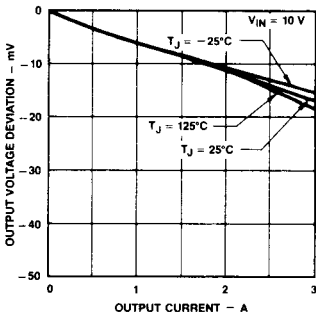


Ripple Rejection

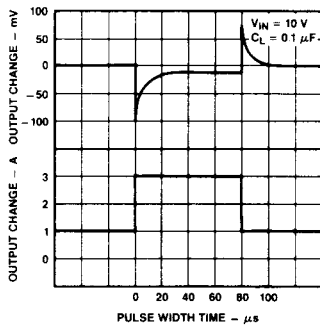


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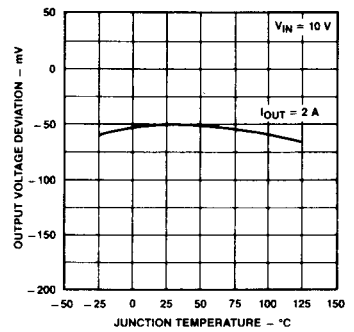
Load Regulation



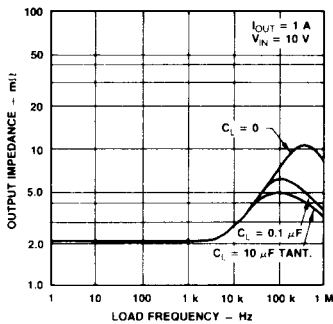
Load Transient Response



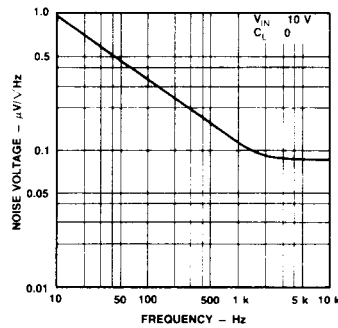
VOUT vs Junction Temperature



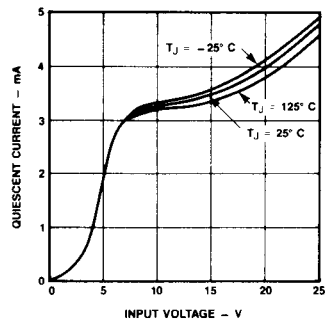
Output Impedance

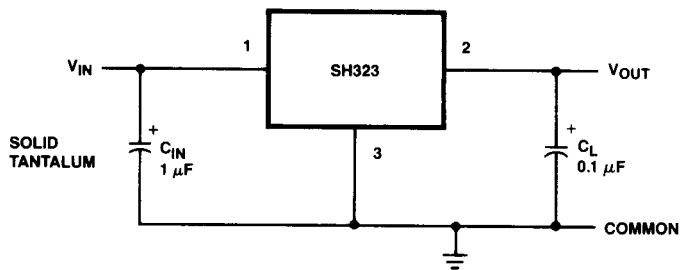


Output Noise Voltage



Quiescent Current



**Test Circuit****Fixed Output Voltage****Design Considerations**

This device has thermal overload protection from excessive power and internal short circuit protection which limits the circuit's maximum current. Thus, the device is protected from overload abnormalities. Although the internal power dissipation is limited, the junction temperature must be kept below the maximum specified temperature (150°C). It is recommended by the manufacturer that the maximum junction temperature be kept as low as possible for increased reliability. To calculate the maximum junction temperature or heat sink required, the following thermal resistance values should be used.

| Package | Typ<br>$\theta_{JC}$ | Max<br>$\theta_{JC}$ |
|---------|----------------------|----------------------|
| TO-3    | 1.8                  | 2.5                  |

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JC} + \theta_{CA}}$$

$$\theta_{CA} = \theta_{CS} + \theta_{SA}$$

Solving for  $T_J$ :

$$T_J = T_A + P_D (\theta_{JC} + \theta_{CA})$$

Where:

$T_J$  = Junction Temperature

$T_A$  = Ambient Temperature

$P_D$  = Power Dissipation

$\theta_{JC}$  = Junction-to-case thermal resistance

$\theta_{CA}$  = Case-to-ambient thermal resistance

$\theta_{CS}$  = Case-to-heat sink thermal resistance

$\theta_{SA}$  = Heat sink-to-ambient thermal resistance

The device is designed to operate without external compensation components. However, the amount of external filtering of this voltage regulator depends upon the circuit layout. If in a specific application the regulator is more than four inches from the filter capacitor, a 1  $\mu$ F solid tantalum capacitor should be used at the input. A 0.1  $\mu$ F capacitor should be used at the output to reduce transients created by fast switching loads, as seen in the basic test circuit. These filter capacitors must be located as close to the regulator as possible.

**Caution:** Permanent damage can result from forcing the output voltage higher than the input voltage. A protection diode from output to input should be used if this condition exists.