

TL780 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS055G – APRIL 1981 – REVISED NOVEMBER 2001

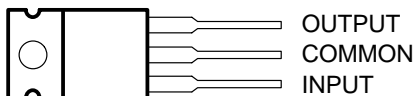
- $\pm 1\%$ Output Tolerance at 25°C
- $\pm 2\%$ Output Tolerance Over Full Operating Range
- Thermal Shutdown
- Internal Short-Circuit Current Limiting
- Pinout Identical to $\mu A7800$ Series
- Improved Version of $\mu A7800$ Series

description

Each fixed-voltage precision regulator in the TL780 series is capable of supplying 1.5 A of load current. A unique temperature-compensation technique, coupled with an internally trimmed band-gap reference, has resulted in improved accuracy when compared to other three-terminal regulators. Advanced layout techniques provide excellent line, load, and thermal regulation. The internal current-limiting and thermal-shutdown features make the devices essentially immune to overload.

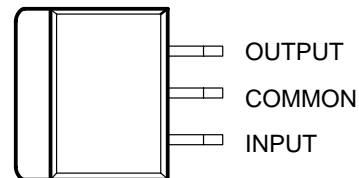
The TL780-xxC series regulators are characterized for operation over the virtual junction temperature range of 0°C to 125°C.

**KC PACKAGE
(TOP VIEW)**

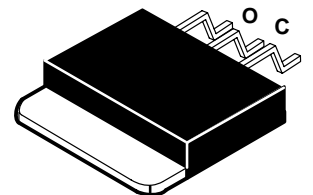
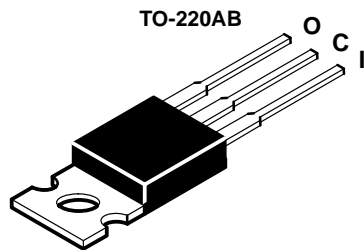


The COMMON terminal is in electrical contact with the mounting base.

**KTE PACKAGE
(TOP VIEW)**



The COMMON terminal is in electrical contact with the mounting base.



AVAILABLE OPTIONS

| T _J | V _O TYP (V) | PACKAGED DEVICES | |
|----------------|------------------------|------------------------|------------------------------|
| | | HEAT-SINK MOUNTED (KC) | PLASTIC FLANGE MOUNTED (KTE) |
| 0°C to 125°C | 5 | TL780-05CKC | TL780-05CKTE |
| | 12 | TL780-12CKC | TL780-12CKTE |
| | 15 | TL780-15CKC | TL780-15CKTE |

The KTE package is available taped and reeled. Add the suffix R to the device type (e.g., TL780-05CKTER).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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**

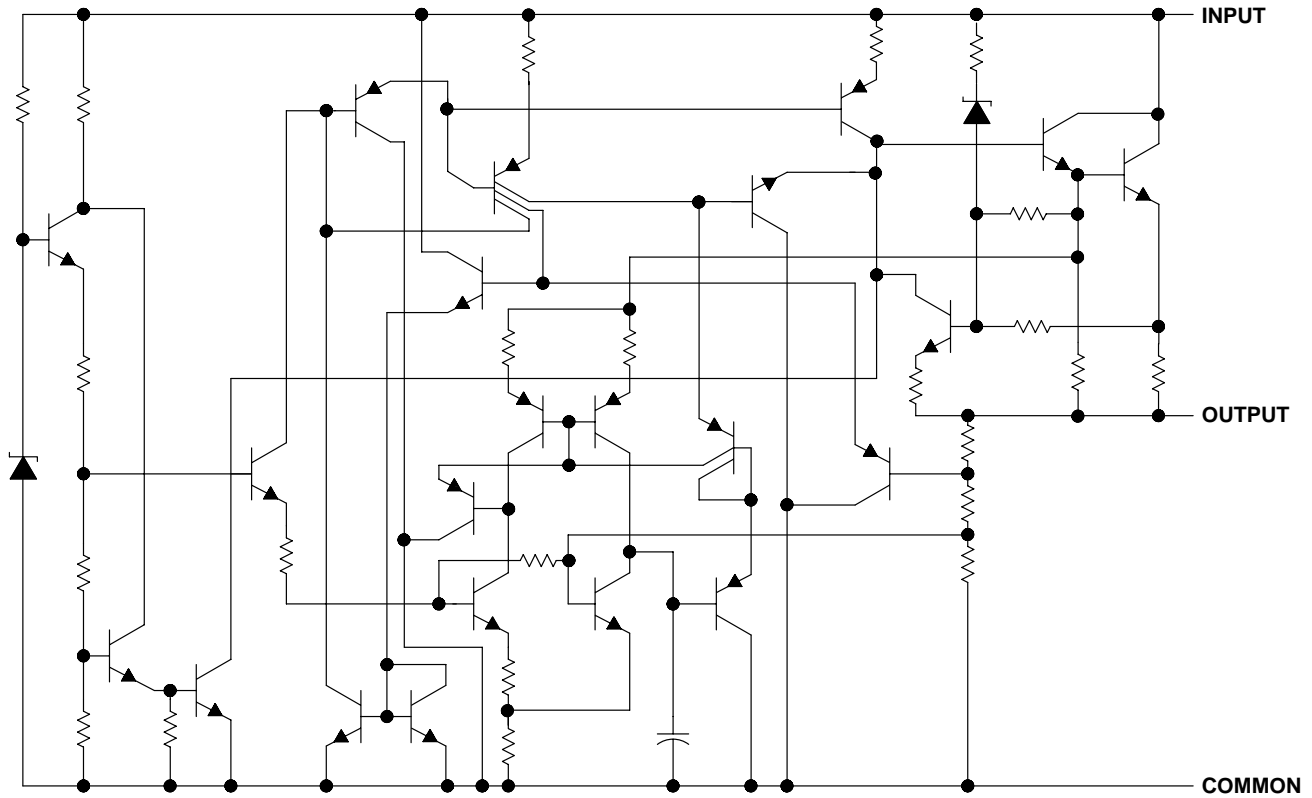
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2001, Texas Instruments Incorporated

TL780 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS055G – APRIL 1981 – REVISED NOVEMBER 2001

schematic



TL780 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS055G – APRIL 1981 – REVISED NOVEMBER 2001

absolute maximum ratings over operating temperature range (unless otherwise noted)†

| | |
|--|----------------|
| Input voltage, V_I | 35 V |
| Package thermal impedance, θ_{JA} (see Notes 1 and 2): KC package | 22°C/W |
| (see Notes 1 and 3): KTE package | 23°C/W |
| Operating free-air, T_A ; case, T_C ; or virtual junction, T_J , temperature range | 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 $T_J(\max)$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can impact reliability. Due to variations 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 51-7.
3. The package thermal impedance is calculated in accordance with JESD 51-5.

recommended operating conditions

| | | MIN | MAX | UNIT | |
|-------|--|-----------|------|------|---|
| V_I | Input voltage | TL780-05C | 7 | 25 | V |
| | | TL780-12C | 14.5 | 30 | |
| | | TL780-15C | 17.5 | 30 | |
| I_O | Output current | | 1.5 | A | |
| T_J | Operating virtual junction temperature | 0 | 125 | °C | |

electrical characteristics at specified virtual junction temperature, $V_I = 10$ V, $I_O = 500$ mA (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_J ‡ | TL780-05C | | | UNIT |
|---|--|--------------|-----------|-----|------|-------|
| | | | MIN | TYP | MAX | |
| Output voltage | $I_O = 5$ mA to 1 A, $P \leq 15$ W, $V_I = 7$ V to 20 V | 25°C | 4.95 | 5 | 5.05 | V |
| | | 0°C to 125°C | 4.9 | | 5.1 | |
| Input voltage regulation | $V_I = 7$ V to 25 V | 25°C | 0.5 | | 5 | mV |
| | $V_I = 8$ V to 12 V | | 0.5 | | 5 | |
| Ripple rejection | $V_I = 8$ V to 18 V, $f = 120$ Hz | 0°C to 125°C | 70 | 85 | | dB |
| Output voltage regulation | $I_O = 5$ mA to 1.5 A | 25°C | 4 | | 25 | mV |
| | $I_O = 250$ mA to 750 mA | | 1.5 | | 15 | |
| Output resistance | $f = 1$ kHz | 0°C to 125°C | 0.0035 | | | Ω |
| Temperature coefficient of output voltage | $I_O = 5$ mA | 0°C to 125°C | 0.25 | | | mV/°C |
| Output noise voltage | $f = 10$ Hz to 100 kHz | 25°C | 75 | | | μV |
| Dropout voltage | $I_O = 1$ A | 25°C | 2 | | | V |
| Input bias current | | 25°C | 5 | | 8 | mA |
| Input bias-current change | $V_I = 7$ V to 25 V | 0°C to 125°C | 0.7 | | 1.3 | mA |
| | $I_O = 5$ mA to 1 A | | 0.003 | | 0.5 | |
| Short-circuit output current | | 25°C | 750 | | | mA |
| Peak output current | | 25°C | 2.2 | | | A |

‡ 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 0.33-μF capacitor across the input and a 0.22-μF capacitor across the output.



TL780 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS055G – APRIL 1981 – REVISED NOVEMBER 2001

electrical characteristics at specified virtual junction temperature, $V_I = 19\text{ V}$, $I_O = 500\text{ mA}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_J † | TL780-12C | | | UNIT |
|---|--|--------------|-----------|-----|-------|---------------|
| | | | MIN | TYP | MAX | |
| Output voltage | $I_O = 5\text{ mA to }1\text{ A}$, $P \leq 15\text{ W}$, $V_I = 14.5\text{ V to }27\text{ V}$ | 25°C | 11.88 | 12 | 12.12 | V |
| | | 0°C to 125°C | 11.76 | | 12.24 | |
| Input voltage regulation | $V_I = 14.5\text{ V to }30\text{ V}$ | 25°C | 1.2 | | 12 | mV |
| | $V_I = 16\text{ V to }22\text{ V}$ | | 1.2 | | 12 | |
| Ripple rejection | $V_I = 15\text{ V to }25\text{ V}$, $f = 120\text{ Hz}$ | 0°C to 125°C | 65 | 80 | | dB |
| Output voltage regulation | $I_O = 5\text{ mA to }1.5\text{ A}$ | 25°C | 6.5 | | 60 | mV |
| | $I_O = 250\text{ mA to }750\text{ mA}$ | | 2.5 | | 36 | |
| Output resistance | $f = 1\text{ kHz}$ | 0°C to 125°C | 0.0035 | | | Ω |
| Temperature coefficient of output voltage | $I_O = 5\text{ mA}$ | 0°C to 125°C | 0.6 | | | mV/°C |
| Output noise voltage | $f = 10\text{ Hz to }100\text{ kHz}$ | 25°C | 180 | | | μV |
| Dropout voltage | $I_O = 1\text{ A}$ | 25°C | 2 | | | V |
| Input bias current | | 25°C | 5.5 | | 8 | mA |
| Input bias-current change | $V_I = 14.5\text{ V to }30\text{ V}$ | 0°C to 125°C | 0.4 | | 1.3 | mA |
| | $I_O = 5\text{ mA to }1\text{ A}$ | | 0.03 | | 0.5 | |
| Short-circuit output current | | 25°C | 350 | | | mA |
| Peak output current | | 25°C | 2.2 | | | A |

† 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 0.33- μF capacitor across the input and a 0.22- μF capacitor across the output.

electrical characteristics at specified virtual junction temperature, $V_I = 23\text{ V}$, $I_O = 500\text{ mA}$ (unless otherwise noted)

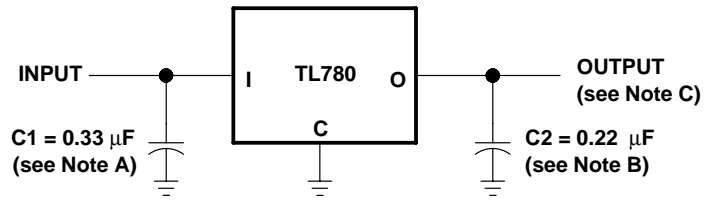
| PARAMETER | TEST CONDITIONS | T_J † | TL780-15C | | | UNIT |
|---|--|--------------|-----------|-----|-------|---------------|
| | | | MIN | TYP | MAX | |
| Output voltage | $I_O = 5\text{ mA to }1\text{ A}$, $P \leq 15\text{ W}$, $V_I = 17.5\text{ V to }30\text{ V}$ | 25°C | 14.85 | 15 | 15.15 | V |
| | | 0°C to 125°C | 14.7 | | 15.3 | |
| Input voltage regulation | $V_I = 17.5\text{ V to }30\text{ V}$ | 25°C | 1.5 | | 15 | mV |
| | $V_I = 20\text{ V to }26\text{ V}$ | | 1.5 | | 15 | |
| Ripple rejection | $V_I = 18.5\text{ V to }28.5\text{ V}$, $f = 120\text{ Hz}$ | 0°C to 125°C | 60 | 75 | | dB |
| Output voltage regulation | $I_O = 5\text{ mA to }1.5\text{ A}$ | 25°C | 7 | | 75 | mV |
| | $I_O = 250\text{ mA to }750\text{ mA}$ | | 2.5 | | 45 | |
| Output resistance | $f = 1\text{ kHz}$ | 0°C to 125°C | 0.0035 | | | Ω |
| Temperature coefficient of output voltage | $I_O = 5\text{ mA}$ | 0°C to 125°C | 0.62 | | | mV/°C |
| Output noise voltage | $f = 10\text{ Hz to }100\text{ kHz}$ | 25°C | 225 | | | μV |
| Dropout voltage | $I_O = 1\text{ A}$ | 25°C | 2 | | | V |
| Input bias current | | 25°C | 5.5 | | 8 | mA |
| Input bias-current change | $V_I = 17.5\text{ V to }30\text{ V}$ | 0°C to 125°C | 0.4 | | 1.3 | mA |
| | $I_O = 5\text{ mA to }1\text{ A}$ | | 0.02 | | 0.5 | |
| Short-circuit output current | | 25°C | 230 | | | mA |
| Peak output current | | 25°C | 2.2 | | | A |

† 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 0.33- μF capacitor across the input and a 0.22- μF capacitor across the output.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

PARAMETER MEASUREMENT INFORMATION



- NOTES: A. C1 is required when the regulator is far from the power-supply filter.
B. C2 is not required for stability; however, transient response is improved.
C. Permanent damage can occur when OUTPUT is pulled below ground.

Figure 1. Test Circuit

TL780 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS055G – APRIL 1981 – REVISED NOVEMBER 2001

APPLICATION INFORMATION

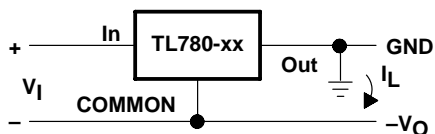
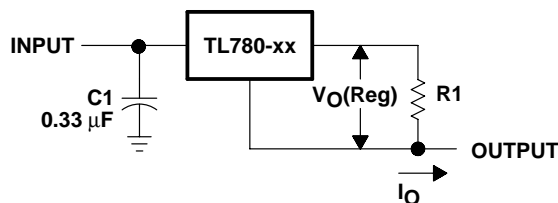


Figure 2. Positive Regulator in Negative Configuration (V_I Must Float)



$$I_O = (V_O/R1) + I_O \text{ Bias Current}$$

Figure 3. Current Regulator

operation with a load common to a voltage of opposite polarity

In many cases, a regulator powers a load that is not connected to ground but, instead, is connected to a voltage source of opposite polarity (e.g., operational amplifiers, level-shifting circuits, etc.). In these cases, a clamp diode should be connected to the regulator output as shown in Figure 4. This protects the regulator from output polarity reversals during startup and short-circuit operation.

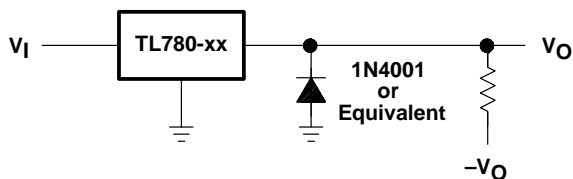


Figure 4. Output Polarity-Reversal-Protection Circuit

reverse-bias protection

Occasionally, the input voltage to the regulator can collapse faster than the output voltage. This, for example, could occur when the input supply is crowbarred during an output overvoltage condition. If the output voltage is greater than approximately 7 V, the emitter-base junction of the series pass element (internal or external) could break down and be damaged. To prevent this, a diode shunt can be employed, as shown in Figure 5.

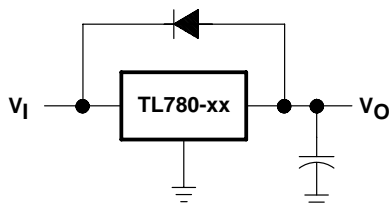


Figure 5. Reverse-Bias-Protection Circuit

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265