

# AN78xx/AN78xxF Series

## 3-pin positive output voltage regulator (1 A type)

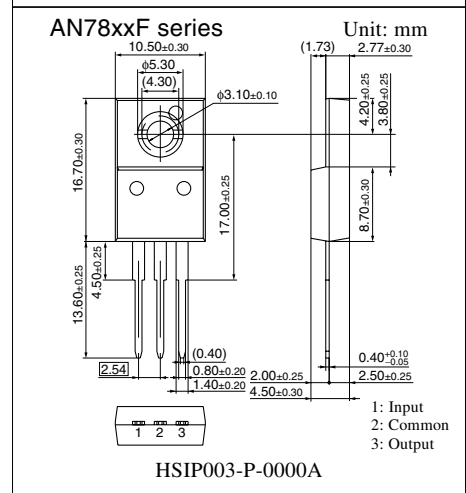
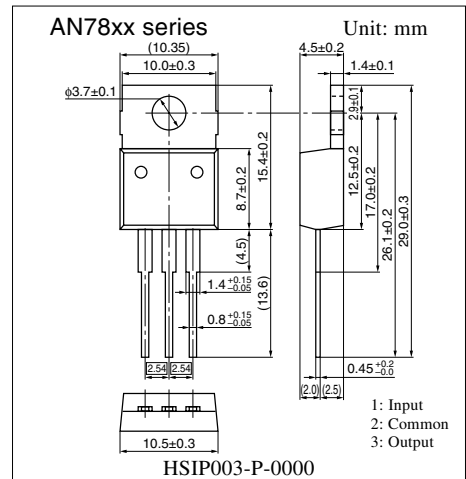
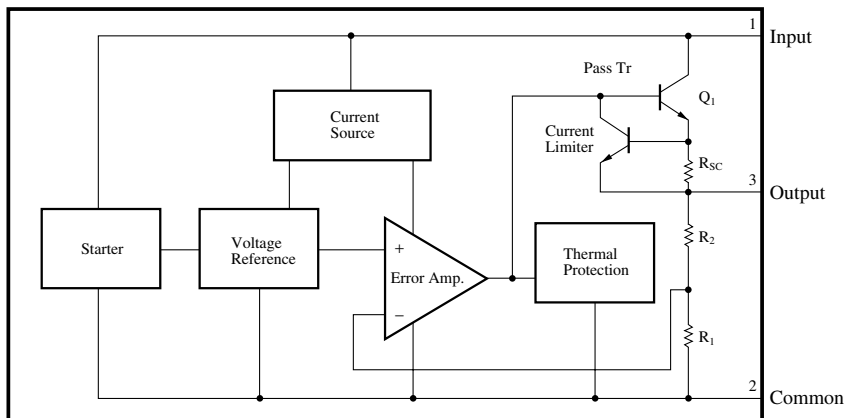
### ■ Overview

The AN78xx series and the AN78xxF series are 3-pin, fixed positive output type monolithic voltage regulators. Stabilized fixed output voltage is obtained from unstable DC input voltage without using any external components. 11 types of fixed output voltage are available; 5V, 6V, 7V, 8V, 9V, 10V, 12V, 15V, 18V, 20V, and 24V. They can be used widely in power circuits with current capacity of up to 1A.

### ■ Features

- No external components
- Output voltage: 5V, 6V, 7V, 8V, 9V, 10V, 12V, 15V, 18V, 20V, 24V
- Built-in overcurrent limit circuit
- Built-in thermal overload protection circuit
- Built-in ASO (area of safe operation) protection circuit

### ■ Block Diagram



### ■ Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

| Parameter                     |                | Symbol    | Rating              | Unit             |
|-------------------------------|----------------|-----------|---------------------|------------------|
| Input voltage                 |                | $V_I$     | 35 <sup>*1</sup>    | V                |
|                               |                |           | 40 <sup>*2</sup>    | V                |
| Power dissipation             | AN78xx series  | $P_D$     | 15 <sup>*3</sup>    | W                |
|                               | AN78xxF series |           | 10.25 <sup>*3</sup> |                  |
| Operating ambient temperature |                | $T_{opr}$ | -30 to +80          | $^\circ\text{C}$ |
| Storage temperature           |                | $T_{stg}$ | -55 to +150         | $^\circ\text{C}$ |

\*1 AN7805/F, AN7806/F, AN7807/F, AN7808/F, AN7809/F, AN7810/F, AN7812/F, AN7815/F, AN7818/F

\*2 AN7820/F, AN7824/F

\*3 Follow the derating curve. When  $T_j$  exceeds  $150^\circ\text{C}$ , the internal circuit cuts off the output.

### ■ Electrical Characteristics at $T_a = 25^\circ\text{C}$

#### • AN7805, AN7805F (5V type)

| Parameter                               | Symbol                | Conditions  | Min  | Typ  | Max  | Unit                       |
|---|-----------------------|---|------|------|------|----------------------------|
| Output voltage                          | $V_O$                 | $T_j = 25^\circ\text{C}$  | 4.8  | 5    | 5.2  | V                          |
| Output voltage tolerance                | $V_O$                 | $V_I = 8$ to $20\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 4.75 | —    | 5.25 | V                          |
| Line regulation                         | $\text{REG}_{IN}$     | $V_I = 7.5$ to $25\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | 3    | 100  | mV                         |
|   |                       | $V_I = 8$ to $12\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | 1    | 50   | mV                         |
| Load regulation                         | $\text{REG}_L$        | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 15   | 100  | mV                         |
|   |                       | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$  | —    | 5    | 50   | mV                         |
| Bias current                            | $I_{Bias}$            | $T_j = 25^\circ\text{C}$  | —    | 3.9  | 8    | mA                         |
| Bias current fluctuation to input       | $\Delta I_{Bias(IN)}$ | $V_I = 7.5$ to $25\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 1.3  | mA                         |
| Bias current fluctuation to load        | $\Delta I_{Bias(L)}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 0.5  | mA                         |
| Output noise voltage                    | $V_{no}$              | $f = 10\text{Hz}$ to $100\text{kHz}$  | —    | 40   | —    | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                    | $V_I = 8$ to $18\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$   | 62   | —    | —    | dB                         |
| Minimum input/output voltage difference | $V_{DIF(min)}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 2    | —    | V                          |
| Output impedance                        | $Z_O$                 | $f = 1\text{kHz}$   | —    | 17   | —    | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{O(short)}$        | $V_I = 25\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 700  | —    | mA                         |
| Peak output current                     | $I_{O(Peak)}$         | $T_j = 25^\circ\text{C}$  | —    | 2    | —    | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$      | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$   | —    | -0.3 | —    | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 10\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_1 = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

### ■ Electrical Characteristics at $T_a = 25^\circ\text{C}$ (continued)

#### • AN7806, 7806F (6V type)

| Parameter                               | Symbol                       | Conditions  | Min  | Typ  | Max  | Unit                       |
|---|------------------------------|---|------|------|------|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$  | 5.75 | 6    | 6.25 | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 9$ to $21\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 5.7  | —    | 6.3  | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 8.5$ to $25\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | 5    | 120  | mV                         |
|   |                              | $V_I = 9$ to $13\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | 1.5  | 60   | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 14   | 120  | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$  | —    | 4    | 60   | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$  | —    | 3.9  | 8    | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 8.5$ to $25\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 1.3  | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 0.5  | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$  | —    | 40   | —    | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 9$ to $19\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$   | 59   | —    | —    | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 2    | —    | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$   | —    | 17   | —    | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 25\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 700  | —    | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$  | —    | 2    | —    | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$   | —    | -0.4 | —    | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 11\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_I = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

#### • AN7807, 7807F (7V type)

| Parameter                               | Symbol                       | Conditions   | Min | Typ  | Max | Unit                       |
|---|------------------------------|--|-----|------|-----|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$   | 6.7 | 7    | 7.3 | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 10$ to $22\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 6.6 | —    | 7.4 | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 9.5$ to $25\text{V}$ , $T_j = 25^\circ\text{C}$   | —   | 5    | 140 | mV                         |
|   |                              | $V_I = 10$ to $15\text{V}$ , $T_j = 25^\circ\text{C}$  | —   | 1.5  | 70  | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$   | —   | 14   | 140 | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$   | —   | 4    | 70  | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$   | —   | 3.9  | 8   | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 9.5$ to $25\text{V}$ , $T_j = 25^\circ\text{C}$   | —   | —    | 1   | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$   | —   | —    | 0.5 | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$   | —   | 46   | —   | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 10$ to $20\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$   | 57  | —    | —   | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$   | —   | 2    | —   | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$  | —   | 16   | —   | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 25\text{V}$ , $T_j = 25^\circ\text{C}$  | —   | 700  | —   | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$   | —   | 2    | —   | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$  | —   | -0.5 | —   | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 12\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_I = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

### ■ Electrical Characteristics at $T_a = 25^\circ\text{C}$ (continued)

#### • AN7808, 7808F (8V type)

| Parameter                               | Symbol                       | Conditions   | Min | Typ  | Max | Unit                       |
|---|------------------------------|--|-----|------|-----|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$   | 7.7 | 8    | 8.3 | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 11$ to $23\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 7.6 | —    | 8.4 | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 10.5$ to $25\text{V}$ , $T_j = 25^\circ\text{C}$  | —   | 6    | 160 | mV                         |
|   |                              | $V_I = 11$ to $17\text{V}$ , $T_j = 25^\circ\text{C}$  | —   | 2    | 80  | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$   | —   | 12   | 160 | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$   | —   | 4    | 80  | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$   | —   | 3.9  | 8   | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 10.5$ to $25\text{V}$ , $T_j = 25^\circ\text{C}$  | —   | —    | 1   | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$   | —   | —    | 0.5 | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$   | —   | 52   | —   | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 11.5$ to $21.5\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$                                       | 56  | —    | —   | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$   | —   | 2    | —   | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$  | —   | 16   | —   | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 25\text{V}$ , $T_j = 25^\circ\text{C}$  | —   | 700  | —   | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$   | —   | 2    | —   | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$  | —   | -0.5 | —   | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 14\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_I = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

#### • AN7809, 7809F (9V type)

| Parameter                               | Symbol                       | Conditions   | Min  | Typ  | Max  | Unit                       |
|---|------------------------------|--|------|------|------|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$   | 8.65 | 9    | 9.35 | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 12$ to $24\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 8.55 | —    | 9.45 | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 11.5$ to $26\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | 7    | 180  | mV                         |
|   |                              | $V_I = 12$ to $18\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | 2    | 90   | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$   | —    | 12   | 180  | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$   | —    | 4    | 90   | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$   | —    | 3.9  | 8    | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 11.5$ to $26\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 1    | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$   | —    | —    | 0.5  | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$   | —    | 57   | —    | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 12$ to $22\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$   | 56   | —    | —    | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$   | —    | 2    | —    | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$  | —    | 16   | —    | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 26\text{V}$ , $T_j = 25^\circ\text{C}$  | —    | 700  | —    | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$   | —    | 2    | —    | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$  | —    | -0.5 | —    | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 15\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_I = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

### ■ Electrical Characteristics at $T_a = 25^\circ\text{C}$ (continued)

#### • AN7810, 7810F (10V type)

| Parameter                               | Symbol                       | Conditions  | Min | Typ  | Max  | Unit                       |
|---|------------------------------|---|-----|------|------|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$  | 9.6 | 10   | 10.4 | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 13$ to $25\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ ,<br>$T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 9.5 | —    | 10.5 | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 12.5$ to $27\text{V}$ , $T_j = 25^\circ\text{C}$   | —   | 8    | 200  | mV                         |
|   |                              | $V_I = 13$ to $19\text{V}$ , $T_j = 25^\circ\text{C}$   | —   | 2.5  | 100  | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$  | —   | 12   | 200  | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$  | —   | 4    | 100  | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$  | —   | 3.9  | 8    | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 12.5$ to $27\text{V}$ , $T_j = 25^\circ\text{C}$   | —   | —    | 1    | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$  | —   | —    | 0.5  | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$  | —   | 63   | —    | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 13$ to $23\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$  | 56  | —    | —    | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$  | —   | 2    | —    | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$   | —   | 16   | —    | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 27\text{V}$ , $T_j = 25^\circ\text{C}$   | —   | 700  | —    | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$  | —   | 2    | —    | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$   | —   | -0.6 | —    | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 16\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_1 = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

#### • AN7812, 7812F (12V type)

| Parameter                               | Symbol                       | Conditions  | Min  | Typ  | Max  | Unit                       |
|---|------------------------------|---|------|------|------|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$  | 11.5 | 12   | 12.5 | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 15$ to $27\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ ,<br>$T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 11.4 | —    | 12.6 | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 14.5$ to $30\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 10   | 240  | mV                         |
|   |                              | $V_I = 16$ to $22\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 3    | 120  | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 12   | 240  | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$  | —    | 4    | 120  | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$  | —    | 4    | 8    | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 14.5$ to $30\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | —    | 1    | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 0.5  | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$  | —    | 75   | —    | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 15$ to $25\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$  | 55   | —    | —    | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 2    | —    | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$   | —    | 18   | —    | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 30\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 700  | —    | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$  | —    | 2    | —    | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$   | —    | -0.8 | —    | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 19\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_1 = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

### ■ Electrical Characteristics at $T_a = 25^\circ\text{C}$ (continued)

#### • AN7815, 7815F (15V type)

| Parameter                               | Symbol                       | Conditions  | Min   | Typ | Max   | Unit                       |
|---|------------------------------|---|-------|-----|-------|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$  | 14.4  | 15  | 15.6  | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 18$ to $30\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ ,<br>$T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 14.25 | —   | 15.75 | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 17.5$ to $30\text{V}$ , $T_j = 25^\circ\text{C}$   | —     | 11  | 300   | mV                         |
|   |                              | $V_I = 20$ to $26\text{V}$ , $T_j = 25^\circ\text{C}$   | —     | 3   | 150   | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$  | —     | 12  | 300   | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$  | —     | 4   | 150   | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$  | —     | 4   | 8     | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 17.5$ to $30\text{V}$ , $T_j = 25^\circ\text{C}$   | —     | —   | 1     | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$  | —     | —   | 0.5   | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$  | —     | 90  | —     | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 18.5$ to $28.5\text{V}$ , $f = 120\text{Hz}$   | 54    | —   | —     | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$  | —     | 2   | —     | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$   | —     | 19  | —     | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 30\text{V}$ , $T_j = 25^\circ\text{C}$   | —     | 700 | —     | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$  | —     | 2   | —     | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$   | —     | -1  | —     | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 23\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_1 = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

#### • AN7818, 7818F (18V type)

| Parameter                               | Symbol                       | Conditions  | Min  | Typ  | Max  | Unit                       |
|---|------------------------------|---|------|------|------|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$  | 17.3 | 18   | 18.7 | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 21$ to $33\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ ,<br>$T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 17.1 | —    | 18.9 | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 21$ to $33\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 14   | 360  | mV                         |
|   |                              | $V_I = 24$ to $30\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 4    | 180  | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 12   | 360  | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$  | —    | 4    | 180  | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$  | —    | 4.1  | 8    | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 21$ to $33\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | —    | 1    | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 0.5  | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$  | —    | 110  | —    | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 22$ to $32\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$  | 53   | —    | —    | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 2    | —    | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$   | —    | 16   | —    | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 35\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 700  | —    | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$  | —    | 2    | —    | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$   | —    | -1.1 | —    | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 27\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_1 = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

### ■ Electrical Characteristics at $T_a = 25^\circ\text{C}$ (continued)

#### • AN7820, 7820F (20V type)

| Parameter                               | Symbol                       | Conditions  | Min  | Typ  | Max  | Unit                       |
|---|------------------------------|---|------|------|------|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$  | 19.2 | 20   | 20.8 | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 24$ to $35\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ ,<br>$T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 19   | —    | 21   | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 23$ to $35\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 15   | 400  | mV                         |
|   |                              | $V_I = 26$ to $32\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 5    | 200  | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 12   | 400  | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$  | —    | 4    | 200  | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$  | —    | 4.1  | 8    | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 23$ to $35\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | —    | 1    | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 0.5  | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$  | —    | 110  | —    | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 24$ to $34\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$  | 53   | —    | —    | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 2    | —    | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$   | —    | 22   | —    | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 35\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 700  | —    | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$  | —    | 2    | —    | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$   | —    | -1.2 | —    | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 29\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_1 = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

#### • AN7824, 7824F (24V type)

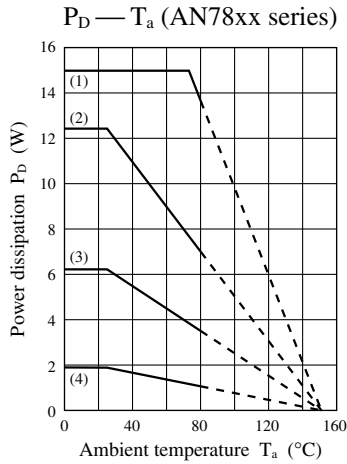
| Parameter                               | Symbol                       | Conditions  | Min  | Typ  | Max  | Unit                       |
|---|------------------------------|---|------|------|------|----------------------------|
| Output voltage                          | $V_O$                        | $T_j = 25^\circ\text{C}$  | 23   | 24   | 25   | V                          |
| Output voltage tolerance                | $V_O$                        | $V_I = 28$ to $38\text{V}$ , $I_O = 5\text{mA}$ to $1\text{A}$ ,<br>$T_j = 0$ to $125^\circ\text{C}$ , $P_D \leq *$ | 22.8 | —    | 25.2 | V                          |
| Line regulation                         | $\text{REG}_{\text{IN}}$     | $V_I = 27$ to $38\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 18   | 480  | mV                         |
|   |                              | $V_I = 30$ to $36\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 6    | 240  | mV                         |
| Load regulation                         | $\text{REG}_{\text{L}}$      | $I_O = 5\text{mA}$ to $1.5\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 12   | 480  | mV                         |
|   |                              | $I_O = 250$ to $750\text{mA}$ , $T_j = 25^\circ\text{C}$  | —    | 4    | 240  | mV                         |
| Bias current                            | $I_{\text{Bias}}$            | $T_j = 25^\circ\text{C}$  | —    | 4.1  | 8    | mA                         |
| Bias current fluctuation to input       | $\Delta I_{\text{Bias(IN)}}$ | $V_I = 27$ to $38\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | —    | 1    | mA                         |
| Bias current fluctuation to load        | $\Delta I_{\text{Bias(L)}}$  | $I_O = 5\text{mA}$ to $1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | —    | 0.5  | mA                         |
| Output noise voltage                    | $V_{\text{no}}$              | $f = 10\text{Hz}$ to $100\text{kHz}$  | —    | 170  | —    | $\mu\text{V}$              |
| Ripple rejection ratio                  | RR                           | $V_I = 28$ to $38\text{V}$ , $I_O = 100\text{mA}$ , $f = 120\text{Hz}$  | 50   | —    | —    | dB                         |
| Minimum input/output voltage difference | $V_{\text{DIF(min)}}$        | $I_O = 1\text{A}$ , $T_j = 25^\circ\text{C}$  | —    | 2    | —    | V                          |
| Output impedance                        | $Z_O$                        | $f = 1\text{kHz}$   | —    | 28   | —    | $\text{m}\Omega$           |
| Output short-circuit current            | $I_{\text{O(Short)}}$        | $V_I = 38\text{V}$ , $T_j = 25^\circ\text{C}$   | —    | 700  | —    | mA                         |
| Peak output current                     | $I_{\text{O(Peak)}}$         | $T_j = 25^\circ\text{C}$  | —    | 2    | —    | A                          |
| Output voltage temperature coefficient  | $\Delta V_O/T_a$             | $I_O = 5\text{mA}$ , $T_j = 0$ to $125^\circ\text{C}$   | —    | -1.4 | —    | $\text{mV}/^\circ\text{C}$ |

Note 1) The specified condition  $T_j = 25^\circ\text{C}$  means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.

Note 2) Unless otherwise specified,  $V_I = 33\text{V}$ ,  $I_O = 500\text{mA}$ ,  $C_1 = 0.33\mu\text{F}$  and  $C_O = 0.1\mu\text{F}$ .

\* AN78xx series: 15W, AN78xxF series: 10.25W

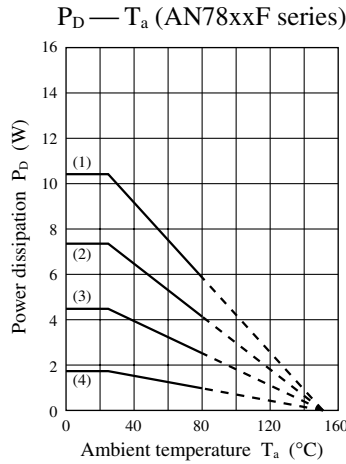
■ Main Characteristic Curve



Thermal resistance value:  
 $R_{th(j-c)} = 5^\circ\text{C/W}$  (max.)  
 $R_{th(j-a)} = 65^\circ\text{C/W}$  (max.)

Installation condition to heat sink  
 Tightening torque 6kg-cm  
 Heat radiation compound used

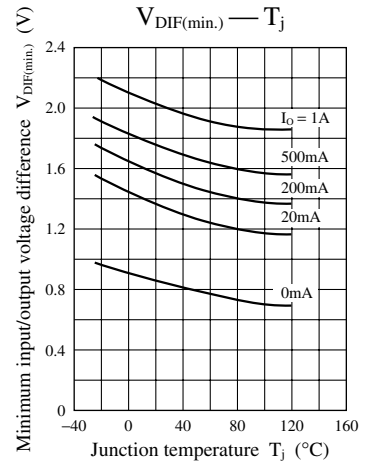
- (1) Infinite heat sink: 15.0W
- (2) 5°C/W heat sink: 12.5W
- (3) 15°C/W heat sink: 6.3W
- (4) Without heat sink: 1.923W



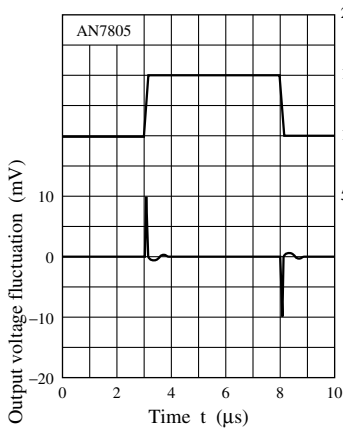
Thermal resistance value:  
 $R_{th(j-c)} = 12.2^\circ\text{C/W}$  (max.)  
 $R_{th(j-a)} = 65^\circ\text{C/W}$  (max.)

Installation condition to heat sink  
 Tightening torque 6kg-cm  
 Heat radiation compound used

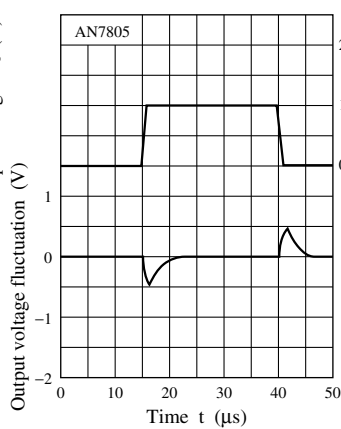
- (1) Infinite heat sink: 10.25W
- (2) 5°C/W heat sink: 7.3W
- (3) 15°C/W heat sink: 4.5W
- (4) Without heat sink: 1.923W



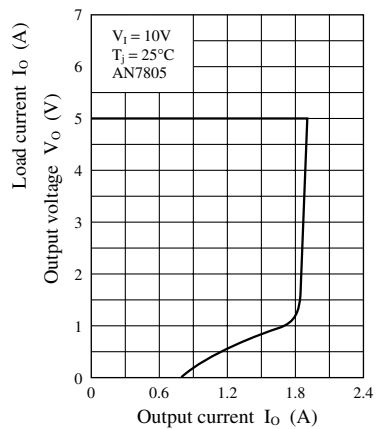
Input transient response



Load transient response

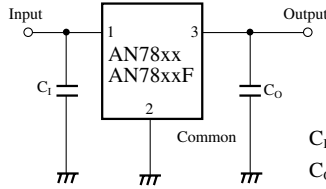


Current limiting characteristic





■ Basic Regulator Circuit



C<sub>1</sub>: C<sub>1</sub> is necessary when the input line is long.  
 C<sub>0</sub>: C<sub>0</sub> improves the transient response.

■ Usage Notes

1. Cautions for a basic circuit

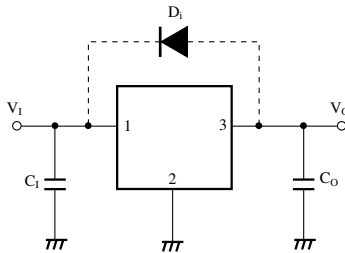


Figure 1

- C<sub>1</sub>: When a wiring from a smoothing circuit to a three-pin regulator is long, it is likely to oscillate in output. A capacitor of 0.1μF to 0.47μF should be connected near an input pin.
- C<sub>0</sub>: When any sudden change of load current is likely to occur, connect an electrolytic capacitor of 10μF to 100μF to improve a transitional response of output voltage.
- D<sub>1</sub>: Normally unnecessary. But add it in the case that there is a residual voltage at the output capacitor C<sub>0</sub> even after switching off the supply power because a current is likely to flow into an output pin of the IC and damage the IC.

2. Other caution items

1) Short-circuit between the input pin and GND pin

If the input pin is short-circuited to GND or is cut off when a large capacitance capacitor has been connected to the IC's load, a voltage of a capacitor connected to an output pin is applied between input/output of the IC and this likely results in damage of the IC. It is necessary, therefore, to connect a diode, as shown in figure 2, to counter the reverse bias between input/output pins.

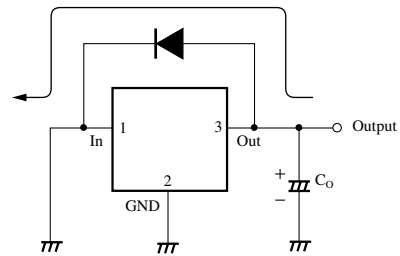


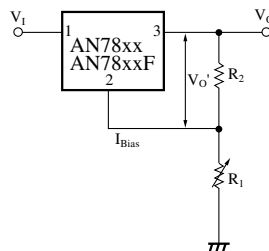
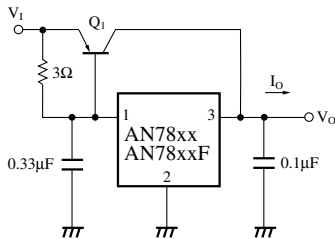
Figure 2

2) Floating of GND pin

If a GND pin is made floating in an operating mode, an unstabilized input voltage is outputted. In this case, a thermal protection circuit inside the IC does not normally operate. In this state, if the load is short-circuited or overloaded, it is likely to damage the IC.

■ Application Circuit Examples

1. Current bootstrap circuit      2. Adjustable output regulator



$$V_O = V_O' + \left( I_{Bias} + \frac{V_O'}{R_2} \right) R_1$$

Note) V<sub>O</sub> varies due to sample to sample variation of I<sub>Bias</sub>.  
 Never fail to adjust individually with R<sub>1</sub>.

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