

KA78MXX

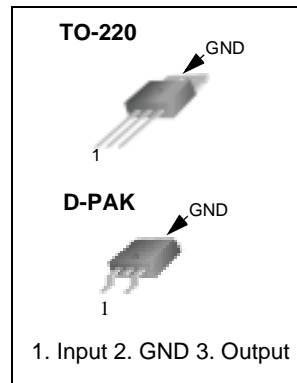
3-Terminal 0.5A Positive Voltage Regulator

Features

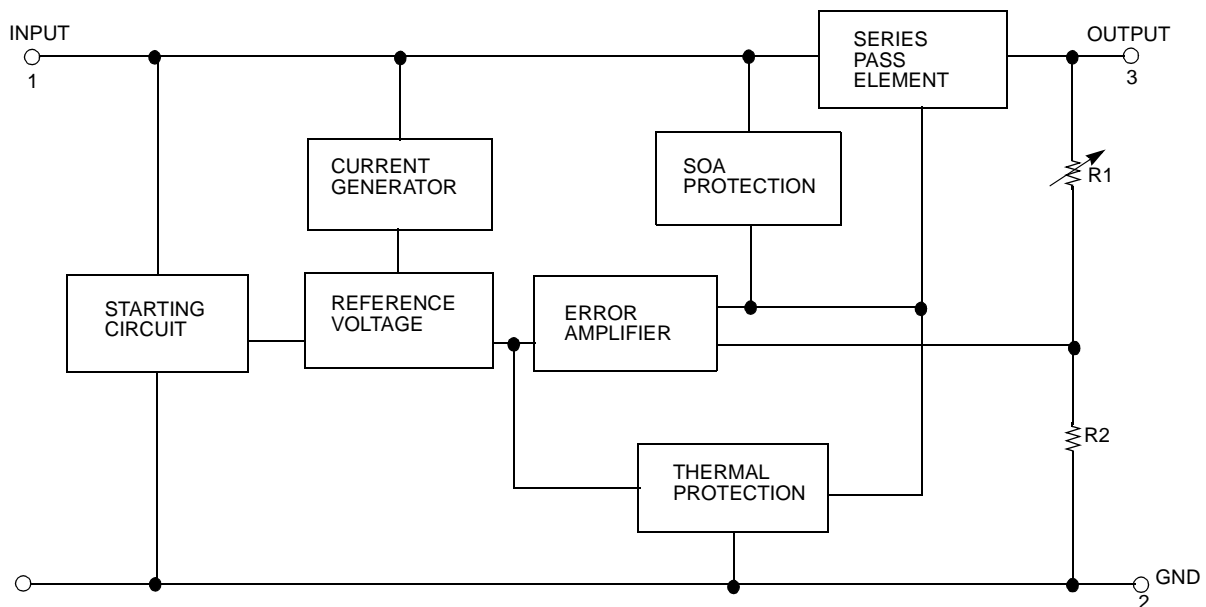
- Output Current up to 0.5A
- Output Voltages of 5, 6, 8, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area (SOA) Protection

Description

The KA78MXX series of three terminal positive regulators are available in the TO-220/D-PAK package with several fixed output voltages making it useful in a wide range of applications.



Internal Block Diagram



Absolute Maximum Ratings

| Parameter | Symbol | Value | Unit |
|--|-----------------|------------|--------------|
| Input Voltage (for $V_O = 5V$ to $18V$) (for $V_O = 24V$) | V_I | 35 | V |
| | V_I | 40 | V |
| Thermal Resistance Junction-Cases (Note1) TO-220 ($T_c = +25^\circ C$) | $R_{\theta JC}$ | 2.5 | $^\circ C/W$ |
| Thermal Resistance Junction-Air (Note1,2) TO-220 ($T_a = +25^\circ C$) D-PAK ($T_a = +25^\circ C$) | $R_{\theta JA}$ | 66 | $^\circ C/W$ |
| | | 92 | |
| Operating Junction Temperature Range | T_{OPR} | 0 ~ +150 | $^\circ C$ |
| Storage Temperature Range | T_{STG} | -65 ~ +150 | $^\circ C$ |

Note:

- Thermal resistance test board
Size: 76.2mm * 114.3mm * 1.6mm(1S0P)
JEDEC standard: JESD51-3, JESD51-7
- Assume no ambient airflow

Electrical Characteristics (KA78M05/KA78M05R)

(Refer to the test circuits, $0 \leq T_J \leq +125^\circ C$, $I_O = 350mA$, $V_I = 10V$, unless otherwise specified, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | |
|--------------------------|---------------------|---|--------------------|------|------|----------------|----|
| Output Voltage | V_O | $T_J = +25^\circ C$ | 4.8 | 5 | 5.2 | V | |
| | | $I_O = 5$ to $350mA$ $V_I = 7$ to $20V$ | 4.75 | 5 | 5.25 | | |
| Line Regulation (Note3) | ΔV_O | $I_O = 200mA$ $T_J = +25^\circ C$ | $V_I = 7$ to $25V$ | - | - | 100 | mV |
| | | | $V_I = 8$ to $25V$ | - | - | 50 | |
| Load Regulation (Note3) | ΔV_O | $I_O = 5mA$ to $0.5A$, $T_J = +25^\circ C$ | - | - | 100 | mV | |
| | | $I_O = 5mA$ to $200mA$, $T_J = +25^\circ C$ | - | - | 50 | | |
| Quiescent Current | I_Q | $T_J = +25^\circ C$ | - | 4.0 | 6.0 | mA | |
| Quiescent Current Change | ΔI_Q | $I_O = 5mA$ to $350mA$ | - | - | 0.5 | mA | |
| | | $I_O = 200mA$ $V_I = 8$ to $25V$ | - | - | 0.8 | | |
| Output Voltage Drift | $\Delta V/\Delta T$ | $I_O = 5mA$ $T_J = 0$ to $+125^\circ C$ | - | -0.5 | - | mV/ $^\circ C$ | |
| Output Noise Voltage | V_N | $f = 10Hz$ to $100kHz$ | - | 40 | - | $\mu V/V_O$ | |
| Ripple Rejection | RR | $f = 120Hz$, $I_O = 300mA$ $V_I = 8$ to $18V$, $T_J = +25^\circ C$ | - | 80 | - | dB | |
| Dropout Voltage | V_D | $T_J = +25^\circ C$, $I_O = 500mA$ | - | 2 | - | V | |
| Short Circuit Current | I_{SC} | $T_J = +25^\circ C$, $V_I = 35V$ | - | 300 | - | mA | |
| Peak Current | I_{PK} | $T_J = +25^\circ C$ | - | 700 | - | mA | |

Note:

- Load and line regulation are specified at constant junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Electrical Characteristics (KA78M06/KA78M06R) (Continued)(Refer to the test circuits, $0 \leq T_J \leq +125^\circ\text{C}$, $I_O=350\text{mA}$, $V_I=11\text{V}$, unless otherwise specified, $C_I=0.33\mu\text{F}$, $C_O=0.1\mu\text{F}$)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | |
|--------------------------|---------------------|--|---------------------------|------|------|----------------------|----|
| Output Voltage | V_O | $T_J = +25^\circ\text{C}$ | 5.75 | 6 | 6.25 | V | |
| | | $I_O = 5$ to 350mA $V_I = 8$ to 21V | 5.7 | 6 | 6.3 | | |
| Line Regulation (Note1) | ΔV_O | $I_O = 200\text{mA}$ $T_J = +25^\circ\text{C}$ | $V_I = 8$ to 25V | - | - | 100 | mV |
| | | | $V_I = 9$ to 25V | - | - | 50 | |
| Load Regulation (Note1) | ΔV_O | $I_O = 5\text{mA}$ to 0.5A , $T_J = +25^\circ\text{C}$ | | - | - | 120 | mV |
| | | $I_O = 5\text{mA}$ to 200mA , $T_J = +25^\circ\text{C}$ | | - | - | 60 | |
| Quiescent Current | I_Q | $T_J = +25^\circ\text{C}$ | - | 4.0 | 6.0 | mA | |
| Quiescent Current Change | ΔI_Q | $I_O = 5\text{mA}$ to 350mA | | - | - | 0.5 | mA |
| | | $I_O = 200\text{mA}$ $V_I = 9$ to 25V | | - | - | 0.8 | |
| Output Voltage Drift | $\Delta V/\Delta T$ | $I_O = 5\text{mA}$ $T_J = 0$ to $+125^\circ\text{C}$ | - | -0.5 | - | mV/ $^\circ\text{C}$ | |
| Output Noise Voltage | V_N | $f = 10\text{Hz}$ to 100kHz | - | 45 | - | $\mu\text{V}/V_O$ | |
| Ripple Rejection | RR | $f = 120\text{Hz}$, $I_O = 300\text{mA}$ $V_I = 9$ to 19V , $T_J = +25^\circ\text{C}$ | - | 80 | - | dB | |
| Dropout Voltage | V_D | $T_J = +25^\circ\text{C}$, $I_O = 500\text{mA}$ | - | 2 | - | V | |
| Short Circuit Current | ISC | $T_J = +25^\circ\text{C}$, $V_I = 35\text{V}$ | - | 300 | - | mA | |
| Peak Current | IPK | $T_J = +25^\circ\text{C}$ | - | 700 | - | mA | |

Note:

1. Load and line regulation are specified at constant, junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Electrical Characteristics (KA78M08/KA78M08R) (Continued)

(Refer to the test circuits, $0 \leq T_J \leq +125^\circ\text{C}$, $I_O=350\text{mA}$, $V_I=14\text{V}$, unless otherwise specified, $C_I=0.33\mu\text{F}$, $C_O=0.1\mu\text{F}$)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | |
|--------------------------|--------------|--|-------------------------------------|------|------|----------------------|----|
| Output Voltage | V_O | $T_J = +25^\circ\text{C}$ | 7.7 | 8 | 8.3 | V | |
| | | $I_O = 5 \text{ to } 350\text{mA}$ $V_I = 10.5 \text{ to } 23\text{V}$ | 7.6 | 8 | 8.4 | | |
| Line Regulation (Note1) | ΔV_O | $I_O = 200\text{mA}$ $T_J = +25^\circ\text{C}$ | $V_I = 10.5 \text{ to } 25\text{V}$ | - | - | 100 | mV |
| | | | $V_I = 11 \text{ to } 25\text{V}$ | - | - | 50 | |
| Load Regulation (Note1) | ΔV_O | $I_O = 5\text{mA to } 0.5\text{A}, T_J = +25^\circ\text{C}$ | | - | - | 160 | mV |
| | | $I_O = 5\text{mA to } 200\text{mA}, T_J = +25^\circ\text{C}$ | | - | - | 80 | |
| Quiescent Current | I_Q | $T_J = +25^\circ\text{C}$ | - | 4.0 | 6.0 | mA | |
| Quiescent Current Change | ΔI_Q | $I_O = 5\text{mA to } 350\text{mA}$ | | - | - | 0.5 | mA |
| | | $I_O = 200\text{mA}$ $V_I = 10.5 \text{ to } 25\text{V}$ | | - | - | 0.8 | |
| Output Voltage Drift | RR | $I_O = 5\text{mA}$ $T_J = 0 \text{ to } +125^\circ\text{C}$ | - | -0.5 | - | mV/ $^\circ\text{C}$ | |
| Output Noise Voltage | V_N | $f = 10\text{Hz to } 100\text{kHz}$ | - | 52 | - | $\mu\text{V}/V_O$ | |
| Ripple Rejection | RR | $f = 120\text{Hz}, I_O = 300\text{mA}$ $V_I = 11.5 \text{ to } 21.5\text{V}, T_J = +25^\circ\text{C}$ | - | 80 | - | dB | |
| Dropout Voltage | V_D | $T_J = +25^\circ\text{C}, I_O = 500\text{mA}$ | - | 2 | - | V | |
| Short Circuit Current | ISC | $T_J = +25^\circ\text{C}, V_I = 35\text{V}$ | - | 300 | - | mA | |
| Peak Current | IPK | $T_J = +25^\circ\text{C}$ | - | 700 | - | mA | |

Note:

1. Load and line regulation are specified at constant, junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Electrical Characteristics (KA78M12/KA78M12R) (Continued)(Refer to the test circuits, $0 \leq T_J \leq +125^\circ\text{C}$, $I_O=350\text{mA}$, $V_I=19\text{V}$, unless otherwise specified, $C_I=0.33\mu\text{F}$, $C_O=0.1\mu\text{F}$)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | |
|--------------------------|---------------------|--|-------------------------------------|------|------|----------------------|----|
| Output Voltage | V_O | $T_J = +25^\circ\text{C}$ | 11.5 | 12 | 12.5 | V | |
| | | $I_O = 5 \text{ to } 350\text{mA}$ $V_I = 14.5 \text{ to } 27\text{V}$ | 11.4 | 12 | 12.6 | | |
| Line Regulation (Note1) | ΔV_O | $I_O = 200\text{mA}$ $T_J = +25^\circ\text{C}$ | $V_I = 14.5 \text{ to } 30\text{V}$ | - | - | 100 | mV |
| | | | $V_I = 16 \text{ to } 30\text{V}$ | - | - | 50 | |
| Load Regulation (Note1) | ΔV_O | $I_O = 5\text{mA} \text{ to } 0.5\text{A}$, $T_J = +25^\circ\text{C}$ | - | - | 240 | mV | |
| | | $I_O = 5\text{mA} \text{ to } 200\text{mA}$, $T_J = +25^\circ\text{C}$ | - | - | 120 | | |
| Quiescent Current | I_Q | $T_J = +25^\circ\text{C}$ | - | 4.1 | 6.0 | mA | |
| Quiescent Current Change | ΔI_Q | $I_O = 5\text{mA} \text{ to } 350\text{mA}$ | - | - | 0.5 | mA | |
| | | $I_O = 200\text{mA}$ $V_I = 14.5 \text{ to } 30\text{V}$ | - | - | 0.8 | | |
| Output Voltage Drift | $\Delta V/\Delta T$ | $I_O = 5\text{mA}$ $T_J = 0 \text{ to } +125^\circ\text{C}$ | - | -0.5 | - | mV/ $^\circ\text{C}$ | |
| Output Noise Voltage | V_N | $f = 10\text{Hz} \text{ to } 100\text{kHz}$ | - | 75 | - | $\mu\text{V}/V_O$ | |
| Ripple Rejection | RR | $f = 120\text{Hz}$, $I_O = 300\text{mA}$ $V_I = 15 \text{ to } 25\text{V}$, $T_J = +25^\circ\text{C}$ | - | 80 | - | dB | |
| Dropout Voltage | V_D | $T_J = +25^\circ\text{C}$, $I_O = 500\text{mA}$ | - | 2 | - | V | |
| Short Circuit Current | I_{SC} | $T_J = +25^\circ\text{C}$, $V_I = 35\text{V}$ | - | 300 | - | mA | |
| Peak Current | I_{PK} | $T_J = +25^\circ\text{C}$ | - | 700 | - | mA | |

Note:

1. Load and line regulation are specified at constant, junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Electrical Characteristics (KA78M15) (Continued)

(Refer to the test circuits, $0 \leq T_J \leq +125^\circ\text{C}$, $I_O=350\text{mA}$, $V_I=23\text{V}$, unless otherwise specified, $C_I=0.33\mu\text{F}$, $C_O=0.1\mu\text{F}$)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--------------------------|---------------------|--|-------|------|-------|----------------------|
| Output Voltage | V_O | $T_J = +25^\circ\text{C}$ | 14.4 | 15 | 15.6 | V |
| | | $I_O = 5 \text{ to } 350\text{mA}$ $V_I = 17.5 \text{ to } 30\text{V}$ | 14.25 | 15 | 15.75 | |
| Line Regulation (Note1) | ΔV_O | $I_O = 200\text{mA}$ $T_J = +25^\circ\text{C}$ | - | - | 100 | mV |
| | | $V_I = 17.5 \text{ to } 30\text{V}$ $V_I = 20 \text{ to } 30\text{V}$ | - | - | 50 | |
| Load Regulation (Note1) | ΔV_O | $I_O = 5\text{mA to } 0.5\text{A}$, $T_J = +25^\circ\text{C}$ | - | - | 300 | mV |
| | | $I_O = 5\text{mA to } 200\text{mA}$, $T_J = +25^\circ\text{C}$ | - | - | 150 | |
| Quiescent Current | I_Q | $T_J = +25^\circ\text{C}$ | - | 4.1 | 6.0 | mA |
| Quiescent Current Change | ΔI_Q | $I_O = 5\text{mA to } 350\text{mA}$ | - | - | 0.5 | mA |
| | | $I_O = 200\text{mA}$ $V_I = 17.5 \text{ to } 30\text{V}$ | - | - | 0.8 | |
| Output Voltage Drift | $\Delta V/\Delta T$ | $I_O = 5\text{mA}$ $T_J = 0 \text{ to } +125^\circ\text{C}$ | - | -1 | - | mV/ $^\circ\text{C}$ |
| Output Noise Voltage | V_N | $f = 10\text{Hz to } 100\text{kHz}$ | - | 100 | - | $\mu\text{V}/V_O$ |
| Ripple Rejection | RR | $f = 120\text{Hz}$, $I_O = 300\text{mA}$ $V_I = 18.5 \text{ to } 28.5\text{V}$, $T_J = +25^\circ\text{C}$ | - | 70 | - | dB |
| Dropout Voltage | V_D | $T_J = +25^\circ\text{C}$, $I_O = 500\text{mA}$ | - | 2 | - | V |
| Short Circuit Current | I_{SC} | $T_J = +25^\circ\text{C}$, $V_I = 35\text{V}$ | - | 300 | - | mA |
| Peak Current | I_{PK} | $T_J = +25^\circ\text{C}$ | - | 700 | - | mA |

Note:

1. Load and line regulation are specified at constant, junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Electrical Characteristics (KA78M18) (Continued)(Refer to the test circuits, $0 \leq T_J \leq +125^\circ\text{C}$, $I_O=350\text{mA}$, $V_I=26\text{V}$, unless otherwise specified, $C_I=0.33\mu\text{F}$, $C_O=0.1\mu\text{F}$)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--------------------------|---------------------|---|------|------|------|----------------------|
| Output Voltage | V_O | $T_J = +25^\circ\text{C}$ | 17.3 | 18 | 18.7 | V |
| | | $I_O = 5$ to 350mA $V_I = 20.5$ to 33V | 17.1 | 18 | 18.9 | |
| Line Regulation (Note1) | ΔV_O | $I_O = 200\text{mA}$ $T_J = +25^\circ\text{C}$ | - | - | 100 | mV |
| | | $V_I = 21$ to 33V $V_I = 24$ to 33V | - | - | 50 | |
| Load Regulation (Note1) | ΔV_O | $I_O = 5\text{mA}$ to 0.5A , $T_J = +25^\circ\text{C}$ | - | - | 360 | mV |
| | | $I_O = 5\text{mA}$ to 200mA , $T_J = +25^\circ\text{C}$ | - | - | 180 | |
| Quiescent Current | I_Q | $T_J = +25^\circ\text{C}$ | - | 4.2 | 6.0 | mA |
| Quiescent Current Change | ΔI_Q | $I_O = 5\text{mA}$ to 350mA | - | - | 0.5 | mA |
| | | $I_O = 200\text{mA}$ $V_I = 21$ to 33V | - | - | 0.8 | |
| Output Voltage Drift | $\Delta V/\Delta T$ | $I_O = 5\text{mA}$, $T_J = 0$ to 125°C | - | -1.1 | - | mV/ $^\circ\text{C}$ |
| Output Noise Voltage | V_N | $f = 10\text{Hz}$ to 100kHz | - | 100 | - | $\mu\text{V}/V_O$ |
| Ripple Rejection | RR | $f = 120\text{Hz}$, $I_O=300\text{mA}$, $V_I=22$ to 32V $T_J = +25^\circ\text{C}$ | - | 70 | - | dB |
| Dropout Voltage | V_D | $T_J = +25^\circ\text{C}$, $I_O=500\text{mA}$ | - | 2 | - | V |
| Short Circuit Current | I_{SC} | $T_J = +25^\circ\text{C}$, $V_I=35\text{V}$ | - | 300 | - | mA |
| Peak Current | I_{PK} | $T_J = +25^\circ\text{C}$ | - | 700 | - | mA |

Note:

1. Load and line regulation are specified at constant, junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Electrical Characteristics (KA78M24) (Continued)

(Refer to the test circuits, $0 \leq T_J \leq +125^\circ\text{C}$, $I_O=350\text{mA}$, $V_I=33\text{V}$, unless otherwise specified, $C_I=0.33\mu\text{F}$, $C_O=0.1\mu\text{F}$)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | |
|--------------------------|---------------------|---|----------------------------|------|------|----------------------|----|
| Output Voltage | V_O | $T_J = +25^\circ\text{C}$ | 23 | 24 | 25 | V | |
| | | $I_O = 5$ to 350mA $V_I = 27$ to 38V | 22.8 | 24 | 25.2 | | |
| Line Regulation | ΔV_O | $I_O = 200\text{mA}$ $T_J = +25^\circ\text{C}$ | $V_I = 27$ to 38V | - | - | 100 | mV |
| | | | $V_I = 28$ to 38V | - | - | 50 | |
| Load Regulation | ΔV_O | $I_O = 5\text{mA}$ to 0.5A , $T_J = +25^\circ\text{C}$ | - | - | 480 | mV | |
| | | $I_O = 5\text{mA}$ to 200mA , $T_J = +25^\circ\text{C}$ | - | - | 240 | | |
| Quiescent Current | I_Q | $T_J = +25^\circ\text{C}$ | - | 4.2 | 6 | mA | |
| Quiescent Current Change | ΔI_Q | $I_O = 5\text{mA}$ to 350mA | - | - | 0.5 | mA | |
| | | $I_O = 200\text{mA}$ $V_I = 27$ to 38V | - | - | 0.8 | | |
| Output Voltage Drift | $\Delta V/\Delta T$ | $I_O = 5\text{mA}$ $T_J = 0$ to $+125^\circ\text{C}$ | - | -1.2 | - | mV/ $^\circ\text{C}$ | |
| Output Noise Voltage | V_N | $f = 10\text{Hz}$ to 100kHz | - | 170 | - | μV | |
| Ripple Rejection | RR | $f = 120\text{Hz}$, $I_O = 300\text{mA}$ $V_I = 28$ to 38V , $T_J = +25^\circ\text{C}$ | - | 70 | - | dB | |
| Dropout Voltage | V_D | $T_J = +25^\circ\text{C}$, $I_O = 500\text{mA}$ | - | 2 | - | V | |
| Short Circuit Current | ISC | $T_J = +25^\circ\text{C}$, $V_I = 35\text{V}$ | - | 300 | - | mA | |
| Peak Current | IPK | $T_J = +25^\circ\text{C}$ | - | 700 | - | mA | |

Note:

1. Load and line regulation are specified at constant, junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Typical Applications

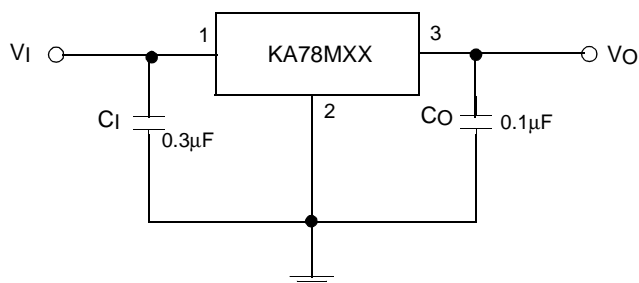


Figure 1. Fixed Output Regulator

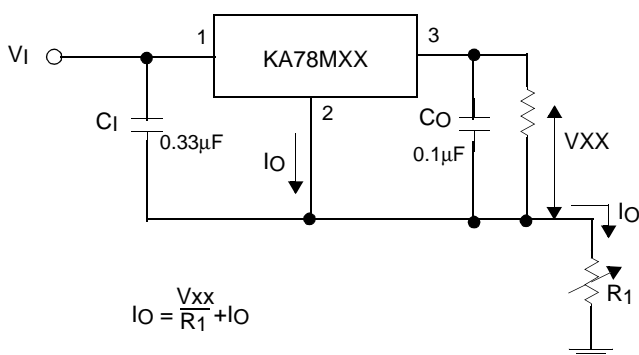


Figure 2. Constant Current Regulator

Notes:

1. To specify an output voltage, substitute voltage value for "XX"
2. Although no output capacitor is needed for stability, it does improve transient response.
3. Required if regulator is located an appreciable distance from power Supply filter

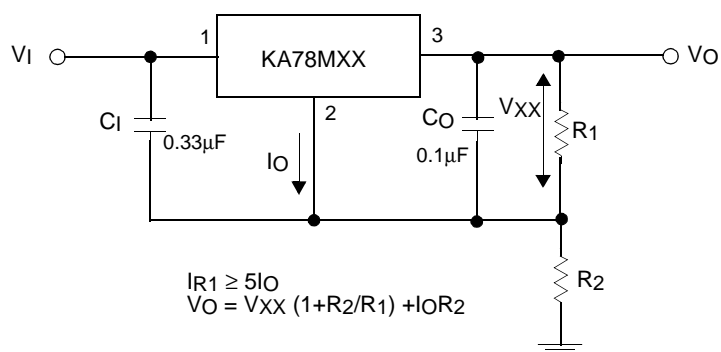


Figure 3. Circuit for Increasing Output Voltage

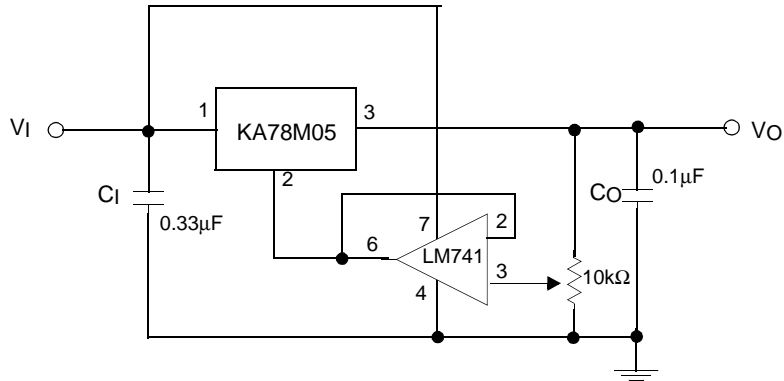


Figure 4. Adjustable Output Regulator (7 to 30V)

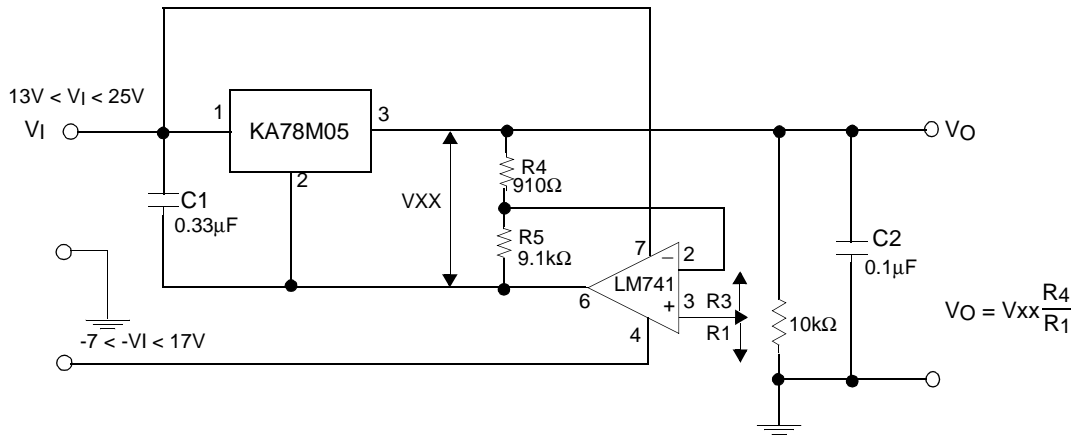


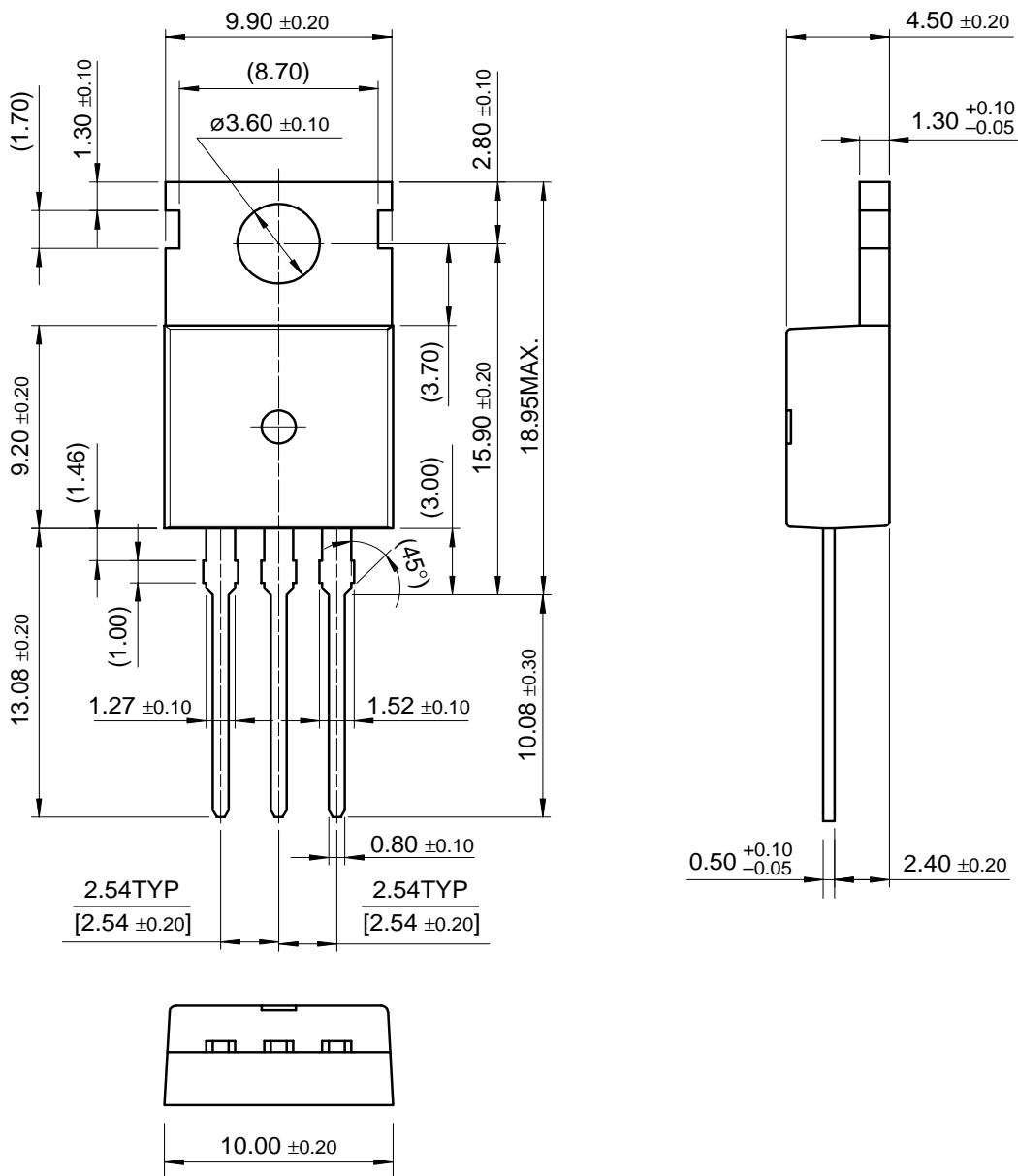
Figure 5. 0.5 to 10V Regulator

Mechanical Dimensions

Package

Dimensions in millimeters

TO-220



Ordering Information

| Product Number | Package | Operating Temperature |
|----------------|---------|-----------------------|
| KA78M05 | TO-220 | 0 ~ +125°C |
| KA78M06 | | |
| KA78M08 | | |
| KA78M12 | | |
| KA78M15 | | |
| KA78M18 | | |
| KA78M24 | | |
| KA78M05R | D-PAK | |
| KA78M06R | | |
| KA78M08R | | |
| KA78M12R | | |

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.