

# HA178M00 Series

3-terminal Fixed Voltage Regulators

# HITACHI

### Features

- Output current less than 500 mA
- Various output voltages: 5, 6, 7, 8, 9, 12, 15, 18, 20, and 24 V
- No external compensation circuit required
- Built-in current control circuit protects elements from destruction by short circuit
- Building chip junction temperature limiting circuit protects elements from thermal destruction
- Building internal power dissipation limiting circuit protects transistors in output stage

### Ordering Information

| Type              | Application    | Package    |
|-------------------|----------------|------------|
| HA178M00PJ Series | Automotive use | TO - 220AB |
| HA178M00P Series  | Industrial use |            |
| HA178M00 Series   | Commercial use |            |

### Output Voltage Accuracy Grade

| Type No. | Grade | Accuracy |
|----------|-------|----------|
| HA178M05 | None  | ±4       |
| HA178M12 | A     | ±2       |
|          | B     | ±3       |
|          | C     | +2, -4   |

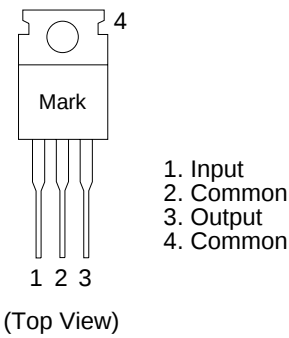
[www.DataSheet4U.com](http://www.DataSheet4U.com)



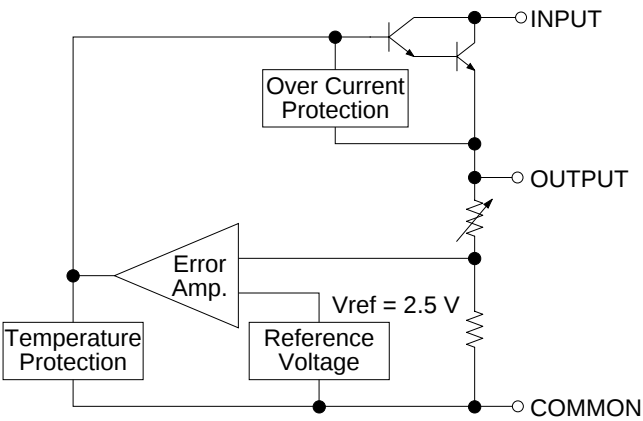
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# HA178M00 Series

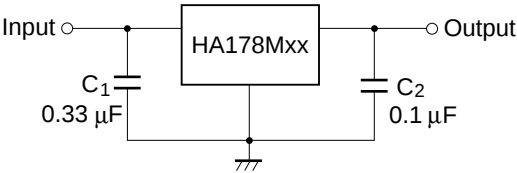
## Pin Arrangement



## Block Diagram



## Standard Circuit

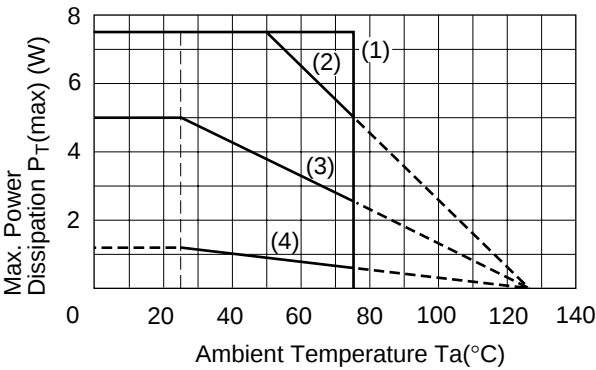


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Absolute Maximum Ratings (Ta = 25°C)

| Item                  | Symbol           | Rating      | Unit | Notes |
|-----------------------|------------------|-------------|------|-------|
| Input voltage         | V <sub>IN</sub>  | 35          | V    | 1     |
| Input voltage         | V <sub>IN</sub>  | 40          | V    | 2     |
| Power dissipation     | P <sub>T</sub>   | 7.5         | W    | 3     |
| Operating temperature | T <sub>opr</sub> | −20 to +75  | °C   |       |
| Junction temperature  | T <sub>j</sub>   | −20 to +125 | °C   |       |
| Storage temperature   | T <sub>stg</sub> | −55 to +125 | °C   |       |

Notes: 1. For HA178M05P–HA178M18P, HA178M05–HA178M18  
2. For HA178M20P, HA178M24P, HA178M20, HA178M24  
3. Follow derating curve



(1) Infinite heat sink  
(2) 5°C/W heat sink  
(3) 15°C/W heat sink  
(4) No heat sink

) Include fixed thermal resistance

Thermal resistance  
θ<sub>jc</sub> = 3.0°C/W (typ)  
5.0°C/W (max)  
θ<sub>ja</sub> = 62°C/W (typ)  
72°C/W (max)

HA178M05P/PJ, HA178M05 Electrical Characteristics (V<sub>IN</sub> = 10 V, I<sub>OUT</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C, C<sub>IN</sub> = 0.33 μF, C<sub>OUT</sub> = 0.1 μF, unless otherwise specified)

| Item                                      | Symbol                             | Min  | Typ  | Max  | Unit  | Test Conditions                                                                           |
|-------------------------------------------|------------------------------------|------|------|------|-------|-------------------------------------------------------------------------------------------|
| Output voltage                            | V <sub>OUT</sub>                   | 4.8  | 5.0  | 5.2  | V     | T <sub>j</sub> = 25°C                                                                     |
|                                           |                                    | 4.75 | —    | 5.25 |       | 7 V ≤ V <sub>IN</sub> ≤ 20 V,<br>5 mA ≤ I <sub>OUT</sub> ≤ 350 mA, P <sub>T</sub> ≤ 7.5 W |
| Line regulation                           | δV <sub>O Line</sub>               | —    | 3    | 100  | mV    | T <sub>j</sub> = 25°C 7 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA          |
|                                           |                                    | —    | 1    | 50   |       | 8 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA                                |
| Load regulation                           | δV <sub>O Load</sub>               | —    | 20   | 100  | mV    | T <sub>j</sub> = 25°C 5 mA ≤ I <sub>OUT</sub> ≤ 500 mA                                    |
|                                           |                                    | —    | 10   | 50   |       | 5 mA ≤ I <sub>OUT</sub> ≤ 200 mA                                                          |
| Quiescent current                         | I <sub>Q</sub>                     | —    | 4.5  | 6.0  | mA    | T <sub>j</sub> = 25°C, I <sub>OUT</sub> = 0                                               |
| Quiescent current change                  | δI <sub>Q</sub>                    | —    | —    | 0.8  | mA    | 8 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA                                |
|                                           |                                    | —    | —    | 0.5  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA                                                          |
| Output noise voltage                      | V <sub>n</sub>                     | —    | 40   | —    | μV    | T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz                                                |
| Ripple rejection ratio                    | R <sub>REJ</sub>                   | —    | 80   | —    | dB    | f = 120 Hz I <sub>OUT</sub> = 100 mA                                                      |
|                                           |                                    | —    | 80   | —    |       | T <sub>j</sub> = 25°C I <sub>OUT</sub> = 300 mA                                           |
| Dropout voltage                           | V <sub>drop</sub>                  | —    | 2.0  | —    | V     | I <sub>OUT</sub> = 350 mA, T <sub>j</sub> = 25°C                                          |
| Output short-circuit current              | I <sub>OS</sub>                    | —    | 300  | —    | mA    | T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V                                             |
| Peak output current                       | I <sub>o peak</sub>                | —    | 700  | —    | mA    | T <sub>j</sub> = 25°C                                                                     |
| Temperature coefficient of output voltage | δV <sub>OUT</sub> /δT <sub>j</sub> | —    | −1.0 | —    | mV/°C | I <sub>OUT</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C                                     |

HA178M06P/PJ, HA178M06 Electrical Characteristics (V<sub>IN</sub> = 11 V, I<sub>OUT</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C, C<sub>IN</sub> = 0.33 μF, C<sub>OUT</sub> = 0.1 μF, unless otherwise specified)

| Item                                      | Symbol                             | Min  | Typ  | Max  | Unit  | Test Conditions                                                                           |
|-------------------------------------------|------------------------------------|------|------|------|-------|-------------------------------------------------------------------------------------------|
| Output voltage                            | V <sub>OUT</sub>                   | 5.75 | 6.0  | 6.25 | V     | T <sub>j</sub> = 25°C                                                                     |
|                                           |                                    | 5.7  | —    | 6.3  |       | 8 V ≤ V <sub>IN</sub> ≤ 21 V,<br>5 mA ≤ I <sub>OUT</sub> ≤ 350 mA, P <sub>T</sub> ≤ 7.5 W |
| Line regulation                           | δV <sub>O Line</sub>               | —    | 5    | 120  | mV    | T <sub>j</sub> = 25°C 8 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA          |
|                                           |                                    | —    | 1.5  | 60   |       | 9 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA                                |
| Load regulation                           | δV <sub>O Load</sub>               | —    | 20   | 120  | mV    | T <sub>j</sub> = 25°C 5 mA ≤ I <sub>OUT</sub> ≤ 500 mA                                    |
|                                           |                                    | —    | 10   | 60   |       | 5 mA ≤ I <sub>OUT</sub> ≤ 200 mA                                                          |
| Quiescent current                         | I <sub>Q</sub>                     | —    | 4.5  | 6.0  | mA    | T <sub>j</sub> = 25°C, I <sub>OUT</sub> = 0                                               |
| Quiescent current change                  | δI <sub>Q</sub>                    | —    | —    | 0.8  | mA    | 9 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA                                |
|                                           |                                    | —    | —    | 0.5  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA                                                          |
| Output noise voltage                      | V <sub>n</sub>                     | —    | 45   | —    | μV    | T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz                                                |
| Ripple rejection ratio                    | R <sub>REJ</sub>                   | —    | 80   | —    | dB    | f = 120 Hz I <sub>OUT</sub> = 100 mA                                                      |
|                                           |                                    | —    | 80   | —    |       | T <sub>j</sub> = 25°C I <sub>OUT</sub> = 300 mA                                           |
| Dropout voltage                           | V <sub>drop</sub>                  | —    | 2.0  | —    | V     | I <sub>OUT</sub> = 350 mA, T <sub>j</sub> = 25°C                                          |
| Output short-circuit current              | I <sub>OS</sub>                    | —    | 270  | —    | mA    | T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V                                             |
| Peak output current                       | I <sub>o peak</sub>                | —    | 700  | —    | mA    | T <sub>j</sub> = 25°C                                                                     |
| Temperature coefficient of output voltage | δV <sub>OUT</sub> /δV <sub>j</sub> | —    | −0.5 | —    | mV/°C | I <sub>OUT</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C                                     |

HA178M00 Series

HA178M07P/PJ, HA178M07 Electrical Characteristics ( $V_{IN} = 12.5\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^{\circ}\text{C} \leq T_j \leq 125^{\circ}\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

| Item                                      | Symbol                      | Min  | Typ  | Max  | Unit                   | Test Conditions                                                                                                        |
|-------------------------------------------|-----------------------------|------|------|------|------------------------|------------------------------------------------------------------------------------------------------------------------|
| Output voltage                            | $V_{OUT}$                   | 6.72 | 7.0  | 7.28 | V                      | $T_j = 25^{\circ}\text{C}$                                                                                             |
|                                           |                             | 6.65 | —    | 7.35 |                        | $9\text{ V} \leq V_{IN} \leq 22\text{ V}$ ,<br>$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$ |
| Line regulation                           | $\delta V_{O\text{ Line}}$  | —    | 5.5  | 140  | mV                     | $T_j = 25^{\circ}\text{C}$ $9\text{ V} \leq V_{IN} \leq 25\text{ V}$ ,<br>$I_{OUT} = 200\text{ mA}$                    |
|                                           |                             | —    | 1.7  | 70   |                        | $10\text{ V} \leq V_{IN} \leq 25\text{ V}$ ,<br>$I_{OUT} = 200\text{ mA}$                                              |
| Load regulation                           | $\delta V_{O\text{ Load}}$  | —    | 23   | 140  | mV                     | $T_j = 25^{\circ}\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$                                               |
|                                           |                             | —    | 10   | 70   |                        | $5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$                                                                          |
| Quiescent current                         | $I_Q$                       | —    | 4.6  | 6.0  | mA                     | $T_j = 25^{\circ}\text{C}$ , $I_{OUT} = 0$                                                                             |
| Quiescent current change                  | $\delta I_Q$                | —    | —    | 0.8  | mA                     | $10\text{ V} \leq V_{IN} \leq 25\text{ V}$ ,<br>$I_{OUT} = 200\text{ mA}$                                              |
|                                           |                             | —    | —    | 0.5  |                        | $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$                                                                          |
| Output noise voltage                      | $V_n$                       | —    | 48.5 | —    | $\mu\text{V}$          | $T_a = 25^{\circ}\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$                                                 |
| Ripple rejection ratio                    | $R_{REJ}$                   | —    | 80   | —    | dB                     | $f = 120\text{ Hz}$ $I_{OUT} = 100\text{ mA}$                                                                          |
|                                           |                             | —    | 80   | —    |                        | $T_j = 25^{\circ}\text{C}$ $I_{OUT} = 300\text{ mA}$                                                                   |
| Dropout voltage                           | $V_{drop}$                  | —    | 2.0  | —    | V                      | $I_{OUT} = 350\text{ mA}$ , $T_j = 25^{\circ}\text{C}$                                                                 |
| Output short-circuit current              | $I_{OS}$                    | —    | 260  | —    | mA                     | $T_j = 25^{\circ}\text{C}$ , $V_{IN} = 35\text{ V}$                                                                    |
| Peak output current                       | $I_{o\text{ peak}}$         | —    | 700  | —    | mA                     | $T_j = 25^{\circ}\text{C}$                                                                                             |
| Temperature coefficient of output voltage | $\delta V_{OUT}/\delta T_j$ | —    | −0.5 | —    | mV/ $^{\circ}\text{C}$ | $I_{OUT} = 5\text{ mA}$ , $0^{\circ}\text{C} \leq T_j \leq 125^{\circ}\text{C}$                                        |

HA178M08P/PJ, HA178M08 Electrical Characteristics (V<sub>IN</sub> = 14 V, I<sub>OUT</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C, C<sub>IN</sub> = 0.33 μF, C<sub>OUT</sub> = 0.1 μF, unless otherwise specified)

| Item                                      | Symbol                             | Min | Typ  | Max | Unit  | Test Conditions                                                                              |
|-------------------------------------------|------------------------------------|-----|------|-----|-------|----------------------------------------------------------------------------------------------|
| Output voltage                            | V <sub>OUT</sub>                   | 7.7 | 8.0  | 8.3 | V     | T <sub>j</sub> = 25°C                                                                        |
|                                           |                                    | 7.6 | —    | 8.4 |       | 10.5 V ≤ V <sub>IN</sub> ≤ 23 V,<br>5 mA ≤ I <sub>OUT</sub> ≤ 350 mA, P <sub>T</sub> ≤ 7.5 W |
| Line regulation                           | δV <sub>O Line</sub>               | —   | 6.0  | 160 | mV    | T <sub>j</sub> = 25°C 10.5 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA          |
|                                           |                                    | —   | 2.0  | 80  |       | 11 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA                                  |
| Load regulation                           | δV <sub>O Load</sub>               | —   | 25   | 160 | mV    | T <sub>j</sub> = 25°C 5 mA ≤ I <sub>OUT</sub> ≤ 500 mA                                       |
|                                           |                                    | —   | 10   | 80  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 200 mA                                                             |
| Quiescent current                         | I <sub>Q</sub>                     | —   | 4.6  | 6.0 | mA    | T <sub>j</sub> = 25°C, I <sub>OUT</sub> = 0                                                  |
| Quiescent current change                  | δI <sub>Q</sub>                    | —   | —    | 0.8 | mA    | 10.5 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA                                |
|                                           |                                    | —   | —    | 0.5 |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA                                                             |
| Output noise voltage                      | V <sub>n</sub>                     | —   | 52   | —   | μV    | T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz                                                   |
| Ripple rejection ratio                    | R <sub>REJ</sub>                   | —   | 80   | —   | dB    | f = 120 Hz I <sub>OUT</sub> = 100 mA                                                         |
|                                           |                                    | —   | 80   | —   |       | T <sub>j</sub> = 25°C I <sub>OUT</sub> = 300 mA                                              |
| Dropout voltage                           | V <sub>drop</sub>                  | —   | 2.0  | —   | V     | I <sub>OUT</sub> = 350 mA, T <sub>j</sub> = 25°C                                             |
| Output short-circuit current              | I <sub>OS</sub>                    | —   | 250  | —   | mA    | T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V                                                |
| Peak output current                       | I <sub>o peak</sub>                | —   | 700  | —   | mA    | T <sub>j</sub> = 25°C                                                                        |
| Temperature coefficient of output voltage | δV <sub>OUT</sub> /δT <sub>j</sub> | —   | −0.5 | —   | mV/°C | I <sub>OUT</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C                                        |

HA178M00 Series

HA178M09P/PJ, HA178M09 Electrical Characteristics (V<sub>IN</sub> = 15 V, I<sub>OUT</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C, C<sub>IN</sub> = 0.33 μF, C<sub>OUT</sub> = 0.1 μF, unless otherwise specified)

| Item                                      | Symbol                             | Min  | Typ  | Max  | Unit  | Test Conditions                                                                              |
|-------------------------------------------|------------------------------------|------|------|------|-------|----------------------------------------------------------------------------------------------|
| Output voltage                            | V <sub>OUT</sub>                   | 8.64 | 9.0  | 9.36 | V     | T <sub>j</sub> = 25°C                                                                        |
|                                           |                                    | 8.55 | —    | 9.45 |       | 11.5 V ≤ V <sub>IN</sub> ≤ 24 V,<br>5 mA ≤ I <sub>OUT</sub> ≤ 350 mA, P <sub>T</sub> ≤ 7.5 W |
| Line regulation                           | δV <sub>O Line</sub>               | —    | 7.0  | 180  | mV    | T <sub>j</sub> = 25°C 11.5 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA          |
|                                           |                                    | —    | 2.5  | 90   |       | 12 V ≤ V <sub>IN</sub> ≤ 25 V<br>I <sub>OUT</sub> = 200 mA                                   |
| Load regulation                           | δV <sub>O Load</sub>               | —    | 25   | 200  | mV    | T <sub>j</sub> = 25°C 5 mA ≤ I <sub>OUT</sub> ≤ 500 mA                                       |
|                                           |                                    | —    | 10   | 100  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 200 mA                                                             |
| Quiescent current                         | I <sub>Q</sub>                     | —    | 4.6  | 6.0  | mA    | T <sub>j</sub> = 25°C, I <sub>OUT</sub> = 0                                                  |
| Quiescent current change                  | δI <sub>Q</sub>                    | —    | —    | 0.8  | mA    | 12 V ≤ V <sub>IN</sub> ≤ 25 V,<br>I <sub>OUT</sub> = 200 mA                                  |
|                                           |                                    | —    | —    | 0.5  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA                                                             |
| Output noise voltage                      | V <sub>n</sub>                     | —    | 52   | —    | μV    | T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz                                                   |
| Ripple rejection ratio                    | R <sub>REJ</sub>                   | —    | 80   | —    | dB    | f = 120 Hz I <sub>OUT</sub> = 100 mA                                                         |
|                                           |                                    | —    | 80   | —    |       | T <sub>j</sub> = 25°C I <sub>OUT</sub> = 300 mA                                              |
| Dropout voltage                           | V <sub>drop</sub>                  | —    | 2.0  | —    | V     | I <sub>OUT</sub> = 350 mA, T <sub>j</sub> = 25°C                                             |
| Output short-circuit current              | I <sub>OS</sub>                    | —    | 250  | —    | mA    | T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V                                                |
| Peak output current                       | I <sub>o peak</sub>                | —    | 700  | —    | mA    | T <sub>j</sub> = 25°C                                                                        |
| Temperature coefficient of output voltage | δV <sub>OUT</sub> /δT <sub>j</sub> | —    | −0.9 | —    | mV/°C | I <sub>OUT</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C                                        |

HA178M12P/PJ, HA178M12 Electrical Characteristics (V<sub>IN</sub> = 19 V, I<sub>OUT</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C, C<sub>IN</sub> = 0.33 μF, C<sub>OUT</sub> = 0.1 μF, unless otherwise specified)

| Item                                      | Symbol                             | Min  | Typ  | Max  | Unit  | Test Conditions                                                                              |
|-------------------------------------------|------------------------------------|------|------|------|-------|----------------------------------------------------------------------------------------------|
| Output voltage                            | V <sub>OUT</sub>                   | 11.5 | 12.0 | 12.5 | V     | T <sub>j</sub> = 25°C                                                                        |
|                                           |                                    | 11.4 | —    | 12.6 |       | 14.5 V ≤ V <sub>IN</sub> ≤ 27 V,<br>5 mA ≤ I <sub>OUT</sub> ≤ 350 mA, P <sub>T</sub> ≤ 7.5 W |
| Line regulation                           | δV <sub>O Line</sub>               | —    | 10   | 240  | mV    | T <sub>j</sub> = 25°C 14.5 V ≤ V <sub>IN</sub> ≤ 30 V,<br>I <sub>OUT</sub> = 200 mA          |
|                                           |                                    | —    | 3.0  | 120  |       | 16 V ≤ V <sub>IN</sub> ≤ 30 V,<br>I <sub>OUT</sub> = 200 mA                                  |
| Load regulation                           | δV <sub>O Load</sub>               | —    | 25   | 240  | mV    | T <sub>j</sub> = 25°C 5 mA ≤ I <sub>OUT</sub> ≤ 500 mA                                       |
|                                           |                                    | —    | 10   | 120  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 200 mA                                                             |
| Quiescent current                         | I <sub>Q</sub>                     | —    | 4.8  | 6.0  | mA    | T <sub>j</sub> = 25°C, I <sub>OUT</sub> = 0                                                  |
| Quiescent current change                  | δI <sub>Q</sub>                    | —    | —    | 0.8  | mA    | 14.5 V ≤ V <sub>IN</sub> ≤ 30 V,<br>I <sub>OUT</sub> = 200 mA                                |
|                                           |                                    | —    | —    | 0.5  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA                                                             |
| Output noise voltage                      | V <sub>n</sub>                     | —    | 75   | —    | μV    | T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz                                                   |
| Ripple rejection ratio                    | R <sub>REJ</sub>                   | —    | 80   | —    | dB    | f = 120 Hz I <sub>OUT</sub> = 100 mA                                                         |
|                                           |                                    | —    | 80   | —    |       | T <sub>j</sub> = 25°C I <sub>OUT</sub> = 300 mA                                              |
| Dropout voltage                           | V <sub>drop</sub>                  | —    | 2.0  | —    | V     | I <sub>OUT</sub> = 350 mA, T <sub>j</sub> = 25°C                                             |
| Output short-circuit current              | I <sub>OS</sub>                    | —    | 240  | —    | mA    | T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V                                                |
| Peak output current                       | I <sub>o peak</sub>                | —    | 700  | —    | mA    | T <sub>j</sub> = 25°C                                                                        |
| Temperature coefficient of output voltage | δV <sub>OUT</sub> /δT <sub>j</sub> | —    | −1.0 | —    | mV/°C | I <sub>OUT</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C                                        |

HA178M00 Series

HA178M15P/PJ, HA178M15 Electrical Characteristics (V<sub>IN</sub> = 23 V, I<sub>OUT</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C, C<sub>IN</sub> = 0.33 μF, C<sub>OUT</sub> = 0.1 μF, unless otherwise specified)

| Item                                      | Symbol                             | Min   | Typ  | Max   | Unit  | Test Conditions                                                                              |
|-------------------------------------------|------------------------------------|-------|------|-------|-------|----------------------------------------------------------------------------------------------|
| Output voltage                            | V <sub>OUT</sub>                   | 14.4  | 15.0 | 15.6  | V     | T <sub>j</sub> = 25°C                                                                        |
|                                           |                                    | 14.25 | —    | 15.75 |       | 17.5 V ≤ V <sub>IN</sub> ≤ 30 V,<br>5 mA ≤ I <sub>OUT</sub> ≤ 350 mA, P <sub>T</sub> ≤ 7.5 W |
| Line regulation                           | δV <sub>O Line</sub>               | —     | 11   | 300   | mV    | T <sub>j</sub> = 25°C 17.5 V ≤ V <sub>IN</sub> ≤ 30 V,<br>I <sub>OUT</sub> = 200 mA          |
|                                           |                                    | —     | 3.0  | 150   |       | 20 V ≤ V <sub>IN</sub> ≤ 30 V,<br>I <sub>OUT</sub> = 200 mA                                  |
| Load regulation                           | δV <sub>O Load</sub>               | —     | 25   | 300   | mV    | T <sub>j</sub> = 25°C 5 mA ≤ I <sub>OUT</sub> ≤ 500 mA                                       |
|                                           |                                    | —     | 10   | 150   |       | 5 mA ≤ I <sub>OUT</sub> ≤ 200 mA                                                             |
| Quiescent current                         | I <sub>Q</sub>                     | —     | 4.8  | 6.0   | mA    | T <sub>j</sub> = 25°C, I <sub>OUT</sub> = 0                                                  |
| Quiescent current change                  | δI <sub>Q</sub>                    | —     | —    | 0.8   | mA    | 17.5 V ≤ V <sub>IN</sub> ≤ 30 V,<br>I <sub>OUT</sub> = 200 mA                                |
|                                           |                                    | —     | —    | 0.5   |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA                                                             |
| Output noise voltage                      | V <sub>n</sub>                     | —     | 90   | —     | μV    | T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz                                                   |
| Ripple rejection ratio                    | R <sub>REJ</sub>                   | —     | 70   | —     | dB    | f = 120 Hz I <sub>OUT</sub> = 100 mA                                                         |
|                                           |                                    | —     | 70   | —     |       | T <sub>j</sub> = 25°C I <sub>OUT</sub> = 300 mA                                              |
| Dropout voltage                           | V <sub>drop</sub>                  | —     | 2.0  | —     | V     | I <sub>OUT</sub> = 350 mA, T <sub>j</sub> = 25°C                                             |
| Output short-circuit current              | I <sub>OS</sub>                    | —     | 240  | —     | mA    | T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V                                                |
| Peak output current                       | I <sub>o peak</sub>                | —     | 700  | —     | mA    | T <sub>j</sub> = 25°C                                                                        |
| Temperature coefficient of output voltage | δV <sub>OUT</sub> /δT <sub>j</sub> | —     | −1.0 | —     | mV/°C | I <sub>OUT</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C                                        |

**HA178M18P/PJ, HA178M18 Electrical Characteristics** ( $V_{IN} = 27\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

| Item                                      | Symbol                      | Min  | Typ  | Max  | Unit                       | Test Conditions                                                                                                         |
|-------------------------------------------|-----------------------------|------|------|------|----------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Output voltage                            | $V_{OUT}$                   | 17.3 | 18.0 | 18.7 | V                          | $T_j = 25^\circ\text{C}$                                                                                                |
|                                           |                             | 17.1 | —    | 18.9 |                            | $21\text{ V} \leq V_{IN} \leq 33\text{ V}$ ,<br>$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$ |
| Line regulation                           | $dV_{O\text{ Line}}$        | —    | 15   | 360  | mV                         | $T_j = 25^\circ\text{C}$ $21\text{ V} \leq V_{IN} \leq 33\text{ V}$ ,<br>$I_{OUT} = 200\text{ mA}$                      |
|                                           |                             | —    | 5.0  | 180  |                            | $24\text{ V} \leq V_{IN} \leq 33\text{ V}$ ,<br>$I_{OUT} = 200\text{ mA}$                                               |
| Load regulation                           | $\delta V_{O\text{ Load}}$  | —    | 25   | 360  | mV                         | $T_j = 25^\circ\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$                                                  |
|                                           |                             | —    | 10   | 180  |                            | $5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$                                                                           |
| Quiescent current                         | $I_Q$                       | —    | 4.8  | 6.0  | mA                         | $T_j = 25^\circ\text{C}$ , $I_{OUT} = 0$                                                                                |
| Quiescent current change                  | $\delta I_Q$                | —    | —    | 0.8  | mA                         | $21\text{ V} \leq V_{IN} \leq 35\text{ V}$ ,<br>$I_{OUT} = 200\text{ mA}$                                               |
|                                           |                             | —    | —    | 0.5  |                            | $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$                                                                           |
| Output noise voltage                      | $V_n$                       | —    | 110  | —    | $\mu\text{V}$              | $T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$                                                    |
| Ripple rejection ratio                    | $R_{REJ}$                   | —    | 70   | —    | dB                         | $f = 120\text{ Hz}$ $I_{OUT} = 100\text{ mA}$                                                                           |
|                                           |                             | —    | 70   | —    |                            | $T_j = 25^\circ\text{C}$ $I_{OUT} = 300\text{ mA}$                                                                      |
| Dropout voltage                           | $V_{drop}$                  | —    | 2.0  | —    | V                          | $I_{OUT} = 350\text{ mA}$ , $T_j = 25^\circ\text{C}$                                                                    |
| Output short-circuit current              | $I_{OS}$                    | —    | 240  | —    | mA                         | $T_j = 25^\circ\text{C}$ , $V_{IN} = 35\text{ V}$                                                                       |
| Peak output current                       | $I_{o\text{ peak}}$         | —    | 700  | —    | mA                         | $T_j = 25^\circ\text{C}$                                                                                                |
| Temperature coefficient of output voltage | $\delta V_{OUT}/\delta T_j$ | —    | −1.0 | —    | $\text{mV}/^\circ\text{C}$ | $I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$                                             |

HA178M00 Series

HA178M20P/PJ, HA178M20 Electrical Characteristics (V<sub>IN</sub> = 29 V, I<sub>OUT</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C, C<sub>IN</sub> = 0.33 μF, C<sub>OUT</sub> = 0.1 μF, unless otherwise specified)

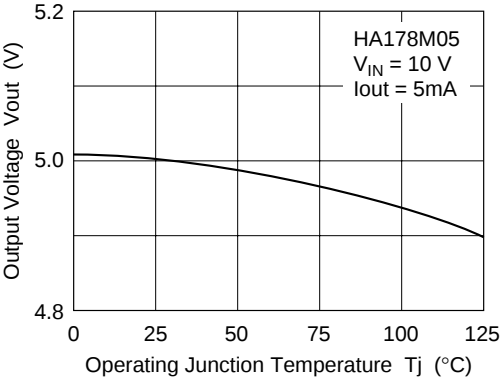
| Item                                      | Symbol                             | Min  | Typ  | Max  | Unit  | Test Conditions                                                                            |
|-------------------------------------------|------------------------------------|------|------|------|-------|--------------------------------------------------------------------------------------------|
| Output voltage                            | V <sub>OUT</sub>                   | 19.2 | 20   | 20.8 | V     | T <sub>j</sub> = 25°C                                                                      |
|                                           |                                    | 19   | —    | 21   |       | 23 V ≤ V <sub>IN</sub> ≤ 35 V,<br>5 mA ≤ I <sub>OUT</sub> ≤ 350 mA, P <sub>T</sub> ≤ 7.5 W |
| Line regulation                           | δV <sub>O Line</sub>               | —    | 17   | 400  | mV    | T <sub>j</sub> = 25°C 23 V ≤ V <sub>IN</sub> ≤ 35 V,<br>I <sub>OUT</sub> = 200 mA          |
|                                           |                                    | —    | 6.0  | 200  |       | 24 V ≤ V <sub>IN</sub> ≤ 35 V,<br>I <sub>OUT</sub> = 200 mA                                |
| Load regulation                           | δV <sub>O Load</sub>               | —    | 30   | 400  | mV    | T <sub>j</sub> = 25°C 5 mA ≤ I <sub>OUT</sub> ≤ 500 mA                                     |
|                                           |                                    | —    | 10   | 200  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 200 mA                                                           |
| Quiescent current                         | I <sub>Q</sub>                     | —    | 4.9  | 6.0  | mA    | T <sub>j</sub> = 25°C, I <sub>OUT</sub> = 0                                                |
| Quiescent current change                  | δI <sub>Q</sub>                    | —    | —    | 0.8  | mA    | 23 V ≤ V <sub>IN</sub> ≤ 35 V,<br>I <sub>OUT</sub> = 200 mA                                |
|                                           |                                    | —    | —    | 0.5  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA                                                           |
| Output noise voltage                      | V <sub>n</sub>                     | —    | 110  | —    | μV    | T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz                                                 |
| Ripple rejection ratio                    | R <sub>REJ</sub>                   | —    | 70   | —    | dB    | f = 120 Hz I <sub>OUT</sub> = 100 mA                                                       |
|                                           |                                    | —    | 70   | —    |       | T <sub>j</sub> = 25°C I <sub>OUT</sub> = 300 mA                                            |
| Dropout voltage                           | V <sub>drop</sub>                  | —    | 2.0  | —    | V     | I <sub>OUT</sub> = 350 mA, T <sub>j</sub> = 25°C                                           |
| Output short-circuit current              | I <sub>OS</sub>                    | —    | 240  | —    | mA    | T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V                                              |
| Peak output current                       | I <sub>o peak</sub>                | —    | 700  | —    | mA    | T <sub>j</sub> = 25°C                                                                      |
| Temperature coefficient of output voltage | δV <sub>OUT</sub> /δT <sub>j</sub> | —    | −1.1 | —    | mV/°C | I <sub>OUT</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C                                      |

HA178M24P/PJ, HA178M24 Electrical Characteristics (V<sub>IN</sub> = 33 V, I<sub>OUT</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C, C<sub>IN</sub> = 0.33 μF, C<sub>OUT</sub> = 0.1 μF, unless otherwise specified)

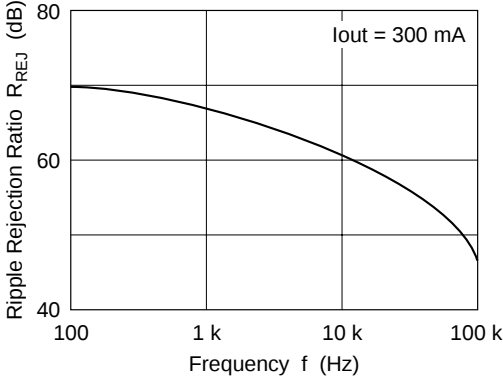
| Item                                      | Symbol                             | Min  | Typ  | Max  | Unit  | Test Conditions                                                                |
|-------------------------------------------|------------------------------------|------|------|------|-------|--------------------------------------------------------------------------------|
| Output voltage                            | V <sub>OUT</sub>                   | 23.0 | 24.0 | 25.0 | V     | T <sub>j</sub> = 25°C                                                          |
|                                           |                                    | 22.8 | —    | 25.2 |       | 27 V ≤ V <sub>IN</sub> ≤ 38 V,                                                 |
|                                           |                                    |      |      |      |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA, P <sub>T</sub> ≤ 7.5 W                       |
| Line regulation                           | δV <sub>O Line</sub>               | —    | 18   | 480  | mV    | T <sub>j</sub> = 25°C 27 V ≤ V <sub>IN</sub> ≤ 38 V, I <sub>OUT</sub> = 200 mA |
|                                           |                                    | —    | 6.0  | 240  |       | 28 V ≤ V <sub>IN</sub> ≤ 38 V, I <sub>OUT</sub> = 200 mA                       |
|                                           |                                    |      |      |      |       |                                                                                |
| Load regulation                           | δV <sub>O Load</sub>               | —    | 30   | 480  | mV    | T <sub>j</sub> = 25°C 5 mA ≤ I <sub>OUT</sub> ≤ 500 mA                         |
|                                           |                                    | —    | 10   | 240  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 200 mA                                               |
|                                           |                                    |      |      |      |       |                                                                                |
| Quiescent current                         | I <sub>Q</sub>                     | —    | 5.0  | 8.0  | mA    | T <sub>j</sub> = 25°C, I <sub>OUT</sub> = 0                                    |
| Quiescent current change                  | δI <sub>Q</sub>                    | —    | —    | 0.8  | mA    | 27 V ≤ V <sub>IN</sub> ≤ 38 V, I <sub>OUT</sub> = 200 mA                       |
|                                           |                                    | —    | —    | 0.5  |       | 5 mA ≤ I <sub>OUT</sub> ≤ 350 mA                                               |
|                                           |                                    |      |      |      |       |                                                                                |
| Output noise voltage                      | V <sub>n</sub>                     | —    | 170  | —    | μV    | T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz                                     |
| Ripple rejection ratio                    | R <sub>REJ</sub>                   | —    | 70   | —    | dB    | f = 120 Hz I <sub>OUT</sub> = 100 mA                                           |
|                                           |                                    | —    | 70   | —    |       | T <sub>j</sub> = 25°C I <sub>OUT</sub> = 300 mA                                |
|                                           |                                    |      |      |      |       |                                                                                |
| Dropout voltage                           | V <sub>drop</sub>                  | —    | 2.0  | —    | V     | I <sub>OUT</sub> = 350 mA, T <sub>j</sub> = 25°C                               |
| Output short-circuit current              | I <sub>OS</sub>                    | —    | 240  | —    | mA    | T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V                                  |
| Peak output current                       | I <sub>o peak</sub>                | —    | 700  | —    | mA    | T <sub>j</sub> = 25°C                                                          |
| Temperature coefficient of output voltage | δV <sub>OUT</sub> /δT <sub>j</sub> | —    | −1.2 | —    | mV/°C | I <sub>OUT</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C                          |

Characteristic Curves

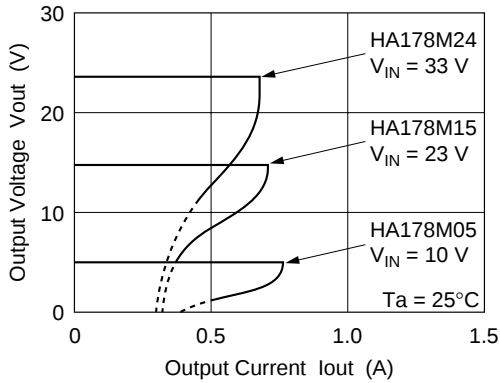
Output Voltage vs. Operating Junction Temperature (1)



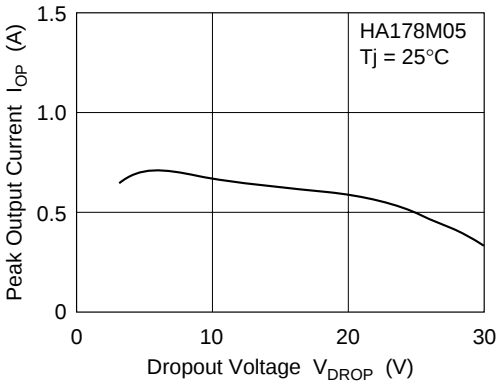
Ripple Rejection Ratio vs. Frequency



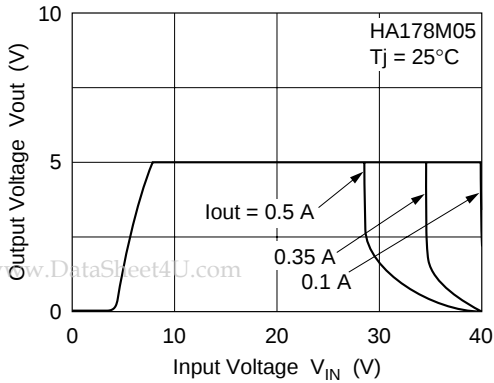
Output Voltage vs. Output Current



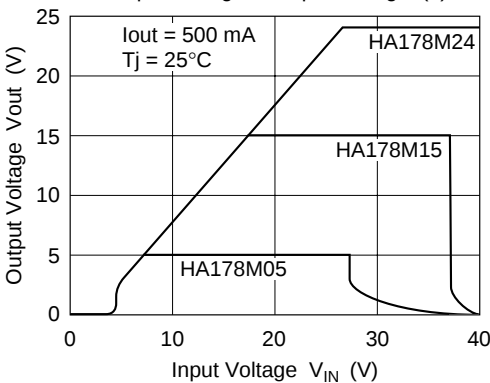
Peak Output Current vs. Dropout Voltage

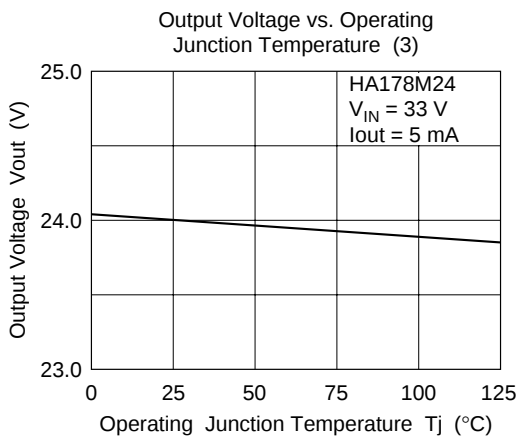
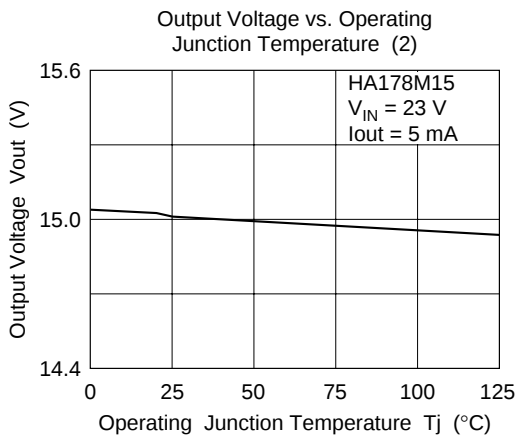
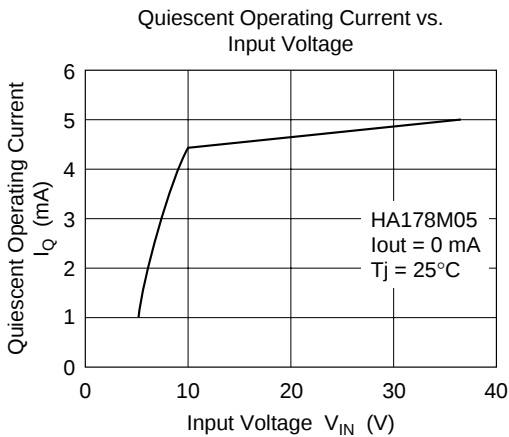


Output Voltage vs. Input Voltage (1)



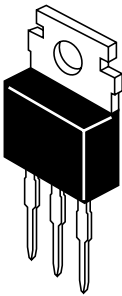
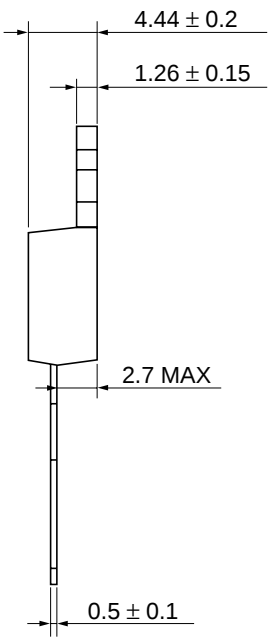
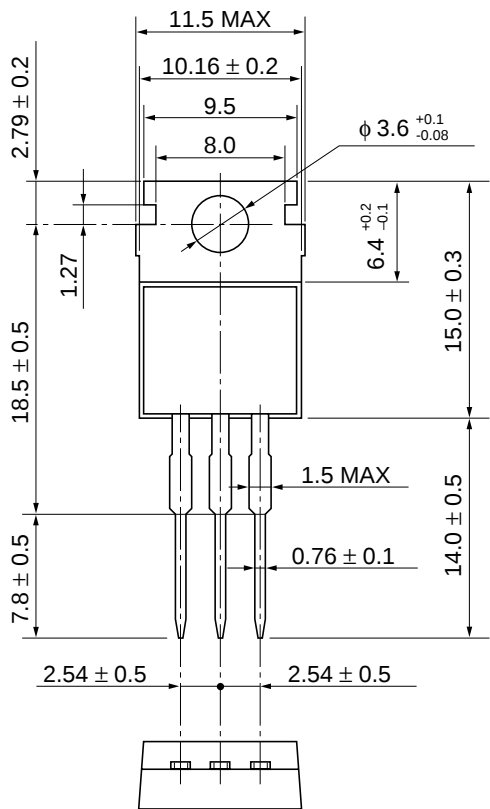
Output Voltage vs. Input Voltage (2)





Package Dimensions

Unit: mm



|                        |          |
|------------------------|----------|
| Hitachi Code           | TO-220AB |
| JEDEC                  | Conforms |
| EIAJ                   | Conforms |
| Mass (reference value) | 1.8 g    |

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