

# 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

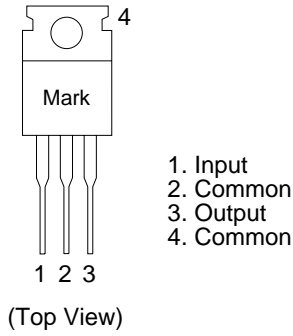
### Ordering Information

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

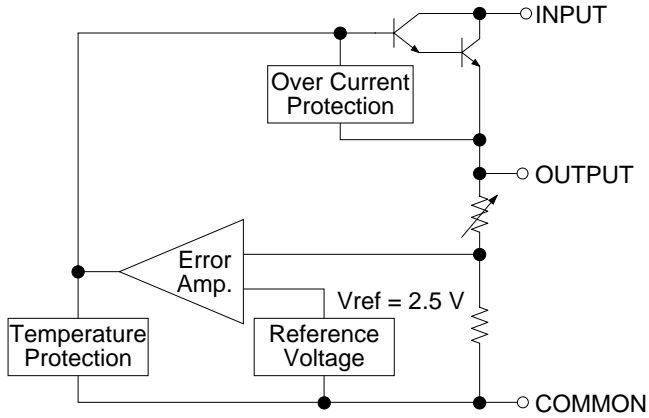
### Output Voltage Accuracy Grade

Type No.	Grade	Accuracy
HA178M05	None	$\pm 4$
HA178M12	A	$\pm 2$
	B	$\pm 3$
	C	+2, -4

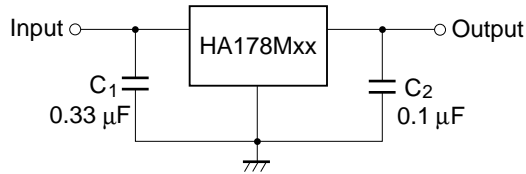
## Pin Arrangement



## Block Diagram



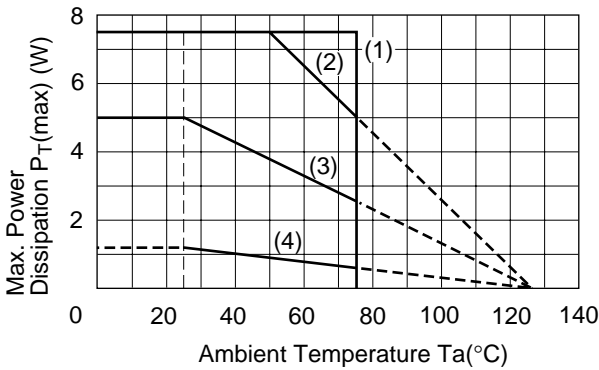
## Standard Circuit



**Absolute Maximum Ratings** ( $T_a = 25^\circ\text{C}$ )

Item	Symbol	Rating	Unit	Notes
Input voltage	$V_{IN}$	35	V	1
Input voltage	$V_{IN}$	40	V	2
Power dissipation	$P_T$	7.5	W	3
Operating temperature	$T_{opr}$	-20 to +75	$^\circ\text{C}$	
Junction temperature	$T_j$	-20 to +125	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-55 to +125	$^\circ\text{C}$	

- 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  
 $\theta_{jc} = 3.0^\circ\text{C/W}$  (typ)  
 $5.0^\circ\text{C/W}$  (max)  
 $\theta_{ja} = 62^\circ\text{C/W}$  (typ)  
 $72^\circ\text{C/W}$  (max)

## HA178M05P/PJ, HA178M05 Electrical Characteristics ( $V_{IN} = 10\text{ V}$ , $I_{OUT} = 350\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ , $C_{IN} = 0.33\text{ }\mu\text{F}$ , $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	$V_{OUT}$	4.8	5.0	5.2	V	$T_j = 25^\circ\text{C}$
		4.75	—	5.25		$7\text{ V} \leq V_{IN} \leq 20\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{OLine}$	—	3	100	mV	$T_j = 25^\circ\text{C}$ $7\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	1	50		$8\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{OLoad}$	—	20	100	mV	$T_j = 25^\circ\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$
		—	10	50		$5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$
Quiescent current	$I_Q$	—	4.5	6.0	mA	$T_j = 25^\circ\text{C}$ , $I_{OUT} = 0$
Quiescent current change	$\delta I_Q$	—	—	0.8	mA	$8\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	0.5		$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$
Output noise voltage	$V_n$	—	40	—	$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
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	$I_{OS}$	—	300	—	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	—	mV/°C	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

**HA178M06P/PJ, HA178M06 Electrical Characteristics** ( $V_{IN} = 11\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	$V_{OUT}$	5.75	6.0	6.25	V	$T_j = 25^\circ\text{C}$
		5.7	—	6.3		$8\text{ V} \leq V_{IN} \leq 21\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{OLine}$	—	5	120	mV	$T_j = 25^\circ\text{C}$ $8\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	1.5	60		$9\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{OLoad}$	—	20	120	mV	$T_j = 25^\circ\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$
		—	10	60		$5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$
Quiescent current	$I_Q$	—	4.5	6.0	mA	$T_j = 25^\circ\text{C}$ , $I_{OUT} = 0$
Quiescent current change	$\delta I_Q$	—	—	0.8	mA	$9\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	0.5		$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$
Output noise voltage	$V_n$	—	45	—	$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
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	$I_{OS}$	—	270	—	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	$\delta V_{OUT}/\delta V_j$	—	-0.5	—	mV/°C	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

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**HA178M07P/PJ, HA178M07 Electrical Characteristics** ( $V_{IN} = 12.5\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\ \mu\text{F}$ ,  $C_{OUT} = 0.1\ \mu\text{F}$ , 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		$9\text{ V} \leq V_{IN} \leq 22\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{O_{Line}}$	—	5.5	140	mV	$T_j = 25^\circ\text{C}$ $9\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	1.7	70		$10\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{O_{Load}}$	—	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	$10\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	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	$I_{o\ peak}$	—	700	—	mA	$T_j = 25^\circ\text{C}$
Temperature coefficient of output voltage	$\delta V_{OUT}/\delta T_j$	—	-0.5	—	mV/°C	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

**HA178M08P/PJ, HA178M08 Electrical Characteristics** ( $V_{IN} = 14\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	$V_{OUT}$	7.7	8.0	8.3	V	$T_j = 25^\circ\text{C}$
		7.6	—	8.4		$10.5\text{ V} \leq V_{IN} \leq 23\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{O\text{Line}}$	—	6.0	160	mV	$T_j = 25^\circ\text{C}$ $10.5\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	2.0	80		$11\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{O\text{Load}}$	—	25	160	mV	$T_j = 25^\circ\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$
		—	10	80		$5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$
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	$10.5\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	0.5		$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$
Output noise voltage	$V_n$	—	52	—	$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
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	$I_{OS}$	—	250	—	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/°C	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

# HA178M00 Series

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**HA178M09P/PJ, HA178M09 Electrical Characteristics** ( $V_{IN} = 15\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	$V_{OUT}$	8.64	9.0	9.36	V	$T_j = 25^\circ\text{C}$
		8.55	—	9.45		$11.5\text{ V} \leq V_{IN} \leq 24\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{O\text{Line}}$	—	7.0	180	mV	$T_j = 25^\circ\text{C}$ $11.5\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	2.5	90		$12\text{ V} \leq V_{IN} \leq 25\text{ V}$ $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{O\text{Load}}$	—	25	200	mV	$T_j = 25^\circ\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$
		—	10	100		$5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$
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	$12\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	0.5		$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$
Output noise voltage	$V_n$	—	52	—	$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
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	$I_{OS}$	—	250	—	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	$\delta V_{OUT}/\delta T_j$	—	-0.9	—	mV/ $^\circ\text{C}$	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$



**HA178M12P/PJ, HA178M12 Electrical Characteristics** ( $V_{IN} = 19\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	$V_{OUT}$	11.5	12.0	12.5	V	$T_j = 25^\circ\text{C}$
		11.4	—	12.6		$14.5\text{ V} \leq V_{IN} \leq 27\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{O\text{Line}}$	—	10	240	mV	$T_j = 25^\circ\text{C}$ $14.5\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	3.0	120		$16\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{O\text{Load}}$	—	25	240	mV	$T_j = 25^\circ\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$
		—	10	120		$5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$
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	$14.5\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	0.5		$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$
Output noise voltage	$V_n$	—	75	—	$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
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	$I_{OS}$	—	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	—	mV/°C	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

# HA178M00 Series

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**HA178M15P/PJ, HA178M15 Electrical Characteristics** ( $V_{IN} = 23\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	$V_{OUT}$	14.4	15.0	15.6	V	$T_j = 25^\circ\text{C}$
		14.25	—	15.75		$17.5\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{O\text{Line}}$	—	11	300	mV	$T_j = 25^\circ\text{C}$ $17.5\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	3.0	150		$20\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{O\text{Load}}$	—	25	300	mV	$T_j = 25^\circ\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$
		—	10	150		$5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$
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	$17.5\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	0.5		$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$
Output noise voltage	$V_n$	—	90	—	$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
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	—	mV/°C	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

**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		$21\text{ V} \leq V_{IN} \leq 33\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$dV_{O\text{Line}}$	—	15	360	mV	$T_j = 25^\circ\text{C}$ $21\text{ V} \leq V_{IN} \leq 33\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	5.0	180		$24\text{ V} \leq V_{IN} \leq 33\text{ V}$ , $I_{OUT} = 200\text{ mA}$
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	$21\text{ V} \leq V_{IN} \leq 35\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	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	—	mV/°C	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

# HA178M00 Series

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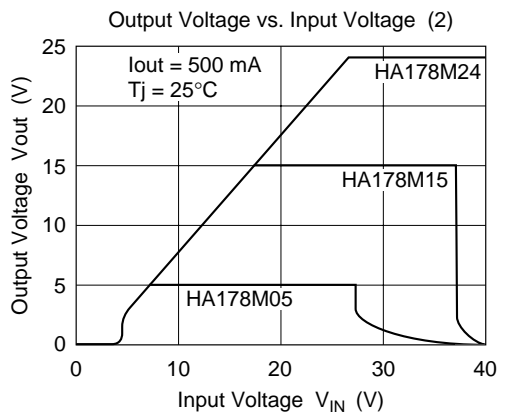
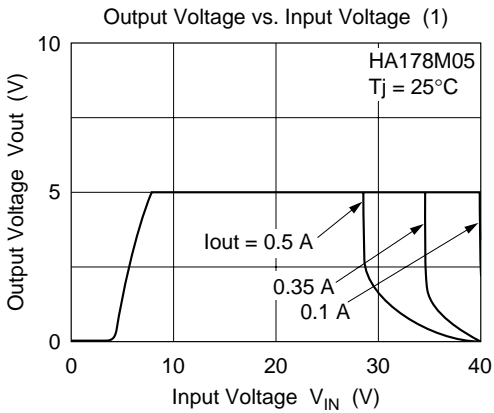
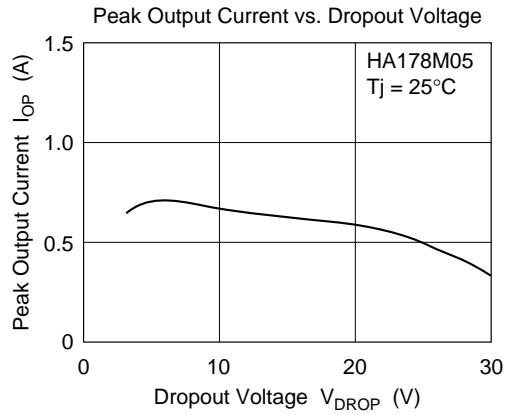
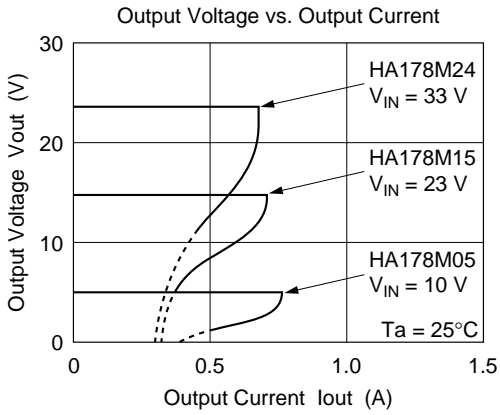
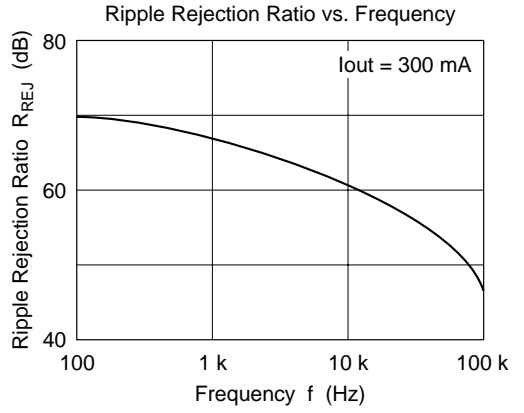
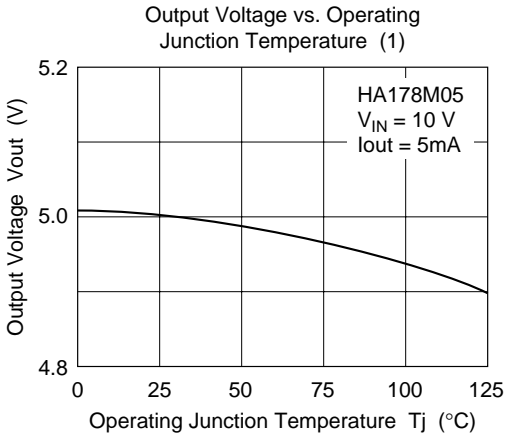
**HA178M20P/PJ, HA178M20 Electrical Characteristics** ( $V_{IN} = 29\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	$V_{OUT}$	19.2	20	20.8	V	$T_j = 25^\circ\text{C}$
		19	—	21		$23\text{ V} \leq V_{IN} \leq 35\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{O\text{Line}}$	—	17	400	mV	$T_j = 25^\circ\text{C}$ $23\text{ V} \leq V_{IN} \leq 35\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	6.0	200		$24\text{ V} \leq V_{IN} \leq 35\text{ V}$ , $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{O\text{Load}}$	—	30	400	mV	$T_j = 25^\circ\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$
		—	10	200		$5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$
Quiescent current	$I_Q$	—	4.9	6.0	mA	$T_j = 25^\circ\text{C}$ , $I_{OUT} = 0$
Quiescent current change	$\delta I_Q$	—	—	0.8	mA	$23\text{ V} \leq V_{IN} \leq 35\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	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	$\delta V_{OUT}/\delta T_j$	—	-1.1	—	mV/ $^\circ\text{C}$	$I_{OUT} = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

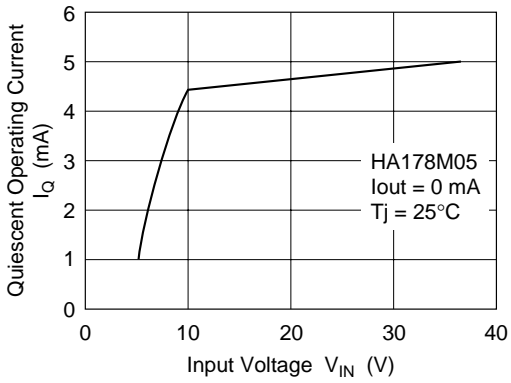
**HA178M24P/PJ, HA178M24 Electrical Characteristics** ( $V_{IN} = 33\text{ V}$ ,  $I_{OUT} = 350\text{ mA}$ ,  $0^{\circ}\text{C} \leq T_j \leq 125^{\circ}\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ , unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	$V_{OUT}$	23.0	24.0	25.0	V	$T_j = 25^{\circ}\text{C}$
		22.8	—	25.2		$27\text{ V} \leq V_{IN} \leq 38\text{ V}$ , $5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$ , $P_T \leq 7.5\text{ W}$
Line regulation	$\delta V_{O\text{Line}}$	—	18	480	mV	$T_j = 25^{\circ}\text{C}$ $27\text{ V} \leq V_{IN} \leq 38\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	6.0	240		$28\text{ V} \leq V_{IN} \leq 38\text{ V}$ , $I_{OUT} = 200\text{ mA}$
Load regulation	$\delta V_{O\text{Load}}$	—	30	480	mV	$T_j = 25^{\circ}\text{C}$ $5\text{ mA} \leq I_{OUT} \leq 500\text{ mA}$
		—	10	240		$5\text{ mA} \leq I_{OUT} \leq 200\text{ mA}$
Quiescent current	$I_Q$	—	5.0	8.0	mA	$T_j = 25^{\circ}\text{C}$ , $I_{OUT} = 0$
Quiescent current change	$\delta I_Q$	—	—	0.8	mA	$27\text{ V} \leq V_{IN} \leq 38\text{ V}$ , $I_{OUT} = 200\text{ mA}$
		—	—	0.5		$5\text{ mA} \leq I_{OUT} \leq 350\text{ mA}$
Output noise voltage	$V_n$	—	170	—	$\mu\text{V}$	$T_a = 25^{\circ}\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
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	$\delta V_{OUT}/\delta T_j$	—	-1.2	—	$\text{mV}/^{\circ}\text{C}$	$I_{OUT} = 5\text{ mA}$ , $0^{\circ}\text{C} \leq T_j \leq 125^{\circ}\text{C}$

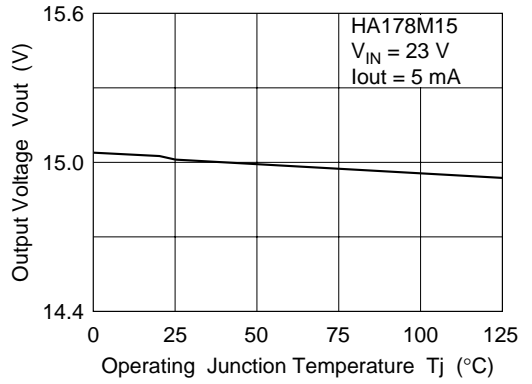
## Characteristic Curves



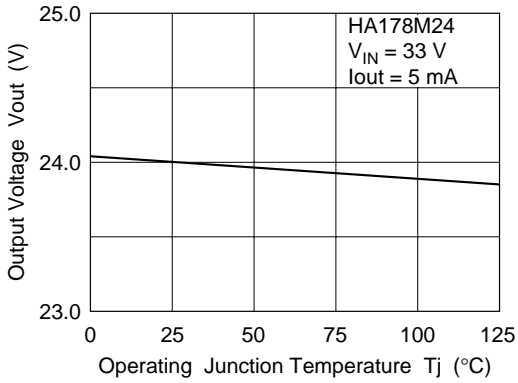
Quiescent Operating Current vs. Input Voltage



Output Voltage vs. Operating Junction Temperature (2)

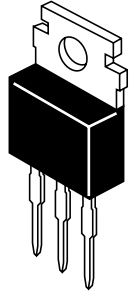
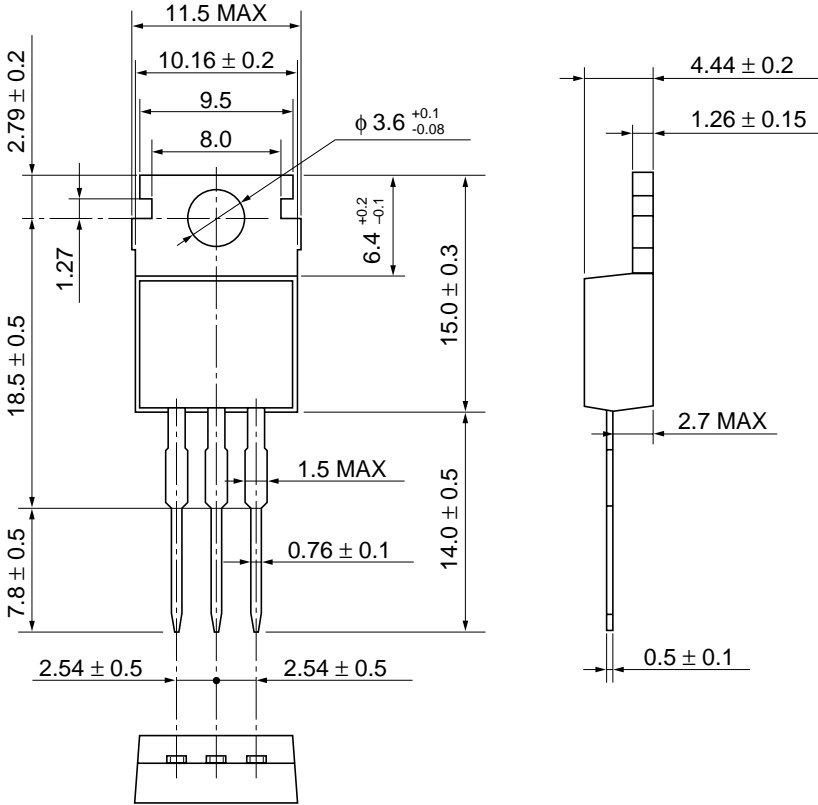


Output Voltage vs. Operating Junction Temperature (3)



## Package Dimensions

Unit: mm



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



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