AN78Lxx/AN78LxxM Series

3-pin positive output voltage regulator (100 mA type)

■ Overview

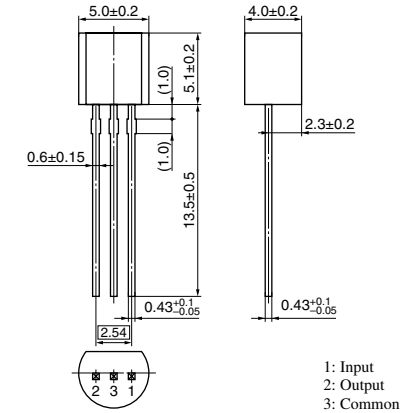
The AN78Lxx series and the AN78LxxM series are 3-pin fixed positive output type monolithic voltage regulator.

A stabilized fixed output voltage is obtained from an unstable DC input voltage without using any external parts. 12 types of fixed output voltage are available; 4V, 5V, 6V, 7V, 8V, 9V, 10V, 12V, 15V, 18V, 20V and 24V. They can be used widely as power circuits with a current capacity of up to 100mA.

■ Features

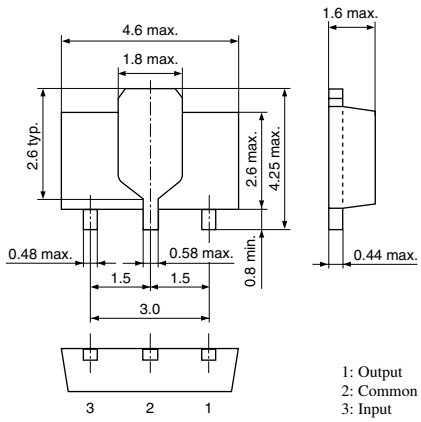
- No external components
- Output voltage: 4V, 5V, 6V, 7V, 8V, 9V, 10V, 12V, 15V, 18V, 20V, 24V
- Built-in overcurrent limit circuit
- Built-in thermal overload protection circuit

AN78Lxx series Unit: mm



SSIP003-P-0000

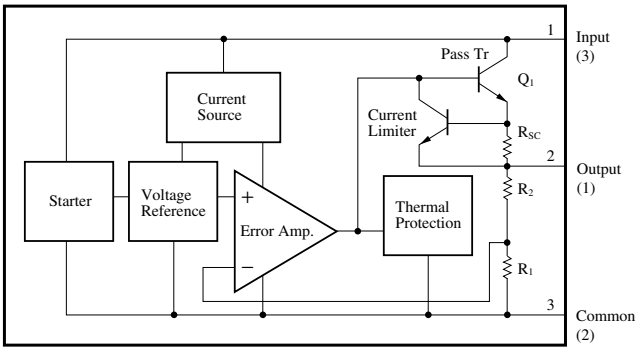
AN78LxxM series Unit: mm



HSIP003-P-0000B

Note) The packages (SSIP003-P-0000 and HSIP003-P-0000B) of this product will be changed to lead-free type (SSIP003-P-0000S and HSIP003-P-0000Q). See the new package dimensions section later of this datasheet.

■ Block Diagram (AN78Lxx series)



Note) The number in ( ) shows the pin number for the AN78LxxM series.

■ Absolute Maximum Ratings at T_a = 25°C

Parameter		Symbol	Rating	Unit
Input voltage		V_I	35 *1	V
			40 *2	V
Power dissipation		P_D	650 *3	mW
Operating ambient temperature		T_{opr}	−30 to +80	°C
Storage temperature	AN78Lxx series	T_{stg}	−55 to +150	°C
	AN78LxxM series		−55 to +125	

*1 AN78L04/M, AN78L05/M, AN78L06/M, AN78L07/M, AN78L08/M, AN78L09/M, AN78L10/M, AN78L12/M, AN78L15/M
*2 AN78L18/M, AN78L20/M, AN78L24/M
*3 Follow the derating curve. When T_j exceeds 150°C, the internal circuit cuts off the output.
AN78LxxM series is mounted on a standard board (glass epoxy: 20mm × 20mm × t1.7mm with Cu foil of 1cm² or more).

■ Electrical Characteristics at T_a = 25°C

• AN78L04, AN78L04M (4V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	3.84	4	4.16	V
Output voltage tolerance	V_O	V_I = 6.5 to 19V, I_O = 1 to 70mA	3.8	—	4.2	V
Line regulation	REG_{IN}	V_I = 6.5 to 19V, T_j = 25°C	—	50	145	mV
		V_I = 7 to 19V, T_j = 25°C	—	40	95	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	10	55	mV
		I_O = 1 to 40mA, T_j = 25°C	—	4.5	30	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 7 to 19V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	40	—	µV
Ripple rejection ratio	RR	V_I = 7 to 17V, I_O = 40mA, f = 120Hz	48	58	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	− 0.6	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 9V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L04) and T_j = 0 to 100°C (AN78L04M)

■ Electrical Characteristics at T_a = 25°C (continued)

• AN78L05, AN78L05M (5V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	4.8	5	5.2	V
Output voltage tolerance	V_O	V_I = 7.5 to 20V, I_O = 1 to 70mA	4.75	—	5.25	V
Line regulation	REG_{IN}	V_I = 7.5 to 20V, T_j = 25°C	—	55	150	mV
		V_I = 8 to 20V, T_j = 25°C	—	45	100	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	11	60	mV
		I_O = 1 to 40mA, T_j = 25°C	—	5	30	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 8 to 20V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	40	—	µV
Ripple rejection ratio	RR	V_I = 8 to 18V, I_O = 40mA, f = 120Hz	47	57	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	– 0.65	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 10V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L05) and T_j = 0 to 100°C (AN78L05M)

• AN78L06, AN78L06M (6V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	5.76	6	6.24	V
Output voltage tolerance	V_O	V_I = 8.5 to 21V, I_O = 1 to 70mA	5.7	—	6.3	V
Line regulation	REG_{IN}	V_I = 8.5 to 21V, T_j = 25°C	—	60	155	mV
		V_I = 9 to 21V, T_j = 25°C	—	50	105	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	12	65	mV
		I_O = 1 to 40mA, T_j = 25°C	—	5.5	35	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 9 to 21V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	50	—	µV
Ripple rejection ratio	RR	V_I = 9 to 19V, I_O = 40mA, f = 120Hz	46	56	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	– 0.7	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 11V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L06) and T_j = 0 to 100°C (AN78L06M)

■ Electrical Characteristics at T_a = 25°C (continued)

• AN78L07, AN78L07M (7V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	6.72	7	7.28	V
Output voltage tolerance	V_O	V_I = 9.5 to 22V, I_O = 1 to 70mA	6.65	—	7.35	V
Line regulation	REG_{IN}	V_I = 9.5 to 22V, T_j = 25°C	—	70	165	mV
		V_I = 10 to 22V, T_j = 25°C	—	60	115	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	13	75	mV
		I_O = 1 to 40mA, T_j = 25°C	—	6	35	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 10 to 22V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	50	—	µV
Ripple rejection ratio	RR	V_I = 10 to 20V, I_O = 40mA, f = 120Hz	45	55	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	– 0.75	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 12V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L07) and T_j = 0 to 100°C (AN78L07M)

• AN78L08, AN78L08M (8V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	7.7	8	8.3	V
Output voltage tolerance	V_O	V_I = 10.5 to 23V, I_O = 1 to 70mA	7.6	—	8.4	V
Line regulation	REG_{IN}	V_I = 10.5 to 23V, T_j = 25°C	—	80	175	mV
		V_I = 11 to 23V, T_j = 25°C	—	70	125	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	15	80	mV
		I_O = 1 to 40mA, T_j = 25°C	—	7	40	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 11 to 23V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	60	—	µV
Ripple rejection ratio	RR	V_I = 11 to 21V, I_O = 40mA, f = 120Hz	44	54	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	– 0.8	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 14V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L08) and T_j = 0 to 100°C (AN78L08M)

■ Electrical Characteristics at T_a = 25°C (continued)

• AN78L09, AN78L09M (9V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	8.64	9	9.35	V
Output voltage tolerance	V_O	V_I = 11.5 to 24V, I_O = 1 to 70mA	8.55	—	9.45	V
Line regulation	REG_{IN}	V_I = 11.5 to 24V, T_j = 25°C	—	90	190	mV
		V_I = 12 to 24V, T_j = 25°C	—	80	140	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	16	85	mV
		I_O = 1 to 40mA, T_j = 25°C	—	8	45	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 12 to 24V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	65	—	µV
Ripple rejection ratio	RR	V_I = 12 to 22V, I_O = 40mA, f = 120Hz	43	53	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	– 0.85	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 15V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L09) and T_j = 0 to 100°C (AN78L09M)

• AN78L10, AN78L10M (10V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	9.6	10	10.4	V
Output voltage tolerance	V_O	V_I = 12.5 to 25V, I_O = 1 to 70mA	9.5	—	10.5	V
Line regulation	REG_{IN}	V_I = 12.5 to 25V, T_j = 25°C	—	100	210	mV
		V_I = 13 to 25V, T_j = 25°C	—	90	160	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	17	90	mV
		I_O = 1 to 40mA, T_j = 25°C	—	9	45	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 13 to 25V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	70	—	µV
Ripple rejection ratio	RR	V_I = 13 to 23V, I_O = 40mA, f = 120Hz	42	52	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	– 0.9	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 16V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L10) and T_j = 0 to 100°C (AN78L10M)

■ Electrical Characteristics at T_a = 25°C (continued)

• AN78L12, AN78L12M (12V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	11.5	12	12.5	V
Output voltage tolerance	V_O	V_I = 14.5 to 27V, I_O = 1 to 70mA	11.4	—	12.6	V
Line regulation	REG_{IN}	V_I = 14.5 to 27V, T_j = 25°C	—	120	250	mV
		V_I = 15 to 27V, T_j = 25°C	—	100	200	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	20	100	mV
		I_O = 1 to 40mA, T_j = 25°C	—	10	50	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3.5	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 15 to 27V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	80	—	µV
Ripple rejection ratio	RR	V_I = 15 to 25V, I_O = 40mA, f = 120Hz	40	50	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	–1	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 19V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L12) and T_j = 0 to 100°C (AN78L12M)

• AN78L15, AN78L15M (15V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	14.4	15	15.6	V
Output voltage tolerance	V_O	V_I = 17.5 to 30V, I_O = 1 to 70mA	14.25	—	15.75	V
Line regulation	REG_{IN}	V_I = 17.5 to 30V, T_j = 25°C	—	130	300	mV
		V_I = 18 to 30V, T_j = 25°C	—	110	250	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	25	150	mV
		I_O = 1 to 40mA, T_j = 25°C	—	12	75	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3.5	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 18 to 30V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	90	—	µV
Ripple rejection ratio	RR	V_I = 18 to 28V, I_O = 40mA, f = 120Hz	38	48	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	–1.3	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 23V, I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF, T_j = 0 to 125°C (AN78L15) and T_j = 0 to 100°C (AN78L15M)

■ Electrical Characteristics at T_a = 25°C (continued)

• AN78L18, AN78L18M (18V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	17.3	18	18.7	V
Output voltage tolerance	V_O	V_I = 20.5 to 33V, I_O = 1 to 70mA	17.1	—	18.9	V
Line regulation	REG_{IN}	V_I = 20.5 to 33V, T_j = 25°C	—	45	300	mV
		V_I = 21 to 33V, T_j = 25°C	—	35	250	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	30	170	mV
		I_O = 1 to 40mA, T_j = 25°C	—	15	85	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3.5	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 21 to 33V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	150	—	μV
Ripple rejection ratio	RR	V_I = 21 to 31V, I_O = 40mA, f = 120Hz	36	46	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	−1.5	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 27V, I_O = 40mA, C_I = 0.33μF, C_O = 0.1μF, T_j = 0 to 125°C (AN78L18) and T_j = 0 to 100°C (AN78L18M)

• AN78L20, AN78L20M (20V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	19.2	20	20.8	V
Output voltage tolerance	V_O	V_I = 22.5 to 35V, I_O = 1 to 70mA	19	—	21	V
Line regulation	REG_{IN}	V_I = 22.5 to 35V, T_j = 25°C	—	50	300	mV
		V_I = 23 to 35V, T_j = 25°C	—	40	250	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25°C	—	35	180	mV
		I_O = 1 to 40mA, T_j = 25°C	—	17	90	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3.5	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 23 to 35V, T_j = 25°C	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25°C	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	170	—	μV
Ripple rejection ratio	RR	V_I = 23 to 33V, I_O = 40mA, f = 120Hz	34	44	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25°C	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25°C, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125°C	—	−1.7	—	mV/°C

Note 1) The specified condition T_j = 25°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 = 29V, I_O = 40mA, C_I = 0.33μF, C_O = 0.1μF, T_j = 0 to 125°C (AN78L20) and T_j = 0 to 100°C (AN78L20M)

■ Electrical Characteristics at T_a = 25°C (continued)

• AN78L24, AN78L24M (24V type)

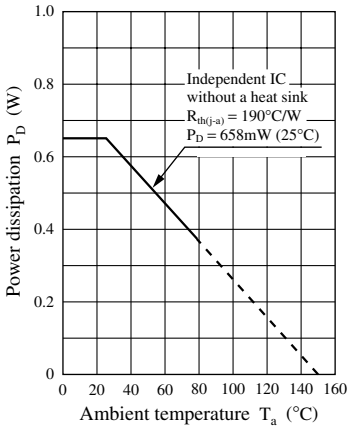
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_O	T_j = 25°C	23	24	25	V
Output voltage tolerance	V_O	V_I = 26.5 to 39V, I_O = 1 to 70mA	22.8	—	25.2	V
Line regulation	REG_{IN}	V_I = 26.5 to 39V, T_j = 25℃	—	60	300	mV
		V_I = 27 to 39V, T_j = 25℃	—	50	250	mV
Load regulation	REG_L	I_O = 1 to 100mA, T_j = 25℃	—	40	200	mV
		I_O = 1 to 40mA, T_j = 25℃	—	20	100	mV
Bias current	I_{Bias}	T_j = 25°C	—	2	3.5	mA
Bias current fluctuation to input	$\Delta I_{Bias(IN)}$	V_I = 27 to 39V, T_j = 25℃	—	—	1	mA
Bias current fluctuation to load	$\Delta I_{Bias(L)}$	I_O = 1 to 40mA, T_j = 25℃	—	—	0.1	mA
Output noise voltage	V_{no}	f = 10Hz to 100kHz	—	200	—	μV
Ripple rejection ratio	RR	V_I = 27 to 37V, I_O = 40mA, f = 120Hz	34	44	—	dB
Minimum input/output voltage difference	$V_{DIF(min)}$	T_j = 25℃	—	1.7	—	V
Output short-circuit current	$I_{O(Short)}$	T_j = 25℃, V_I = 35V	—	140	—	mA
Output voltage temperature coefficient	$\Delta V_O/T_a$	I_O = 5mA, T_j = 0 to 125℃	—	–2	—	mV/°C

Note 1) The specified condition T_j = 25°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.

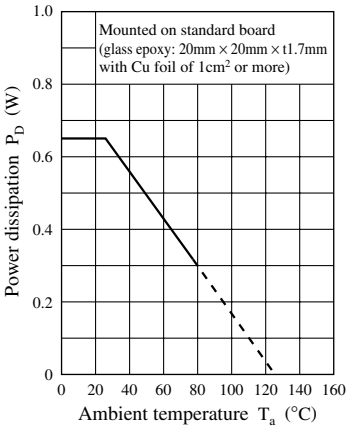
Note 2) Unless otherwise specified, V_I = 33V, I_O = 40mA, C_I = 0.33μF, C_O = 0.1μF, T_j = 0 to 125°C (AN78L24) and T_j = 0 to 100°C (AN78L24M)

■ Main Characteristics

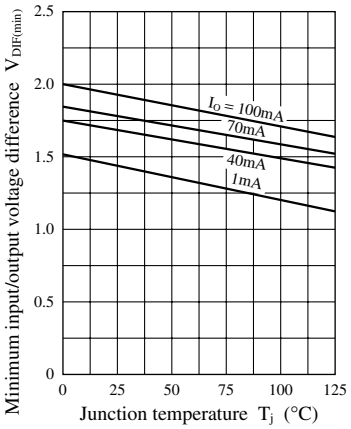
P_D — T_a (AN78Lxx series)



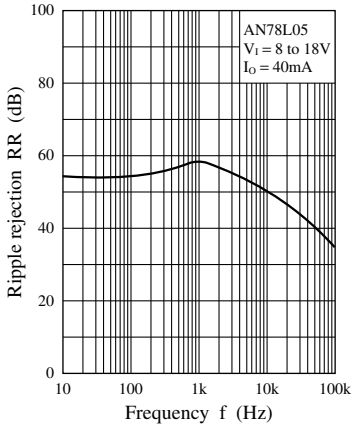
P_D — T_a (AN78LxxM series)



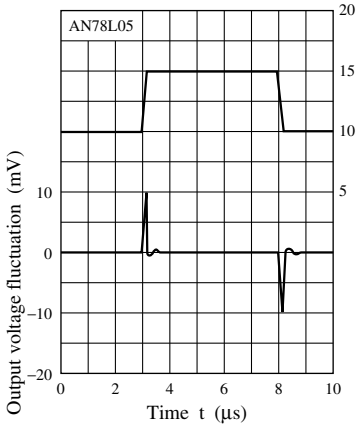
$V_{DIF(min)}$ — T_j



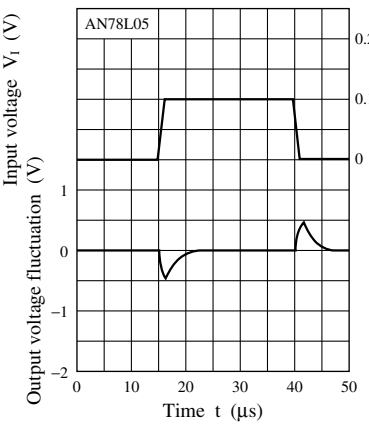
RR — f



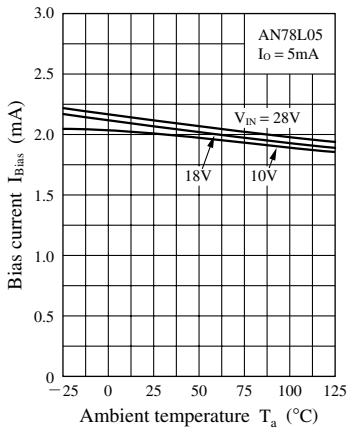
Input transient response



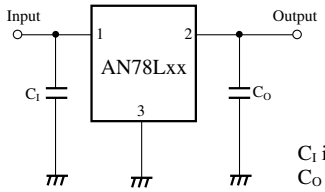
Load transient response



I_{Bias} — T_a



■ Basic Regulator Circuit



C_I is necessary when the input line is long.
C_O improves the transient response.

■ Usage Notes

1. Cautions for a basic circuit

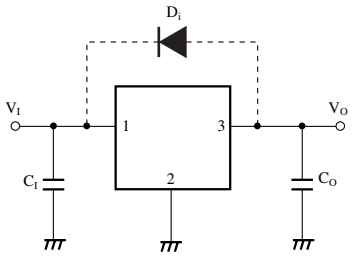


Figure 1

C_I: When a wiring from a smoothing circuit to a three-pin regulator is long, it is likely to oscillate at output. A capacitor of 0.1µF to 0.47µF should be connected near an input pin.

C_O: 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_i: Normally unnecessary. But add it in the case that there is a residual voltage at the output capacitor Co 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-circuitted 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.

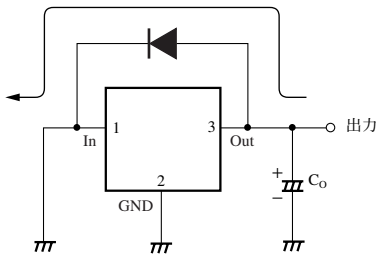
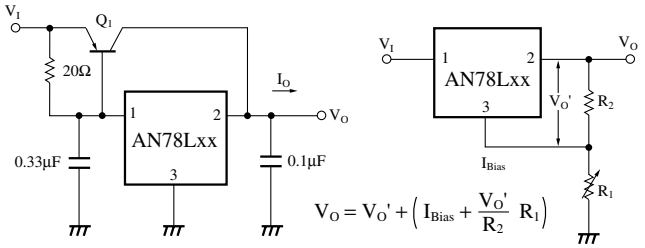


Figure 2

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

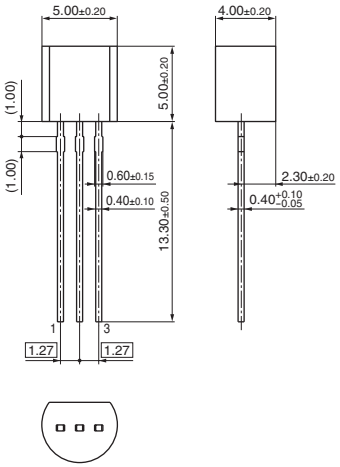


$$V_O = V_O' + \left(I_{Bias} + \frac{V_O'}{R_2} R_1 \right)$$

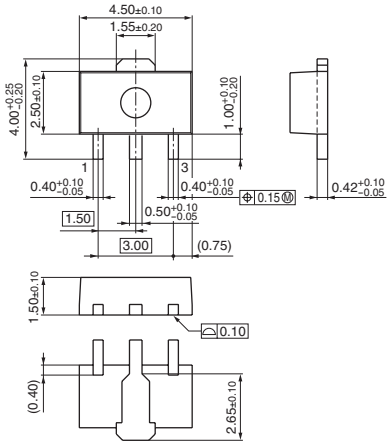
Note) V_O varies due to sample to sample variation of I_{Bias} .
Never fail to adjust individually with R_1 .

■ New Package Dimensions (Unit: mm)

• SSIP003-P-0000S (Lead-free package)



• HSIP003-P-0000Q (Lead-free package)



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