NEC

BIPOLAR ANALOG INTEGRATED CIRCUI

μPC24M00A Series

THREE TERMINAL LOW DROPOUT VOLTAGE REGULATOR

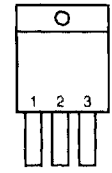
DESCRIPTION

μPC24M00A Series are low dropout regulators which have 500 mA capable for output current.
These ICs are built-in the saturation protection circuit of the output transistor.

FEATURES

- Built-in the saturaiton protection circuit of the output transistor.
- The capability of output current is 500 mA.
- High accuracy of output voltage.
  $|\Delta V_O| \leq \pm 2$ % (T_J = 25 °C)
  $|\Delta V_O| \leq \pm 3$ % (0 °C ≤ T_J ≤ 125 °C)
- Low dropout voltage.
  $V_{DIF} \leq 1$ V ($I_O \leq 500$ mA, $T_J \leq 125$ °C)
- Built-in overcurrent protection circuit, thermal shut-down circuit.
- Built-in Safe Operating Area protection circuit.
- Compatible for μPC24M00 Series.

CONNECTION DIAGRAM
(TOP VIEW)



1 : INPUT
2 : GND
3 : OUTPUT

ORDERING INFORMATION

Output Voltage	Type Number	Package
5 V	μPC24M05AHF	MP-45G (Isolated TO-220)
6 V	μPC24M06AHF	
7 V	μPC24M07AHF	
8 V	μPC24M08AHF	
9 V	μPC24M09AHF	
10 V	μPC24M10AHF	
12 V	μPC24M12AHF	
15 V	μPC24M15AHF	
18 V	μPC24M18AHF	

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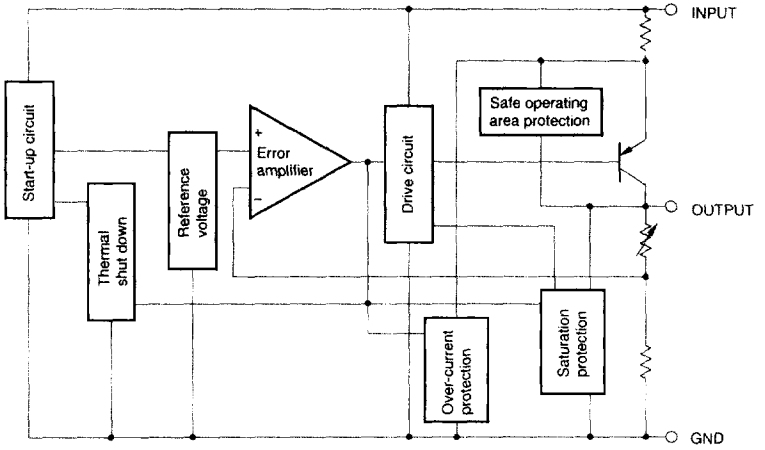
BLOCK DIAGRAM

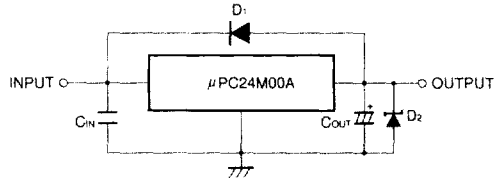


ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C, Unless otherwise specified.)

PARAMETER	SYMBOL	RATING	UNIT
Input Voltage	V_{IN}	36	V
Internal Power Dissipation	P_T	15 Note	W
Operating Ambient Temperature Range	T_A	−20 to +85	°C
Operating Junction Temperature Range	T_J	−20 to +150	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C
Thermal Resistance (Junction to Case)	$R_{th(J-C)}$	7.0	°C/W
Thermal Resistance (Junction to Ambient)	$R_{th(J-A)}$	65	°C/W

Note Internally limited.

TYPICAL CONNECTION



C_{IN} : 0.1 to 0.47 μF.
C_{OUT} : More than 47 μF.
D_1 : Need for $V_O > V_{IN}$.
D_2 : Need for $V_O <$ GND.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	TYPE NUMBER	MIN.	TYP.	MAX.	UNIT
Input Voltage	V_{IN}	μPC24M05AHF	6	9	20	V
		μPC24M06AHF	7	10	21	
		μPC24M07AHF	8	11	22	
		μPC24M08AHF	9	13	23	
		μPC24M09AHF	10	14	24	
		μPC24M10AHF	11	15	25	
		μPC24M12AHF	13	18	27	
		μPC24M15AHF	16	22	27	
		μPC24M18AHF	19	25	28	
Output Current	I_O	All	0		500	mA
Operating Ambient Temperature Range	T_A	All	−20		+85	°C
Operating Junction Temperature Range	T_J	All	−20		+125	°C

ELECTRICAL CHARACTERISTICS

μPC24M05A (V_{IN} = 9 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	4.9	5.0	5.1	V	
		4.85		5.15		6 V ≤ V_{IN} ≤ 20 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		4.85		5.15		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		5	50	mV	6.5 V ≤ V_{IN} ≤ 20 V
Load Regulation	REG_L		3	25	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.3	3.2	mA	I_O = 0
			7	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 4.5 V, I_O = 0 mA
				45		V_{IN} = 4.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	6.5 V ≤ V_{IN} ≤ 20 V, I_O = 500 mA
Output Noise Voltage	V_n		90		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	55	60		dB	f = 120 Hz, 6.5 V ≤ V_{IN} ≤ 16.5 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.6		A	V_{IN} = 20 V
Peak Output Current	I_{Opeak}	0.75	1.0	1.63	A	V_{IN} = 9 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		0.2		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

μPC24M06A (V_{IN} = 10 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	5.88	6.0	6.12	V	
		5.82		6.18		7 V ≤ V_{IN} ≤ 21 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		5.82		6.18		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		6	60	mV	7.5 V ≤ V_{IN} ≤ 21 V
Load Regulation	REG_L		4	30	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.3	3.2	mA	I_O = 0
			7	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 5.5 V, I_O = 0 mA
				45		V_{IN} = 5.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	7.5 V ≤ V_{IN} ≤ 21 V, I_O = 500 mA
Output Noise Voltage	V_n		110		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	53	58		dB	f = 120 Hz, 7.5 V ≤ V_{IN} ≤ 17.5 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.6		A	V_{IN} = 21 V
Peak Output Current	I_{Opeak}	0.75	1.0	1.63	A	V_{IN} = 10 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		−0.4		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

μPC24M07A (V_{IN} = 11 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	6.86	7.0	7.14	V	
		6.79		7.21		8 V ≤ V_{IN} ≤ 22 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		6.79		7.21		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		7	70	mV	8.5 V ≤ V_{IN} ≤ 22 V
Load Regulation	REG_L		4	35	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.3	3.2	mA	I_O = 0
			7	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 6.5 V, I_O = 0 mA
				45		V_{IN} = 6.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	8.5 V ≤ V_{IN} ≤ 22 V, I_O = 500 mA
Output Noise Voltage	V_n		130		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	52	57		dB	f = 120 Hz, 8.5 V ≤ V_{IN} ≤ 18.5 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.6		A	V_{IN} = 22 V
Peak Output Current	I_{Opeak}	0.75	1.0	1.63	A	V_{IN} = 11 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		0.4		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

μPC24M08A (V_{IN} = 13 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	7.85	8.0	8.15	V	
		7.75		8.25		9 V ≤ V_{IN} ≤ 23 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		7.75		8.25		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		8	80	mV	9.5 V ≤ V_{IN} ≤ 23 V
Load Regulation	REG_L		5	40	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.3	3.2	mA	I_O = 0
			7	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 7.5 V, I_O = 0 mA
				45		V_{IN} = 7.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	9.5 V ≤ V_{IN} ≤ 23 V, I_O = 500 mA
Output Noise Voltage	V_n		150		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	51	56		dB	f = 120 Hz, 9.5 V ≤ V_{IN} ≤ 19.5 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.5		A	V_{IN} = 23 V
Peak Output Current	I_{Opeak}	0.74	1.0	1.62	A	V_{IN} = 13 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		0.8		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

μPC24M09A (V_{IN} = 14 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	8.82	9.0	9.18	V	
		8.73		9.27		10 V ≤ V_{IN} ≤ 24 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		8.73		9.27		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		9	90	mV	10.5 V ≤ V_{IN} ≤ 24 V
Load Regulation	REG_L		5	45	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.4	3.2	mA	I_O = 0
			7	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 8.5 V, I_O = 0 mA
				45		V_{IN} = 8.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	10.5 V ≤ V_{IN} ≤ 24 V, I_O = 500 mA
Output Noise Voltage	V_n		170		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	50	55		dB	f = 120 Hz, 10.5 V ≤ V_{IN} ≤ 20.5 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.5		A	V_{IN} = 24 V
Peak Output Current	I_{Opeak}	0.74	1.0	1.62	A	V_{IN} = 14 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		1.0		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

μPC24M10A (V_{IN} = 15 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	9.8	10	10.2	V	
		9.7		10.3		11 V ≤ V_{IN} ≤ 25 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		9.7		10.3		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		10	100	mV	11.5 V ≤ V_{IN} ≤ 25 V
Load Regulation	REG_L		6	50	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.4	3.2	mA	I_O = 0
			7	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 9.5 V, I_O = 0 mA
				45		V_{IN} = 9.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	11.5 V ≤ V_{IN} ≤ 25 V, I_O = 500 mA
Output Noise Voltage	V_n		190		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	49	54		dB	f = 120 Hz, 11.5 V ≤ V_{IN} ≤ 21.5 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.4		A	V_{IN} = 25 V
Peak Output Current	I_{Opeak}	0.74	1.0	1.62	A	V_{IN} = 15 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		1.6		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

μPC24M12A (V_{IN} = 18 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	11.75	12	12.25	V	
		11.65		12.35		13 V ≤ V_{IN} ≤ 27 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		11.65		12.35		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		12	120	mV	14 V ≤ V_{IN} ≤ 27 V
Load Regulation	REG_L		7	60	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.4	3.2	mA	I_O = 0
			8	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 11.5 V, I_O = 0 mA
				45		V_{IN} = 11.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	14 V ≤ V_{IN} ≤ 27 V, I_O = 500 mA
Output Noise Voltage	V_N		230		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	47	52		dB	f = 120 Hz, 14 V ≤ V_{IN} ≤ 24 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.4		A	V_{IN} = 27 V
Peak Output Current	I_{Opeak}	0.73	1.0	1.61	A	V_{IN} = 18 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		0.7		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

μPC24M15A (V_{IN} = 22 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

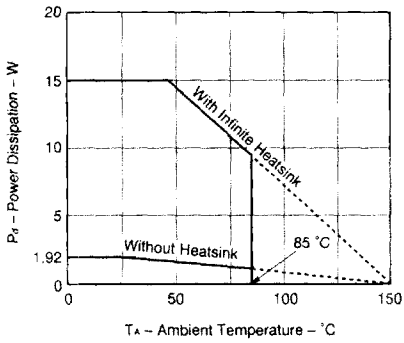
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	14.7	15	15.3	V	
		14.55		15.45		16 V ≤ V_{IN} ≤ 27 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		14.55		15.45		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		15	150	mV	17 V ≤ V_{IN} ≤ 27 V
Load Regulation	REG_L		9	75	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.5	3.2	mA	I_O = 0
			8	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 14.5 V, I_O = 0 mA
				45		V_{IN} = 14.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	17 V ≤ V_{IN} ≤ 27 V, I_O = 500 mA
Output Noise Voltage	V_N		290		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	46	51		dB	f = 120 Hz, 17 V ≤ V_{IN} ≤ 27 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.4		A	V_{IN} = 27 V
Peak Output Current	I_{Opeak}	0.72	1.0	1.6	A	V_{IN} = 22 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		1.6		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

μPC24M18A (V_{IN} = 25 V, I_O = 350 mA, T_J = 25 °C, Unless otherwise specified)

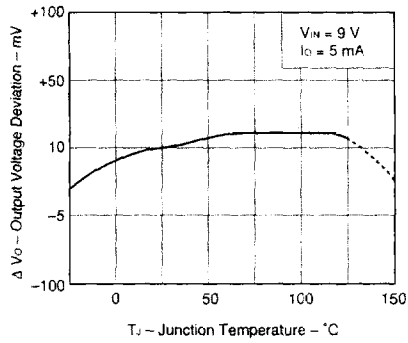
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V_O	17.64	18	18.36	V	
		17.46		18.54		19 V ≤ V_{IN} ≤ 28 V, 5 mA ≤ I_O ≤ 350 mA, 0 °C ≤ T_J ≤ 125 °C
		17.46		18.54		5 mA ≤ I_O ≤ 500 mA, 0 °C ≤ T_J ≤ 125 °C
Line Regulation	REG_{IN}		18	180	mV	20 V ≤ V_{IN} ≤ 28 V
Load Regulation	REG_L		11	90	mV	5 mA ≤ I_O ≤ 500 mA
Quiescent Current	I_{BIAS}		2.5	3.2	mA	I_O = 0
			8	30		I_O = 500 mA
Start-up Current	$I_{BIAS(S)}$			15	mA	V_{IN} = 17.5 V, I_O = 0 mA
				45		V_{IN} = 17.5 V, I_O = 500 mA
Quiescent Current Change	ΔI_{BIAS}			10	mA	20 V ≤ V_{IN} ≤ 28 V, I_O = 500 mA
Output Noise Voltage	V_n		350		μV_{rms}	10 Hz ≤ f ≤ 100 kHz
Ripple Rejection	R·R	44	49		dB	f = 120 Hz, 20 V ≤ V_{IN} ≤ 28 V
Dropout Voltage	V_{DIF}		0.5	1.0	V	I_O = 500 mA, 0 °C ≤ T_J ≤ 125 °C
Short Circuit Current	I_{Oshort}		0.4		A	V_{IN} = 28 V
Peak Output Current	I_{Opeak}	0.72	1.0	1.6	A	V_{IN} = 25 V
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		2.2		mV/°C	I_O = 5 mA, 0 °C ≤ T_J ≤ 125 °C

TYPICAL CHARACTERISTICS

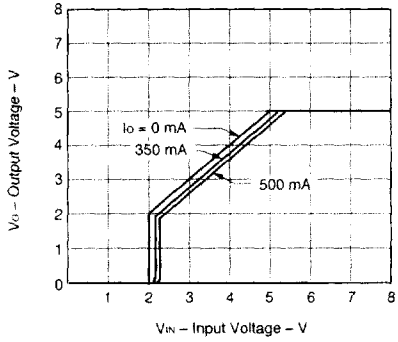
P_d - T_A



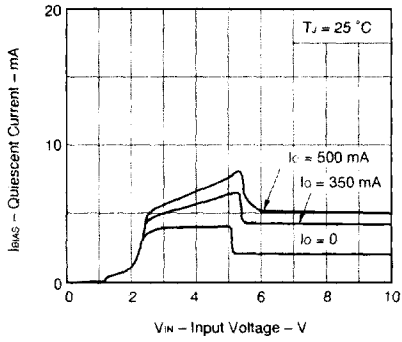
Δ V_O - T_J (μPC24M05A)



V_O - V_{IN} (μPC24M05A)

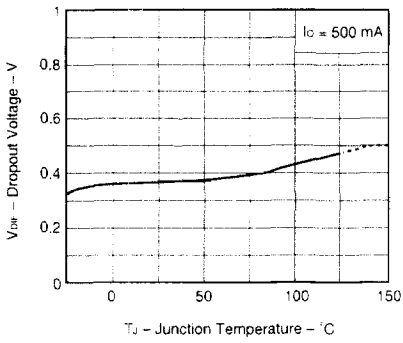


I_{BIAS}($I_{BIAS(S)}$) - V_{IN} (μPC24M05A)

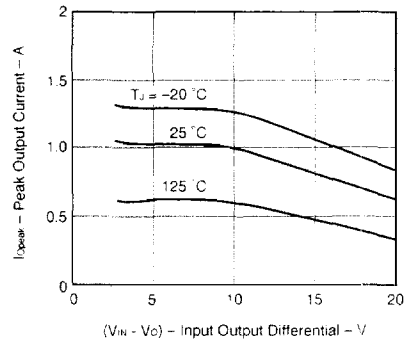


TYPICAL CHARACTERISTICS

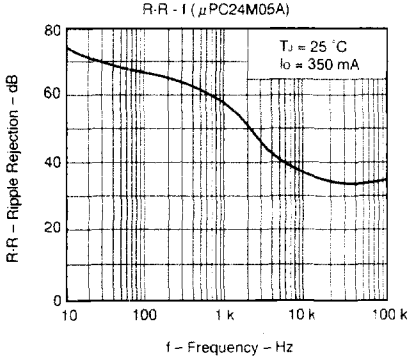
V_{DIF} - T_J



I_{Opeak} - (V_{IN} - V_O)



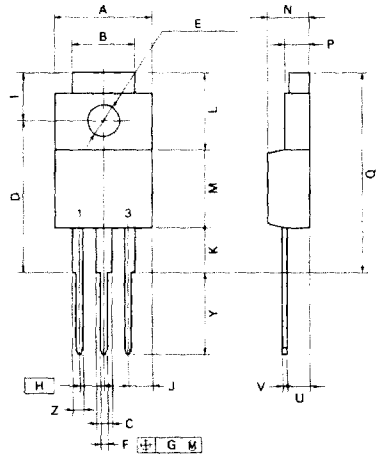
R-R - f (μPC24M05A)



PACKAGE DIMENSIONS (Unit: mm)

μPC24M00AHF Series

3PIN PLASTIC SIP (MP-45G)



P3HF-254B-1

NOTE

Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	10.4 MAX.	0.410 MAX.
B	7.0	0.276
C	1.2 MIN.	0.047 MIN.
D	$17.0^{\pm 0.3}$	$0.669^{+0.013}_{-0.012}$
E	$\phi 3.3^{\pm 0.2}$	$\phi 0.130^{\pm 0.008}$
F	$0.75^{\pm 0.10}$	$0.030^{+0.004}_{-0.005}$
G	0.25	0.010
H	2.54 (T.P.)	0.100 (T.P.)
I	$5.0^{\pm 0.3}$	$0.197^{\pm 0.012}$
J	2.66 MAX.	0.105 MAX.
K	4.8 MIN.	0.188 MIN.
L	8.5	0.335
M	8.5	0.335
N	$4.5^{\pm 0.2}$	$0.177^{\pm 0.008}$
P	$2.8^{\pm 0.2}$	$0.110^{+0.008}_{-0.009}$
Q	22.4 MAX.	0.882 MAX.
U	$2.4^{\pm 0.5}$	$0.094^{+0.021}_{-0.020}$
V	$0.65^{\pm 0.10}$	$0.026^{+0.004}_{-0.005}$
Y	$8.9^{\pm 0.7}$	$0.350^{\pm 0.028}$
Z	1.0 MIN.	0.039 MIN.

RECOMMENDED SOLDERING CONDITIONS

The following conditions (see table below) must be met when soldering this product.

Please consult with our sales offices in case other soldering process is used, or in case soldering is done under different conditions.

TYPES OF THROUGH HOLE MOUNT DEVICE

μPC24M00AHF Series

Soldering Process	Soldering Conditions	Symbol
Wave soldering	Solder temperature: 260 °C or below. Flow Time: 10 seconds or below.	

REFERENCE

Document Name	Document No.
NEC semiconductor device reliability/quality control system	IEI-1212
Quality grade on NEC semiconductor devices	IEI-1209
Semiconductor device mounting technology manual	IEI-1207
Semiconductor device package manual	IEI-1213
Guide to quality assurance for semiconductor devices	MEI-1202
Semiconductor selection guide	MF-1134