DATA SHEET
17 December 2003

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Rev 1-03

REPLACEMENT OF:
LT108x SERIES

MIK108x series

LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

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DESCRIPTION

The MIK1083/MIK1084/MIK1085 series of positive adjustable regulators are designed to provide 7.5A, 5A and 3A with higher efficiency than currently available devices. All internal circuitry is designed to operate down to 1V input to output differential and the dropout voltage is fully specified as a function of load current. Dropout is guaranteed at a maximum of 1.5 V at maximum output current. On-chip trimming adjusts the reference voltage to 1%. Current limit is also trimmed, minimizing the stress on both the regulator and power source circuitry under overload conditions.

The MIK1083/MIK1084/MIK1085 devices are pin compatible with older 3 terminal regulators. A 10µF output capacitor is required on these new devices; however, this is usually included in most regulator designs.

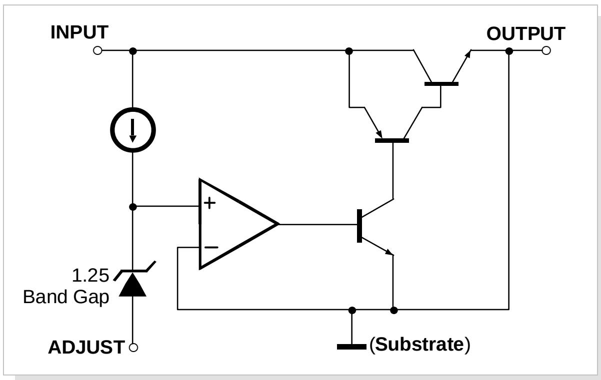
FEATURES

- Three Terminal Adjustable
- Output Current of 3A, 5A or 7.5A
- Operates Down to 1V dropout
- Guaranteed Dropout Voltage at Multiple Current Levels
- 0.015% Line Regulation
- 0.1% Load Regulation
- 100% Thermal Limit Burn-In

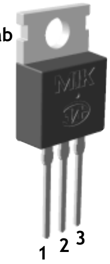
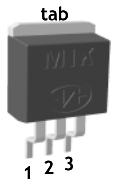
APPLICATIONS

- High Efficiency Linear Regulators
- Post Regulators for Switching Supplies
- Constant Current Regulators
- Battery Chargers

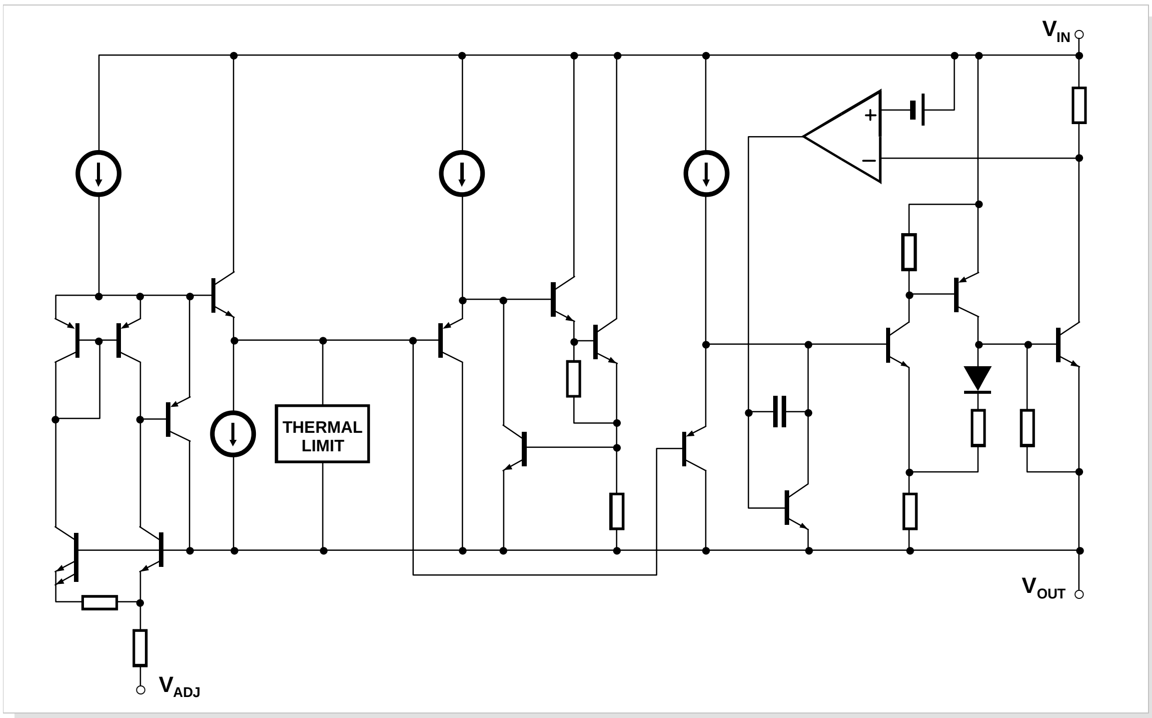
BASIC FUNCTIONAL DIAGRAM



PIN DESCRIPTION

	MIK108xCT	MIK108xCS
	TO-220-3	TO-263-3
1 — ADJ 2 — V_{OUT} 3 — V_{IN} tab — V_{OUT}		

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	MAXIMUM	UNIT
P_D	Power Dissipation	Internally Limited	W
V_{IN}	Input to Output Voltage Differential	30	V
T_J	Operating Junction Temperature Range		
	Control Section	0 to 125	°C
	Power Transistor	0 to 150	
T_{STG}	Storage Temperature	-65 to 150	°C
T_{LEAD}	Lead Temperature (Soldering, 10 sec)	300	°C

ELECTRICAL CHARACTERISTICS (THE • DENOTES THE SPECIFICATIONS WHICH APPLY OVER THE FULL OPERATING TEMPERATURE RANGE, OTHERWISE SPECIFICATIONS ARE AT T_A = 25ºC)

SYMBOL	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{REF}	Reference Voltage	I_{OUT} = 10mA, (V_{IN} - V_{OUT}) = 3V		1.238	1.250	1.262	V
		10mA ≤ I_{OUT} ≤ $I_{FULL\ LOAD}$ 1.5V ≤ (V_{IN} - V_{OUT}) ≤ 25V (Note 3)	•	1.225	1.250	1.270	
R_{LINE}	Line Regulation	I_{LOAD}=10mA, 1.5 ≤ (V_{IN} - V_{OUT}) ≤ 15V			0.015	0.2	%
			•		0.035	0.2	
		15V ≤ (V_{IN} - V_{OUT}) ≤ 30V (Notes 1,2)	•		0.05	0.5	
R_{LOAD}	Load Regulation	(V_{IN} - V_{OUT}) = 3V 10mA ≤ I_{OUT} ≤ $I_{FULL\ LOAD}$ (Notes 1,2,3)			0.1	0.3	%
			•		0.2	0.4	
V_{DROP}	Dropout Voltage	ΔV_{REF} = 1%, I_{OUT} = $I_{FULL\ LOAD}$ (Note 4)	•		1.3	1.5	V
$V_{REFCLIM}$	Current Limit						
	MIK1083	(V_{IN} - V_{OUT}) = 5V	•	8.0	9.5		A
		(V_{IN} - V_{OUT}) = 25V	•	0.4	1.0		
	MIK1084	(V_{IN} - V_{OUT}) = 5V	•	5.5	6.5		
		(V_{IN} - V_{OUT}) = 25V	•	0.3	0.6		
	MIK1085	(V_{IN} - V_{OUT}) = 5V	•	3.2	4.0		
		(V_{IN} - V_{OUT}) = 25V	•	0.2	0.5		
	Minimum Load Current	(V_{IN} - V_{OUT}) = 25V	•		5	10	mA
	Thermal Regulation						
	MIK1083	T_A = 25°C, 30ms pulse			0.002	0.010	%/W
	MIK1084				0.003	0.015	
	MIK1085				0.004	0.020	
RR	Ripple Rejection	f = 120Hz, C_{ADJ} = 25µF, C_{OUT} = 25µF Tantalum, I_{OUT} = $I_{FULL\ LOAD}$, (V_{IN} - V_{OUT}) = 3V	•	60	75		dB
I_{ADJ}	Adjust Pin Current	T_j = 25°C			55		µA
			•			120	
I_{ADJCH}	Adjust Pin Current Change	10mA ≤ I_{OUT} ≤ $I_{FULL\ LOAD}$, 1.5V ≤ (V_{IN} - V_{OUT}) = 25V	•		0.2	5	µA
	Temperature Stability		•		0.5		%
	Long Term Stability	T_A = 125°C, 1000Hrs			0.3	1	%
	RMS Output Noise (% of V_{OUT})	T_A = 25°C, 10Hz ≤ f ≤ 10kHz			0.003		%

Note 1: See thermal regulation specifications for changes in output voltage due to heating effects. Load and line regulation are measured at a constant junction temperature by low duty cycle pulse testing.

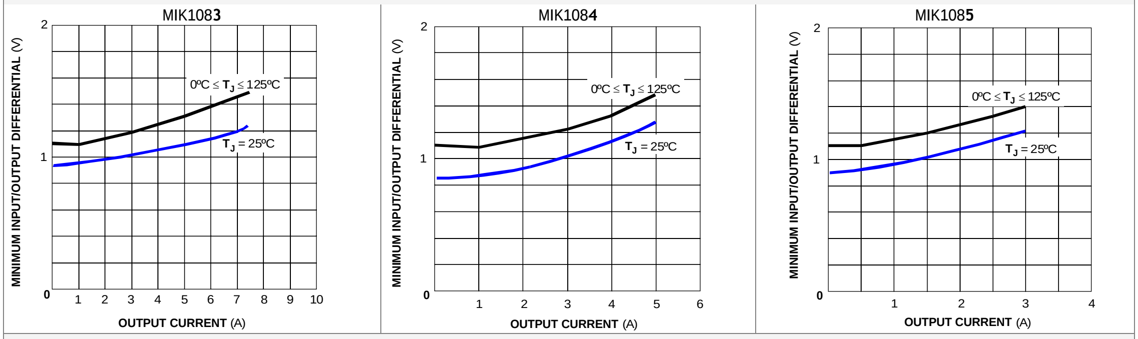
Note 2: Line and load regulation are guaranteed up to the maximum power dissipation (30W for the MIK1083 /MIK1084 /MIK1085). Power dissipation is determined by the input/output differential and the output current. Guaranteed maximum power dissipation will not be available over the full input/output voltage range.

Note 3: $I_{FILL\ LOAD}$ is defined in the current limit curves. $I_{FILL\ LOAD}$ curve is defined as the minimum value of current limit as a function of input to output voltage.

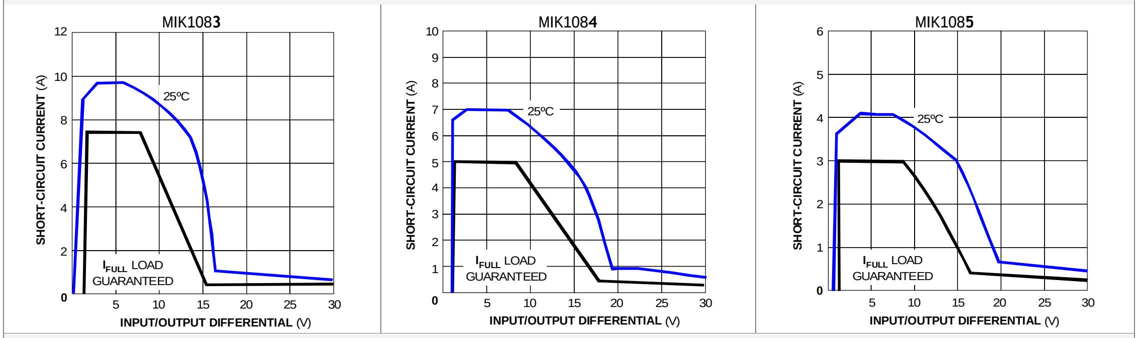
Note 4: Dropout voltage is specified over the full output current range of the device.

TYPICAL CHARACTERISTICS

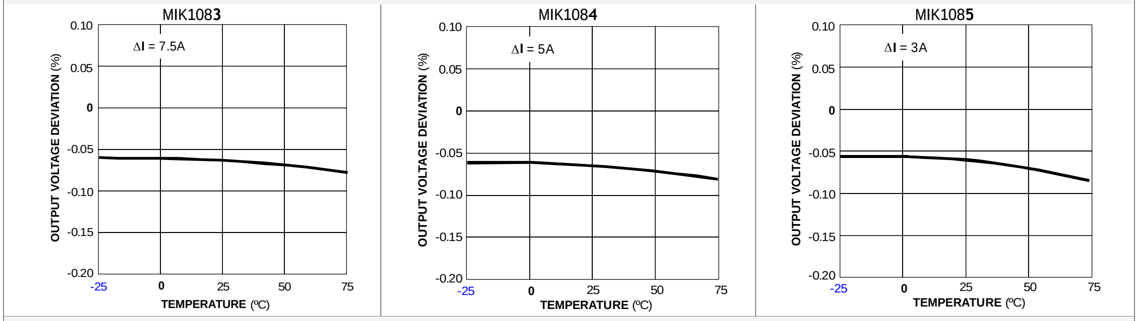
DROPOUT VOLTAGE



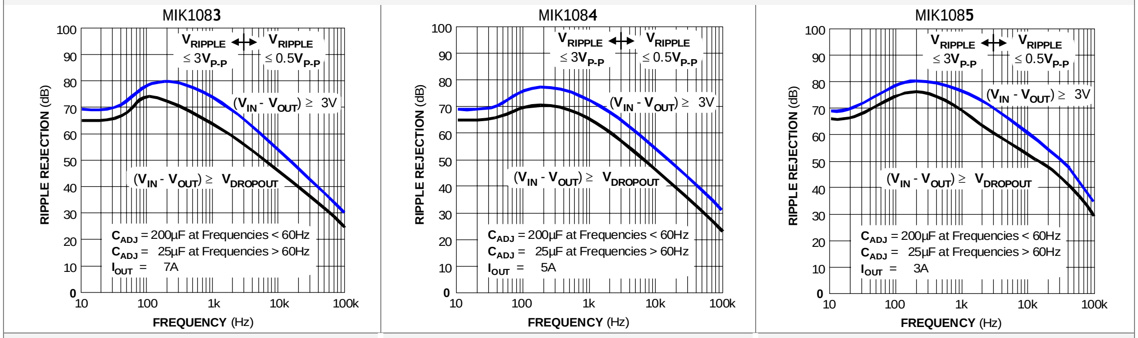
SHORT-CIRCUIT CURRENT



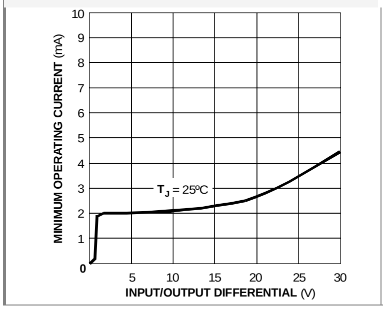
LOAD REGULATION



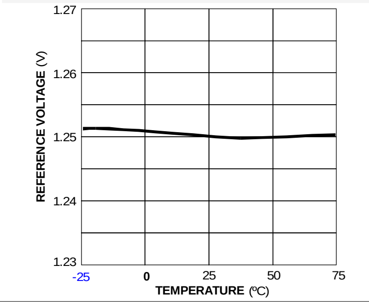
RIPPLE REJECTION



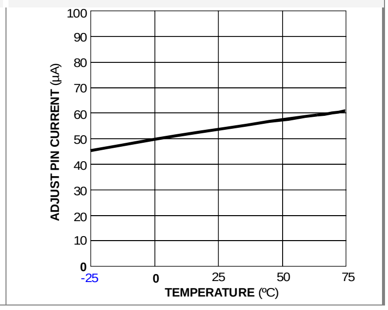
MINIMUM OPERATING CURRENT



TEMPERATURE STABILITY

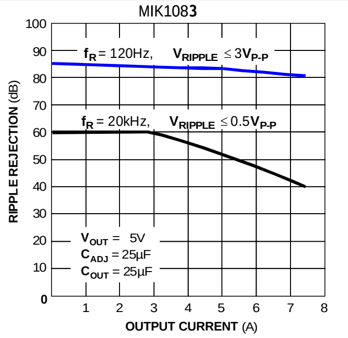


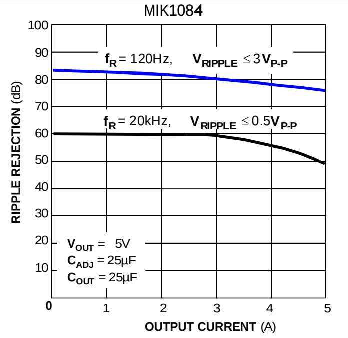
ADJUST PIN CURRENT

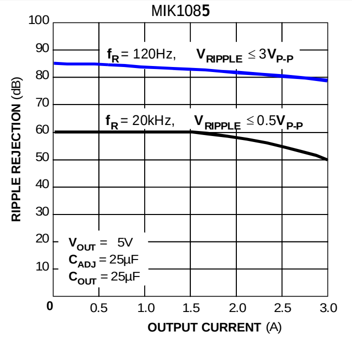


TYPICAL CHARACTERISTICS (CONTINUED)

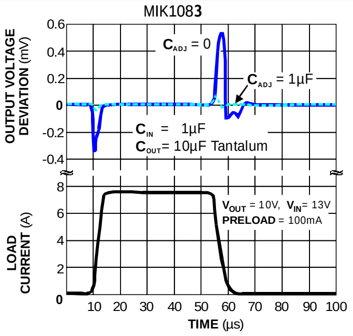
RIPPLE REJECTION vs. CURRENT

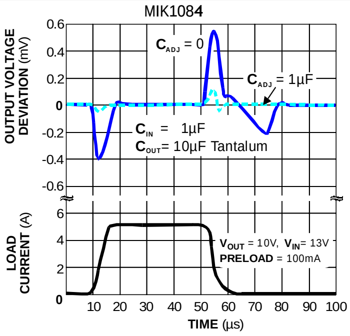


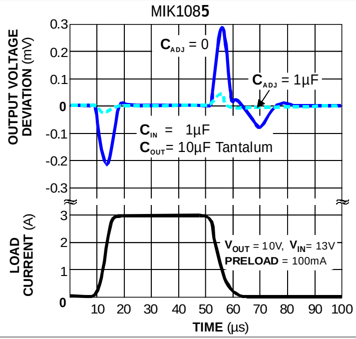




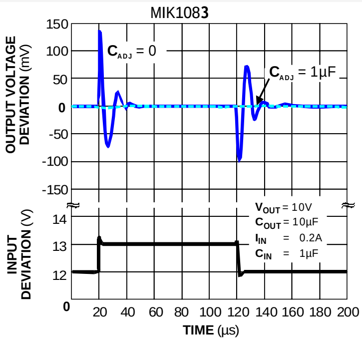
LOAD TRANSIENT RESPONSE

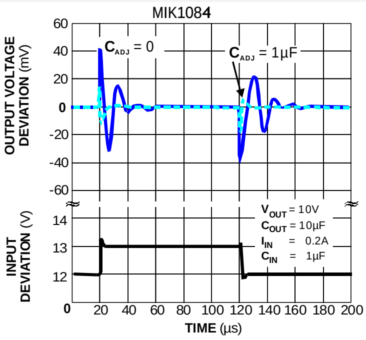


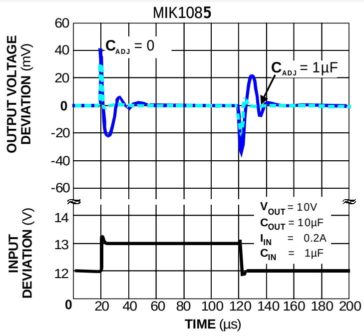




LINE TRANSIENT RESPONSE

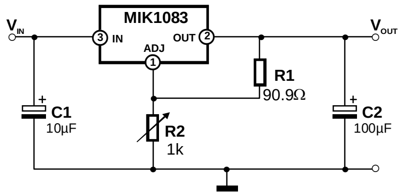






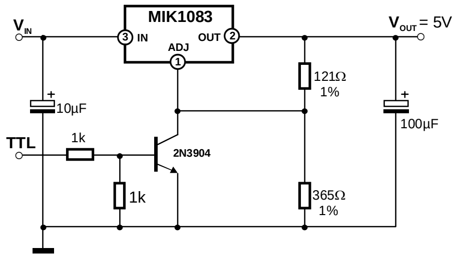
TYPICAL APPLICATIONS

1.2V TO 15V ADJUSTABLE REGULATOR



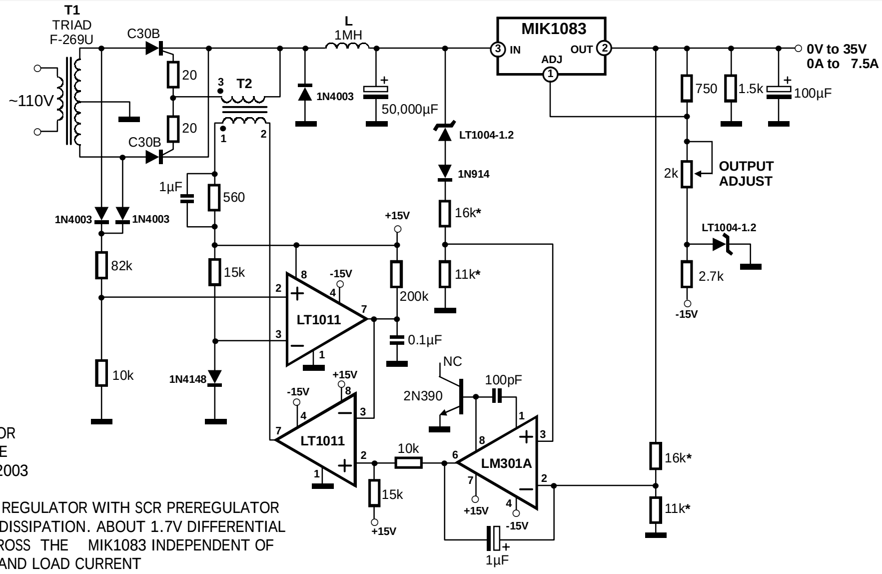
C1 needed if device is far from filter capacitor
V_{OUT} = 1.25V x (1 + R2 / R1)

5V REGULATOR WITH SHUTDOWN*



* OUTPUT shuts down to 1.3V

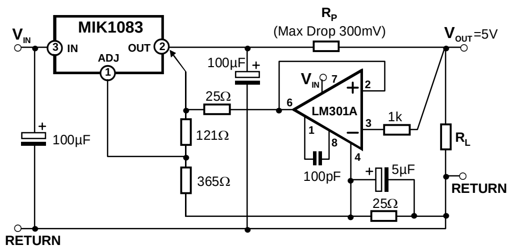
7.5A VARIABLE REGULATOR



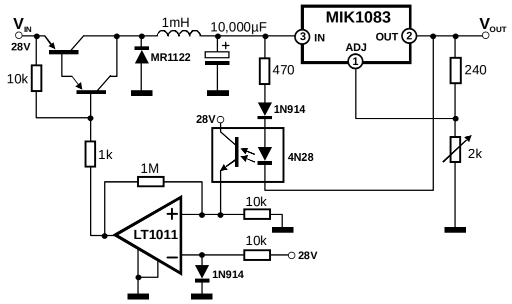
* 1% FILM RESISTOR
L : DALE TO-5 TYPE
T2: STANCOR 11Z-2003

GENERAL PURPOSE REGULATOR WITH SCR PREREGULATOR TO LOWER POWER DISSIPATION. ABOUT 1.7V DIFFERENTIAL IS MAINTAINED ACROSS THE MIK1083 INDEPENDENT OF OUTPUT VOLTAGE AND LOAD CURRENT

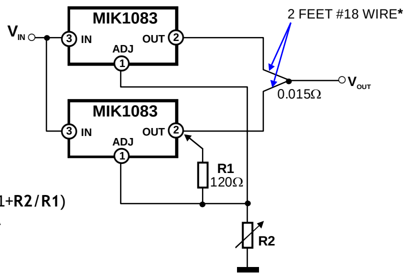
REMOTE SENSING



HIGH EFFICIENCY REGULATOR WITH SWITCHING PREREGULATOR



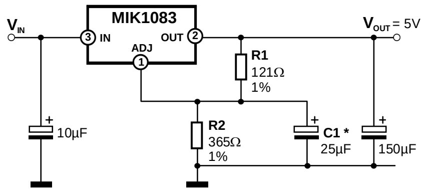
PARALLELING REGULATORS



V_{OUT} = 1.25V x (1+**R2**/**R1**)
I_{OUT} = 0A to 15A

* THE #18 WIRE ACTS AS BALLAST RESISTANCE INSURING CURRENT SHARING BETWEEN BOTH DEVICES

IMPROVING RIPPLE REJECTION



* **C1** IMPROVES RIPPLE REJECTION.
X_C SHOULD BE < R1 AT RIPPLE FREQUENCY

APPLICATION INFORMATION

The MIK1083 family of three-terminal adjustable regulators is easy to use and has all the protection features that are expected in high performance voltage regulators. They are short-circuit protected, and have safe area protection as well as thermal shutdown to turn off the regulator should the junction temperature exceed about 165°C.

These regulators are pin compatible with older three-terminal adjustable devices, offer lower dropout voltage and more precise reference tolerance. Further, the reference stability with temperature is improved over older types of regulators. The only circuit difference between using the MIK1083 family and older regulators is that this new family requires an output capacitor for stability.

STABILITY

The circuit design used in the MIK1083 family requires the use of an output capacitor as part of the device frequency compensation. For all operating conditions, the addition of 150mF aluminium electrolytic or a 22mF solid tantalum on the output will ensure stability. Normally, capacitors much smaller than this can be used with the MIK1083. Many different types of capacitors with widely varying characteristics are available. These capacitors differ in capacitor tolerance (sometimes ranging up to ±100%), equivalent series resistance, and capacitance temperature coefficient. The 150mF or 22mF values given will ensure stability.

When the adjustment terminal is bypassed to improve the ripple rejection, the requirement for an output capacitor increases. The value of 22mF tantalum or 150mF aluminum covers all cases of bypassing the adjustment terminal. Without bypassing the adjustment terminal, smaller capacitors can be used with equally good results and the table below shows approximately what size capacitors are needed to ensure stability.

RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJUSTMENT
10µF	10µF Tantalum, 50µF Aluminum	None
10µF	22µF Tantalum, 150µF Aluminum	20µF

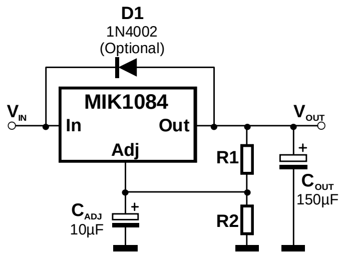
Normally, capacitor values on the order of 100mF are used in the output of many regulators to ensure good transient response with heavy load current changes. Output capacitance can be increased without limit and larger values of output capacitor further improve stability and transient response of the MIK1083 regulators. Another possible stability problem that can occur in monolithic IC regulators is current limit oscillations. These can occur because, in current limit, the safe area protection exhibits a negative impedance. The safe area protection decreases the current limit as the input-to-output voltage increases. That is the equivalent of having a negative resistance since increasing voltage causes current to decrease. Negative resistance during current limit is not unique to the MIK1083 series and has been present on all power IC regulators. The value of the negative resistance is a function of how fast the current limit is folded back as input-to-output voltage increases. This negative resistance can react with capacitors or inductors on the input to cause oscillation during current limiting. Depending on the value of series resistance, the overall circuitry may end up unstable. Since this is a system problem, it is not necessarily easy to solve; however, it does not cause any problems with the IC regulator and can usually be ignored.

PROTECTION DIODES

In normal operation, the MIK1083 family does not need any protection diodes. Older adjustable regulators required protection diodes between the adjustment pin and the output and from the output to the input to prevent overstressing the die. The internal current paths on the MIK1083 adjustment pin are limited by internal resistors. Therefore, even with capacitors on the adjustment pin, no protection diode is needed to ensure device safety under short-circuit conditions.

Diodes between input and output are usually not needed. The internal diode between the input and the output pins of the MIK1083 family can handle microsecond surge currents of 50A to 100A. Even with large output capacitances, it is very difficult to get those values of surge currents in normal operations. Only with a high value of output capacitors, such as 1000mF to 5000mF and with the input pin instantaneously shorted to ground, can damage occur. A crowbar circuit at the input of the MIK1083 can generate those kinds of currents, and a diode from output to input is then recommended. Normal power supply cycling or even plugging and unplugging in the system will not generate current large enough to do any damage.

The adjustment pin can be driven on a transient basis ±25V, with respect to the output without any device degradation. Of course, as with any IC regulator, exceeding the maximum input to output voltage differential causes the internal transistors to break down and none of the protection circuitry is functional.



OVERLOAD RECOVERY

Like any of the IC power regulators, the MIK1083 has safe area protection. The safe area protection decreases the current limit as input-to-output voltage increases and keeps the power transistor inside a safe operating region for all values of input-to-output voltage. The MIK1083 protection is designed to provide some output current at all values of input-to-output voltage up to the device breakdown.

When power is first turned on, as the input voltage rises, the output follows the input, allowing the regulator to start up into very heavy loads. During the start-up, as the input voltage is rising, the input-to-output voltage differential remains small, allowing the regulator to supply large output currents. With high input voltage, a problem can occur wherein removal of an output short will not allow the output voltage to recover. Older regulators, such as the 7800 series, also exhibited this phenomenon, so it is not unique to the MIK1083.

The problem occurs with a heavy output load when the input voltage is high and the output voltage is low, such

APPLICATION INFORMATION (CONTINUED)

as immediately after removal of a short. The load line for such a load may intersect the output current curve at two points. If this happens, there are two stable output operating points for the regulator. With this double intersection, the power supply may need to be cycled down to zero and brought up again to make the output recover.

RIPPLE REJECTION

The typical curves for ripple rejection reflect values for a bypassed adjustment pin. This curve will be true for all values of output voltage. For proper bypassing and ripple rejection approaching the values shown, the impedance of the adjust pin capacitor at the ripple frequency should be less than the value of R1, (normally 100W to 120W). The size of the required adjust pin capacitor is a function of the input ripple frequency. At 120Hz the adjust pin capacitor should be 25mF if R1 = 100W. At 10kHz only 0.22mF is needed.

For circuits without an adjust pin bypass capacitor, the ripple rejection will be a function of output voltage. The output ripple will increase directly as a ratio of the output voltage to the reference voltage (V_{OUT}/V_{REF}). For example, with the output voltage equal to 5V and no adjust pin capacitor, the output ripple will be higher by the ratio of 5V/1.25V or four times larger. Ripple rejection will be degraded by 12dB from the value shown on the typical curve.

OUTPUT VOLTAGE

The MIK1083 develops a 1.25V reference voltage between the output and the adjust terminal (see Figure 1). By placing a resistor R1 between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because I_{ADJ} is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

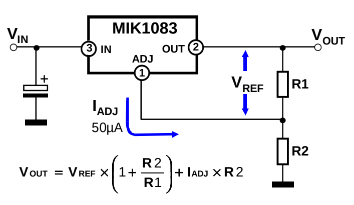


Fig 1. BASIC ADJUSTABLE REGULATOR

LOAD REGULATION

Because the MIK1083 is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider R1 is connected directly to the case not to the load. This is illustrated in Figure 2. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_P \times \left(\frac{R2+R1}{R1}\right),\ R_P = \text{Parasitic Line Resistance}$$

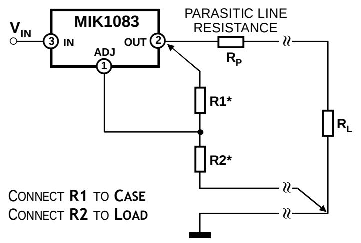


Fig 2. CONNECTIONS FOR BEST LOAD REGULATIONS

Connected as shown, R_P is not multiplied by the divider ratio. R_P is about 0.004W per foot using 16-gauge wire. This translates to 4mV/ft at 1A load current, so it is important to keep the positive lead between regulator and load as short as possible and use large wire or PC board traces.

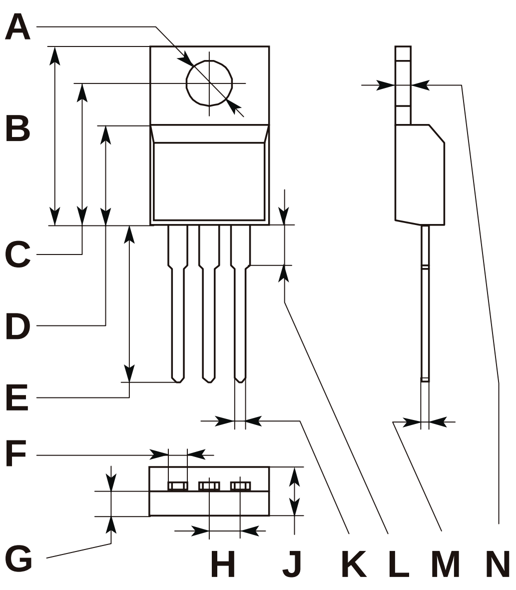
THERMAL CONSIDERATIONS

The MIK1083 series of regulators have internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction-to-case, case-to-heat sink interface, and heat sink resistance itself. New thermal resistance specifications have been developed to more accurately reflect device temperature and ensure safe operating temperatures. The data section for these new regulators provides a separate thermal resistance and maximum junction temperature for both the Control Section and the Power Transistor. Previous regulators, with a single junction-to-case thermal resistance specification, used an average of the two values provided here and therefore could allow excessive junction temperatures under certain conditions of ambient temperature and heat sink resistance. To avoid this possibility, calculations should be made for both sections to ensure that both thermal limits are met.

Junction-to-case thermal resistance is specified from the IC junction to the bottom of the case directly below the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

PHYSICAL DIMENSIONS AND MARKING DIAGRAMS

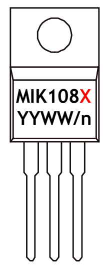
TO-220-3 PACKAGE



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	3.75	3.85	0.147	0.151
B	15.24	15.75	0.600	0.620
C	12.47	12.9	0.491	0.508
D	9.05	9.15	0.356	0.360
E	13.00	14.00	0.511	0.551
F	1.14	1.70	0.044	0.067
G	2.40	2.72	0.094	0.107
H	2.40	2.70	0.094	0.106
J	4.40	4.60	0.173	0.181
K	0.61	0.88	0.024	0.034
L	3.50	3.93	0.137	0.154
M	0.49	0.70	0.019	0.027
N	1.23	1.32	0.048	0.051

TO-220-3

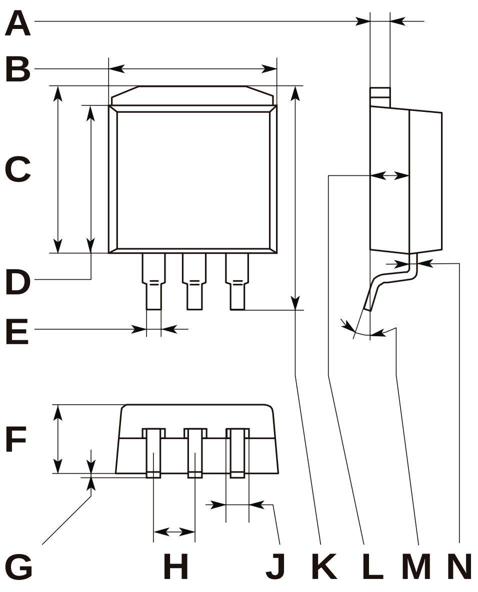
MARKING DIAGRAM



X — output current (see table below)
YY — Year
WW — Work Week
n — assembly location

X	OUTPUT CURRENT
3	7.5 A
4	5.0 A
5	3.0 A

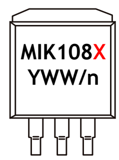
TO-263-3 PACKAGE



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.143	1.397	0.045	0.055
B	9.804	10.236	0.386	0.403
C	11.074	11.506	0.406	0.418
D	9.042	9.347	0.356	0.368
E	0.660	0.914	0.026	0.036
F	4.318	4.572	0.170	0.180
G	0.000	0.254	0.000	0.010
H	2.540 BSC		0.100 BSC	
J	1.295 REF		0.051 REF	
K	13.691	14.707	0.539	0.579
L	0.457	0.660	0.018	0.026
M	5º REF		5º REF	
N	2.235	2.591	0.088	0.102

TO-263-3

MARKING DIAGRAM



X — output current (see table below)
Y — Year
WW — Work Week
n — assembly location

X	OUTPUT CURRENT
3	7.5 A
4	5.0 A
5	3.0 A

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ORDERING INFORMATION

ORDERING NUMBER	OUTPUT CURRENT	PACKAGE	OPERATING TEMPERATURE	SHIPPING	
MIK 1083 **CT**	7.5 A	TO-220-3	0°C to +70°C	25 units/Rail	
MIK 1084 **CT**	5.0 A				
MIK 1085 **CT**	3.0 A				
MIK 1083 **CS**	7.5 A	TO-263-3	0°C to +70°C	55 units/Rail	2500 units/Reel
MIK 1084 **CS**	5.0 A				
MIK 1085 **CS**	3.0 A				

NOTE: The form of packing is stipulated in the contract.

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