LM1117 Qualification Package

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800mA LOW-DROPOUT LINEAR REGULATOR

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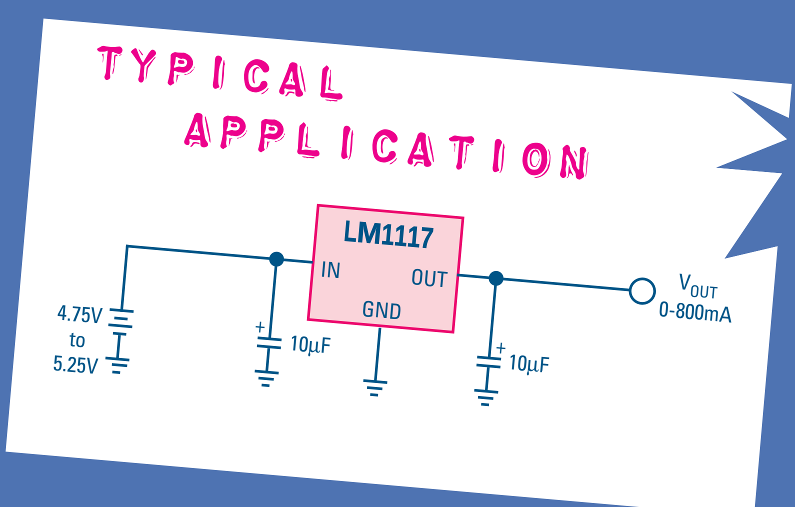

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LM1117
QUALIFICATION PACKAGE

Summer 1998

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1.0 INTRODUCTION

1.1 General Product Description

National Semiconductor Corporation's LM1117 is, for most applications, a low cost alternative to several other quasi-low dropout (quasi-LDO) regulators which are currently available. The device is produced in four voltage options: 5.0V, 3.3V, 2.85V, adjustable. Its operation is guaranteed at junction temperatures ranging from 0°C to 125°C. There are two package types available: TO-220 and SOT-223. The package drawings are contained in the datasheet, which is included as part of this booklet. The various product/package combinations are listed below.

Output Voltage	Full Device Name	Packaging Details
5.0V	LM1117T-5.0	TO-220
	LM1117MP-5.0	SOT-223, 250 units/reel
	LM1117MPX-5.0	SOT-223, 2000 units/reel
3.3V	LM1117T-3.3	TO-220
	LM1117MP-3.3	SOT-223, 250 units/reel
	LM1117MPX-3.3	SOT-223, 2000 units/reel
2.85V	LM1117T-2.85	TO-220
	LM1117MP-2.85	SOT-223, 250 units/reel
	LM1117MPX-2.85	SOT-223, 2000 units/reel
Adjustable	LM1117T-ADJ	TO-220
	LM1117MP-ADJ	SOT-223, 250 units/reel
	LM1117MPX-ADJ	SOT-223, 2000 units/reel

The LM1117 is fabricated using National's bipolar LB300 process. Fabrication steps are summarized in section 3-2 of this booklet. The four output voltage options are processed identically except that each receives a unique metal mask. The die size is 80 mils x 50 mils. For a more detailed description of the fabrication process refer to section 3-0.

1.2 Reliability/Qualification Overview

The LM1117 was qualified almost entirely in the 3.3V option in SOT-223 (i.e. LM1117MP-3.3). The SOT-223 was chosen because it is the most commonly used package in this device's application. The other options were qualified by extension. Only the electrostatic discharge (ESD) testing was done in TO-220. Please refer to section 5-1 for details regarding the qualification.

1.3 Technical Assistance

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2.0 DEVICE INFORMATION

National Semiconductor

June 1998

LM1117
800mA Low-Dropout Linear Regulator

General Description

The LM1117 is a series of low dropout voltage regulators with a dropout of 1.2V at 800mA of load current. It has the same pin-out as National Semiconductor's industry standard LM317.

The LM1117 is available in an adjustable version, which can set the output voltage from 1.25V to 13.8V with only two external resistors. In addition, it is also available in three fixed voltages, 2.85V, 3.3V, and 5V.

The LM1117 offers current limiting and thermal shutdown. Its circuit includes a zener trimmed bandgap reference to assure output voltage accuracy to within ±1%.

The LM1117 series is available in SOT-223 and TO-220 packages. A minimum of 10µF tantalum capacitor is required at the output to improve the transient response and stability.

Features

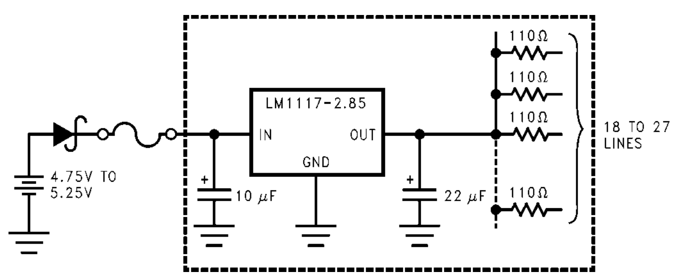
- Available in 2.85V, 3.3V, 5V, and Adjustable Versions
- Space Saving SOT-223 Package
- Current Limiting and Thermal Protection
- Output Current 800mA
- Temperature Range 0˚C to 125˚C
- Line Regulation 0.2% (Max)
- Load Regulation 0.4% (Max)

Applications

- 2.85V Model for SCSI-2 Active Termination
- Post Regulator for Switching DC/DC Converter
- High Efficiency Linear Regulators
- Battery Charger
- Battery Powered Instrumentation

Typical Application

Active Terminator for SCSI-2 Bus



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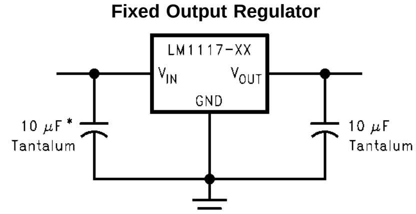
Fixed Output Regulator



* Required if the regulator is located far from the power supply filter.

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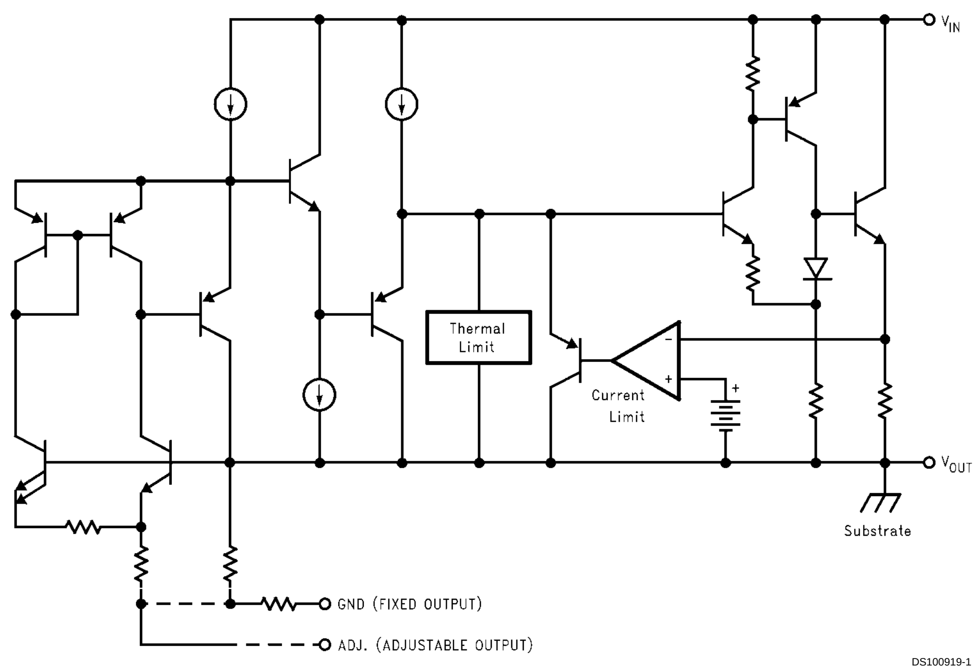
Ordering Information

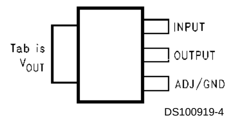
Package	Temperature Range 0˚C to +125˚C	Packaging Marking	Transport Media	NSC Drawing
3-lead SOT-223	LM1117MPX-ADJ	N03A	Tape and Reel	MA04A
	LM1117MPX-2.85	N04A	Tape and Reel	
	LM1117MPX-3.3	N05A	Tape and Reel	
	LM1117MPX-5.0	N06A	Tape and Reel	
3-lead TO-220	LM1117T-ADJ	LM1117T-ADJ	Rails	T03B
	LM1117T-2.85	LM1117T-2.85	Rails	
	LM1117T-3.3	LM1117T-3.3	Rails	
	LM1117T-5.0	LM1117T-5.0	Rails	

Block Diagram



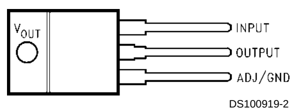
Connection Diagrams

SOT-223



Top View

TO-220



Top View

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Maximum Input Voltage (V_{IN} to GND)	
LM1117-ADJ, LM1117-3.3, LM1117-5.0	20V
Power Dissipation (Note 2)	Internally Limited
Junction Temperature (T_J) (Note 2)	150˚C
Storage Temperature Range	-65˚C to 150˚C
Lead Temperature	
TO-220 (T) Package	260˚C, 10 sec
SOT-223 (IMP) Package	260˚C, 4 sec
ESD Tolerance (Note 3)	2000V

Operating Ratings (Note 1)

Input Voltage (V_{IN} to GND)	
LM1117-ADJ, LM1117-3.3, LM1117-5.0	15V
LM1117-2.85	10V
Junction Temperature Range (T_J) (Note 2)	0˚C to 125˚C

Electrical Characteristics

Typicals and limits appearing in normal type apply for T_J = 25˚C. Limits appearing in **Boldface** type apply over the entire junction temperature range for operation, 0˚C to 125˚C.

Symbol	Parameter	Conditions	Min (Note 5)	Typ (Note 4)	Max (Note 5)	Units
V_{REF}	Reference Voltage	LM1117-ADJ				
		I_{OUT}=10mA, V_{IN}-V_{OUT}=2V, T_J=25˚C	1.238	1.250	1.262	V
		10mA≤I_{OUT}≤ 800mA, 1.4V≤ V_{IN}-V_{OUT}≤10V	**1.225**	1.250	**1.270**	V
V_{OUT}	Output Voltage	LM1117-2.85				
		I_{OUT} =10mA, V_{IN}=4.85V, T_J=25˚C	2.820	2.850	2.880	V
		O≤I_{OUT}≤800mA, 4.25V≤ V_{IN}≤10V	**2.790**	2.850	**2.910**	V
		O≤I_{OUT} ≤500mA, V_{IN}=4.10V	**2.790**	2.850	**2.910**	V
		LM1117-3.3				
		I_{OUT}=10mA, V_{IN}=5V T_J=25˚C	3.267	3.300	3.333	V
		O≤I_{OUT}≤800mA, 4.75V≤ V_{IN}≤10V	**3.235**	3.300	**3.365**	V
		LM1117-5.0				
		I_{OUT}=10mA, V_{IN}=7V, T_J=25˚C	4.950	5.000	5.050	V
		O≤I_{OUT}≤ 800mA, 6.5V≤ V_{IN}≤12V	**4.900**	5.000	**5.100**	V
ΔV_{OUT}	Line Regulation (Note 6)	LM1117-ADJ				
		I_{OUT}=10mA, 1.5V≤ V_{IN}-V_{OUT}≤13.75V		0.035	**0.2**	%
		LM1117-2.85				
		I_{OUT}=0mA, 4.25V≤ V_{IN}≤10V		1	**6**	mV
		LM1117-3.3				
		I_{OUT}=0mA, 4.75V≤ V_{IN}≤15V		1	**6**	mV
		LM1117-5.0				
		I_{OUT}=0mA, 6.5V≤ V_{IN}≤15V		1	**10**	mV
ΔV_{OUT}	Load Regulation (Note 6)	LM1117-ADJ				
		V_{IN}-V_{OUT}=3V, 10≤I_{OUT}≤800mA		0.2	**0.4**	%
		LM1117-2.85				
		V_{IN}=4.25V, 0≤I_{OUT}≤800mA		1	**10**	mV
		LM1117-3.3				
		V_{IN}=4.75V, 0≤I_{OUT}≤800mA		1	**10**	mV
		LM1117-5.0				
		V_{IN}=6.5V, 0≤I_{OUT}≤800mA		1	**15**	mV
V_{IN}-V_{OUT}	Dropout Voltage (Note 7)	I_{OUT}=100mA		1.10	**1.20**	V
		I_{OUT}=500mA		1.15	**1.25**	V
		I_{OUT}=800mA		1.20	**1.30**	V
I_{LIMIT}	Current Limit	V_{IN}-V_{OUT}=5V, T_J=25˚C	800	1200	1500	mA
	Minimum Load Current (Note 8)	LM1117-ADJ				
		V_{IN}=15V		1.7	**5**	mA

Electrical Characteristics (Continued)

Typicals and limits appearing in normal type apply for T_J = 25˚C. Limits appearing in **Boldface** type apply over the entire junction temperature range for operation, 0˚C to 125˚C.

Symbol	Parameter	Conditions	Min (Note 5)	Typ (Note 4)	Max (Note 5)	Units
	Quiescent Current	LM1117-2.85 V_{IN}≤10V		5	**10**	mA
		LM1117-3.3 V_{IN}≤15V		5	**10**	mA
		LM1117-5.0 V_{IN}≤15V		5	**10**	mA
	Thermal Regulation	T_A=25˚C, 30ms Pulse		0.01	0.1	%/W
	Ripple Regulation	f_{RIPPLE}=120Hz, V_{IN}-V_{OUT}=3V V_{RIPPLE}=1V_{PP}	**60**	75		dB
	Adjust Pin Current			60	**120**	µA
	Adjust Pin Current Change	10≤ I_{OUT}≤ 800mA, 1.4V≤ V_{IN}-V_{OUT}≤ 10V		0.2	**5**	µA
	Temperature Stability			0.5		%
	Long Term Stability	T_A=125˚C, 1000Hrs		0.3		%
	RMS Output Noise	(% of V_{OUT}), 10Hz≤f≤10kHz		0.003		%
	Thermal Resistance Junction-to-Case	3-Lead SOT-223 3-Lead TO-220		15.0 3.0		˚C/W ˚C/W
	Thermal Resistance Junction-to-Ambient (No heat sink; No air flow)	3-Lead SOT-223 3-Lead TO-220		136 79		˚C/W ˚C/W

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

Note 2: The maximum power dissipation is a function of $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(max)}-T_A)/\theta_{JA}$. All numbers apply for packages soldered directly into a PC board.

Note 3: For testing purposes, ESD was applied using human body model, 1.5kΩ in series with 100pF.

Note 4: Typical Values represent the most likely parametric norm.

Note 5: All limits are guaranteed by testing or statistical analysis.

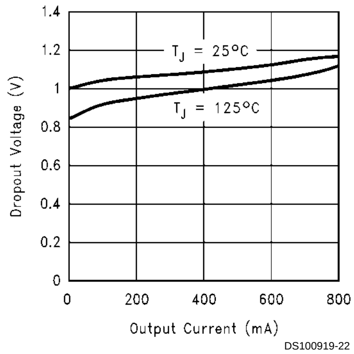
Note 6: Load and line regulation are measured at constant junction room temperature.

Note 7: The dropout voltage is the input/output differential at which the circuit ceases to regulate against further reduction in input voltage. It is measured when the output voltage has dropped 100mV from the nominal value obtained at V_{IN}=V_{OUT}+1.5V.

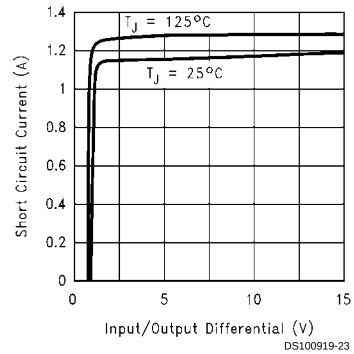
Note 8: The minimum output current required to maintain regulation.

Typical Performance Characteristics

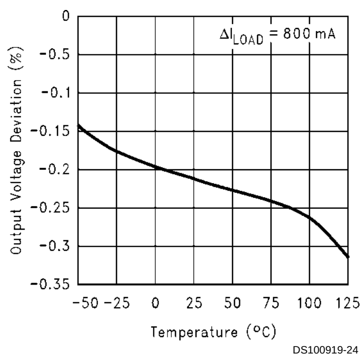
Dropout Voltage (V_{IN}-V_{OUT})



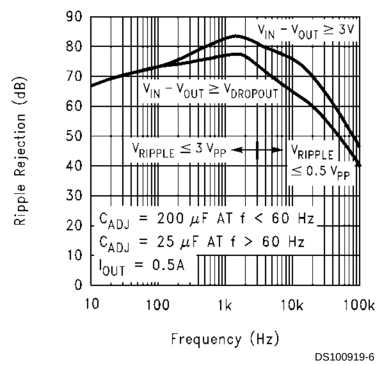
Short-Circuit Current



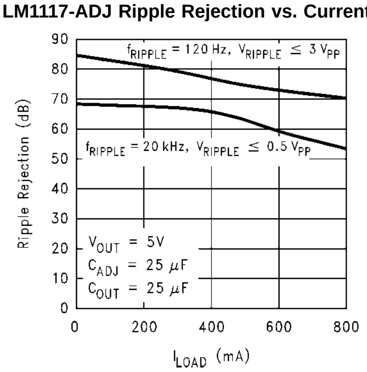
Load Regulation



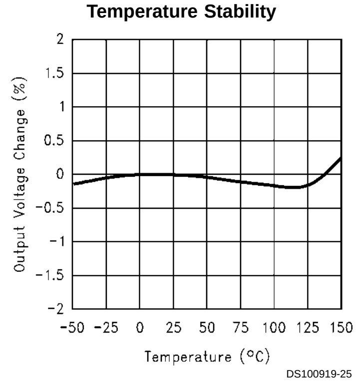
LM1117-ADJ Ripple Rejection



LM1117-ADJ Ripple Rejection vs. Current

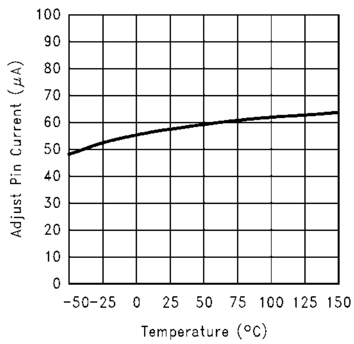


Temperature Stability



Typical Performance Characteristics (Continued)

Adjust Pin Current



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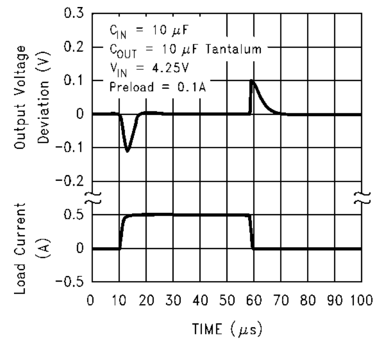
LM1117-2.85 Load Transient Response



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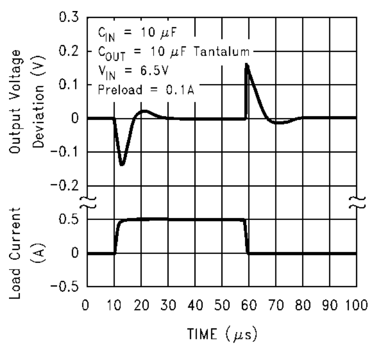
LM1117-5.0 Load Transient Response



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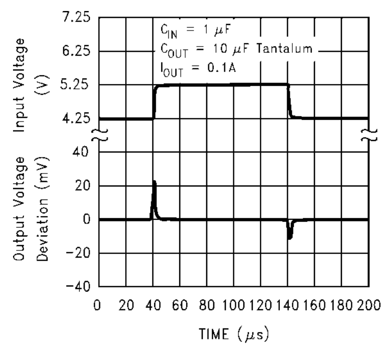
LM1117-2.85 Line Transient Response



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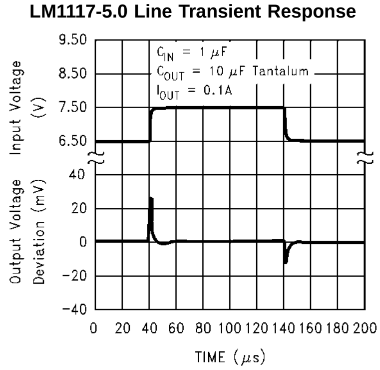
LM1117-5.0 Line Transient Response



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APPLICATION NOTE

1.0 External Capacitors/Stability

1.1 Input Bypass Capacitor

An input capacitor is recommended. A 10µF tantalum on the input is a suitable input bypassing for almost all applications.

1.2 Adjust Terminal Bypass Capacitor

The adjust terminal can be bypassed to ground with a bypass capacitor (C_{ADJ}) to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. At any ripple frequency, the impedance of the C_{ADJ} should be less than R1 to prevent the ripple from being amplified:

$1/(2\pi * f_{RIPPLE} * C_{ADJ}) < R1$

The R1 is the resistor between the output and the adjust pin. Its value is normally in the range of 100-200Ω. For example, with R1=124Ω and f_{RIPPLE}=120Hz, the C_{ADJ} should be 11µF.

1.3 Output Capacitor

The output capacitor is critical in maintaining regulator stability, and must meet the required conditions for both minimum amount of capacitance and ESR (Equivalent Series Resistance). The minimum output capacitance required by the LM1117 is 10µF, if a tantalum capacitor is used. Any increase of the output capacitance will merely improve the loop stability and transient response. The ESR of the output capacitor should be less than 0.5Ω. In the case of the adjustable regulator, when the C_{ADJ} is used, a larger output capacitance (22µf tantalum) is required.

2.0 Output Voltage

The LM1117 adjustable version develops a 1.25V reference voltage, V_{REF}, between the output and the adjust terminal. As shown in Figure 1, this voltage is applied across resistor R1 to generate a constant current I1. The current I_{ADJ} from the adjust terminal could introduce error to the output. But since it is very small (60µA) compared with the I1 and very constant with line and load changes, the error can be ignored. The constant current I1 then flows through the output set resistor R2 and sets the output voltage to the desired level.

For fixed voltage devices, R1 and R2 are integrated inside the devices.

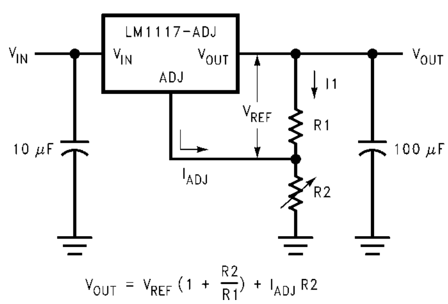


Figure 1. Basic Adjustable Regulator

3.0 Load Regulation

The LM1117 regulates the voltage that appears between its output and ground pins, or between its output and adjust pins. In some cases, line resistances can introduce errors to the voltage across the load. To obtain the best load regulation, a few precautions are needed.

Figure 2 shows a typical application using a fixed output regulator. The Rt1 and Rt2 are the line resistances. It is obvious that the V_{LOAD} is less than the V_{OUT} by the sum of the voltage drops along the line resistances. In this case, the load regulation seen at the R_{LOAD} would be degraded from the data sheet specification. To improve this, the load should be tied directly to the output terminal on the positive side and directly tied to the ground terminal on the negative side.

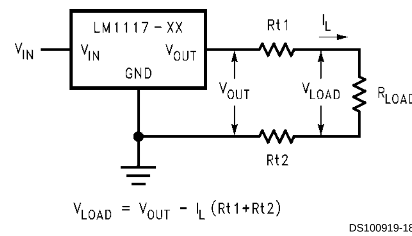


Figure 2. Typical Application using Fixed Output Regulator

When the adjustable regulator is used (Figure 3), the best performance is obtained with the positive side of the resistor R1 tied directly to the output terminal of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation. For example, a 5V regulator with 0.05Ω resistance between the regulator and load will have a load regulation due to line resistance of 0.05Ω x I_L. If R1 (=125Ω) is connected near the load, the effective line resistance will be 0.05Ω (1+R2/R1) or in this case, it is 4 times worse. In addition, the ground side of the resistor R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

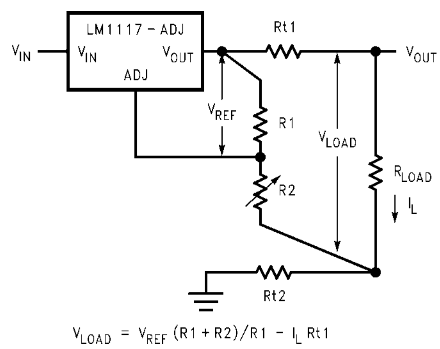


Figure 3. Best Load Regulation using Adjustable Output Regulator

4.0 Protection Diodes

Under normal operation, the LM1117 regulators do not need any protection diode. With the adjustable device, the internal resistance between the adjust and output terminals limits the current. No diode is needed to divert the current around the regulator even with capacitor on the adjust terminal. The adjust pin can take a transient signal of ±25V with respect to the output voltage without damaging the device.

When a output capacitor is connected to a regulator and the input is shorted to ground, the output capacitor will discharge

APPLICATION NOTE (Continued)

into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and rate of decrease of V_{IN}. In the LM1117 regulators, the internal diode between the output and input pins can withstand microsecond surge currents of 10A to 20A. With an extremely large output capacitor (≥1000 µF), and with input instantaneously shorted to ground, the regulator could be damaged.

In this case, an external diode is recommended between the output and input pins to protect the regulator, as shown in Figure 4.

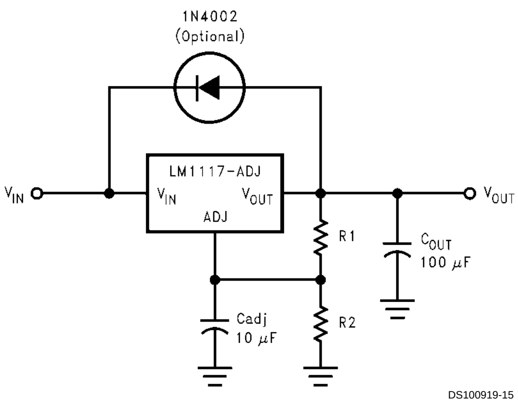


Figure 4. Regulator with Protection Diode

5.0 Heatsink Requirements

The LM1117 regulators have internal thermal shutdown to protect the device from over-heating. Under all possible operating conditions, the junction temperature of the LM1117 must be within the range of 0˚C to 125˚C. A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application. To determine if a heatsink is needed, the power dissipated by the regulator, P_D , must be calculated:

$I_{IN} = I_L + I_G$

$P_D = (V_{IN}-V_{OUT})I_L + V_{IN}I_G$

Figure 5 shows the voltages and currents which are present in the circuit.

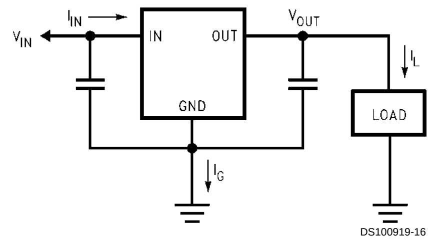


Figure 5. Power Dissipation Diagram

The next parameter which must be calculated is the maximum allowable temperature rise, T_R(max):

$T_R(max)=T_J(max)-T_A(max)$

where T_J(max) is the maximum allowable junction temperature (125˚C), and T_A(max) is the maximum ambient temperature which will be encountered in the application.

Using the calculated values for T_R(max) and P_D, the maximum allowable value for the junction-to-ambient thermal resistance (θ_{JA}) can be calculated:

$\theta_{JA} = T_R(max)/P_D$

If the maximum allowable value for θ_{JA} is found to be ≥136˚C/W for SOT-223 package or ≥79˚C/W for TO-220 package, no heatsink is needed since the package alone will dissipate enough heat to satisfy these requirements. If the calculated value for θ_{JA} falls below these limits, a heatsink is required.

As a design aid, Table 1 shows the value of the θ_{JA} of SOT-223 for different heatsink area. The copper patterns that we used to measure these θ_{JA}s are shown at the end of the Application Notes Section. Figure 6 reflects the same test results as what are in the Table 1.

Table 1. θ_{JA} of SOT-223 for Different Heatsink Area

Layout	1oz Copper Area		Thermal Resistance
	Top Side (in^2)*	Bottom Side (in^2)	(θ_{JA},˚C/W)
1	0.0123	0	136
2	0.066	0	123
3	0.3	0	84
4	0.53	0	75
5	0.76	0	69
6	1	0	66
7	0	0.2	115
8	0	0.4	98
9	0	0.6	89
10	0	0.8	82
11	0	1	79
12	0.066	0.066	125
13	0.175	0.175	93
14	0.284	0.284	83

APPLICATION NOTE (Continued)

Table 1. θ_{JA} of SOT-223 for Different Heatsink Area (Continued)

Layout	1oz Copper Area		Thermal Resistance
15	0.392	0.392	75
16	0.5	0.5	70

*Tab of device attached to topside copper

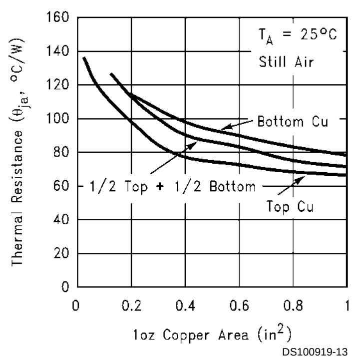


Figure 6. θ_{JA} vs. 1oz Copper Area

Figure 7 shows the maximum allowable power dissipation vs. ambient temperature for the SOT-223 device. Figure 8 shows the maximum allowable power dissipation vs. 1oz copper area (in^2) for the SOT-223 device. Please see AN1028 for power enhancement techniques to be used with SOT-223 package.

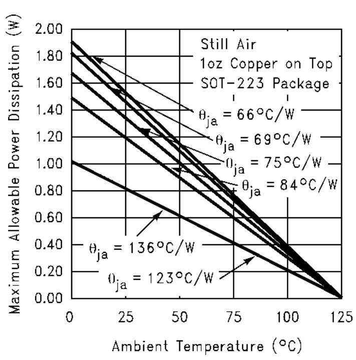


Figure 7. Maximum Allowable Power Dissipation vs. Ambient Temperature

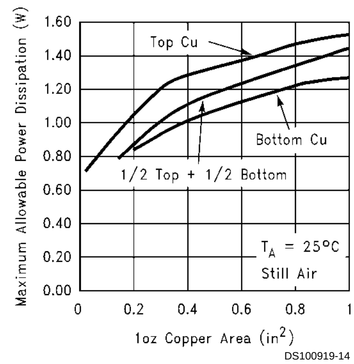


Figure 8. Maximum Allowable Power Dissipation vs. 1oz Copper Area

APPLICATION NOTE (Continued)

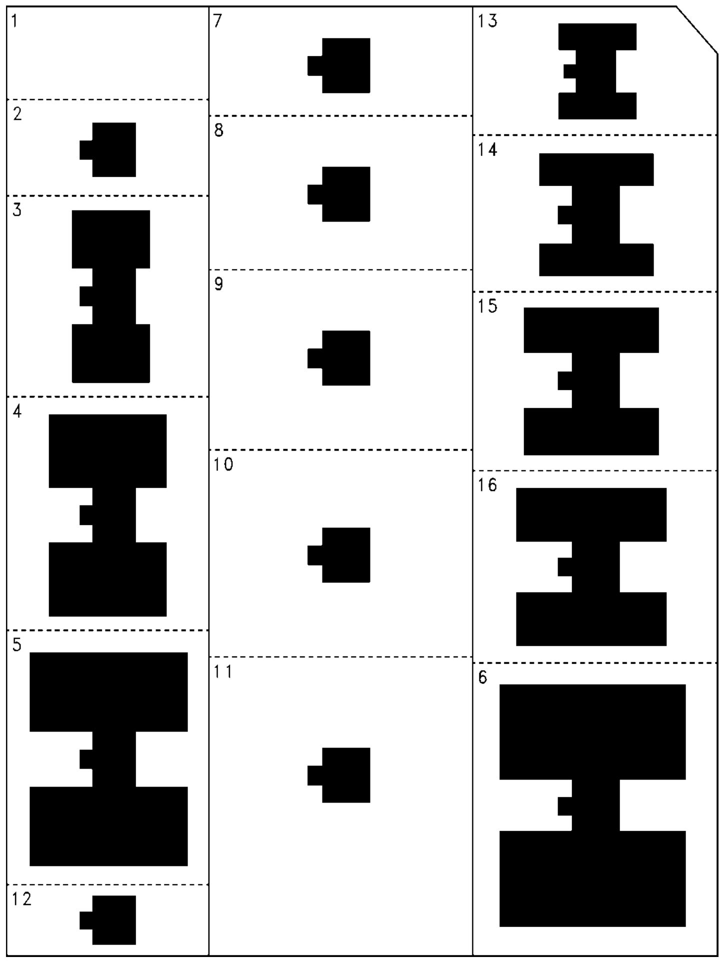


Figure 9. Top View of the SOT-223 Thermal Test Pattern in Actual Scale

APPLICATION NOTE (Continued)

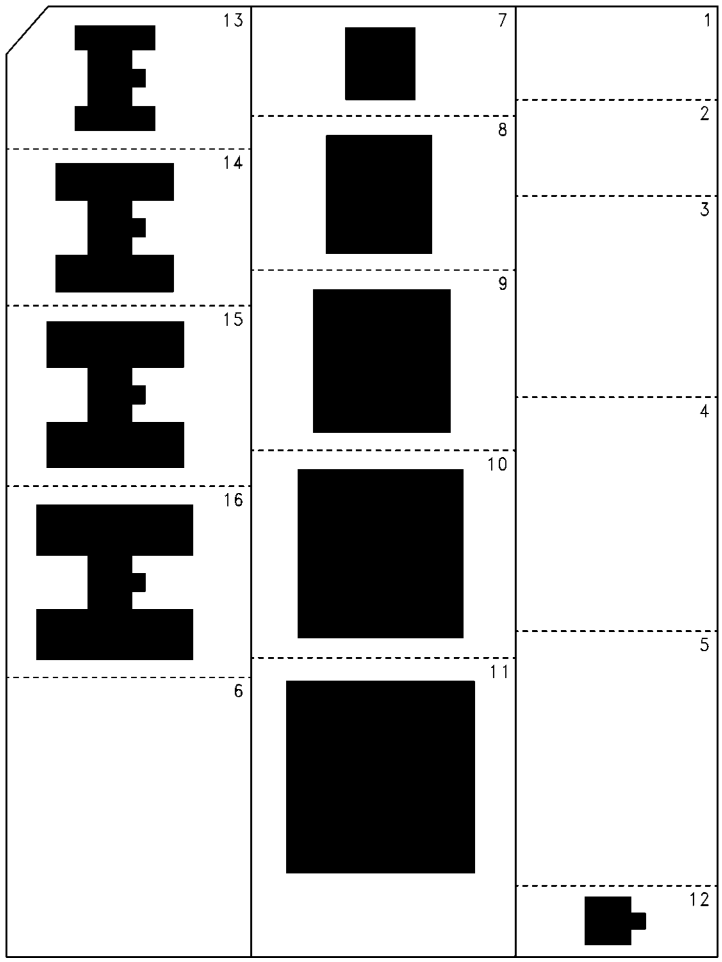
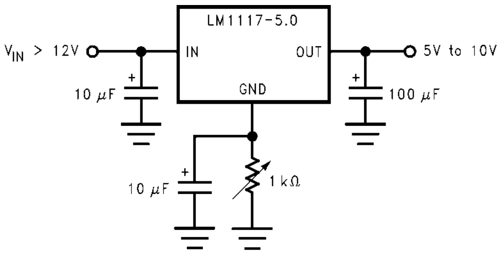
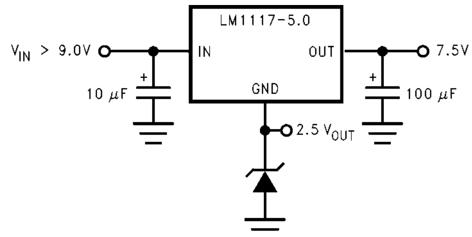


Figure 10. Bottom View of the SOT-223 Thermal Test Pattern in Actual Scale

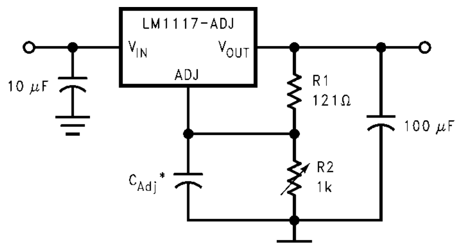
Typical Application Circuits



Adjusting Output of Fixed Regulators



Regulator with Reference

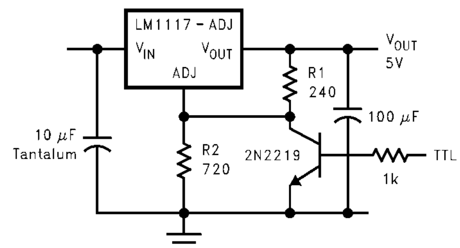


$$V_{OUT} = 1.25\left(1 + \frac{R2}{R1}\right)$$

*C_{Adj} is optional, however it will improve ripple rejection.

DS100919-29

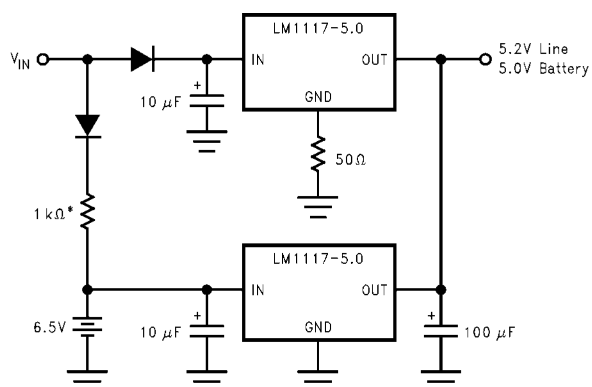
1.25V to 10V Adjustable Regulator with Improved Ripple Rejection



* Min. output ≈ 1.25V

DS100919-27

5V Logic Regulator with Electronic Shutdown*

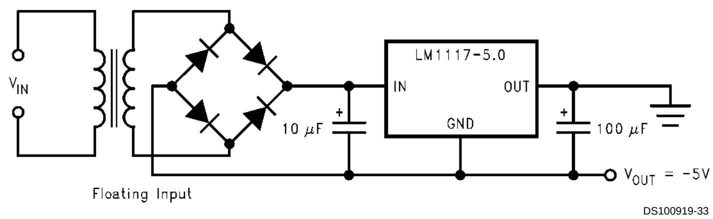


* Select for charge rate.

DS100919-32

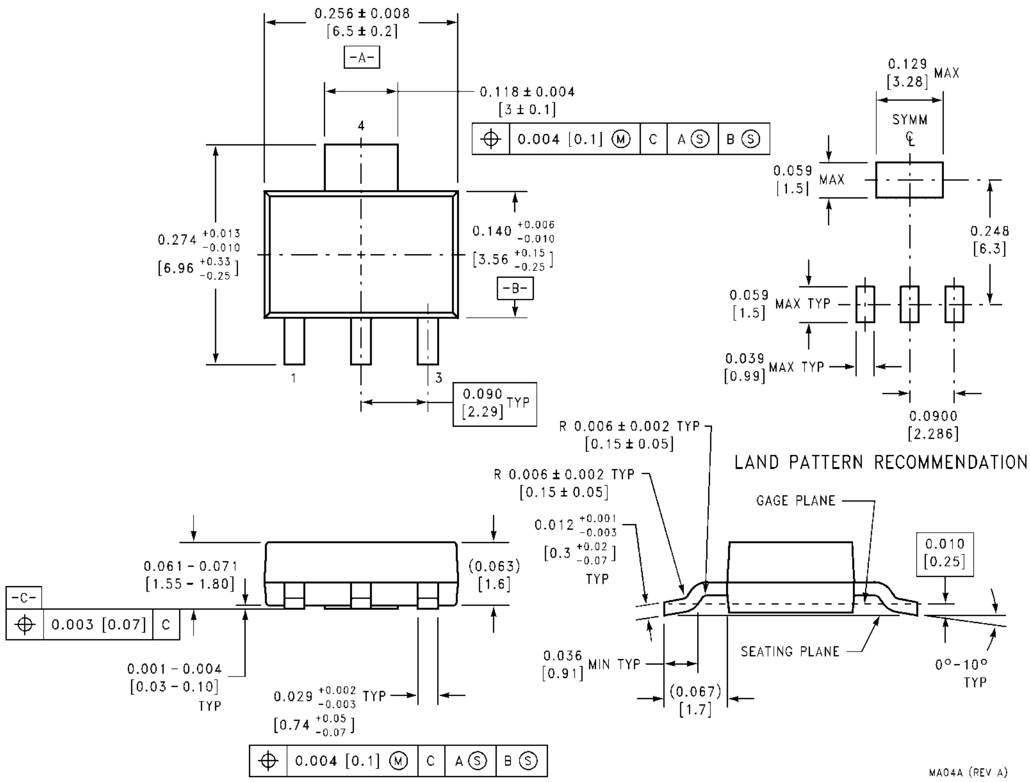
Battery Backed-Up Regulated Supply

Typical Application Circuits (Continued)



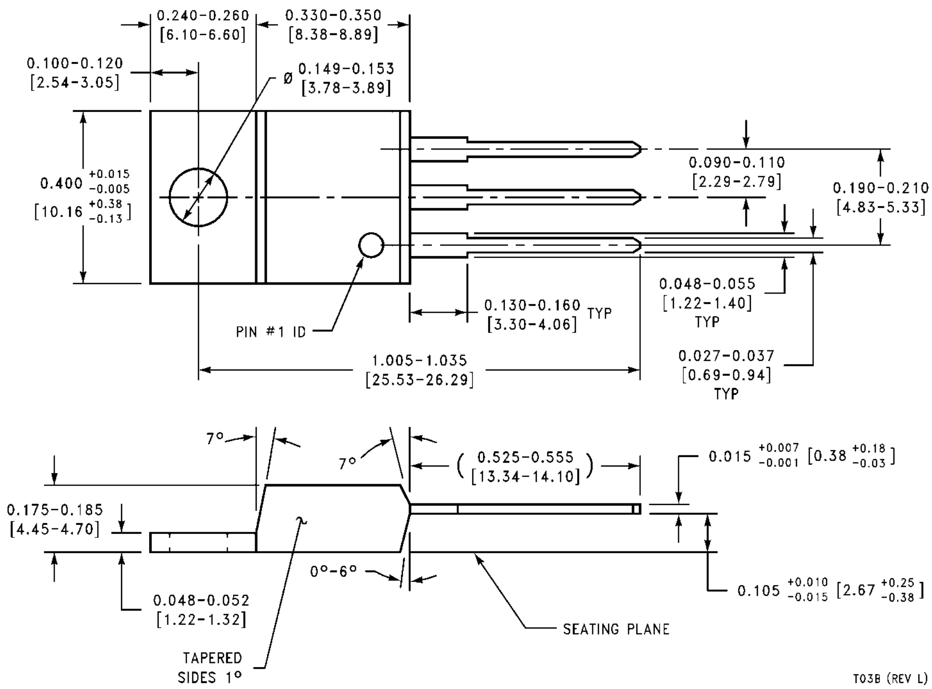
Low Dropout Negative Supply

Physical Dimensions inches (millimeters) unless otherwise noted



3-Lead SOT-223 Package
Order Number LM1117MPX-ADJ, LM1117MPX-2.85, LM1117MPX-3.3, or LM1117MPX-5.0
NSC Package Number MA04A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



3-Lead TO-220 Package
Order Number LM1117T-ADJ, LM1117T-2.85, LM1117T-3.3, or LM1117T-5.0
NSC Package Number T03B

LIFE SUPPORT POLICY

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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National Semiconductor Japan Ltd.
Tel: 81-3-5620-6175
Fax: 81-3-5620-6179

3.0 PROCESS INFORMATION

3.1 PROCESS DETAILS

Fabrication Site: Greenock, Scotland
Process Technology: LB300 (Bipolar)
Wafer Diameter: 6 inches (150 mm)
Number of Masks: 11
Metallization: Al with 0.5% Cu
Top Side Passivation: Oxide/Nitride

3.2 PROCESS FLOW AND MASKS

1: Laser Scribe
2: Initial Oxide
3: Collector Mask
4: Collector Implant
5: Collector Diffusion
6: Iso-Up Mask
7: Iso-Up Implant
8: Strip/Inspect
9: Epi Growth
10: Epi Reox
11: Plug Mask
12: Plug PreDep
13: Plug Diffusion
14: Iso Down Mask
15: Pre Iso-Down Implant Ox
16: Iso Down Implant
17: Iso Down Diffusion
18: FTA mask
19: FTA Implant
20: FTA Reox
21: Base Mask
22: Pre Base Implant Ox
23: Base Implant
24: Base Diffusion
25: Post Base Ox
26: Emitter Mask
27: Iso/CB Diode Check
28: Screen Ox
29: Emitter Implant
30: Emitter Diffusion
31: Resistor Mask
32: Resistor Implant
33: VOE (Vapox Over Emitter)
34: Getter
35: Capacitor Ox
36: Anneal
37: Contact Mask
38: Platinum Depostion
39: Platinum Silicide
40: Platinum Strip
41: Titanium Tungsten Sputter
42: Metal Deposition
43: Metal Mask
44: Passivation
45: Passivation Mask
46: Anneal
47: Electrical Test

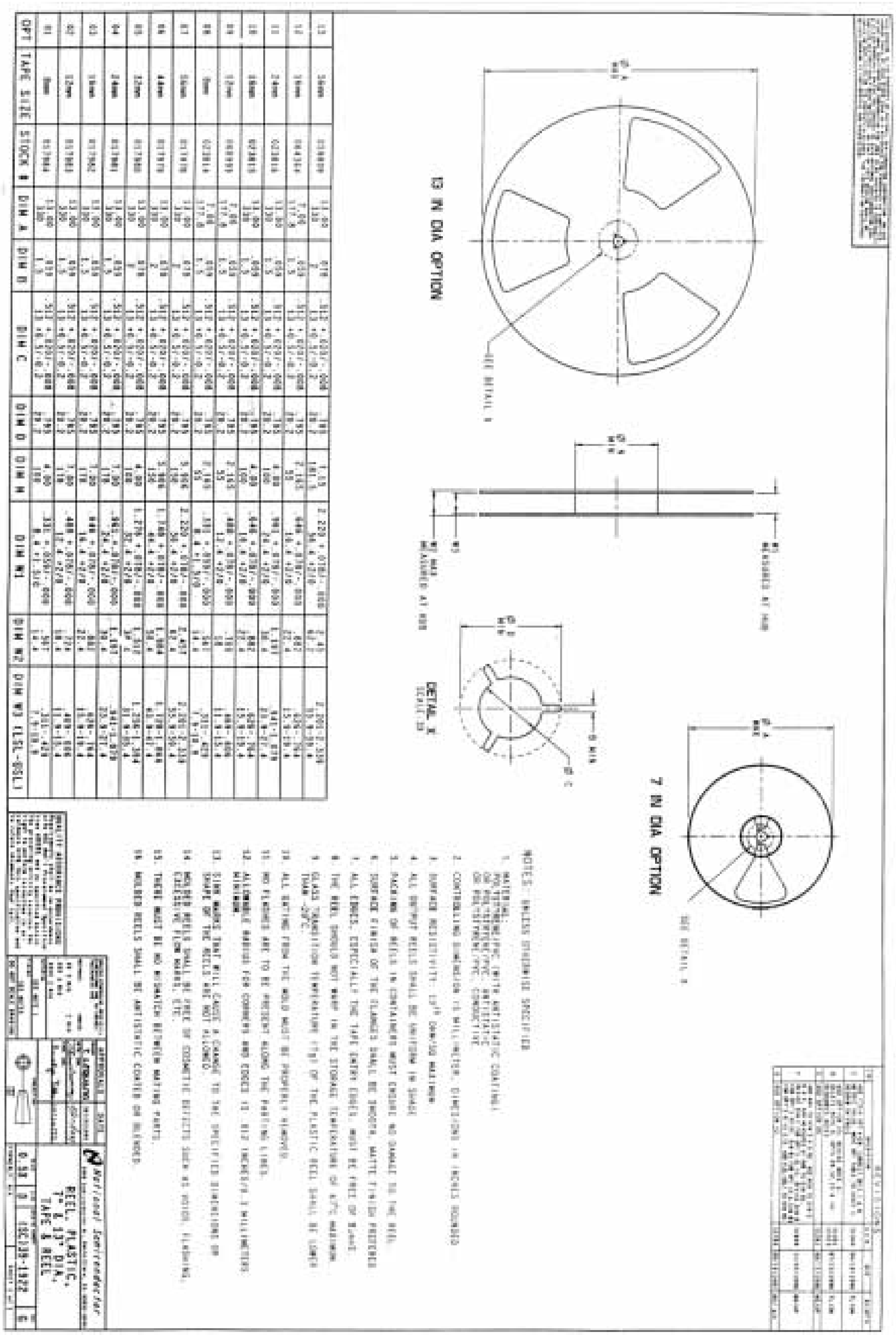
3.0 PROCESS INFORMATION

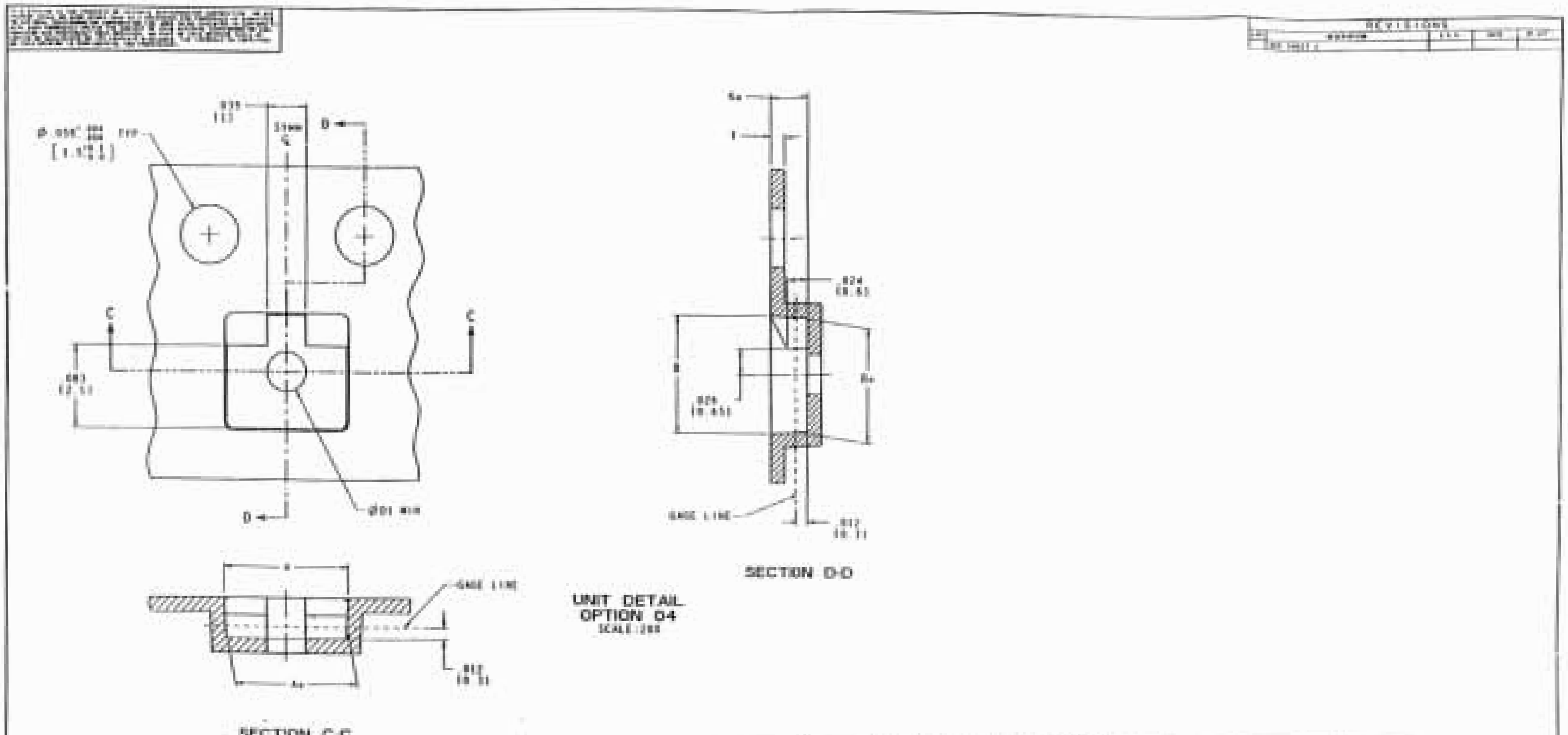
4.0 PACKAGING INFORMATION

4.1 PACKAGE MATERIAL

Generic Package Type	**3 Lead SOT-223**	**TO-220**
NS Package Number	MA04A	TO3B
Mold Compound Manufacturer, Designation	Sumitomo EME-6710	Plaskon 7115 or Sumitomo EME-6700
Lead Frame Material Manufacturer	Copper QPL	Copper Gotoh
External Lead Frame Coating	Solder Plate Sn/Pb	Solder Plate Sn/Pb
Die Attached Method	Preform (Eutectic)	Preform (Eutectic)
Bond Wire	Gold, 1.5mils	Gold, 1.5mils
Bond Type	Thermosonic Ball	Thermosonic Ball
Package Thermal	136°C/W	79°C/W

4.2 TAPE & REEL DIMENSIONS





OPT	STOCK #	DESC	PKG TYPE	TAPE SIZE	DIM A	DIM Ao	DIM B	DIM Bo	DIM D1	DIM F	DIM Ko	DIM P1	DIM T	DIM W
05	003444	STD PROFILE	3/4/5LD SOT-223	16 mm	.280 (7.1)	.276 (7)	.299 (7.6)	.295 (7.5)	.059 (1.5)	.295 ±.002 (7.5 ±0.05)	.087 ±.004 (2.2 ±0.1)	.472 (12)	.012 ±.004 (0.3 ±0.1)	.630 ±.012 (16 ±0.3)
04	000836	STD PROFILE	3LD SUPER SOT	8 mm	.126 (3.2)	.122 (3.1)	.118 (3)	.114 (2.9)	.039 (1)	.138 ±.002 (3.5 ±0.05)	.049 ±.004 (1.24 ±0.1)	.157 (4)	.0080 ±.0012 (0.20 ±0.03)	.315 [illegible] (8 [illegible])
03	032803	STD PROFILE	3/5LD SOT-23	8 mm	.130 (3.3)	.124 (3.15)	.130 (3.3)	.126 (3.2)	.039 (1)	.138 ±.002 (3.5 ±0.05)	.055 ±.004 (1.4 ±0.1)	.157 (4)	.008 ±.004 (0.2 ±0.1)	.315 ±.012 (8 ±0.3)
02	000576	LOW PROFILE	3LD SOT-23	8 mm	.130 (3.3)	.124 (3.15)	.106 (2.7)	.100 (2.55)	.039 (1)	.138 ±.002 (3.5 ±0.05)	.042 ±.002 (1.07 ±0.05)	.157 (4)	.008 ±.004 (0.2 ±0.1)	.315 ±.012 (8 ±0.3)
01	000553	STD PROFILE	3LD SOT-23	8 mm	.130 (3.3)	.124 (3.15)	.106 (2.7)	.100 (2.55)	.039 (1)	.138 ±.002 (3.5 ±0.05)	.047 ±.002 (1.19 ±0.05)	.157 (4)	.008 ±.004 (0.2 ±0.1)	.315 ±.012 (8 ±0.3)

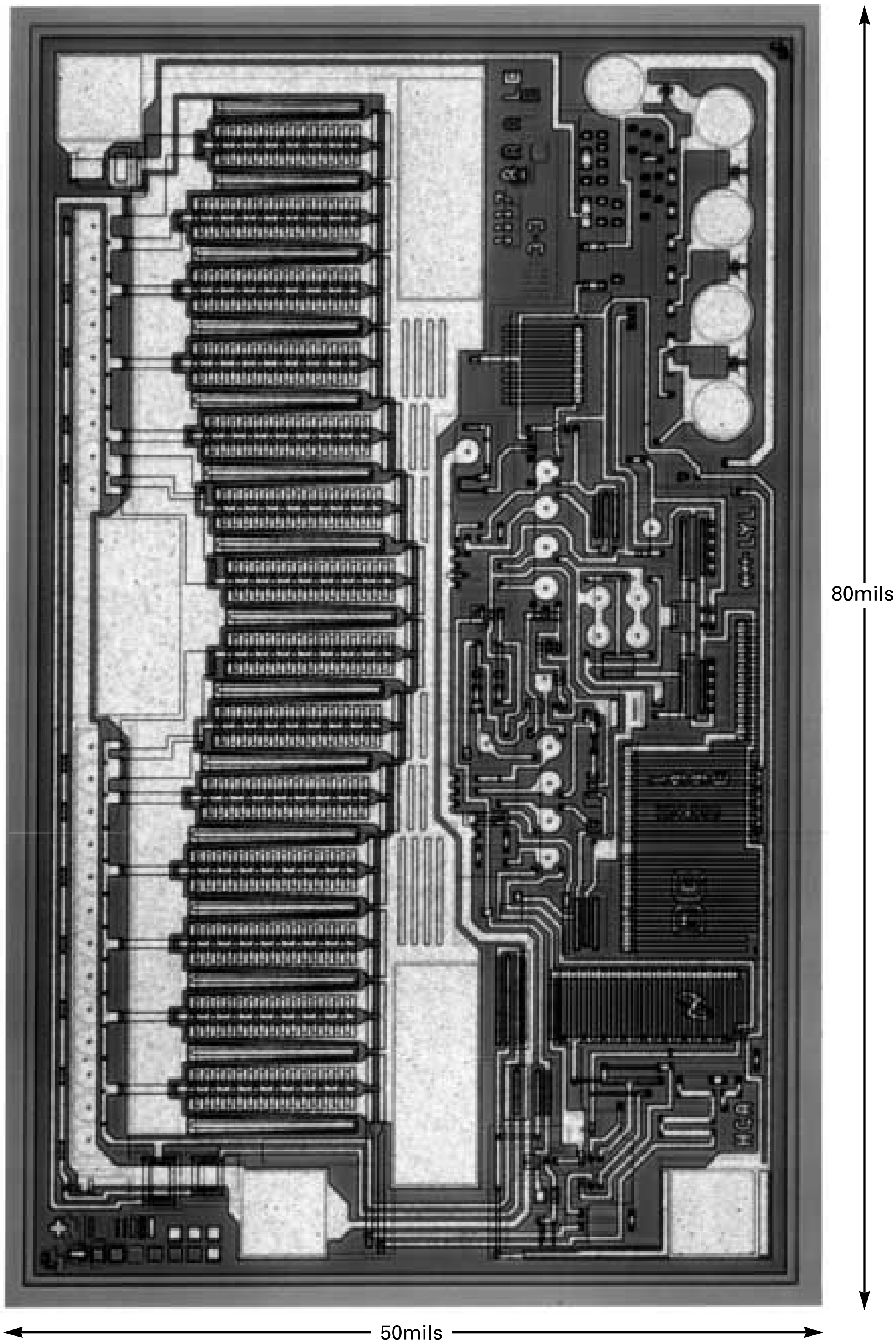
CONTROLLING DIMENSION IS MILLIMETER

National Semiconductor

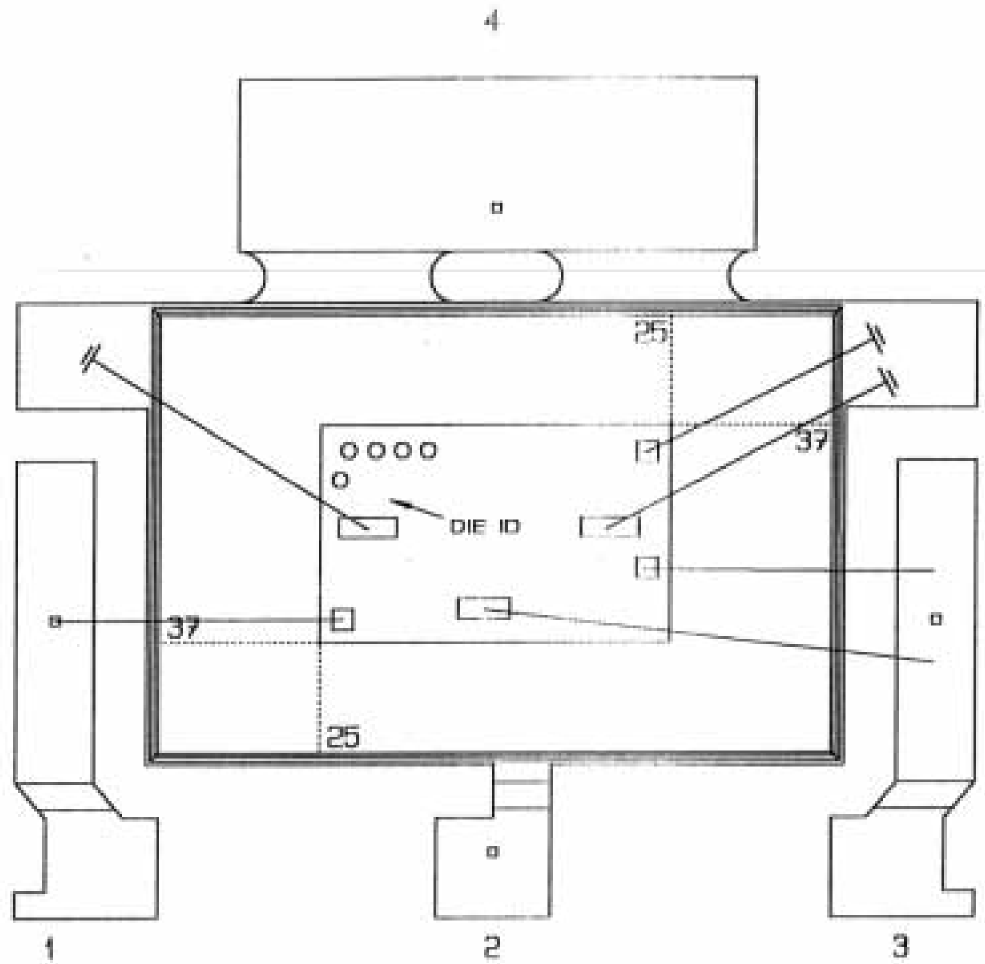
TAPE, EMBOSSED, 8 & 16mm, SOT-23/223

D | 1SC139-1481 | F

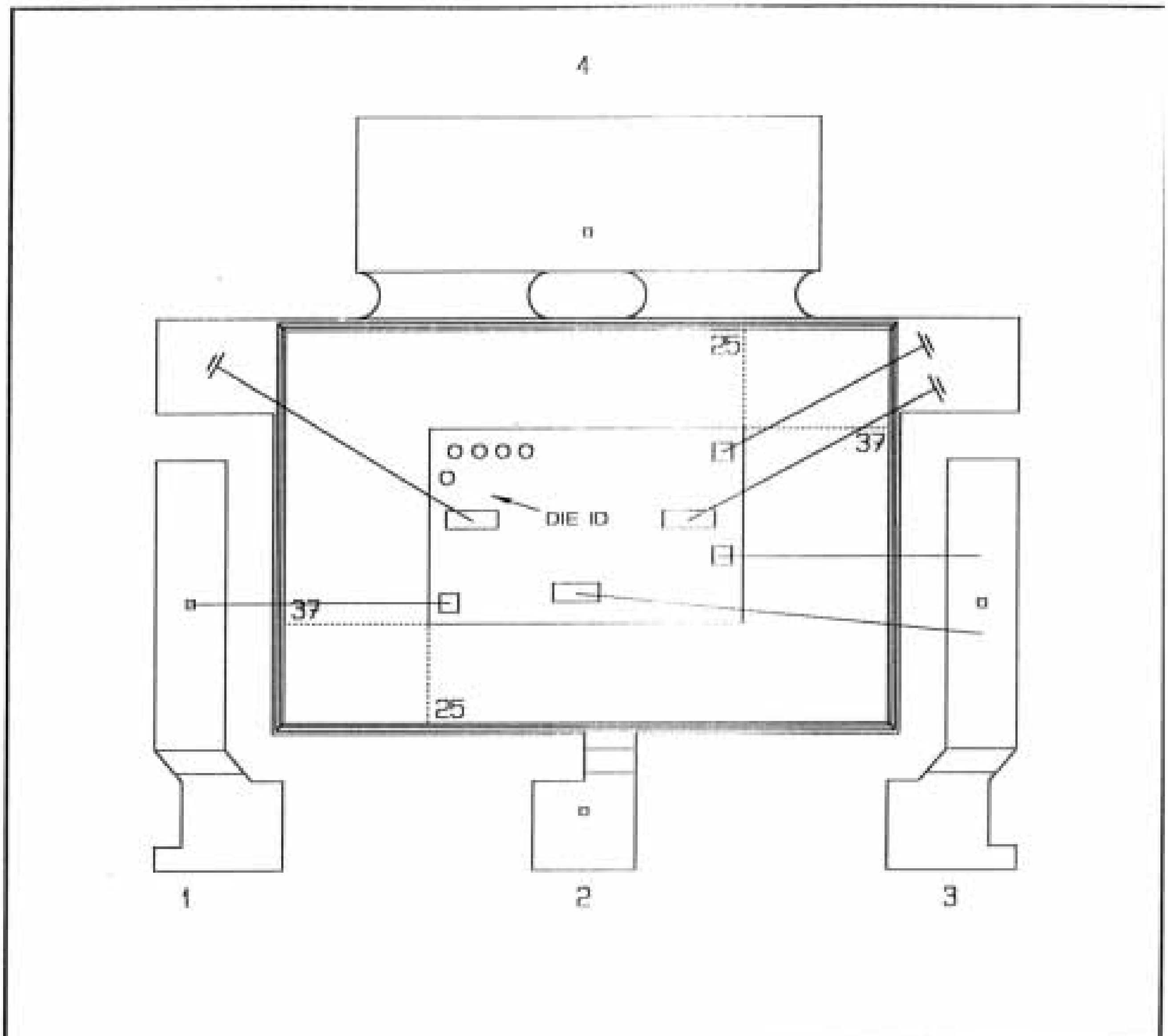
4.3 DIE PHOTO



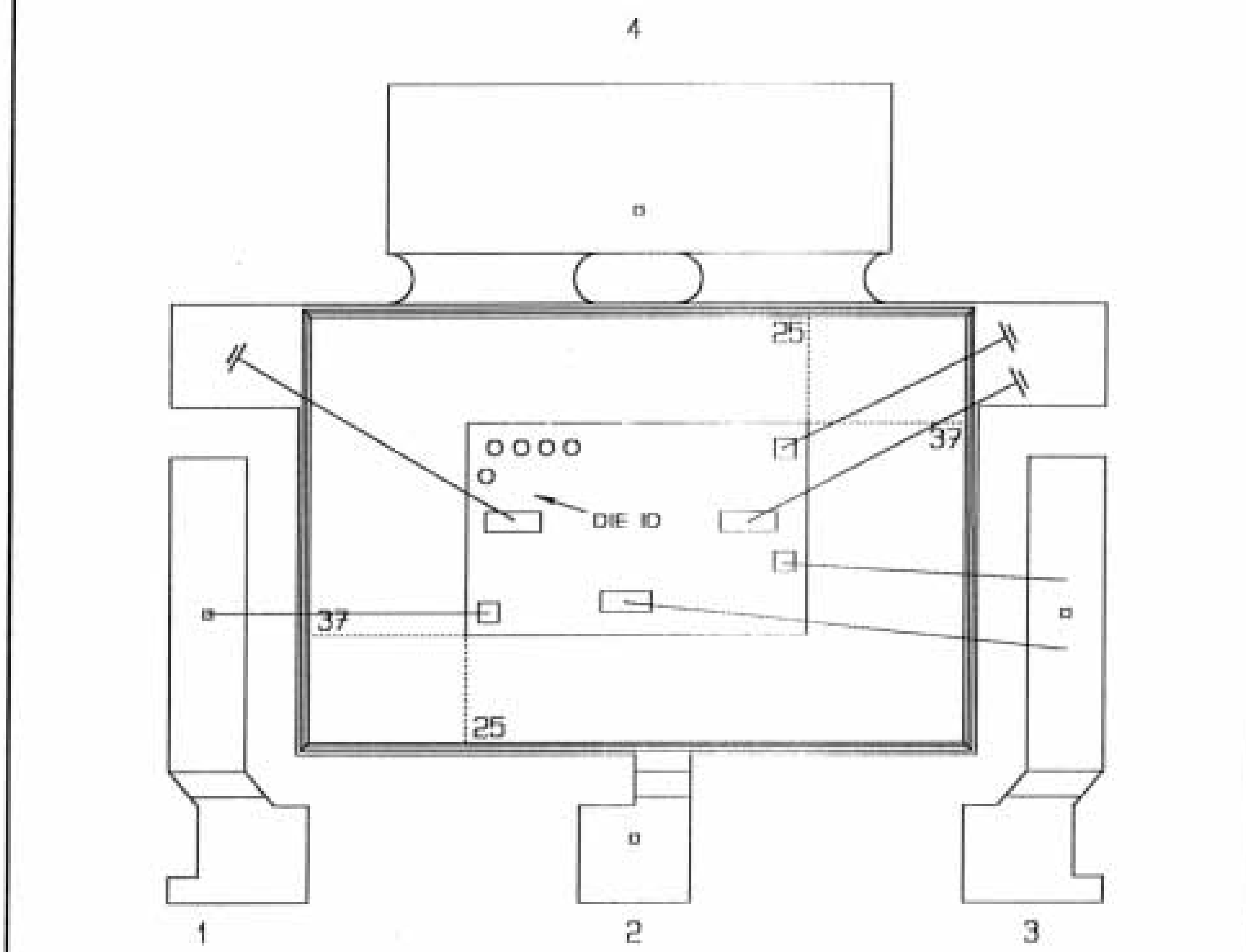
4.4 BONDING DIAGRAMS



■FRAME DWG: 36-0848-01 SK: 062413 PAD: .154 X .100	AD- MA004ACB MB REV: B PKG: MA DIE ID: LM1117AT-5.0 STEP/REV: A	Metallization: BOND-CODE: 0.5% CU, DLM
■DIE ATTACH SK: 052549 TYPE: PREFORM ■WIRE SK: 031629 TYPE: AU DIA =.0015 # WIRES: 6	DIE SIZE(* CALCULATED) (MIL): 80 X 50 (MIC): 2032 X 1270 * DIE PLACEMENT X= 37 Y= 25 ANGLE= 0.0	MBS NOTE
■MOLD COMPOUND SK: 058072 TYPE: B-18	■ADHESIVE SK: N/A ■HEAT SINK SK: N/A ■CHIP CAPS SK: N/A QTY: N/A DWG: N/A	
	NOTE	06/18/98 CLLHEM 06/19/98 TJNDSC
MIN. PAD PITCH: 32.46MILS	ASS'Y : LM1117MP-5.0 DASH- 01	REV: A PDCN:



■FRAME DWG: 36-0848-01 SK: 062413 PAD: .154 X .100	AD- MA004ACB MB REV: B PKG: MA DIE ID: LM1117AT-3.3 STEP/REV: A	Metallization: BOND-CODE: 0.5% CU, DLM
■DIE ATTACH SK: 052549 TYPE: PREFORM ■WIRE SK: 031629 TYPE: AU DIA =.0015 # WIRES: 6	DIE SIZE(* CALCULATED) (MIL): 80 X 50 (MIC): 2032 X 1270 * DIE PLACEMENT X= 37 Y= 25 ANGLE= 0.0	MBS NOTE
■MOLD COMPOUND SK: 058072 TYPE: B-18	■ADHESIVE SK: N/A ■HEAT SINK SK: N/A ■CHIP CAPS SK: N/A QTY: N/A DWG: N/A	
	NOTE	06/18/98 CLLHEM 06/19/98 TJNDSC
MIN. PAD PITCH: 32.46MILS	ASS'Y : LM1117MP-3.3	DASH- 01 REV: A PDCN:



■FRAME DWG: 36-0848-01
SK: 062413 PAD: .154 X .100
■DIE ATTACH
SK: 052549 TYPE: PREFORM
■WIRE
SK: 031629 TYPE: AU
DIA =.0015 # WIRES: 6
■MOLD COMPOUND
SK: 058072 TYPE: B-18

AD- MA004ACB MB REV: B PKG: MA
DIE ID: LM1117AT-2.85 STEP/REV: A
DIE SIZE(* CALCULATED)
(MIL): 80 X 50
(MIC): 2032 X 1270 *
DIE PLACEMENT
X= 37 Y= 25 ANGLE= 0.0
■ADHESIVE SK: N/A
■HEAT SINK SK: N/A
■CHIP CAPS SK: N/A QTY: N/A
DWG: N/A

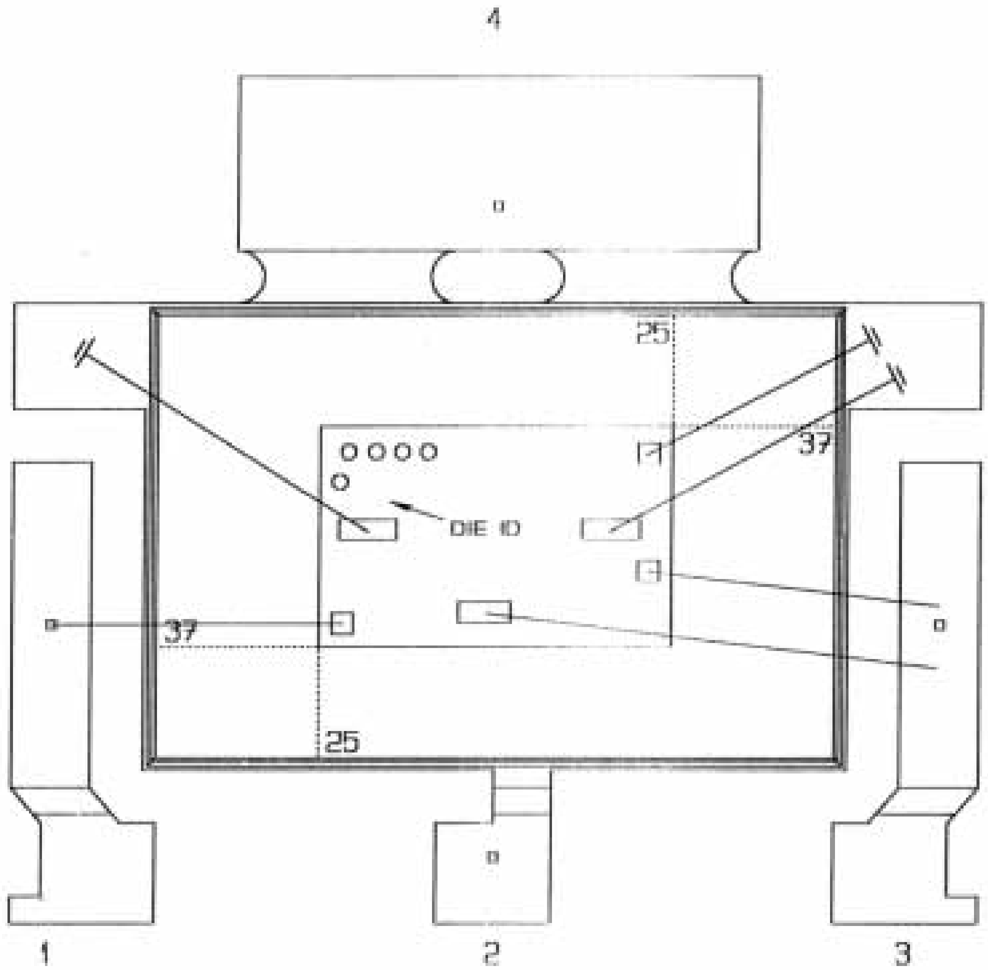
Metallization: BOND-CODE:
0.5% CU, DLM

MBS NOTE

NOTE

06/18/98	CLLHEM
06/19/98	TJNDSC

MIN. PAD PITCH: 32.46MILS
ASS'Y : LM1117MP-2.85 DASH- 01 REV: A PDCN:



■FRAME DWG: 36-0848-01
SK: 062413 PAD: .154 X .100
■DIE ATTACH
SK: 052549 TYPE: PREFORM
■WIRE
SK: 031629 TYPE: AU
DIA =.0015 # WIRES: 6
■MOLD COMPOUND
SK: 058072 TYPE: B-18

AD- MA004ACB MB REV: B PKG: MA
DIE ID: LM1117AT-ADJ STEP/REV: A
DIE SIZE(* CALCULATED)
(MIL): 80 X 50
(MIC): 2032 X 1270 *
DIE PLACEMENT
X= 37 Y= 25 ANGLE= 0.0
■ADHESIVE SK: N/A
■HEAT SINK SK: N/A
■CHIP CAPS SK: N/A QTY: N/A
DWG: N/A

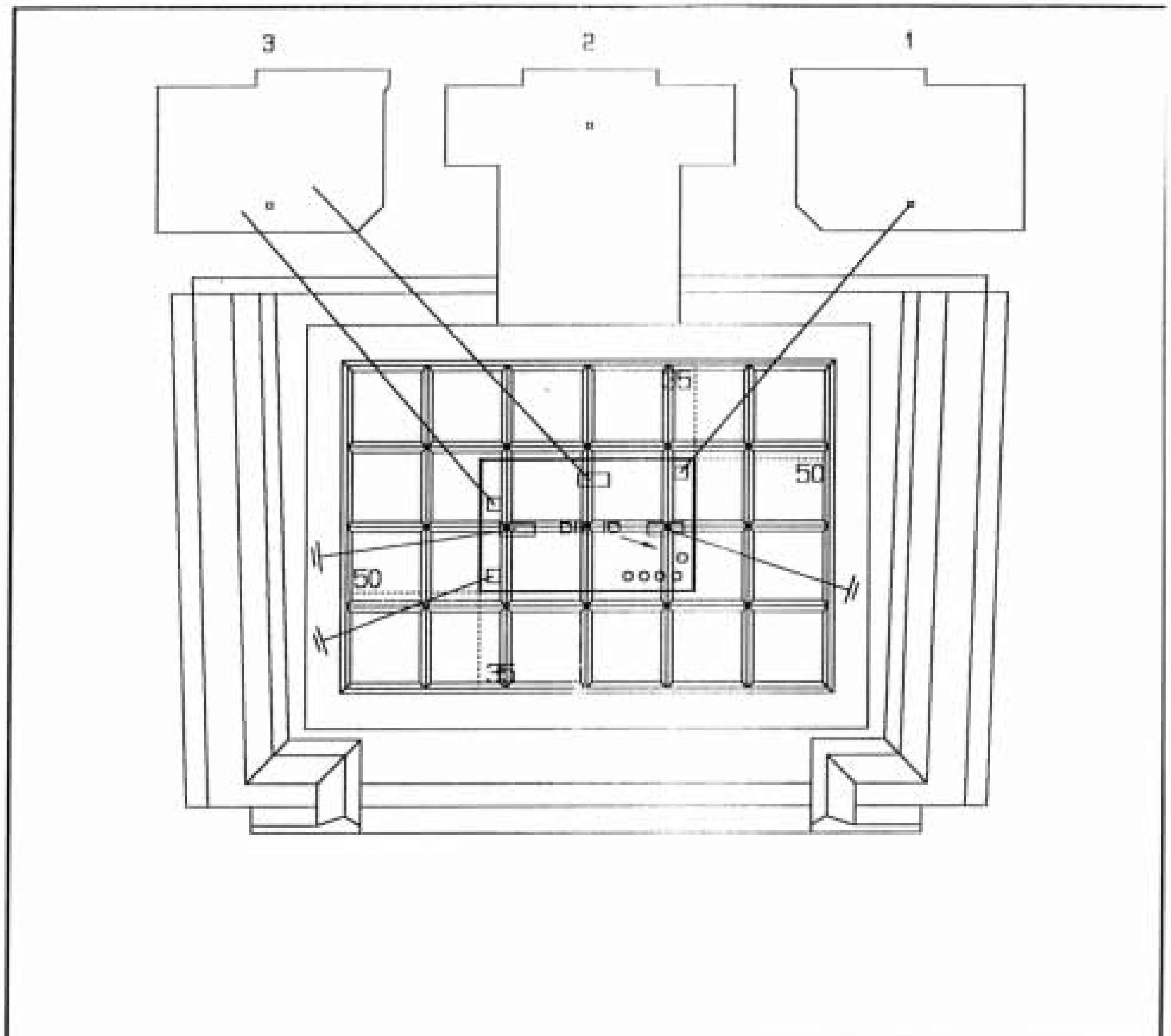
Metalization: BOND-CODE:
0.5% CU, DLM

MBS NOTE

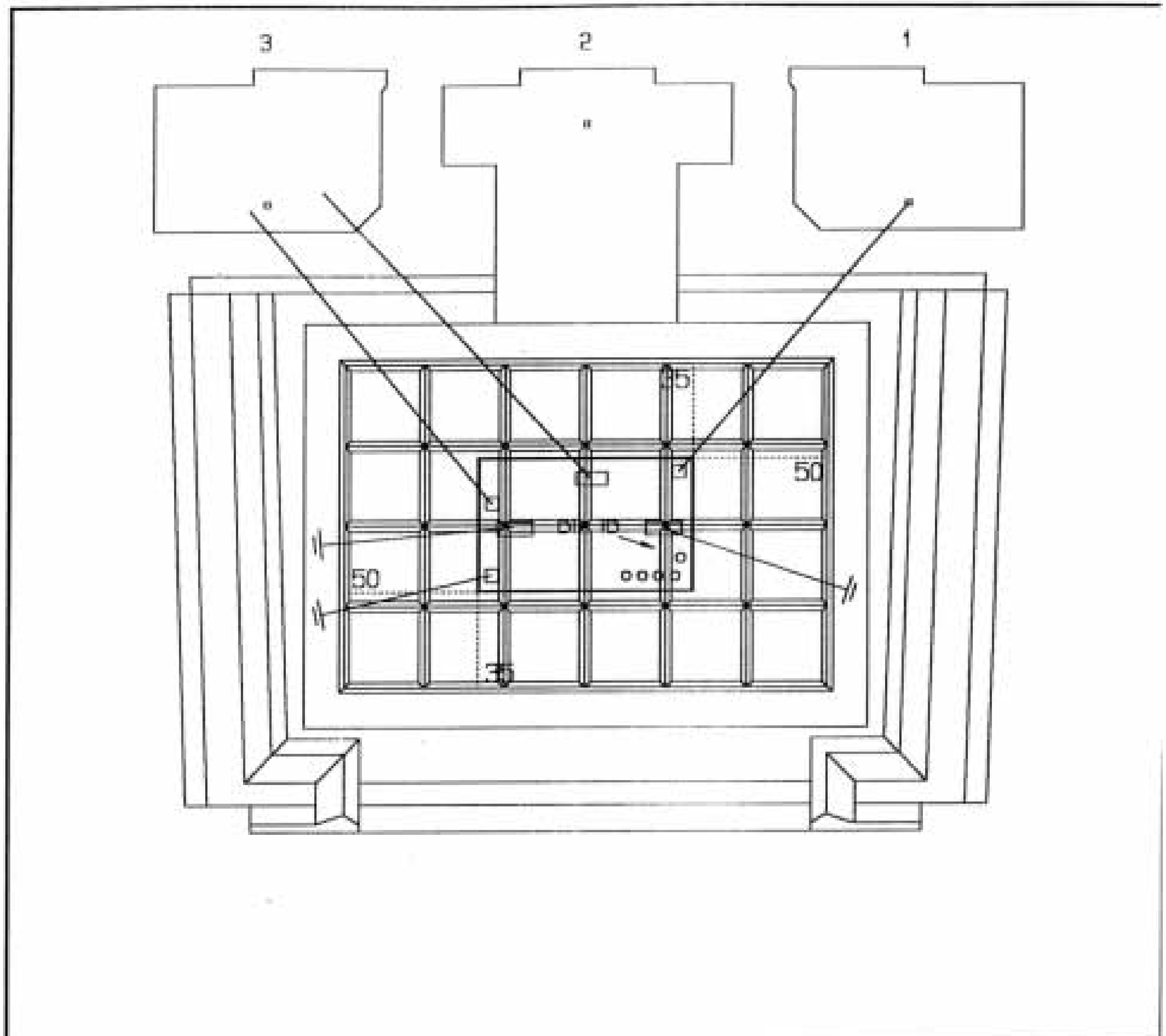
NOTE

06/18/98	CLLHEM
06/19/98	TJNDSC

MIN. PAD PITCH: 32.46MILS
ASS'Y : LM1117MP-ADJ DASH- 01 REV: A PDCN:



■FRAME DWG: 36-0427-01 SK: 023100 PAD: .180 X .120	AD- TA003NAA MB REV: A PKG: TA DIE ID: LM1117AT-5.0 STEP/REV: A	Metalization: BOND-CODE: 0.5% CU, DLM
■DIE ATTACH SK: 047496 TYPE: PREFORM ■WIRE SK: 031629 TYPE: AU DIA =.0015 # WIRES: 6	DIE SIZE(* CALCULATED) (MIL): 80 X 50 (MIC): 2032 X 1270 * DIE PLACEMENT X= 50 Y= 35 ANGLE= 0.0	MBS NOTE
■MOLD COMPOUND SK: 010265 TYPE: B8	■ADHESIVE SK: N/A ■HEAT SINK SK: N/A ■CHIP CAPS SK: N/A QTY: N/A DWG: N/A	
	NOTE 1. ALTERNATE PREFORM STK# 030378	06/18/98 CLLHEM 06/19/98 TJNDSC
MIN. PAD PITCH: 32.46MILS	ASS'Y : LM1117T-5.0 DASH- 01	REV: A PDCN:



■FRAME DWG: 36-0427-01
SK: 023100 PAD: .180 X .120
■DIE ATTACH
SK: 047496 TYPE: PREFORM
■WIRE
SK: 031629 TYPE: AU
DIA =.0015 # WIRES: 6
■MOLD COMPOUND
SK: 010265 TYPE: B8

AD- TA003NAA MB REV: A PKG: TA
DIE ID: LM1117AT-3.3 STEP/REV: A
DIE SIZE(* CALCULATED)
(MIL): 80 X 50
(MIC): 2032 X 1270 *
DIE PLACEMENT
X= 50 Y= 35 ANGLE= 0.0
■ADHESIVE SK: N/A
■HEAT SINK SK: N/A
■CHIP CAPS SK: N/A QTY: N/A
DWG: N/A

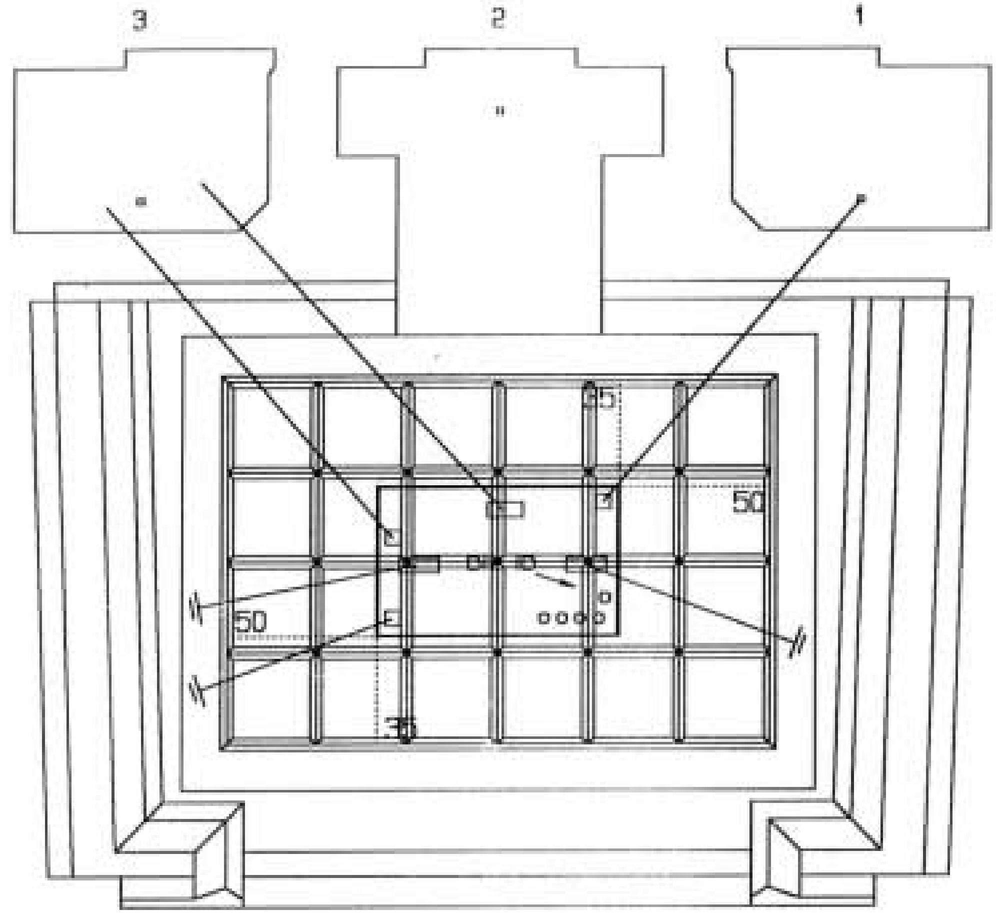
Metallization: BOND-CODE:
0.5% CU, DLM

MBS NOTE

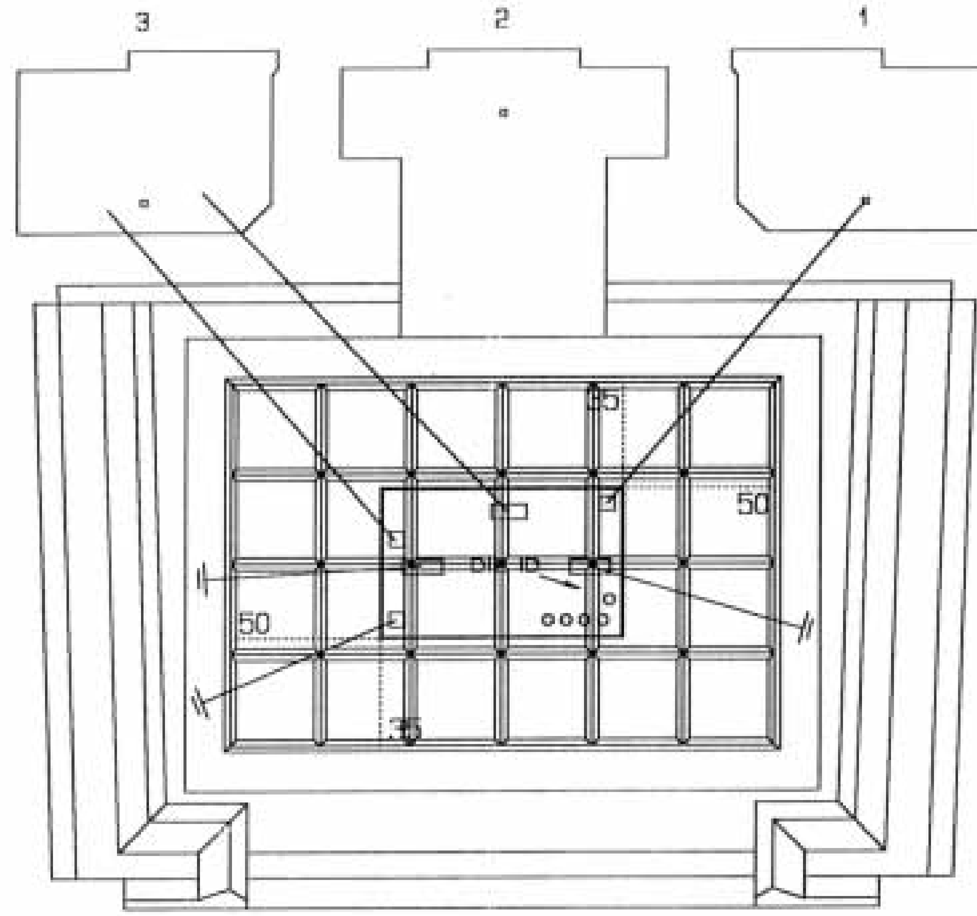
NOTE ALTERNATE PREFORM STK# 030378

06/18/98	CLLHEM
06/19/98	TJNDSC

MIN. PAD PITCH: 32.46MILS
ASS'Y : LM1117T-3.3 DASH- 01 REV: A PDCN:



■FRAME DWG: 36-0427-01 SK: 023100 PAD: .180 X .120	AD- TA003NAA MB REV: A PKG: TA DIE ID: LM1117AT-2.85 STEP/REV: A	Metalization: BOND-CODE: 0.5% CU, DLM
■DIE ATTACH SK: 047496 TYPE: PREFORM ■WIRE SK: 031629 TYPE: AU DIA =.0015 # WIRES: 6	DIE SIZE(* CALCULATED) (MIL): 80 X 50 (MIC): 2032 X 1270 * DIE PLACEMENT X= 50 Y= 35 ANGLE= 0.0	MBS NOTE
■MOLD COMPOUND SK: 010265 TYPE: 88	■ADHESIVE SK: N/A ■HEAT SINK SK: N/A ■CHIP CAPS SK: N/A QTY: N/A DWG: N/A	
	NOTE: ALTERNATE PREFORM STK# 030378	06/18/98 CLLHEM 06/19/98 TJNDSC
MIN. PAD PITCH: 32.46MILS	ASS'Y ; LM1117T-2.85	DASH- 01 REV: A PDCN:



■FRAME DWG: 36-0427-01 SK: 023100 PAD: .180 X .120	AD- TA003NAA MB REV: A PKG: TA DIE ID: LM1117AT-ADJ STEP/REV: A	Metalization: 0.5% CU, DLM | BOND-CODE:
■DIE ATTACH SK: 047496 TYPE: PREFORM ■WIRE SK: 031629 TYPE: AU DIA =.0015 # WIRES: 6	DIE SIZE(* CALCULATED) (MIL): 80 X 50 (MIC): 2032 X 1270 * DIE PLACEMENT X= 50 Y= 35 ANGLE= 0.0	MBS NOTE
■MOLD COMPOUND SK: 010265 TYPE: B8	■ADHESIVE SK: N/A ■HEAT SINK SK: N/A ■CHIP CAPS SK: N/A QTY: N/A DWG: N/A	
	NOTE: ALTERNATE PREFORM STK# 030378	06/18/98 CLLHEM 06/19/98 TJNDSC
MIN. PAD PITCH: 32.46MILS	ASS'Y : LM1117T-ADJ DASH- 01 REV: A	PDCN:

5.0 RELIABILITY DATA

National Semiconductor

Reliability Test Report	File Number: FSC19980214 Originator: Nick Stanco Date:May 14, 1998

Purpose

LM1117 NEW DEVICE QUALIFICATION

Approvals

Reliability Engineer

Mgr Ref Engineering

Reference File Numbers

RSC199801268
RSC199801267
RSC199800916
REM199800705
Q19970942

Distribution List

Jim Dreyfus
Nick Stanco

Abstract

The LM1117 800 mA Low Drop Out Voltage Regulator fabricated on the NSUK LB300 process was subjected to reliability testing per qual Q19970942 for qualification as a new device. All required reliability testing has been completed without the occurrence of a single failure. Based on these results the LM1117 is now fully qualified and released to production in the 3L SOT-223 and TO-220 packages and in all voltage options.

Description

Test Request	Device Name	Sbgp	Loc	Fab Line	Pkg Code	# Leads	Loc	Date Cd	Mold Cmpd
RSC199801267	LM1117MP	A	UK	6 INCH	T\MSON	3	EM	9252	B18
RSC199801268	LM1117MP-ADJ	A	UK	6 INCH	T\P223	3	EM	9252	B18
REM199800705	LM1117MP	A	UK	6 INCH	T\MSON	3	EM	9806	B18
REM199800705	LM1117MP	B	UK	6 INCH	T\MSON	3	EM	9806	B18
REM199800705	LM1117MP	C	UK	6 INCH	T\MSON	3	EM	9806	B18
RSC199800916	LM1117MP	A	UK	6 INCH	T\MSON	3	EM	9806	B18

Tests Performed

Test: Electrostatic Discharge - Human Body Model (ESDH)

Test Request	Device	Method
RSC199801267	LM1117MP	ATE
RSC199801268	LM1117MP-ADJ	ATE

Test: Electrostatic Discharge - Machine Model (ESDM)

Test Request	Device	Method
RSC199801267	LM1117MP	ATE
RSC199801268	LM1117MP-ADJ	ATE

Tests Performed (cont)

Test: Autoclave Test (ACLV)

Test Request	Device	Sbgrp	Rel Humidity	Pressure	High Temp	LowTemp
REM199800705	LM1117MP	A	100	15	121	-
REM199800705	LM1117MP	B	100	15	121	-
REM199800705	LM1117MP	C	100	15	121	-

Test: Operating Life Test (Static) (SOPL)

Test Request	Device	Sbgrp	Rel Humidity	Pressure	High Temp	LowTemp
REM199800705	LM1117MP	A	-	-	125	-
REM199800705	LM1117MP	B	-	-	125	-
REM199800705	LM1117MP	C	-	-	125	-

Test: Power Cycle (PRCL)

Test Request	Device	Sbgrp	Rel Humidity	Pressure	High Temp	LowTemp
RSC199800916	LM1117MP	A			150	25

Test: Temperature Cycle (TMCL)

Test Request	Device	Sbgrp	Rel Humidity	Pressure	High Temp	LowTemp
REM199800705	LM1117MP	A	-	-	150	-65
REM199800705	LM1117MP	B	-	-	150	-65
REM199800705	LM1117MP	C	-	-	150	-65

Test: Temperature Humidity Bias Test (THBT)

Test Request	Device	Sbgrp	Rel Humidity	Pressure	High Temp	LowTemp
REM199800705	LM1117MP	A	85	-	85	-
REM199800705	LM1117MP	B	85	-	85	-
REM199800705	LM1117MP	C	85	-	85	-

Test: Preconditioning (all units were preconditioned per RAI-5-039 using a Level 1 85C/85% RH 168 hour moisture soak and 235C IR reflow)

Results

		Rejects per Lot Sample Size		
Tests	**Time/Cycles**	**Lot 1**	**Lot 2**	**Lot 3**
SOPL-IB1	168 hours	0/77	0/77	0/77
	500 hours	0/77	0/77	0/77
	1000 hours	0/77	0/77	-----
THBT-IB1	168 hours	0/77		
	500 hours	0/77		
	1000 hours	0/77		
ACLV-IB1	96 hours	0/77		
	168 hours	0/77		
TMCL-IB1	500 cycles	0/77		
	1000 cycles	0/77		
PRCL-IB1	3000 cycles	0/77		

Results (cont)

HBM ESD	**LM1117MP-ADJ**		**LM1117MP-3.3**	
	500 volts	0/5	500 volts	0/5
	1000 volts	0/5	1000 volts	0/5
	1500 volts	0/5	1500 volts	0/5
	2000 volts	0/5	2000 volts	0/5
MM ESD	**LM1117MP-ADJ**		**LM1117MP-3.3**	
	50 volts	0/5	50 volts	0/5
	100 volts	0/5	100 volts	0/5
	150 volts	0/5	150 volts	0/5
	200 volts	0/5	200 volts	0/5

Conclusion

The LM1117 is now fully qualified and released to production in the 3L SOT-223 and TO-220 packages and in all voltage options.

6.0 CHARACTERIZATION DATA

6.1 TEST SUMMARIES

LM1117-ADJ Typical

	Units	Mean	Sigma
Reference Voltage, Vin - Vout = 2V, Iout = 10mA	V	1.252	0.003
Reference Voltage, Vin - Vout = 1.4V, Iout = 1 mA	V	1.252	0.003
Reference Voltage, Vin - Vout = 1.4V, Iout = 800mA	V	1.250	0.003
Reference Voltage, Vin - Vout = 10V, Iout =10mA	V	1.252	0.003
Reference Voltage, Vin - Vout = 10V, Iout =100mA	V	1.251	0.003
Line Regulation, 1.5V < Vin - Vout < 13.75V, Iout = 10mA	%	-0.004	0.013
Load Regulation, Vin - Vout = 3.0V, 10mA < Iout < 800mA	%	0.175	0.025
Dropout Voltage, Iout = 100mA	Refer to LM1117-3.3V Data		
Dropout Voltage, Iout = 500mA	Refer to LM1117-3.3V Data		
Dropout Voltage, Iout = 80 mA	Refer to LM1117-3.3V Data		
Current Limit	mA	1177	17.9
Thermal Regulation, Vin - Vout = 10V, Iout = 100mA, 30 sec Pulse	%	0.006	0.023
Minimum Load Current	mA	1.052	0.0315
Adjust Pin Current	uA	55.1	1.1
Adjust Pin Current Change, Vin - Vout = 1.4V, 10mA < Iout < 800mA	uA	-0.236	0.143

LM1117-5.0 Typical

	Units	Mean	Sigma
Output Voltage, Vin = 6.5V, Iout = 0mA	V	5.005	0.020
Output Voltage, Vin =6.5V, Iout = 800mA	V	5.003	0.020
Output Voltage, Vin = 7.0V, Iout = 10mA	V	5.005	0.020
Output Voltage, Vin = 12V, Iout = 0mA	V	5.006	0.020
Output Voltage, Vin = 12V, Iout = 100mA	V	5.004	0.020
Line Regulation, 6.5V < Vin < 15V, Iout = 0mA	mV	0.395	0.238
Load Regulation, Vin = 6.5V, 0 < Iout < 800mA	mV	1.638	1.108
Dropout Voltage, Iout = 100mA	Refer to LM1117-3.3V Data		
Dropout Voltage, Iout = 500mA	Refer to LM1117-3.3V Data		
Dropout Voltage, Iout = 800mA	Refer to LM1117-3.3V Data		
Thermal Regulation, Vin - Vout = 10V, Iout = 100 mA, 30 sec Pulse	%	-0.001	0.007
Current Limit	mA	1312	28.6
Quiescent Current, Vin < 15V	mA	5.749	0.069

6.0 CHARACTERIZATION DATA

LM1117-2.85 Typical	Units	Mean	Sigma
Output Voltage, Vin = 4.85V, Iout = 10mA	V	2.857	0.007
Output Voltage, Vin = 4.25V, Iout = 0mA	V	2.857	0.007
Output Voltage, Vin = 4.10V, Iout = 0mA	V	2.857	0.007
Output Voltage, Vin = 10V, Iout = 0mA	V	2.857	0.007
Output Voltage, Vin = 10V, Iout = 100mA	V	2.856	0.007
Output Voltage, Vin =4.10V, Iout=500mA	V	2.856	0.007
Output Voltage, Vin =4.25V, Iout=800mA	V	2.855	0.007
Line Regulation, 4.25V < Vin < 10V, Iout = 0mA	mV	0.297	0.198
Load Regulation, 0 < Iout < 800mA, Vin = 4.25V	mV	1.590	0.347
Dropout Voltage, Iout = 100mA	Refer to LM1117-3.3V Data		
Dropout Voltage, Iout = 500mA	Refer to LM1117-3.3V Data		
Dropout Voltage, Iout = 800mA	Refer to LM1117-3.3V Data		
Thermal Regulation, Vin - Vout = 10V, Iout = 100mA, 30 sec Pulse	%	0.028	0.010
Current Limit	mA	1212	22.8
Quiescent Current	mA	5.729	0.098

LM1117-3.3 Typical	Units	Mean	Sigma
Output Voltage, Vin = 5V, Iout = 10mA	V	3.309	0.008
Output Voltage, Vin = 4.75V, Iout = 0mA	V	3.309	0.008
Output Voltage, Vin = 4.75V, Iout = 800mA	V	3.309	0.008
Output Voltage, Vin = 10V, Iout = 0mA	V	3.310	0.008
Output Voltage, Vin =10V, Iout = 100mA	V	3.308	0.008
Line Regulation, 4.75V < Vin < 15V, Iout = 0mA	mV	-0.014	0.235
Load Regulation, 0 < Iout < 800 mA, Vin = 4.75V	mV	0.738	0.403
Dropout Voltage, Iout = 100mA	V	1.032	0.009
Dropout Voltage, Iout = 500mA	V	1.171	0.008
Dropout Voltage, Iout = 800mA	V	1.189	0.004
Thermal Regulation, Vin - Vout = 10V, Iout = 100mA, 30 sec Pulse	%	0.020	0.010
Current Limit	mA	1245	28.3
Quiescent Current	mA	5.862	0.093

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