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新型电压检测芯片

PT7M610X及其应用

文/唐黎明

编者按： PT7M610X系列是由上海百利通公司生产的电压检测芯片，《无线电》杂志社将送出300片。如果读者对它感兴趣，并想动手试验其实际效果，可以写信到《无线电》杂志社，来信请注明“百利通IC索取表”，信件中请写明姓名、邮编、地址、单位、联系电话、E-mail、索取目的及对芯片要求的封装形式（SOT封装或TO-94封装），为您试验与代换提供最大的便利，同时也希望您有好的设想和方案与我们分享。

索取函请寄至：北京市崇文区夕照寺街14号A座《无线电》杂志社，邮编：100061。

多年以来电压检测芯片TL-431在各种稳压器，电池检测和保护电路、通讯设备、电脑电源以及小型开关电源SMPS(Switch Mode Power Supply)上都是不可或缺的组成部件。但是随着新型产品的供电电压逐步下降和工作电流逐步提升，其内部能隙基准电压源电路输出的参考电压约达2.5V的缺点越来越明显，例如，TL431无法在1.8V甚至2.5V供电电压的电路中使用。在输出电流超过2A的限流型SMPS中，用于限流的电流检测电阻功耗将高达5W，TL431就不能满足要求了。

为此，笔者在此介绍一款可替代TL431的新型电压检测芯片IC——PT7M610X，该系列IC设计用于过电流保护、过温保护、新型电源以及电压检测电路等，其检测输入端IN具有较高的输入阻抗，使得外部配用的检测电阻可采用较大阻值，工作电压范围达0.9V～5.5V，无负载时的电流小于20μA，其输出端驱动电流可达数毫安。该IC包括一系列型号：可选SC-70/SOT23-5/TO-94封装（分别带A/B/C后缀），可选高有效/低有效或者开漏极输出（带CL/CH/NC后缀），可选内部稳压基准为100mV/200mV（PT7M6101/6102），林林总总不下十余款，用以配合外部各种要求。鉴于该系列型号众多，故此笔者在此以其中一款典型型号PT7M6101NLN为例介绍一下其内部结构和典型应用。

PT7M6101NLN采用TO-94封装（关于该封装的描述请参见本刊2006年第10期相关文章），该IC共有4条引脚，采用低有效的开漏极输出方式，即平时其输出端为高阻态，输出有效时为低电平。其封装形式见图1，内部电路框图见图2。

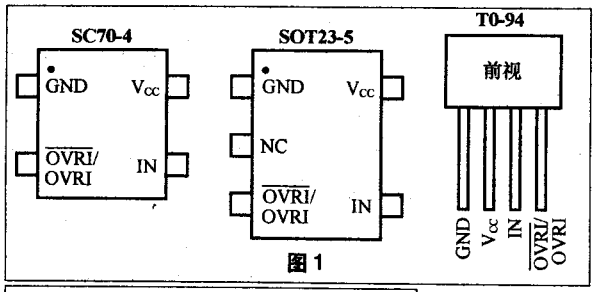

图1

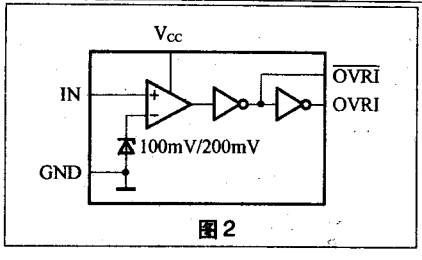

图2

由图2可见，该IC其实就是一个带高精度100mV参考电压的低漂移比较器（PT7M6102带的是200mV参考电压），其功能就是监测输入端IN的电压，一旦达到或超过参考电压，输出端立即翻转。值得注意的是，该比较器采用了一些具有专利的附加电路以及采用封装前激光校准（Trimming）等工艺以达到低电压工作并满足低输入漂移的要求，在Vcc=1.1V～3.3V，工作温度-40℃～+85℃时，其基准电压漂移极限值<3%。而内建的100/200mV基准电压源具有一定回差，具体来讲，对于PT7M6101这个电压范围是90mV～100mV，对于PT7M6102则是190mV～200mV，这样选用PT7M6102时可以有更窄的回差。

下面我们再来分析一些应用电路。图3是一个采用PT7M6101的典型电流检测电路，一般的充电电路采用TL431或者MCU的输入端配合检测取样电阻来检测充电电流或者采用外接/内接的ADC取

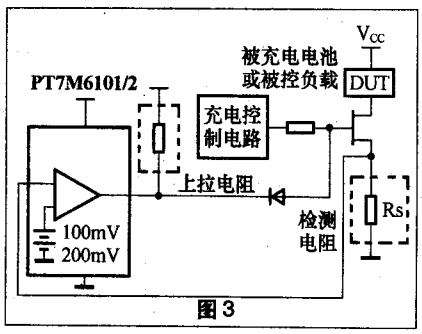

图3

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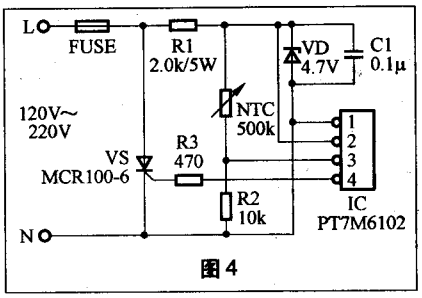

图4

样，TL431的参考电压为2.5V，普通MCU引脚的翻转电压至少为0.7V，导致检测电阻上功率消耗太大（例如对于2A电流的检测，MCU配套电阻最少消耗1.5W），而采用PT7M6101，同样用于检测2A的负载电流，检测电阻上的功耗不超过0.2W，可以采用普通1/4W电阻，并能有效降低系统的温升，提高系统效率。它性能卓越、电路简洁，此外，PT7M6101具有10mV回差电压，不需要额外的回差控制电路，就能有效避免系统频繁翻转甚至自激。

图4是已被大量生产的某款温度检测电路，用于家用电热器具的过温保护（当然也可以用作简单的加热器控制），其中NTC采用R25=500kΩ的热敏电阻，电阻值变化范围大，可实现较高的检测精度，VD、C1配合R1降压提供比较稳定的供电电源供IC1及其他电路使用，而NTC与R2串联提供检测电压，当发热体温度升高时，紧贴发热头安装的NTC阻值变小，使IC的3脚电压上升，当温度上升使之超过参考电压（对6102而言为200mV），IC输出高电平使单向晶闸管VS导通，瞬间短路L、N两端，使保险丝烧断，从而保护系统温度不致过高产生危险。

上述电路是作为一个附加的保护电路设计的，即正常情况下电路不能动作，IC采用输出高有效的形式，如果要改为用作简单高效的加热或恒温控制，可以将发热丝串在VS上部，NTC与R2互换即可。

作为一个工作电压低至0.9V，具有0.1V/0.2V 可选的较低而又极精确的参考电压的集成电路，该IC可以有很多意想不到的用途。例如，用作电池过放电保护电路，采用SC-70或者SOT23-5封装，甚至可以连同配用的MOSFET一起装入电池组件内。这种应用方法可以适用于对任何种类电池的保护（Ni-MH、Ni-CD、或Li+电池，即使低至仅采用一节电池的电路），或者也可以单独采用PT7M610X作为一个可靠的高精度电压监测器给主控器（MCU）提供可靠的电池状态监测。对于目前五花八门的便携式电子设备而言不失为一个提高产品档次的好方法。参考电路如图5。

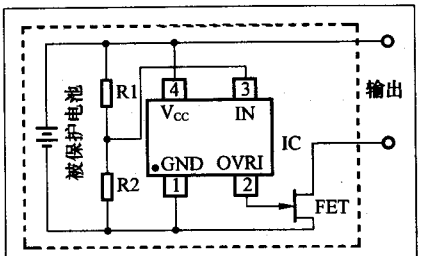

图5

IC配合一个FET管和两个微型SMD电阻，整个电路的体积可以做到极小，对于MP3、MP4等耗电较少的电子设备而言FET管也可以采用廉价的小功率型号。当然，上述电路也可以配合简单的充电电路提供完整的电池管理方案，或者改用P-MOS管接在输入正端即可组成简单而高效的限流充电电路，在此就不多作描述了。

其实讲到替换TL-431，莫过于在小型SMPS中的应用见图6，该电路是一个同时具有限压和限流功能的高性能廉价SMPS方案。电路左半部分是最普通的TNY264组成的高效开关式降压电路，IC3采用低有效或开漏极输出，RV1、RV2是输出电压检测电阻，R4是输出电流检测电阻，两路检测电路同时作用而又互不干涉，达到既限制输出电压又限制输出电流的目的，电路非常简洁。

同样利用这个方法，我们可以组装一个高效率的开关式DC-DC降压电路，见图7，这个电路采用PT7M6101

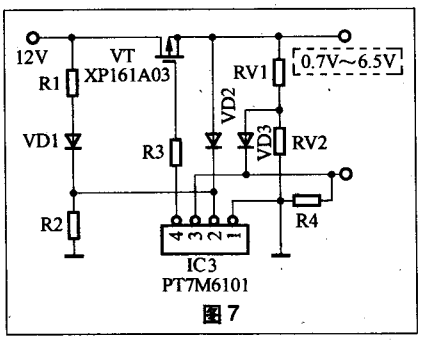

图7

配合廉价的MOSFET管，组成的电路可以输出0.7V~6.5V的电压，大于2A的电流，而整个电路的功耗和温升极低。稍作修改还可以用于更大输入电压范围或者更大输出电压的场合。

通过上述介绍，我们不难发现，PT7M610X针对现有电压检测IC参考电压过高的不足，结合近年来半导体科技的发展（更低工作电压的能隙电压源基准）提出了一个崭新的解决办法，方便了广大电子工程师设计新产品或改进已有产品。

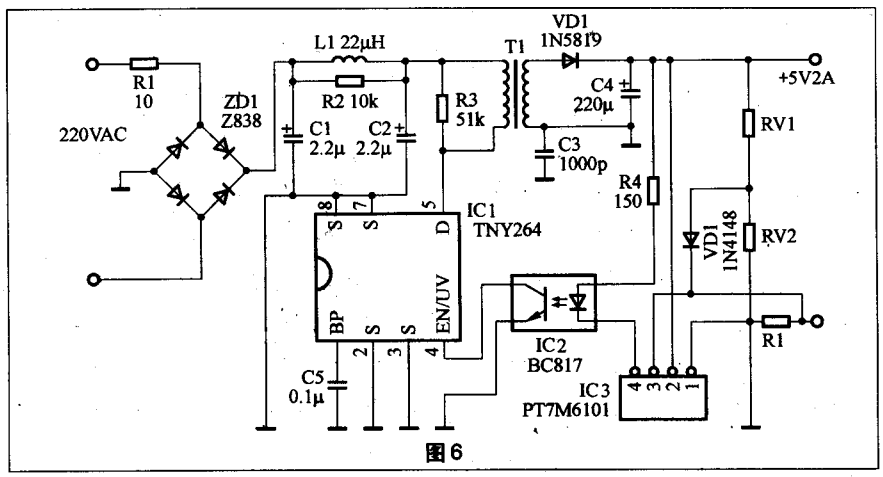

图6

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Features

- Low/High Threshold voltage with 90mV/100mV for PT7M6101 and 190mV/200mV for PT7M6102 Internal Reference (10mV hysteresis)
- ±10mV Threshold Voltage Accuracy Over Temperature
- Low Power Consumption: 8µA (typical)
- Three Output Configurations
  Push-Pull Active Low-- $\overline{\text{OVRI}}$
  Push-Pull Active High--- OVRI
  Open-Drain Active Low--- $\overline{\text{OVRI}}$
- Guaranteed OVRI Valid to Vcc=1.0V
- Immune to Short Negative Vcc Transients
- SC70-4, SOT23-5 and TO94 Packages are available

Ordering Information

Part Number	Package
PT7M610xCLC4E	Lead free and Green SC70-4
PT7M610xCHC4E	Lead free and Green SC70-4
PT7M610xNLC4E	Lead free and Green SC70-4
PT7M610xCLTAE	Lead free and Green SOT23-5
PT7M610xCHTAE	Leas free and Green SOT23-5
PT7M610xNLTAE	Lead free and Green SOT23-5
PT7M610xCLNE	Lead free TO94
PT7M610xCHNE	Lead free TO94
PT7M610xNLNE	Lead free TO94

Note: 1. Suffix "x" shows 1 or 2 with different function. See Table 1.

Description

PT7M6101/6102 series are designed for over current detector. They provide excellent circuit reliability and low cost by eliminating external components. These devices assert an OVRI signal when the voltage at IN pin rises above the high threshold. After IN pin declines below the low threshold, OVRI signal is de-asserted.

PT7M6101CL/6102CL have a push-pull active-low output. PT7M6101CH/6102CH have a push-pull active-high output. PT7M6101NL/6102NL have an open-drain active-low output. The open-drain active-low output requires a pull-up resistor that can be connected to a voltage higher than V_{DD}.

Low supply current of 8µA makes PT7M6101//6102 series ideal for using in battery power supply. These devices are available in SC70-4, SOT23-5, TO94 lead free packages.

Applications

- Over Current Protection in Battery Charger etc.
- Over Temperature Protection
- Power Supply
- Voltage Monitoring

Table 1 Function comparison of PT7M6101/6102

Item	Part No.	Output			
		Open-Drain		Push-Pull	
		Active high	Active low	Active high	Active low
1	PT7M6101CL/6102CL	-	-	-	√
2	PT7M6101CH/6102CH	-	-	√	-
3	PT7M6101NL/6102NL	-	√	-	-

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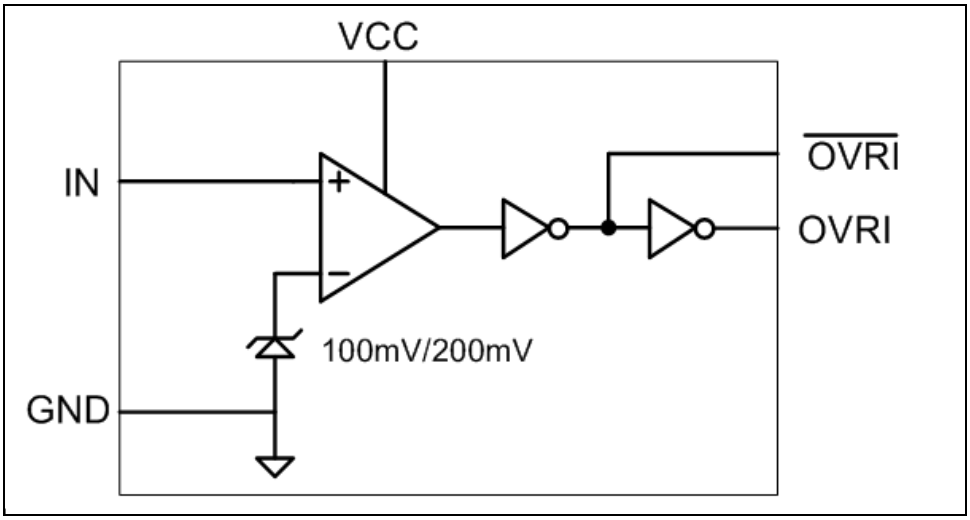
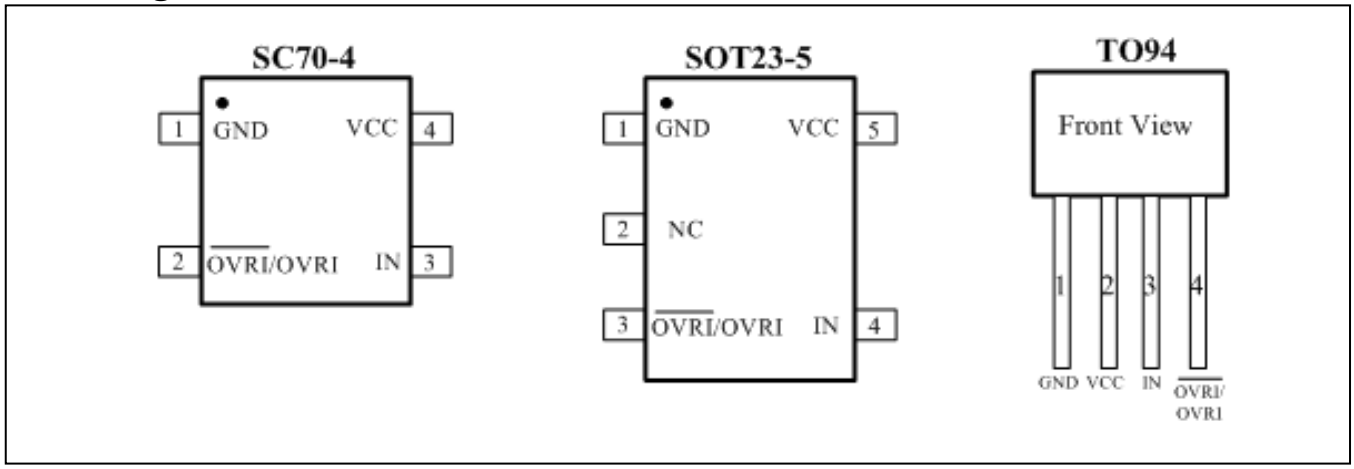
Block Diagram



Pad Assignment



Pad Description

Pin Name	I/O	Description
GND	GND	Ground
$\overline{\text{OVRI}}$	O	Over-current Output, Push-Pull or Open-Drain, Active-Low. OVRI changes from HIGH to LOW when IN rises above the typical high detection threshold (100mV). OVRI remains HIGH after IN drops below the low detection threshold (90mV).
OVRI	O	Over-current Output, Push-Pull, Active-High. OVRI changes from LOW to HIGH when IN rises above the typical high detection threshold (100mV). OVRI remains LOW after IN drops below the low detection threshold (90mV).
IN	I	Detection Voltage Input. High-impedance input for comparator. Connect this pin to over-current sampling network. OVRI is asserted when IN is above the high threshold voltage.
VCC	Power	Supply Voltage

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Functional Description

PT7M6101/6102 series are designed for over current detector. They provide excellent circuit reliability and low cost by eliminating external components. These devices assert an OVRI signal when the voltage at IN pin rises above the high threshold. After IN pin declines below the low threshold, OVRI signal is de-asserted.

Maximum Ratings

Storage Temperature…… - 65°C to +150°C
Ambient Temperature with Power Applied.....-40°C to +85°C
Supply Voltage to Ground Potential (V_{CC} to GND)……... - 0.3 to V_{CC} +6.0V
DC Input/Output Current ……20mA
Power Dissipation…….245mW

Note:
Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

AC Electrical Characteristics

(V_{CC} = +0.9V to +5.5V, unless otherwise noted. Typical values are at T_A = +25ºC)

Description	Symbol	Test Conditions	Min	Typ	Max	Unit
Vcc or RESET-IN to Reset Delay		IN rising, step signal from 0V to 1V	-	60	-	µs
Propagation Delay(D0 only)	t_P	IN falling, step signal from 1V to 0V	-	40	-	µs

DC Electrical Characteristics

(V_{CC} = +0.9V to +5.5V, unless otherwise noted. Typical values are at T_A = +25ºC)

Description	Sym.	Test Conditions	Min	Typ	Max	Unit
Operating Voltage Range	V_{CC}	T_A= -40ºC ~+85ºC	0.9	-	5.5	V
Supply Current	I_{CC}	V_{CC}=1.2V, no load , reset not asserted	-	7.5	13	µA
		V_{CC}=1.8V, no load , reset not asserted	-	9	16	
		V_{CC}=3.6V, no load , reset not asserted	-	16	25	
IN Threshold	V_{RSTIN}	1.3V<=V_{CC}<=5.5V, -40ºC ~+85ºC (PT7M6101)	90	100	110	mV
		1.3V<=V_{CC}<=5.5V, -40ºC ~+85ºC (PT7M6102)	190	200	210	
Push-pull $\overline{OVRI}$ Output High Voltage	V_{OH}	V_{CC}>=1.1V, I_{source}=50µA, reset not asserted	0.8×Vcc	-	-	-
		V_{CC}>=1.5V, I_{source}=150µA, reset not asserted	0.8×Vcc	-	-	
		V_{CC} >=1.0V, I_{source}=50µA, reset asserted	0.8×Vcc	-	-	
		V_{CC} >=1.5V, I_{source}=150µA, reset asserted	0.8×Vcc	-	-	
Push-pull OVRI Output Low Voltage	V_{OL}	V_{CC} >=1.0V, I_{sink}=80µA, reset asserted	-	-	0.2×Vcc	V
		V_{CC} >=1.5V, I_{sink}=200µA, reset asserted	-	-	0.2×Vcc	
Push-pull $\overline{OVRI}$ Output Low Voltage		V_{CC} >=1.1V, I_{sink}=80µA, reset not asserted	-	-	0.2×Vcc	
		V_{CC} >=1.5V, I_{sink}=200µA, reset not asserted	-	-	0.2×Vcc	
Open-Drain $\overline{OVRI}$ Output Low Voltage		V_{CC} >=1.0V, I_{sink}=80µA, reset asserted	-	-	0.15	V
		V_{CC} >=1.5V, I_{sink}=200µA, reset asserted	-	-	0.2	
Open-Drain $\overline{OVRI}$ Output Leakage Current	I_{LKG}	V_{CC} > V_{TH} , reset not asserted	-	-	1.0	µA
IN Leakage Current	I_{RSTIN}	-	-25	-	+25	nA
Reset Threshold Hysteresis	V_{HYS}	-	-	10	-	mV

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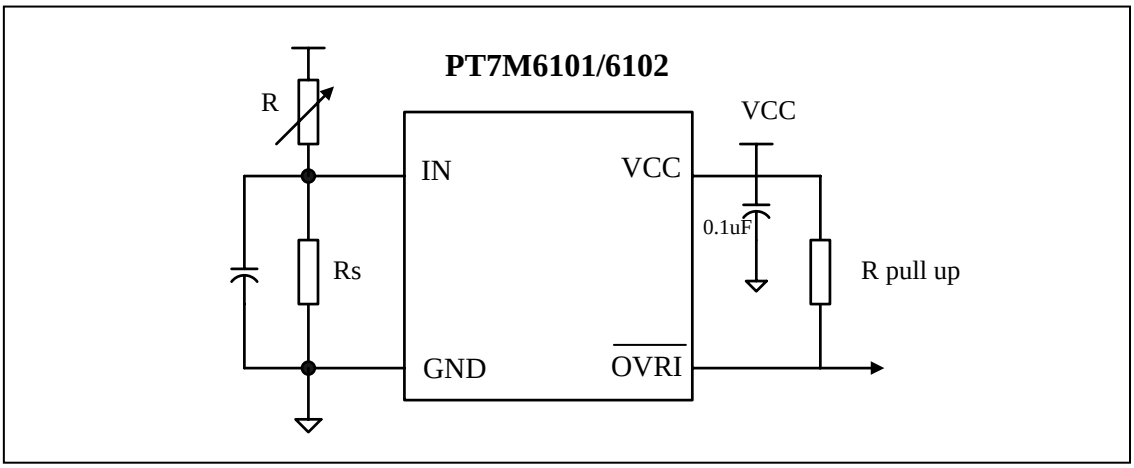
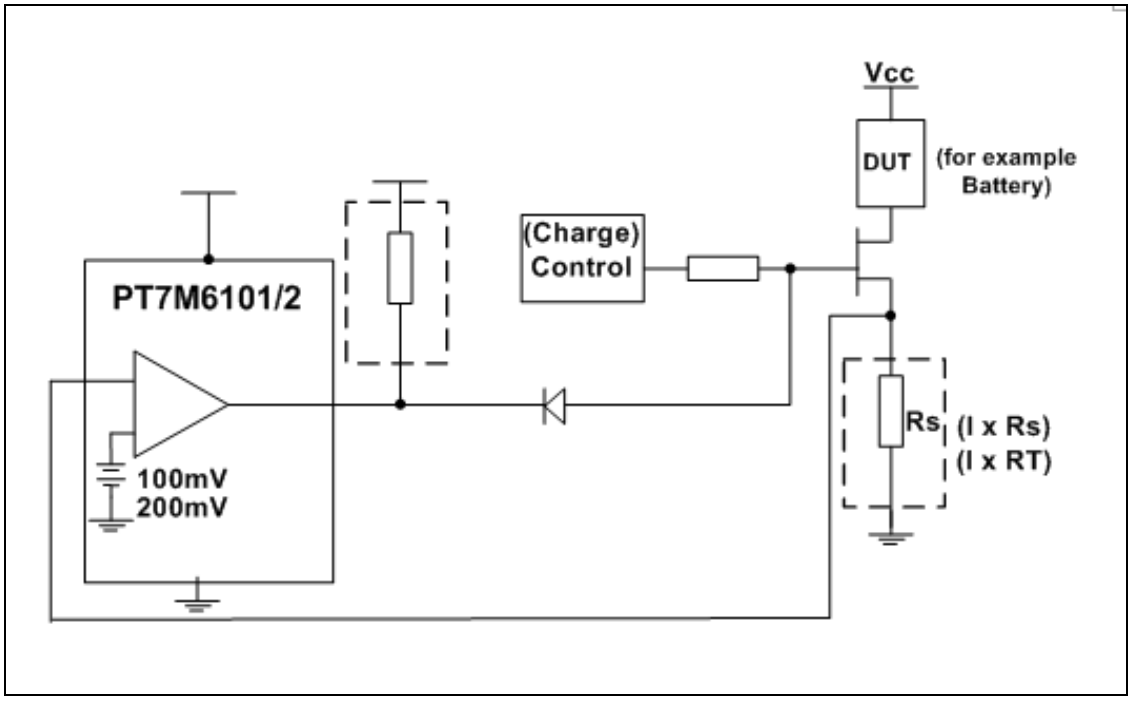
Application Circuit





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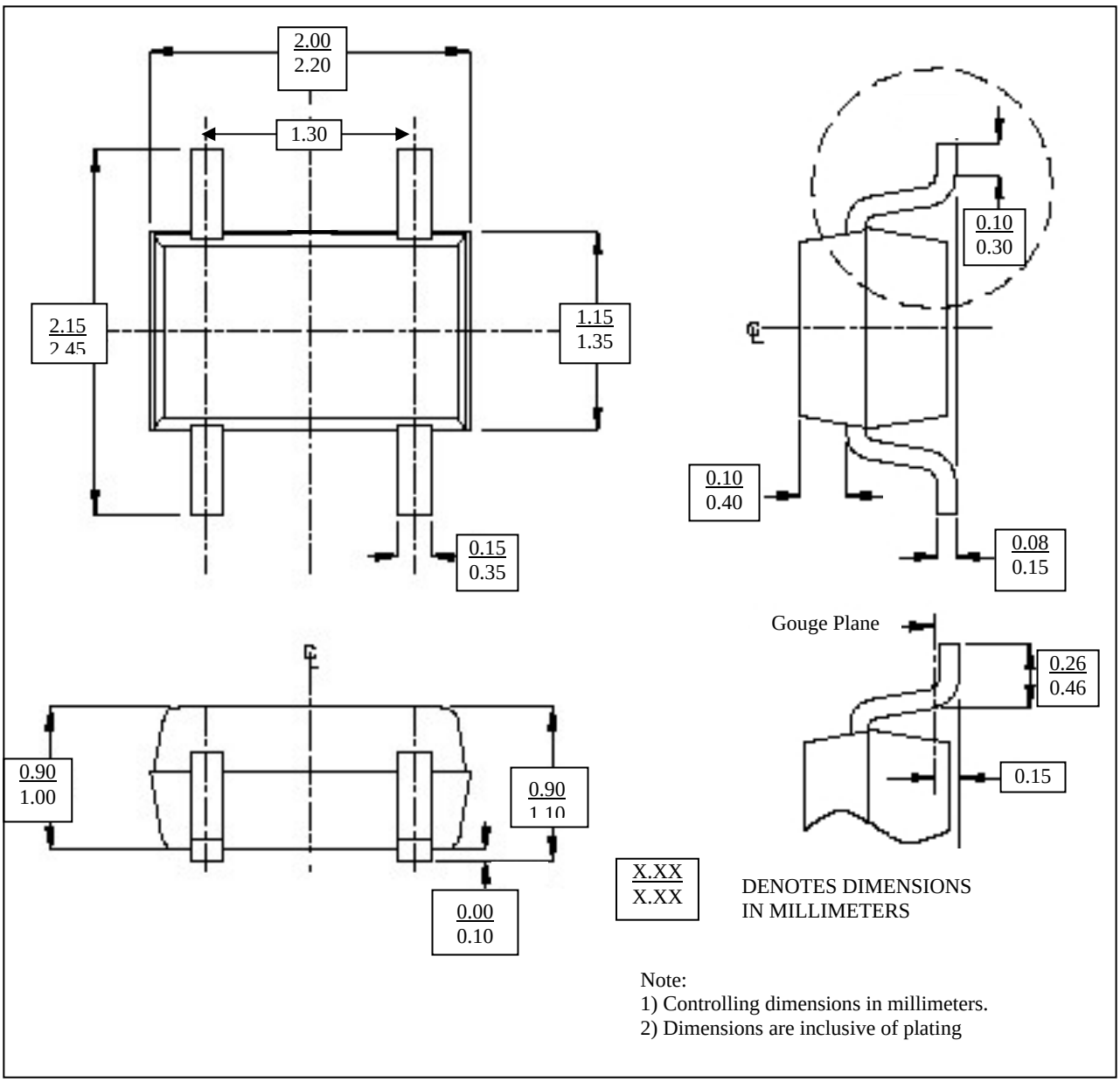
Mechanical Information

C4E (SC70-4)



Note:
1) Controlling dimensions in millimeters.
2) Dimensions are inclusive of plating

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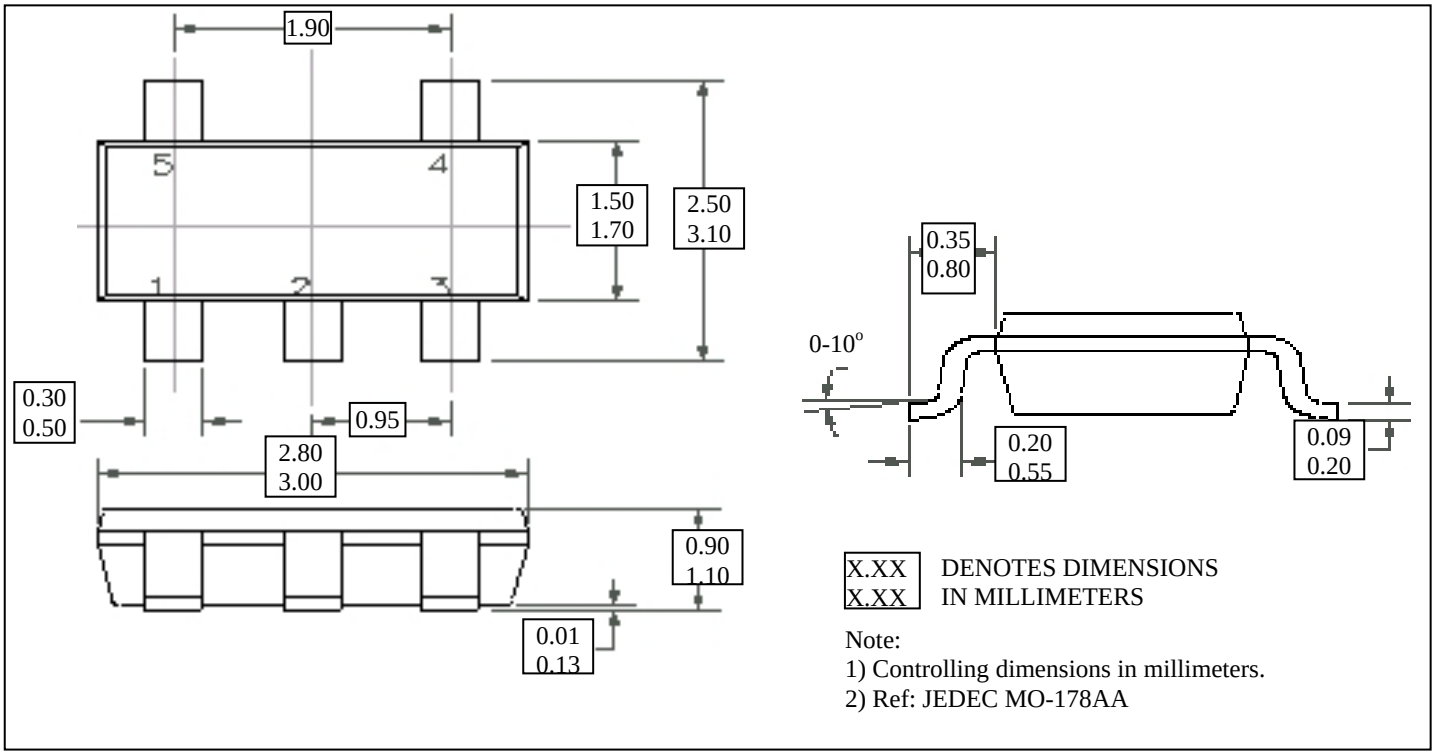
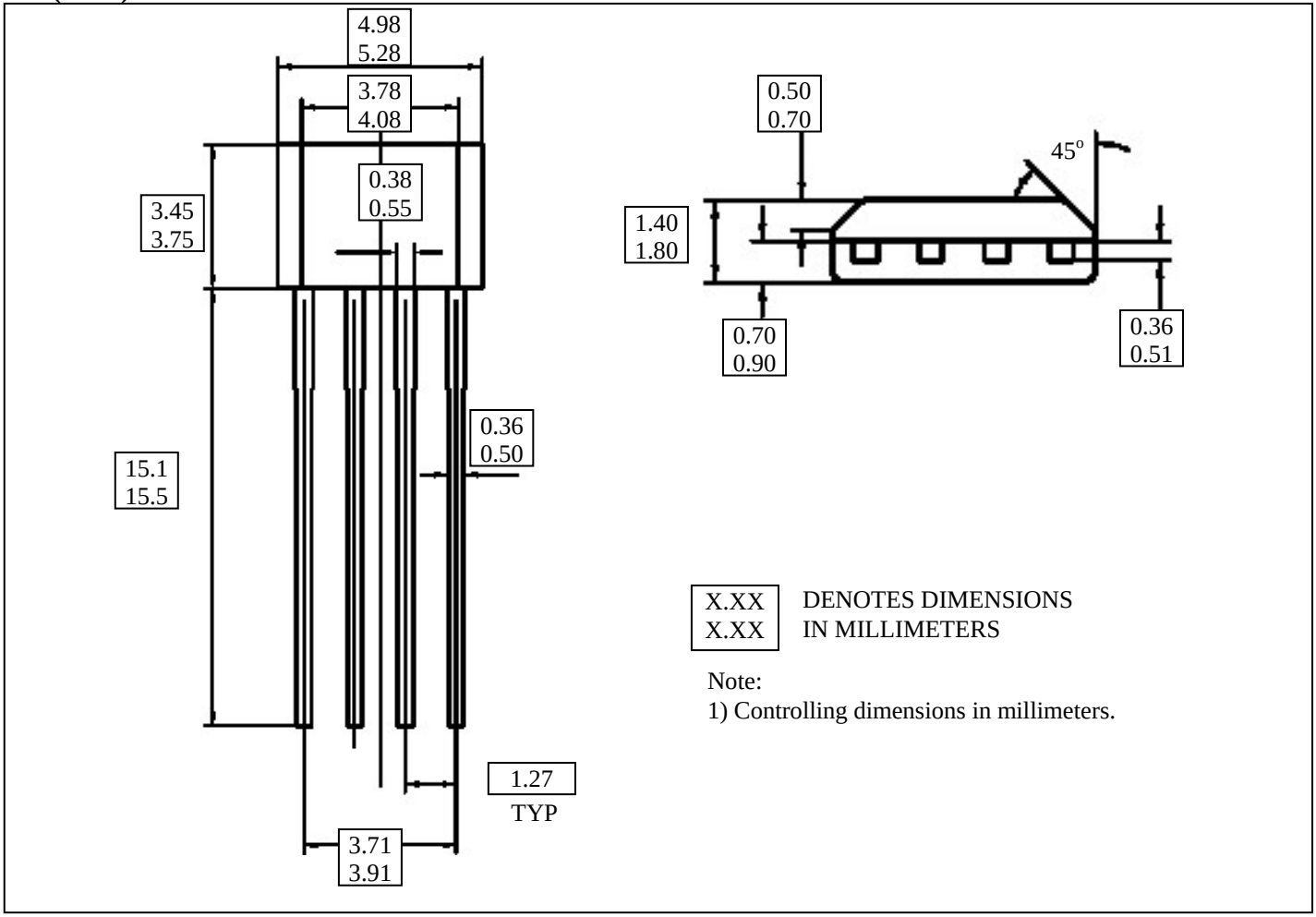
TAE (SOT23-5)



Note:
1) Controlling dimensions in millimeters.
2) Ref: JEDEC MO-178AA

NE (TO94)



Note:
1) Controlling dimensions in millimeters.

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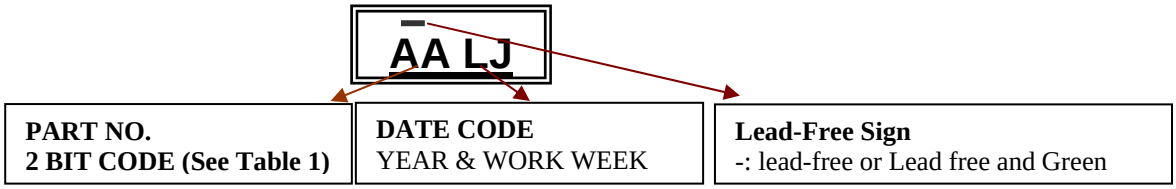
SOT23/SC70/SOT143 Package Top Marking Instruction



Example: **jp SN** PART NO.: PT7M6832WD0TA3
DATE CODE: YEAR 2006 WW10

$\overline{\text{jp}}$ SN PART NO.: PT7M6832WD0TA3E
DATE CODE: YEAR 2006 WW10
Lead –free package

Table 1 Part No code comparison table

No.	Part No.	Code
1	PT7M6101CL	jp
2	PT7M6101CH	jq
3	PT7M6101NL	jl
4	PT7M6102CL	rz
5	PT7M6102CH	sa
6	PT7M6102NL	sb

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Notes

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