How to Read a Datasheet

Prepared for the WIMS outreach program
5/6/02, D. Grover

如何阅读数据手册

Prepared for the WIMS outreach program
5/6/02, D. Grover

为了使用PIC微控制器，触发器，光电检测器或者其它任何电子器件，您都应该参考数据手册。数据手册是生产厂商提供给您包含以下信息的文档：

* 器件的典型性能
* 最小和最大需求和特性
* 在不损坏器件的前提下可用它来做什么
* 使用建议和提示

生产厂商希望您（设计者）在使用他们的器件时具有成功的经历。他们试图对您有所帮助，然而这并不总是成功的。下面 附带的这份数据手册是相对比较好的数据手册。它试图简明地告诉您那些您想了解的关于该器件（一个通用的555时基芯片）的所有东西。大部分集成电路（IC）的数据都按照大体同样的布局。

您没有必要去理解数据手册中的每个部分。数据手册中有很多信息或许是对您没有任何用处的。后面的注释试图指出数据手册中你应该要特别留意的那些部分。

In
pr
do
s the
M
ith
the
The
da
co
non
555 timer chip (the duct-tape of the electronics hobbyist). Most datasheets for ICs follow the same general layout.

You don't have to understand everything in a datasheet. There's a lot of information that might not be of any use to you. The annotations that follow try to point out parts of the datasheet that you should pay particular attention to.

Where do you find datasheets? Nowadays you can find almost any datasheet on the internet, often in PDF (Acrobat) form. For example, the LM555 datasheet from National Semiconductor is on their website at www.national.com.

What is the LM555? The LM555 is a timer chip that uses external resistors and capacitors to generate either a single pulse of a certain duration, or a

LM555是什么呢？LM555是一个时基芯片，使用外部电阻和电容它既可以产生一个固定宽度的单脉冲，也可以产生一个脉冲宽度可变的连续脉冲序列。因为它很通用的集成了如比较器，触发器，内部分压器，输出驱动级等等，所以可以实现很多不同的跟时间相关的功能。全面介绍关于555的书有很多，即便其它的IC可以比它工作得更好，555还是经常被使用。（实例请参看CD4538时基芯片。）

as
,
and so on, a number of different timing-related functions are possible. Entire books have been written about the 555, though it is often used when another IC would work better. (See for example the CD4538 timer chip.)

There will always be a date. Datasheets do change, especially if Preliminary or Advance. Check the date!
通常总会有一个日期。数据手册变动，尤其是预备版或者修正版，核对一下日期。

National

February 2000

LM555 Timer

Look up here to see if the datasheet is Advance Information or Preliminary.
检查这里看数据手册是修正信息或是者预备的。

General Description

The LM555 is a highly sta
time delays or oscillation
for triggering or resetting i
operation, the time is prec
sistor and capacitor. For
the free running frequen
controlled with two extern
circuit may be triggered a
the output circuit can so
TTL circuits.

Features tell you general characteristics-- always check the Electrical Characteristics for conditions and exceptions.
特性（*Features*）提供常规特性信息--确认电气特性所在的条件以及特殊情况。

seconds through hours
stable and monostable modes
cle
or sink 200 mA
TTL compatible
ity better than 0.005% per ˚C
ormally off output
■ Available in 8-pin MSOP package

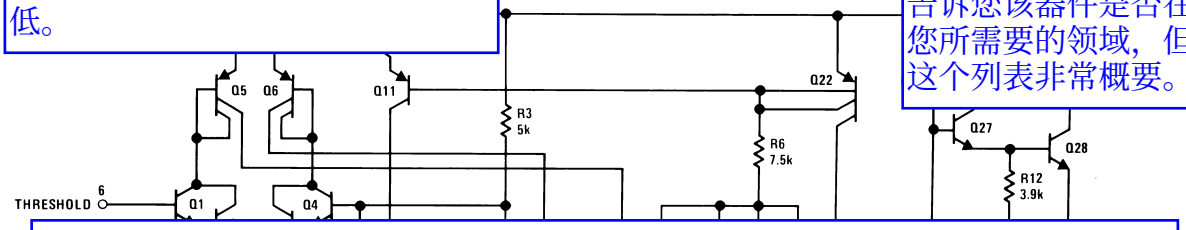
Sometimes the General Description will tell you about a feature or usage not mentioned anywhere else! For example, you might need to hold a specific pin low for some operation.
有时常规描述（*General Description*）会给出一些其它地方没提到的特性或者用法。例如，在某些操作时您需要将某个引脚拉低。

Applications

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation
- Pulse position modulation
- Linear ramp generator

Application suggestions can often tell you quickly if this device is in the ballpark for what you want to do, but these lists are often very general.
应用提示通常简捷地告诉您该器件是否在您所需要的领域，但这个列表非常概要。

S



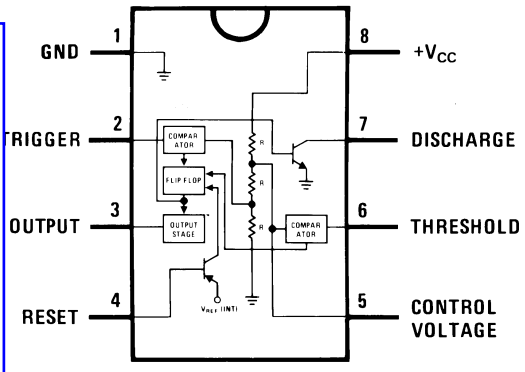
Usually called the Equivalent Schematic Diagram, this schematic isn't what is necessarily in the device, but the device acts as if this was what was inside. It can help explain behavior that isn't otherwise described in the datasheet. Could you duplicate this circuit on a breadboard? Only if you knew what the characteristics of the transistors were--which are not given.
通常叫做等效原理图，该原理不是该芯片中必须的，但是该芯片将按照里面的来运作。它能帮助解释在数据手册中未被描述的行为。能把这个电路在面包板上搭出来吗？除非您知道那些并未给出参数的晶体管的参数。

D

DS007851-1

Connection Diagram

Dual-In-Line, Small Outline and Molded Mini Small Outline Packages



Top View

Make sure you're looking at the pinout for the correct package. In the back pages you'll find drawings of the package types. Here all the packages have the same pinout--that's not always the case!
确认您所看到的引脚分布对应着正确的封装。在后面您将看到封装类型的图。在这里，所有的封装都具有相同的引脚分布，然而并非所有的情形都是如此的。

	nber	Package Marking	Media Transport	NSC Drawing
	CM	LM555CM	Rails	M08A
	MX	LM555CM	2.5k Units Tape and Reel	
	MM	Z55	1k Units Tape and Reel	MUA08A
	LM555CMMX	Z55	3.5k Units Tape and Reel	
8-Pin MDIP	LM555CN	LM555CN	Rails	N08E

Under Ordering Information you'll find a list of every variation of this device along with the COMPLETE part number. Often the first few letters are either industry-standard or identify the manufacturer (e.g., PIC). The generic identifier comes next ("555"). Suffixes generally give package type (surface mount and through hole types), temperature range (wider range = more expensive), speed (faster = more expensive), and other variations such as power, voltage range, etc.
在订货信息（*Ordering Information*）下，可以找到带有完整零件编号的该器件的每个变种的列表。通常开始的几个字母是行业标准或者厂商标识（例如，PIC）。紧接着的是常规标识（“555”）。后缀通常给出封装类型（贴片安装型或直插型），温度范围（宽范围型，当然也会更贵），速度（快速型，当然也会更贵），以及其它各种如功耗，电压范围等等。

Other elements in datasheets:
--Related devices, such as devices this supercedes, exactly replaces, or is replaced by
--Block diagrams of internals
--Information to support programming or configuring the device (registers, etc.)
--Interfacing with other devices (including input/output characteristics)
数据手册中的其它成分：
--相关器件，如它可替换的，可直接替换的，或者可以被其它替换的器件
--内部方块图
--提供编程或者配置该器件的信息（寄存器等）
--与其它器件之间的连接（包括输入/输出特性）

Absolute Maximum Ratings tell you what will damage the chip--NOT the maximum operating limits!
绝对最大额定值（*Absolute Maximum Ratings*，也叫做极限参数）给出什么条件将毁坏芯片，而不是最大运作限制。

please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Soldering (10 Seconds)	260˚C
Small Outline Packages	
(SOIC an	
Vapor Pha	215˚C
Infrared (	220˚C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

See Note 2 for details.
看标注2获取详细信息。

Electrical Characteristics are sometimes split into DC (power supply, static input/ouput characteristics) and AC or Timing, these tell you what you can count on.
电器特性有时分成直流DC（电源，静态输入/输出特性）和交流AC或动态，这些可用来计算。

Electrical Characteristics (T_A = 25˚C, V_{CC} = +5V to +15V, unless otherwise specified)

Parameter	Conditions	Limits LM555C Min	Typ	Max	Units
Supply Voltage		4.5		16	V
Supply Current	(Low State) (Note 4)		3 10	6 15	mA
Timing Error, Monostable					
Initial Accuracy					%
Drift with Temperature	R_A = 1k to C = 0.1µF				µ/˚C
Accuracy over Temperature					%
Drift with Supply					%/V
Timing Error, Astable					
Initial Accuracy					%
Drift with Temperature	R_A, R_B = 1 C = 0.1µF, (Note 5)				µ/˚C
Accuracy over Temperature			3.0		%
Drift with Supply			0.30		%/V
Threshold V			0.667		x V_{CC}
Trigger Volt			5 1.67		V V
Trigger Cur			0.5	0.9	µA
Reset Volta		0.4	0.5	1	V
Reset Curr			0.1	0.4	mA
Threshold C			0.1	0.25	µA
Control		9 2.6	10 3.33	11 4	V
Pin 7 Leaka			1	100	nA
Pin 7 Sat (I					
Output Low	V_{CC} = 15V, I_7 = 15mA		180		mV
Output Low	V_{CC} = 4.5V, I_7 = 4.5mA		80	200	mV

Watch out--the datasheet might discuss more than one part!
注意--数据手册可能讨论多个部分。

Design to the minimum and maximum limits, not to the typical. This gives you an idea of the likely behavior, but not the worst-case. Good, robust design does not count on the typical!
按照最小和最大限制来设计，而不是典型值。这让您了解到它比较可能的行为，但不是最坏的情况。优良的设计不能依靠典型值。

Pay attention to the conditions noted. Here the device is at a specific temperature. Often, plots later on in the datasheet will show temperature-related parameters (as well as those dependent on supply voltage, speed, etc.).
注意工作条件。这里该器件工作在一个特定的温度下。通常，数据手册下面会给出温度相关参数的图（与那些依赖电源电压，速度等的参数一样）。

Electrical Characteristics (Notes 1, 2) (Continued)

(T_A = 25˚C, V_{CC} = +5V to +15V, unless othewise specified)

Parameter	Conditions	Limits			Units
		LM555C			
		Min	Typ	Max	
Output Voltage Drop (Low)	V_{CC} = 15V				
	I_{SINK} = 10mA		0.1	0.25	V
	I_{SINK} = 50mA		0.4	0.75	V
	I_{SINK} = 100mA		2	2.5	V
	I_{SINK} = 200mA		2.5		V
	V_{CC} = 5V				
	I_{SINK} = 8mA				V
	I_{SINK} = 5mA		0.25	0.35	V
Output Voltage Drop (High)	I_{SOURCE} = 200mA, V_{CC} = 15V		12.5		V
	I_{SOURCE} = 100mA, V_{CC} = 15V	12.75	13.3		V
	V_{CC} = 5V	2.75	3.3		V
Rise Time of Output			100		ns
Fall Time of Output			100		ns

Note 1: All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Note 3: For operating at elevated temperatures the device must be derated above 25˚C based on a +150˚C maximum junction temperature and a thermal resistance of 106˚C/W (DIP), 170˚C/W (S0-8), and 204˚C/W (MSOP) junction to ambient.

Note 4: Supply current when output high typically 1 mA less at V_{CC} = 5V.

Note 5: Tested at V_{CC} = 5V and V_{CC} = 15V.

Note 6: This will determine the maximum value of $R_A + R_B$ for 15V operation. The maximum total ($R_A + R_B$) is 20MΩ.

Note 7: No protection against excessive pin 7 current is necessary providing the package dissipation rating will not be exceeded.

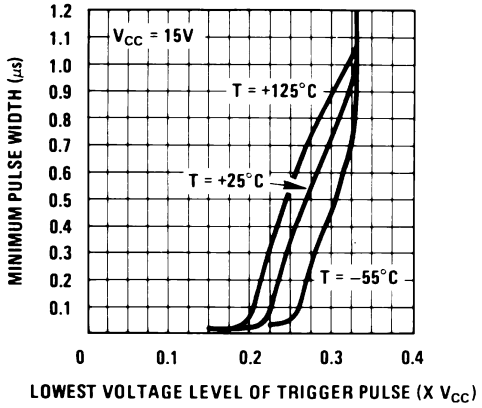
Note 8: Refer to RETS555X drawing of military LM555H and LM555J versions for specifications.

(Here is Note 2 in large print)
Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional,but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

（这里是占很大版面的标注2）
标注2：绝对最大额定值（*Absolute Maximum Ratings*）表示超过将损坏芯片的限制。
工作额定值（*Operating Ratings*）表示芯片基本功能的，但不保证特殊性能的限制条件。
电气参数（*Electrical Characteristics*）是在保证特殊性能限制下的特殊测试条件下规定的直流和交流电气规范。以上规定是假设器件工作在额定值下的。虽然规范并不保证在没有给定限制时的参数，然而典型值依然是衡量器件性能的一项很好的指标。

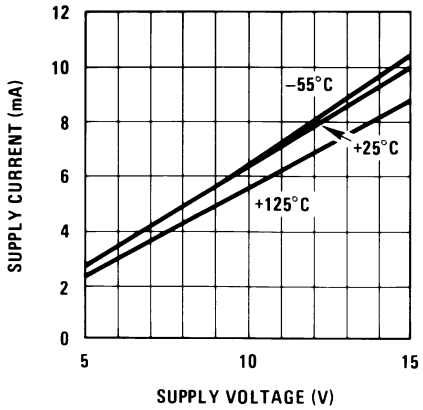
Typical Performance Characteristics

Minimuim Pulse Width Required for Triggering



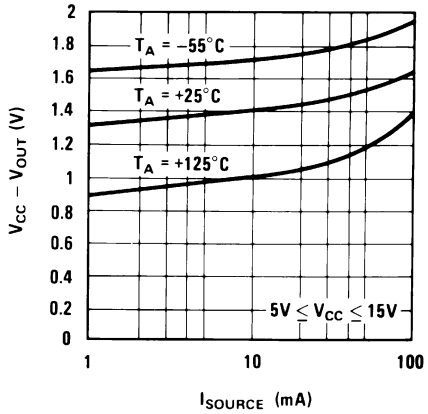
DS007851-4

Supply Current vs. Supply Voltage



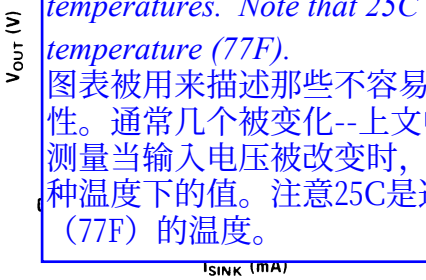
DS007851-19

High Output Voltage vs. Output Source Current



DS007851-20

Low Output Output Sink

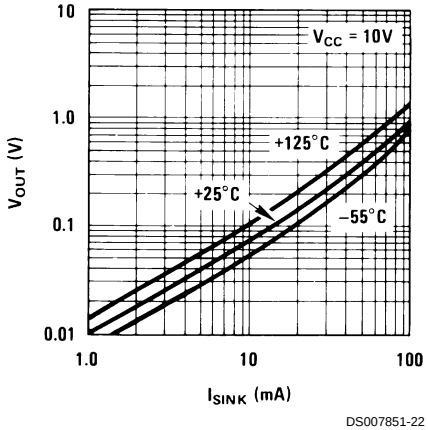


DS007851-21

Graphs are used to describe characteristics that can't be captured easily in a table. Often several things are being varied--above, supply current is measured as voltage is changed, but this is also being show for three different temperatures. Note that 25C is roughly room temperature (77F).

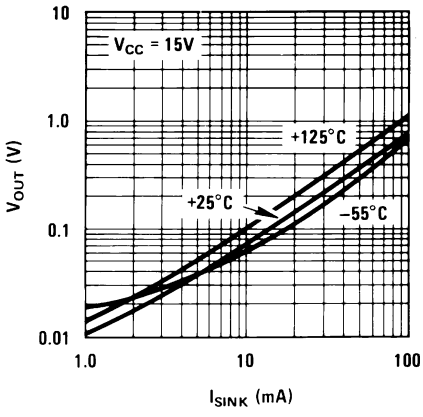
图表被用来描述那些不容易放在表格里的特性。通常几个被变化--上文中，供电电流被测量当输入电压被改变时，并同时显示了三种温度下的值。注意25C是近似室温（77F）的温度。

Low Output Voltage vs. Output Sink Current



DS007851-22

Low Output Voltage vs. Output Sink Current



DS007851-23

Page 6 of the datasheet is omitted.

数据手册的第6页被省略。

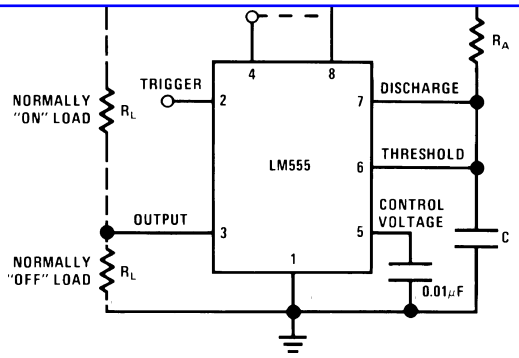
Applications Information

MONOSTABLE OPERATION

In this mode of operation, the timer functions as a one-shot (*Figure 1*). The external capacitor is initially held discharged

NOTE: In monostable operation, the trigger should be driven high before the end of timing cycle.

Here are example circuits and application notes. Note too that often there are other sources for application information, such as separate Application Notes available from the manufacturer.
这里是示例电路和使用标注。注意通常有其它的应用信息来源，例如厂商提供的独立的应用标注。

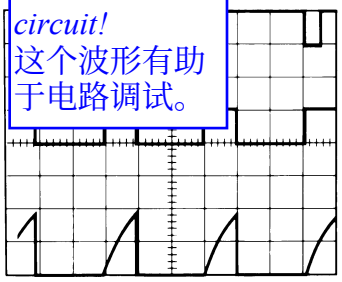


DS007851-5

FIGURE 1. Monostable

The voltage across the capacitor then increases exponentially for a period of $t = 1.1 R_A C$, at the end of which time the voltage equa... comparator then resets the flip-flop which... capacitor and drives the output to its lo... ws the waveforms generated in this r... nce the charge and the threshold leve... are both directly proportional to supp... nternal is independent of supply.

These waveforms would be helpful in debugging a circuit!
这个波形有助于电路调试。



DS007851-6

V_{CC} = 5V
TIME = 0.1 ms/DIV.
R_A = 9.1kΩ
C = 0.01μF

Top Trace: Input 5V/Div.
Middle Trace: Output 5V/Div.
Bottom Trace: Capacitor Voltage 2V/Div.

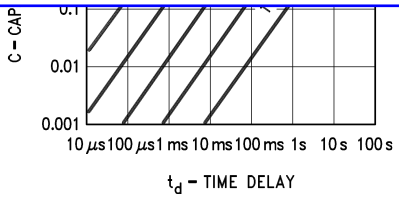
FIGURE 2. Monostable Waveforms

During the timing cycle when the output is high, the further application of a trigger pulse will not effect the circuit so long as the trigger input is returned high at least 10μs before the end of the timing interval. However the circuit can be reset during this time by the application of a negative pulse to the reset terminal (pin 4). The output will then remain in the low state until a trigger pulse is again applied.

When the reset function is not in use, it is recommended that it be connected to V_{CC} to avoid any possibility of false triggering.

Figure ... R, C values for

Pages 8-11 have been omitted.
*8-11*页被省略。

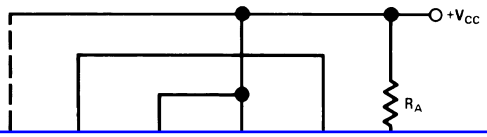


DS007851-7

FIGURE 3. Time Delay

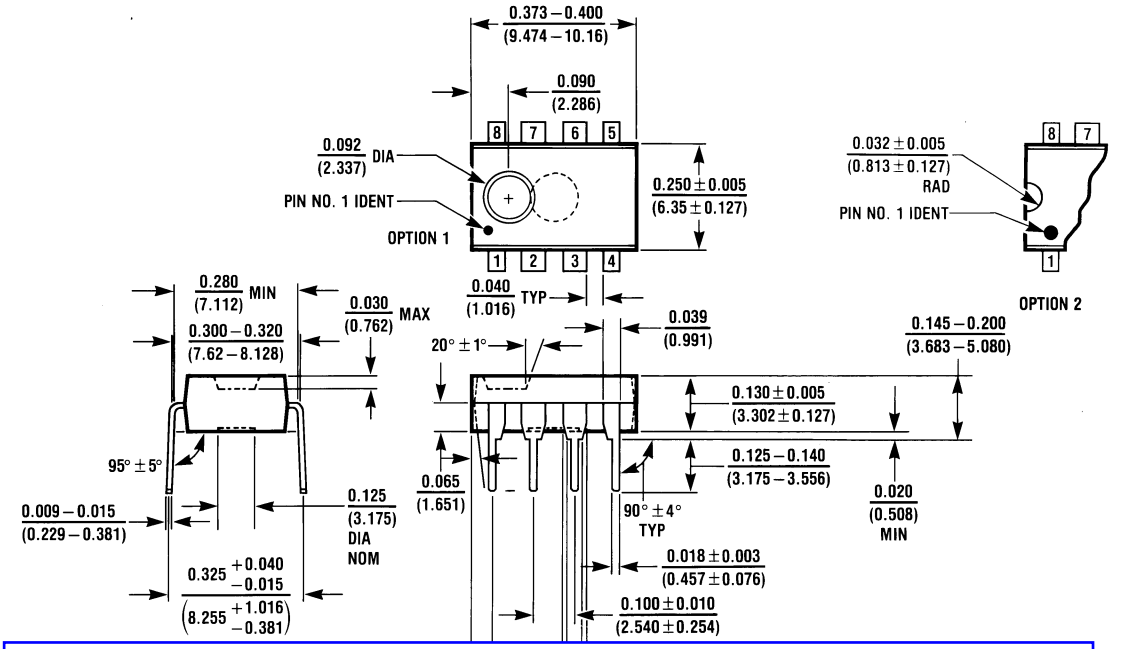
ASTABLE OPERATION

If the circuit is connected as shown in *Figure 4* (pins 2 and 6 connected) it will trigger itself and free run as a multivibrator. The external capacitor charges through $R_A + R_B$ and discharges through R_B. Thus the duty cycle may be precisely set by the ratio of these two resistors.



Not all datasheet application examples are so well written--sometimes you just get the raw schematics. For more complex devices, such as microcontrollers, different aspects might be handled in different sections--for example, a clock circuit in one part, a reset circuit in another. Read over all the sections to make sure you are using the device correctly and have supplied all the necessary components.
并非所有的数据手册应用示例都写得这么充分，有时你仅得到一个不完整的原理图。对于更复杂的器件，例如微控制器，不同的方面可能被放在不同的部分--例如，时钟电路在一处，而复位电路却在另一处。阅读整个部分确保正确的使用器件以及提供了所有需要的元件。

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



The package outlines can also be a source for pin-numbering if you are in doubt. Note that plastic DIP is the most common package for prototyping. Avoid surface mount packages (e.g., SOIC, MSOP, PQFP), though with the proper socket PLCC packages can be soldered to relatively easily (but not used in a plastic prototype board without an adapter). There is great variation in pricing depending on package type (and other factors such as temperature range, speed, etc.), so be sure to double-check part numbers.

封装轮廓图也可以作为引脚编号的一个参考，如果你对引脚编号有疑问的话。注意塑料双列直插封装（DIP）是做原型设计最常用的封装。避免贴片封装（例如SOIC，MSOP，PQFP），然而使用合适的插座，PLCC封装能够比较容易的被焊接（但是不要不使用适配器而直接使用在塑料原型板上）。不同的封装类型（其它因素例如温度范围，速度等）价格相差很大，因此请仔细确认零件编号。

(REV F)

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSE

1. Life s… component of a life system… se failure to perform into th… cause the failure of whose… stem, or to affect its accord… labelin… signific…

Finally, remember that datasheets can always be in error. But just like programming, 99% of errors are user errors. If you find what you think is an error, make sure you have the most recent datasheet, and send a polite query to the appropriate technical support. Newsgroups such as sci.electronics.design might be useful to query first.

最后，记住数据手册总可能会有错误的。但就像编程一样，99%的错误是用户错误。如果您找到您认为是错误的地方，请确认您的数据手册是最新的，并且发送一个有礼貌的咨询给适当的技术支持。首先咨询象 *sci.electronics.design*这样的新闻组应该是比较有用的。

Nation… Corpo… Ameri… Tel: 1-… Fax: 1… Email: … www.national.…

National Semiconductor Japan Ltd.
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507

译者：computer00
如果有理解错误的地方，见谅。
Blog： http://computer00.21ic.org
http://www.ednchina.com/blog/computer00