

LB-38

LB-38 Wide Range Timer



Literature Number: SNOA694

Wide Range Timer

National Semiconductor
Linear Brief 38
February 1977



Wide Range Timer

One of the problems encountered in potentiometer controlled circuits is dynamic range. With a linear pot, about a 100:1 range is the limit. Although the pot resolution may be better than 1%, the angular displacement for good control becomes too small. Usually, range switching is then used.

A logarithmic control is a possible solution. With log controls, the resolution is the same anywhere within the operating range. For example, if 40° rotation is equal to a change from 10% to 100% of full scale, then 40° rotation is also equal to a change from 0.01% to 0.1% of full scale. It is easy to control a function over a 1,000,000:1 range with good control anywhere within the range.

The exponential relationship between the emitter-base voltage of a transistor and its collector current is well known. This relationship holds true within a few percent over extremely wide ranges. Using a transistor pair, and an op amp, it is easy to make a current source controllable over a 6 decade range.

Figure 1 shows a timer which can be adjusted from 2 ms to 2000 seconds with a single control. An LM122 is used for the timing function in conjunction with a current source that is logarithmically controlled from a pot. The operation is as follows:

Transistors Q1 and Q2 are a matched PNP pair. Resistor R1 and the op amp set up a constant current of 1 mA through Q1 using the internal 3V reference from the timer. With R2 at the most positive end of its range, the non-inverting input

of the op amp is a V_{REF} . This forces the emitter-base voltage of Q2 to equal Q1 and since the transistors are matched, the collector current of Q2 is also 1 mA. A time-out period of 2 ms results.

Rotating R2 subtracts the voltage between the arm of the pot and V_{REF} from the emitter-base voltage of Q2—lowering its collector current. The current is decreased by a factor of 10 for every 60 mV developed. A total of 360 mV is dropped across the pot, allowing a reduction in Q2 collector current by a factor of 1,000,000 or from 1 mA to 1 nA. A 1 nA charging current gives a 2000 second time out. (At maximum time, there is about a 30% error due to the 0.3 nA input current of the comparator). Finally, diodes D1 and D2 temperature compensate the voltage across the pot.

Calibrating the circuit is relatively easy (except for obtaining a log dial for the pot). Resistor R1 is adjusted for the minimum operating time removing for mismatch in the transistors, capacitor tolerance, and the offset of the op amp. R3 is used to calibrate the full scale time by adjusting the drop across R2 to 360 mV.

This type of log control is not limited to timers. If used in oscillator or function generator circuits, an ultra wide range VCO can be made. Also, in power supply circuitry, it is possible for a regulator to have as much resolution when adjusted for 0.001V output as when the output is 10V. Finally, a log current generator makes an easily adjusted low value current source without high value resistors.

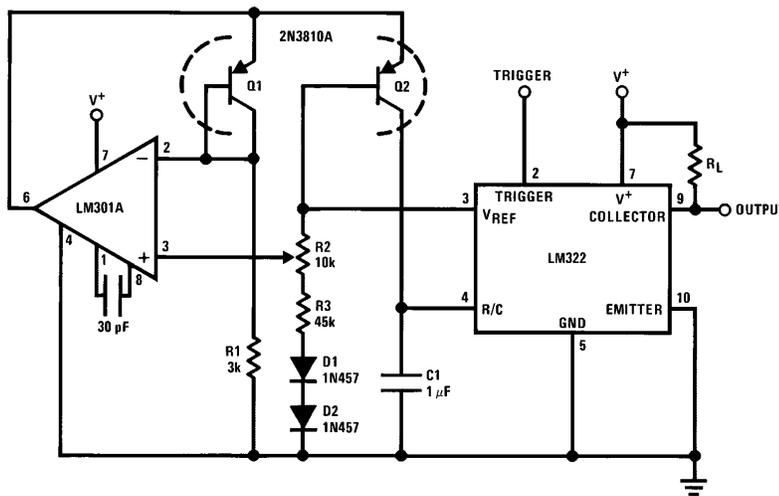


FIGURE 1. 2 ms to 2000 Second Timer

TL/H/8487-1

LB-38

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 OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

- 1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
- 2. A critical component is 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.



National Semiconductor Corporation
 1111 West Bardin Road
 Arlington, TX 76017
 Tel: 1(800) 272-9959
 Fax: 1(800) 737-7018

National Semiconductor Europe
 Fax: (+49) 0-180-530 85 86
 Email: cnjwge@tevm2.nsc.com
 Deutsch Tel: (+49) 0-180-530 85 85
 English Tel: (+49) 0-180-532 78 32
 Français Tel: (+49) 0-180-532 93 58
 Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
 19th Floor, Straight Block,
 Ocean Centre, 5 Canton Rd.
 Tsimshatsui, Kowloon
 Hong Kong
 Tel: (852) 2737-1600
 Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
 Tel: 81-043-299-2309
 Fax: 81-043-299-2408

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Mobile Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Transportation and Automotive	www.ti.com/automotive
Video and Imaging	www.ti.com/video

TI E2E Community Home Page

e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated