

LM9830

Voltage Regulator Controls Scanner Lamp Brightness



Literature Number: SNOA832



VOLTAGE REGULATOR CONTROLS SCANNER LAMP BRIGHTNESS

APPLICATION

Best possible performance in an image scanning device can only be obtained when the scanner IC is able to control the brightness of the image reflected into the light sensors. The best way to do this is to adjust the intensity (light output) of the fluorescent lamp which shines light onto the item being scanned.

Traditionally, adjustable brightness has not been economically feasible in most scanners due to the cost of implementing a high-current voltage source which is software programmable. This paper describes a simple, low-cost circuit which can be used with National Semiconductor's LM9830 "scanner-on-a-chip" IC to implement full-range lamp brightness control.

DESCRIPTION OF BRIGHTNESS CONTROL REGULATOR

The fluorescent lamp in most low-cost scanners is typically run from a fixed +12V source, which operates the lamp at maximum brightness. If the 12V used to power the lamp is reduced to a lower voltage, the brightness of the lamp can be adjusted to virtually any level. To accomplish this, a circuit is used which takes 12V in and produces a regulated DC output voltage which varies between 0 and 12V, depending on the brightness control signal coming from the LM9830 IC (see Figure 1). This control signal is a 5V pulse train, whose duty cycle is set by the LM9830.

The lamp brightness controller circuit (Figure 2) takes in +12V and regulates it down to any voltage between 0 and 12V. Since the ON-resistance of the NDP6020P FET is only about 50 m Ω , the maximum regulated output voltage the circuit can provide is within about 25mV of the input voltage at the typical lamp current of 0.5A.

The regulated output voltage is generated by the error amplifier U1B, resistive divider R8 and R9, and the reference voltage produced by averaging the square wave pulse train. The square waves are filtered into a DC voltage by R4, C3, R6, and C4. The voltage across C4 is the average value of the pulse train, which is directly proportional to the duty cycle:

$$V_{C4} = 5V \times (\text{Duty cycle})$$

This shows that the reference voltage applied to pin 6 of U1B can be varied linearly between 0 and 5V by adjusting the duty cycle of the 5V pulse train. When used with the LM9830, a maximum of 4095 different values of duty cycle can be programmed (which yields 4095 different brightness levels).

The error amplifier U1B compares the C4 voltage to the voltage at the center of resistive divider R8 and R9 (which is derived from the regulated output voltage Vout). The regulating action of U1B is such that it constantly adjusts the gate drive voltage to the FET Q1 to cause Vout to be the value required to keep the voltages at the inputs of U1B equal. In this way, the voltage at C4 (which is proportional to the duty cycle of the pulse train) controls the regulated voltage Vout. Vout can be calculated from:

$$V_{out} = V_{C4} \times (R8 + R9) / R9 = V_{pk} \times (\text{duty cycle}) \times (R8 + R9) / R9$$

Where **Vpk** is the peak amplitude of the pulse train (5V in this application) and **duty cycle** is the pulse ON time divided by the total period (see Figure 2).

Components C2, R5, R7, C1, and C5 are required for compensation and stability. For component values shown, best performance is obtained with the frequency of the pulse train between 10 kHz and 50 kHz.

FIGURE 1. TYPICAL IMAGE SCANNER

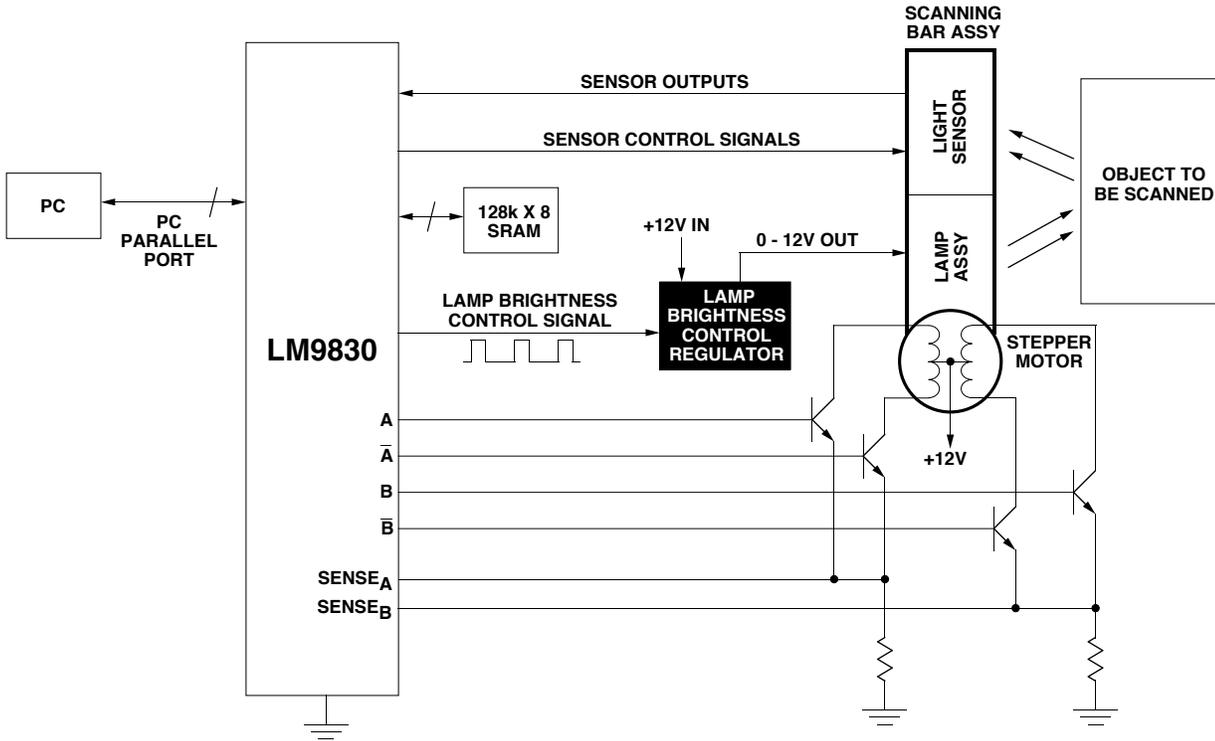
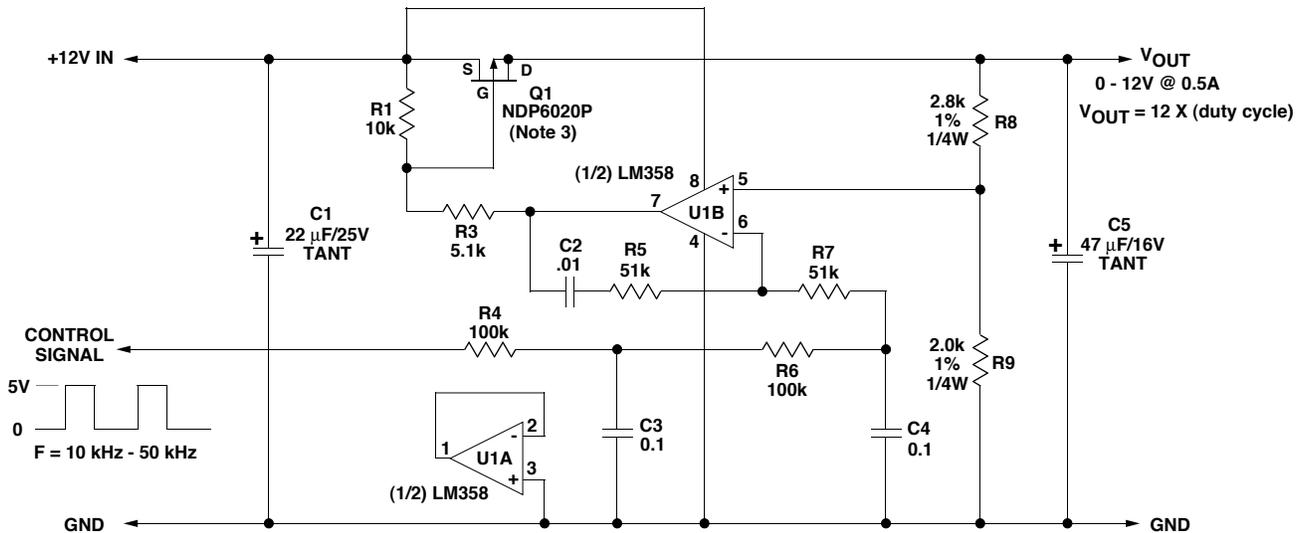


FIGURE 2. LAMP BRIGHTNESS CONTROL REGULATOR



NOTES (UNLESS OTHERWISE SHOWN):

- 1) All resistors are 5% tolerance, 1/8W.
- 2) TANT capacitors are solid Tantalum. All other capacitors are ceramic.
- 3) Solder to PC board with copper area $\geq 1 \text{ in}^2$ for heatsinking.

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