Using the NM95C12 CMOS EEPROM with Programmable Switches for Analog Applications

National Semiconductor
Application Note 765
Alfred P. Neves
May 1991

INTRODUCTION

National's NM95C12 EEPROM programmable switch occupies a unique niche in the switch marketplace. Consisting of a 1024-bit serial input EEPROM with 8 programmable switches, the output can provide either an analog switch or TTL compatible logic functions.

The combination of switch performance and the flexibility offered in the ability to software reconfigure the switching function makes the NM95C12 an excellent device for analog systems requiring switching or multiplexing. Often calibration sequences or multiplexing functions have either required using several IC's or manually shorting and opening printed circuit board connections, until the availability of the NM95C12.

However, the limited analog range of the NM95C12 makes it difficult to use for general analog functions. In order to capitalize on the full capabilities of programmable switches, it is important to understand the appropriate design techniques in level shifting, increasing the output drive capability, and increasing the output signal range. The focus of this application note is to summarize general circuits that perform this function, and thereafter provide a practical transducer measurement system example. The discussion will be solely devoted to extending the use of the NM95C12's switches function, and not on the actual software programming or operation of the IC.

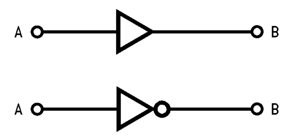
GENERAL DESCRIPTION

A detailed description of the overall operation of the NM95C12 can be found in AN-735, ''Understanding National's NM95C12 EEPROM with Programmable Switches'', or the NM95C12 data sheet. However, for the sake of completeness, the NM95C12 consists of a 61-word x 16-bit EEPROM array, a 16-bit Initial Switch Register, a 16-bit Switch Configuration Register, a 16-bit Switch Readback Register, four identical blocks of switch logic, programming and power-up circuits and control logic. Essentially, the NM95C12 programmable switch can be easily configured, and reconfigured, for applications including both analog and digital switching functions. 60 internal addresses are available to reconfigure the switch settings on the fly. Upon power-up the Initial Switch Register, address 61, provides a defined set-up state. This operational feature is extremely valuable since it provides an established initial condition for the system.

SWITCH DETAILS

Each switch pair can be configured for either logic functions, or as an analog switch. Functional block details relating control of the switches to the input control logic can be found in Table I of the NM95C12 data sheet. Basically, the logic switch configurations are at standard TTL levels. Also, the analog switch configurations can be looked at as standard MUX switches. Since this note specifically focuses on extending the operating voltage range of the analog switches, the emphasis will be on the analog switches. *Figure 1* summarizes the salient operating features of the switch pairs.

Logic Function



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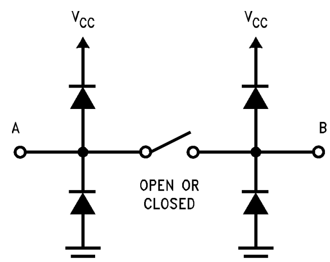
Input Leakage ±2.5 μA max

TTL Level Input/Output

Switch Functions



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R_{ON} 200Ω max

R_{OFF} 10 MΩ min

$(+0.7) \geq V_{OUT} \geq (V_{CC} - 0.7V)$

FIGURE 1. The NM95C12 can be Programmed to Configure either Logic Function or an Analog Switch

LEVEL SHIFTING AND EXTENDING THE SWITCHES RANGE

In considering level switching and enhancement of the voltage range for the NM95C12, it is logical to examine some simple level translations that can be solved with commercially available IC's. Examples of simple translation circuits includes the DS1630B Hex CMOS Compatible Buffer shown in *Figure 2*. Where simple translation of TTL output signals to higher levels of output voltage is required (such as CMOS compatible signals), used at the output of logic configured NM95C12 switch, the DS1630B represents a simple solution.

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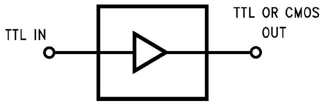

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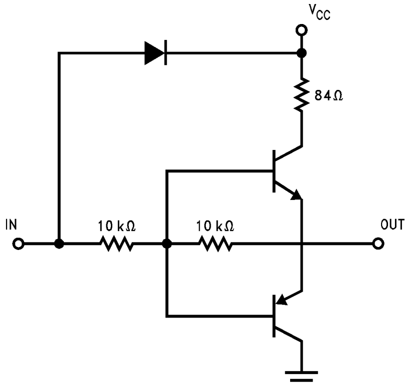
1/6 DS3630B



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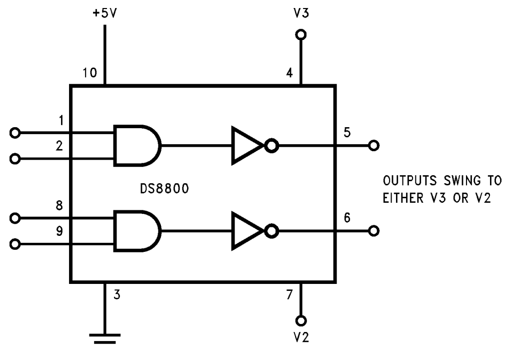
Equivalent Circuit

FIGURE 2. The DS1630B/DS3630B is a Hex CMOS Buffer Amplifier. It Features Low Power Consumption, and an Output Voltage that can go to 16V (V_{CC}).

An example of a voltage translation is the DS8800 Dual Voltage Level Translator which can be found in *Figure 3*. Custom control of output swing can be established over a 31V range by setting V3, and V2 to the appropriate values. Additional information can be found in the DS8800 data sheet.



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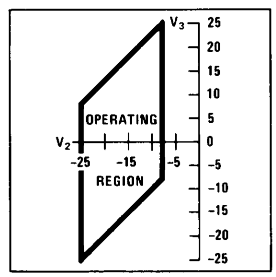

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FIGURE 3. The DS8800 is a Dual Voltage Translator that is useful for Programming MOS Type Memory, Establishing Bias Voltages, and Driving Transducers. Output Swing is Limited to 31V.

Figures 4 through *10* illustrate some useful translation circuits that use discrete components to achieve higher output drive than typical monolithic IC's. The circuit in *Figure 4* is similar in functionality to the DS8800. However, wider output swings (limited to BVCeo of the output transistor), and larger sink/source current ability is achieved.

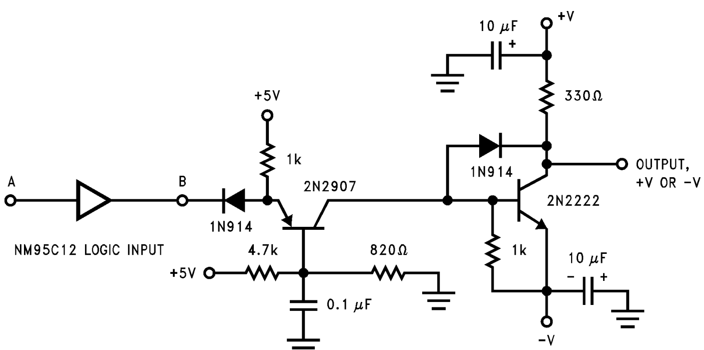

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FIGURE 4. –V to +V Voltage Translation, from TTL Input Signal

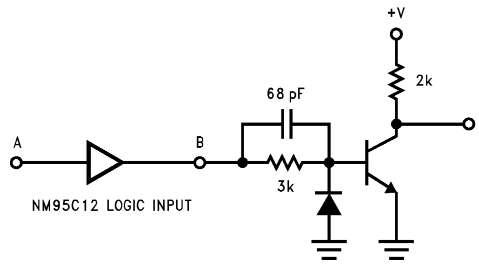

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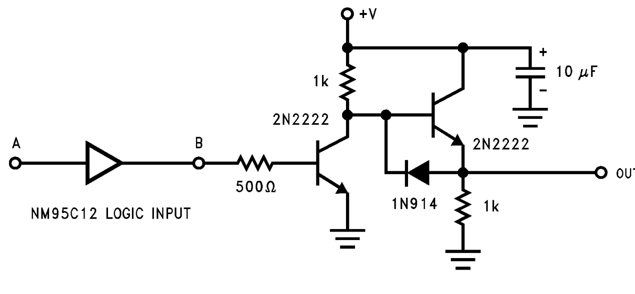
FIGURE 5. A Simple 0 → +V (+V Typically is 3V → +18V) Level Translation Stage. $I_{SOURCE} > I_{SINK}$



$I_{SINK} > I_{SOURCE}$

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FIGURE 6. High Output Current Sink Level Translation Stage—Excellent for Transducer Bridge Drive

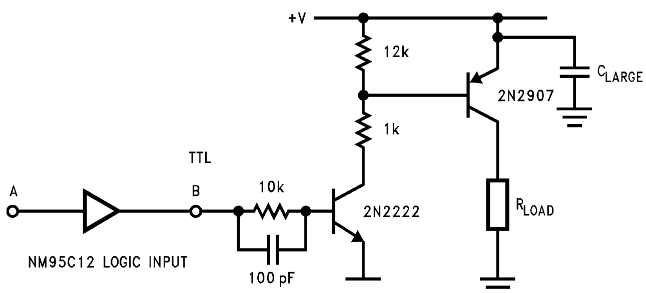

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FIGURE 7. A Simple 0V → +V Switch, from TTL Input

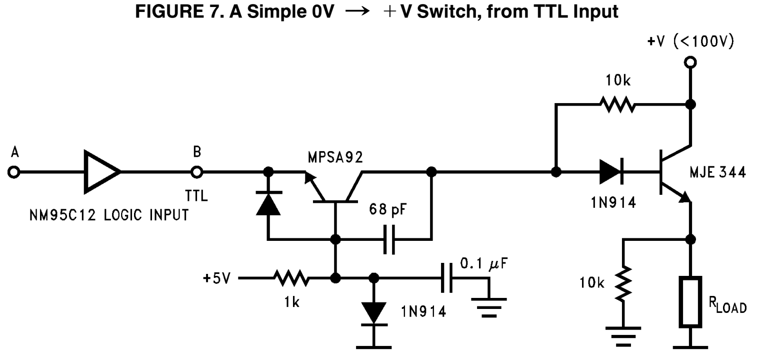

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FIGURE 8. 0V to High Voltage Translation Circuit, from TTL Input

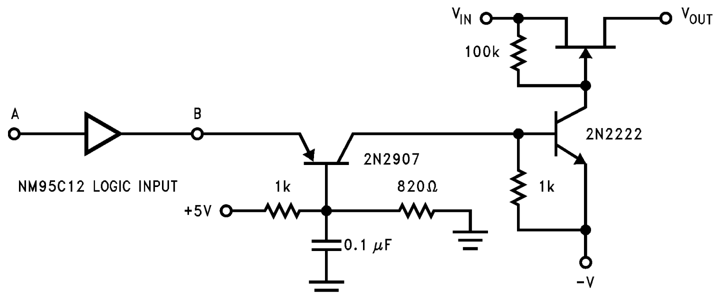


FIGURE 9. Control of FET Switch

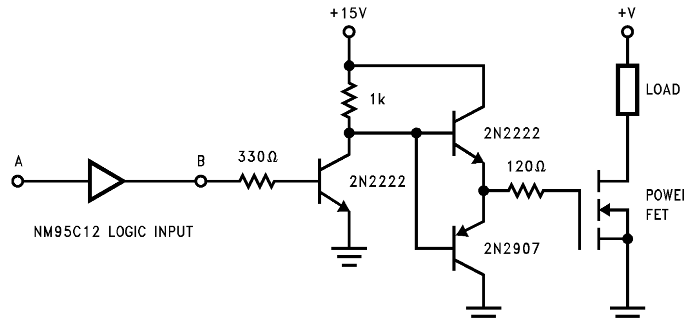


FIGURE 10. TTL Control of Power FET

TWO PRACTICAL EXAMPLES

Bridge circuits play a dominant role in many measurement applications. Typically, providing a trimmed, calibrated output response is usually the goal of a bridge transducer signal processing system. Often this requires calibration, switching for it's operation, and adjustments for operating conditions related to available supply voltage. The NM95C12 provides a software reconfigurable analog system, where manual shorting and opening circuit board traces is not required for either altering the operation of the system, or performing calibration.

Figure 9 shows how the NM95C12 can be used to control a transducer measurement system. By shifting through the 61-word sequence of the NM95C12 operation of the bridge—pulsing or exciting the bridge, sampling with the LF398, and strobing the A/D converter can be performed with the switches, which are configured in the TTL output mode.

Figure 10 illustrates the inherent flexibility in using the NM95C12 for controlling analog applications. One NM95C12 is used as a switch to directly control both the excitation voltage output level and enable to the bridge, provide TTL control signals for nulling the bridge-amplifier offset voltage, and strobe the LF398 sample/hold. Complete control of the transducer measurement system can now be controlled by the reconfigurable memory contents of the NM95C12.

A stable LM185-2.5 reference is used to generate an accurate 2.5V voltage. The 1K, 0.001 μF, 20K circuit provides a soft-start to the transducer bridge. This prevents potential damage to metal-foil type 350 bridge transducers. SW1 must be programmed to either enable or disable the bridge drive. A single-supply, low-power dual op-amp is used to drive Q1 which provides the appropriate bridge drive. Reliability is enhanced by including a 100 mA short circuit current limit.

The circuit is compatible with positive supply voltages extending from +5V to +15V. SW2 can be enabled to alter the output voltage range of the bridge drive. SW3 and SW4, in combination with the LF11333 can be programmed to provide a short to the instrumentation amplifier to null the amplifiers offset.

Since the output range of the NM95C12 switch is limited to a diode drop from the +5V supply line, a LF13333 multiplexer is used to provide switching the bridge output voltage, which will probably exceed this limited voltage range.

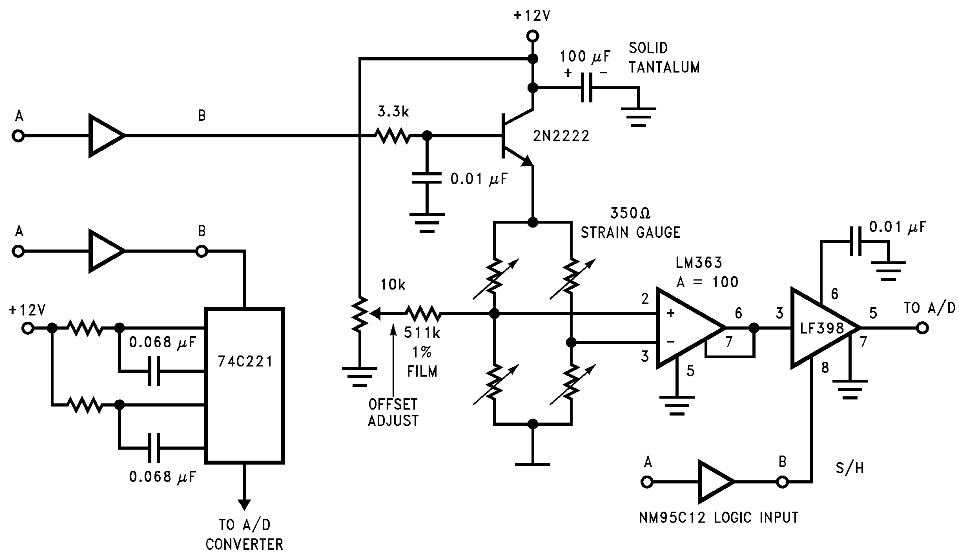
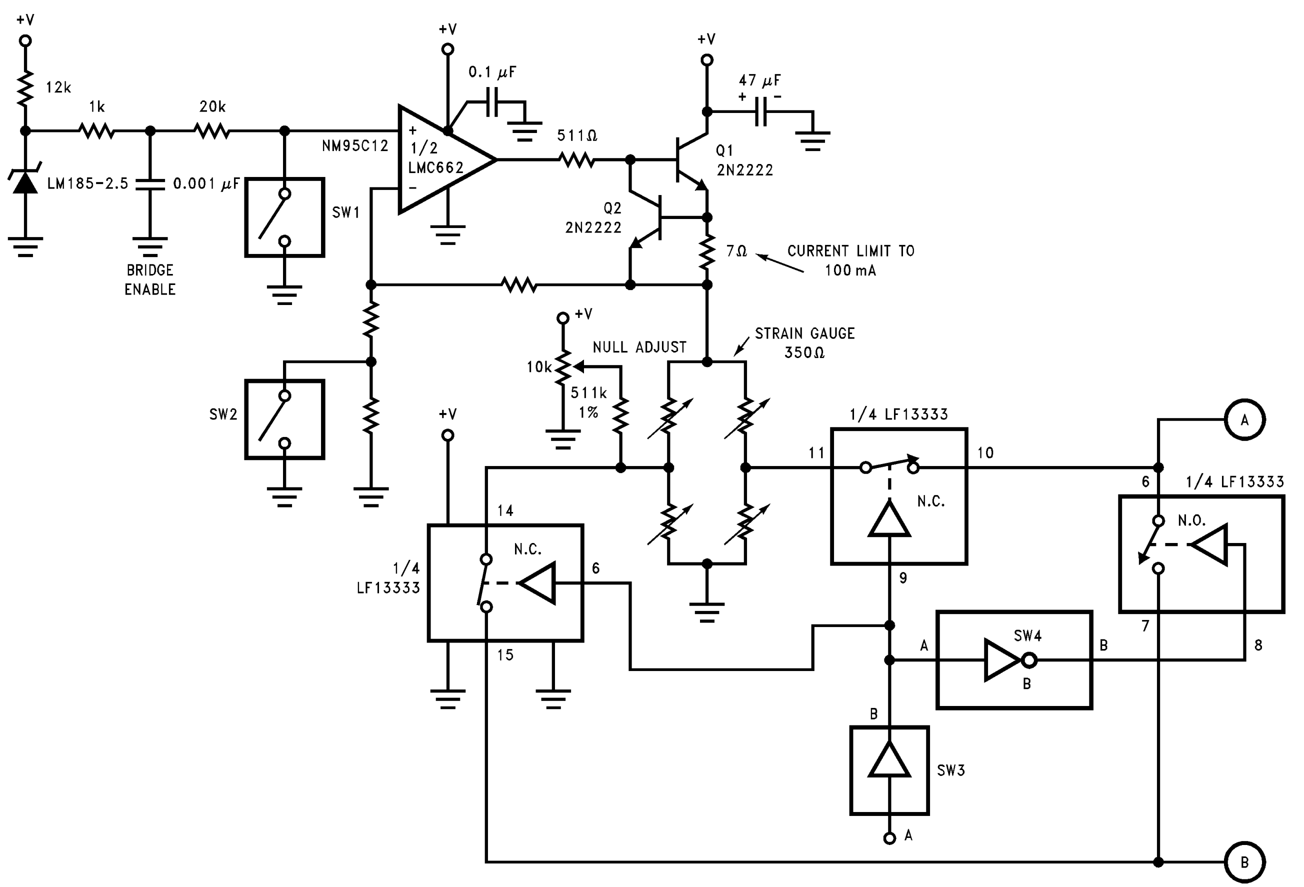


FIGURE 11. Using the NM95C12 in the TTL Output Switch Mode to Control Transducer Bridge Operation



SWX are Internal Switches to the NM95C12

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FIGURE 12. Transducer Measurement System

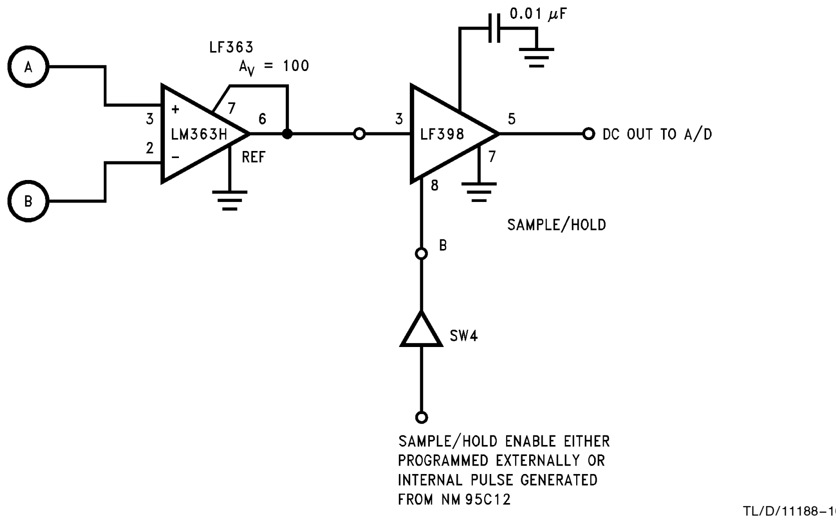

FIGURE 12. Transducer Measurement System (Continued)

National Semiconductor Corporation
2900 Semiconductor Drive
P.O. Box 58090
Santa Clara, CA 95052-8090
Tel: 1(800) 272-9959
TWX: (910) 339-9240

National Semiconductor GmbH
Livry-Gargan-Str. 10
D-82256 Fürstenfeldbruck
Germany
Tel: (81-41) 35-0
Telex: 527649
Fax: (81-41) 35-1

National Semiconductor Japan Ltd.
Sumitomo Chemical Engineering Center
Bldg. 7F
1-7-1, Nakase, Mihama-Ku
Chiba-City,
Ciba Prefecture 261
Tel: (043) 299-2300
Fax: (043) 299-2500

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductores Do Brazil Ltda.
Rue Deputado Lacorda Franco
120-3A
Sao Paulo-SP
Brazil 05418-000
Tel: (55-11) 212-5066
Telex: 391-1131931 NSBR BR
Fax: (55-11) 212-1181

National Semiconductor (Australia) Pty, Ltd.
Building 16
Business Park Drive
Monash Business Park
Nottinghill, Melbourne
Victoria 3168 Australia
Tel: (3) 558-9999
Fax: (3) 558-9998