Relay7 ™

Seven power relays and seven high voltage drivers for industrial applications

Technical Manual

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Temperature readings for controllers are based on the results of limited sample tests; they are provided for design reference use only.

Chapter 1: Introduction

1.1 Functional Description

In many industrial applications, 12V or 24V control signals are required; however, most embedded controllers provide TTL level (0-5V) input or output only. The Relay7 (R7) board is designed to support signal conversion of high voltage (up to 30V) digital signals and TTL level digital signals.

The Relay7 offers seven power relays. Each power relay provides Normal Close, Normal Open, and COM contacts, rated at 5A or more @ 35V. Seven red LED indicators are installed to indicate the power relay status. The user may install MOVs to protect relay contacts.

An additional seven I/O channels with high voltage drivers are also on board. These seven high voltage I/O channels are hardware-configurable as 0V to 30V inputs or as 0V to 30V outputs at the screw terminals, T1.

1.2 Features

- Dimensions: 4.4 x 2.2 x 0.8 inches
- Power supply input voltage: +12 V unregulated DC
- Seven mechanical power relays with Normal Open, Normal Close, and Common contacts rated at least 5A @ 250V.
- Seven channels of high voltage (0V to 30V) inputs or outputs.

A functional block diagram of the Relay7 is shown below in Figure 1.1.

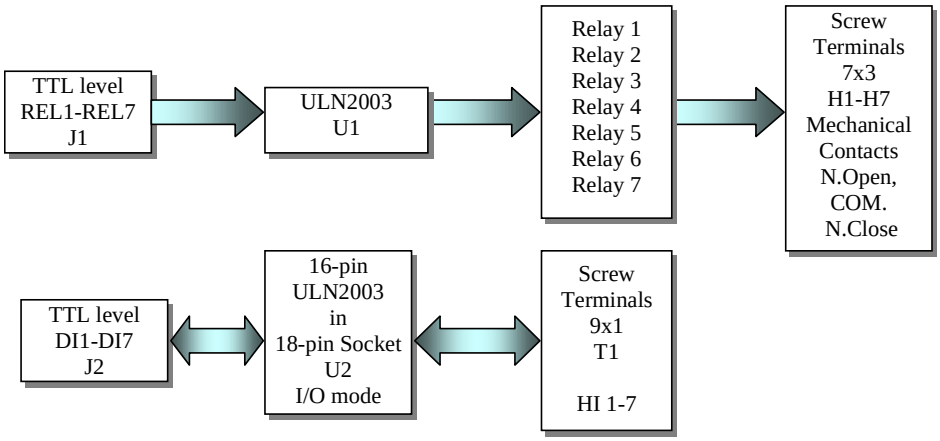


Figure 1.1 Relay7 functional block diagram

1.3 Physical Description

Figure 1.2 shows the physical layout of the Relay7. Dimensions are given in inches.

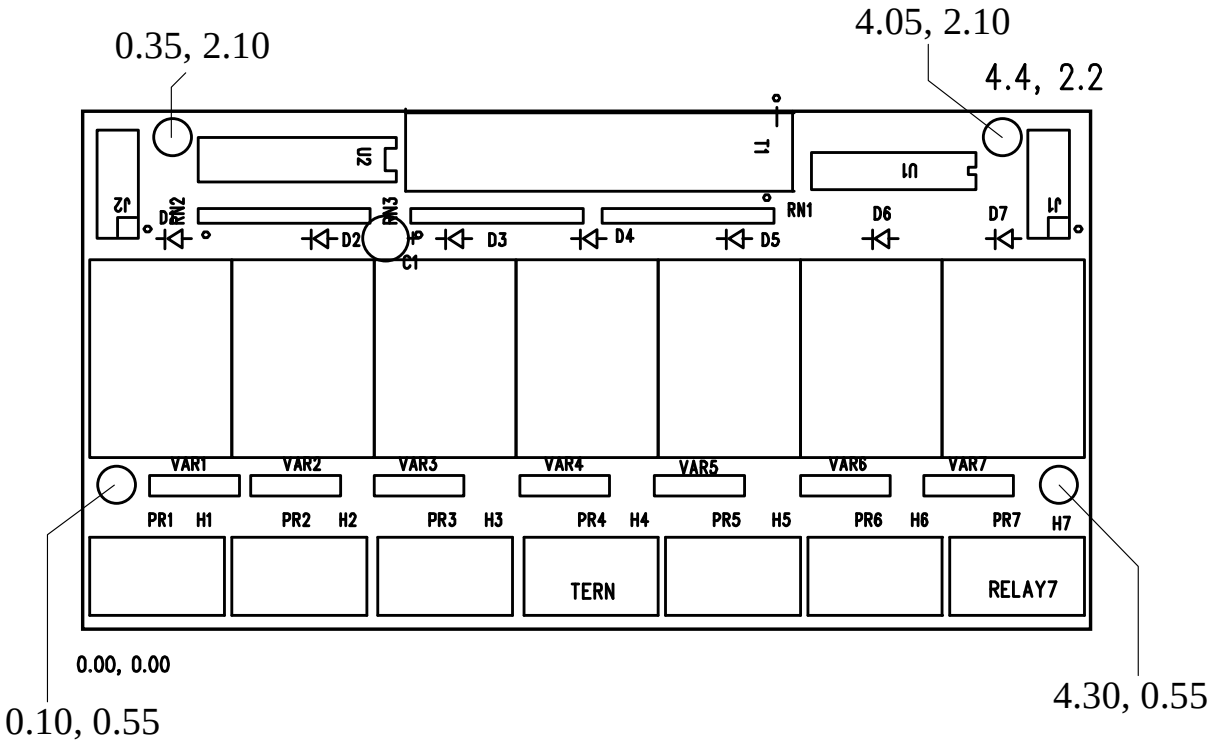


Figure 1.2 Layout of the Relay7

Chapter 2: Hardware

For many industrial applications, contact switch signals need to be 12V or 24V. In order to be useful, a control signal may have to drive a solenoid coil or a mechanical relay at 12V or 24V DC.

Most microcontrollers provide TTL-level digital control signals only. The Relay7 is designed to provide a buffer interface between TTL digital signals and the industrial control environment.

The ULN2003 is a high voltage, high current Darlington transistor array, consisting of seven silicon NPN Darlington pairs on a common monolithic substrate. All channels feature open-collector outputs for sinking 350 mA at 50V, and integral protection diodes for driving inductive loads. Peak inrush currents of up to 600 mA sinking are allowed. The outputs may be paralleled to achieve high-load capability, although each driver has a maximum continuous collector current rating of 350 mA at 50V. The maximum power dissipation allowed is 2.20 W per chip at 25 degrees Celsius (ºC).

The common substrate G is routed to GND. All currents sinking in return through the J2 GND pin. A heavy gauge (20) wire must be used to connect the T1 GND pin to the external power supply ground return.

K provides a connection to the protection diodes. K should be tied to the highest voltage in the external load system. It is connected to +12V at U2 pin 1 and T1 pin 9. ULN2003 is a sinking driver, not a sourcing driver.

Please refer to the Relay7 schematic “RELAY7.SCH” (found at the end of this manual) for the following discussion.

2.1 Power Relays

The Relay7 provides seven mechanical power relays. The Normal Open, Normal Close, and Common pins of each power relay are connected to the terminal blocks (T1) with heavy traces that support at least 5A current. The relays are driven by seven solenoid drivers (U1, ULN2003) that are controlled by seven TTL control signals, REL1-7. They are routed to a 5x2-pin dual row pin header, J1. The user can drive a relay via the J1 header with an input voltage of 0V to turn the relay off, or a positive voltage ranging from +3V to +30V to turn the relay on.

For mechanical relay contact protection, you may install MOVs on the pads labeled “VARx”.

2.2 High-voltage I/Os

An additional seven high voltage drivers are installed in the U2 socket to provide seven high voltage inputs or outputs.

The 16-pin ULN2003 chip is installed in the 18-pin U2 socket. This allows you to configure the chip to operate in either input mode or output mode.

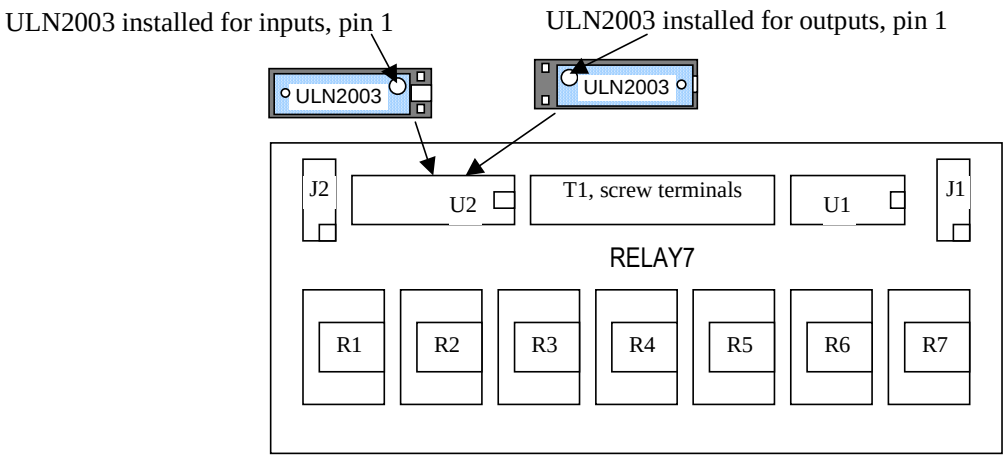


Figure 2.1 Installation of user-configurable Darlington Transistor Array in U2.

The ULN2003 is installed as a solenoid driver output by factory default. When the ULN2003 is installed as a solenoid driver output, pins 1 to 8 of the chip are next to the power relays, and the other side of the chip (pins 9 to 16) is next to the outside edge of the board, leaving pins 9 and 10 of the socket empty.

For using the ULN2003 as output, see Figure 2.2.

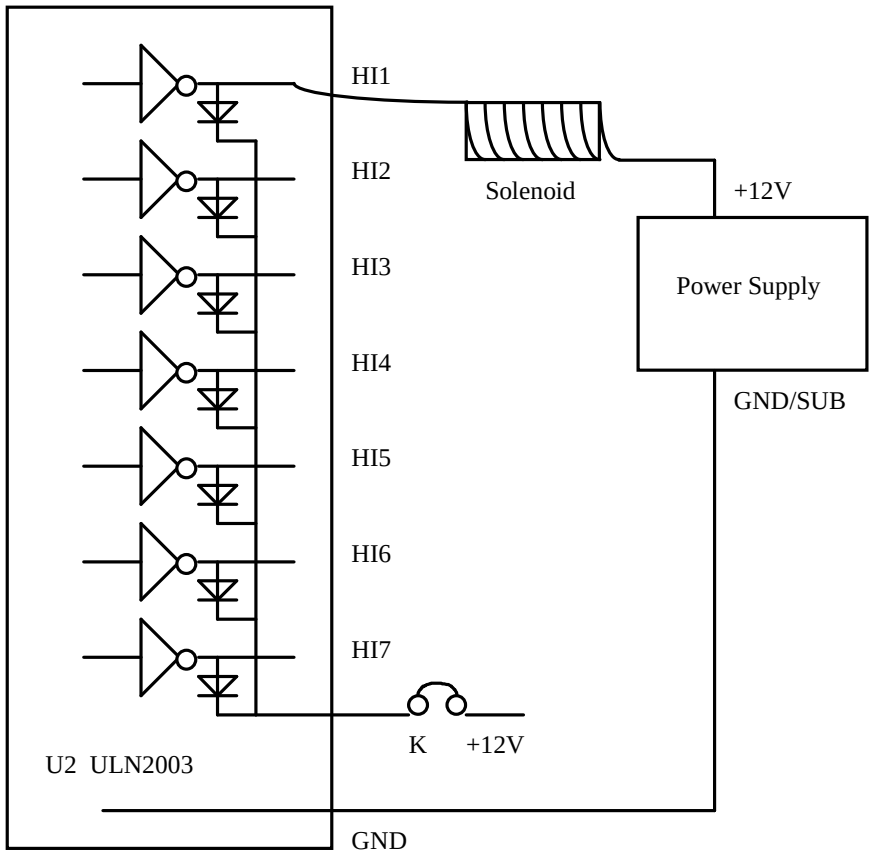


Figure 2.2 Using ULN2003 as output: drive inductive load with high voltage/current drivers

If you wish to use high voltage inputs, you must take the ULN2003 chip out of the socket, turn it 180 degrees, and line it up in the U2 socket with pins 9 and 10, thus leaving pins 1 and 18 of the U2 socket empty.

The maximum input voltage is 30V. You may install a pull-up resistor network in RN3. A valid input low voltage is less than 0.8V, and the input high voltage must be higher than 3V and less than 30V.

For using ULN2003 as input, see Figure 2.3.

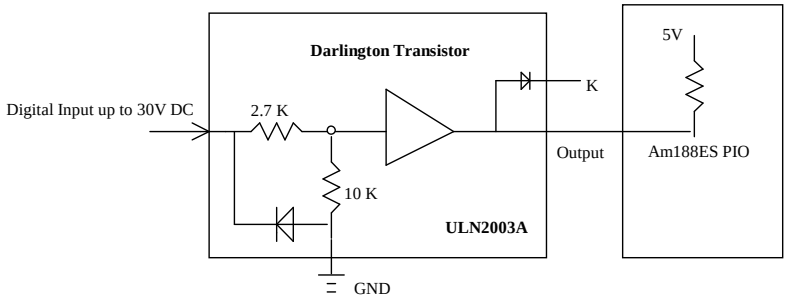
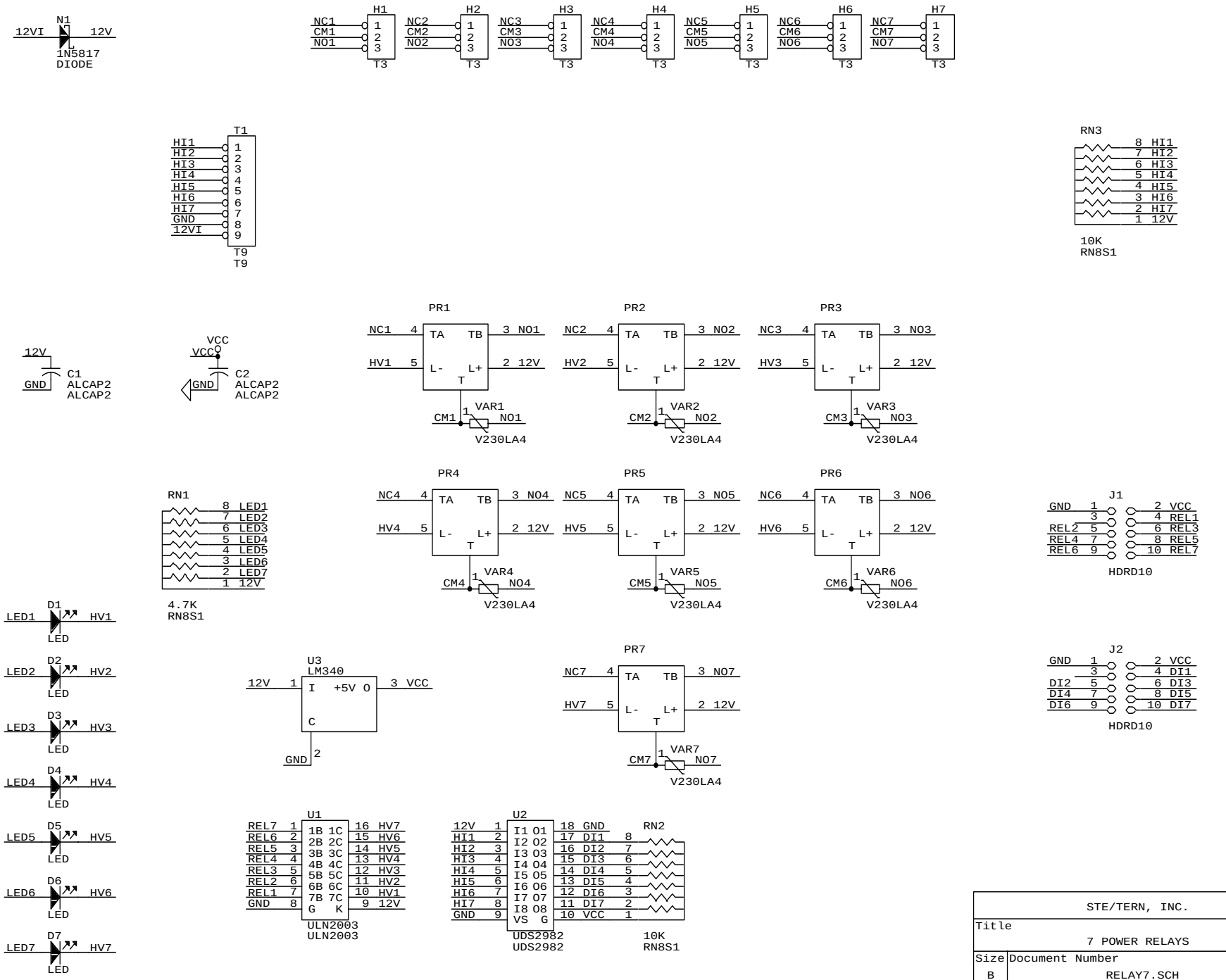


Figure 2.3 Darlington Transistors can be used as Protective High Voltage Inputs.


N1
12VI
12V
1N5817
DIODE
H1
NC1
CM1
NO1
H2
NC2
CM2
NO2
H3
NC3
CM3
NO3
H4
NC4
CM4
NO4
H5
NC5
CM5
NO5
H6
NC6
CM6
NO6
H7
NC7
CM7
NO7
T3
T1
HI1
HI2
HI3
HI4
HI5
HI6
HI7
GND
12VI
T9
RN3
8 HI1
7 HI2
6 HI3
5 HI4
4 HI5
3 HI6
2 HI7
1 12V
10K
RN8S1
12V
GND
C1
ALCAP2
VCC
C2
PR1
PR2
PR3
NC1
NC2
NC3
HV1
HV2
HV3
TA
TB
L-
L+
T
3 NO1
3 NO2
3 NO3
2 12V
CM1
CM2
CM3
VAR1
VAR2
VAR3
NO1
NO2
NO3
V230LA4
RN1
8 LED1
7 LED2
6 LED3
5 LED4
4 LED5
3 LED6
2 LED7
1 12V
4.7K
RN8S1
PR4
PR5
PR6
NC4
NC5
NC6
HV4
HV5
HV6
3 NO4
3 NO5
3 NO6
CM4
CM5
CM6
VAR4
VAR5
VAR6
NO4
NO5
NO6
J1
GND
REL2
REL4
REL6
2 VCC
4 REL1
6 REL3
8 REL5
10 REL7
HDRD10
D1
LED1
HV1
LED
D2
LED2
HV2
D3
LED3
HV3
D4
LED4
HV4
D5
LED5
HV5
D6
LED6
HV6
D7
LED7
HV7
U3
LM340
I
+5V O
C
3 VCC
PR7
NC7
HV7
3 NO7
CM7
VAR7
NO7
J2
DI2
DI4
DI6
2 VCC
4 DI1
6 DI3
8 DI5
10 DI7
U1
REL7
REL6
REL5
REL4
REL3
REL2
REL1
1B 1C
2B 2C
3B 3C
4B 4C
5B 5C
6B 6C
7B 7C
G K
16 HV7
15 HV6
14 HV5
13 HV4
12 HV3
11 HV2
10 HV1
9 12V
ULN2003
U2
I1 O1
I2 O2
I3 O3
I4 O4
I5 O5
I6 O6
I7 O7
I8 O8
VS G
18 GND
17 DI1
16 DI2
15 DI3
14 DI4
13 DI5
12 DI6
11 DI7
10 VCC
UDS2982
RN2
10K
RN8S1
STE/TERN, INC.
Title
7 POWER RELAYS
Size
B
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RELAY7.SCH
REV
Date:
August 10, 1999
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