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FAA TECHNICAL CENTER LETTER REPORT

INVESTIGATION OF PARTY LINE CONFIGURATION FOR RS-232 AND RS-422 DEVICES

by

Joseph Henley

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
TECHNICAL CENTER
Atlantic City Airport, N.J. 08405

INTRODUCTION

PURPOSE.

The purpose of this activity was to investigate the feasibility of using RS-232 devices in a party line configuration. This information would be useful in field operations of Remote Maintenance Monitoring Systems (RMMS) since it is one approach to using a single communication line to service several different devices. The utilization of such a party line configuration, as proposed with RS-232 devices, would be an efficient and innovative use of RS-232 devices beyond their present field capability.

DISCUSSION

TEST CONDUCT.

The following equipment was used in these party line configuration tests:

a. MC-1488-P Quad Line Driver. *
b. SN-75188-N Quad Line Driver. *
c. MC-1489-AN Quad Line Receiver. *
d. AM26LS30 Dual Differential Driver. **
e. AM26LS30 Quad Differential Line Receiver. **
f. Ohmite Resistors.
g. Tektronix 475 Oscilloscope

*Note: RS-232 device.
**Note: RS-422 device.

These tests involved various configurations of electronic circuitry or relays at the transmitting end of an interchange circuit (1488, 75188, or 26LS30 driver) to determine if a transmitted digital signal would be received via interconnecting cable at the terminator (1489 or 26LS32 receiver). RS-232 and RS-422 devices were tested with up to six drivers connected to one receiver. Inversely, tests were conducted with one driver to several receivers. The results in both cases, were observed on an oscilloscope. Positive results, any collected data from the test which falls within the specifications of EIA standard RS-232, will be deemed conclusively that RS-232 devices have party line data transmission capability and could have eventual use in RMMS field work. The specifications of EIA standard RS-232 define the minimum output levels of the impulses at plus and minus three volts. Therefore, the output readings from the tests will be the determining factor in concluding if RS-232 and RS-422 devices will be practical in party line configurations.

A series of fourteen tests were conducted. The first eleven tests used RS-232 devices. The last three tests used RS-422 devices. The objective of each of the tests was to determine which particular configurations would be an operable solution for a multiple communication line.

Test 1 used the configuration shown in Figure 1. The purpose of this test was to determine the effects of directly connecting RS-232 drivers to an RS-232 receiver. The data collected is shown in Table 1.

Test 2 through Test 6 followed the test designs of their respective figures. Each of these tests was conducted to determine the effects of various configurations of power supplies and grounds on RS-232 drivers two through six connected to one receiver (1489). (See Figures 2 through 6.) The data collected is shown in Tables 2 through 6.

Tests 7 through 10 used the configurations shown in Figures 7 through 10. The purpose of these tests were to determine the effects on transmission using an isolating relay or diode on the outputs of the RS-232 drivers connected to the receiver (1489). (See Figures 7 through 10). The data collected is shown in Tables 7 thru 10. (See Note 1.)

Test 11 followed the test design shown in Figure 11. The purpose of this test was to determine the effects on transmission response with one RS-232 driver connected to six receivers. The data collected is shown in Table 11.

Tests 12 and 13 used the configurations shown in Figures 12 and 13. (In Test 12 through 14 , RS-422 devices were use to compare their performance to the RS-232 devices used in Tests 1 through 11.) The purpose of these two investigations were to determine the effects of directly connecting the RS-422 drivers (AM26LS30) to the receiver (AM26LS32). (See Figures 12 and 13). The data collected is shown in Tables 12 and 13. (See Note 2.)

Test 14 used the test design shown in Figure 14. The purpose of this investigation was to determine the effects on transmission with one RS-422 driver (AM26LS30) in direct connection with six receivers with and without a termination resistance. (See Figure 14.) The collected data is shown in Table 14.

Note 1: Tests 7 through 14 have all required power supplies.

TEST RESULTS.

1. The data from Test 1 show with two or more drivers on the line at the same time that their output voltages will react to produce loading when one driver is in the high state and the others in the low state. As a result, the loading decreases the voltage in the line so that the receiver is incapable of switching. The output voltages of this test, therefore, are not within the specifications of EIA standard RS-232.

2. The data from Tests 2 through 6 indicate, without the power supplies connected, that the ground on drivers two through six reduce the source voltage of the transmitting driver, thus the output voltage is below the specifications of RS-232. When the ground is also removed (Test 3 and 4) the output voltage is within RS-232 specifications.

3. Test 7 and 8 data show that with a relay the outputs of 1488 drivers can be opened and closed on the transmitter line making the voltage in the line appear as if there is only one driver on. With Test 7 however, the problem exists that the input to the receiver goes to 0.0V when all the relays are open. The solution is shown in Test 8 by putting a termination resistance on the receiver. Based on the data, to achieve the optimum number of drivers on line, the termination resistance should be between 3K and 12K ohms.

4. Test 9 and 10 data indicates that the use of a properly biased diode on the outputs of the drivers prevents the loading of the source drivers and produces output voltages within the specifications of RS-232. (It should be noted that the input to all the inactive transmitters must be in a defined state.)

5. In Test 11 data it is seen that the output voltages are within the specifications of RS-232. However, since the receivers are connected in parallel their input impedance begins to load the line permitting a maximum of six receivers at one time.

6. Test 12 and 13 data show that six RS-422 drivers (AM26LS30) to one RS-422 receiver (AM26LS32) in direct connection produces output voltages within the specifications of EIA standard RS-422.

7. Test 14 data indicates with one RS-422 driver (AM26LS30) connected to six RS-422 receivers (AM26LS32) in parallel that the low output impedance of the driver prevents loading on the line.

DISCUSSION.

RS-232 devices are prone to loading with more than one driver on the line (See Test result 1.) By using precautionary measures, however, some signals may be received. In Test 11 data it is seen that with one driver (1488) transmission of a signal is received, but is limited to six receivers on the line. Based on the data it is evident that problems occur in transmission with several drivers to one receiver. Since the measures undertaken to utilize RS-232 devices in the field would be costly and inefficient, it was shown that devices for another standard (RS-422) could be used in the party line configuration. The RS-422 driver (AM26LS30) is a tristated device which eliminates problems of line impedance and loading so that transmission in the party line configuration is achieved with very few alterations. Because of their compatibility with this particular configuration, RS-422 devices allow for immediate installation of the devices in the line. Therefore, with a design in accordance with the specifications of EIA standard RS-422, little or no modifications are needed to run a party line configuration.

CONCLUSIONS.

1. It was found that by using multiple RS-232 drivers a signal could not be transmitted with direct connection between the drivers and receiver.

2. RS-232 devices could transmit a signal with the use of an isolating relay or diode if the number of drivers was limited to six.

3. A party line configuration works best using the differential tristated devices (RS-422) because they require few modifications to be made operable in the field, and allow more devices (drivers AM26LS30 and receivers AM26LS32) on the line.

RECOMMENDATIONS.

1. Tests should be conducted using other RS-232 and RS-422 line drivers and receivers.

2. Investigate the possibility of using tristated RS-232 line drivers in a partyline configuration, if such devices become available.

FIRST	INPUT OTHERS	NUMBER OF MC-1488 (#)	VOLTAGE IN LINE (VOLTS)	RECEIVER OUTPUT (VOLTS)
HIGH	N/A	1	-10.0v	HIGH
LOW	N/A	1	+10.0v	LOW
HIGH	HIGH	2	-10.0v	HIGH
HIGH	LOW	2	-01.0v	HIGH
LOW	HIGH	2	-01.0v	HIGH
LOW	LOW	2	+10.0v	LOW
HIGH	HIGH	3	-10.0v	HIGH
HIGH	LOW	3	+01.0v	HIGH
LOW	HIGH	3	-01.0V	HIGH
LOW	LOW	3	+10.0v	LOW

HIGH= +VCC
LOW = GROUND

TABLE 1. DATA FROM TEST 1 (SEE FIGURE 1).

NUMBER OF MC-1488 (#)	HIGH VOLTAGE (VOLTS)	LOW VOLTAGE (VOLTS)
1	+10.0v	-10.0v
2	+ 3.5v	- 3.2v
3	+ 2.0v	- 2.0v
4	+ 1.5v	- 1.7v
5	+ 1.5v	- 1.7v
6	+ 1.5v	- 1.7v

TABLE 2. DATA FROM TEST 2 (SEE FIGURE 2).

NUMBER OF MC-1488 (#)	HIGH VOLTAGE (VOLTS)	LOW VOLTAGE (VOLTS)
1	+10.0v	-10.0v
2	+10.0v	-10.0v
3	+10.0v	-10.0v
4	+10.0v	-10.0v
5	+10.0v	-10.0v
6	+10.0v	-10.0v

TABLE 3. DATA FROM TEST 3 (SEE FIGURE 3).

NUMBER OF DRIVER (#)	HIGH VOLTAGE (VOLTS)	LOW VOLTAGE (VOLTS)
1	+10.00	-10.00
2	+10.00	-10.00
3	+10.00	-10.00
4	+10.00	-10.00
5	+10.00	-10.00
6	+10.00	-10.00

TABLE 4. DATA FROM TEST 4 (SEE FIGURE 4).

NUMBER OF SN-75188 (#)	HIGH VOLTAGE (VOLTS)	LOW VOLTAGE (VOLTS)
1	+10.00	-10.00
2	+ 5.50	- 5.90
3	+ 2.40	- 3.90
4	+ 2.00	- 3.00
5	+ 1.80	- 2.40
6	+ 1.80	- 2.10

TABLE 5. DATA FROM TEST 5 (SEE FIGURE 5).

NUMBER OF SN-75188 (#)	HIGH VOLTAGE (VOLTS)	LOW VOLTAGE (VOLTS)
1	+10.00	−10.00
2	+ 9.20	− 7.20
3	+ 8.40	− 3.40
4	+ 8.30	− 2.80
5	+ 8.30	− 2.80
6	+ 8.20	− 2.20

TABLE 6. DATA FROM TEST 6 (SEE FIGURE 6).

INPUT TO 1488	RELAY POSITION	VOLTAGE IN LINE	RESISTOR TO −12v	OUTPUT OF 1489
LOW	OPEN	0.0 v	OPEN	HIGH
LOW	CLOSED	+10.0 v	OPEN	LOW
LOW	OPEN	0.0 v	OPEN	HIGH
HIGH	OPEN	0.0 v	OPEN	HIGH
HIGH	CLOSED	−10.0 v	OPEN	HIGH
HIGH	OPEN	0.0 v	OPEN	HIGH

TABLE 7. DATA FROM TEST 7 (SEE FIGURE 7).

INPUT TO 1488	RELAY POSITION	VOLTAGE IN LINE	RESISTOR TO -12v	OUTPUT OF 1489
LOW	OPEN	-6.5 v	3.6 K	HIGH
LOW	CLOSED	+6.8 v	3.6 K	LOW
LOW	OPEN	-6.5 v	3.6 K	HIGH
HIGH	OPEN	-6.2 v	3.6 K	HIGH
HIGH	CLOSED	-10.0 v	3.6 K	HIGH
HIGH	OPEN	-6.2 v	3.6 K	HIGH
LOW	OPEN	-6.0 v	4.7 K	HIGH
LOW	CLOSED	+7.0 v	4.7 K	LOW
LOW	OPEN	-6.0 v	4.7 K	HIGH
HIGH	OPEN	-6.0 v	4.7 K	HIGH
HIGH	CLOSED	-10.0 v	4.7 K	HIGH
HIGH	OPEN	-6.0 v	4.7 K	HIGH
LOW	OPEN	-4.0 v	8.2 K	HIGH
LOW	CLOSED	+9.0 v	8.2 K	LOW
LOW	OPEN	-4.0 v	8.2 K	HIGH
HIGH	OPEN	-4.0 v	8.2 K	HIGH
HIGH	CLOSED	-10.0 v	8.2 K	HIGH
HIGH	OPEN	-4.0 v	8.2 K	HIGH
LOW	OPEN	-3.0 v	12.0 K	HIGH
LOW	CLOSED	+10.0 v	12.0 K	LOW
LOW	OPEN	-3.0 v	12.0 K	HIGH
HIGH	OPEN	-3.0 v	12.0 K	HIGH
HIGH	CLOSED	-10.0 v	12.0 K	HIGH
HIGH	OPEN	-3.0 v	12.0 K	HIGH

HIGH = +VCC
LOW = GROUND

TABLE 8. DATA FROM TEST 8 (SEE FIGURE 8).

FIRST 1488 (VOLTS)	2nd thru 6th 1488 (VOLTS)	VOLTAGE IN LINE (VOLTS)	OUTPUT OF 1489 (VOLTS)	RESISTOR TIED TO POWER (VOLTS)
LOW	0.0v	+10.0v	LOW	3.6k to -12v
HIGH	0.0v	+ 9.5v	LOW	3.6k to -12v
LOW	5.0v	+ 6.0v	LOW	3.6k to -12v
HIGH	5.0v	- 7.0v	HIGH	3.6k to -12v
LOW	0.0v	+11.0v	LOW	3.6k to +12v
HIGH	0.0v	+11.0v	LOW	3.6k to +12v
LOW	5.0v	+10.0v	LOW	3.6k to +12v
HIGH	5.0v	+ 6.5v	LOW	3.6k to +12v
LOW	0.0v	+10.5v	LOW	7.5k to -12v
HIGH	0.0v	+10.5v	LOW	7.5k to -12v
LOW	5.0v	+ 8.5v	LOW	7.5k to -12v
HIGH	5.0v	- 4.5v	HIGH	7.5k to -12v
LOW	0.0v	+10.0v	LOW	7.5k to +12v
HIGH	0.0v	+10.0v	LOW	7.5k to +12v
LOW	5.0v	+ 9.5v	LOW	7.5k to +12v
HIGH	5.0v	+ 4.0v	LOW	7.5k to +12v

TABLE 9. DATA FROM TEST 9 (SEE FIGURE 9).

FIRST 1488 (VOLTS)	2nd thru 6th 1488 (VOLTS)	VOLTAGE IN LINE (VOLTS)	OUTPUT OF 1489 (VOLTS)	RESISTOR TIED TO POWER (VOLTS).
LOW	HIGH	-10.0v	HIGH	3.6k to +12v
HIGH	HIGH	-10.0v	HIGH	3.6k to +12v
LOWv	HIGH	-10.0v	HIGH	7.5k to +12v
HIGH	HIGH	-10.0v	HIGH	7.5k to +12v
LOW	LOW	+ 6.0v	LOW	3.6k to +12v
HIGH	LOW	- 7.0v	HIGH	3.6k to +12v
LOW	LOW	+ 4.0v	LOW	7.5k to +12v
HIGH	LOW	- 9.5v	HIGH	7.5k to +12v

TABLE 10. DATA FROM TEST 10 (SEE FIGURE 10).

NUMBER OF MC-1489 (#)	(SPACE) HIGH VOLTAGE (VOLTS)	(MARK) LOW VOLTAGE (VOLTS)
1	+10.0	−10.0
2	+ 9.2	− 9.2
3	+ 8.4	− 9.0
4	+ 7.0	− 8.0
5	+ 6.6	− 7.8
6	+ 4.0	− 6.8

TABLE 11. DATA FROM TEST 11 (SEE FIGURE 11).

NUMBER OF TRANSMITTERS	INPUT AM26LS30	VOLTAGE IN LINE +	VOLTAGE IN LINE -	OUTPUT AM26SL30
(#)	(VOLTS)	(VOLTS)	(VOLTS)	(VOLTS)
	HIGH	4.4v	.7v	HIGH
1	LOW	.7v	4.4v	LOW
	HIGH	4.4v	.7v	HIGH
2	LOW	.7v	4.4v	LOW
	HIGH	4.4v	.7v	HIGH
3	LOW	.7v	4.4v	LOW
	HIGH	4.4v	.7v	HIGH
4	LOW	.7v	4.4v	LOW
	HIGH	4.4v	.7v	HIGH
5	LOW	.7v	4.4v	LOW
	HIGH	4.4v	.7v	HIGH
6	LOW	.7v	4.4v	LOW

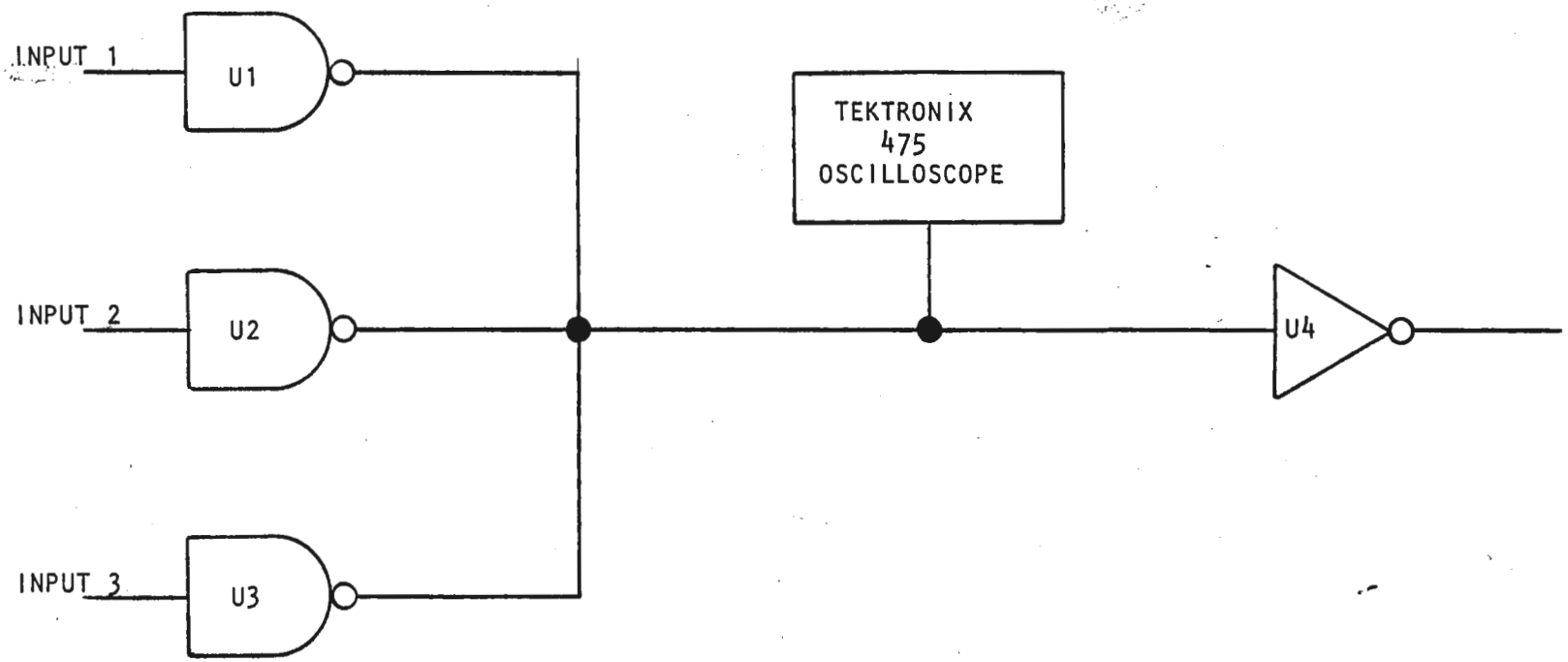
TABLE 12. DATA FROM TEST 12 (SEE FIGURE 12).

NUMBER OF TRANSMITTERS	INPUT AM26SL30	VOLTAGE IN LINE +	VOLTAGE IN LINE -	OUTPUT AM26SL32
(#)	(VOLTS)	(VOLTS)	(VOLTS)	(VOLTS)
1	HIGH	4.4v	.7v	HIGH
	LOW	.5v	3.9v	LOW
2	HIGH	4.2v	.7v	HIGH
	LOW	.6v	4.2v	LOW
3	HIGH	4.4v	.6v	HIGH
	LOW	.6v	4.4v	LOW
4	HIGH	4.4v	6v	HIGH
	LOW	.6v	4.4v	LOW
5	HIGH	4.2v	.6v	HIGH
	LOW	.6v	4.4v	LOW
6	HIGH	4.2v	6v	HIGH
	LOW	.6v	4.4v	LOW

TABLE 13. DATA FROM TEST 13 (SEE FIGURE 13)

TEST	INPUT AM26SL30 (VOLTS)	VOLTAGE IN LINE + (VOLTS)	VOLTAGE IN LINE − (VOLTS)	OUTPUT AM26SL30 (VOLTS)
(a)	HIGH	4.0v	1.2v	HIGH
	LOW	1.2v	4.0v	LOW
(b)	HIGH	4.0v	.9v	HIGH
	LOW	.9v	4.0v	LOW
(c)	HIGH	4.4v	.7v	HIGH
	LOW	.7v	4.2v	LOW

TABLE 14. DATA FROM TEST 14 (SEE FIGURE 14).



U1, U2, U3-1488
U4-1489

NOTE: U1 through U4 are connected to the required supply voltages.

Figure 1. 3 RS-232-C (MC-1488) to 1 RS-232-C Receiver (MC-1489-A) with inputs to all transmitters.

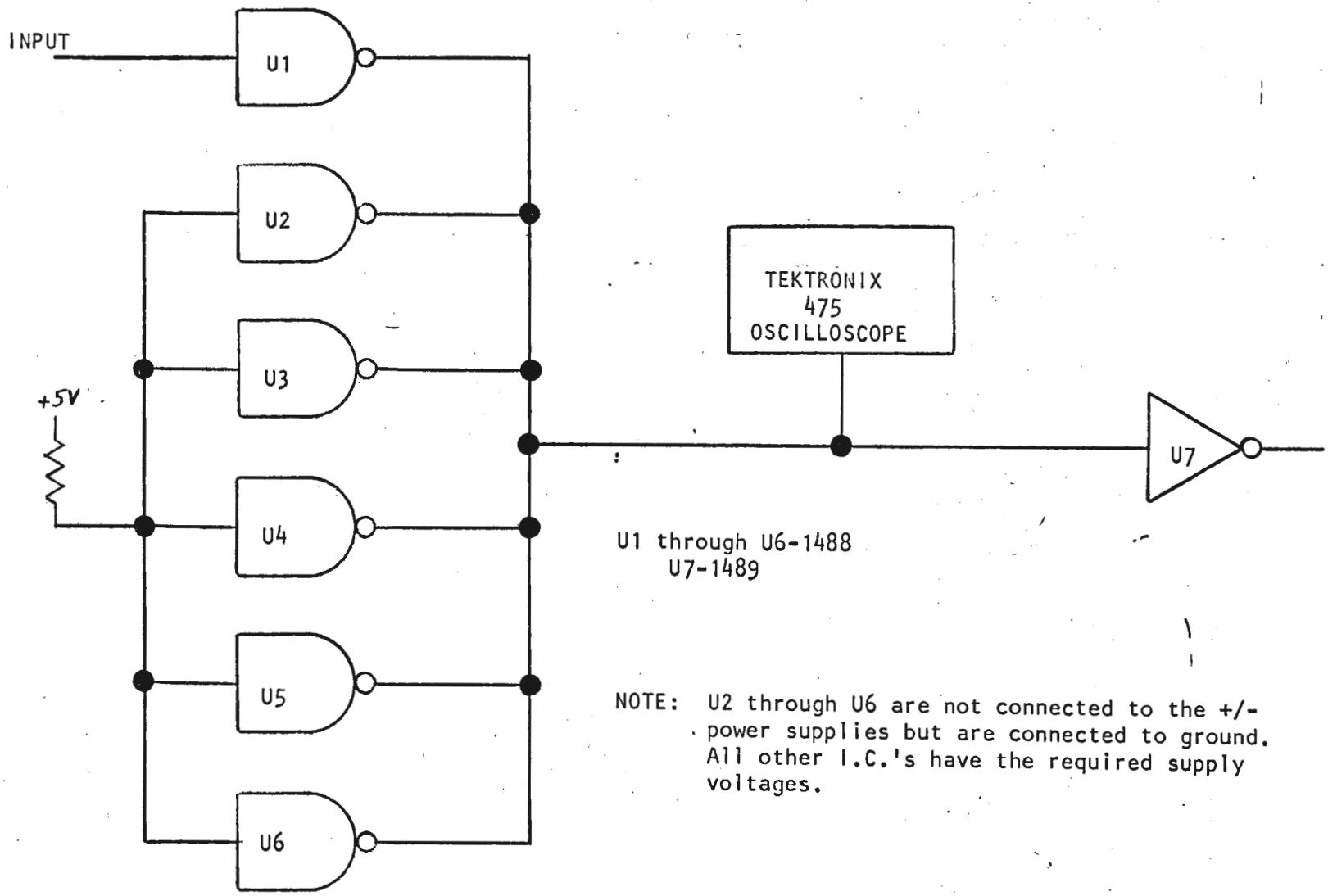


Figure 2. 6 MC-1488-P to 1 MC-1489-AN with Ground.

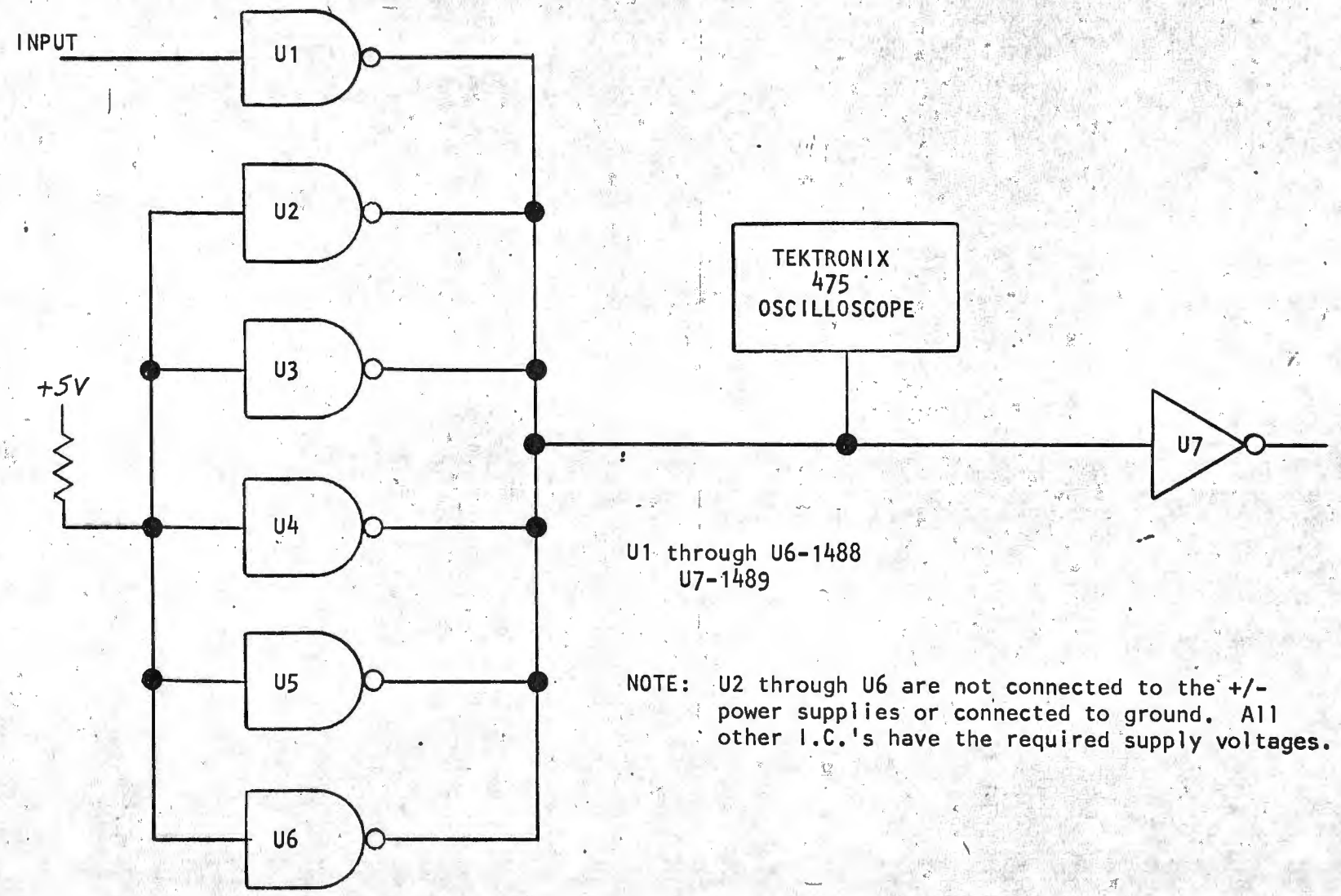


Figure 3. 6 MC-1488 to 1 MC-1489-AN without ground.

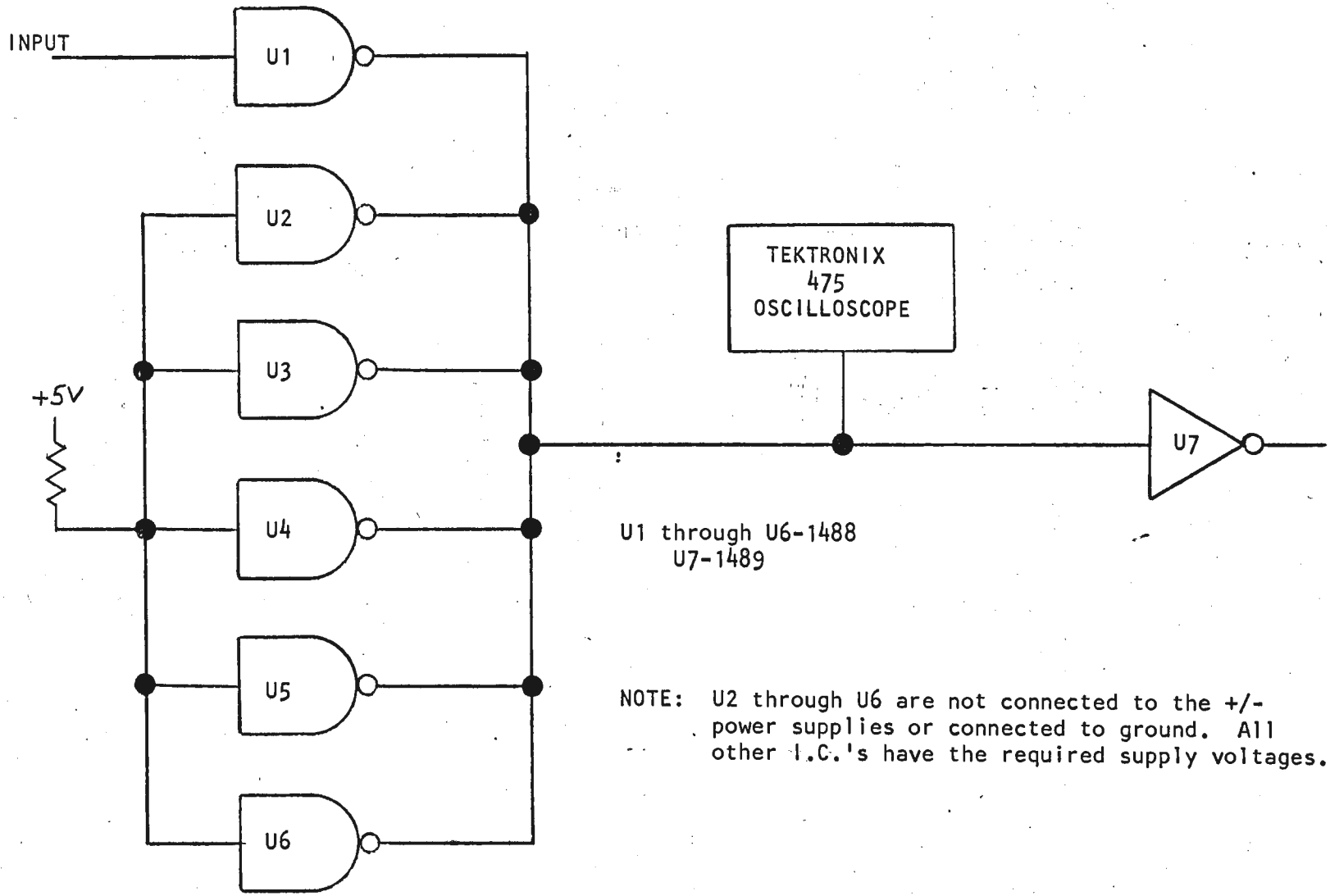


Figure 4. 6 SN75188N to 1 MC-1489-AN without ground.

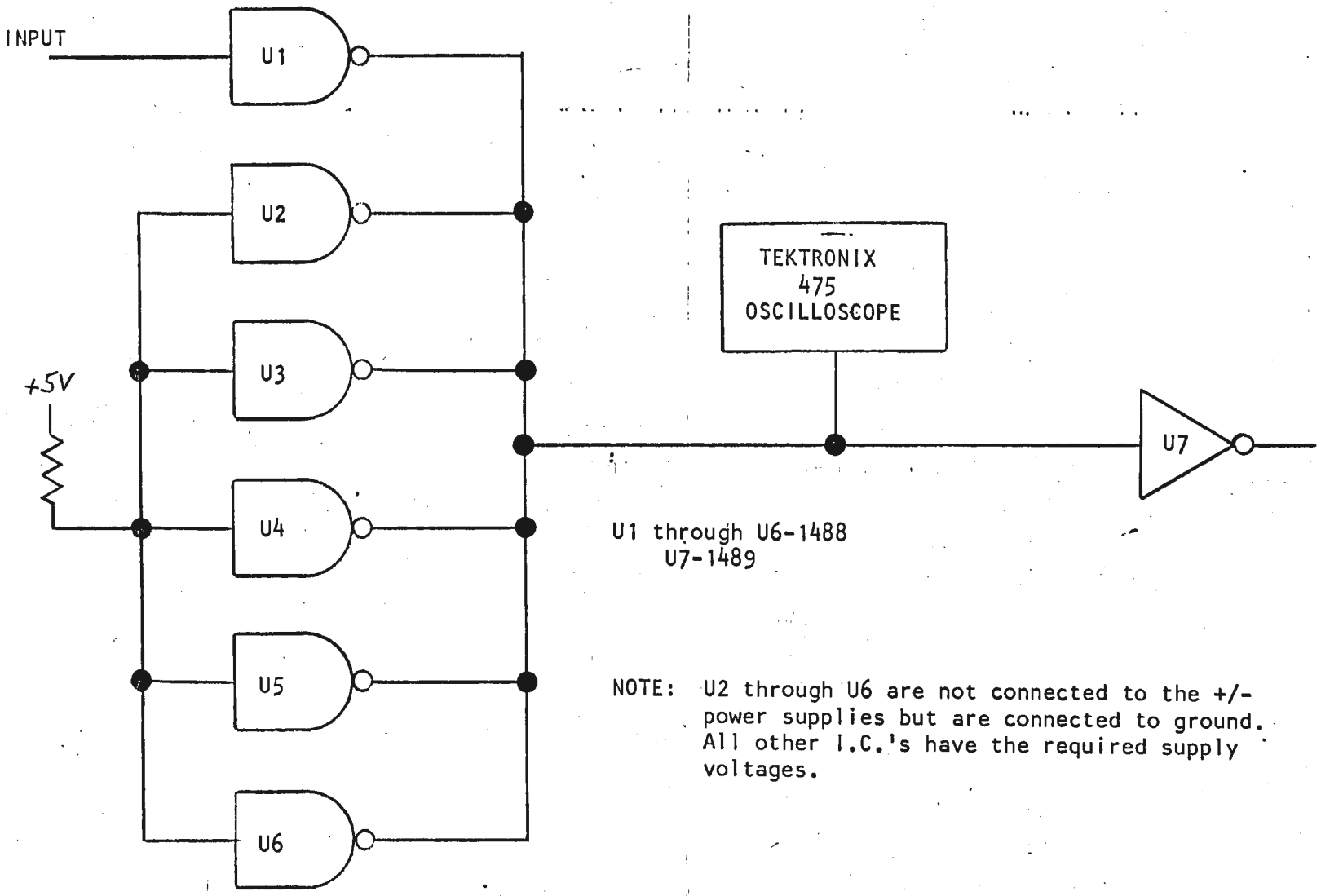


Figure 5. 6 SN-75188-N to 1 MC-1489 with ground.

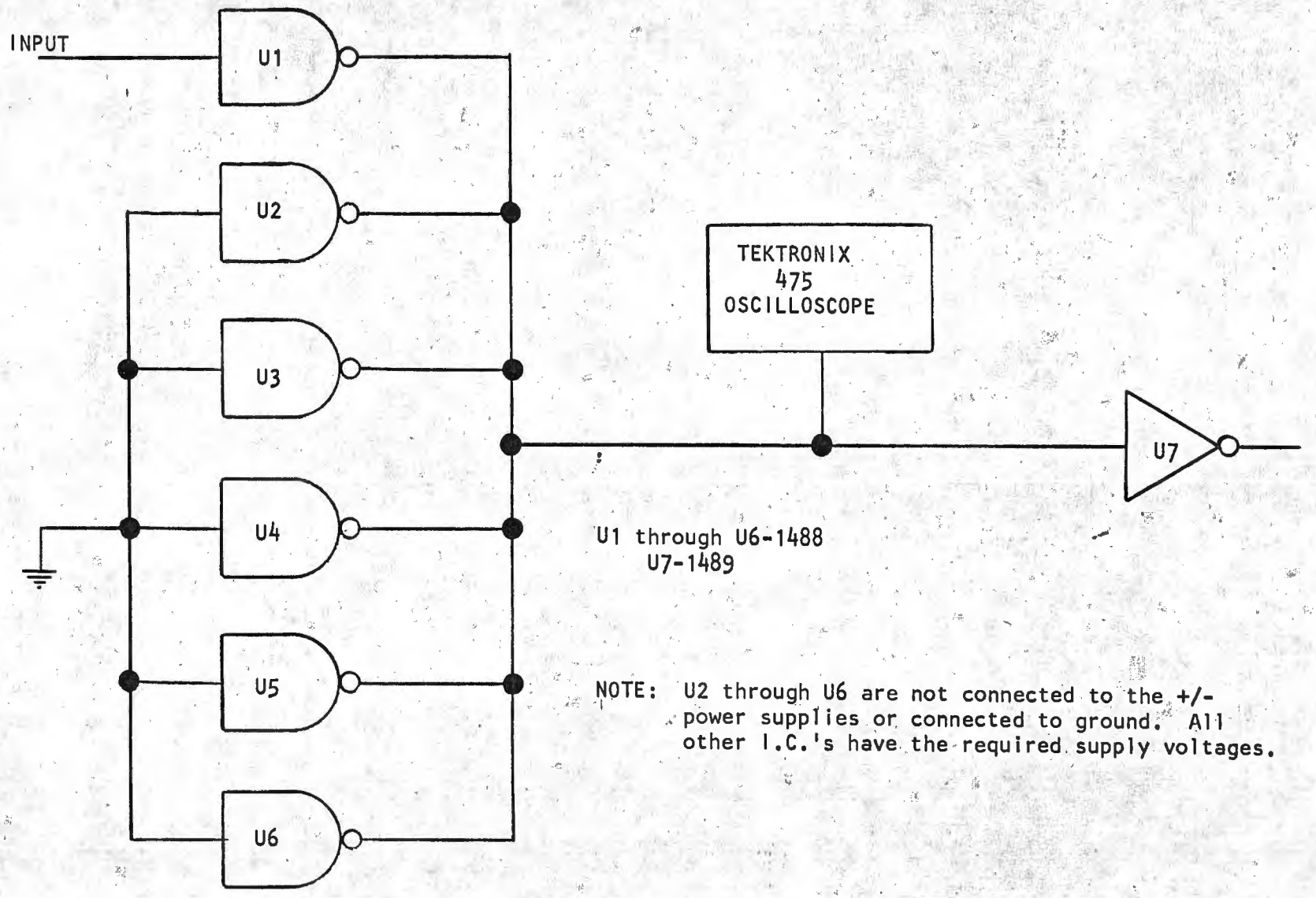


Figure 6. 6 SN75188-N to 1 MC-1489-AN without ground and data grounded.

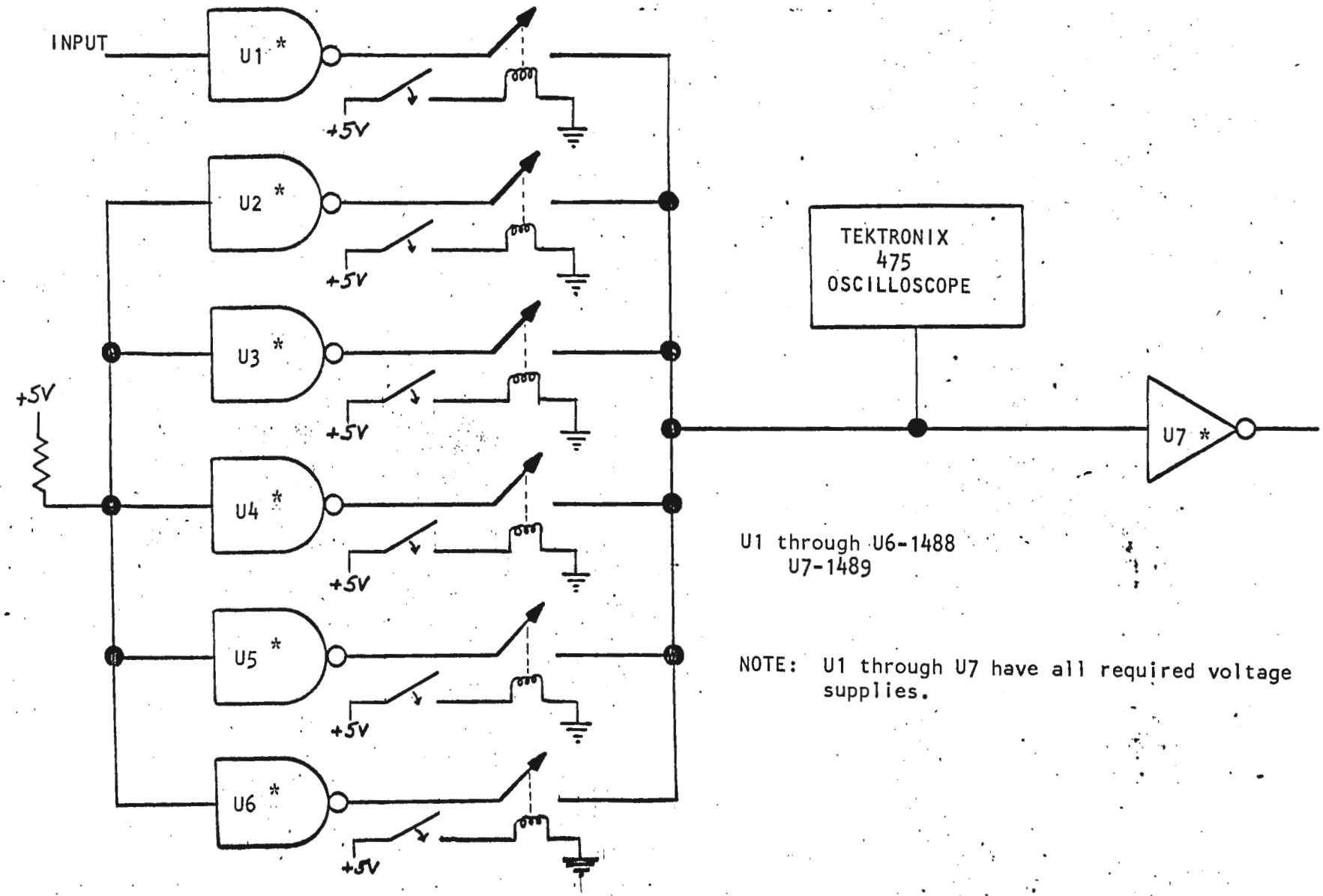
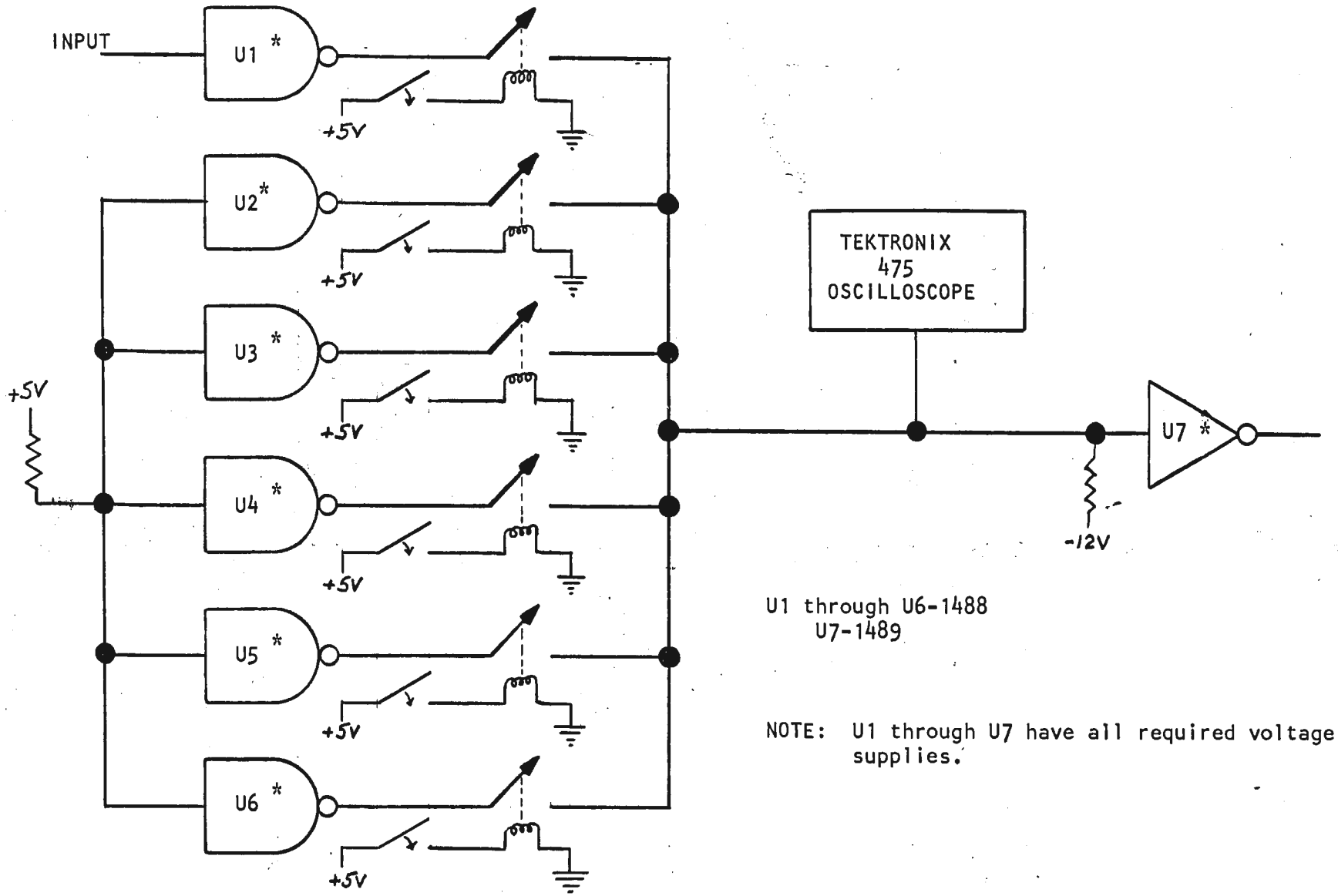


Figure 7. 6 MC-1488 with relays to 1 MC-1489 without termination resistance.



Fugure 8. 6 MC-1488 with relays to 1 MC-1489 with termination resistance of 3.6K, 4K, 7K, 8.2K, and 12K.

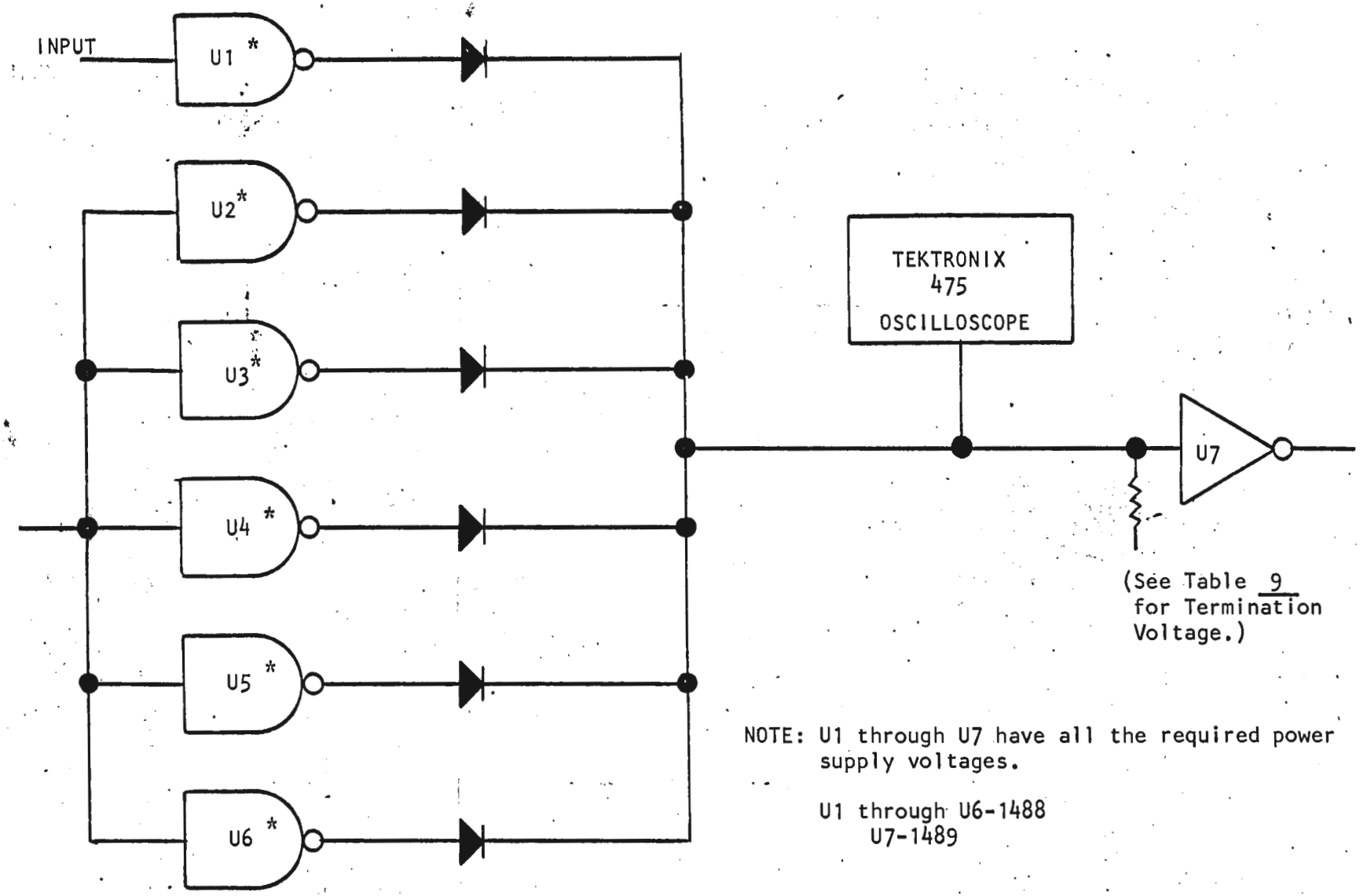


Figure 9. 6 MC-1488-D with a diode to 1 MC-1489-AN with termination resistances of 3.K and 7.5K.

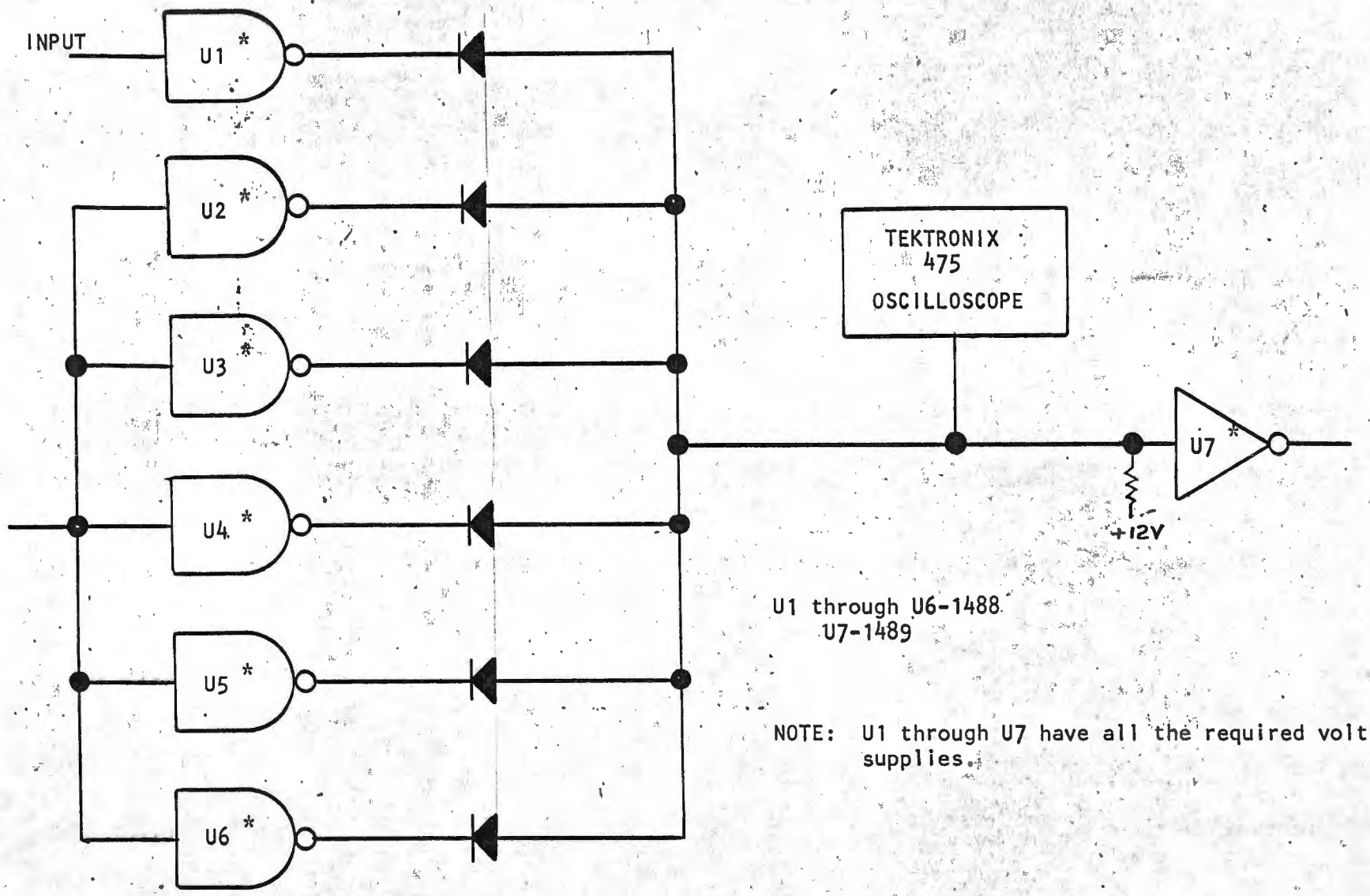


Figure 10. 6 MC-1488 with a diode reversed to 1 MC-1489 with pull-up resistances of 3.6K and 7.5K ohms.

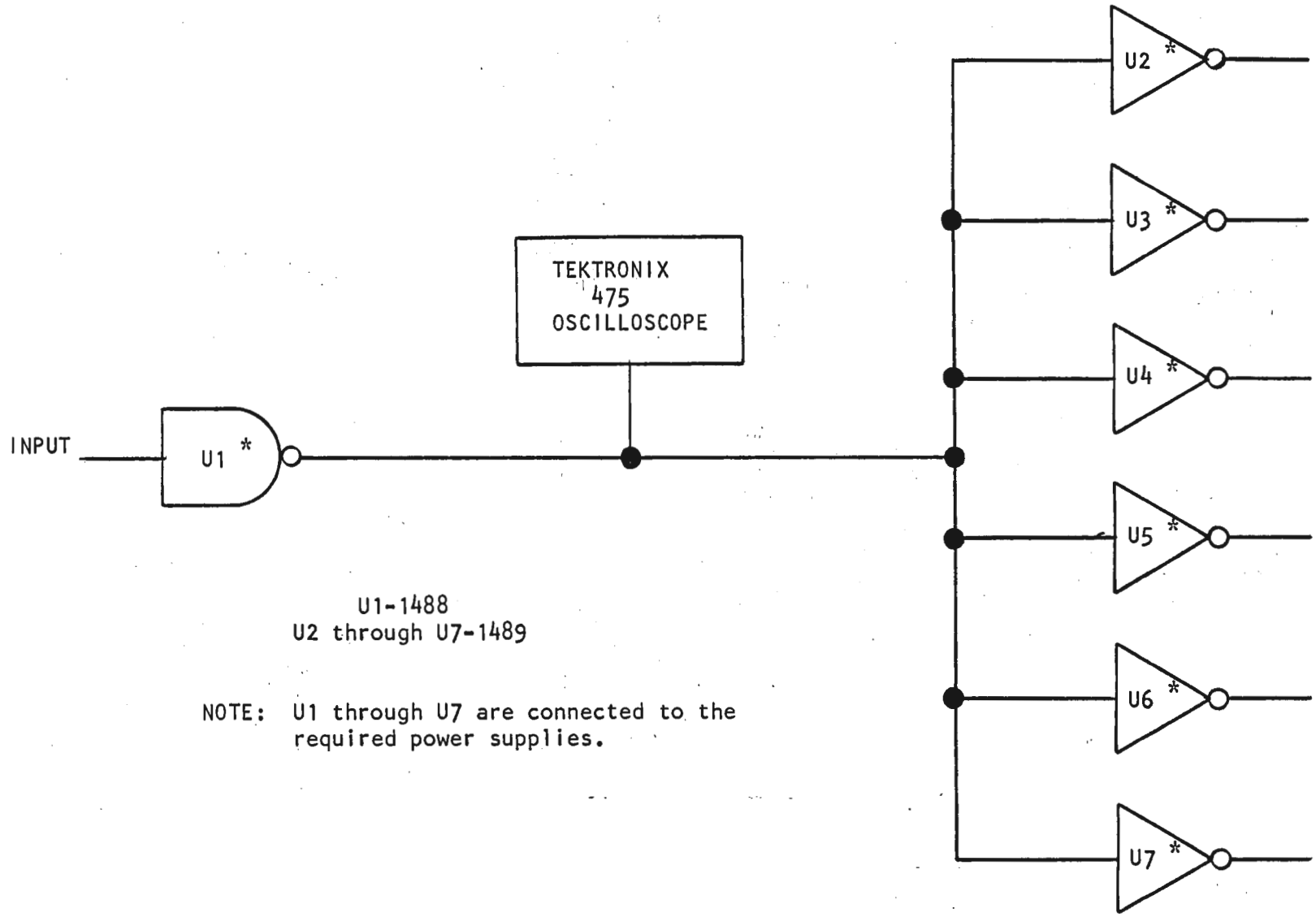


Figure 11. 1 MC-1488-P to 6 MC-1489-AN with ground and +5.0 volts (+VCC).

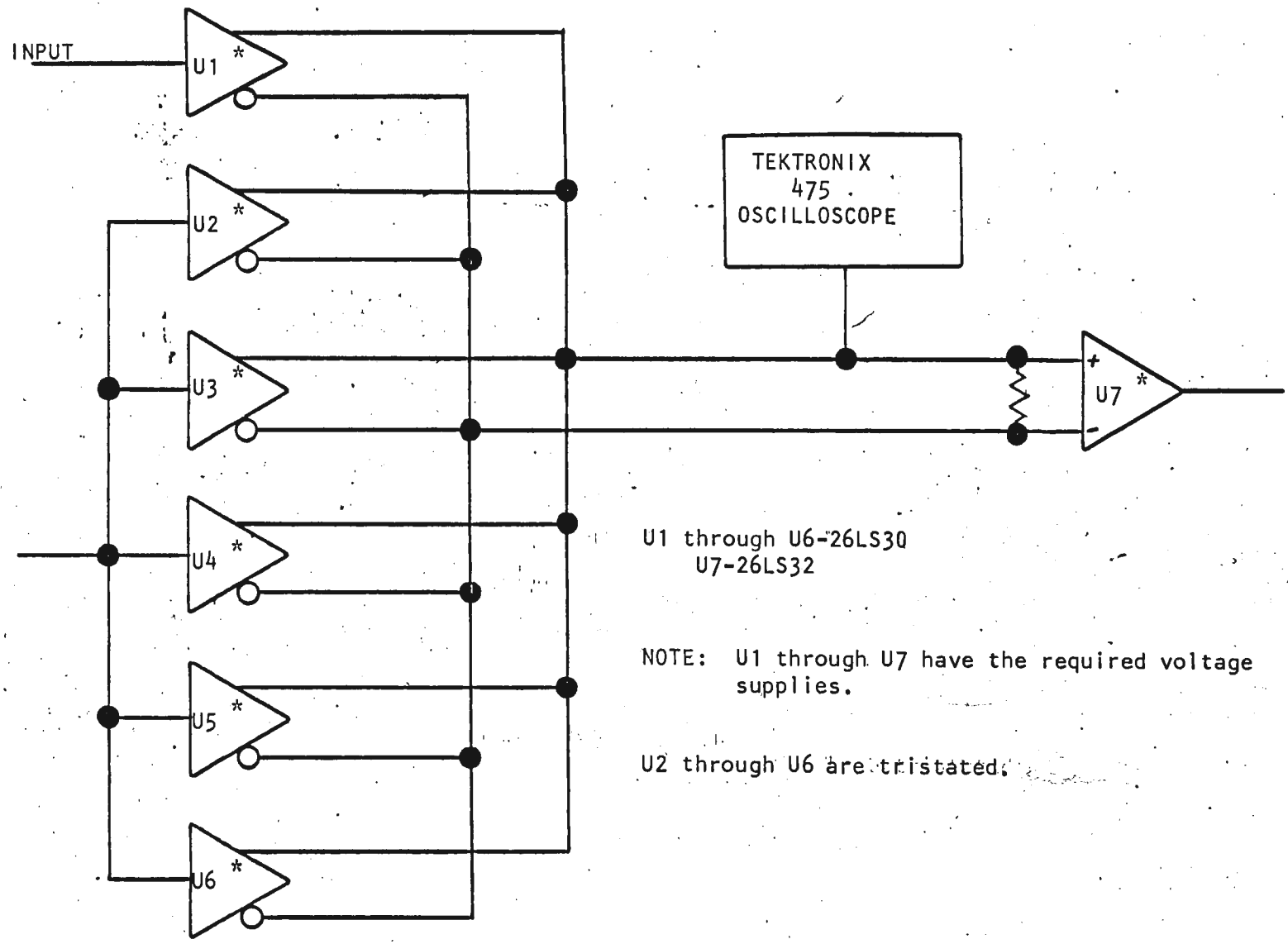


Figure 12. 6 AM26LS30 to 1 AM26LS32 with a termination resistance of 120 ohms.

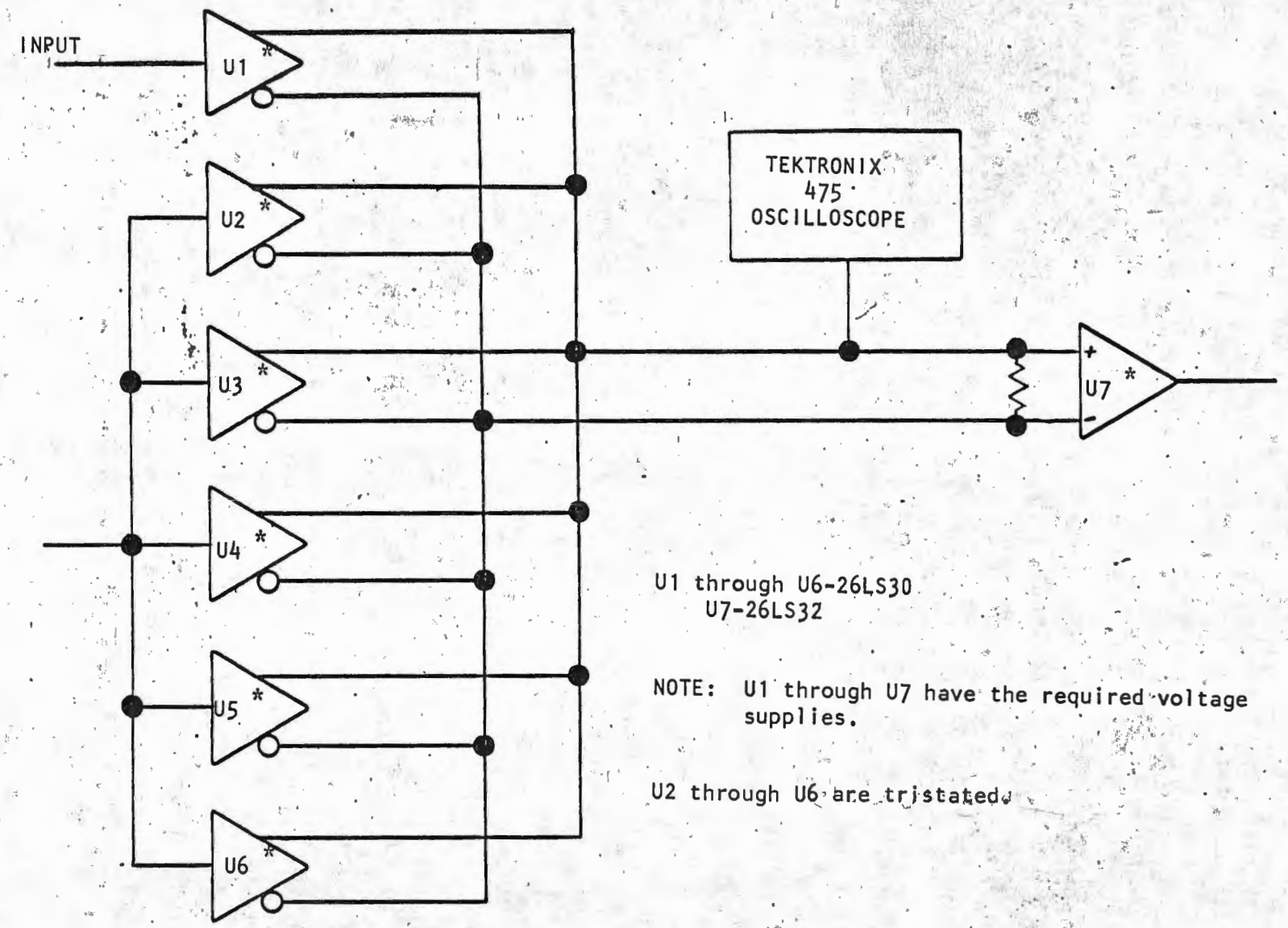


Figure 13. 6 AM26LS30 to 1 AM26LS32 with a termination resistance of 240 ohms.

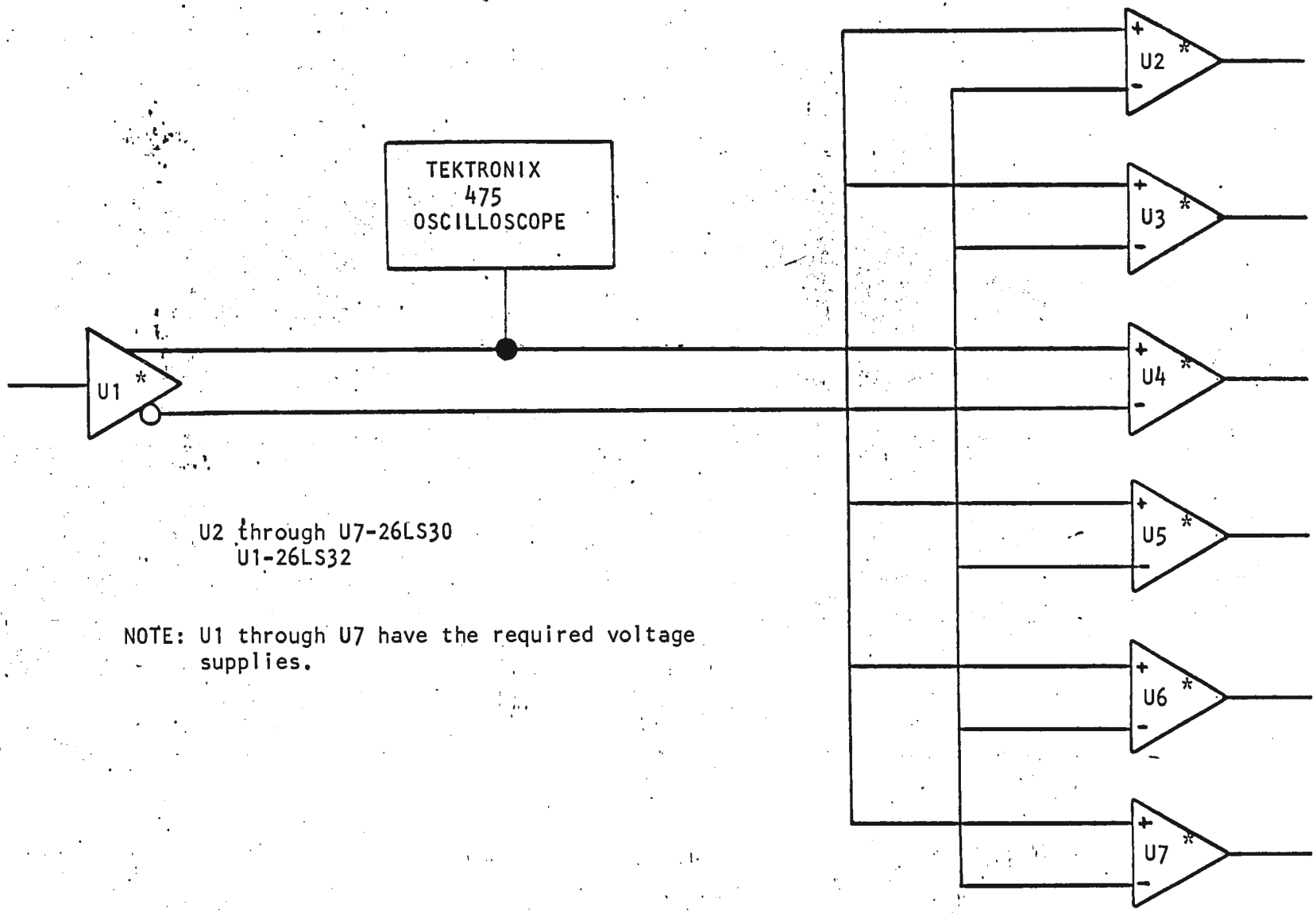


Figure 14a. 1 AM26LS30 to 6 AM26LS32 without termination resistance.

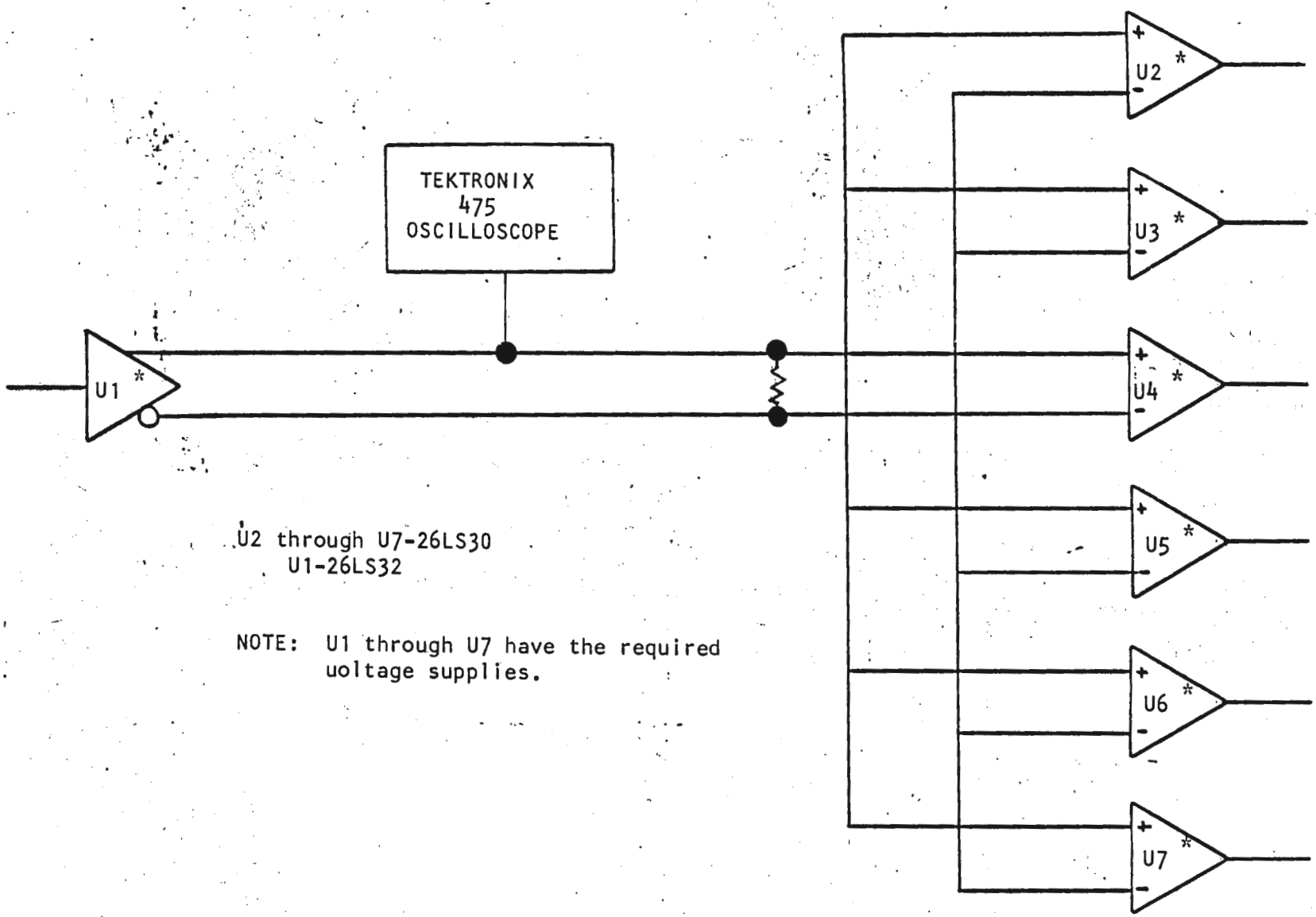


Figure 14b) & c). 1 AM26LS30 to 6 AM26LS32 with termination resistances of 120 and 240 ohms.