BCD/Decimal Decoders/Drivers

General Description

The DM5441A/DM7441A is a BCD-to-decimal decoder designed to drive gas-filled NIXIE tubes. The device is also capable of driving other types of low-current lamps and relays.

An over-range decoding feature provides that if binary numbers between 10 and 15 are applied to the input, the least significant bit (0-5) will be decoded on the output.

The DM54141/DM74141 is a BCD-to-decimal decoder designed specifically to drive cold-cathode indicator tubes.

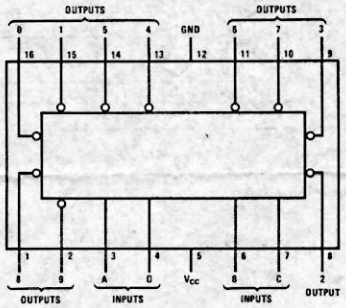
Full decoding is provided for all possible input states. For binary inputs 10 through 15, all the outputs are off. Therefore the DM54141/DM74141, combined with a minimum of external circuitry, can use these invalid codes in blanking leading- and/or trailing-edge zeros in a display.

Input clamp diodes are also provided to clamp negative-voltage transitions in order to minimize transmission-line effects.

Features

- Drive cold-cathode, numeric indicator tubes directly
- Fully decoded inputs
- Low leakage current
  - DM54/7441A 1.8μA @ 50V
  - DM54/74141 50μA @ 55V
- Low power dissipation
  - DM54/7441A 105 mW typical
  - DM54/74141 55 mW typical

Connection Diagram



5441A(J), (W); 7441A(J), (N), (W);
54141(J), (W); 74141(J), (N), (W)

Truth Tables

5441A/7441A

INPUT				OUTPUT
D	C	B	A	ON*
L	L	L	L	0
L	L	L	H	1
L	L	H	L	2
L	L	H	H	3
L	H	L	L	4
L	H	L	H	5
L	H	H	L	6
L	H	H	H	7
H	L	L	L	8
H	L	L	H	9
(OVER RANGE)				
H	L	H	L	0
H	L	H	H	1
H	H	L	L	2
H	H	L	H	3
H	H	H	L	4
H	H	H	H	5

54141/74141

INPUT				OUTPUT
D	C	B	A	ON*
L	L	L	L	0
L	L	L	H	1
L	L	H	L	2
L	L	H	H	3
L	H	L	L	4
L	H	L	H	5
L	H	H	L	6
L	H	H	H	7
H	L	L	L	8
H	L	L	H	9
(OVER RANGE)				
H	L	H	L	NONE
H	L	H	H	NONE
H	H	L	L	NONE
H	H	L	H	NONE
H	H	H	L	NONE
H	H	H	H	NONE

H = High Level, L = Low Level

*All other outputs are off

Electrical Characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		CONDITIONS			DM54/74 41A MIN	DM54/74 41A TYP(1)	DM54/74 41A MAX	DM54/74 141 MIN	DM54/74 141 TYP(1)	DM54/74 141 MAX	UNITS
V_{IH}	High Level Input Voltage				2			2			V
V_{IL}	Low Level Input Voltage						0.8			0.8	V
V_I	Input Clamp Voltage	V_{CC} = Min, I_I = −12 mA					N/A			−1.5	V
V_{OL}	On-State Output Voltage	V_{CC} = Min, I_O = 7 mA		−55°C to +70°C			2.5			2.5	V
				125°C			3.0			3.0	
I_{OH}	Off-State Reverse Current	V_{CC} = Max	V_O = 50V	T_A = 125°C			60				μA
				T_A = 70°C			40				
				T_A = −55°C, 0°C, 25°C			1.8				
			V_O = 55V							50	
I_{OH}	Off-State Reverse Current for Input Counts 10-15	V_{CC} = Max, V_O = 30V		T_A = 55°C			N/A			5	μA
				T_A = 70°C			N/A			15	
V_{OH}	Off-State Output Voltage	V_{CC} = Max	I_O = 0.5 mA					60			V
			I_O = 1.0 mA		70						
I_I	Input Current at Maximum Input Voltage	V_{CC} = Max, V_I = 5.5V					1			1.0	mA
I_{IH}	High Level Input Current	V_{CC} = Max, V_I = 2.4V		A Input		3	40			40	μA
				B, C, or D Input		3	40			80	
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.4V		A Input		−1.0	−1.6			−1.6	mA
				B, C, or D Input		−1.0	−1.6			−3.2	
I_{CC}	Supply Current	V_{CC} = Max(2)				21	36		11	25	mA

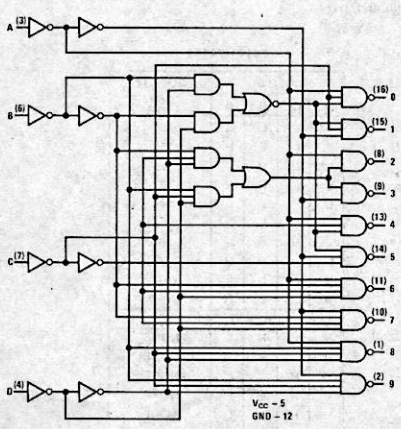
Notes

(1) All typical values are at V_{CC} = 5V, T_A = 25°C.

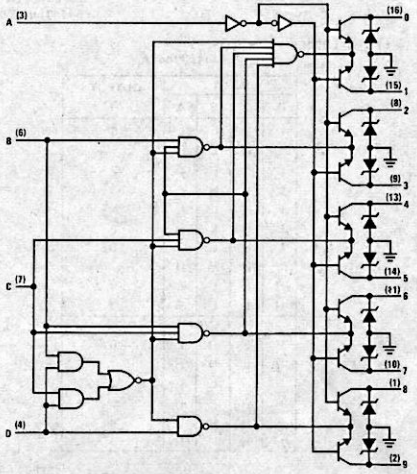
(2) I_{CC} is measured with all inputs grounded and outputs open.

Logic Diagrams

5441A/7441A



54141/74141

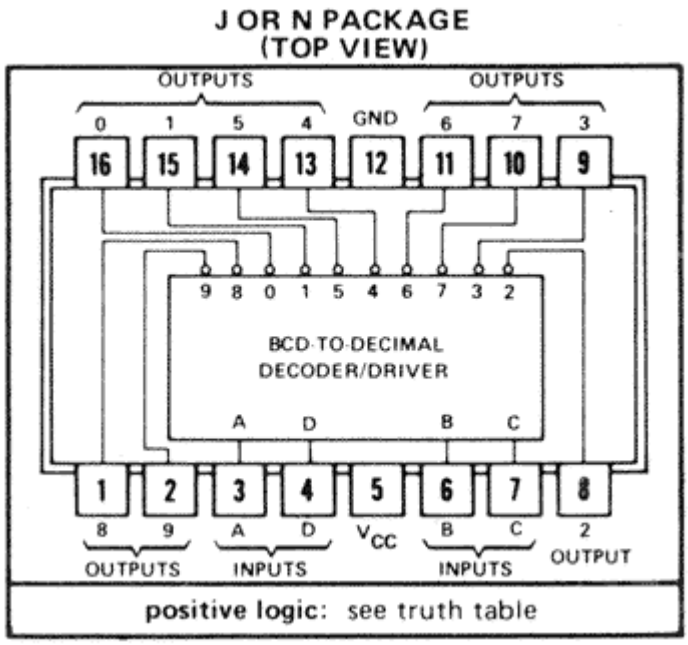


Nixie Tube Drivers:

74141 Decoder IC:
The 74141 BCD to decimal decoder and Nixie driver IC is still in production; and is manufactured* by NTE Electronics (http://www.nteinc.com/)(part no. NTE74141), and marketed by Mouser Electronics. (http://www.mouser.com/)

(* The 'manufacturing' process has been noted by some observers to involve erasing the markings on NOS Texas chips and re-marking them as new parts).

SN74141 Data:
· Drives gas-filled cold-cathode indicator tubes directly.
· Fully decoded inputs ensure all outputs are off for invalid codes.
· Input clamping diodes minimise transmission-line effects.



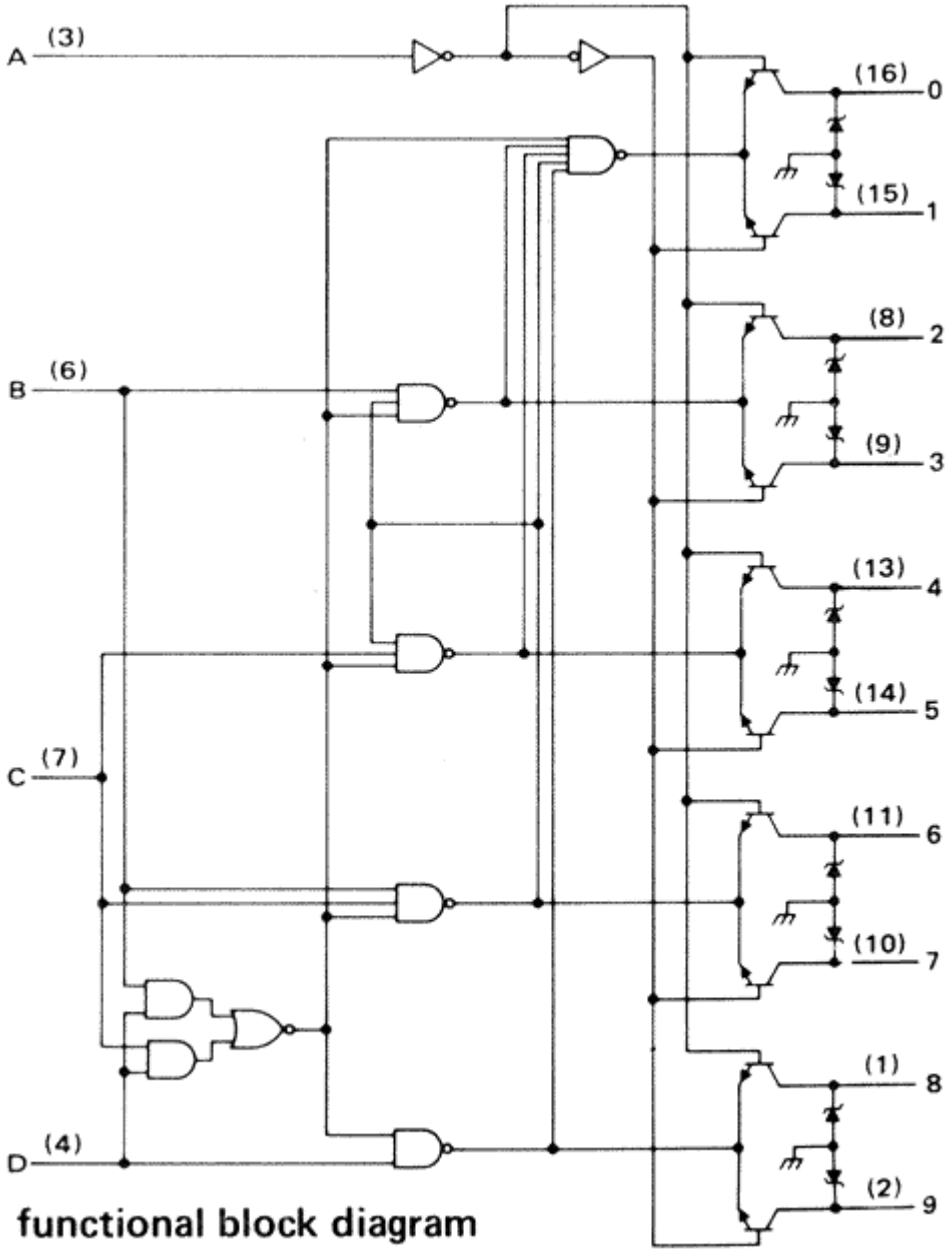
Full decoding is provided for all possible input states. For hexadecimal inputs A - F, all the outputs are off. Therefore, the 74141 can use these invalid codes to blank leading or trailing zeros in a display.

The high-voltage NPN output transistors have a maximum leakage current of 50μA at 55V.
Power dissipation: 80mW typ.

Truth Table

Input				Output on
D	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	none
1	0	1	1	none
1	1	0	0	none
1	1	0	1	none
1	1	1	0	none
1	1	1	1	none

Equivalent Circuit:



functional block diagram

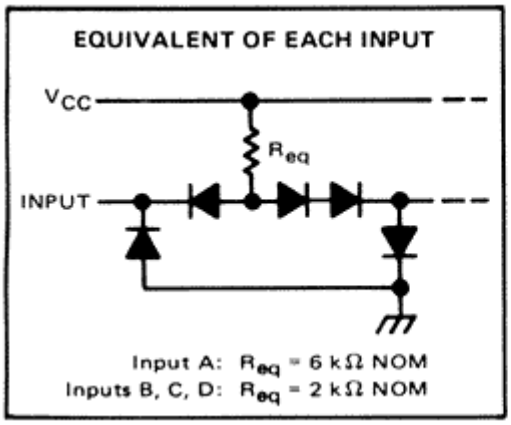
Absolute maximum ratings over operating free-air temperature range:

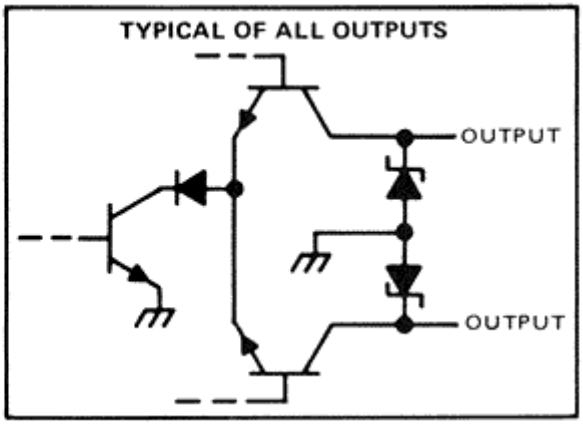
Supply Voltage V_{CC}	7 V
Input voltage	5.5 V
Current into any output (off state)	2 mA
Operating free-air temp. range	0°C to 70°C
Storage temp. range	-65°C to 150°C

Recommended operating conditions:	Min	Nom	Max	Unit
Supply Voltage V_{CC}	4.75	5	5.25	V
Off-state output voltage			60	V
Free-air temp T_A	0		70	°C

Electrical characteristics over recommended operating free-air temp. range:

Parameter		Test Conditions		Min	Typ	Max
V_{IH} High-level input Voltage				2		
V_{IL} Low-level input voltage						0.8
V_{IK} Input clamp voltage		V_{CC} = 4.75, I_I = -5mA				-1.5
$V_{o(on)}$ On-state output voltage		V_{CC} = 4.75, I_o = 7mA				2.5
$V_{o(off)}$ Off-state output voltage for input counts 0 - 9		V_{CC} = 5.25, I_o = 0.5mA		60		
$I_{o(off)}$ Off-state reverse current		V_{CC} = 5.25, V_o = 55V				50
$I_{o(off)}$ Off state reverse current for input counts (hexadecimal) A - F		V_{CC} = 5.25 V_o = 30V	T_A = 55°C			5
			T_A = 70°C			15
I_I Input current at max. input voltage		V_{CC} = 5.25, V_I = 5.5V				1
I_{IH} High-level input current	Input A	V_{CC} = 5.25, V_I = 2.4V				40
	Input B,C,D					80
I_{IL} Low-level input current	Input A	V_{CC} = 5.25, V_I = 0.4V				-1.6
	Input B,C,D					-3.2
I_{CC} Supply Current (all inputs grounded and outputs open).		V_{CC} = 5V, T_A = 25°C			16	
		V_{CC} = 5.25				25





Note on the SN7441:

In equipment manufactured prior to about 1970, you may come across Nixie tubes driven by the 7441 IC. The 7441 is the original BCD to Decimal decoder / driver offered by TI. It differs from the 74141 in that the input signals are not fully decoded, ie., it will output nonsense (several cathodes on at once if I recall rightly) on reciept of Hex inputs A - F. This was found to be a pain when using digital counters in conjunction with valve oscillators (because BCD counters often contain invalid counts at switch-on and don't get corrected until the oscillator starts), and the device was quickly superceded by the 74141. The 7441 is pin compatible with the 74141 and can be replaced by it, provided that the original circuit designer hasn'd done something clever (ie., stupid) involving the invalid codes.