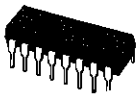
LIQUID-CRYSTAL DISPLAY DRIVERS

40544-SEGMENT DISPLAY DRIVER - STROBED LATCH FUNCTION

4055 BCD TO 7-SEGMENT DECODER/DRIVER, WITH "DISPLAY-FREQUENCY" OUTPUT

4056 BCD TO 7-SEGMENT DECODER/DRIVER WITH STROBED LATCH FUNCTION



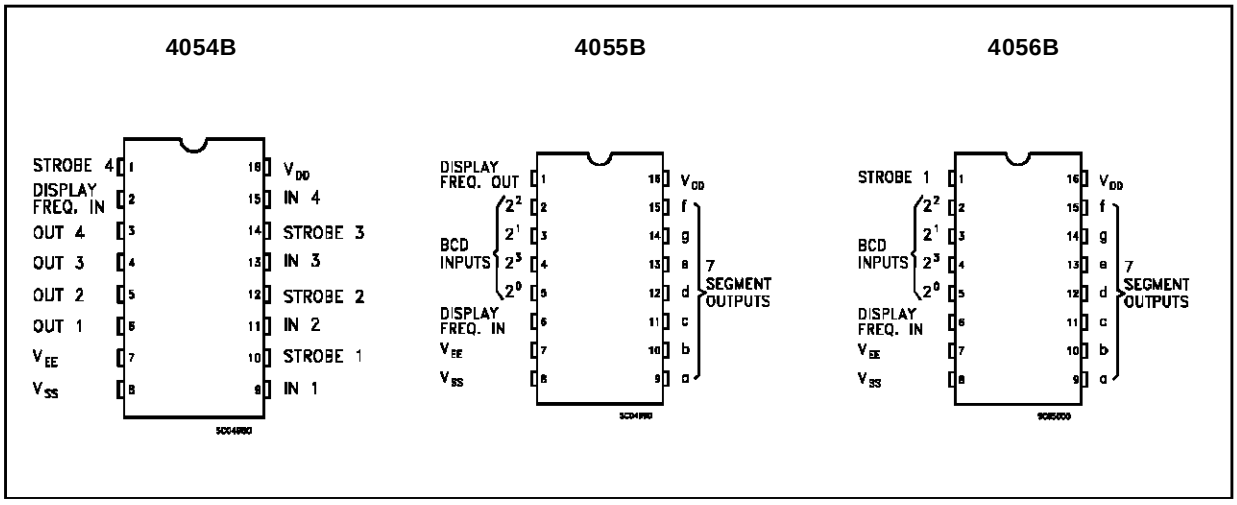
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- OPERATION OF LIQUID CRYSTALS WITH COS/MOS CIRCUITS PROVIDES ULTRA-LOW-POWER DISPLAYS
- EQUIVALENT AC OUTPUT DRIVE FOR LIQUID-CRYSTAL DISPLAYS-NO EXTERNAL CAPACITOR REQUIRED
- VOLTAGE DOUBLING ACROSS DISPLAY [(V_{DD} – V_{EE}) = 18V)] RESULTS IN EFFECTIVE 36V (p-p) DRIVE ACROSS SELECTED DISPLAY SEGMENTS
- LOW-OR HIGH-OUTPUT LEVEL DC DRIVE FOR OTHER TYPES OF DISPLAYS
- ON-CHIP LOGIC-LEVEL CONVERSION FOR DIFFERENT INPUT AND OUTPUT-LEVEL SWINGS
- FULL DECODING OF ALL INPUT COMBINATIONS : "0 – 9, L, H, P, A– " AND BLANK POSITIONS
- INPUT CURRENT OF 100nA AT 18V AND 25°C FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD N°. 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

DESCRIPTION

The **CC4054** , **CC4055** and **CC4056** (extended temperature range) and the **CC4054, CC4055** and **CC4056** (intermediate temperature range) are monolithic integrated circuits available in 16-lead dual in-line plastic or ceramic package and plastic micro package. The **CC4055** and **CC4056** types are single-digit BCD-to-7-segment decoder/driver circuits that provide level-shifting functions on the chip. This feature permits the BCD input-signal swings (V_{DD} to V_{SS}) to be the same as or different from the 7-segment output-signal swings (V_{DD} to V_{EE}). For example, the BCD input-signal swings (V_{DD} to V_{SS}) may be as low as 0 to – 3V, whereas the output-display drive-signal swing (V_{DD} to V_{EE}) may be from 0 to – 5V. If V_{DD} to V_{EE} exceeds 15V, V_{DD} to V_{SS} should be at least 4V. The 7-segment outputs are controlled by the DISPLAY-FREQUENCY (DF) input which causes the selected segment outputs to be low, high, or a square-wave output (for liquid-crystal displays). When the DF input is low the output segments will be high when selected by the BCD inputs. When the DF input is high, the output segments will be low when selected by the BCD inputs. When a square-wave is present at the DF input, the selected segments will have a square-wave output that is 180° out of phase with the DF input. Those segments which are not selected will have a square-wave output that is in phase with the input. DF square-wave repetition rates for liquid-crystal displays usually range from 30Hz (well above flicker rate) to 200Hz (well below the upper limit of the liquid-crystal frequency response). The **CC4055** provides a level-shifted high-amplitude DF output which is required for driving the common electrode in liquid-crystal displays. The **CC4056** provides a strobed-latch function at the BCD inputs. Decoding of all input combinations on the **CC4055** and **CC4056** provides displays of 0 to 9 as well

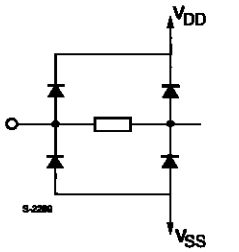
as L, P, H, A,– , and a blank position. (see typical application for other letters). The **CC4054** provides level shifting similar to the **CC4055** and **CC4056** independently strobed latches, and common DF control on 4 signal lines. The **CC4054** is intended to provide drive-signal compatibility with the **CC4055** and **CC4056** 7-segment decoder types for the decimal point, colon, polarity, and similar display lines. A level-shifted high-amplitude DF output can be obtained from any **CC4054** output line by connecting the corresponding input and strobe lines to a low and high level, respectively. The **CC4054** may also be utilized for logic-level "up conversion" or "down conversion". For example, input-signal swings (V_{DD} to V_{SS}) from + 5 to 0V can be converted to output-signal swings (V_{DD} to V_{EE}) of + 5 to – 5V. The level-shifted function on all three types permits the use of different input-and output-signal swings. The input swings from a low level of V_{SS} to a high level of V_{DD} while the output swings from a low level of V_{EE} to the same high level of V_{DD}. Thus, the input and output swings can be selected independently of each other over a 3-to-18V range. V_{SS} may be connected to V_{EE} when no level-shift function is required. For the **CC4054** and **CC4056** , data are transferred from input to output by placing a high voltage level at the strobe input. A low voltage level at the strobe input latches the data input and the corresponding output segments remain selected (or non-selected) while the strobe is low. Whenever the level-shifting function is required, the **CC4055** can be used by itself to drive a liquid-crystal display (fig. 10 and fig. 12). The **CC4056** , however, must be used together with a **CC4054** to provide the common DF output (fig. 14). The capability of extending the voltage swing on the negative end (this voltage cannot be extended on the positive end) can be used to advantage in the set-up of fig. 11. Fig. 9 is common to all three types.

PIN CONNECTIONS

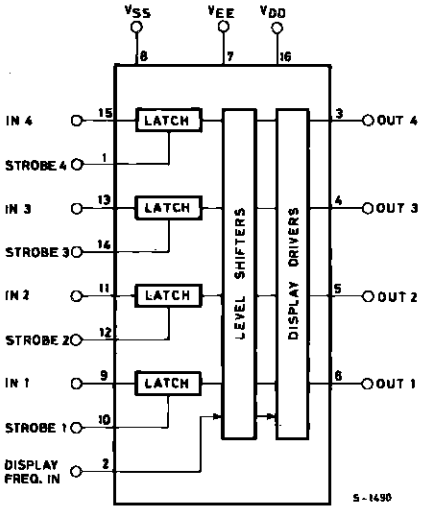


FUNCTIONAL DIAGRAMS

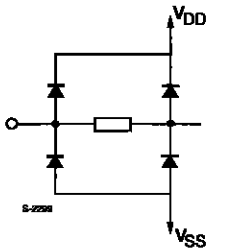
4054B



ALL INPUTS ARE PROTECTED BY COS/MOS PROTECTION NETWORK



4055B



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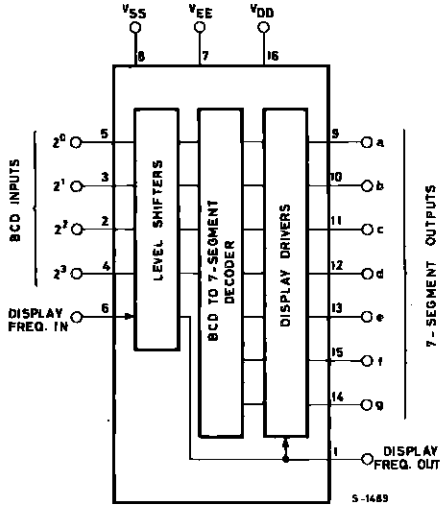
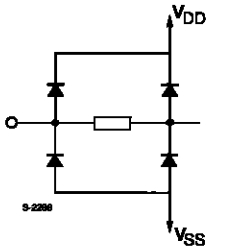


4056B



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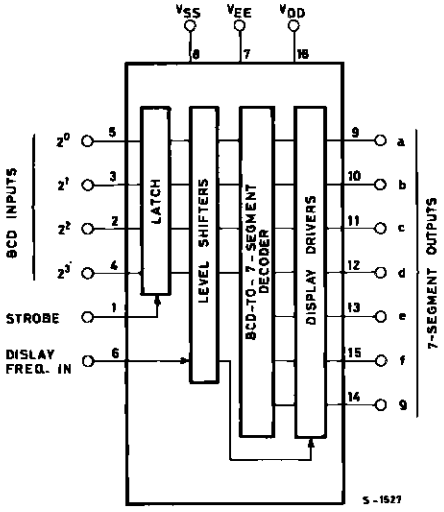


ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{DD}*	Supply Voltage :	– 0.5 to + 20	V
V_i	Input Voltage	– 0.5 to V_{DD} + 0.5	V
I_I	DC Input Current (any one input)	± 10	mA
P_{tot}	Total Power Dissipation (per package) Dissipation per Output Transistor for T_{op} = Full Package-temperature Range	200 100	mW mW
T_{op}	Operating Temperature :	– 55 to + 125	°C °C
T_{stg}	Storage Temperature	– 65 to + 150	°C

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for external periods may affect device reliability.

* All voltage values are referred to V_{SS} pin voltage.

RECOMMENDED OPERATING CONDITIONS

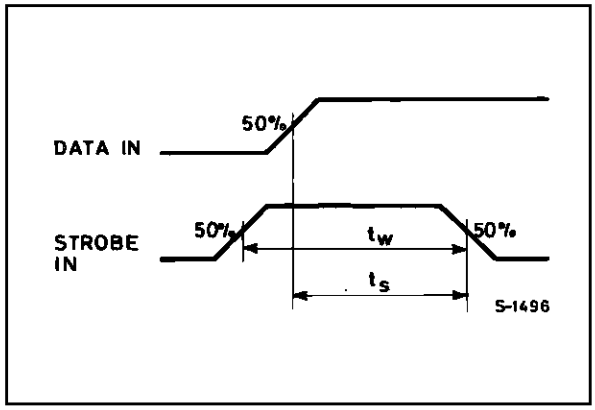
Symbol	Parameter	Value	Unit
V_{DD}	Supply Voltage :	3 to 18	V
V_I	Input Voltage	0 to V_{DD}	V
T_{op}	Operating Temperature :	– 55 to 125	°C

TRUTH TABLE

4055 B and **4056 B**

Input Code				Output State							Display Character
2^3	2^2	2^1	2^0	a	b	c	d	e	f	g	
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	1	0	1	1	9
1	0	1	0	0	0	0	1	1	1	0	L
1	0	1	1	0	1	1	0	1	1	1	H
1	1	0	0	1	1	0	0	1	1	1	P
1	1	0	1	1	1	1	0	1	1	1	A
1	1	1	0	0	0	0	0	0	0	1	–
1	1	1	1	0	0	0	0	0	0	0	BLANK

Data Setup Time and Strobe Pulse Duration.



STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

Symbol	Parameter	Test Conditions					Value							Unit
		V_{EE} (V)	V_I (V)	V_O (V)	V_{SS} (V)	V_{DD} (V)	T_{Low}*		25°C			T_{High}*		
							Min.	Max.	Min.	Typ.	Max.	Min.	Max.	
I_L	Quiescent Supply Current	– 5	0/5		0	5		5		0.04	5		150	µA
		0	0/10		0	10		10		0.04	10		300	
		0	0/15		0	15		20		0.04	20		600	
		0	0/18		0	18		100		0.08	100		3000	
V_{OH}	Output High Voltage	0	0/5		0	5	4.95		4.95			4.95		V
		0	0/10		0	10	9.95		9.95			9.95		
		0	0/15		0	15	14.95		14.95			14.95		
V_{OL}	Output Low Voltage	0	5/0		0	5		0.05			0.05		0.05	V
		0	10/0		0	10		0.05			0.05		0.05	
		0	15/0		0	15		0.05			0.05		0.05	
V_{IH}	Input High Voltage	– 5		0.5/4.5	0	5	3.5		3.5			3.5		V
		0		1/9	0	10	7		7			7		
		0		1.5/13.5	0	15	11		11			11		
V_{IL}	Input Low Voltage	5		0.5/4.5	0	5		1.5			1.5		1.5	V
		0		9/1	0	10		3			3		3	
		0		1.5/13.5	0	15		4			4		4	
I_{OH}	Output High Current	– 5	0/5	4.5	0	5	– 0.6		– 0.45	– 0.9		– 0.3		mA
		0	0/10	9.5	0	10	– 0.6		– 0.45	– 0.9		– 0.3		
		0	0/15	13.5	0	15	– 1.9		– 1.5	– 3		– 1.1		
I_{OL}	Output Low Current	– 5	0/5	0.4	0	5	1.6		1.3	2.6		0.9		mA
		0	0/10	0.5	0	10	1.6		1.3	2.6		0.9		
		0	0/15	1.5	0	15	4.2		3.4	6.8		2.4		
I_{IH}, I_{IL}**	Input Leakage Current	0	0/18		0	18		± 0.1		$\pm 10^{-5}$	± 0.1		± 1	µA
C_I**	Input Capacitance									5	7.5			pF

* T_{Low} = – 55°C for **HCC** device : – 40°C for **HCF** device.
* T_{High} = 125°C fr **HCC** device : + 85°C for **HCF** device.
The Noise Margin for both "1" and "0" level is : 1V min. with V_{DD} = 5V, 2V min. with V_{DD} = 10V, 2.5 V min. with V_{DD} = 15V.
** Any input