COS/MOS INTEGRATED CIRCUIT

HCC/HCF 4511B

BCD-TO-SEVEN SEGMENT LATCH/DECODER/DRIVER

- HIGH-OUTPUT-SOURCING CAPABILITY (up to 25 mA)
- INPUT LATCHES FOR BCD CODE STORAGE
- LAMP TEST AND BLANKING CAPABILITY
- 7-SEGMENT OUTPUTS BLANKED FOR BCD INPUT CODES > 1001
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- STANDARDIZED SYMMETRICAL OUTPUT CHARACTERISTICS
- 5V, 10V, AND 15V PARAMETRIC RATINGS
- INPUT CURRENT OF 100 mA AT 18V AND 25°C FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD No. 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

The **HCC 4511B** (extended temperature range) and the **HCF 4511B** (intermediate temperature range) are monolithic integrated circuits available in 16-lead dual in-line plastic or ceramic package and ceramic flat package.
The **HCC/HCF 4511B** types are BCD-to-7-segment latch decoder drivers constructed with COS/MOS logic and n-p-n bipolar transistor output devices on a single monolithic structure. These devices combine the low quiescent power dissipation and high noise immunity features of COS/MOS with n-p-n bipolar output transistors capable of sourcing up to 25 mA. This capability allows the **HCC/HCF 4511B** types to drive LED's and other displays directly.
Lamp Test ($\overline{LT}$), Blanking ($\overline{BL}$), and Latch Enable or Strobe inputs are provided to test the display, shut off or intensity-modulate it, and store or strobe a BCD code, respectively. Several different signal may be multiplexed and displayed when external multiplexing circuitry is used.

ABSOLUTE MAXIMUM RATINGS

V_{DD}*	Supply voltage: **HCC** types	-0.5 to 20	V
	HCF types	-0.5 to 18	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)	200	mW
	Dissipation per output transistor for T_{op} = full package-temperature range	100	mW
T_{op}	Operating temperature: **HCC** types	-55 to 125	°C
	HCF types	-40 to 85	°C
T_{stg}	Storage temperature	-65 to 150	°C

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

ORDERING NUMBERS:

HCC 4511 BD for dual in-line ceramic package
HCC 4511 BF for dual in-line ceramic package, frit seal
HCC 4511 BK for ceramic flat package
HCF 4511 BE for dual in-line plastic package
HCF 4511 BF for dual in-line ceramic package, frit seal

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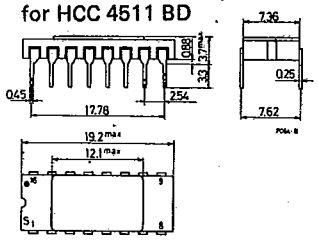
HCC/HCF 4511 B

41C 08987 D T-51-17

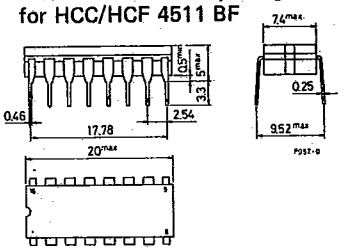
7929225 S G S SEMICONDUCTOR CORP

MECHANICAL DATA (dimensions in mm)

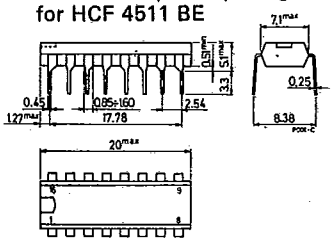
Dual in-line ceramic package for HCC 4511 BD



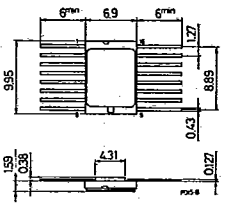
Dual in-line ceramic package for HCC/HCF 4511 BF



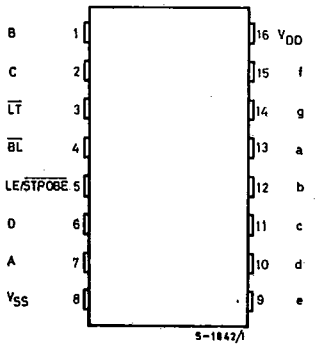
Dual in-line plastic package for HCF 4511 BE



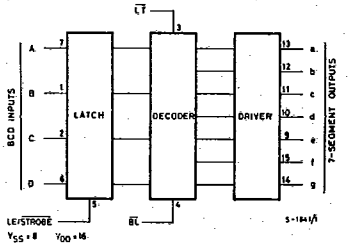
Ceramic flat package for HCC 4511 BK



CONNECTION DIAGRAM



FUNCTIONAL DIAGRAM

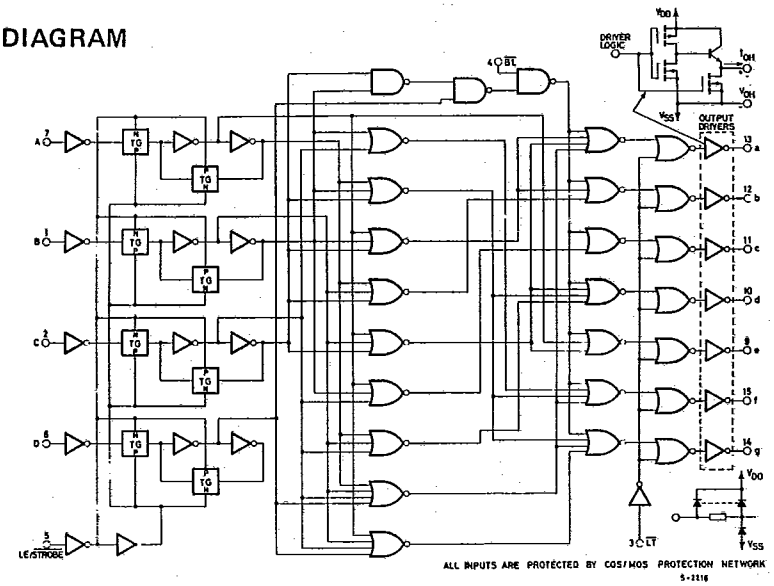


DISPLAY

RECOMMENDED OPERATING CONDITIONS

V_{DD}	Supply voltage: **HCC** types	3 to 18	V
	HCF types	3 to 15	V
V_I	Input voltage	0 to V_{DD}	V
T_{op}	Operating temperature: **HCC** types	-55 to 125	°C
	HCF types	-40 to 85	°C

LOGIC DIAGRAM

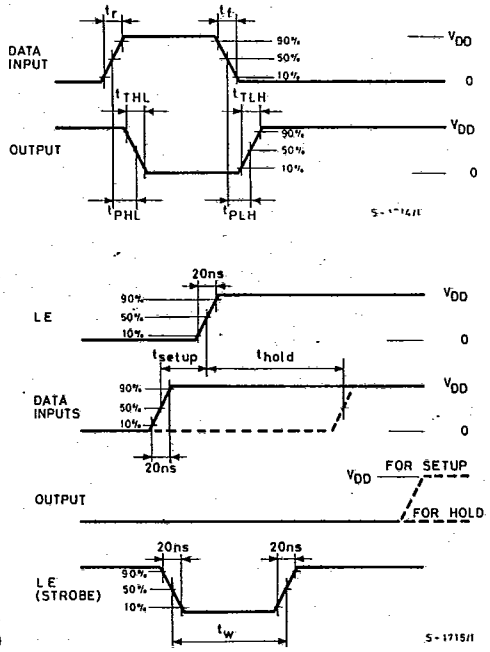


TRUTH TABLE

LE	$\overline{BI}$	$\overline{LT}$	D	C	B	A	a	b	c	d	e	f	g	Display
X	X	0	X	X	X	X	1	1	1	1	1	1	1	8
X	0	1	X	X	X	X	0	0	0	0	0	0	0	Blank
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	0	1	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	1	0	0	0	0	0	0	0	Blank
1	1	1	X	X	X	X				*				*

X = Don't care
* = Depends on BCD code previously applied when LE= 0
Note: Display is blank for all illegal input codes (BCD > 1001)

WAVEFORMS



STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

Parameter			Test conditions				Values							Unit
			V_I (V)	V_O (V)	$\|I_{OH}\|$ (mA)	V_{DD} (V)	T_{Low}*		25°C			T_{High}*		
							Min.	Max.	Min.	Typ.	Max.	Min.	Max.	
I_L	Quiescent current	HCC types	0/ 5			5		5		0.04	5		150	µA
			0/10			10		10		0.04	10		300	
			0/15			15		20		0.04	20		600	
			0/20			20		100		0.08	100		3000	
		HCF types	0/ 5			5		20		0.04	20		150	
			0/10			10		40		0.04	40		300	
			0/15			15		80		0.04	80		600	
V_{OH}	Output high voltage		0/ 5			5	4		4.1	4.55		4.2		V
			0/10			10	9		9.1	9.55		9.2		
			0/15			15	14		14.1	14.55		14.2		
V_{OL}	Output low voltage		5/0			5		0.05			0.05		0.05	V
			10/0			10		0.05			0.05		0.05	
			15/0			15		0.05			0.05		0.05	
V_{IH}	Input high voltage			0.5/3.8		5	3.5		3.5			3.5		V
				1/8.8		10	7		7			7		
				1.5/13.8		15	11		11			11		
V_{IL}	Input low voltage			3.8/0.5		5		1.5			1.5		1.5	V
				8.8/1		10		3			3		3	
				13.8/1.5		15		4			4		4	
V_{OH}	Output drive voltage	HCC types			0	5	4.1		4.10	4.55		4.20		V
					5					4.25				
					10		3.80		3.90	4.10		3.90		
					15					3.95				
					20		3.55		3.40	3.75				
					25		3.40		3.10	3.55				
					0	10	9		9.10	9.55		9.20		
					5					9.25				
					10		8.85		9	9.15				
					15					9.05				
					20		8.70		8.60	8.90		8.40		
					25		8.60		8.30	8.75				
					0	15	14		14.10	14.55		14.20		
					5					14.30				
					10		13.90		14	14.20		14		
					15					14.10				
					20		13.75		13.70	13.95		13.50		
					25		13.65		13.50	13.80		13.10		

STATIC ELECTRICAL CHARACTERISTICS (continued)

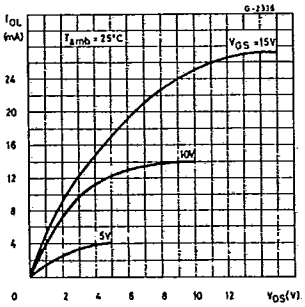
Parameter			Test conditions				Values							Unit
			V_I (V)	V_O (V)	$\|I_{OH}\|$ (mA)	V_{DD} (V)	T_{Low}* Min.	T_{Low}* Max.	25°C Min.	25°C Typ.	25°C Max.	T_{High}* Min.	T_{High}* Max.	
V_{OH}	Output drive voltage	HCF types			0	5	4.1		4.1	4.57		4.1		V
					5					4.24				
					10		3.6		3.6	4.12		3.3		
					15					3.94				
					20		2.8		2.8	3.75		2.5		
					25					3.54				
					0	10	9.1		9.1	9.58		9.1		V
					5					9.26				
					10		8.75		8.75	9.17		8.45		
					15					9.04				
					20		8.1		8.1	8.90		7.8		
					25					8.75				
					0	15	14.1		14.1	14.59		14.1		V
					5					14.27				
					10		13.75		13.75	14.18		13.45		
					15					14.07				
					20		13.1		13.1	13.95		12.8		
					25					13.80				
I_{OL}	Output sink current	HCC types	0/ 5	0.4		5	0.64		0.51	1		0.36		mA
			0/10	0.5		10	1.6		1.3	2.6		0.9		
			0/15	1.5		15	4.2		3.4	6.8		2.4		
		HCF types	0/ 5	0.4		5	0.52		0.44	1		0.36		
			0/10	0.5		10	1.3		1.1	2.6		0.9		
			0/15	1.5		15	3.6		3	6.8		2.4		
I_{IH}, I_{IL}	Input leakage current	HCC types	0/18	Any input		18		±0.1		$\pm 10^{-5}$	±0.1		± 1	µA
		HCF types	0/15			15		±0.3		$\pm 10^{-5}$	±0.3		± 1	
C_I	Input capacitance			Any input						5	7.5			pF

* T_{Low} = −55°C for **HCC** device; −40°C for **HCF** device.
* T_{High} = +125°C for **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
2.5V min. with V_{DD}= 15V

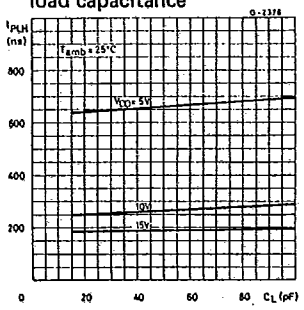
DYNAMIC ELECTRICAL CHARACTERISTICS (T_{amb}= 25°C, C_L= 50 pF, R_L= 200 kΩ. typical temperature coefficient for all V_{DD}= 0.3%/°C values, all input rise and fall time= 20 ns)

Parameter		Test conditions	Values			Unit
		V_{DD} (V)	Min.	Typ.	Max.	
t_{PHL}	Propagation delay time (Data)	5		520	1040	ns
		10		210	420	
		15		150	300	
t_{PLH}	Propagation delay time (Data)	5		660	1320	ns
		10		260	520	
		15		180	360	
t_{PHL}	Propagation delay time ($\overline{BL}$)	5		350	700	ns
		10		175	350	
		15		125	250	
t_{PLH}	Propagation delay time ($\overline{BL}$)	5		400	800	ns
		10		175	350	
		15		150	300	
t_{PHL}	Propagation delay time ($\overline{LT}$)	5		250	500	ns
		10		125	250	
		15		85	170	
t_{PLH}	Propagation delay time ($\overline{LT}$)	5		150	300	ns
		10		75	150	
		15		50	100	
t_{TLH}	Transition time	5		40	80	ns
		10		30	60	
		15		20	50	
t_{THL}	Transition time	5		125	310	ns
		10		75	185	
		15		65	160	
t_{setup}	Setup time	5	150	75		ns
		10	70	35		
		15	40	20		
t_{hold}	Hold time	5	0	-75		ns
		10	0	-35		
		15	0	-20		
t_W	Strobe pulse width	5	400	200		ns
		10	160	80		
		15	100	50		

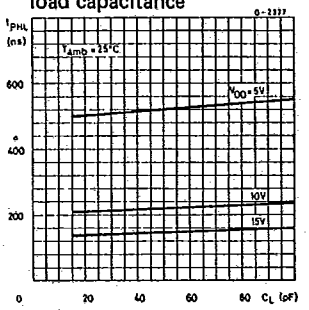
Typical output low (sink) current characteristics



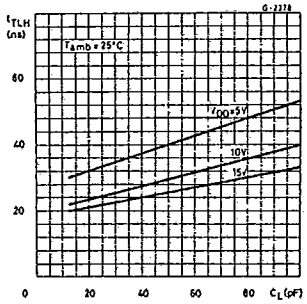
Typical data-to-output,low-to-high-level propagation delay time as a function of load capacitance



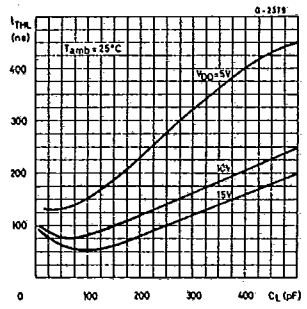
Typical data-to-output,high-to-low-level propagation delay time as a function of load capacitance



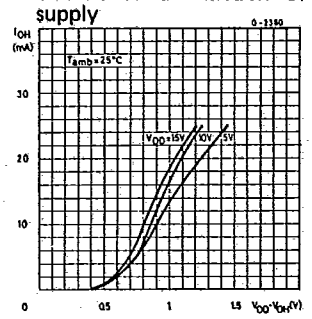
Typical low-to-high level transition time as a function of load capacitance



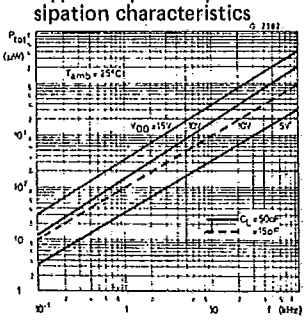
Typical high-to-low transition time as a function of load capacitance



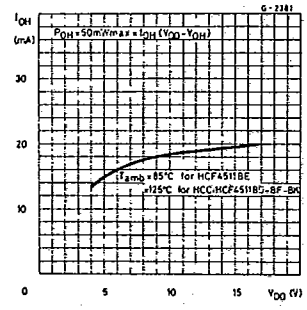
Typical voltage drop (V_{DD} to output) vs. output source current as a function of supply



Typical dynamic power dissipation characteristics



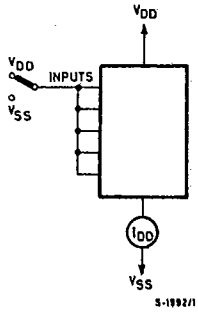
Derated static output current per output



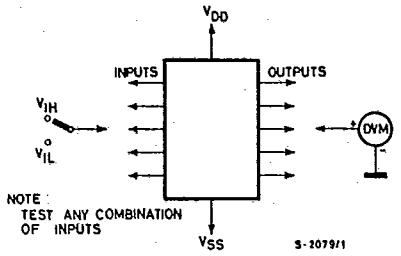
Maximum continuous derated output current I_{OH} applies to a single output with all other outputs sourcing an equal amount of current at the supply voltages shown. Operation above the derating curve is not recommended.

TEST CIRCUITS

Quiescent device current

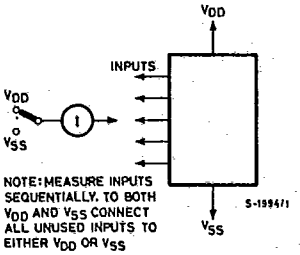


Noise immunity



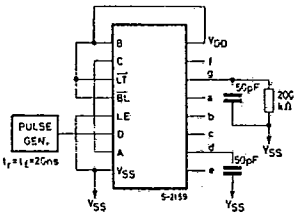
NOTE
TEST ANY COMBINATION OF INPUTS

Input leakage current



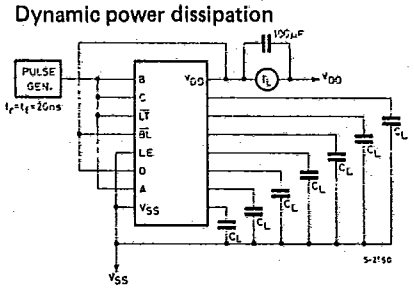
NOTE: MEASURE INPUTS SEQUENTIALLY. TO BOTH V_{DD} AND V_{SS} CONNECT ALL UNUSED INPUTS TO EITHER V_{DD} OR V_{SS}

Data propagation delay



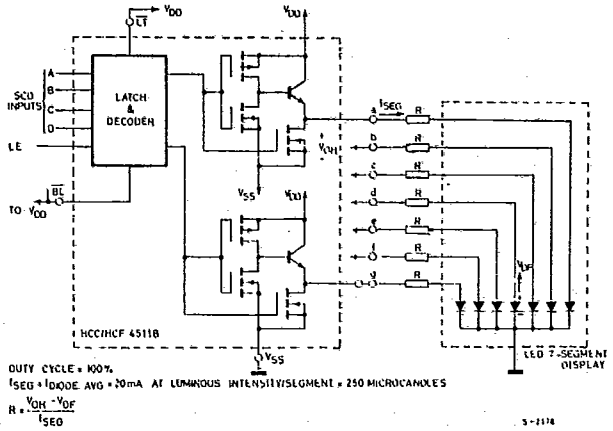
MEASURE OUTPUT d FOR t_{PLH}
MEASURE OUTPUT g FOR t_{PHL}

Dynamic power dissipation



APPLICATIONS (Interfacing with various displays)

Driving common-cathode 7-segment LED displays

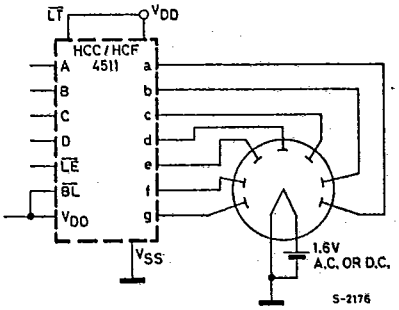


DUTY CYCLE = 100%
$I_{SEG} = I_{DIODE\ AVG} = 20mA$ AT LUMINOUS INTENSITY/SEGMENT = 250 MICROCANDLES

$$R = \frac{V_{OH} - V_{OF}}{I_{SEG}}$$

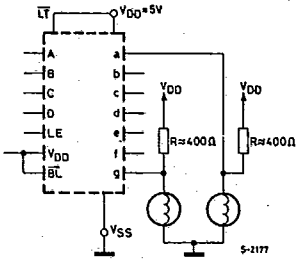
APPLICATIONS (continued)

Driving low-voltage fluorescent displays



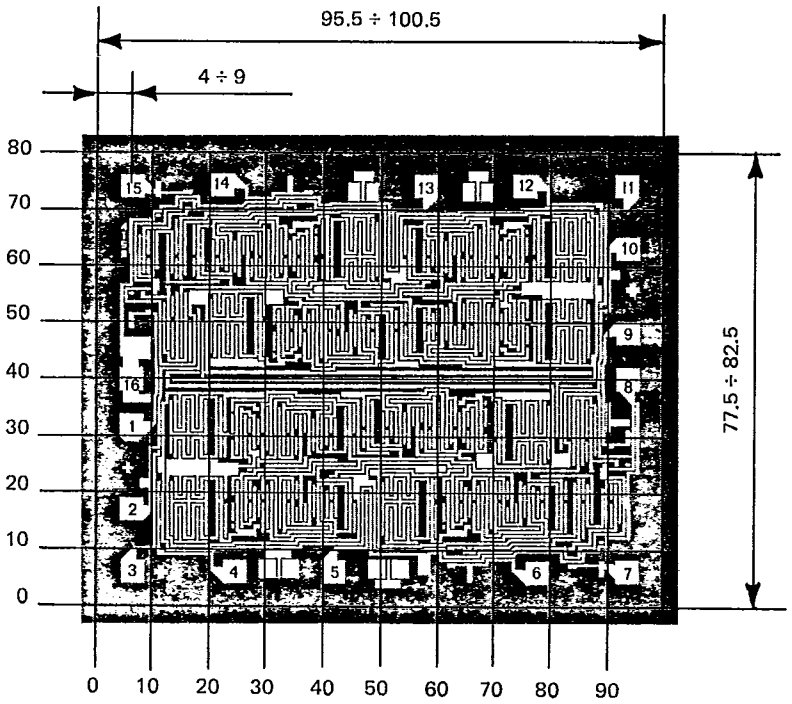
A medium-brightness intensity display can be obtained with low-voltage fluorescent displays such as the Tung-Sot Digivac S/G Series.

Driving incandescent displays

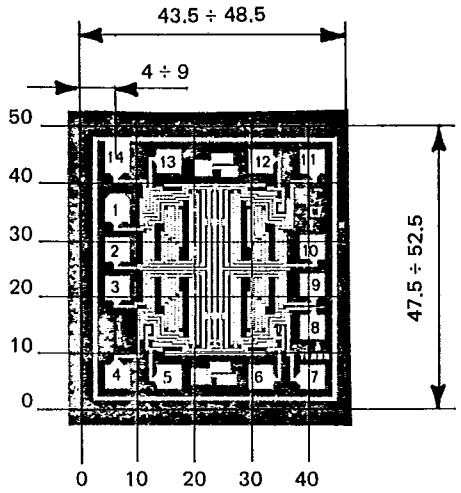


2 of 7 Segments Shown Connected

Resistors R from V_{DD} to each 7-segment driver output are chosen to keep all Numitron segments slightly on and warm.


95.5 ÷ 100.5
4 ÷ 9
77.5 ÷ 82.5
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90
15 14 13 12 11 10 9 8 16 1 2 3 4 5 6 7

4015B


43.5 ÷ 48.5
4 ÷ 9
47.5 ÷ 52.5
50
40
30
20
10
0
0 10 20 30 40
14 13 12 11 1 2 3 10 9 8 4 5 6 7

4016B