

LCD Segment Driver CMOS

The MC141511A is an LCD frontplane (segment) driver chip which includes a 656 x 8 display RAM. The MC68HC05L10 microcomputer is the companion device which provides the backplane drive.

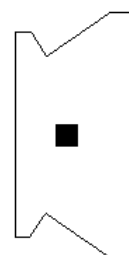
The MC68HC05L10, together with one MC141511A, may be used to drive a 5248-pixel muxed-by-41 display or a 4096-pixel muxed-by-32 display. Larger displays may be driven by adding additional MC141511A.

The MC141511A is a low operating voltage version of MC141511. It is pin to pin compatible to the MC141511.

See Application Note AN-HK-13A.

- Operating Supply Voltage Range -
Control Logic, RAM, and Latch (VDD Pin): 2.7V to 5.5V
Frontplane Drivers (VLCD Pin): 4.5V to 13.2V
- Operating Temperature Range: -20 to 70°C
- Direct Interface with the MC68HC05L10
- 656 x 8 Static RAM (Display RAM)
- 128 LCD Segment (Frontplane) Driving Signals
- 10-Bit Address Bus and 8-Bit Bidirectional Data Bus
- Selectable 1:32 or 1:41 Multiplex Ratios
- Available in Two Forms:
TAB (Tape Automated Bonding), 161 Contacts, 10 sprocket hole device
Die Form Without Gold Bumps, 159 Pads with 4.5 mil Pads Pitch

MC141511A



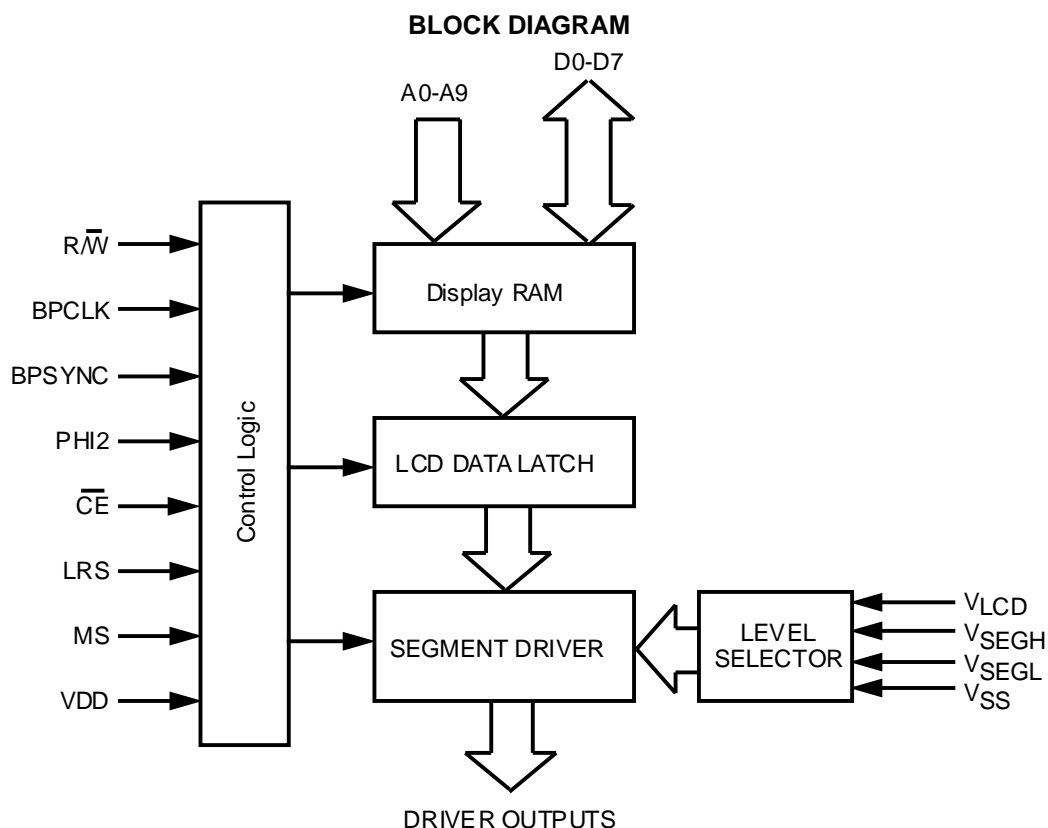
**MC141511AT2
TAB**



**MCC141511A
DIE**

ORDERING INFORMATION

MCC141511A	BARE DIE
MC141511AT2	TAB



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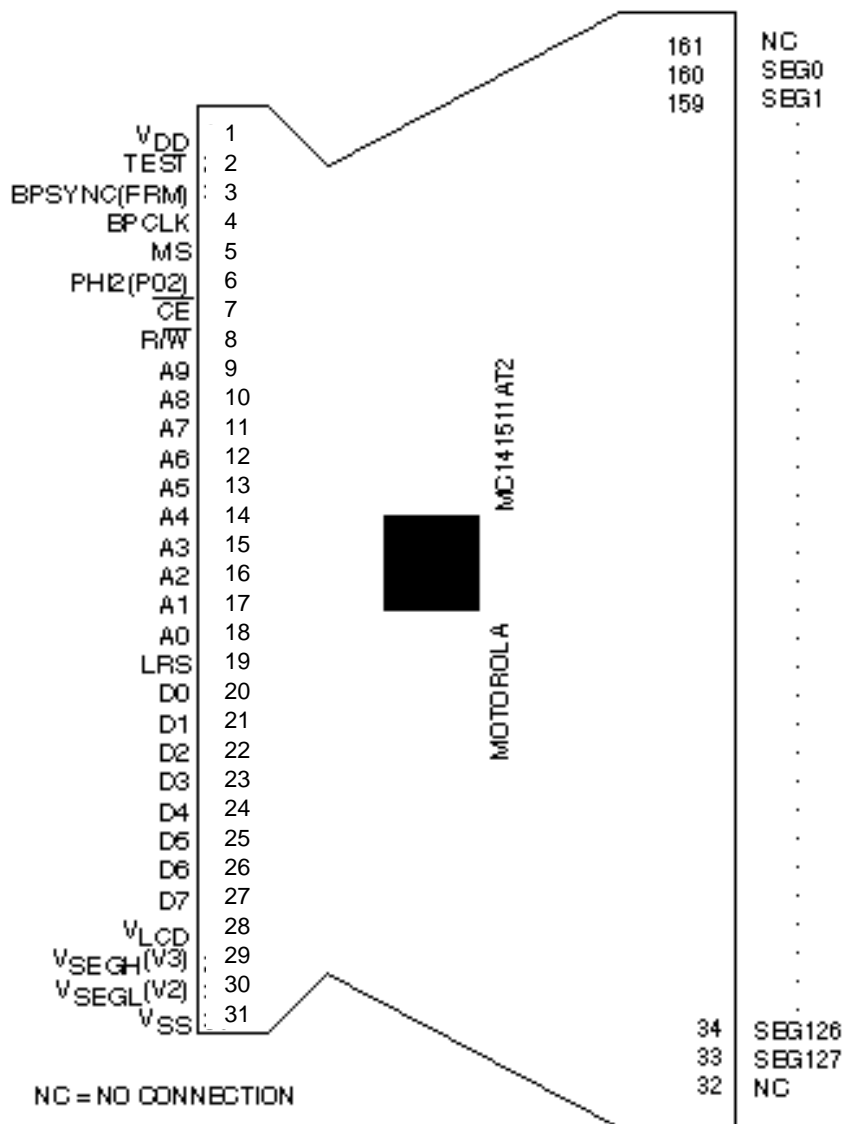


Figure 1A. TAB Package Contact Assignment (Copper View)

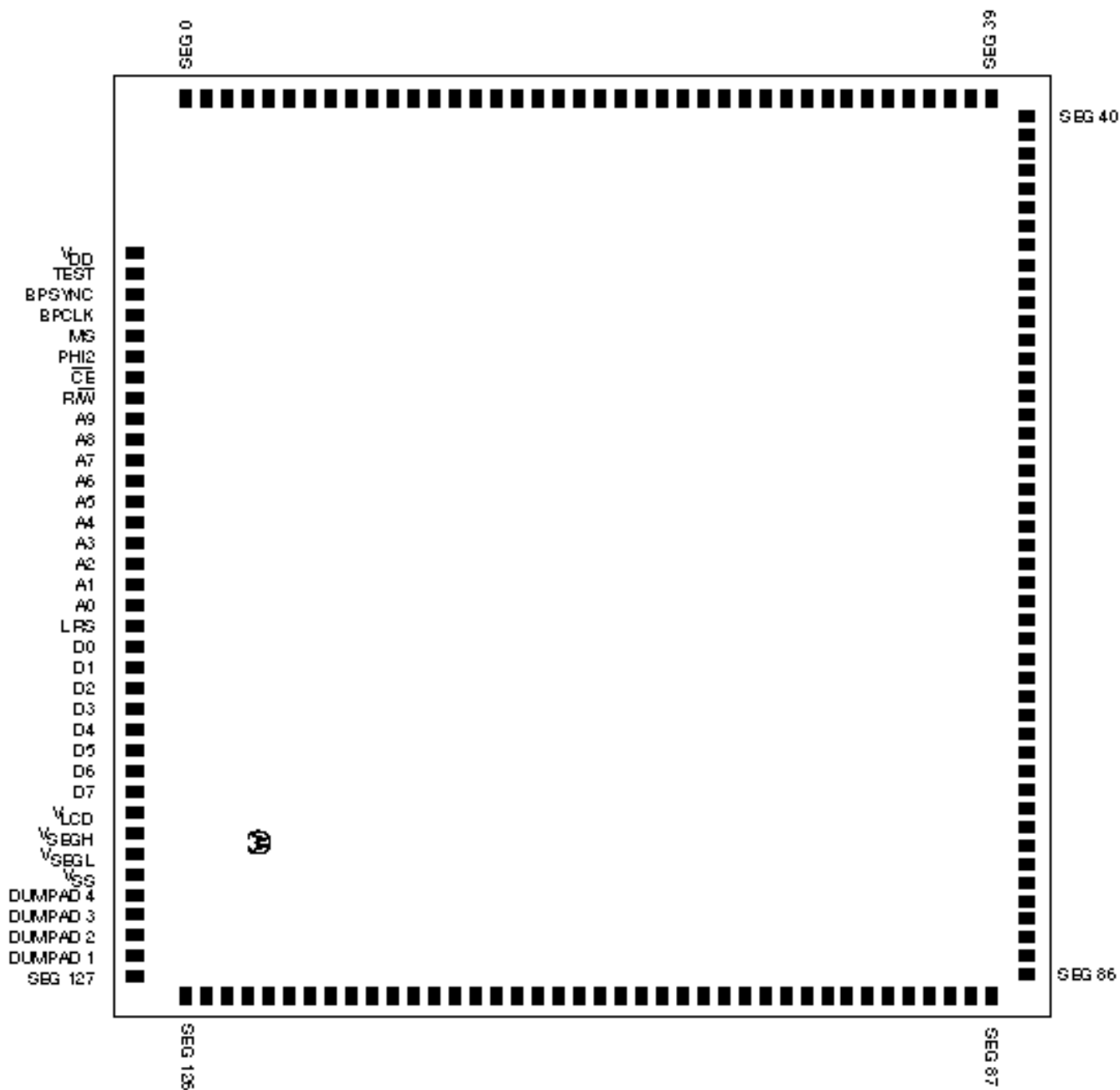


Figure 1B. Chip Pad Assignment

MAXIMUM RATINGS*(Voltages Referenced to V_{SS} , $T_A = 25^\circ\text{C}$)

Symbol	Parameter	Value	Unit
V_{DD}	Supply Voltage	-0.3 to +7.0	V
V_{LCD}		-0.3 to +14.0	V
V_{in}	Input Voltage	$V_{SS}-0.3$ to $V_{DD}+0.3$	V
I	Current Drain Per Pin Excluding V_{DD} and V_{SS}	25	mA
T_A	Operating Temperature	-20 to +70	$^\circ\text{C}$
T_{stg}	Storage Temperature Range	-65 to +150	$^\circ\text{C}$

* Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the limits in the Electrical Characteristics tables or Pin Description section.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions to be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} < \text{or} = (V_{in} \text{ or } V_{out}) < \text{or} = V_{DD}$. Reliability of operation is enhanced if unused input are connected to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open. This device may be light sensitive. Caution should be taken to avoid exposure of this device to any light source during normal operation. This device is not radiation protected.

ELECTRICAL CHARACTERISTICS (Voltage Referenced to V_{SS} , $T_A = 25^\circ\text{C}$)

Symbol	Parameter	Min	Typ	Max	Unit
V_{DD}	Operating Voltage	2.7	-	5.5	V
V_{LCD}	Supply Voltage	4.5	-	13.2	V
	LCD Voltage				
	Supply Current				
	at $V_{DD}=5.5\text{V}$ ($\text{PHI2}=3.685\text{MHz}$)				
I_{AC}	ACCESS	-	-	200	μA
I_{DP}	DISPLAY	-	25	30	μA
I_{SB}	STANDBY (Using D_{ON} bit of the MCU)	-	15	20	μA
	at $V_{DD}=3.0\text{V}$ ($\text{PHI2}=1.25\text{MHz}$)				
I_{AC}	ACCESS	-	-	200	μA
I_{DP}	DISPLAY	-	17	30	μA
I_{SB}	STANDBY (Using D_{ON} bit of the MCU)	-	10	20	μA
I_{LCD}	Supply Current at V_{LCD}	-	-	200	μA
V_{OL}	Output Voltage, $I_{load} 10.0\mu\text{A}$	-	-	0.1	V
V_{OH}		$V_{LCD}-0.1$	-	-	V
V_{OH}	Output High Voltage ($I_{load}=1.6\text{mA}$)	D7-D0	$V_{DD}-0.8$	-	V
V_{OL}	Output Low Voltage ($I_{load}=1.6\text{mA}$)	D7-D0	-	0.4	V
V_{IH}	Input High Voltage	R/\bar{W} , BPCLK, BPSYNC, PHI2, MS, $\bar{C}\bar{E}$, D7-D0	$0.8 \times V_{DD}$	-	V_{DD}
V_{IL}	Input Low Voltage	R/\bar{W} , BPCLK, BPSYNC, PHI2, MS, $\bar{C}\bar{E}$, D7-D0	V_{SS}	-	$0.2 \times V_{DD}$
V_R	Data Retention		2.0	-	V
I_{in}	Input Current	BPCLK, BPSYNC, R/\bar{W} , PHI2, D7-D0	-	-	1
C_{in}	Capacitance	R/\bar{W} , BPCLK, BPSYNC, PHI2, MS, $\bar{C}\bar{E}$, D7-D0	-	-	8
I_{OH}	Output current ($V_{OH}=4.5\text{V}$, $V_{OL}=0.5\text{V}$)	D7-D0	+20	-	μA
I_{OL}			-	-20	μA

AC ELECTRICAL CHARACTERISTICS - WRITE CYCLE ($V_{DD}=3.0V\pm 10\%$, $V_{SS}=0V$)

Symbol	Parameter	Min	Max	Unit
t_{CYCW}	Write Cycle Time	400	-	ns
t_{AS}	Address Set Up Time	100	-	ns
t_{AH}	Address Hold Time	70	-	ns
t_{CS}	Chip Select Pulse Width	260	-	ns
t_{WCS}	Write to Chip Select Delay Time	100	-	ns
t_{DSW}	Data Setup Time	200	-	ns
t_H	Input Hold Time	15	-	ns
t_{WH}	Write Hold Time from Chip Select	70	-	ns

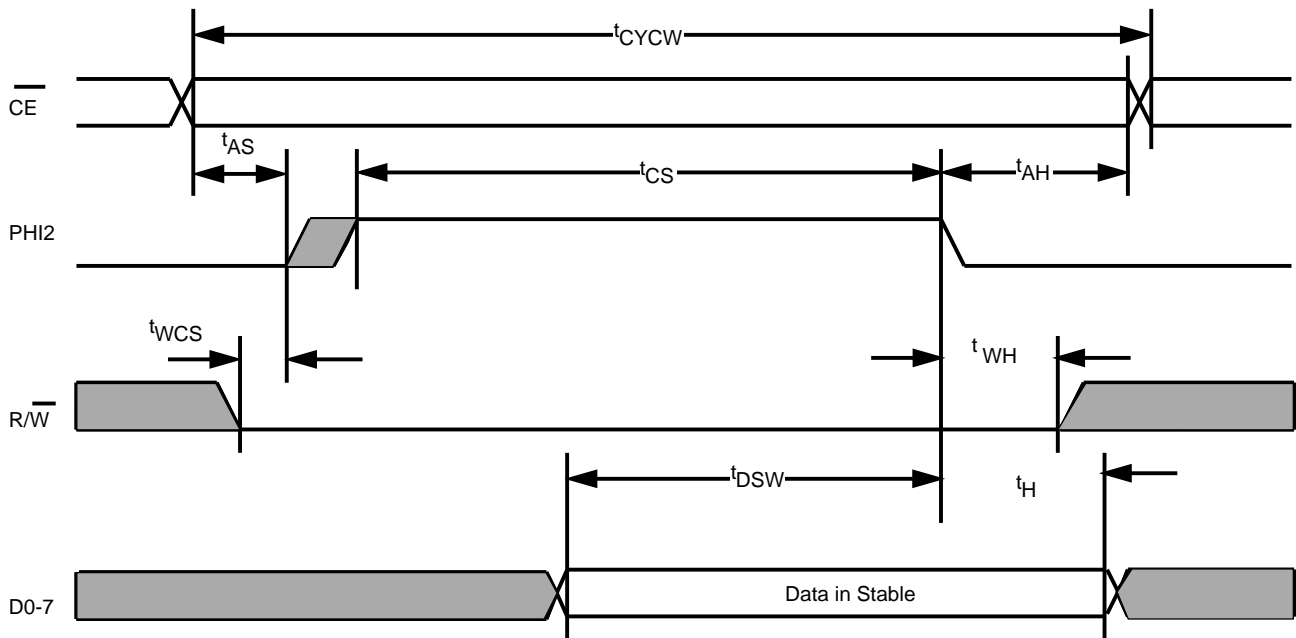


Figure 2. Write Cycle Timing

AC ELECTRICAL CHARACTERISTICS - READ CYCLE ($V_{DD}=3.0V\pm 10\%$, $V_{SS}=0V$)

Symbol	Parameter	Min	Max	Unit
t_{CYCR}	READ Cycle Time	400	-	ns
t_{AS}	Address Setup Time	100	-	ns
t_{DDR}	Data Delay Time (Read)	-	350	ns
t_H	Output Hold Time	10	-	ns

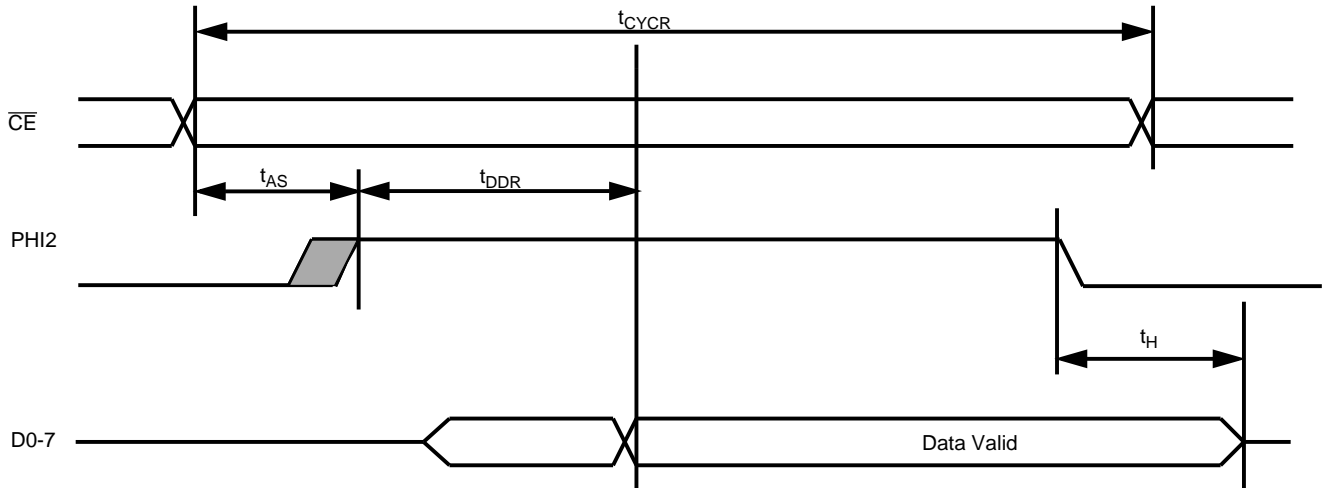


Figure 3. Read Cycle Timing

PIN DESCRIPTIONS

V_{DD} AND V_{SS}

The main dc power is supplied to the part by these two connections. V_{DD} is the most-positive supply level for logic circuitry and V_{SS} is ground.

V_{LCD}

This supply connection provides the voltage level for the segment drivers and is connected to the V_{out} connection of the MC68HC05L10 MCU.

V_{SEGL} , V_{SEGH}

These inputs are connected to V2 and V3 of an external voltage divider. See Figure 4.

D0 - D7

These connections form an eight bit wide bidirectional data bus which are connected to D0 through D7 of the MC68HC05L10.

A0 - A9

These inputs form a ten-bit wide address bus for addressing the display RAM and are connected to A0 through A9 of the MC68HC05L10.

BPSYNC

This input is a periodic active-low signal from the MC68HC05L10 for timing synchronization. BPSYNC is connected to FRM of MC68HC05L10. See Figure 5.

BPCLK

This input may be run as high as 4.096 kHz (50% duty cycle). It provides the required frame frequency for the segment driver. It is connected to BPCLK of the MC68HC05L10. Thus, the frequency is usually 2.048 kHz. See Figure 5.

PHI2

This input is a bus clock input that is used for data bus timing synchronization. It is connected to P02 of MC68HC05L10.

SEG0 - SEG127

These 128 output lines provide the frontplane drive signals to the LCD panel. These outputs are forced to a low level while display is turned off. Any unused segment outputs should be left open.

\overline{CE}

This is an active low chip enable input and is connected to either $\overline{CS1}$, $\overline{CS2}$, $\overline{CS3}$ or $\overline{CS4}$ of the MC68HC05L10.

LRS

The left-right selection input defines the direction of the segment driver display. See Figure 8.

0 or Low = SEG 0 - 127

1 or High = SEG 127 - 0

MS

This input selects how display RAM is addressed. Either a 1:32 or 1:41 multiplex ratio is possible.

0 or Low = 1:32 multiplex addressing

1 or High = 1:41 multiplex addressing

R/\overline{W}

This input indicates which direction the data is to be passed over the data bus. When R/\overline{W} is low, the LCD driver reads data from the data bus (D0-D7). When R/\overline{W} is high, the LCD driver writes data to the data bus (D0-D7). This input is connected to R/W of MC68HC05L10.

TEST

Allowing this connection to float or connecting it to VSS (GND) places the part in the normal mode of operation. This input has an on-chip pulldown resistance of approximately 1M .

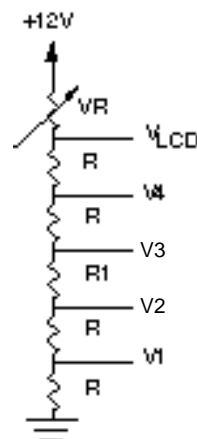


Figure 4. External Voltage Divider

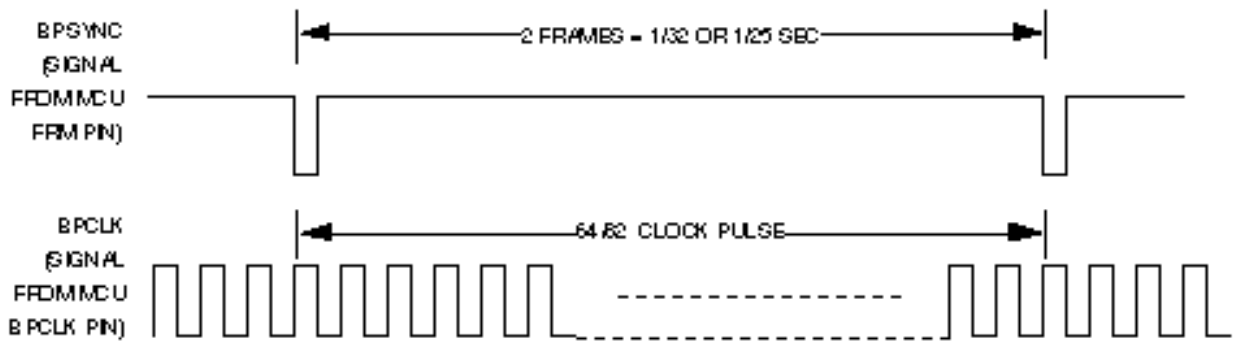


Figure 5. Relationship between BPSYNC and BPCLK

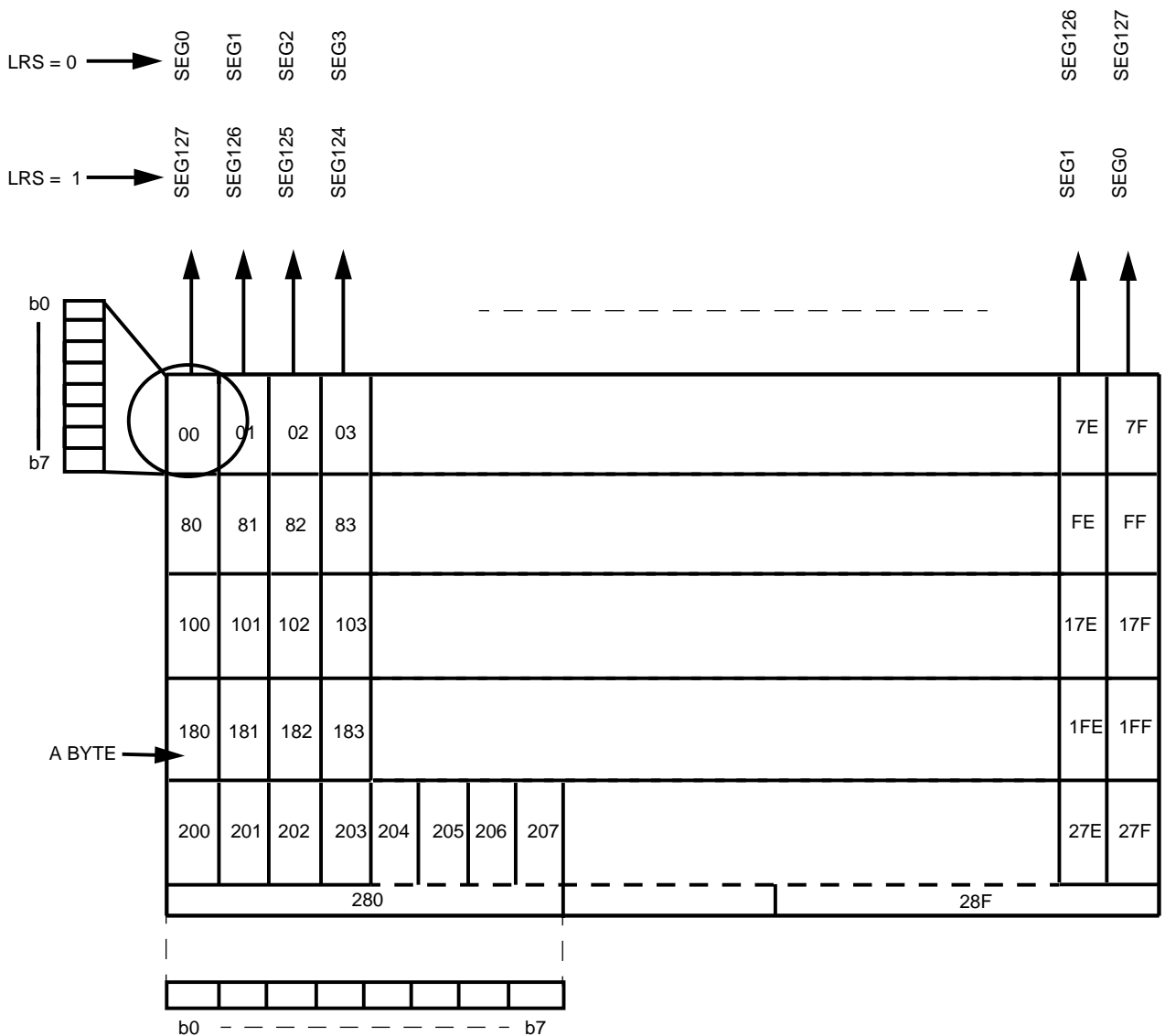


Figure 6. Display RAM Configuration

OPERATION OF LCD DRIVER

INTRODUCTION

The MC141511 is LCD driver with selectable 1:32 or 1:41 multiplex ratios. The device consists of the following functional blocks as shown in the Block Diagram.

CONTROL LOGIC - accepts the control signals from the MCU and generates internal signals for synchronisation.

DISPLAY RAM - stores the display data. Each bit of the display RAM has one-to-one correspondence to a pixel of the LCD. The display RAM is in vertical byte oriented format as shown in Figure 6 and the way the display RAM is addressed depends on the multiplexing mode of the LCD (Figure 8). With reference to Figure 6, the display RAM also contains 16 bytes of memory which is in horizontal format (\$280-\$28F). The display RAM is addressed when backplane reaches 41.

LEVEL SELECTOR - consists of a switching circuit to select appropriate voltage levels from an external voltage divider. See figure 4.

SEGMENT DRIVERS - provides the segment driving signals to the LCD frontplane. See Figure 7.

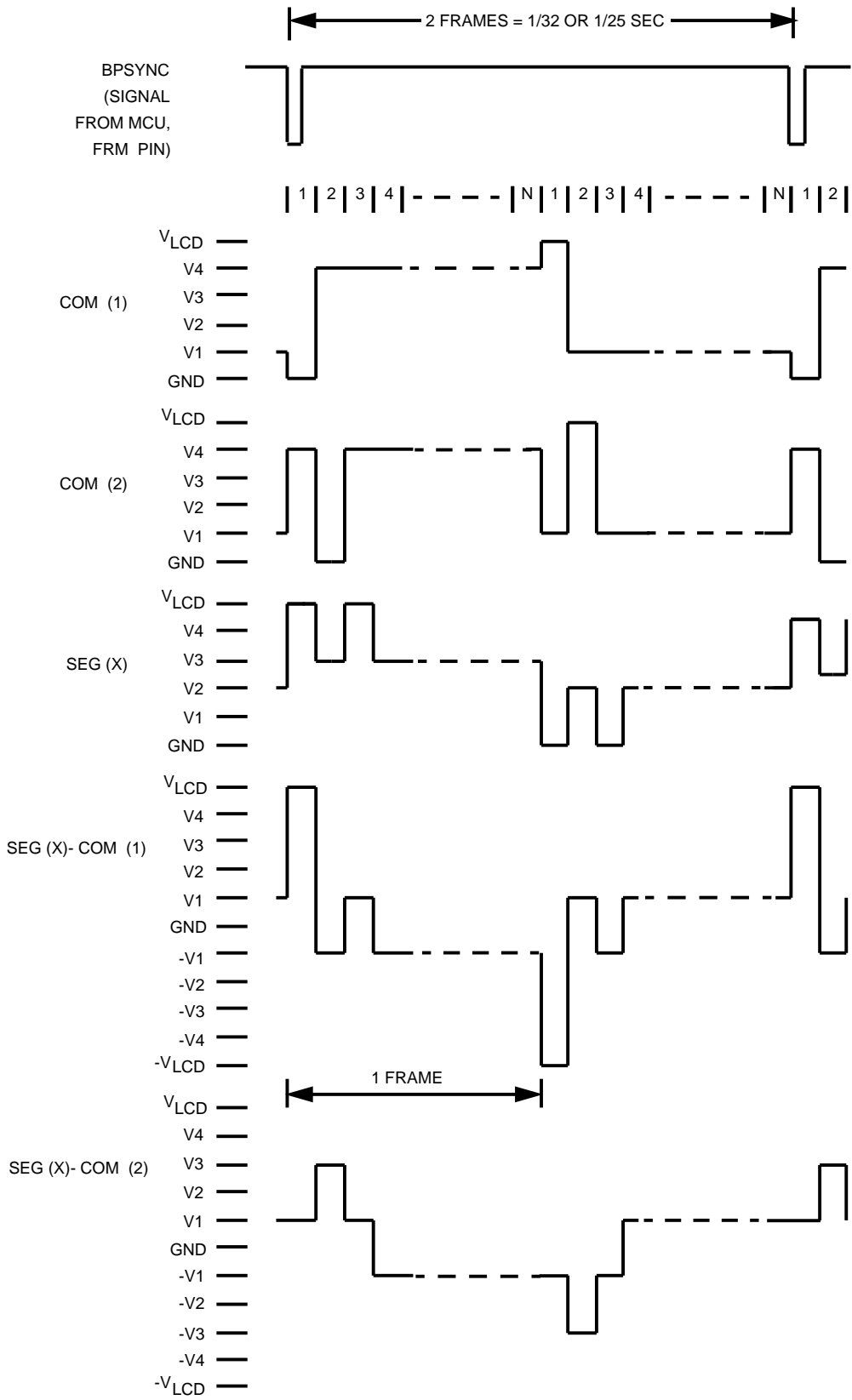
The LCD driver clock is derived from the 2.048KHz BPCLK and frame frequency is 64 Hz for 1:32 multiplex and 50 Hz for 1:41 multiplex ratio. See Figure 5.

GENERATION OF LCD BIAS LEVELS

Refer to Figure 4. In order to obtain optimum contrast for LCD panels, the bias levels should be selected such that

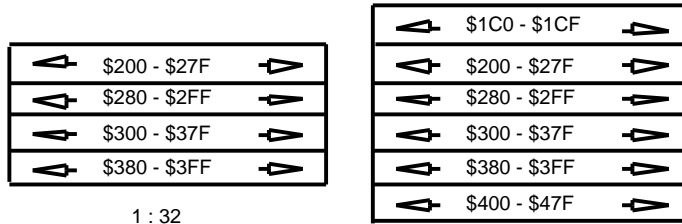
$$\begin{aligned} \text{BIAS} &= R/(4R+R1) = 1/(\overline{\text{MUX}} + 1) \\ V1/\text{VLCD} &= 1/(\overline{\text{MUX}} + 1) \\ V2/\text{VLCD} &= 2/(\overline{\text{MUX}} + 1) \\ V3/\text{VLCD} &= (\overline{\text{MUX}} - 1)/(\overline{\text{MUX}} + 1) \\ V4/\text{VLCD} &= \overline{\text{MUX}} /(\overline{\text{MUX}} + 1) \end{aligned}$$

Example: Mux = 41 ----- Bias = 1: 7.4,
R = 10K, R1 = 33K, VR = 100K
Mux = 32 ----- Bias = 1: 6.6,
R = 10K, R1 = 27K, VR = 100K



N = 32, 41

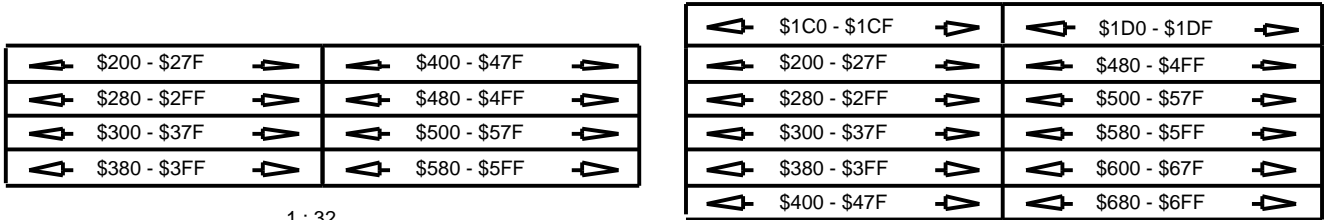
Figure. 7 Driving Waveform of 1:5 Bias, 1:32 or 1:41 Multiplex Ratio



1 : 32

1 : 41

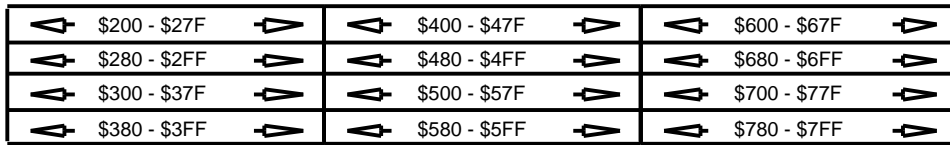
ONE SLAVE



1 : 32

1 : 41

TWO SLAVES

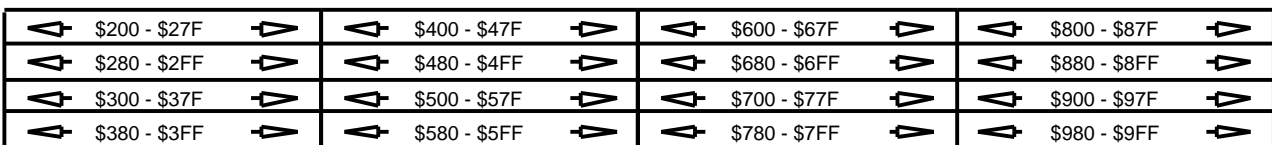


1 : 32

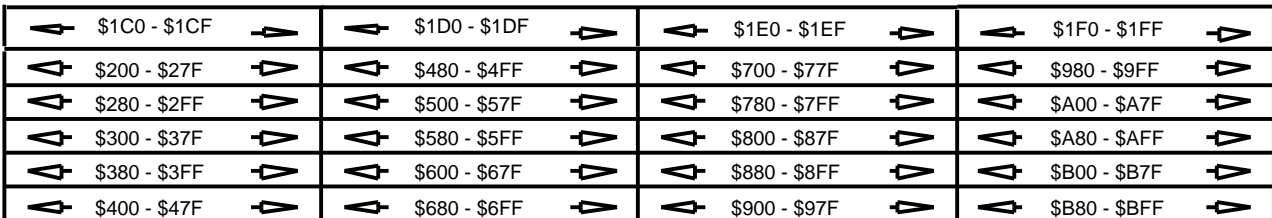


1 : 41

THREE SLAVES



1 : 32

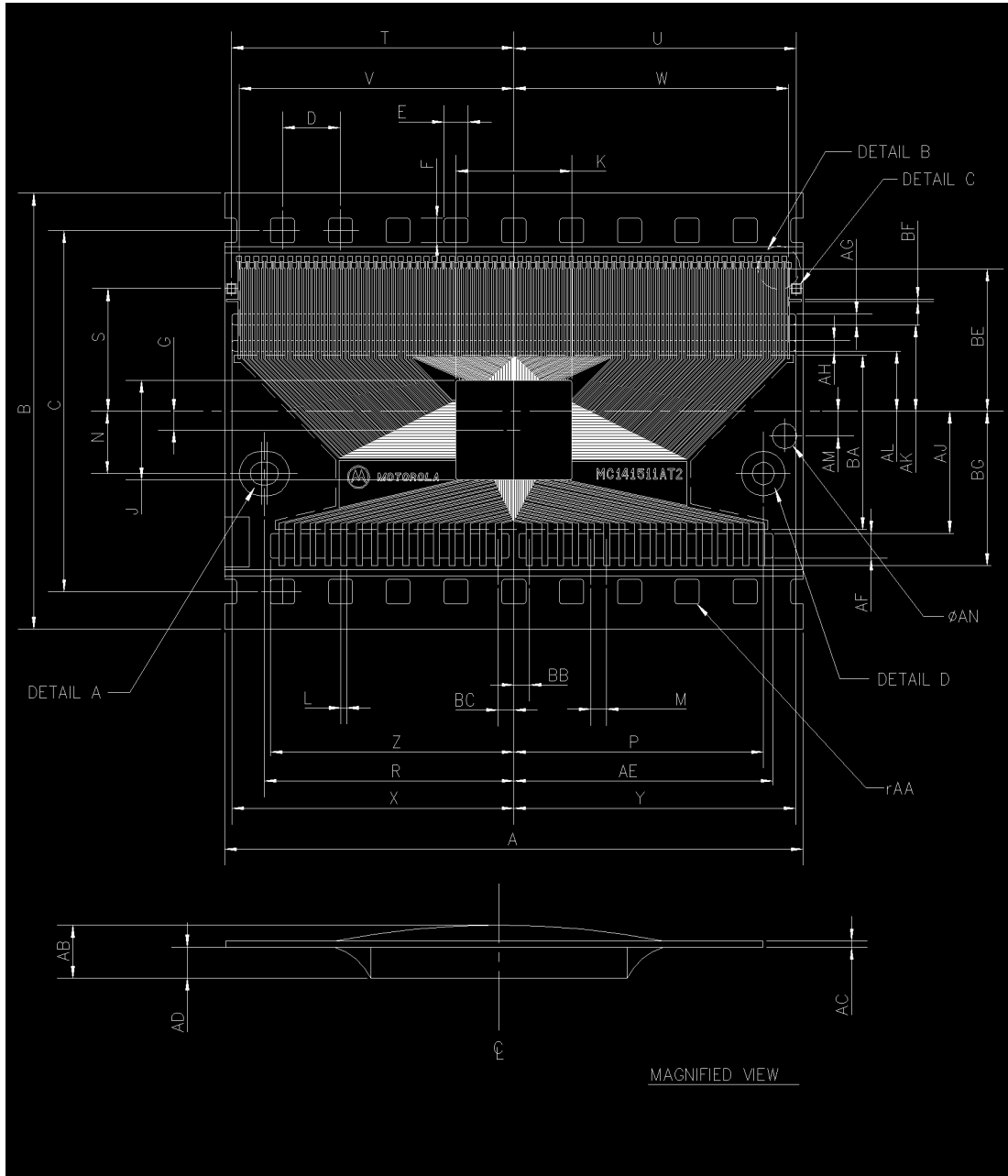


1 : 41

FOUR SLAVES

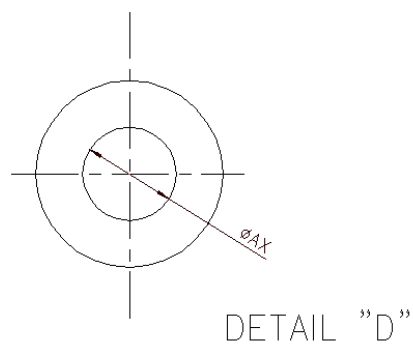
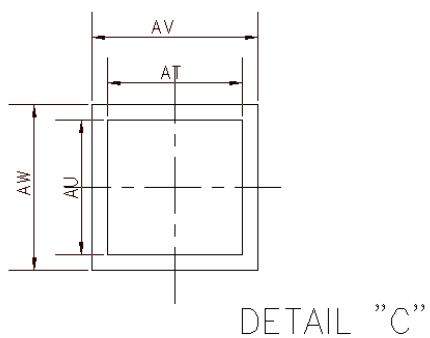
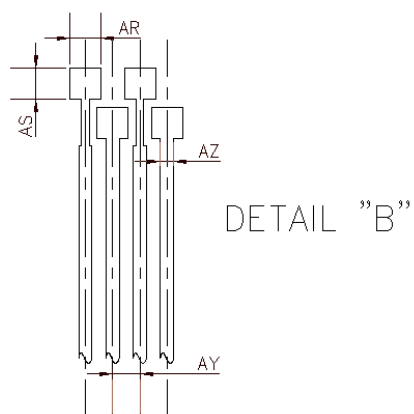
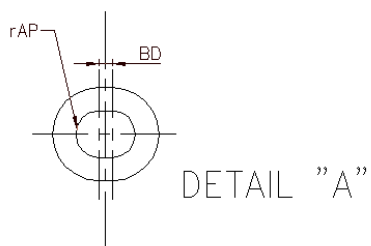
Figure 8. Display RAM Mapping for 1:32 and 1:41 Multiplex Ratio

PACKAGE DIMENSIONS
MC141511AT2
TAB PACKAGE DIMENSION
 (DO NOT SCALE THIS DRAWING)



Reference: 98ASL00183A	Issue "A" released on 04/15/96
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MC141511AT2
TAB PACKAGE DIMENSION
(DO NOT SCALE THIS DRAWING)



Reference: 98ASL00183A

Issue "A" released on 04/15/96

MC141511AT2 TAB PACKAGE DIMENSION

Dim	Millimeters		Inches		Dim	Millimeters		Inches	
	Min	Max	Min	Max		Min	Max	Min	Max
A	46.55	47.55	1.8327	1.8720	AE	21.25	21.35	0.8366	0.8406
B	34.775	35.175	1.3691	1.3848	AF	1.95	2.05	0.0768	0.0807
C	28.947	29.007	1.1396	1.1420	AG	0.85	0.95	0.0335	0.0374
D	4.72	4.78	0.1858	0.1882	AH	0.85	0.95	0.0335	0.0374
E	1.951	2.011	0.0768	0.0792	AJ	9.75	9.85	0.3839	0.3878
F	1.951	2.011	0.0768	0.0792	AK	6.85	6.95	0.2697	0.2736
G	1	2	0.0394	0.0787	AL	4.75	4.85	0.1870	0.1909
H	-	-	-	-	AM	1.95	2.05	0.0768	0.0807
J	7.469	8.469	0.2941	0.3334	AN	1.95	2.05	0.0768	0.0807
K	9.04	10.04	0.3559	0.3953	AP	0.085	0.095	0.0033	0.0037
L	0.48	0.52	0.0189	0.0205	AR	0.35	0.45	0.0014	0.0177
M	1.26	1.28	0.0496	0.0504	AS	0.35	0.45	0.0014	0.0177
N	4.95	5.05	0.1949	0.1988	AT	0.6	0.7	0.0236	0.0276
P	20.45	20.55	0.8051	0.8091	AU	0.6	0.7	0.0236	0.0276
R	20.45	20.55	0.8051	0.8091	AV	0.75	0.85	0.0295	0.0335
S	9.78	9.88	0.3850	0.3890	AW	0.75	0.85	0.0295	0.0335
T	23.155	23.255	0.9116	0.9156	AX	1.75	1.85	0.0689	0.0728
U	23.155	23.255	0.9116	0.9156	AY	0.34	0.36	0.0134	0.0142
V	22.53	22.62	0.8870	0.8905	AZ	0.15	0.19	0.0059	0.0075
W	22.53	22.62	0.8870	0.8905	BA	13.7	14.3	0.5394	0.5630
X	23.1	23.2	0.9094	0.9134	BB	1.22	1.32	0.0480	0.0520
Y	23.1	23.2	0.9094	0.9134	BC	1.22	1.32	0.0480	0.0520
Z	19.95	20.05	0.7854	0.7894	BD	0.45	0.55	0.0177	0.0217
AA	-	0.2	-	0.0079	BE	11.35	11.45	0.4469	0.4508
AB	0.686	0.838	0.027	0.033	BF	0.12	0.22	0.0047	0.0087
AC	0.068	0.063	0.0027	0.0024	BG	12.35	12.45	0.4862	0.4902
AD	0.579	0.629	0.0227	0.0247					

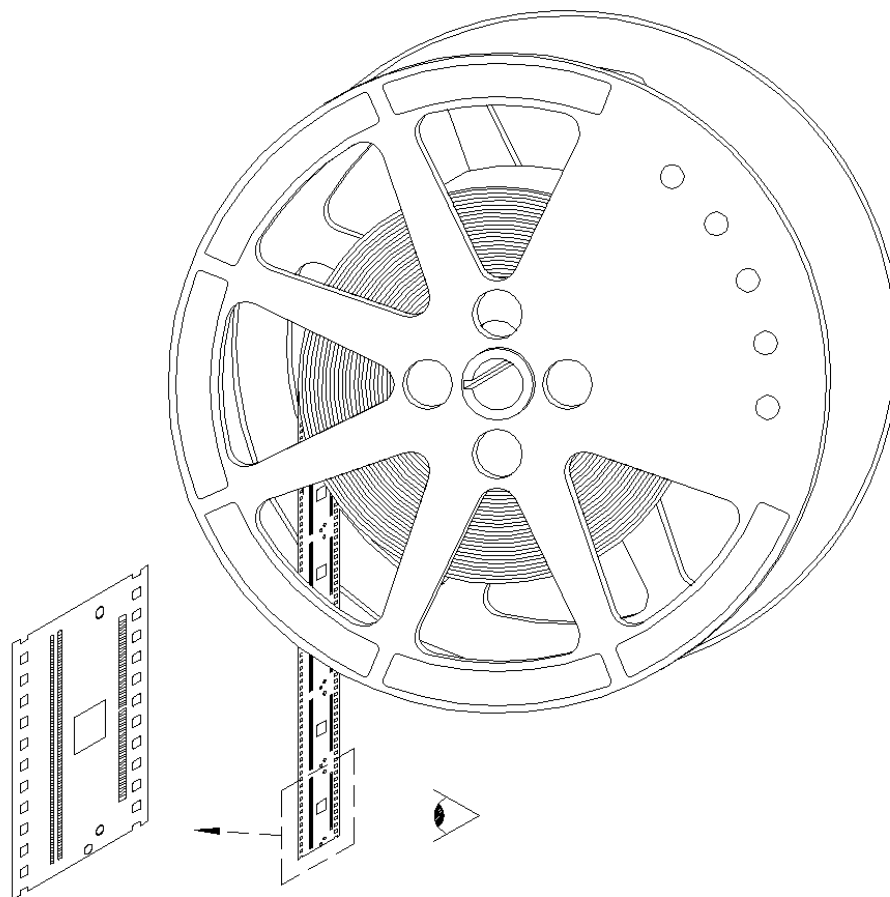
NOTES:

1. Dimensioning and tolerancing per ANSI Y14.5M, 1982.
2. Controlling dimension: millimeter
3. Copper thickness: 1 oz

Reference: 98ASL00183A	Issue "A" released on 04/15/96
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MC141511AT2

TAB TAPE REEL ORIENTATION



Reference: 98ASL00183A

Issue "A" released on 04/15/96

MCC141511A PAD COORDINATES
(UNIT: um)

Pin Name	X	Y	Pin Name	X	Y	Pin Name	X	Y	Pin Name	X	Y
VDD	-1874.62	-2498.76	SEG126	2728.66	-2233.88	SEG86	2630.76	2432.32	SEG39	-2728.66	2227.72
TEST	-1738.66	-2498.76	SEG125	2728.66	-2119.48	SEG85	2516.36	2432.32	SEG38	-2728.66	2113.32
BPSYNC	-1611.06	-2498.76	SEG124	2728.66	-2005.08	SEG84	2401.96	2432.32	SEG37	-2728.66	1998.92
BPCLK	-1483.46	-2498.76	SEG123	2728.66	-1890.68	SEG83	2287.56	2432.32	SEG36	-2728.66	1884.52
MS	-1355.86	-2498.76	SEG122	2728.66	-1776.28	SEG82	2173.16	2432.32	SEG35	-2728.66	1770.12
PHI2	-1228.26	-2498.76	SEG121	2728.66	-1661.88	SEG81	2058.76	2432.32	SEG34	-2728.66	1655.72
CE	-1100.66	-2498.76	SEG120	2728.66	-1547.48	SEG80	1944.36	2432.32	SEG33	-2728.66	1541.32
RW	-973.06	-2498.76	SEG119	2728.66	-1433.08	SEG79	1829.96	2432.32	SEG32	-2728.66	1426.92
A9	-845.46	-2498.76	SEG118	2728.66	-1318.68	SEG78	1715.56	2432.32	SEG31	-2728.66	1312.52
A8	-717.86	-2498.76	SEG117	2728.66	-1204.28	SEG77	1601.16	2432.32	SEG30	-2728.66	1198.12
A7	-590.26	-2498.76	SEG116	2728.66	-1089.88	SEG76	1486.76	2432.32	SEG29	-2728.66	1083.72
A6	-462.66	-2498.76	SEG115	2728.66	-975.48	SEG75	1372.36	2432.32	SEG28	-2728.66	969.32
A5	-335.06	-2498.76	SEG114	2728.66	-861.08	SEG74	1257.96	2432.32	SEG27	-2728.66	854.92
A4	-207.46	-2498.76	SEG113	2728.66	-746.68	SEG73	1143.56	2432.32	SEG26	-2728.66	740.52
A3	-79.86	-2498.76	SEG112	2728.66	-632.28	SEG72	1029.16	2432.32	SEG25	-2728.66	626.12
A2	47.74	-2498.76	SEG111	2728.66	-517.88	SEG71	914.76	2432.32	SEG24	-2728.66	511.72
A1	175.34	-2498.76	SEG110	2728.66	-403.48	SEG70	800.36	2432.32	SEG23	-2728.66	397.32
A0	302.94	-2498.76	SEG109	2728.66	-289.08	SEG69	685.96	2432.32	SEG22	-2728.66	282.92
LRS	430.54	-2498.76	SEG108	2728.66	-174.68	SEG68	571.56	2432.32	SEG21	-2728.66	168.52
D0	558.14	-2498.76	SEG107	2728.66	-60.28	SEG67	457.16	2432.32	SEG20	-2728.66	54.12
D1	685.74	-2498.76	SEG106	2728.66	54.12	SEG66	342.76	2432.32	SEG19	-2728.66	-60.28
D2	813.34	-2498.76	SEG105	2728.66	168.52	SEG65	228.36	2432.32	SEG18	-2728.66	-174.68
D3	940.94	-2498.76	SEG104	2728.66	282.92	SEG64	113.96	2432.32	SEG17	-2728.66	-289.08
D4	1068.54	-2498.76	SEG103	2728.66	397.32	SEG63	-0.44	2432.32	SEG16	-2728.66	-403.48
D5	1196.14	-2498.76	SEG102	2728.66	511.72	SEG62	-114.84	2432.32	SEG15	-2728.66	-517.88
D6	1323.74	-2498.76	SEG101	2728.66	626.12	SEG61	-229.24	2432.32	SEG14	-2728.66	-632.28
D7	1451.12	-2498.76	SEG100	2728.66	740.52	SEG60	-343.64	2432.32	SEG13	-2728.66	-746.68
VLCD	1578.94	-2498.76	SEG99	2728.66	854.92	SEG59	-458.04	2432.32	SEG12	-2728.66	-861.08
VSEGH	1706.54	-2498.76	SEG98	2728.66	969.32	SEG58	-572.44	2432.32	SEG11	-2728.66	-975.48
VSEGL	1834.14	-2498.76	SEG97	2728.66	1083.72	SEG57	-686.84	2432.32	SEG10	-2728.66	-1089.88
VSS	1979.78	-2498.76	SEG96	2728.66	1198.12	SEG56	-801.24	2432.32	SEG9	-2728.66	-1204.28
DUMPAD 4	2111.78	-2498.76	SEG95	2728.66	1312.52	SEG55	-915.64	2432.32	SEG8	-2728.66	-1318.68
DUMPAD 3	2239.38	-2498.76	SEG94	2728.66	1426.92	SEG54	-1030.04	2432.32	SEG7	-2728.66	-1433.08
DUMPAD 2	2366.98	-2498.76	SEG93	2728.66	1541.32	SEG53	-1144.44	2432.32	SEG6	-2728.66	-1547.48
DUMPAD 1	2494.58	-2498.76	SEG92	2728.66	1655.72	SEG52	-1258.84	2432.32	SEG5	-2728.66	-1661.88
SEG127	2619.54	-2498.76	SEG91	2728.66	1770.12	SEG51	-1373.24	2432.32	SEG4	-2728.66	-1776.28
			SEG90	2728.66	1884.52	SEG50	-1487.64	2432.32	SEG3	-2728.66	-1890.68
			SEG89	2728.66	1998.92	SEG49	-1602.04	2432.32	SEG2	-2728.66	-2005.08
			SEG88	2728.66	2113.32	SEG48	-1716.44	2432.32	SEG1	-2728.66	-2119.48
			SEG87	2728.66	2227.72	SEG47	-1830.84	2432.32	SEG0	-2728.66	-2233.88
						SEG46	-1945.24	2432.32			
						SEG45	-2059.64	2432.32			
						SEG44	-2174.04	2432.32			
						SEG43	-2288.44	2432.32			
						SEG42	-2402.84	2432.32			
						SEG41	-2517.24	2432.32			
						SEG40	-2631.64	2432.32			

Die Size : 240.0 x 212.0 mil²

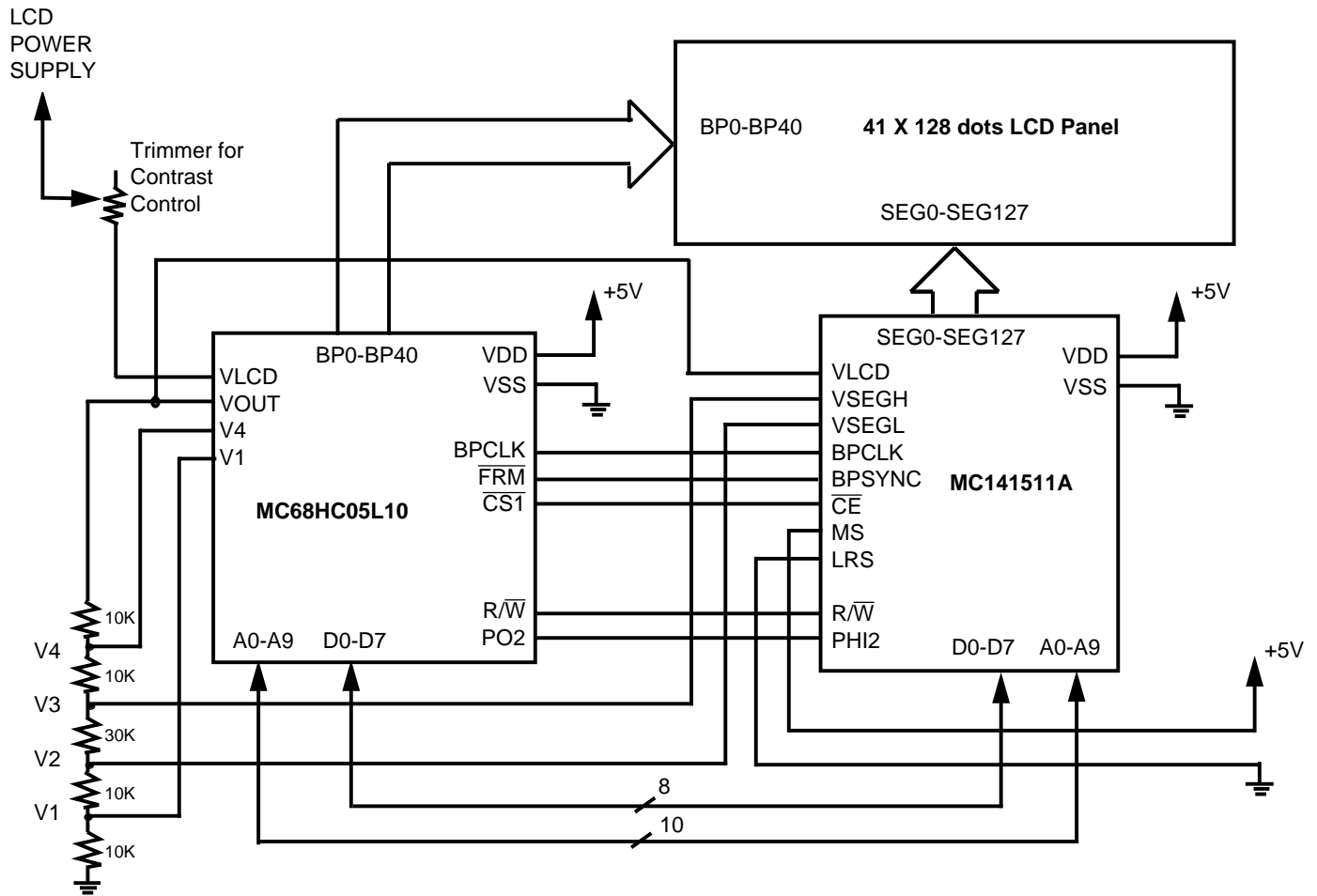
Pad Pitch : 4.5 mil

Note : 1 mil ~ 25.4 μm

DUMPAD 1-4: Dummy pad without connections to internal circuitry

TYPICAL APPLICATIONS

128 X 41 SINGLE PANEL LCD SYSTEM WITH MC68HC05L10



Note : Full capability of MC68HC05L10 can control up to four MC141511A slave LCD drivers with 41 x 512 dots LCD panel. Refer to application note, MC68HC05L10 AN ENHANCED VERSION OF L9 FOR HANDHELD EQUIPMENT APPLICATIONS (AN-HK-13A) for more details.