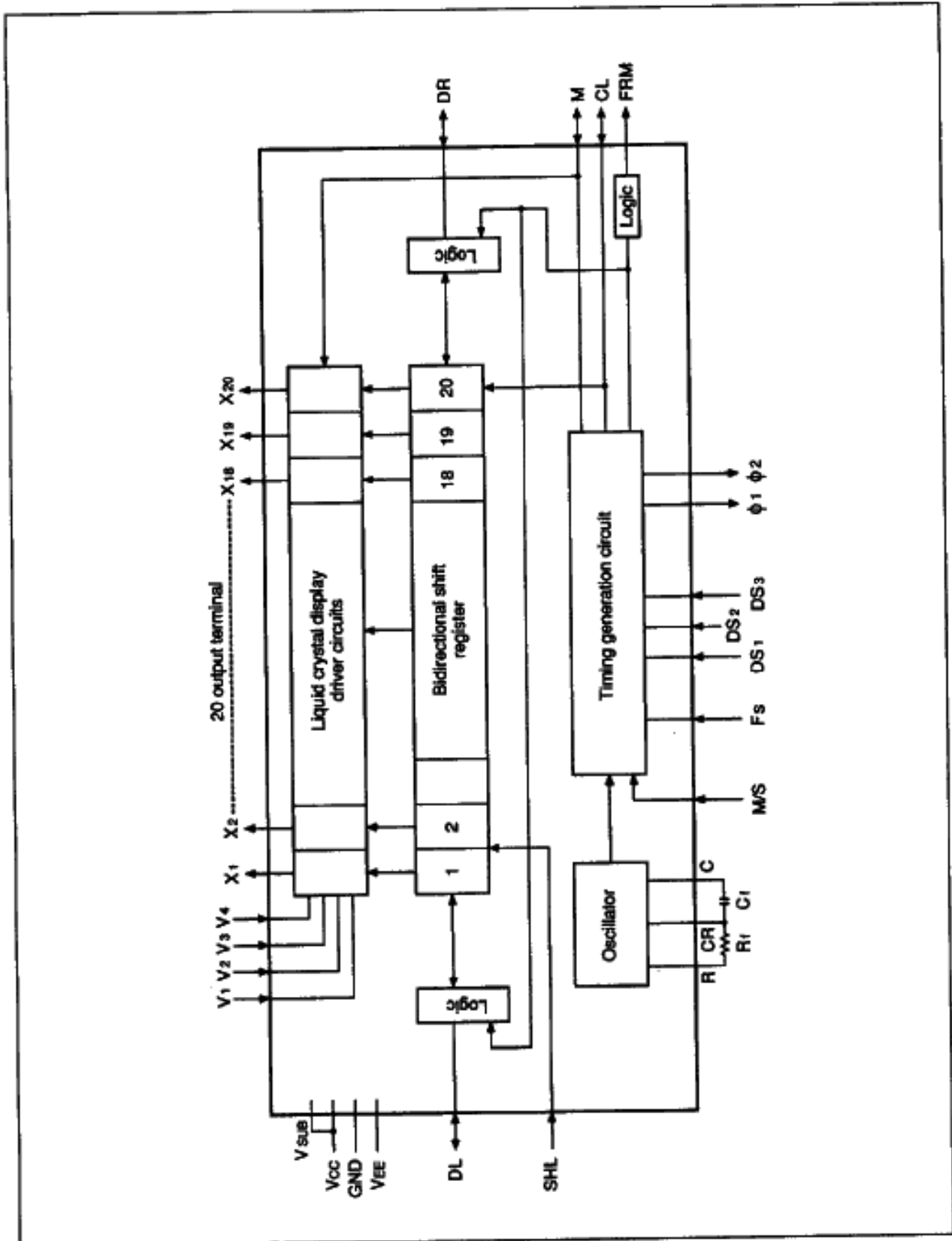




Block Diagram



**Absolute Maximum Ratings**

Item	Symbol	Rated Value	Unit	Note
Supply voltage (1)	$V_{CC}$	-0.3 to +7.0	V	1
Supply voltage (2)	$V_{EE}$	$V_{CC} - 13.5$ to $V_{CC} + 0.3$	V	4
Terminal voltage (1)	$V_{T1}$	-0.3 to $V_{CC} + 0.3$	V	1, 2
Terminal voltage (2)	$V_{T2}$	$V_{EE} - 0.3$ to $V_{CC} + 0.3$	V	3
Operating temperature	$T_{opr}$	-20 to +75	°C	
Storage temperature	$T_{stg}$	-55 to +125	°C	

- Notes: 1. Referenced to GND = 0.  
 2. Applied to input terminals (except V1, V2, V5, and V6) and I/O common terminals.  
 3. Applied to terminals V1, V2, V5, and V6.  
 4. Connect a protection resistor of  $220 \Omega \pm 5\%$  to  $V_{EE}$  power supply in series.

**Electrical Characteristics**

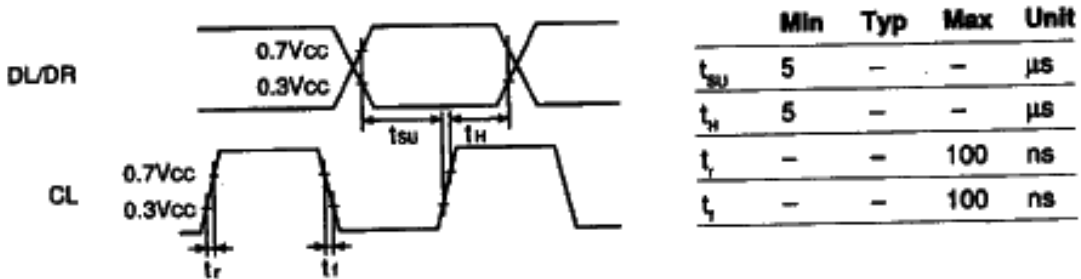
( $V_{CC} = +5 V \pm 10\%$ , GND = 0 V,  $V_{EE} = 0$  to  $-5.5 V$ ,  $T_a = -20$  to  $+75$  °C) (Note 5)

Item	Symbol	Min	Typ	Max	Unit	Test condition	Note
Input high voltage	$V_{IH}$	$0.7 \times V_{CC}$	-	$V_{CC}$	V		6
Input low voltage	$V_{IL}$	0	-	$0.3 \times V_{CC}$	V		6
Output high voltage	$V_{OH}$	$V_{CC} - 0.4$	-	-	V	$I_{OH} = -400 \mu A$	7
Output low voltage	$V_{OL}$	-	-	0.4	V	$I_{OL} = +400 \mu A$	7
VI-Xj on resistance	$R_{ON}$	-	-	500	$\Omega$	$V_{EE} = -5 \pm 10\%$ , Load current $\pm 150 \mu A$	
Input leakage current (1)	$I_{IL1}$	-1	-	1	$\mu A$	$V_{IN} = V_{CC}$ to GND	8
Input leakage current (2)	$I_{IL2}$	-2	-	2	$\mu A$	$V_{IN} = V_{CC}$ to $V_{EE}$	9
Shift frequency	$f_{SFT}$	-	-	50	kHz	In slave mode	10
Oscillation frequency	$f_{OSC}$	300	430	560	kHz	$R_1 = 68 k\Omega \pm 2\%$ $C_1 = 10 pF \pm 5\%$	11
External clock operating frequency	$f_{cp}$	50	-	560	kHz		
External clock duty	Duty	45	50	55	%		12
External clock rise time	$t_{rtp}$	-	-	50	ns		12
External clock fall time	$t_{fcp}$	-	-	50	ns		12
Dissipation power (master)	$P_{w1}$	-	-	4.4	mW	CR oscillation = 430 kHz	13
Dissipation power (slave)	$P_{w2}$	-	-	1.1	mW	Frame frequency = 70 Hz	14

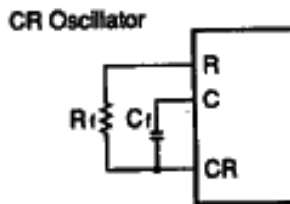


# HD44103

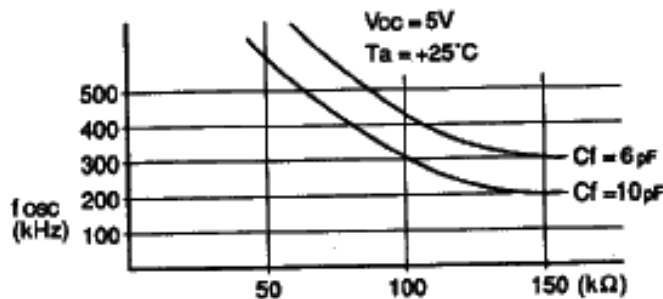
- Notes:
5. Specified within this range unless otherwise noted.
  6. Applied to CR, FS, DS1 to DS3, M, SHL, M/S, CL, DR, and DL.
  7. Applied to DL, DR, M, FRM, CL,  $\phi 1$  and  $\phi 2$ .
  8. Applied to input terminals CR, FS, DS1 to DS3, SHL and M/S, and I/O common terminals DL, DR, M, and CL at high impedance.
  9. Applied to V1, V2, V5, and V6.
  10. Shift operation timing



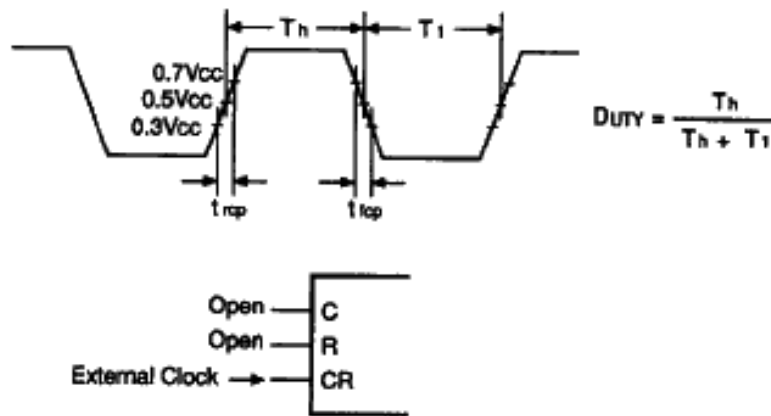
## 11. Relationship between oscillation frequency and $R_1/C_1$



The values of  $R_1$  and  $C_1$  are typical values. The oscillation frequency varies with the mounting condition. Adjust oscillation frequency to the required value.



12.



- 13. Measured by  $V_{CC}$  terminal at output non-load of  $R_l = 68\text{ k}\Omega \pm 2\%$  and  $C_l = 10\text{ pF} \pm 5\%$ , 1/32 duty factor in the master mode. Input terminals must be fixed at  $V_{CC}$  or GND while measuring.
- 14. Measured by  $V_{CC}$  terminal at output non-load, 1/32 duty factor, frame frequency of 70 Hz in the slave mode. Input terminals must be fixed at  $V_{CC}$  or GND while measuring.

**Pin Description**

Pin Name	Pin Number	I/O	Function
X1-X20	20	O	Liquid crystal display driver output. Relationship among output level, M, and data (D) in shift register: 
CR, R, C	3		Oscillator 
M	1	I/O	Signal for converting liquid crystal display driver signal into AC. Master: Output terminal Slave: Input terminal

# HD44103

Pin Name	Pin Number	I/O	Function																												
CL	1	I/O	Shift register shift clock. Master: Output terminal Slave: Input terminal																												
FRM	1	O	Frame signal, Display synchronous signal.																												
DS1-DS3	3	I	Display duty ratio select. <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Display Duty Ratio</th> <th>1/24</th> <th>1/12</th> <th>X</th> <th>1/32</th> <th>1/16</th> <th>1/8</th> </tr> </thead> <tbody> <tr> <td>DS1</td> <td>L</td> <td>H L H</td> <td></td> <td>L</td> <td>H L H</td> <td></td> </tr> <tr> <td>DS2</td> <td>L</td> <td>L H H</td> <td></td> <td>L</td> <td>L H H</td> <td></td> </tr> <tr> <td>DS3</td> <td>L</td> <td>L L L</td> <td></td> <td>H</td> <td>H H H</td> <td></td> </tr> </tbody> </table>	Display Duty Ratio	1/24	1/12	X	1/32	1/16	1/8	DS1	L	H L H		L	H L H		DS2	L	L H H		L	L H H		DS3	L	L L L		H	H H H	
Display Duty Ratio	1/24	1/12	X	1/32	1/16	1/8																									
DS1	L	H L H		L	H L H																										
DS2	L	L H H		L	L H H																										
DS3	L	L L L		H	H H H																										
FS	1	I	Frequency select. The relationship between the frame frequency $f_{FRM}$ and the oscillation frequency $f_{OSC}$ is as follows: FS = High: $f_{OSC} = 6144 \times f_{FRM}$ (1) FS = Low: $f_{OSC} = 3072 \times f_{FRM}$ (2) Example (1) When FS = high, adjust Rf and Cf so that the oscillation frequency is approx. 430 kHz if the frame frequency is 70 Hz. Example (2) When FS = low, adjust Rf and Cf so that the oscillation is approx. 215 kHz, in order to obtain the same display waveforms as example 1. When compared with example 1, the power dissipation is reduced because of operation at lower frequency. However, the operating clocks $\phi 1$ and $\phi 2$ supplied to the column driver have lower frequencies. Therefore, the access time of the column driver HD44102CH becomes longer.																												
DL, DR	2	I/O	Data I/O terminals of bidirectional shift register.																												
SHL	1	I	Shift direction select of bidirectional shift register. <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>SHL</th> <th>Shift Direction</th> </tr> </thead> <tbody> <tr> <td>H</td> <td>DL → DR</td> </tr> <tr> <td>L</td> <td>DL ← DR</td> </tr> </tbody> </table>	SHL	Shift Direction	H	DL → DR	L	DL ← DR																						
SHL	Shift Direction																														
H	DL → DR																														
L	DL ← DR																														

Pin Name	Pin Number	I/O	Function
M/S	1	I	<p>Master/slave select.</p> <p><b>M/S = High: Master mode</b>                      The oscillator and timing generation circuit supply display timing signals to the display system. Each of I/O common terminals, DL, DR, M, and CL is placed in the output state.</p> <p><b>M/S = Low: Slave mode</b>                      The timing generation circuit stops operating. The oscillator is not required. Connect terminal CR to <math>V_{CC}</math>.                      Open terminals C and R. One (determined by SHL) of DL and DR, and terminals M and Cl are placed in the input state.                      Connect M, CL and one of DL and DR of the master to the respective terminals.                      Connect FD, DS1, DS2, and DS3 to <math>V_{CC}</math>.</p> <p>When display duty ratio is 1/8, 1/12, or 1/16, one HD44103CH is required. Use it in the master mode.</p> <p>When display duty ratio is 1/24 or 1/32, two HD44103CHs are required. Use the one in the master mode to drive common signals 1 to 20, and the other in the slave mode to drive common signals 21 to 24 (32).</p>
$\phi 1, \phi 2$	2	O	<p>Operating clock output terminals for HD44102CH.</p> <p>The frequencies of <math>\phi 1</math> and <math>\phi 2</math> become half of oscillation frequency.</p>
V1, V2, V5, V6	4		<p>Liquid crystal display driver level power supply.</p> <p>V1 and V2: Selected level                      V5 and V6: Non-selected level</p>
$V_{CC}$ GND $V_{EE}$	3		<p>Power supply.</p> <p><math>V_{CC}</math>-GND: Power supply for internal logic  <math>V_{CC}</math>-<math>V_{EE}</math>: Power supply for driver circuit logic</p>





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## HD44103

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### Block Functions

#### Oscillator

The oscillator is a CR oscillator attached to an oscillation resistor  $R_f$  and oscillation capacity  $C_f$ . The oscillation frequency varies with the values of  $R_f$  and  $C_f$  and the mounting conditions. Refer to Electrical Characteristics (Note 10) to make proper adjustment.

#### Timing Generation Circuit

The timing generation circuit divides the signals from the oscillator and generates display timing signals (M, CL, and FRM) and operating clock ( $\phi 1$  and  $\phi 2$ ) for HD44102CH according to the display duty ratio set by DS1 to DS3. In the slave mode, this block stops operating. It is meaningless to set FS, DS1 to DS3. However, connect them to  $V_{CC}$  to prevent floating current.

#### Bidirectional Shift Register

20-bit bidirectional shift register. The shift direction is determined by SHL. The data input from DL or DR performs a shift operation at the rise of shift clock CL.

#### Liquid Crystal Display Driver Circuit

Each of 20 driver circuits is a multiplex circuit composed of four CMOS switches. The combination of the data from the shift register with M signal allows one of the four liquid crystal display driver levels V1, V2, V5, and V6 to be transferred to the output terminals.

#### Applications

Refer to the applications of the HD44102CH.