

T6C03

COLUMN AND ROW DRIVER FOR A DOT MATRIX LCD

The T6C03 is a 160-channel-output column and row driver for an STN dot matrix LCD.

The T6C03 features a 42-V LCD drive voltage and an 8-MHz maximum operating frequency. The T6C03 is able to drive LCD panels with a duty ratio of up to 1 / 480.

Features

- Display duty application : to 1 / 480
- LCD drive signal : 160
- Data transfer : Column: 4 / 8-bit bidirectional
Row: Single / Dual bidirectional
- Operating frequency : 8 MHz ($V_{DD} = 5\text{ V} \pm 10\%$)
- LCD drive voltage : 14 to 42 V
- Power supply voltage : 2.7 to 5.5 V
- Operating temperature : -20 to 75°C
- LCD drive output resistance : 1.3 k Ω (max) (20 V, 1 / 13 bias)
- Display-off function : When / DSPOF is L, all LCD drive outputs (O1 to O160) remain at the V5 level.
- Low power consumption : Cascade connection and auto enable transfer functions are available.
- EI / LP input : EI / LP input enables LSI operation.
Connect EIO1 / 2 from the 1st LSI to L.

Unit: mm

T6C03	LEAD PITCH	
	IN	OUT
(UA)	0.8	0.14

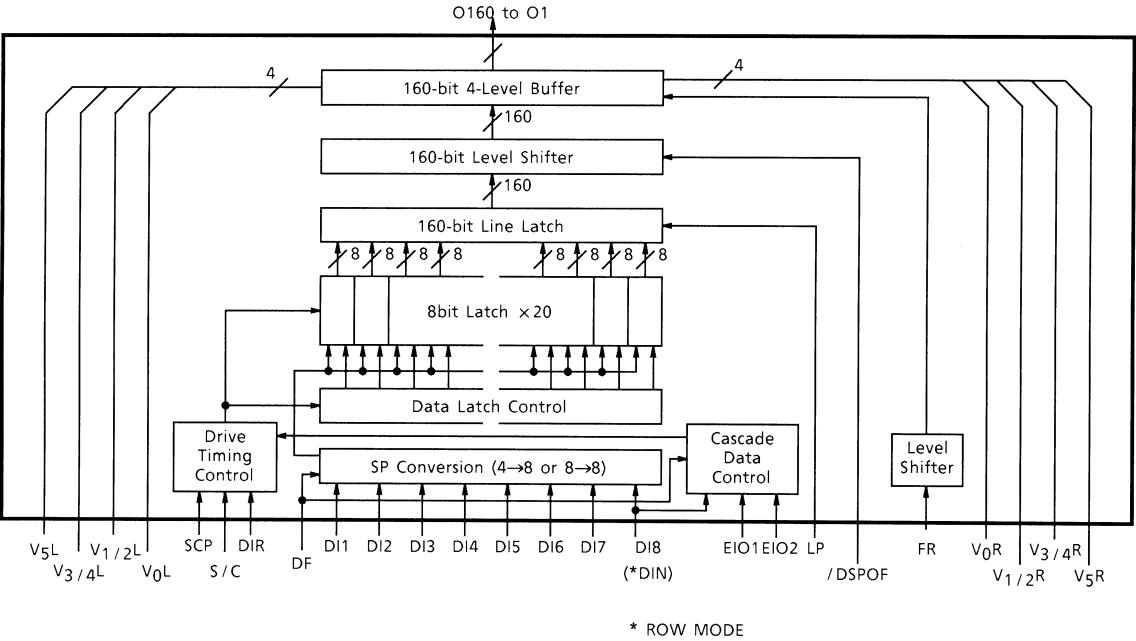
Please contact with Toshiba or an authorized Toshiba dealer for information on package dimensions.

TCP (Tape Carrier Package)

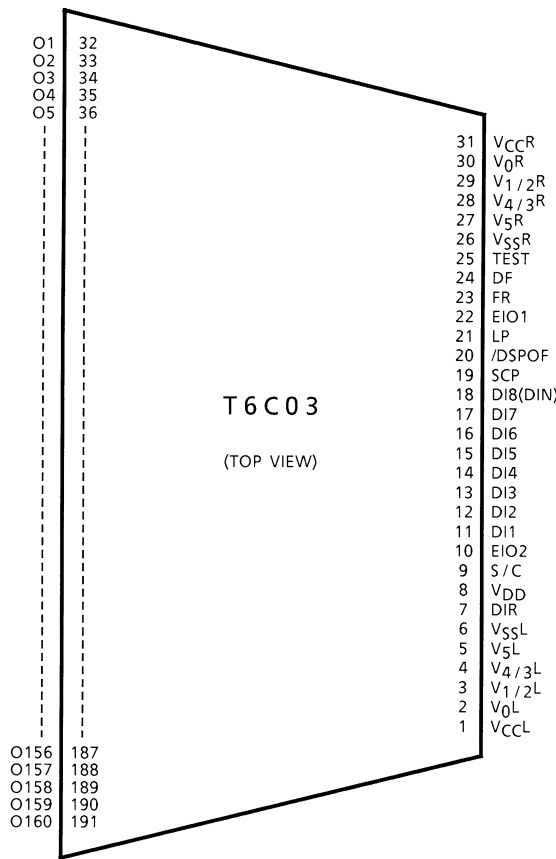
000707EBE1

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- Polyimide base film is hard and thin. Be careful not to injure yourself on the film or to scratch any other parts with the film. Try to design and manufacture products so that there is no chance of users touching the film after assembly, or if they do, that there is no chance of them injuring themselves. When cutting out the film, try to ensure that the film shavings do not cause accidents. After use, treat the leftover film and reel spacers as industrial waste.
- Light striking a semiconductor device generates electromotive force due to photoelectric effects. In some cases this can cause the device to malfunction.
This is especially true for devices in which the surface (back), or side of the chip is exposed. When designing circuits, make sure that devices are protected against incident light from external sources. Exposure to light both during regular operation and during inspection must be taken into account.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.

Block Diagram



Pin Assignment



Note: The above diagram shows the pin configuration of the LSI Chip, not that of the tape carrier package.

Pin Functions

Pin Name	I / O	Functions	Level
O1 to O160	Output	Output for LCD drive signal	V ₀ to V ₅
EIO1, EIO2	I / O	(Column mode) Input / output for enable signal DIR selects In or Out. Connect EIO (IN) of 1st LSI to L. For a cascade connection, connect EIO (OUT) to EIO (IN) of next LSI.	V _{DD} to V _{SS}
		(Row mode) Input / output for shift data DIR = L : EIO1 is output, EIO2 is input DIR = H : EIO1 is input, EIO2 is output	
DI1 to DI8	Input	(Column mode) Input for data signal	
		(Row mode) DI1 to DI7: Fix to H or L, DI8: when DF = H, use as DIN	
DIR	Input	(Direction) Input for data flow direction select	
/ DSPOF	Input	(Display off) / DSPOF = L : Display-off mode, (O1 to O160) remain at the V ₅ level / DSPOF = H: Display-on mode, (O1 to O160) are operational.	
DF	Input	(Data format) Input for data bit select	
LP	Input	(Latch pulse) Display data is latched on falling edges of LP. When EIO (IN) = L, SCP · LP = H enables the 1st LSI.	
		(Row mode) Input for shift clock pulse	
FR	Input	(Frame) Input for frame signal	
SCP	Input	(Column mode) Input for shift clock pulse	
		(Row mode) Fix to H or L	
TEST	Input	(TEST) Fix to L	
S / C	Input	Input for mode select: H = Column mode, L = Row mode	

Pin Name	I / O	Functions	Level
V _{DD}	—	Power supply for internal logic (+5.0 V)	—
V _{SS}	—	Power supply for internal logic (0 V)	
V _{5L} · R	—	Power supply for LCD drive circuit	
V _{3/4L} · R	—	Power supply for LCD drive circuit	
V _{2/1L} · R	—	Power supply for LCD drive circuit	
V _{0L} · R	—	Power supply for LCD drive circuit	
V _{CC} L · R, V _{SS} L · R	—	Power supply for LCD drive circuit	

Relation Between FR, Data Input and Output Level

F R	Data Input	/ Dspof	Output Level (Column Mode)	Output Level (Row Mode)
L	L	H	V ₃	V ₄
L	H	H	V ₅	V ₀
H	L	H	V ₂	V ₁
H	H	H	V ₀	V ₅
(Note)	(Note)	L	V ₅	V ₅

Note: Don't Care

Data Input Format

Column Mode

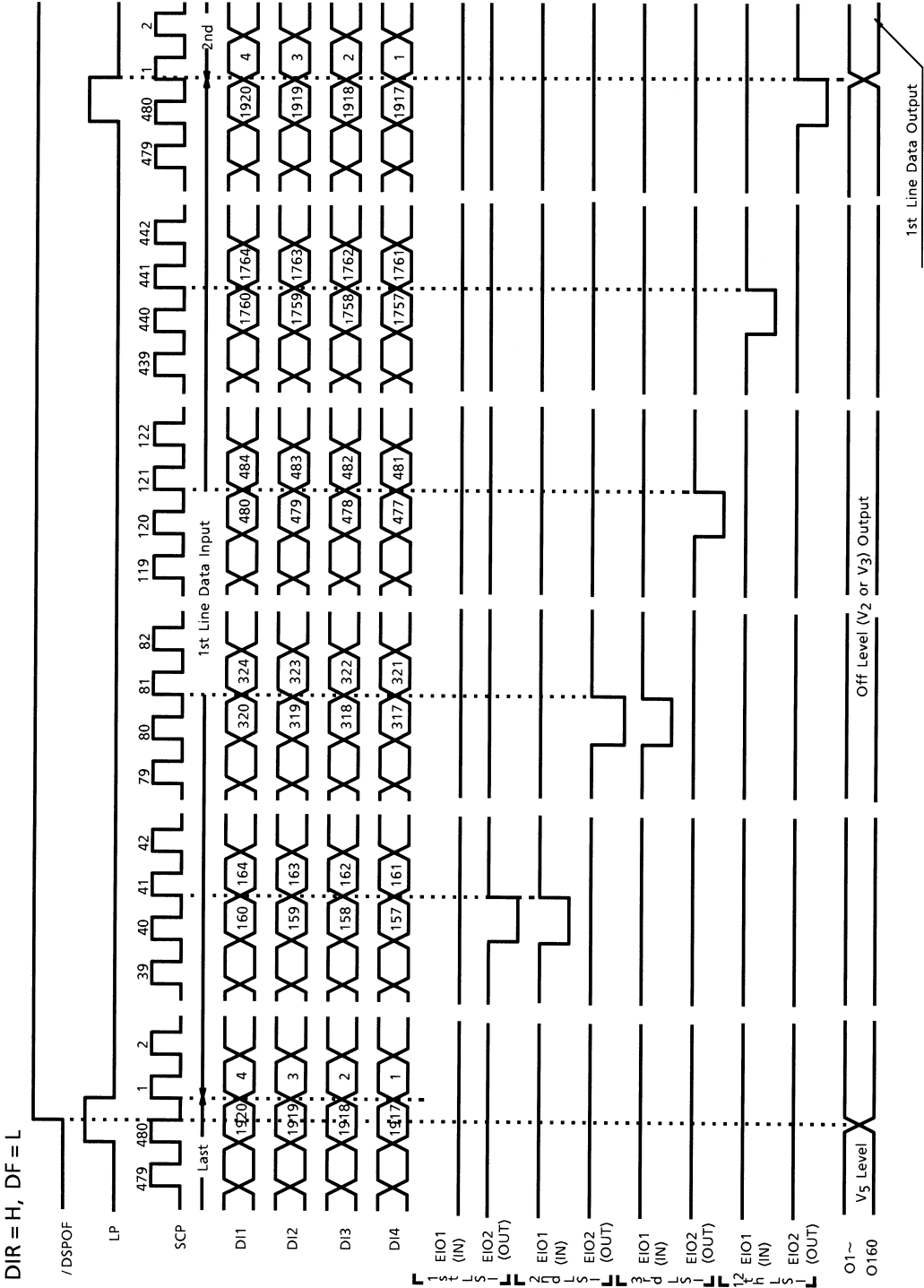
DIR	DF	BIT Mode	Enable Pin		(Note 1)	Input Data Line and Output Buffers							
			EIO1	EIO2		DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8
H	L	4-BIT	IN	OUT	L	O160	O159	O158	O157	—	—	—	—
					F	O4	O3	O2	O1	—	—	—	—
L			OUT	IN	L	O1	O2	O3	O4	—	—	—	—
					F	O157	O158	O159	O160	—	—	—	—
H	H	8-BIT	IN	OUT	L	O160	O159	O158	O157	O156	O155	O154	O153
					F	O8	O7	O6	O5	O4	O3	O2	O1
L			OUT	IN	L	O1	O2	O3	O4	O5	O6	O7	O8
					F	O153	O154	O155	O156	O157	O158	O159	O160

Note 1: L: Last Data
F: First Data

Row Mode

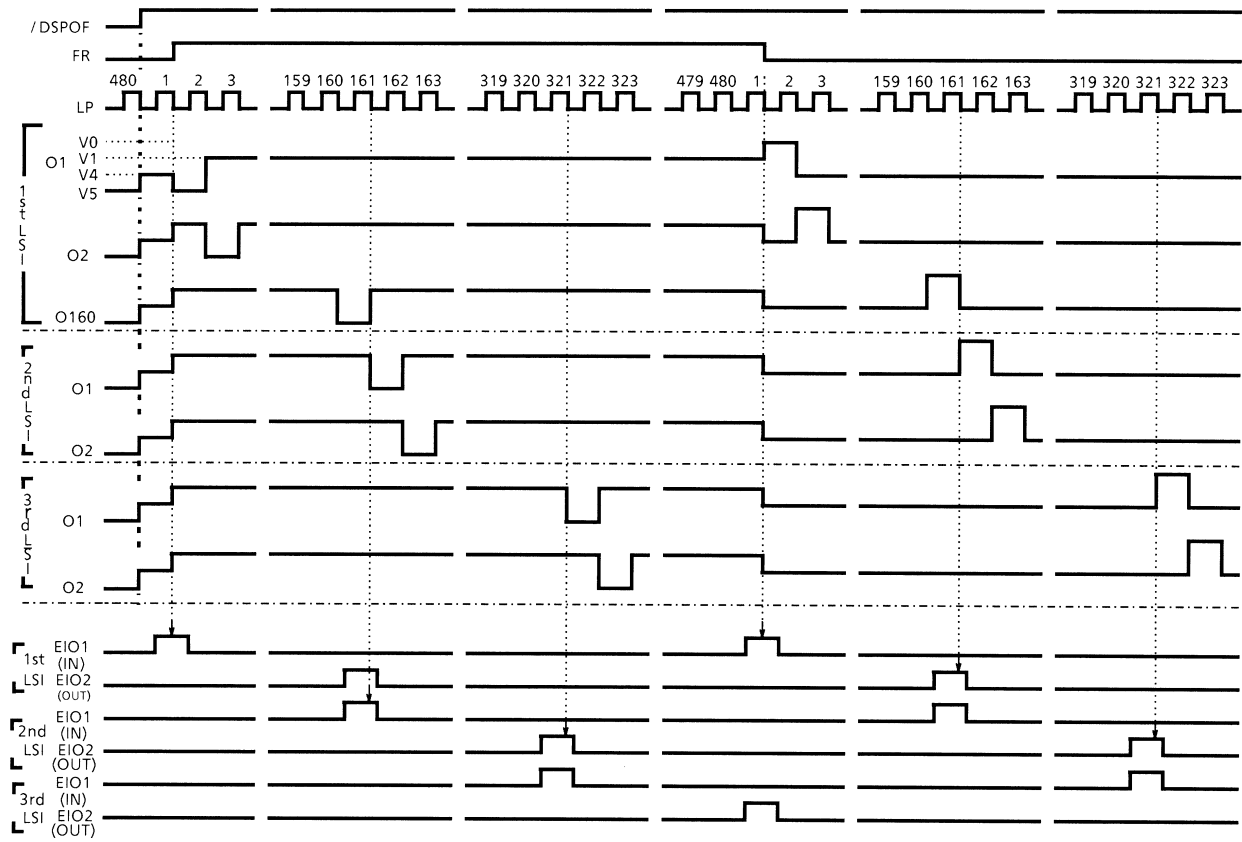
DIR	DF	Data Flow	Data Input Terminals		
			EIO1	EIO2	DIN
L	L	O160 → O1	OUT	IN	—
H		O1 → O160	IN	OUT	—
L	H	O160 → O81 O80 → O1	OUT	IN	IN
H		O1 → O80 O81 → O160	IN	OUT	IN

Timing Diagram (Column mode)



Timing Diagram (Row mode)

DIR = H, DUAL = L



Absolute Maximum Ratings(Ensure that the following conditions are maintained, $V_{CC} \geq V_0 \geq V_2 \geq V_3 \geq V_5 \geq V_{SS}$)

Item	Symbol	Pin Name	Rating	Unit
Supply Voltage (1)	V_{DD}	V_{DD}	-0.3 to 7.0	V
Supply Voltage (2)	V_{CC}	V_{CCL} / R	-0.3 to 45.0	V
Supply Voltage (3)	V_0, V_2	$V_{0L} / R \ V_{2L} / R$	-0.3 to $V_{CC} + 0.3$	V
Supply Voltage (4)	V_3, V_5	$V_{3L} / R \ V_{5L} / R$	-0.3 to 7.0	V
Input Voltage	V_{IN}	(Note 2)	-0.3 to $V_{DD} + 0.3$	V
Operating Temperature	T_{opr}	—	-20 to 75	°C
Storage Temperature	T_{stg}	—	-40 to 125	°C

Note 2: SCP, FR, LP, DIR, DF, S / C, EIO1, EIO2, DI1 to 8, / DSPOF, TEST

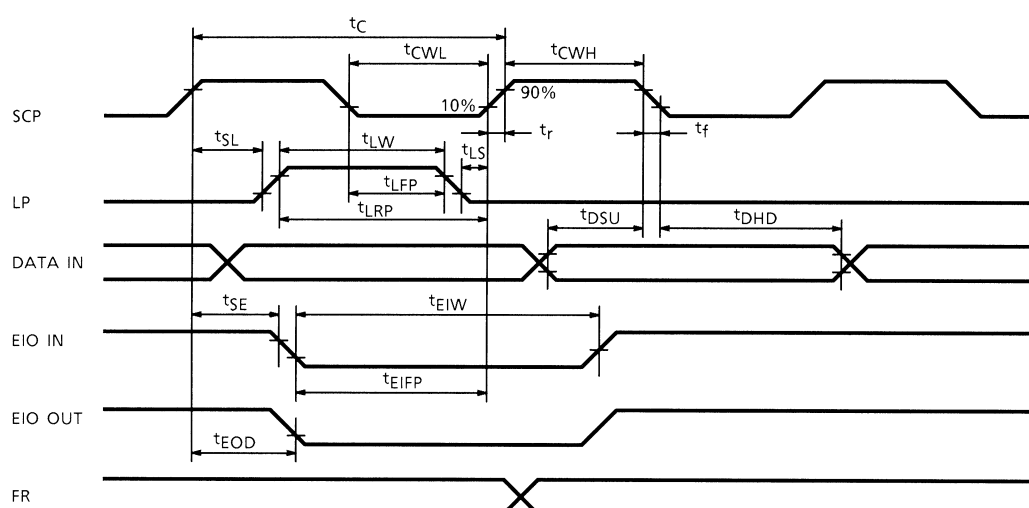
Electrical Characteristics**DC Characteristics**(Unless otherwise noted, $V_{SS} = 0$ V, $V_{DD} = 2.7$ to 5.5 V, $T_a = -20$ to 75°C)

Item	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit	Pin Name
Supply Voltage 1	V_{DD}	—	—	2.7	5.0	5.5	V	V_{DD}
Supply Voltage 2	V_{CC}	—	—	14	—	42		V_{CCL} / R
Input Voltage	H Level	V_{IH}	(Note 2)	0.8 V_{DD}	—	V_{DD}		SCP, FR, LP, DIR, DF, S / C, EIO1, EIO2, DI1 to 8, / DSPOF, TEST
	L Level	V_{IL}		0	—	0.2 V_{DD}		
Output Voltage	H Level	V_{OH}	—	$I_{OH} = -0.5$ mA	$V_{DD} - 0.5$	—	V	EIO1, EIO2
	L Level	V_{OL}	—	$I_{OL} = 0.5$ mA	0	—		
Output Resistance	H Level	R_{OH}	—	$V_{OUT} = V_0 - 0.5$ V (Note 3)	—	0.6	k Ω	O1 to O160
	M Level	R_{OM}	—	$V_{OUT} = V_2 \pm 0.5$ V (Note 3)	—	0.6		
			—	$V_{OUT} = V_3 \pm 0.5$ V (Note 3)	—	0.6		
	L Level	R_{OL}	—	$V_{OUT} = V_5 + 0.5$ V (Note 3)	—	0.6		
Current Consumption (Note 4)	I_{DD}	—	$V_{DD} = 5.5$ V $V_{CC} = 42$ V $f_{LP} = 33$ kHz $f_{FR} = 8.3$ kHz $f_{scp} = 8.0$ MHz Input Data: every bit inverted $V_{IH} = 5.5$ V, $V_{IL} = 0$ V	—	—	4.0	mA	V_{DD}

Note 3: $V_{CC} = 20$ V, 1 / 13 bias

Note 4: Current consumption while the internal data receiver is operating

AC Electrical Characteristics (Column mode)

Test Conditions (1) ($V_{SS} = 0\text{ V}$, $V_{DD} = 5\text{ V} \pm 10\%$, $V_{CC} = 14\text{ to }42\text{ V}$, $T_a = -20\text{ to }75^\circ\text{C}$)

Item	Symbol	Test Condition	Min	Max	Unit
Clock Cycle	t_C	—	125	—	ns
SCP Pulse Width	t_{CWL} , t_{CWH}	—	50	—	ns
Data Set-Up Time	t_{DSU}	—	50	—	ns
Data Hold Time	t_{DHD}	—	50	—	ns
SCP Rise / Fall Time	t_r , t_f	—	—	(Note 5)	ns
LP Rise Time	t_{LRP}	—	50	—	ns
LP Fall Time	t_{LFP}	—	50	—	ns
LP Pulse Width	t_{LW}	—	45	—	ns
SCP-to-LP Delay Time	t_{SL}	—	40	—	ns
LP-to-SCP Delay Time	t_{LS}	—	40	—	ns
EIO IN Fall Time	t_{EIFP}	—	40	—	ns
EIO IN Pulse Width	t_{EIW}	—	40	—	ns
SCP-to-EIO Delay Time	t_{SE}	—	20	—	ns
EIO-OUT Delay Time	t_{EOD}	(Note 6)	—	80	ns

Note 5: t_r , $t_f \leq (t_C - t_{CWH} - t_{CWL}) / 2$ and t_r , $t_f \leq 50\text{ ns}$ Note 6: $C_L = 30\text{ pF}$

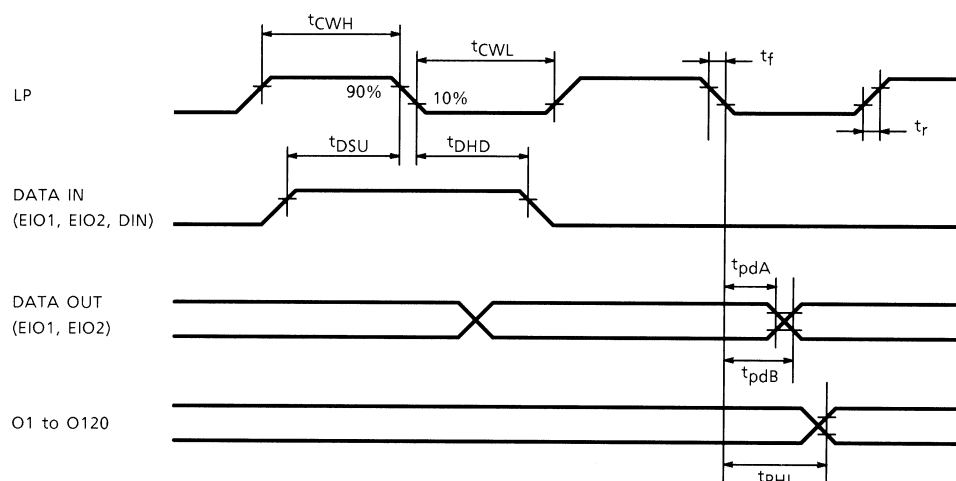
Test Conditions (2) ($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{ to }4.5\text{ V}$, $V_{CC} = 14\text{ to }42\text{ V}$, $T_a = -20\text{ to }75^\circ\text{C}$)

Item	Symbol	Test Condition	Min	Max	Unit
Clock Cycle	t_C	—	500	—	ns
SCP Pulse Width	t_{CWH} , t_{CWL}	—	240	—	ns
Data Set-Up Time	t_{DSU}	—	240	—	ns
Data Hold Time	t_{DHD}	—	240	—	ns
SCP Rise / Fall Time	t_r , t_f	—	—	(Note 7)	ns
LP Rise Time	t_{LRP}	—	220	—	ns
LP Fall Time	t_{LFP}	—	240	—	ns
LP Pulse Width	t_{LW}	—	240	—	ns
SCP-to-LP Delay Time	t_{SL}	—	70	—	ns
LP-to-SCP Delay Time	t_{LS}	—	100	—	ns
EIO IN Fall Time	t_{EIFP}	—	240	—	ns
EIO IN Pulse Width	t_{EIW}	—	240	—	ns
SCP-to-EIO Delay Time	t_{SE}	—	50	—	ns
EIO-OUT Delay Time	t_{EOD}	(Note 8)	—	260	ns

Note 7: t_r , $t_f \leq (t_C - t_{CWH} - t_{CWL}) / 2$ and t_r , $t_f \leq 50\text{ ns}$

Note 8: $C_L = 30\text{ pF}$

AC Electrical Characteristics (Row mode)



Test Conditions (1) ($V_{SS} = 0\text{ V}$, $V_{DD} = 4.5\text{ to }5.5\text{ V}$, $V_{CC} = 14\text{ to }42\text{ V}$, $T_a = -20\text{ to }75^\circ\text{C}$)

Item	Symbol	Test Condition	Min	Max	Unit
LP Pulse Width H	t_{CWH}	LP	30	—	ns
LP Pulse Width L	t_{CWL}	LP	195	—	ns
SCP Rise / Fall Time	t_r, t_f	LP, FR, EIO1, EIO2, DIN	—	20	ns
Data Set-up Time	t_{DSU}	EIO1, EIO2, DIN	80	—	ns
Data Hold Time	t_{DHD}	EIO1, EIO2, DIN	0	—	ns
EIO-OUT Delay Time A (Note 9)	t_{pdA}	EIO1, EIO2, DIN	5	—	ns
EIO-OUT Delay Time B (Note 9)	t_{pdB}	EIO1, EIO2, DIN	—	150	ns
LCD Drive Data Delay Time (Note 10)	t_{PHL}	O1 to O120	—	800	ns

Test Conditions (2) ($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{ to }5.5\text{ V}$, $V_{CC} = 14\text{ to }42\text{ V}$, $T_a = -20\text{ to }75^\circ\text{C}$)

Item	Symbol	Test Condition	Min	Max	Unit
LP Pulse Width H	t_{CWH}	LP	100	—	ns
LP Pulse Width L	t_{CWL}	LP	400	—	ns
SCP Rise / Fall Time	t_r, t_f	LP, FR, EIO1, EIO2, DIN	—	20	ns
Data Set-up Time	t_{DSU}	EIO1, EIO2, DIN	100	—	ns
Data Hold Time	t_{DHD}	EIO1, EIO2, DIN	0	—	ns
EIO-OUT Delay Time A (Note 9)	t_{pdA}	EIO1, EIO2, DIN	5	—	ns
EIO-OUT Delay Time B (Note 9)	t_{pdB}	EIO1, EIO2, DIN	—	400	ns
LCD Drive Data Delay Time (Note 10)	t_{PHL}	O1 to O120	—	1000	ns

Note 9: $C_L = 30\text{ pF}$

Note 10: $C_L = 20\text{ pF}$

Note: Insert the bypass capacitor ($0.1\text{ }\mu\text{F}$) between V_{DD} and V_{SS} , to decrease power supply noise.
Place the bypass capacitor as close to the LSI as possible.