1/2, 1/3 DUTY LCD DRIVER WITH KEY SCAN

■ GENERAL DESCRIPTION

The NJU6435 is a 1/2 or 1/3 duty LCD driver for segment type LCD panel with key scan function.

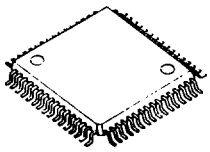
Display data and Key input data are communicated by serial data transmission, therefore, the communication between NJU6435 and MPU is performed by only 5 lines.

80-segment or 120-segment are displayed by 40-segment driver and 2- or 3-common driver.

The key scan function scanning up to 30 keys and the data is transferred to the MPU.

The NJU6435 can design simple front panel, therefore it is easy to apply car mounted audio, general audio and other products which have a display and key input.

■ PACKAGE OUTLINE



NJU6435XF

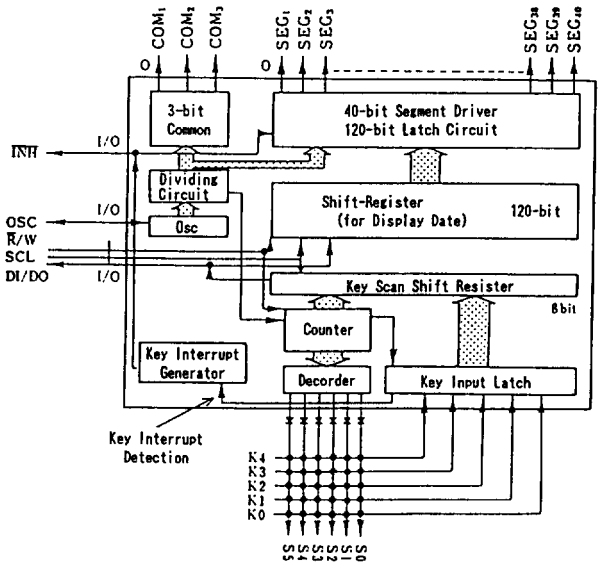
■ FEATURES

- 40-Segment Drivers
- Duty Ratio and Bias Level
  - 1/2 duty, 1/2 bias 80-Segment Drive (Version D)
  - 1/3 duty, 1/2 bias 120-segment Drive (Version E)
  - 1/3 duty, 1/3 bias 120-segment Drive (Version F)
- 30 Key Scan Function (6-out x 5-in Matrix)
- Serial Data Transmission
- Display Off Function ($\overline{INH}$ Terminal)
- Operating Voltage --- 5V±10%
- Package Outline --- QFP 64
- C-MOS Technology

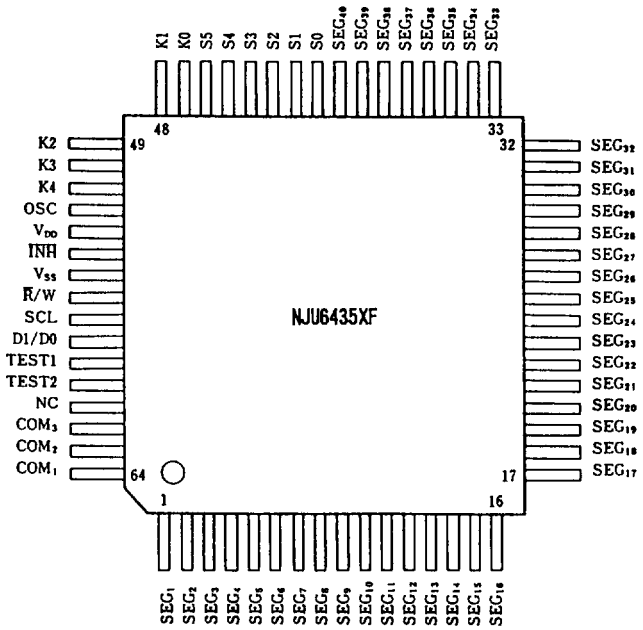
■ LINE UP

LINE UP	DUTY RATIO	BIAS LEVEL	MAX. DISPLAY SEGMENT	COMMON
NJU6435D	1/2 Duty	1/2 Bias	80 Segment	2
NJU6435E	1/3 Duty	1/2 Bias	120 Segment	3
NJU6435F	1/3 Duty	1/3 Bias	120 Segment	3

■ BLOCK DIAGRAM



■ PIN CONFIGURATION



■ TERMINAL DESCRIPTION

NO.	SYMBOL	F U N C T I O N
1~40	SEG_1 ~ SEG_{40}	Segment Output Terminal
41~46	S0 ~ S5	Key Scanning Signal Output Terminal
47~51	K0 ~ K4	Key Scanning Input Terminal (Built-in Pull-down Resistance)
52	OSC	CR Oscillating Terminal (External C, R Connecting)
53,55	V_{DD}, V_{SS}	Power Supply
54	$\overline{INH}$	Display-Off Control / Key Input Interrupt Signal Output Terminal
56	$\overline{R}/W$	Read / Write Control Terminal
57	SCL	Serial Data Transmission Clock Terminal
58	DI/DO	Serial Data Input / Output Terminal
59,60	TEST1, TEST2	Testing Terminal (Normally OPEN)
61	NC	Non Connection
62 63 64	COM_3 COM_2 COM_1	Common Output Terminal. (In the Version D, COM_3 is no active (V_{SS}))

■ FUNCTIONAL DESCRIPTION

(1) Operation of each block

(1-1) Oscillation Circuit
Oscillation by connecting external resistor and capacitor.
This circuits supply the basical clock signal to other circuits like as common driver and segment driver and key scan circuits.

(1-2) Dividing Circuit
This circuit divide the oscillating frequency, and generate the common and segment output timing signals.

(1-3) Common Driver
Output the common driving signal for LCD.

(1-4) Segment Driver
Output the segment driving signal for LCD.
ON and OFF signal output according to the latched data.

(1-5) Shift-Register
During the $\overline{R}/W$ signal is "H", the data input to the shift-register by synchronousing the shift clock on SCL terminal.

(1-6) Counter circuit
This circuits generate key scanning timing. When the key input, the data in the counter is transferred to the key scan shift resistor.

(1-7) Decoder
Decoding the counter output and generate the key scan signal.

(1-8) Key Input Latch
When the key depressed, the decoder output is transfer to the latch.

(1-9) Key Scan Shift Register
Output the data sent from counter circuits and key input latch to the MPU by serial format through the DI/DO port.

(2) Mode of each terminal and Initialization

(2-1) Mode of each Terminal controlled by $\overline{R}/W$ signal

$\overline{R}/W$	$\overline{INH}$	DI / DO
H	LCD Display Control Mode (Input) "H" - Display ON "L" - Display Enforced OFF Key Scan is stopped	LCD Display Data Input Mode (Input) "H" - ON "L" - OFF
L	Key Scan Mode (Output) When key input, Interrupt signal Output LCD enforced off is not effective	Key Input Signal Output Mode (Output) After key interrupt signal output, key input data output from this terminal synchronized by the clock signal.

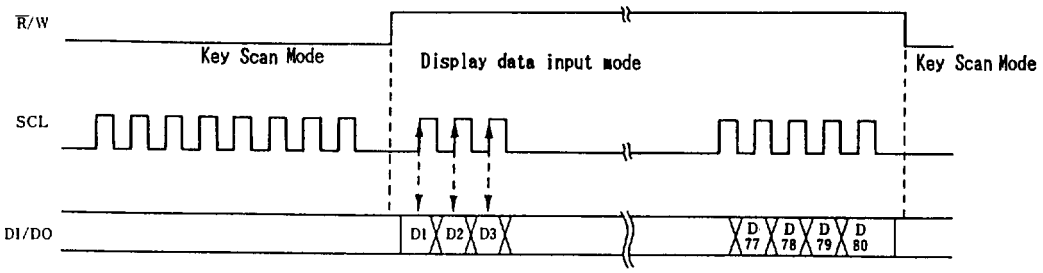
(2-2) Initialization
The NJU6435 series doesn't have a initialization function for the display data.
Therefore, the data in the Shift Register and Latch connected to the segment driver is unfixed when the power turns on.
To avoid the no meaning display, the $\overline{R}/W$ = "H" and $\overline{INH}$ = "L" status should be kept during the display data transmission from the controller to the NJU6435.

(3) Display Data Correspond to Segment Terminals

(3-1) Version D (1/2 Duty)

Data	Segment	COM_1	COM_2
D1	SEG_1	○	
D2	SEG_2	○	
D3	SEG_3	○	
D4	SEG_4	○	
D37	SEG_{37}	○	
D38	SEG_{38}	○	
D39	SEG_{39}	○	
D40	SEG_{40}	○	
D41	SEG_1		○
D42	SEG_2		○
D43	SEG_3		○
D44	SEG_4		○
D77	SEG_{37}		○
D78	SEG_{38}		○
D79	SEG_{39}		○
D80	SEG_{40}		○

・ Data Input / Output Timing



(3-2) Version E and F (1/3 Duty)

Data	Segment	COM_1	COM_2	COM_3
D1	SEG_1	○		
D2	SEG_2	○		
D3	SEG_3	○		
D4	SEG_4	○		
D37	SEG_{37}	○		
D38	SEG_{38}	○		
D39	SEG_{39}	○		
D40	SEG_{40}	○		
D41	SEG_1		○	
D42	SEG_2		○	
D43	SEG_3		○	
D44	SEG_4		○	
D77	SEG_{37}		○	
D78	SEG_{38}		○	
D79	SEG_{39}		○	
D80	SEG_{40}		○	
D81	SEG_1			○
D82	SEG_2			○
D83	SEG_3			○
D84	SEG_4			○
D117	SEG_{37}			○
D118	SEG_{38}			○
D119	SEG_{39}			○
D120	SEG_{40}			○

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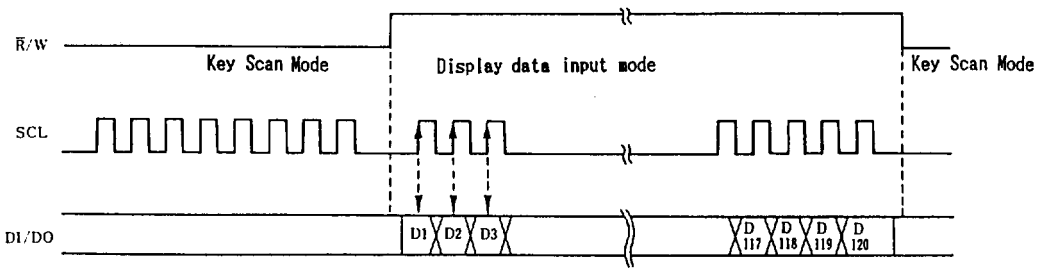
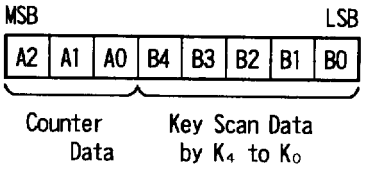
· Data Input / Output Timing

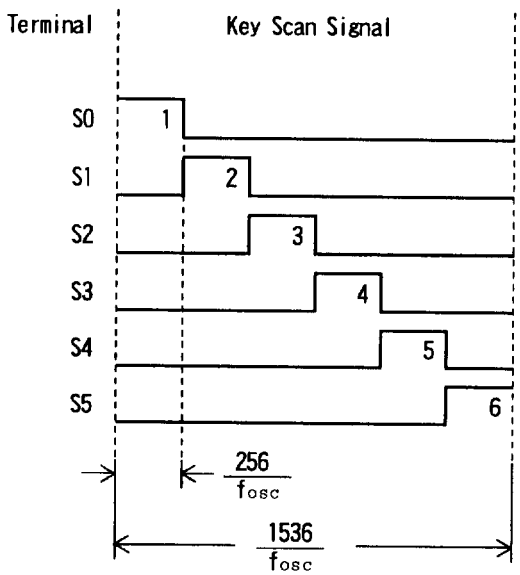


(4) Key Input Data Output Format

(4-1) Data Format



Key Scan Signal Correspond to Counter Data is as follows:



Counter Data		
A2	A1	A0
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1

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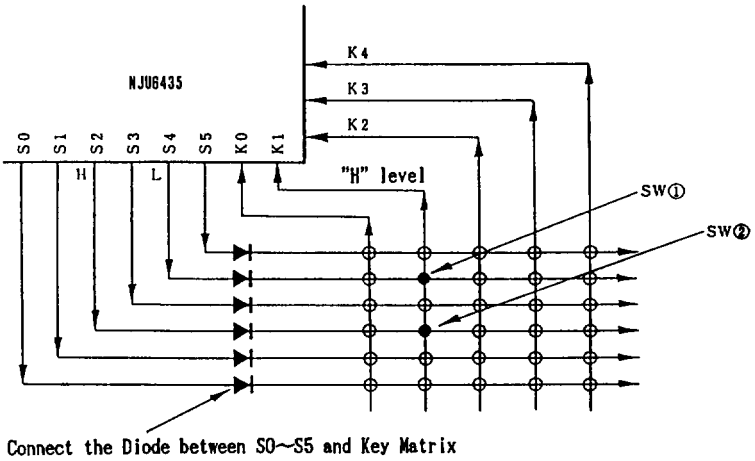
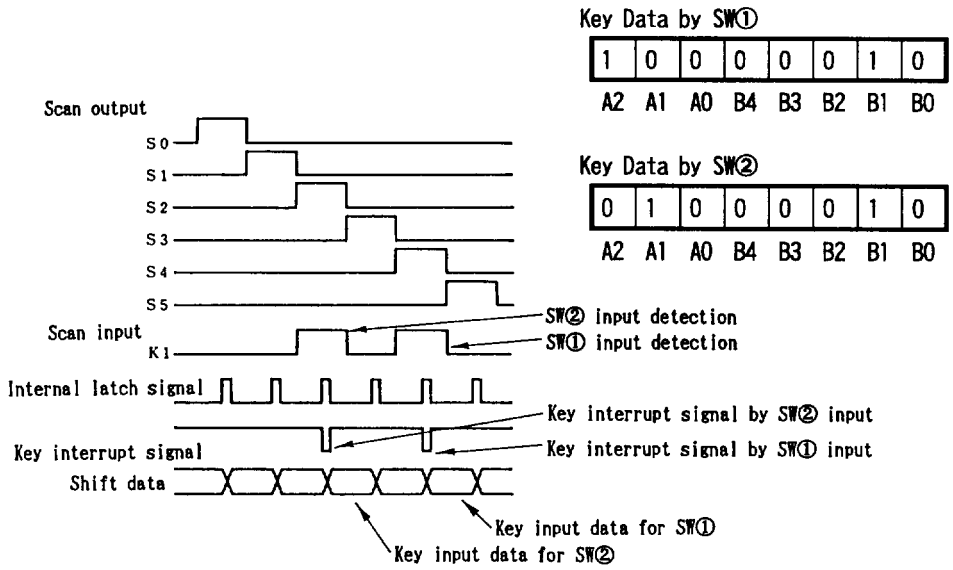
(4-2) Key Scan Output Data in Double or More Input.

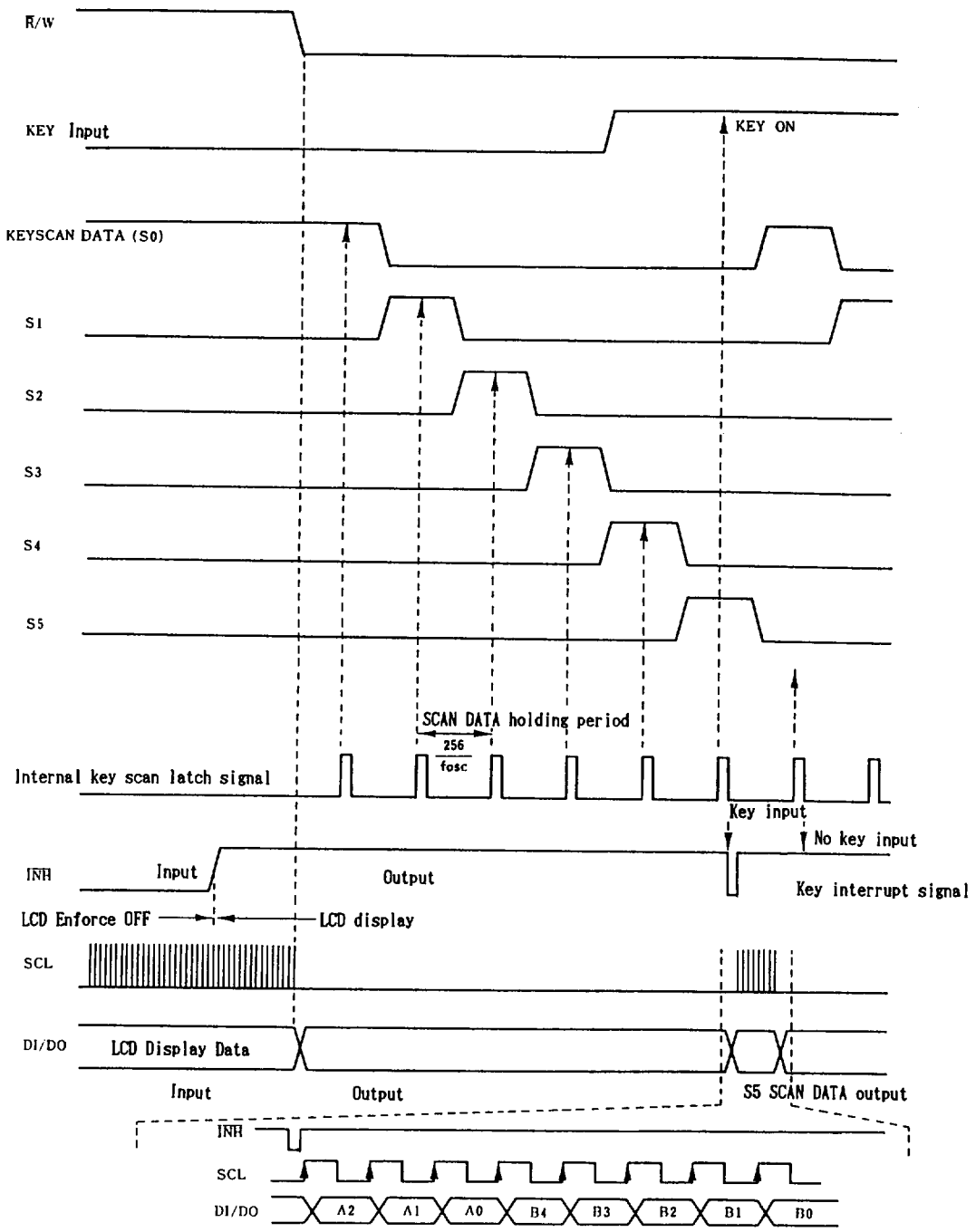
In case of two or more key are depressed at same time, the output data is as follows:
Below example is mentioned SW① and SW② are depressed at once.



In this time, two of key scan code is output as follows:



· Key Scan Timing Chart



■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
Operating Voltage (1)	V_{DD}	- 0.3 ~ + 7.0	V
Input Voltage (1)	V_{IN}	- 0.3 ~ V_{DD}+7.0	V
Output Current (2)	$I_{O(1)}$	100	μA
Output Current (3)	$I_{O(2)}$	1.0	mA
Power Dissipation	P_D	300	mW
Operating Temperature	Topr	- 30 ~ + 85	°C
Storage Temperature	Tstg	- 55 ~ + 150	°C

* 1) $\overline{R}/W$, SCL, $\overline{INH}$, S_0~S_5, DI/DO Terminals
* 2) SEG_1~SEG_{40} Terminals
* 3) COM_1, COM_2, COM_3 Terminals

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■ ELECTRICAL CHARACTERISTICS

DC Characteristics

(Ta=-20～+85°C, V_{DD}=5.0V±10%, V_{SS}=0V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Supply Voltage	V_{DD}		4.5	5.0	5.5	V
Operating Current	I_{DD}	V_{DD} Terminal			2.0	mA
"H" Input Voltage (1)	$V_{IH(1)}$	$\overline{INH}$,K_0～K_4 Terminals	0.7V_{DD}			V
"H" Input Voltage (2)	$V_{IH(2)}$	$\overline{R/W}$,SCL,DI/DO Terminals	0.8V_{DD}			V
"L" Input Voltage (1)	$V_{IL(1)}$	$\overline{INH}$,K_0～K_4 Terminals			0.3V_{DD}	V
"L" Input Voltage (2)	$V_{IL(2)}$	$\overline{R/W}$,SCL,DI/DO Terminals			0.2V_{DD}	V
"H" Input Current	I_{IH}	$\overline{R/W}$,SCL,DI/DO, $\overline{INH}$,K_0～K_4 Terminals			5	μA
"L" Input Current	I_{IL}	$\overline{R/W}$,SCL,DI/DO, $\overline{INH}$,K_0～K_4 Terminals			5	μA
"H" Output Voltage (1)	$V_{OH(1)}$	I_O=-40μA $\overline{INH}$,DI/DO,S_0～S_5 Terminals	4.2			V
"H" Output Voltage (2)	$V_{OH(2)}$	I_O=-10μA SEG_1～SEG_{40} Terminals	4.0			V
"H" Output Voltage (3)	$V_{OH(3)}$	I_O=-100μA COM_1～COM_3 Terminals	4.4			V
"L" Output Voltage (1)	$V_{OL(1)}$	I_O=400μA $\overline{INH}$,DI/DO,S_0～S_5 Terminals			0.4	V
"L" Output Voltage (2)	$V_{OL(2)}$	I_O=10μA SEG_1～SEG_{40} Terminals			1.0	V
"L" Output Voltage (3)	$V_{OL(3)}$	I_O=100μA COM_1～COM_3 Terminals			0.6	V
COM 1/2 Level Voltage	$V_{MC1/2}$	I_O=±100μA COM_1,COM_2 Terminals 1)	1.9	2.5	3.1	V
COM 1/3 Level Voltage	$V_{MC1/3}$	I_O=±100μA COM_1～COM_3 Terminals 2)	1.06	1.66	2.26	V
COM 2/3 Level Voltage	$V_{MC2/3}$	I_O=±100μA COM_1～COM_3 Terminals 2)	2.73	3.33	3.93	V
SEG 1/3 Level Voltage	$V_{MS1/3}$	I_O=±10μA SEG_1～SEG_{40} Terminals 2)	0.66	1.66	2.66	V
SEG 2/3 Level Voltage	$V_{MS2/3}$	I_O=±10μA SEG_1～SEG_{40} Terminals 2)	2.33	3.33	4.33	V
External Resistance	R	OSC Terminal		51		kΩ
External Capacitance	C	OCS Terminal		680		pF
Oscillator Frequency	f_{osc}	R=51kΩ,C=680pF	40	50	60	kHz

Note 1) Version D and E
2) Version F

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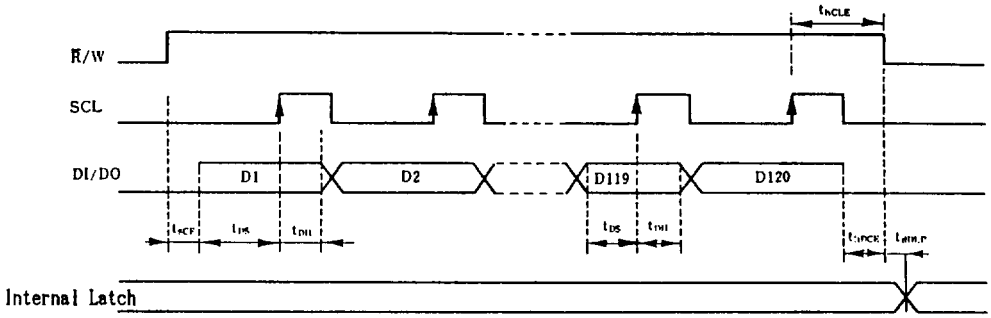
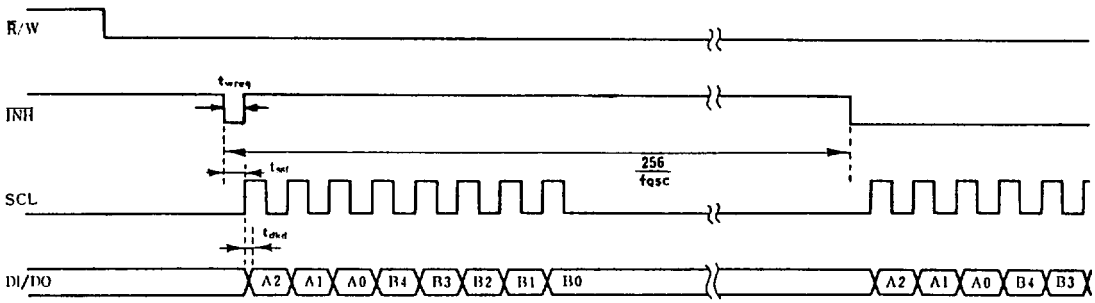
AC Characteristics (Ta=-20~+85°C, V_{DD}=5.0V±10%, V_{SS}=0V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
"L" Clock Pulse Width	tw_{CLL}	SCL Terminal	0.50			μs
"H" Clock Pulse Width	tw_{CLH}	SCL Terminal	0.50			μs
Data Set-up Time	t_{DS}	SCL,DI/DO Terminals	0.50			μs
Data Hold Time	t_{DH}	SCL,DI/DO Terminals	0.50			μs
CE Set-up Time	ts_{CE}	$\overline{R}$/W,DI/DO Terminals	1.0			μs
CE Hold Time (1)	th_{DCE}	$\overline{R}$/W,DI/DO Terminals	1.0			μs
CE Hold Time (2)	th_{CLE}	$\overline{R}$/W,SCL Terminals	1.50			μs
Data Latch Delay Time	td_{DLP}				1.0	μs
"L" Clock Enable Pulse Width	tw_{CEL}	$\overline{R}$/W Terminal	4.0			μs
Request Pulse Width	twreq	$\overline{INH}$ Terminal		1/fosc		μs
Data Shift Set-up Time	tssf	$\overline{INH}$,SCL Terminals	0.5			μs
Data Output Delay Time	tdkd	SCL,DI/DO Terminals	0.1			μs

・Input Timing Characteristics

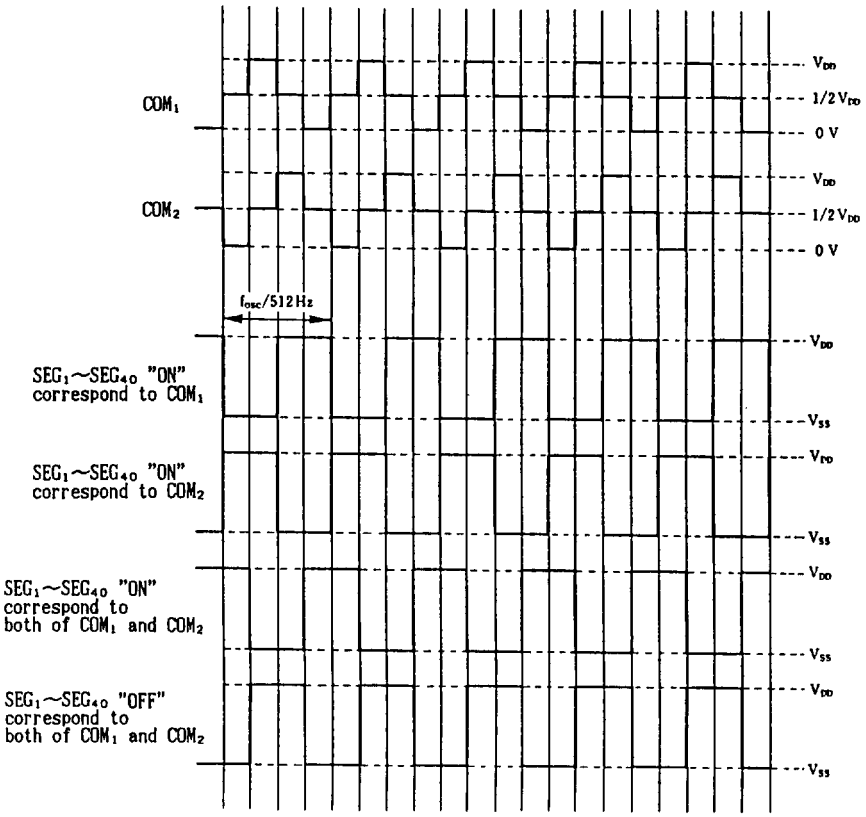


・Output Timing Characteristics

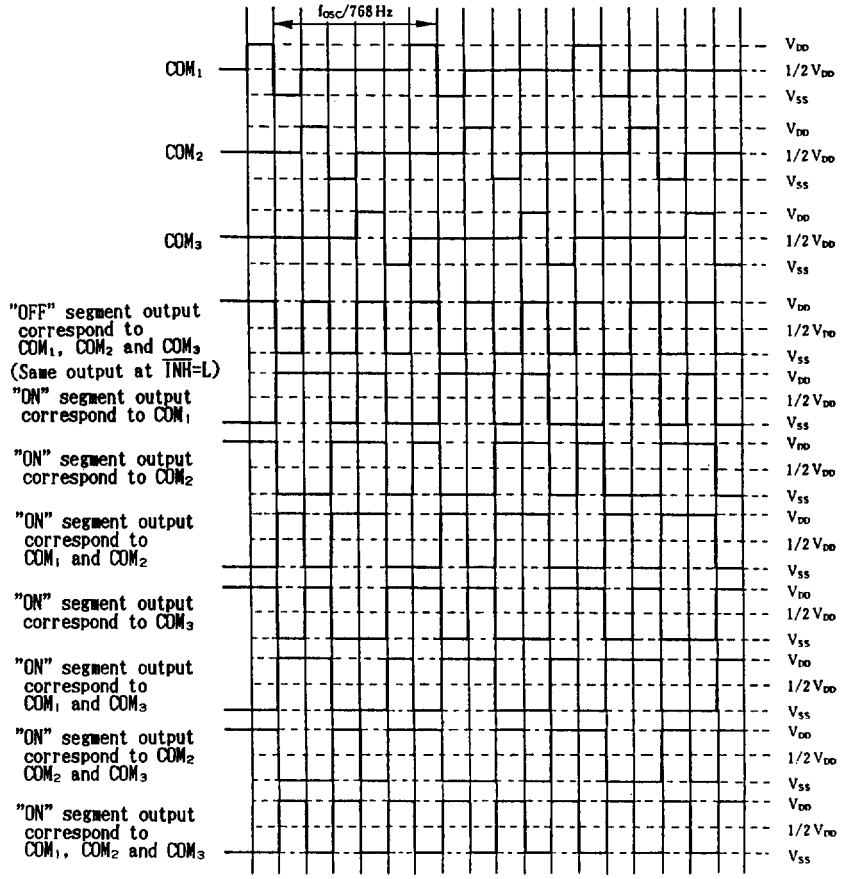


(5) LCD Driving Waveform

(5-1) Version D (1/2Bias,1/2Duty)



(5-2) Version E (1/2Bias,1/3Duty)



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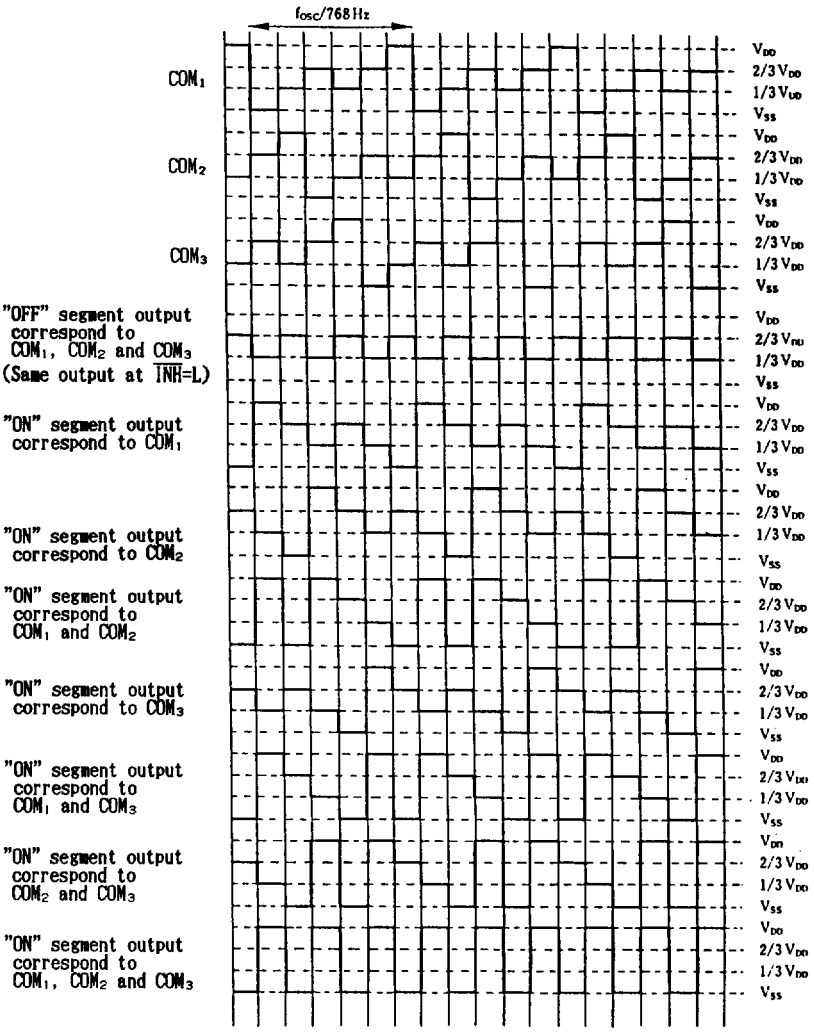
(5-3) Version F (1/3Bias,1/3Duty)



■ APPLICATION CIRCUIT