

40 CH Driver for Dot Matrix LCD

## FEATURES

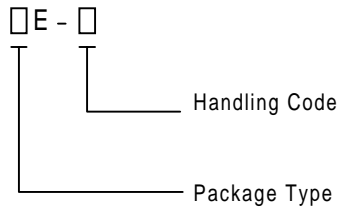
- Display driving bias ; static-1/5
- Power supply voltage ;  $V_{DD} = +5V \pm 10\%$   
 $V_{DD} = +3V \pm 10\%$
- Supply voltage range for display :  $\leq 10V$
- Negative display voltage :  
 $0 \geq V_{EE} \geq V_{DD} - 10V$
- Interface

<b>Driver (cascade connection)</b>	<b>Controller</b>
Other APU0065	APU0066

## GENERAL DESCRIPTION

The APU0065 is a LCD driver LSI that is fabricated by low power CMOS technology. Basically this LSI consists of  $20 \times 2$  bit bi-directional shift register,  $20 \times 2$  bit data latch and  $20 \times 2$  bit driver. This LSI can be CMOS Process used a Common or Segment driver.

## ORDERING INFORMATION

<p>APU0065 □E - □</p> 	<p>Package Type Q : QFP Y : Chip</p> <p>Handling Code TY : Tray</p>
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## APPLICATIONS

- Dot matrix LCD driver with 40 channel output.
- Selectable function to use Common / Segment drivers simultaneously.
- Input / Output signal
- Output ;  $20 \times 2$  channel waveform for LCD driving
- Input ; - Serial display data and control pulse from the controller LSI .
- Bias voltage ( $V_1 - V_6$ )
- QFP64 and bare chip available

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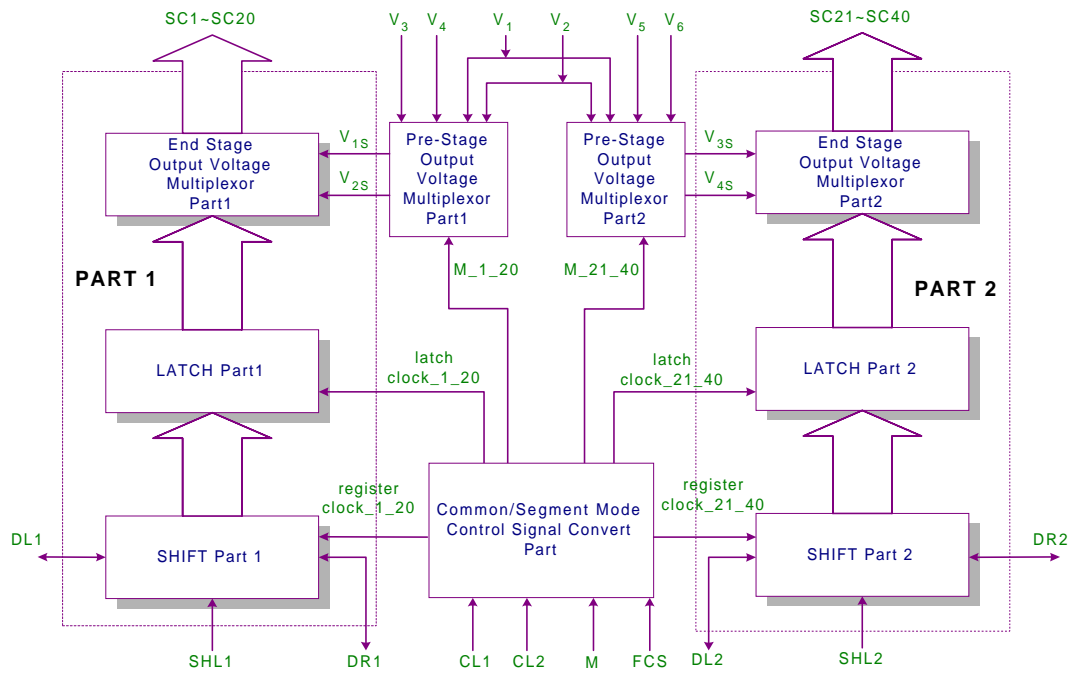


Figure 1. Block diagram of APU0065

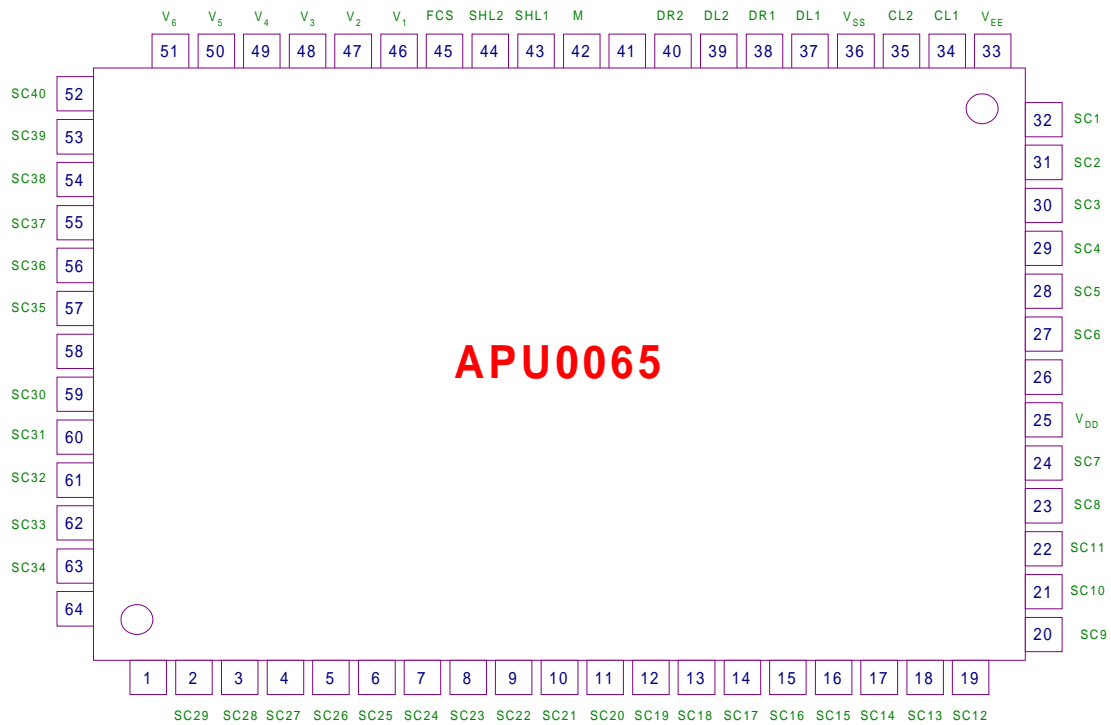

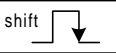

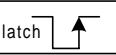

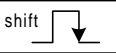

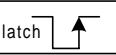

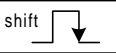

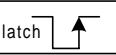


Figure 2. QFP 64 Top View

## PIN DESCRIPTION-QFP100

PAD (NO.)	INPUT/OUTPUT	NAME	DESCRIPTION	INTERFACE												
V <sub>EE</sub> (33)	Power	Negative Supply Voltage	For LCD driver circuit( $0 \geq V_{EE} \geq V_{DD} - 10V$ )	Power Supply												
V <sub>DD</sub> (25)	Power	Operating Voltage	For logical circuit ( $+5V \pm 10\%$ , $+3V \pm 10\%$ )	Power Supply												
V <sub>SS</sub> (36)	Power	Operating Voltage	0V (GND)	Power Supply												
V <sub>1</sub> ~ V <sub>6</sub> (46 ~ 51)	Input	Bias Voltage	Bias Voltage level for LCD drive	Power Supply												
M (42)	Input	Altemated signal for LCD driver output	This is the signal for LCD twisting	Controller												
CL1, CL2 (34, 35)	Input	Data shift / latch clock	These signal control the shift and latch of driver. More detail scription in next line <b>FCS</b> .	Controller												
FCS (45)	Input	Mode selection	<p>If FCS equals to V<sub>SS</sub>, Part1 and Part2 both are segment mode.                      If FCS equals to V<sub>DD</sub>, Part1 is segment mode but Part2 is common mode .</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Mode</th> <th>CL1</th> <th>CL2</th> <th>M</th> </tr> </thead> <tbody> <tr> <td>Segment</td> <td>latch </td> <td>shift </td> <td>M</td> </tr> <tr> <td>Common</td> <td>shift </td> <td>latch </td> <td><math>\bar{M}</math></td> </tr> </tbody> </table>	Mode	CL1	CL2	M	Segment	latch 	shift 	M	Common	shift 	latch 	$\bar{M}$	Controller
Mode	CL1	CL2	M													
Segment	latch 	shift 	M													
Common	shift 	latch 	$\bar{M}$													
SHL1 (43)	Input	Shifting direction control signal of Part1	Selection of the shift direction of Part 1 shift register <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>SHL1</th> <th>DL1</th> <th>DR1</th> </tr> </thead> <tbody> <tr> <td>V<sub>DD</sub></td> <td>output</td> <td>input</td> </tr> <tr> <td>V<sub>SS</sub></td> <td>input</td> <td>output</td> </tr> </tbody> </table>	SHL1	DL1	DR1	V <sub>DD</sub>	output	input	V <sub>SS</sub>	input	output	Controller			
SHL1	DL1	DR1														
V <sub>DD</sub>	output	input														
V <sub>SS</sub>	input	output														
DL1, DR1 (37, 38)	Input Output	Data interface	Data input / output of Part1 shift register	Controller or APU0063												
SC1 ~ SC20	Output	LCD driver	LCD driver output of Part1	LCD												
SHL2 (44)	Input	Shifting direction control signal of Part2	Selection of the shift direction of Part 2 shift register <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>SHL2</th> <th>DL2</th> <th>DR2</th> </tr> </thead> <tbody> <tr> <td>V<sub>DD</sub></td> <td>output</td> <td>Input</td> </tr> <tr> <td>V<sub>SS</sub></td> <td>Input</td> <td>output</td> </tr> </tbody> </table>	SHL2	DL2	DR2	V <sub>DD</sub>	output	Input	V <sub>SS</sub>	Input	output	Controller			
SHL2	DL2	DR2														
V <sub>DD</sub>	output	Input														
V <sub>SS</sub>	Input	output														
DL2, DR2 (39, 40)	Input Output	Data interface	Data input / output of Part 2 shift register	Controller or APU0063												
SC21 ~ SC40	Output	LCD driver	LCD driver output of Part2	LCD												

Note : Input pin can not be floated, or it will cause large leakage current.

## SEGMENT MODE

When Part1 or Part2 be selected to work in segment mode (FCS pin =  $V_{SS}$ ), these are the liquid crystal segment drive outputs. A signal of driving pin in segment mode is the one of  $V_1, V_2, V_3$  or  $V_4$ . These selecting are following.

Data of latch	M	Output voltage
High	High	$V_1$
High	Low	$V_2$
Low	High	$V_3$
Low	Low	$V_4$

## COMMON MODE

Only Part2 can be selected to work in common mode (FCS pin =  $V_{DD}$ ). These are the liquid crystal common drive outputs signal of driving pin in segment mode is the one of  $V_1, V_2, V_5$  or  $V_6$ . These selecting are following.

Data of latch	M	Output voltage
High	High	$V_2$
High	Low	$V_1$
Low	High	$V_6$
Low	Low	$V_5$

## SHIFT DIRECTION SPECIFICATION

### Part1

When Part1 shift direction control signal, SHL1, is set to  $V_{SS}$ .  
 Now the Part1 register shift direction is  
 $DL1 \rightarrow SC1 \rightarrow SC2 \rightarrow \dots \rightarrow SC19 \rightarrow SC20 \rightarrow DR1$   
 Otherwise, when SHL1 is set to  $V_{DD}$ . Its direction is  
 $DL1 \leftarrow SC1 \leftarrow SC2 \leftarrow \dots \leftarrow SC19 \leftarrow SC20 \leftarrow DR1$

### Part2

When Part2 shift direction control signal, SHL2, is set to  $V_{SS}$ .  
 Now the Part1 register shift direction is  
 $DL2 \rightarrow SC21 \rightarrow SC22 \rightarrow \dots \rightarrow SC39 \rightarrow SC40 \rightarrow DR2$   
 Otherwise, when SHL2 is set to  $V_{DD}$ . Its direction is  
 $DL2 \leftarrow SC21 \leftarrow SC22 \leftarrow \dots \leftarrow SC39 \leftarrow SC40 \leftarrow DR2$

## MAXIMUM ABSOLUTE LIMIT (Ta = 25 °C)

Characteristic	Symbol	Value	Unit
Operating Voltage	$V_{DD}$	-0.3 ~ +7.0	V
Driver Supply Voltage	$V_{LCD}$	$V_{DD}-13.5 \sim V_{DD}+0.3$	V
Input Voltage 1	$V_{IN1}$	-0.3 ~ $V_{DD}+0.3$	V
Input Voltage 2 ( $V_1 \sim V_6$ )	$V_{IN2}$	$V_{DD}+0.3 \sim V_{EE}-0.3$	V
Operating Temperature	$T_{OPR}$	-30 ~ +85	°C
Storage Temperature	$T_{STG}$	-55 ~ +125	°C

**ELECTRICAL CHARACTERISTICS**

 DC characteristics ( $V_{DD} = 2.7 \sim 5.5V$ ,  $0 \geq V_{EE} \geq V_{DD} - 10V$ ,  $V_{SS} = 0V$ ,  $T_a = -30 \sim +85 \text{ }^\circ\text{C}$ )

Characteristic	Symbol	Test condition	Min	Max	Unit	Applicable pin
Operating Current*	$I_{DD}$	$f_{CL2} = 400\text{KHz}$	-	1	mA	-
Supply Current*	$I_{EE}$	$f_{CL1} = 1\text{KHz}$	-	10	$\mu\text{A}$	
Input High Voltage	$V_{IH}$	-	$0.7 V_{DD}$	$V_{DD}$	V	CL1, CL2, DR1, DR2, DR1, DR2, SHL1, SHL2, M, FCS
Input Low Voltage	$V_{IL}$		0	$0.2 V_{DD}$		
Input Leakage Current	$I_{LKC}$	$V_{IN} = 0 - V_{DD}$	-5	5	$\mu\text{A}$	
Output High Voltage	$V_{OH}$	$I_{OH} = -0.4\text{mA}$	$V_{DD} - 0.4$	-	V	
Output Low Voltage	$V_{OL}$	$I_{OL} = +0.4\text{mA}$	-	0.4		
Voltage Descending	$V_{D1}$	$I_{ON} = 0.1\text{mA}$ for one of SC1 ~ SC40	-	1.1		V ( $V_1 \sim V_6$ ) - SC ( SC1 ~ SC40 )
	$V_{D2}$	$I_{ON} = 0.05\text{mA}$ for each SC1 ~ SC40	-	1.5		
Leakage Current	$I_V$	$V_{IN} = V_{DD} \sim V_{EE}$ (Output SC1 ~ SC40 : floating)	-10	10	$\mu\text{A}$	$V_1 \sim V_6$

 AC characteristics ( $V_{DD} = 2.7 \sim 5.5V$ ,  $0 \geq V_{EE} \geq V_{DD} - 10V$ ,  $V_{SS} = 0V$ ,  $T_a = -30 \sim +85 \text{ }^\circ\text{C}$ )

Characteristic	Symbol	Test condition	Min	Max	Unit	Applicable pin
Data shift Frequency	$f_{CL}$	-	-	400	KHz	CL2
Clock High Level Width	$t_{WCKH}$	-	800	-	ns	CL1, CL2
Clock Low Level Width	$t_{WCKL}$	-	800	-		CL2
Clock Set-up Time	$t_{SL}$	from CL2 to CL1	500	-		CL1, CL2
	$t_{LS}$	from CL1 to CL2	500	-		
Clock Rise / Fall Time	$t_R / t_F$	-	-	200		DL1, DL2, DR1, DR2, FLM
Data Set-up Time	$t_{SU}$	-	300	-		
Data Hold Time	$t_{DH}$	-	300	-		
Data Delay Time	$t_D$	-	-	600		

TIMING CHARACTERISTICS

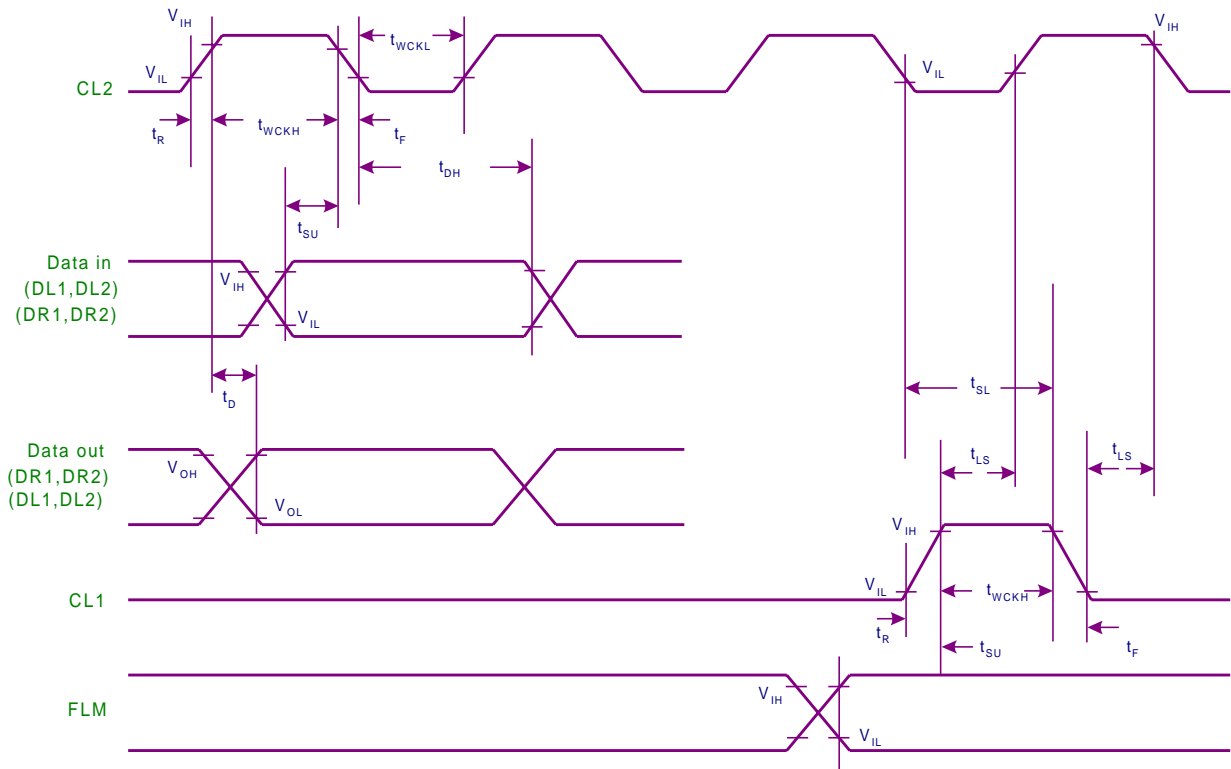
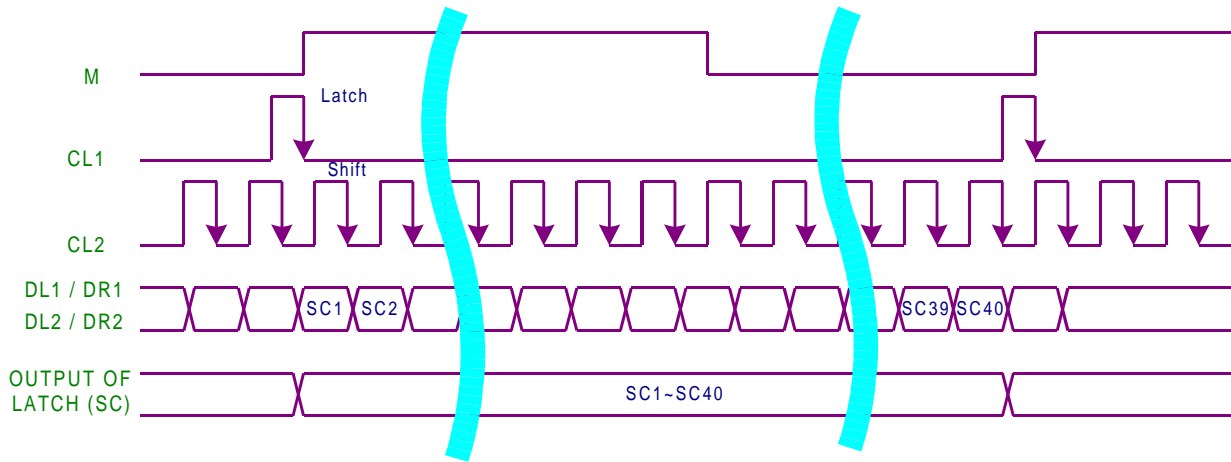


Figure 3. Timing diagram of signals

**FUNCTIONAL DESCRIPTION**

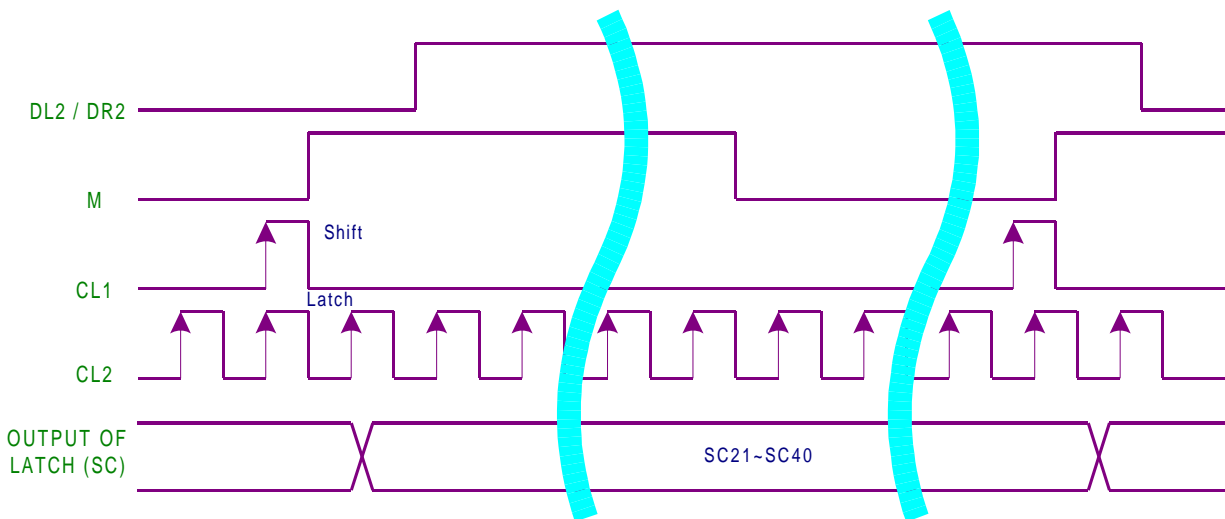
1) Segent mode



When the FCS is connected to  $V_{SS}$ , APU0065 (SC1 ~ SC40) is operated as segment driver.  
(refer to figure 5)

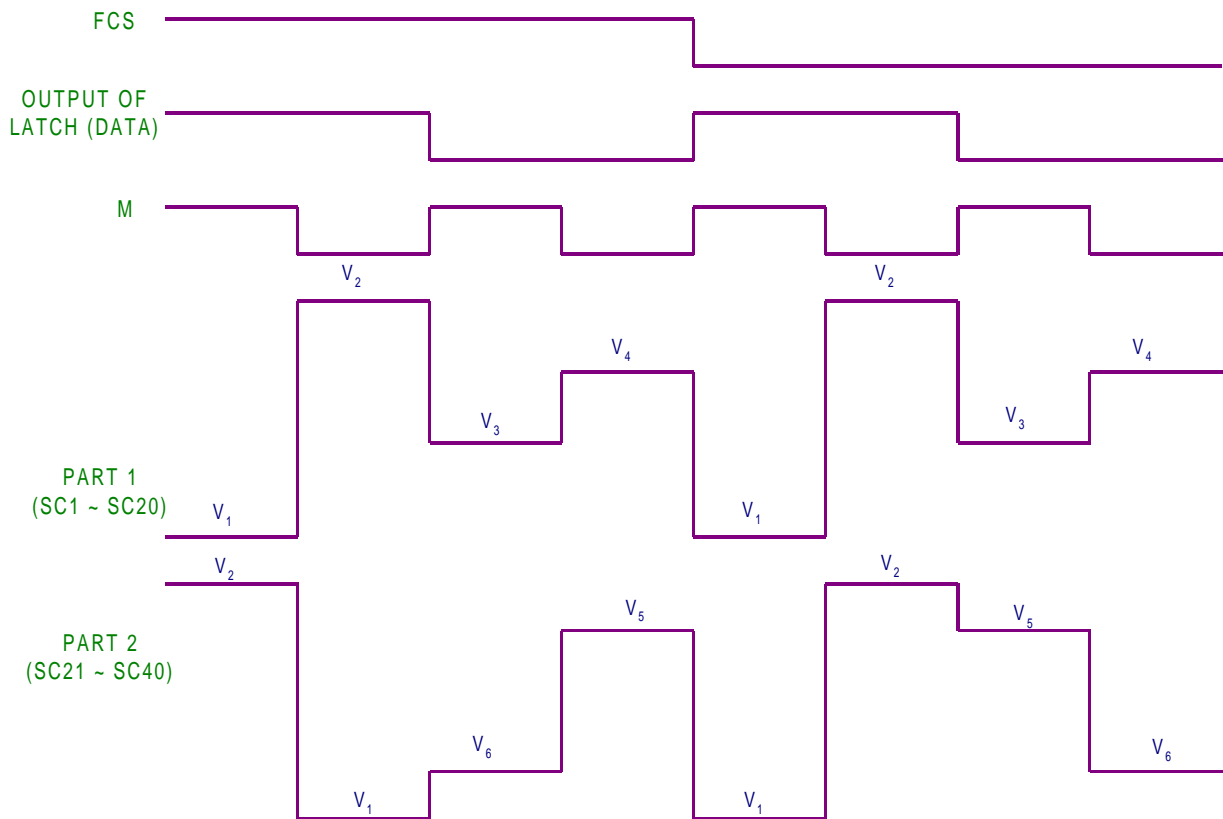
Figure 4. timing diagram of Segent mode

2) Common mode



When the FCS is connected to  $V_{DD}$ , only part2 (SC21 ~ SC40) of APU0065 is operated as common driver.  
(refer to figure 6.)

Figure 5. timing diagram of Common mode



Note : When fcs equals to high voltage, PART 2 (SC21 ~ SC40) is operated as LCD Common driver.  
 PART 1 (SC1 ~ SC20) always be operated as LCD segment driver, no matter fcs equals to high or low

Figure 6. SC1 ~ SC40 output waveform

## Customer Service

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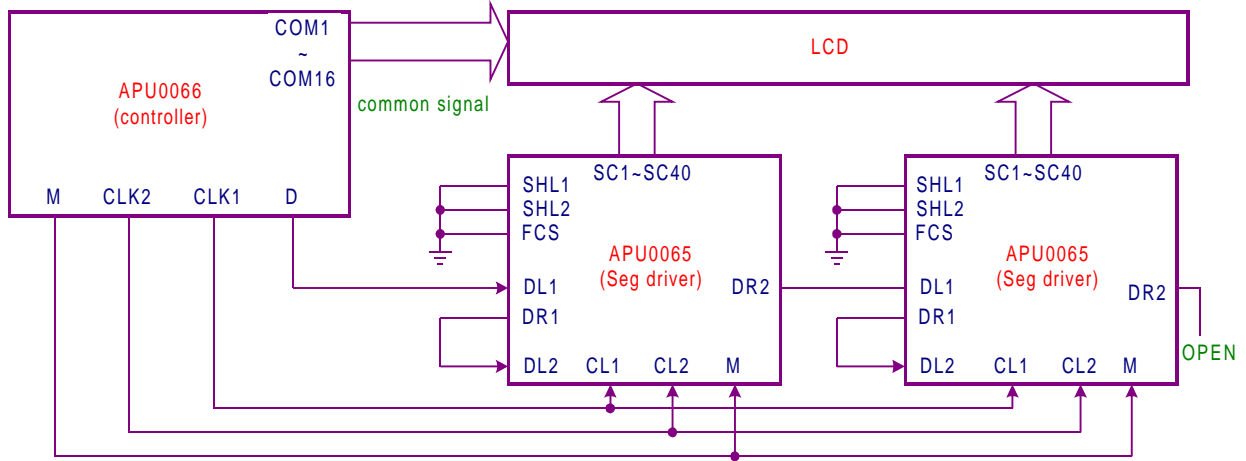
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 Fax : 886-2-89191369



**APPLICATION CIRCUIT**

1. Segment driver



2. Segment / Common driver

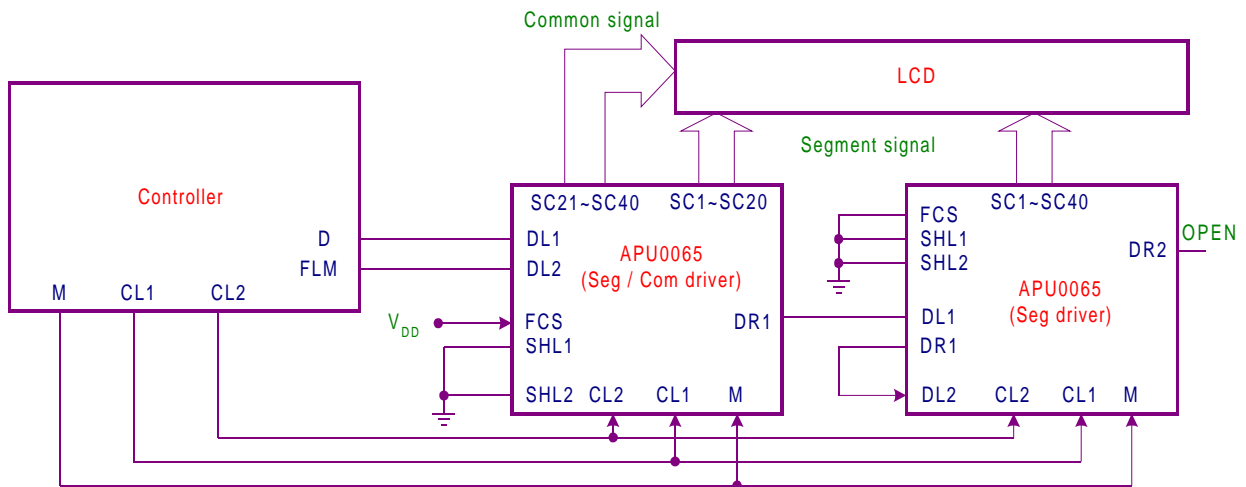


Figure 7. Connection between APU0065 and Controller



**PAD LOCATION**

PAD NUMBER	PAD NAME	COORDINATE		PAD NUMBER	PAD NAME	COORDINATE	
		X	Y			X	Y
1	SC29	902.5	630.0	31	VEE	-902.5	-630.0
2	SC28	850.0	732.5	32	CL1	-800.0	-722.5
3	SC27	725.0	732.5	33	CL2	-700.0	-732.5
4	SC26	600.0	732.5	34	Vss	-600.0	-732.5
5	SC25	500.0	732.5	35	DL1	-500.0	-732.5
6	SC24	400.0	732.5	36	DR1	-400.0	-732.5
7	SC23	300.0	732.5	37	DL2	-300.0	-732.5
8	SC22	200.0	732.5	38	DR2	-200.0	-732.5
9	SC21	100.0	732.5	40	M	-100.0	-732.5
10	SC20	0.0	732.5	41	SHL1	0.0	-732.5
11	SC19	-100.0	732.5	42	SHL2	100.0	-732.5
12	SC18	-200.0	732.5	43	FCS	200.0	-732.5
13	SC17	-300.0	732.5	44	V1	315.0	-732.5
14	SC16	-400.0	732.5	45	V2	430.0	-732.5
15	SC15	-500.0	732.5	46	V3	545.0	-732.5
16	SC14	-600.0	732.5	47	V4	660.0	-732.5
17	SC13	-725.0	732.5	48	V5	775.0	-732.5
18	SC12	-850.0	732.5	49	V6	905.0	-632.5
19	SC9	-902.5	630.0	50	SC40	902.5	-525.0
20	SC10	-902.5	525.0	51	SC39	902.5	-420.0
21	SC11	-902.5	420.0	52	SC38	902.5	-315.0
22	SC8	-902.5	315.0	53	SC37	902.5	-210.0
23	SC7	-902.5	210.0	54	SC36	902.5	-105.0
24	VDD	-902.5	105.0	55	SC35	902.5	0.0
25	SC6	-902.5	0.0	56	SC30	902.5	105.0
26	SC5	-902.5	-105.0	57	SC31	902.5	210.0
27	SC4	-902.5	-210.0	58	SC32	902.5	315.0
28	SC3	-902.5	-315.0	59	SC33	902.5	420.0
29	SC2	-902.5	-420.0	60	SC34	902.5	525.0
30	SC1	-902.5	-525.0				