

Features

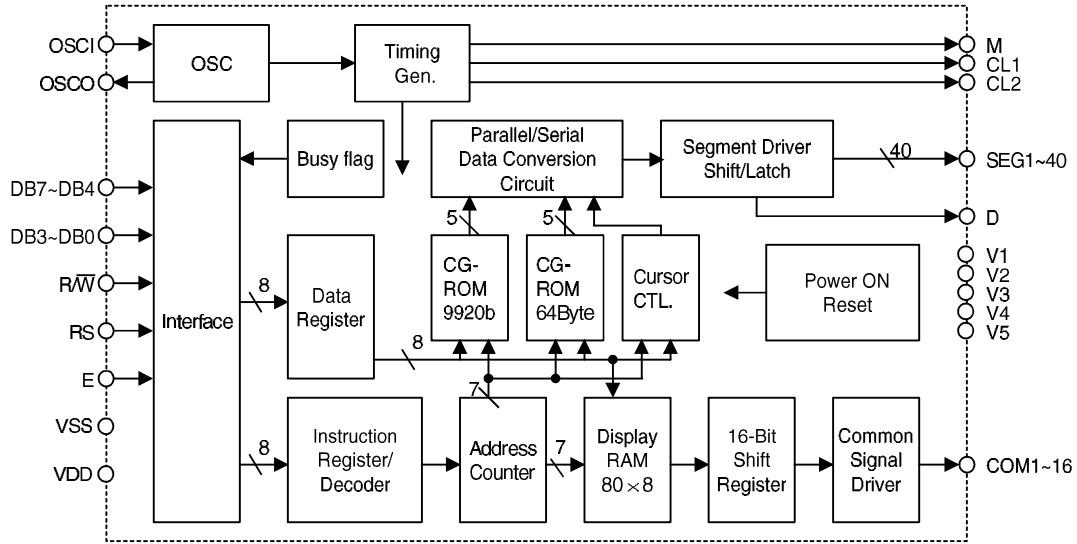
- Low power operating voltage: 2.7V to 5.5V
- Internal LCD driver: 16 Common and 40 Segment (segment can be extended by HT1602L/HT1608)
- Provide 4-bit or 8-bit interface function
- Interface bus clock rating: 4 MHz ($V_{DD}=5V$)
- Built-in 80×8 bits display RAM
- 9920-bit character generator ROM for a total of 240 character fonts
 - 208 character fonts (5×8)
 - 32 character fonts (5×10)
- Character generator RAM
 - 8 character fonts (5×8)
 - 4 character fonts (5×10)
- Programmable duty cycles
 - 1/8 duty for one line of 5×8 dots with cursor
 - 1/11 duty for one line of 5×10 dots with cursor
 - 1/16 for two lines of 5×8 dots with cursor
- Built-in oscillator circuit with external resistor
- Powerful instruction sets: Display clear, Display on/off, cursor home, cursor on/off, display character blink, cursor shift, display shift
- Built-in power on reset function
- Low power consumption

General Description

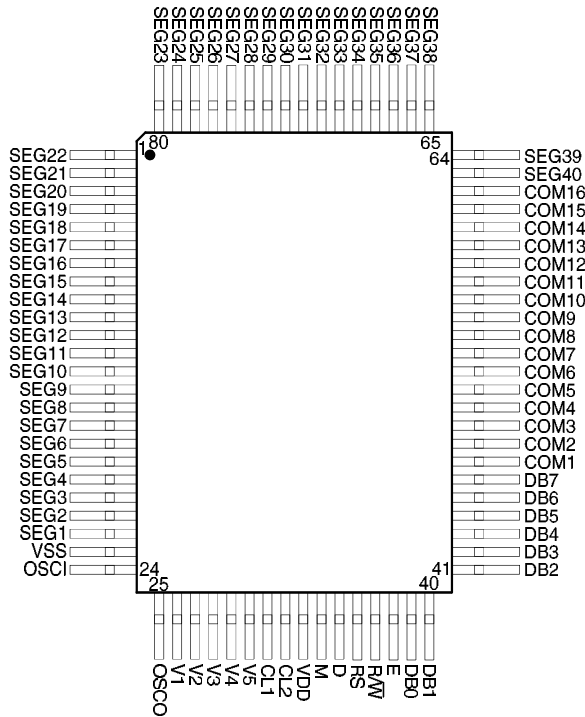
The HT163A is a dot matrix LCD controller and driver LSI which has low power consumption and fabricated by CMOS technology. It can operate with either a 4-bit or 8-bit microprocessor (MPU) at high speed clock rating. The HT163A

built-in CGROM and CGRAM provide very user friendly interface for the programmer. It contains 208 5×8 dot character fonts and 32 5×10 dot character fonts for a total of 240 different character fonts.

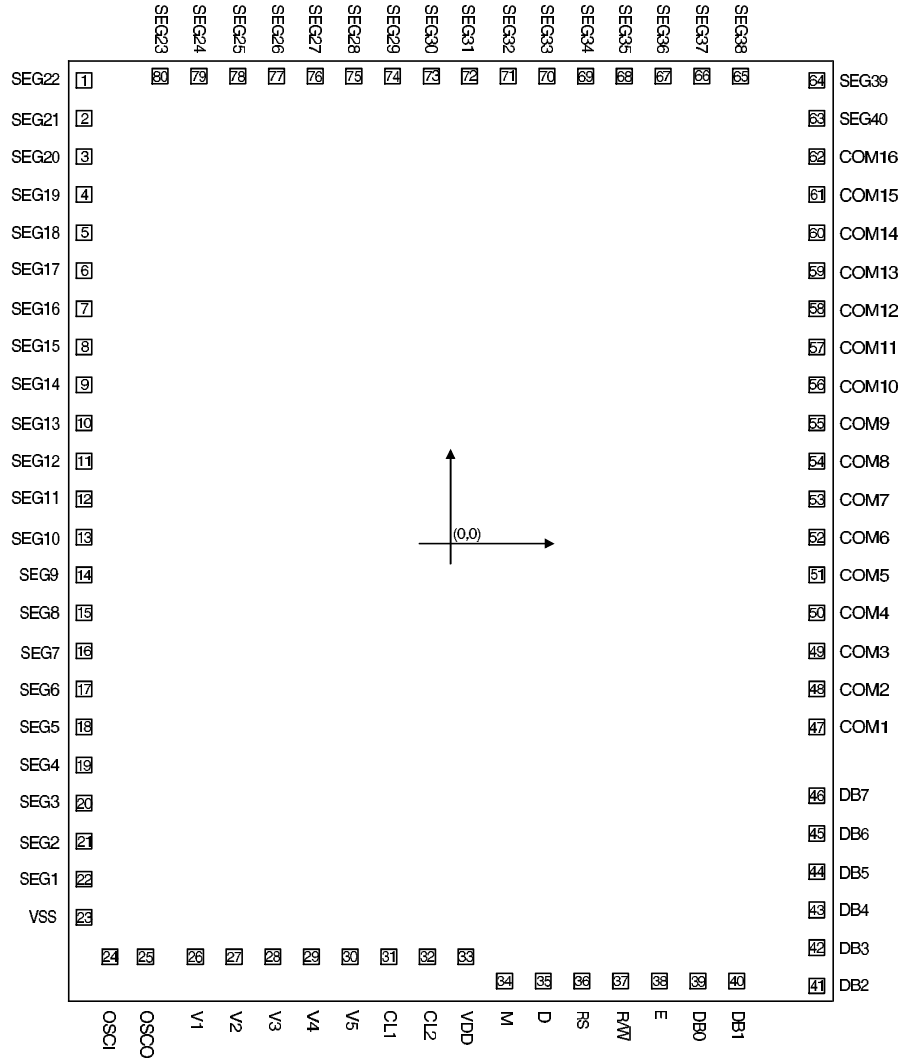
Block Diagram



Pin Assignment: (PQFP80)



Pad Assignment



Chip size: 104 × 134 (mil)²

* The IC substrate should be connected to VDD in the PCB layout artwork.

Pad Coordinates

Unit: mil

Pad No.	X	Y	Pad No.	X	Y
1	-1183.70	1521.30	41	1183.70	-1453.70
2	-1183.70	1396.30	42	1183.70	-1328.70
3	-1183.70	1271.30	43	1183.70	-1203.70
4	-1183.70	1146.30	44	1183.70	-1078.70
5	-1183.70	1021.30	45	1183.70	-953.70
6	-1183.70	896.30	46	1183.70	-828.70
7	-1183.70	771.30	47	1183.70	-603.70
8	-1183.70	646.30	48	1183.70	-478.70
9	-1183.70	521.30	49	1183.70	-353.70
10	-1183.70	396.30	50	1183.70	-228.70
11	-1183.70	271.30	51	1183.70	-103.70
12	-1183.70	146.30	52	1183.70	21.30
13	-1183.70	21.30	53	1183.70	146.30
14	-1183.70	-103.70	54	1183.70	271.30
15	-1183.70	-228.70	55	1183.70	396.30
16	-1183.70	-353.70	56	1183.70	521.30
17	-1183.70	-478.70	57	1183.70	646.30
18	-1183.70	-603.70	58	1183.70	771.30
19	-1183.70	-728.70	59	1183.70	896.30
20	-1183.70	-853.70	60	1183.70	1021.30
21	-1183.70	-978.70	61	1183.70	1146.30
22	-1183.70	-1103.70	62	1183.70	1271.30
23	-1183.70	-1228.70	63	1183.70	1396.30
24	-1121.90	-1357.10	64	1183.70	1521.30
25	-985.90	-1357.10	65	937.50	1535.90
26	-824.60	-1357.10	66	812.50	1535.90
27	-699.60	-1357.10	67	687.50	1535.90
28	-574.60	-1357.10	68	562.50	1535.90
29	-449.60	-1357.10	69	437.50	1535.90
30	-324.60	-1357.10	70	312.50	1535.90
31	-199.60	-1357.10	71	187.50	1535.90
32	-74.60	-1357.10	72	62.50	1535.90
33	50.40	-1357.10	73	-62.50	1535.90
34	175.40	-1437.10	74	-187.50	1535.90
35	300.40	-1437.10	75	-312.50	1535.90
36	425.40	-1437.10	76	-437.50	1535.90
37	550.40	-1437.10	77	-562.50	1535.90
38	675.40	-1437.10	78	-687.50	1535.90
39	800.40	-1437.10	79	-812.50	1535.90
40	925.40	-1437.10	80	-937.50	1535.90

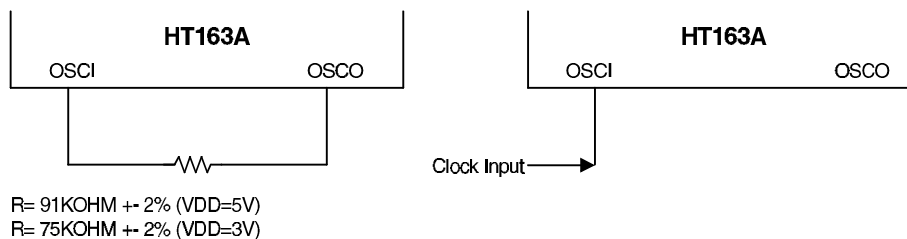
Pad Description

Pad No.	Pad Name	I/O	Description
1~22	SEG22~SEG1	O	LCD driver output for segment signal
23	VSS	P	Ground
24	OSCI	I	Connect external resistor for RC Oscillator circuit
25	OSCO	O	
26~30	V1~V5	P	Power supply for LCD driver level
31	CL1	O	Clock to latch serial data send to the extension driver
32	CL2	O	Clock to shift serial data
33	VDD	P	Power supply for logic circuit
34	M	O	The alternating signal to convert LCD drive waveform to AC
35	D	O	Character pattern data corresponding to each segment signal, "0" is Non-selected, "1" is Selected
36	RS	I	Register select signal "0" : Instruction register (for write) Busy flag, address counter (for read) "1" : Data register, (for read and write)
37	R/W	I	Select read or write "0" : Write "1" : Read
38	E	I	Start data Read/Write
39~42	DB0~DB3	I/O	Low order bi-directional tri-state data bus pins for transmitting and receiving data between the MPU and the HT163A. These pins are not used during 4-bit operation
43~46	DB4~DB7	I/O	High order bi-directional tri-state data bus pins for transmitting and receiving data between the MPU and the HT163A. The DB7 pin can be used as a busy flag
47~62	COM1~16	O	LCD driver output for common signal
63~80	SEG40~23	O	LCD driver output for segment signal

Note:

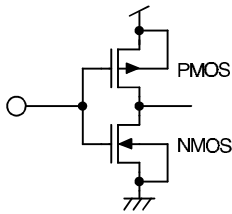
1. $V_{dd} \geq V1 \geq V2 \geq V3 \geq V4 \geq V5$ must be maintained

2. Two clock options:

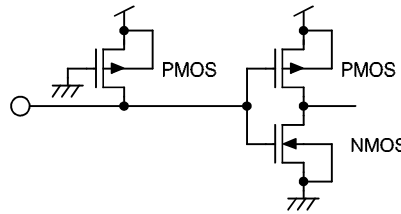


3. Input terminal:

Pin: E (without pull high)

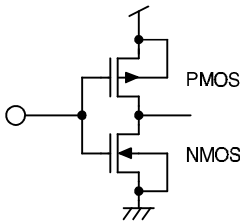


Pin: RS, RWB (with pull high)

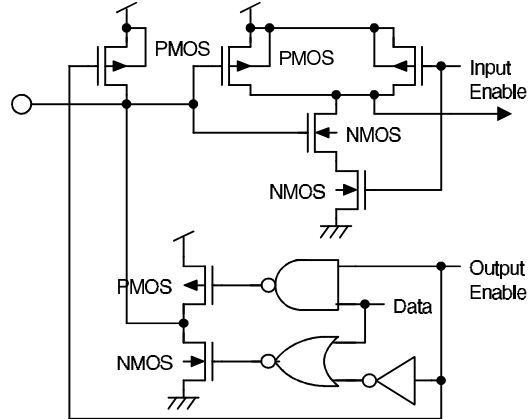


4. Output terminal:

Pin: CL1, CL, M, D



5. I/O terminal: (DB0~DB7)



Absolute Maximum Ratings*

Supply Voltage -0.3V to 5.5V
 Input Voltage $V_{SS}-0.3V$ to $V_{DD}+0.3V$

Storage Temperature -40°C to 125°C
 Operating Temperature -20°C to 75°C

*Note: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

D.C. Characteristics

 (Ta=-20 to 75°C V_{DD}=4.5V~5.5V V_{SS}=0V)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DD}	Operating Voltage	—	—	4.5	—	5.5	V
V _{LCD}	LCD Driving Voltage	4.5V~5.5V	V _{DD} -V ₅	3.0	—	5.5	V
I _{DD}	Power Consumption	4.5V~5.5V	f _{OSC} =270kHz	—	0.35	0.6	mA
V _{IH1}	Input High Voltage (except OSCI)	4.5V~5.5V	—	2.2	—	V _{DD}	V
V _{IL1}	Input low Voltage (except OSCI)	4.5V~5.5V	—	-0.3	—	0.6	V
V _{IH2}	Input High Voltage (OSCI)	4.5V~5.5V	—	V _{DD} -1.0	—	V _{DD}	V
V _{IL2}	Input Low Voltage (OSCI)	4.5V~5.5V	—	—	—	1.0	V
V _{OH1}	Output High Voltage (DB0~DB7)	4.5V~5.5V	I _{OH} =-0.2mA (DB0~DB7)	2.4	—	—	V
V _{OL1}	Output Low Voltage (DB0~DB7)	4.5V~5.5V	I _{OL} =1.2mA (DB0~DB7)	—	—	0.4	V
V _{OH2}	Output High Voltage (except DB0~DB7)	4.5V~5.5V	I _{OH} =-0.04mA (except DB0~DB7)	0.9V _{DD}	—	—	V
V _{OL2}	Output Low Voltage (except DB0~DB7)	4.5V~5.5V	I _{OL} =0.04mA (except DB0~DB7)	—	—	0.1V _{DD}	V
R _{COM}	Driver on Resistor	4.5V~5.5V	V _{LCD} =4V, I _{COM} =0.05mA (Between V _{DD} , V ₁ , V ₄ , V ₅ and each COM pin)	—	—	20	kΩ
R _{SEG}	Driver on Resistor	4.5V~5.5V	V _{LCD} =4V, I _{SEG} =0.05mA (Between V _{DD} , V ₁ , V ₄ , V ₅ and each SEG pin)	—	—	30	kΩ
I _{LEAK}	Input Leakage Current	4.5V~5.5V	V _{IN} =0 to V _{DD}	-1	—	1	μA
R _{PH}	Pull High Resistance	5V	V _{DD} =5V	100	40	20	kΩ

D.C. Characteristics

 (Ta=-20 to 75°C, V_{DD}=2.7V~4.5V V_{SS}=0V)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DD}	Operating Voltage	—	—	2.7	—	5.5	V
V _{LCD}	LCD Driving Voltage	2.7V~4.5V	V _{DD} -V ₅	2.7	—	5.5	V
I _{DD}	Power Consumption	2.7V~4.5V	f _{OSC} =270kHz	—	0.15	0.3	mA
V _{IH1}	Input High Voltage (except OSCI)	2.7V~4.5V	—	0.7V _{DD}	—	V _{DD}	V
V _{IL1}	Input Low Voltage (except OSCI)	2.7V~4.5V	—	-0.3	—	0.55	V
V _{IH2}	Input High Voltage (OSCI)	2.7V~4.5V	—	0.7V _{DD}	—	V _{DD}	V
V _{IL2}	Input Low Voltage (OSCI)	2.7V~4.5V	—	—	—	0.2V _{DD}	V
V _{OH1}	Output High Voltage (DB0~DB7)	2.7V~4.5V	I _{OH} =-0.2mA (DB0~DB7)	0.7V _{DD}	—	—	V
V _{OL1}	Output Low Voltage (DB0~DB7)	2.7V~4.5V	I _{OL} =1.2mA (DB0~DB7)	—	—	0.2V _{DD}	V
V _{OH2}	Output High Voltage (except DB0~DB7)	2.7V~4.5V	I _{OH} =-0.04mA (except DB0~DB7)	0.8V _{DD}	—	—	V
V _{OL2}	Output Low Voltage (except DB0~DB7)	2.7V~4.5V	I _{OL} =0.04mA (except DB0~DB7)	—	—	0.2V _{DD}	V
R _{COM}	Driver on Resistor	2.7V~4.5V	V _{LCD} =4V, I _{COM} =0.05mA (Between V _{DD} , V1, V4, V5 and each COM pin)	—	—	20	kΩ
R _{SEG}	Driver on Resistor	2.7V~4.5V	V _{LCD} =4V, I _{SEG} =0.05mA (Between V _{DD} , V1, V4, V5 and each SEG pin)	—	—	30	kΩ
I _{LEAK}	Input Leakage Current	2.7V~4.5V	V _{IN} =0 to V _{DD}	-1	—	1	μA
R _{PH}	Pull High Resistance	3V	V _{DD} =3V	500	100	45	kΩ

A.C. Characteristics

 (Ta=-30 to 85°C, V_{DD}=4.5V~5.5V V_{SS}=0V)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
t _c	E Cycle Time	4.5V~5.5V	Write Mode	500	—	—	ns
t _R , t _F	E Rise/Fall Time	4.5V~5.5V	Write Mode	—	—	20	ns
t _w	E Pulse Width	4.5V~5.5V	Write Mode	230	—	—	ns
t _{SU1}	R/ \overline{W} and RS Setup Time	4.5V~5.5V	Write Mode	40	—	—	ns
t _{H1}	R/ \overline{W} and RS Hold Time	4.5V~5.5V	Write Mode	10	—	—	ns
t _{SU2}	Data Setup Time	4.5V~5.5V	Write Mode	60	—	—	ns
t _{H2}	Data Hold Time	4.5V~5.5V	Write Mode	10	—	—	ns
t _c	E Cycle Time	4.5V~5.5V	Read Mode	500	—	—	ns
t _R , t _F	E Rise/Fall Time	4.5V~5.5V	Read Mode	—	—	20	ns
t _w	E Pulse Width	4.5V~5.5V	Read Mode	230	—	—	ns
t _{SU}	R/ \overline{W} and RS Setup Time	4.5V~5.5V	Read Mode	40	—	—	ns
t _H	R/ \overline{W} and RS Hold Time	4.5V~5.5V	Read Mode	10	—	—	ns
t _D	Data Output Delay Time	4.5V~5.5V	Read Mode	—	—	120	ns
t _{DH}	Data Hold Time	4.5V~5.5V	Read Mode	5	—	—	ns

A.C. Characteristics

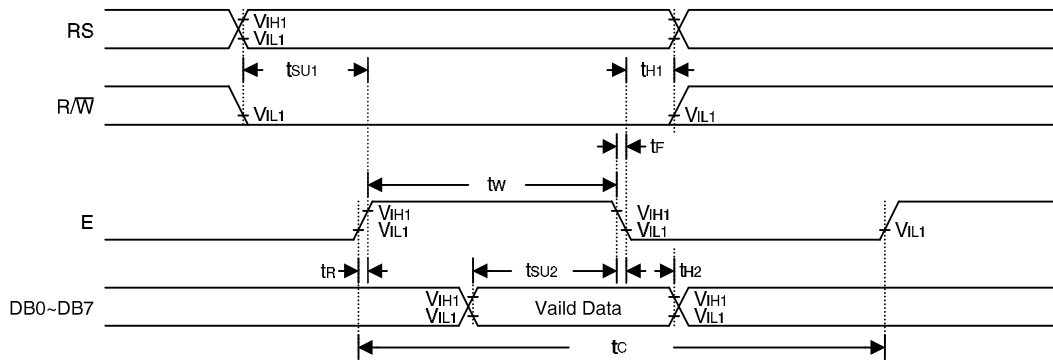
 (Ta=-30 to 85°C, V_{DD}=2.7V~4.5V V_{SS}=0V)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
t _c	E Cycle Time	2.7V~4.5V	Write Mode	1000	—	—	ns
t _R , t _F	E Rise/Fall Time	2.7V~4.5V	Write Mode	—	—	25	ns
t _w	E Pulse Width	2.7V~4.5V	Write Mode	450	—	—	ns
t _{SU1}	R/ \bar{W} and RS Setup Time	2.7V~4.5V	Write Mode	60	—	—	ns
t _{H1}	R/ \bar{W} and RS Hold Time	2.7V~4.5V	Write Mode	20	—	—	ns
t _{SU2}	Data Setup Time	2.7V~4.5V	Write Mode	195	—	—	ns
t _{H2}	Data Hold Time	2.7V~4.5V	Write Mode	10	—	—	ns
t _c	E Cycle Time	2.7V~4.5V	Read Mode	1000	—	—	ns
t _R , t _F	E Rise/Fall Time	2.7V~4.5V	Read Mode	—	—	25	ns
t _w	E Pulse Width	2.7V~4.5V	Read Mode	450	—	—	ns
t _{SU}	R/ \bar{W} and RS Setup Time	2.7V~4.5V	Read Mode	60	—	—	ns
t _H	R/ \bar{W} and RS Hold Time	2.7V~4.5V	Read Mode	20	—	—	ns
t _D	Data Output Delay Time	2.7V~4.5V	Read Mode	—	—	360	ns
t _{DH}	Data Hold Time	2.7V~4.5V	Read Mode	5	—	—	ns
t _w	Clock Pulse Width	2.7V~4.5V	Interface with Driver	800	—	—	ns
t _R , t _F	Clock Rise/Fall Time	2.7V~4.5V	Interface with Driver	—	—	25	ns
t _{SU1}	Clock Setup Time	2.7V~4.5V	Interface with Driver	500	—	—	ns

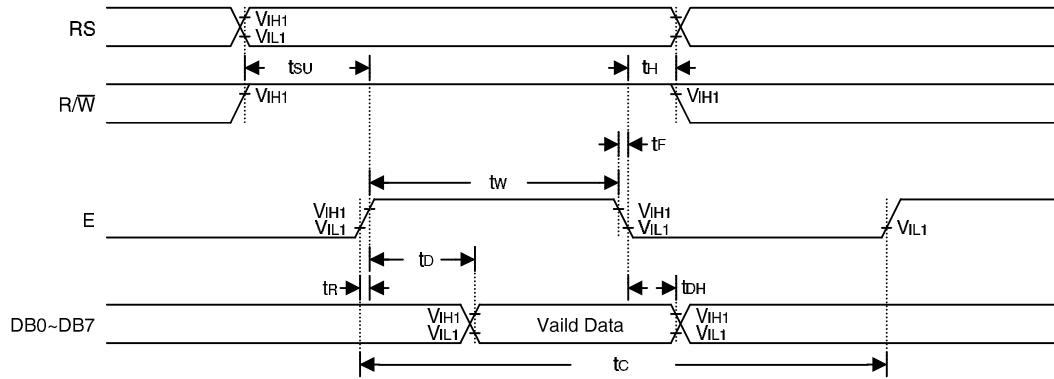
Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
t _{SU2}	Data Setup Time	2.7V~4.5V	Interface with Driver	300	—	—	ns
t _{DH}	Data Hold Time	2.7V~4.5V	Interface with Driver	300	—	—	ns
t _{DM}	M Delay Time	2.7V~4.5V	Interface with Driver	-1000	—	1000	ns

Timing Diagram

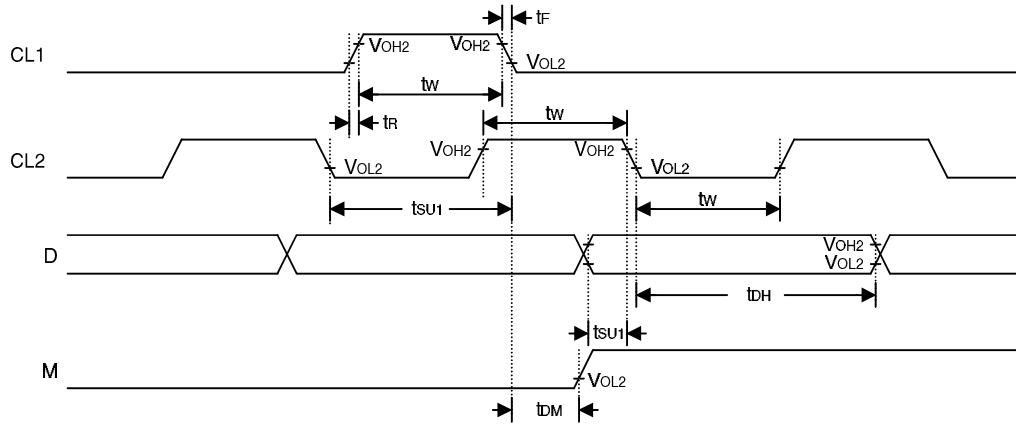
- Write mode timing diagram



• Read mode timing diagram

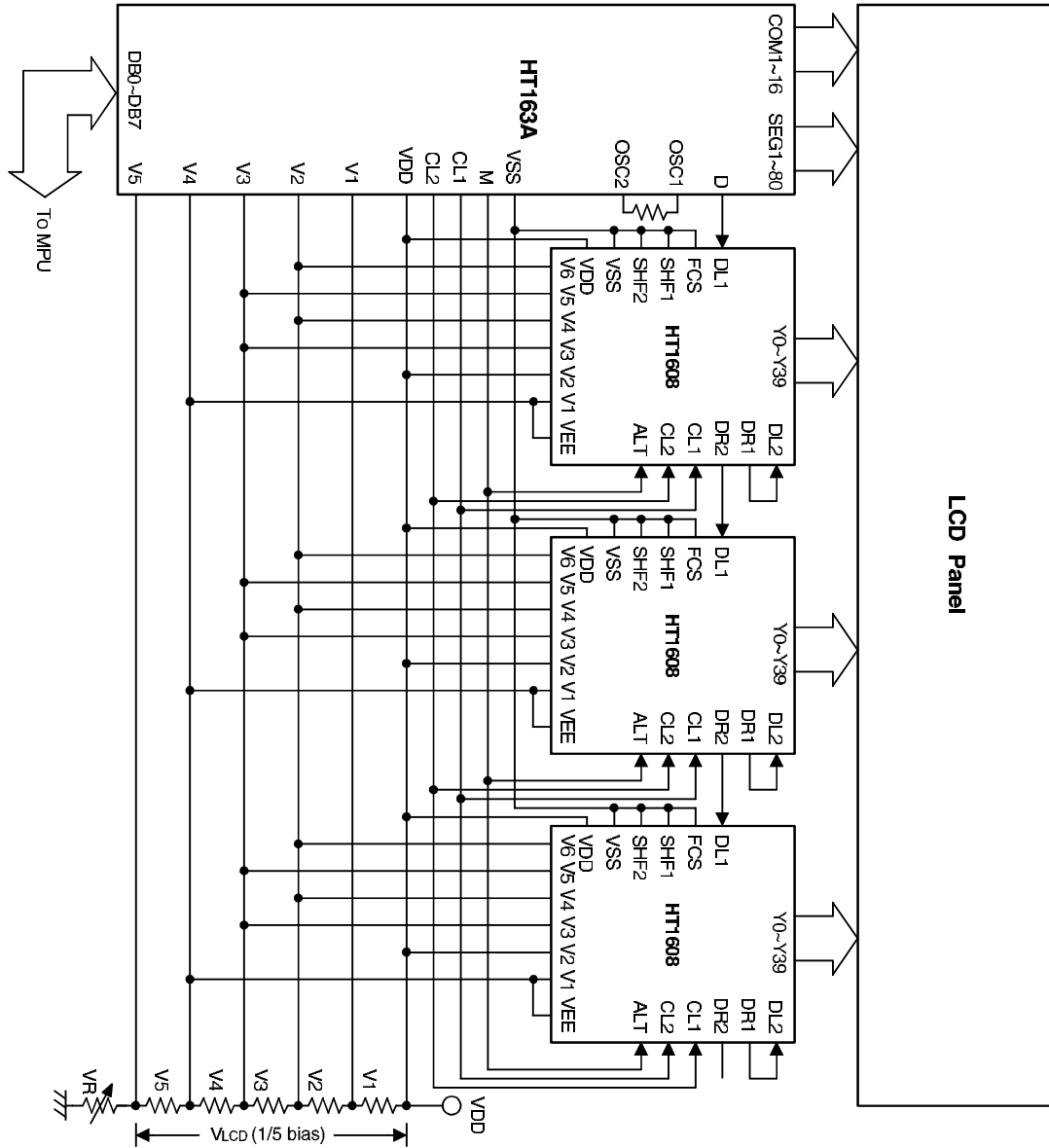


• Interface mode with external driver timing diagram



Function Description

The HT163A LCD driver consists of 16 common signal drivers and 40 segment signal drivers which can extend display size by cascading segment driver HT1608, HT1602 or HT1602L. The maximum display size can be either 80 characters in 1-line display or 40 characters in 2-line display.



The HT163A has two kinds of interface type with MPU: 4-bit and 8-bit bus. 4-bit bus and 8-bit bus is selected by DL bit in the instruction register. It can receive both instructions and data from the MPU. Some instructions set the operation modes, such as function mode, data entry mode, display mode, read or write both data and address etc.

Instruction Table

Instruction	Instruction Code										Description	Execution time ($f_{osc}=270kHz$)	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
Clear display	0	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM and set DDRAM address to "00H" from AC.	1.52ms
Display Return home	0	0	0	0	0	0	0	0	0	1	X	Set DDRAM address to "00H" from AC and return cursor to it's original position if shifted. The contents of DDRAM are not changed.	1.52ms
Entry mode set	0	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and make shift of entire display enable. I/D: 1-Increment 0-Decrement SH: 1-Display, Shift on	37 μ s
Display ON/OFF control	0	0	0	0	0	0	0	1	D	C	B	Set display(D), cursor(C), and blinking of cursor(B) on/off control bit. D: 1-On, 0-Off C: 1-On, 0-Off B: 1-Ofw, 0-Off	37 μ s
Cursor or display shift	0	0	0	0	0	0	1	S/C	R/L	X	X	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data. S/C: 0-Cursor move 1-Dispaly R/L: 0-Shift to the left 1-Shift to the right	37 μ s
Function set	0	0	0	0	0	1	DL	N	F	X	X	Set interface data length, DL: 0-4 bits/1-8 bits numbers of display line, N: 0-1 line/1-2 lines display font type. F: 0-5 \times 7dots 1-50-5 \times 10 dots	37 μ s

Instruction	Instruction Code										Description	Execution time ($f_{osc}=270kHz$)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Set CGRAM address	0	0	0	1	AD5	AD4	AD3	AD2	AD1	AD0	Set CGRAM address in address counter.	37 μ s
Set DDRAM address	0	0	1	A6	AD5	AD4	AD3	AD2	AD1	AD0	Set DDRAM address in address counter.	37 μ s
Read busy flag and address	0	1	BF	AD6	AD5	AD4	AD3	AD2	AD1	AD0	Whether during internal operation or not, can be known by reading BF. The contents of address counter can also be read. BF: 0-Can accept Instruction 1-Internsly operating	0 μ s
Write data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43 μ s
Read data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM)	43 μ s

* "X": don't care

The character generator ROM (CGROM) generates 5x8 dot or 5x10 dot character patterns from 8-bit character codes. It can generate 208 5x8 dot character patterns and 32 5x10 dot character patterns. User-defined character patterns are also available by mask-programmed ROM.

- Example of correspondence between address data and character pattern (5x8 dots)

EPROM Address										Data						
A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	O4	O3	O2	O1	O0
								0	0	0	0	1	0	0	0	0
								0	0	0	1	1	0	0	0	0
								0	0	1	0	1	0	1	1	0
								0	0	1	1	1	0	0	0	1
								0	1	0	0	1	0	0	0	1
								0	1	0	1	1	0	0	0	1
								0	1	1	0	1	1	1	1	0
0	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	0
								1	0	0	0	0	0	0	0	0
								1	0	0	1	0	0	0	0	0
								1	0	1	0	0	0	0	0	0
								1	0	1	1	0	0	0	0	0
								1	1	0	0	0	0	0	0	0
								1	1	0	1	0	0	0	0	0
								1	1	1	0	0	0	0	0	0
								1	1	1	1	0	0	0	0	0

← Cursor position

Character Code Line Position

- Example of correspondence between address data and character pattern (5×10 dots)

EPROM Address											Data					
A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	O4	O3	O2	O1	O0
								0	0	0	0	0	0	0	0	0
								0	0	0	1	0	0	0	0	0
								0	0	1	0	0	1	1	0	1
								0	0	1	1	1	0	0	1	1
								0	1	0	0	1	0	0	0	1
								0	1	0	1	1	0	0	0	1
								0	1	1	0	0	1	1	1	1
0	1	0	1	0	0	1	0	0	1	1	0	0	0	0	0	1
								1	0	0	0	0	0	0	0	1
								1	0	0	1	0	0	0	0	1
								1	0	1	0	0	0	0	0	0
								1	0	1	1	0	0	0	0	0
								1	1	0	0	0	0	0	0	0
								1	1	0	1	0	0	0	0	0
								1	1	1	0	0	0	0	0	0
								1	1	1	1	0	0	0	0	0

← Cursor position

Character Code Line Position

Upper 4 bit Lower 4 bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL	CG RAM (1)															
LLLH	(2)															
LLHL	(3)															
LLHH	(4)															
LHLL	(5)															
LHLH	(6)															
LHHL	(7)															
LHHH	(8)															
HLLL	(1)															
HLLH	(2)															
HLHL	(3)															
HLHH	(4)															
HHLL	(5)															
HHLH	(6)															
HHHL	(7)															
HHHH	(8)															

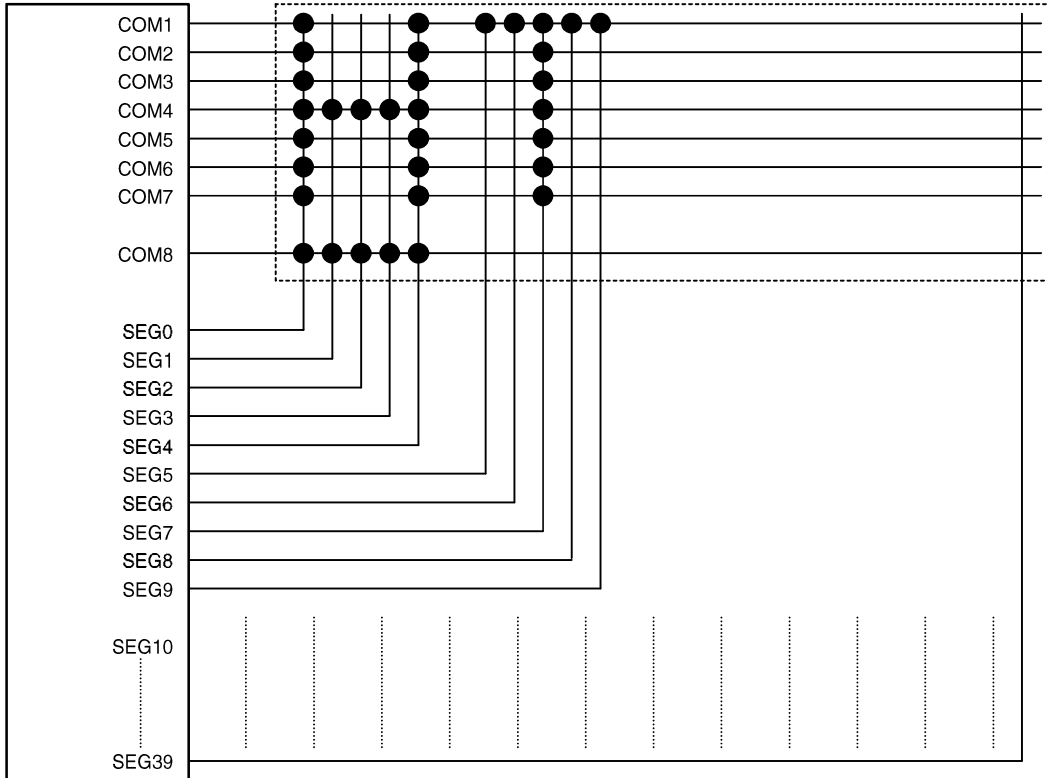
• Character codes and character patterns (ROM code: H00)

Upper 4 bit Lower 4 bit	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)															
xxxx0001	CG RAM (2)															
xxxx0010	CG RAM (3)															
xxxx0011	CG RAM (4)															
xxxx0100	CG RAM (5)															
xxxx0101	CG RAM (6)															
xxxx0110	CG RAM (7)															
xxxx0111	CG RAM (8)															
xxxx1000	CG RAM (1)															
xxxx1001	CG RAM (2)															
xxxx1010	CG RAM (3)															
xxxx1011	CG RAM (4)															
xxxx1100	CG RAM (5)															
xxxx1101	CG RAM (6)															
xxxx1110	CG RAM (7)															
xxxx1111	CG RAM (8)															

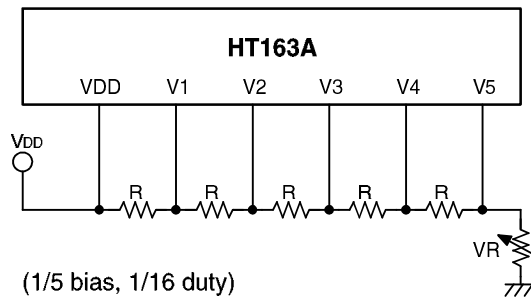
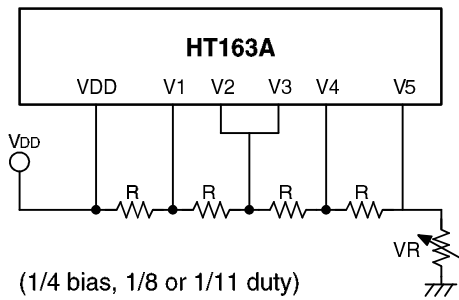
Application Diagram

Number of Lines	Character Font	Number of Common	Duty	Bias
1	5×8 dots+cursor	8	1/8	1/4
1	5×10 dots+cursor	11	1/11	1/4
2	5×8 dots+cursor	16	1/16	1/5

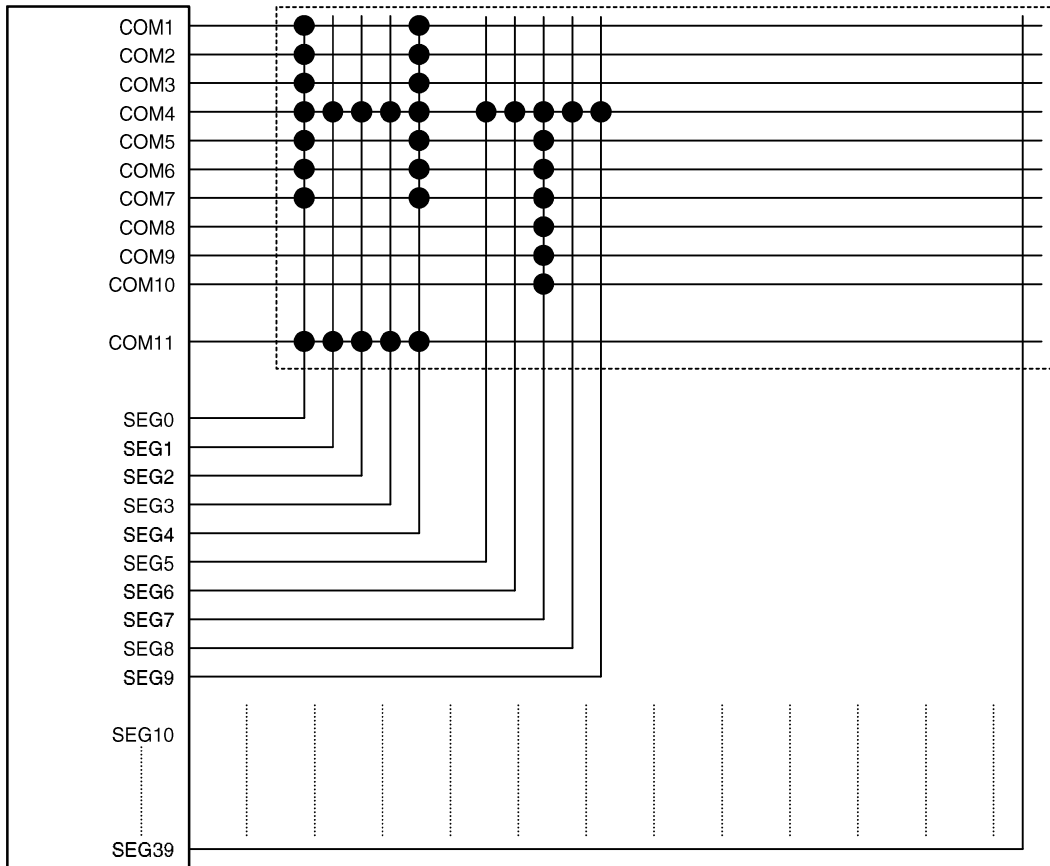
- LCD panel (5×8 dots, 8 characters × 1 line)



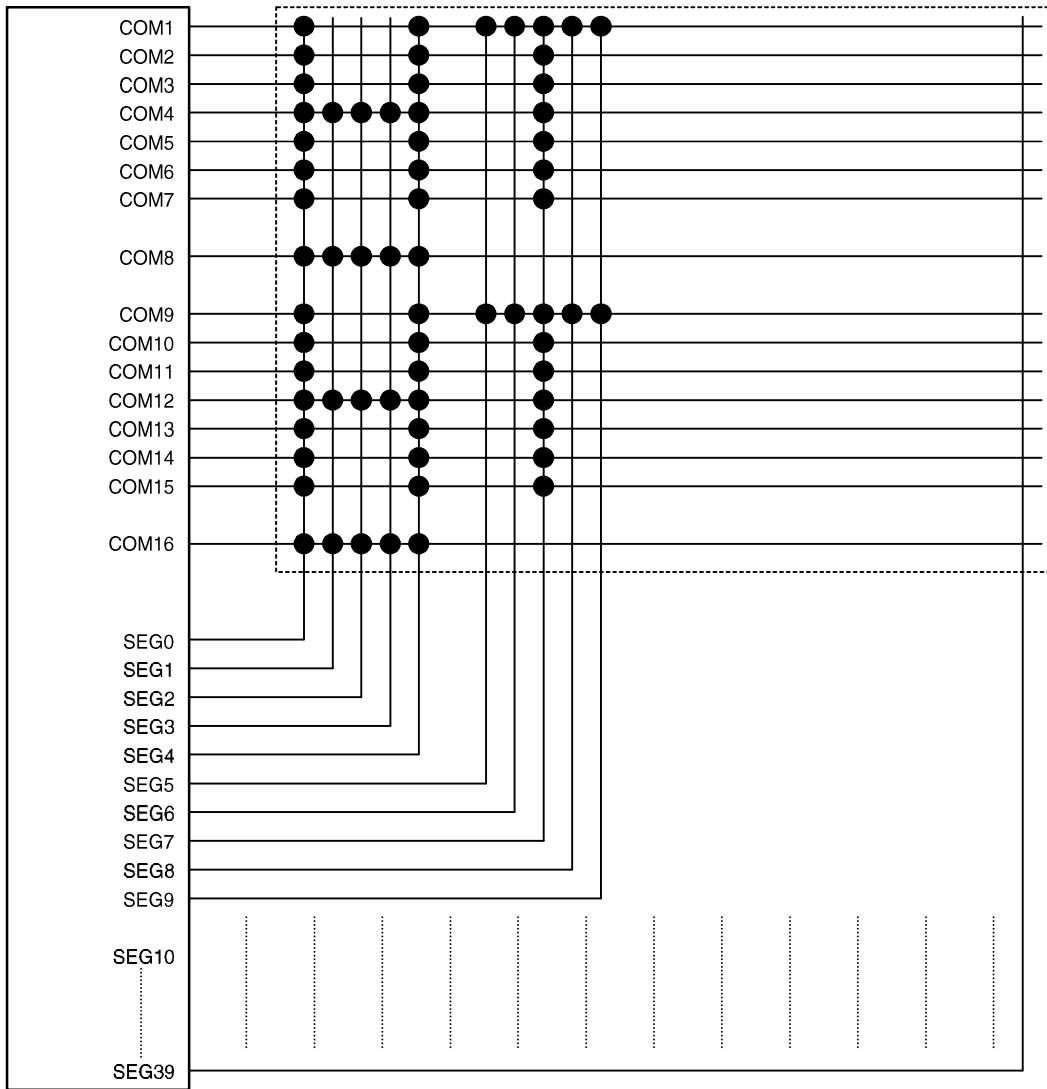
Bias voltage divider circuit



- LCD panel (5×10 dots, 8 characters × 1 line)



• LCD panel (5x8 dots, 8 characters x 2 line)



Package Outlines: 80 pin QFP (80 QFP)

