A.HE83131 Introduction

HE83131 is a member of 8-bit Micro-controller series that is developed by King Billion. This IC built-in 640-dot LCD driver and has one OP comparator. The built-in OP comparator can be used with (light、voice、temperature、humility) sensor etc. The 7-bit current-type D/A converter and PWM device provide the complete speech output mechanism. This IC is applicable to the medium systems such as LCD Games and Educational Toy etc. Use external SRAM or Flash RAM to have recording function.

This IC is very easy to learn and use. Most of instructions take only 3 oscillator clocks (machine cycles). As a result this IC is suitable for the applications that require higher performance system.

B.HE83131 Features

- Operation Voltage： 2.2V – 5.5V
- System Clock： DC ~ 8MHz @ 5.0V
  DC ~ 4MHz @ 2.2V
- Internal ROM： 16K Bytes(16K Program ROM)
- Internal RAM： 256 Bytes
- Dual Clock System ： Normal (Fast) clock： 32.768K ~ 8MHz
  Slow clock： 32.768KHz
- Operation Mode： DUAL、FAST、SLOW、IDLE、SLEEP Mode.
- With WDT (WATCH DOG TIMER) to prevent deadlock condition.
- 12-bit Bi-directional I/O port. Mask Option can select PUSH-PULL or OPEN DRAIN output mode for each I/O pin.
- One built-in OP comparator.
- 640 dots LCD driver (A、B TYPE selectable).
- One 7-bit current-type DAC output.
- PWM device.
- Two external interrupts and two internal timers interrupts.
- Two 16-bit timers.
- Instruction set： 32 instructions, 4 addressing mode. 8-bit DATA POINTER for RAM and 14-bit TABLE POINTER for ROM.

C. Internal Block

Item	I.F.C.	E.S.C.	I.P.R	PROM	DROM	TP	TP+1	RAM	PP	DP	I/O	DTMF	WDT	Timer
HE83131	◎	◎	◎	16KB	—	14-bit	◎	256B	—	8-bit	12	—	◎	T1,T2

Item	VO	DAO	OP	PWM	LCD	COM*SEG	Bias	Rgr	ChrgPmp	LV2	LR	LVG	REC	S.R.
HE83131	◎	◎	◎	◎	640	16*40	1/5	—	1,3/2	—	4:0	◎	Ext.	I

D. Pin Assignment

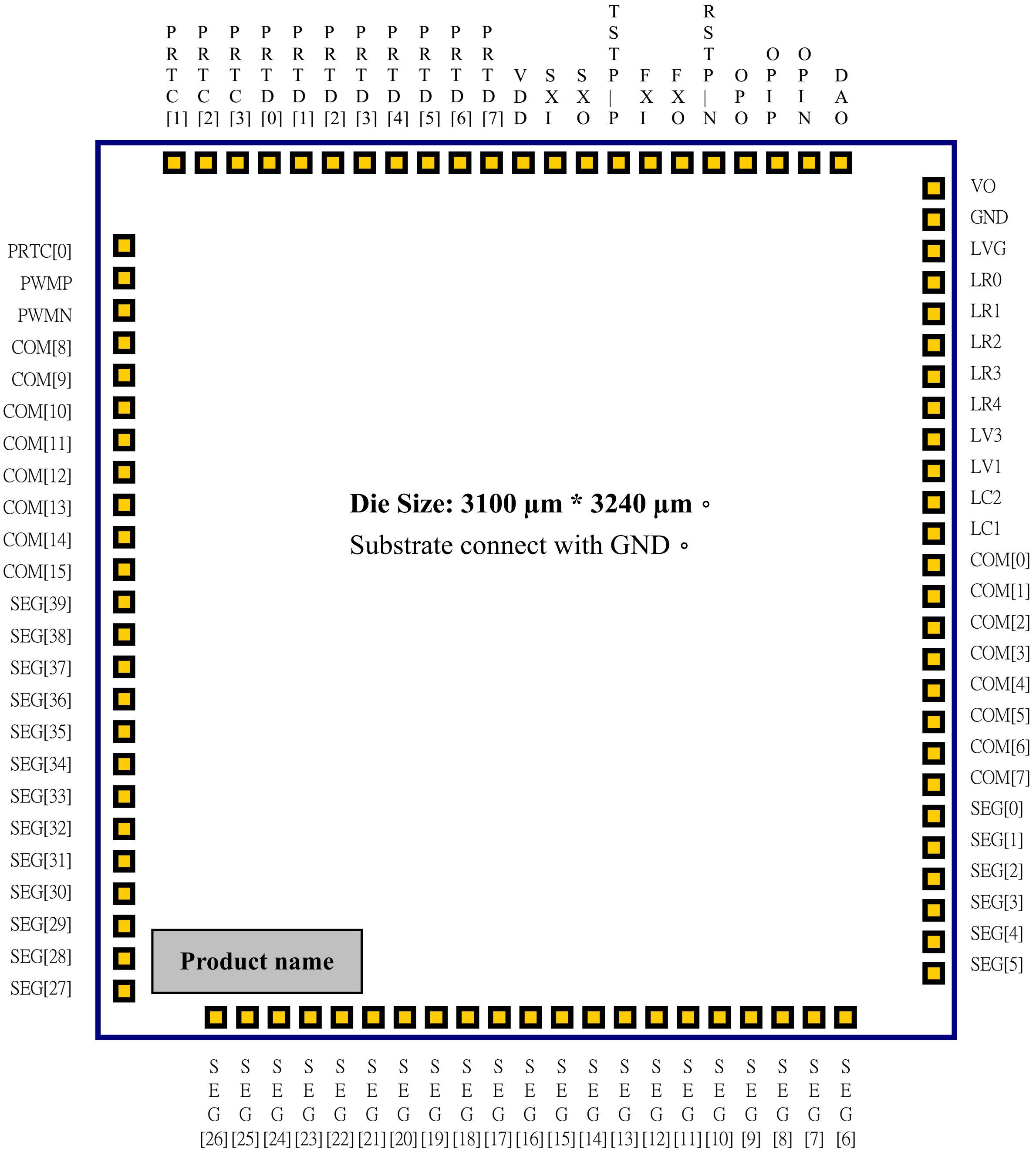
Pin#	Pin Name	I/O	Function	Description
78 77	**FXI, FXO**	B, O	External fast clock pin. Connecting to crystal or RC to generate 32.768 kHz ~ 8MHz system clock.	Mask Option settings： MO_FCK/SCKN=00：Slow Clock only 01：Illegal 10：Dual Clock 11：Fast Clock only MO_FOSCE=0：Internal fast oscillation 1： External fast oscillation MO_FXTAL=0：R,C oscillation for Fast Clock 1：Crystal oscillation for Fast Clock MO_SXTAL=0：R,C oscillation for 32.768K Clock 1：Crystal oscillation for 32.768K Clock。 Program the value of OP1and OP2 to change the operating modes (Normal, Slow, Idle and Sleep). In Dual Clock mode , the system runs in Fast Clock, only the LCD and timer I use the 32.768K clock source。
81 80	**SXI, SXO**	I, O	External slow clock pin. Connecting with 32.768 Hz OSC to generate the stable frequency for Slow Clock Mode and Timer clock source.	
76	**RSTP_N**	I	System Reset Signal.	Pull this pin to low level to reset the system. Besides, select the Mask Option (MQ_PORE=1) to enable the HE83131 internal Power-on Reset function. In addition, the MO_WDTE is used for Watch Timer setting： MO_WDTE=0：Disable Watch Dog Timer =1：Enable Watch Dog Timer
79	**TSTP_P**	I	Test Pin	Pull the pin to high level to enter into testing mode.
91, 92, 93, 1	**PRTC[3:0]**	B	Port C bi-directional I/O Pin (4Pins)	Mask Option MO_CPP[3:0] to preset the output type： MO_CPP=1 : Push-pull output; =0 : Open-drain output When assigned the port to input pin, send a '1' and read the result to get the input value
83.. 90	**PRTD[7:0]**	B	Port D bi-directional I/O pin，(8 pins). PRTD[7:2] is also a Wake-up pin and PRTD[7:6] is used for interrupt input pin.	Mask Option MO_DPP[7:0] to preset the output type： MO_DPP=1 : Push-pull output; =0 : Open-drain output When assigned the port to input pin, send a '1' and read the result to get the input value
11..4 52.. 59	**COM[15:0]**	O	LCD COMmon Output	D Data filled from D8H, please refer the LCD RAM map
12.. 51	**SEG[39:0]**	O	LCD SEGment Output	
61	**LC2**	B	Charge Pump Switch 1	LV3=VDD，Charge Pump for LCD is turn off。Take one 0.1 μF capacitor between LC1 and LC2 off. Please refer the application circuit in order to avoid power consumption.
60	**LC1**	B	Charge Pump Switch 2	
63	**L V3**	B	Charge Pump V3	Please refer the application circuit.
62	**L V1**	B	Charge Pump V1	

64..68	**LR[4..0]**	B	LCD Resister level 4 ~ 0	Please refer the application circuit.
69	**L VG**	I	LCD Virtual Ground	Please refer the application circuit.
2	**PWMP**	O	PWM +ve output pin can directly drive Speaker or Buzzer for sound output.	Set the Bit2 for VOC register (PWM =1) to turn on the PWM
3	**PWMN**	O	PWM -ve output pin can directly drive Speaker or Buzzer for sound output.	Set the Bit2 for VOC register (PWM =1) to turn on the PWM
71	**VO**	O	D/A voice output	Set the bit1 (DA=1) of VOC register to turn on VO
72	**DAO**	O	D/A voice output for OP use.	Set the bit0 (OP=1) of VOC register to turn on DAO
73	**OPIN**	I	OPAMP Inverting pin	Set the bit1 (OP=1) register to turn on OP Individual Op comparator
74	**OPIP**	I	OPAMP Non-Inverting pin	
75	**OPO**	O	OPAMP Output pin	
82	**VDD**	P	Positive Power Input	
70	**GND**	P	Power Ground Input	

E.LCD RAM Map

Page 0	SEG [7:0]	SEG [15:8]	SEG [23:16]	SEG [31:24]	SEG [39:32]
COM0	80H	90H	A0H	B0H	C0H
COM1	81H	91H	A1H	B1H	C1H
COM2	82H	92H	A2H	B2H	C2H
:	:	:	:	:	:
:	:	:	:	:	:
COM13	8DH	9DH	ADH	BDH	CDH
COM14	8EH	9EH	AEH	BEH	CEH
COM15	8FH	9FH	AFH	BFH	CFH

F. Pin Diagram



G. Bonding Pad Location

PIN Number	PIN Name	X Coordinate	Y Coordinate	PIN Number	PIN Name	X Coordinate	Y Coordinate
1	PRTC[0]	X= -1475.80	Y= 1246.95	48	SEG[3]	X= 1474.30	Y= -1236.15
2	PWMP	X= -1475.80	Y= 1107.20	49	SEG[2]	X= 1474.30	Y= -1120.65
3	PWMN	X= -1475.80	Y= 943.85	50	SEG[1]	X= 1474.30	Y= -1005.15
4	COM[8]	X= -1475.80	Y= 804.75	51	SEG[0]	X= 1474.30	Y= -889.65
5	COM[9]	X= -1475.80	Y= 689.25	52	COM[7]	X= 1474.30	Y= -774.15
6	COM[10]	X= -1475.80	Y= 573.75	53	COM[6]	X= 1474.30	Y= -658.65
7	COM[11]	X= -1475.80	Y= 458.25	54	COM[5]	X= 1474.30	Y= -543.15
8	COM[12]	X= -1475.80	Y= 342.75	55	COM[4]	X= 1474.30	Y= -427.65
9	COM[13]	X= -1475.80	Y= 227.25	56	COM[3]	X= 1474.30	Y= -312.15
10	COM[14]	X= -1475.80	Y= 111.75	57	COM[2]	X= 1474.30	Y= -196.65
11	COM[15]	X= -1475.80	Y= -3.75	58	COM[1]	X= 1474.30	Y= -81.15
12	SEG[39]	X= -1475.80	Y= -119.25	59	COM[0]	X= 1474.30	Y= 34.35
13	SEG[38]	X= -1475.80	Y= -234.75	60	LC1	X= 1474.30	Y= 149.85
14	SEG[37]	X= -1475.80	Y= -350.25	61	LC2	X= 1474.30	Y= 265.35
15	SEG[36]	X= -1475.80	Y= -465.75	62	LV1	X= 1474.30	Y= 380.85
16	SEG[35]	X= -1475.80	Y= -581.25	63	LV3	X= 1474.30	Y= 496.35
17	SEG[34]	X= -1475.80	Y= -696.75	64	LR4	X= 1474.30	Y= 611.85
18	SEG[33]	X= -1475.80	Y= -812.25	65	LR3	X= 1474.30	Y= 727.35
19	SEG[32]	X= -1475.80	Y= -927.75	66	LR2	X= 1474.30	Y= 842.85
20	SEG[31]	X= -1475.80	Y= -1043.25	67	LR1	X= 1474.30	Y= 958.35
21	SEG[30]	X= -1475.80	Y= -1158.75	68	LR0	X= 1474.30	Y= 1073.85
22	SEG[29]	X= -1475.80	Y= -1274.25	69	LVG	X= 1474.30	Y= 1189.35
23	SEG[28]	X= -1475.80	Y= -1389.75	70	GND	X= 1474.30	Y= 1304.85
24	SEG[27]	X= -1475.80	Y= -1505.25	71	VO	X= 1474.30	Y= 1438.50
25	SEG[26]	X= -1155.05	Y= -1541.50	72	DAO	X= 1124.45	Y= 1539.10
26	SEG[25]	X= -1039.55	Y= -1541.50	73	OPIN	X= 990.80	Y= 1539.10
27	SEG[24]	X= -924.05	Y= -1541.50	74	OPIP	X= 875.30	Y= 1539.10
28	SEG[23]	X= -808.55	Y= -1541.50	75	OPO	X= 759.80	Y= 1539.10
29	SEG[22]	X= -693.05	Y= -1541.50	76	RSTP_N	X= 644.30	Y= 1539.10
30	SEG[21]	X= -577.55	Y= -1541.50	77	FXO	X= 528.80	Y= 1539.10
31	SEG[20]	X= -462.05	Y= -1541.50	78	FXI	X= 413.30	Y= 1539.10
32	SEG[19]	X= -346.55	Y= -1541.50	79	TSTP_P	X= 297.80	Y= 1539.10
33	SEG[18]	X= -231.05	Y= -1541.50	80	SXO	X= 182.30	Y= 1539.10
34	SEG[17]	X= -115.55	Y= -1541.50	81	SXI	X= 66.80	Y= 1539.10
35	SEG[16]	X= -0.05	Y= -1541.50	82	VDD	X= -48.70	Y= 1539.10
36	SEG[15]	X= 115.45	Y= -1541.50	83	PRTD[7]	X= -164.20	Y= 1539.10
37	SEG[14]	X= 230.95	Y= -1541.50	84	PRTD[6]	X= -279.70	Y= 1539.10
38	SEG[13]	X= 346.45	Y= -1541.50	85	PRTD[5]	X= -395.20	Y= 1539.10
39	SEG[12]	X= 461.95	Y= -1541.50	86	PRTD[4]	X= -510.70	Y= 1539.10
40	SEG[11]	X= 577.45	Y= -1541.50	87	PRTD[3]	X= -626.20	Y= 1539.10
41	SEG[10]	X= 692.95	Y= -1541.50	88	PRTD[2]	X= -741.70	Y= 1539.10
42	SEG[9]	X= 808.45	Y= -1541.50	89	PRTD[1]	X= -857.20	Y= 1539.10

43	SEG[8]	X= 923.95	Y= -1541.50	90	PRTD[0]	X= -972.70	Y= 1539.10
44	SEG[7]	X= 1039.45	Y= -1541.50	91	PRTC[3]	X= -1088.20	Y= 1539.10
45	SEG[6]	X= 1154.95	Y= -1541.50	92	PRTC[2]	X= -1203.70	Y= 1539.10
46	SEG[5]	X= 1474.30	Y= -1467.15	93	PRTC[1]	X= -1319.20	Y= 1539.10
47	SEG[4]	X= 1474.30	Y= -1351.65				

H. DC/AC Characteristics

Absolute Maximum Rating

Item	Sym.	Rating	Condition
Supply Voltage	V_{dd}	-0.5V ~ 8V	
Input Voltage	V_{in}	-0.5V ~ V_{dd}+0.5V	
Output Voltage	V_o	-0.5V ~ V_{dd}+0.5V	
Operating Temperature	T_{op}	0^0C ~ 70^0C	
Storage Temperature	T_{st}	-50^0C ~ 100^0C	

Recommended Operating Conditions

Item	Sym.	Rating	Condition
Supply Voltage	V_{dd}	2.2V ~ 5.5V	
Input Voltage	V_{ih}	0.9 V_{dd} ~ V_{dd}	
	V_{il}	0.0V ~ 0.1V_{dd}	
Operating Frequency	Fmax	8MHz	V_{dd} =5.0V
		4MHz	V_{dd} =2.2V
Operating Temperature	T_{op}	0^0C ~ 70^0C	
Storage Temperature	T_{st}	-50^0C ~ 100^0C	

Test Condition : TEMP=25℃， VDD=3V+/-10%， GND=0V

	PARAMETER		CONDITION	MIN	TYP	MAX	UNIT
I_{Fast}	NORMAL Mode Current	System	2M ext. R/C		0.75	1	mA
I_{Slow}	SLOW Mode Current	System	32.768K X'tal LCD Disable		10	20	μA
I_{Idle}	IDLE Mode Current	System	32.769K X'tal LCD Disable		6	10	μA
I_{LCD}	Extra Current if LCD ON	System	LCD Enable, LCD option=300Kohm Voltage-doubler OFF		12	20	μA
			LCD Enable, LCD option=30Kohm, Voltage-doubler ON		100	120	
I_{Sleep}	Sleep Mode Current	System				1	μA
I_{oHPWM}	PWM Output Drive Current	PWMP, PWMN*2	V_{DD}=3V; V_{oh}=2V	12	15		mA
I_{oLPWM}	PWM Output Sink Current	PWMP, PWMN*2	V_{DD}=3V; V_{oL}=1V	33	40		mA
I_{oVO}	DAC Output Current	VO, DAO	V_{DD}=3V;VO=0~2V,Data=7F	2.5	3		mA
V_{iH}	Input High Voltage	I/O pins		0.8 V_{DD}			V
V_{iL}	Input Low Voltage	I/O pins				0.2 V_{DD}	V
V_{hys}	Input Hysteresis Width	I/O, RSTP_N	Threshold=2/3V_{DD}(input from low to high) Threshold=1/3V_{DD}(input from high to low)		1/3 V_{DD}		V
I_{oH}	Output Drive Current	I/O pull-high*1	V_{oL}=2.0V	50			μA
I_{oL_1}	Output Sink Current	I/O pull-low*1	V_{oL}=0.4V	1.0			mA
I_{iL_1}	Input Low Current	RSTP_N	V_{iL}=GND, pull high Internally		20		μA
I_{iL_2}	Input Low Current	I/O	V_{iL}=GND, if pull high Internally by user		100		μA

Note: *1: Drive Current Spec. for Push-Pull I/O port only
Sink Current Spec. for both Push-Pull and Open-Drain I/O port.

*2: This Spec. base on one driver only. There are five build-in driver, so user just multiply the number of driver he used to one driver current
to get the total amount of current.(**I_{oHPWM}** 、**I_{oLPWM}** * N; N=0,1,2,3,4,5)

I. Application Circuit