A.HE83115 Introduction

HE83115 is a member of 8-bit Micro-controller series developed by King Billion Electronics Ltd. Users can chose any one of combination among 【80 dots LCD Driver + 12 Bit I/O Port】…【48 dots LCD Driver + 20 Bit I/O Port】etc. The built-in OP comparator can be used with (light、voice、temperature、humility) sensor and used as battery low detection. And the 7-bit current-type D/A converter and PWM device provide the complete speech output mechanism. The 64K ROM Size can be used in the storage of speech (20 seconds at 3Kbytes per second), graphic, text etc. This IC is applicable to the small systems such as sport match, sport recorder, digital watch etc..

The instruction set of HE83115 are quite easy to learn and simple to use. Only about thirty instructions with four-type addressing mode are provided. Most of instructions take only 3 oscillator clocks (machine cycles). The processing power is enough to most of battery operation system.

B.HE83115 Features

- Operation Voltage： 2.4V – 5.5V
- System Clock： DC ~ 8MHz @ 5.0V
  DC ~ 4MHz @ 2.4V
- Internal ROM： 64K Bytes(64K 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..
- 12~20 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.
- 80~48 dots LCD driver (A、B TYPE selectable).
- One 7-bit current-type DAC output.
- PWM device.
- Two external interrupts and two internal timer interrupts.
- Two 16-bit timer.
- Instruction set： 32 instructions, 4 addressing mode. 8-bit DATA POINTER for RAM and 16-bit TABLE POINTER for ROM.

C.HE83115 Application

Please always take in mind that ICE is different from IC. ICE is the whole set of HE80000 series IC, but each IC is a subset of ICE. Never use any hardware resource that real IC didn't have, especially RAM and register. KBIDS and compiler cannot prevent user to use some hardware resource that didn't exist. Please check the following table and refer the abbreviation in HE80000 user's manual.

I.F.C.	E.S.C.	I.P.R	PROM	DROM	TP	TP+1	RAM	PP	DP	I/O	DTMF	WDT	Timer
◎	◎	◎	64KB	—	16-bit	◎	256B	—	8-bit	12~20	—	◎	T1,T2

VO	DAO	OP	PWM	LCD	COM*SEG	Bias	Rgr	ChrgPmp	LV2	LR	LVG	REC	S.R.
◎	—	◎	◎	80~48	4*20	1/3	—	1,3/2,3	◎	—	—	—	—

D. Pin Description

Pin #	Pin name	I/O	Function	Description
43 42	**FXI,** **FXO**	B, O	External fast clock pin. Connecting to crystal or RC to generate 32.768 kHz ~ 8MHz frequency.	Mask option setting： MO_FCK/SCKN= 00：Slow Clock only 01：Illegal 10：Dual Clock 11：Fast Clock only MO_FOSCE = 0：Internal fast osc. = 1：External fast osc. MO_FXTAL= 0：RC osc. for fast clock = 1：X'tal osc. for fast clock MO_SXTAL= 0：RC for 32768 Hz clock = 1：X'tal for 32768 Hz clock Use OP1 and OP2 to switch among different operation mode (NORMAL, SLOW, IDEL and SLEEP). In Dual Clock mode, the main system clock is still the Fast Clock. The 32768 Hz clock is for LCD and Timer 1 only.
46 45	**SXI,** **SXO**	I, O	External slow clock pin. Connecting with 32768 Hz crystal or resistor as slow clock and providing clock source for LCD display, TIMER1, Time-Base and other internal blocks.	
41	**RSTP_N**	I	System Reset.	Level trigger, active low. Except for using this pin, using mask option (MO_PORE=1) could enable IC build-in power-on reset circuit. Besides, MO_WDTE can set Watch Dog Timer： MO_WDTE=0：Disable Watch Dog Timer =1：Enable Watch Dog Timer
44	**TSTP_P**	I	Test Pin	Please bond this pin and add a test point on PCB for debugging. Leave this pin floating is OK.
1..4	**PRTC[3:0]**	B	4-pin bi-directional I/O port.	Mask options： MO_CPP[3..0]=1 ~ Push-pull. =0 ~ Open-drain. Output must be "1" before reading whenever use them as input (No tri-state structure).
48.. 55	**PRTD[7:0]**	B	8-pin bi-directional I/O port. PRTD[7..2] as wake-up pin. PRTD[7..6] as external interrupt pin.	Mask options： MO_DPP[7..0]=1 ~ Push-pull. =0 ~ Open-drain. Output must be "1" before reading whenever use them as input (No tri-state structure).
7..14	**PRT14[7:0]/** **SEG[19:12]**	B/ O	8-pin bi-directional I/O port that is shared with LCD segment pin.	Mask options： MO_LIO14[7..0]=1 ~ LCD Pin. =0 ~ I/O Pin. MO_14PP[7..0]=1 ~ Push-pull. =0 ~ Open-drain. Output must be "1" before reading whenever use them as input (No tri-state structure).
27.. 30	**COM[3:0]**	O	LCD COMmon Output	LCD Data filled from F0H, please refer the LCD RAM map.
15.. 26	**SEG[11:0]**	O	LCD SEGment Output	
32	**LC2**	B	Charge Pump Switch 2	Add one 0.1 μF capacitor between LC1 and LC2. Please refer the application circuit.
31	**LC1**	B	Charge Pump Switch 1	
35	**LV3**	B	Charge Pump V3	LV3< 9 Volts.

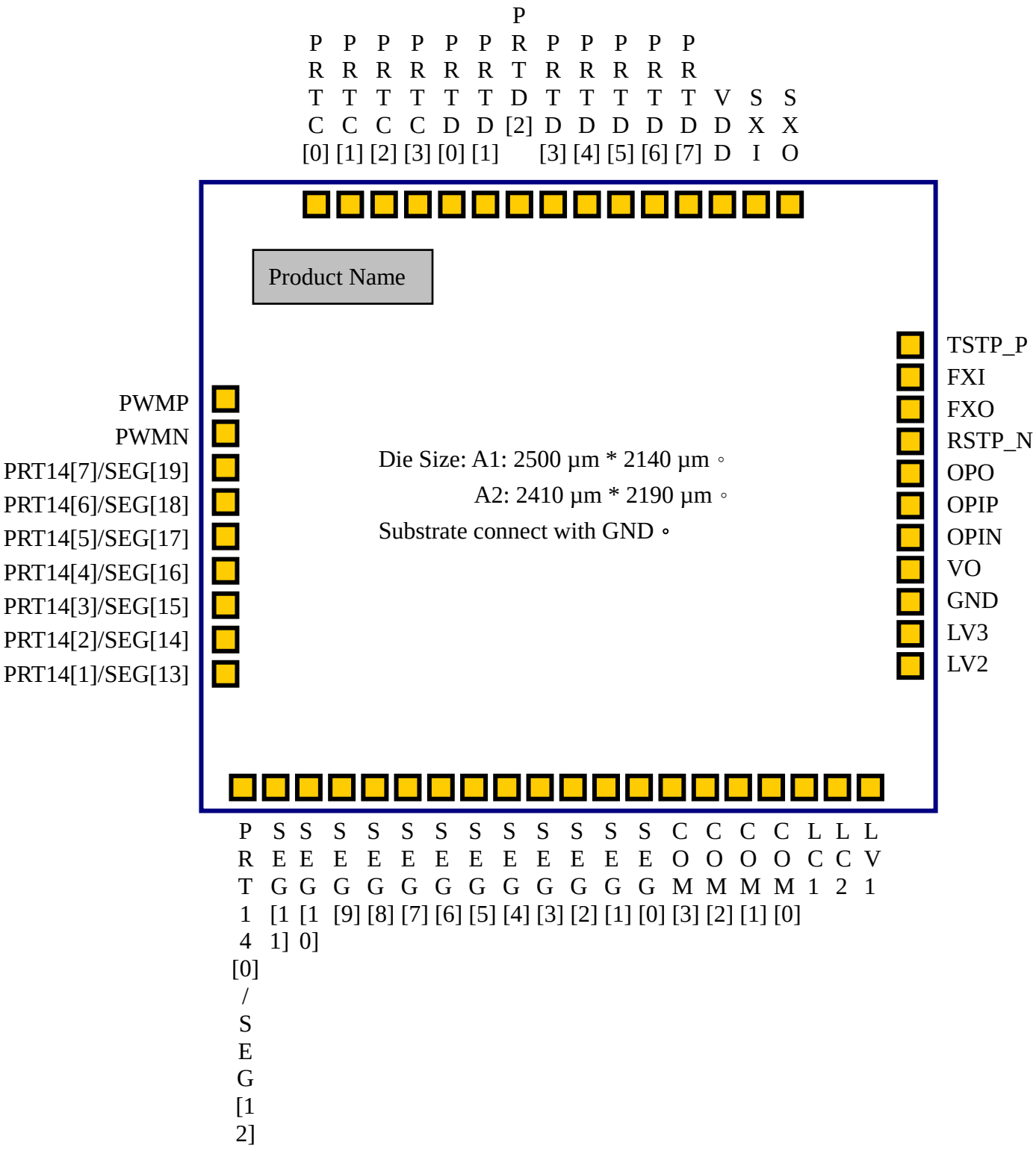
Pin #	Pin name	I/O	Function	Description
34	**LV2**	B	Charge Pump V2	Please refer the application circuit.
33	**LV1**	B	Charge Pump V1	
5	**PWMP**	O	The PWM positive output can drive speaker or buzzer directly.	Set the bit2 of VOC register as one to turn on PWM.
6	**PWMN**	O	The PWM positive output can drive speaker or buzzer directly.	Set the bit2 of VOC register as one to turn on PWM.
37	**VO**	O	D/A output.	Bit 1 of VOC = '1' , Turn on DA
38	**OPIN**	I	OPAMP negative input pin.	Built-in OP comparator. Set Bit 0 of VOC = '1' , Turn on OP
39	**OPIP**	I	OPAMP positive input pin.	
40	**OPO**	O	OPAMP output pin.	
47	**VDD**	P	Positive Power Input	Adding 0.1 µF capacitor as by-pass capacitor on power pins is necessary.(within 1 cm distance)
36	**GND**	P	Power Ground Input	

E. LCD RAM Map

Page 0:

F0H	SEG1	SEG0	F5H	SEG11	SEG10
	COM[3:0]	COM[3:0]		COM[3:0]	COM[3:0]
F1H	SEG3	SEG2	F6H	SEG13	SEG12
	COM[3:0]	COM[3:0]		COM[3:0]	COM[3:0]
F2H	SEG5	SEG4	F7H	SEG15	SEG14
	COM[3:0]	COM[3:0]		COM[3:0]	COM[3:0]
F3H	SEG7	SEG6	F8H	SEG17	SEG16
	COM[3:0]	COM[3:0]		COM[3:0]	COM[3:0]
F4H	SEG9	SEG8	F9H	SEG19	SEG18
	COM[3:0]	COM[3:0]		COM[3:0]	COM[3:0]

F. Pin Diagram



G. Bonding Pad Location

Which version of IC decided by KB when customer gives order to KB. Please make sure which version will be used before you make a PCB!

Version A1:

PIN Number	PIN Name	X Coordinate	Y Coordinate	PIN Number	PIN Name	X Coordinate	Y Coordinate
1	PRTC[3]	X= -532.10	Y= 991.60	29	COM[1]	X= 617.20	Y= -991.50
2	PRTC[2]	X= -647.60	Y= 991.60	30	COM[0]	X= 732.80	Y= -991.50
3	PRTC[1]	X= -763.10	Y= 991.60	31	LC1	X= 848.20	Y= -991.50
4	PRTC[0]	X= -878.60	Y= 991.60	32	LC2	X= 963.80	Y= -991.50
5	PWMP	X= -1173.80	Y= 288.20	33	LV1	X= 1079.20	Y= -991.50
6	PWMN	X= -1173.80	Y= 124.80	34	LV2	X= 1173.50	Y= -702.80
7	PRT14[7]	X= -1173.80	Y= -14.30	35	LV3	X= 1173.50	Y= -587.20
8	PRT14[6]	X= -1173.80	Y= -129.80	36	GND	X= 1173.50	Y= -471.80
9	PRT14[5]	X= -1173.80	Y= -245.30	37	VO	X= 1173.50	Y= -356.20
10	PRT14[4]	X= -1173.80	Y= -360.80	38	OPIN	X= 1173.50	Y= -240.80
11	PRT14[3]	X= -1173.80	Y= -476.20	39	OPIP	X= 1173.50	Y= -125.20
12	PRT14[2]	X= -1173.80	Y= -591.80	40	OPO	X= 1173.50	Y= -9.80
13	PRT14[1]	X= -1173.80	Y= -707.20	41	RSTP_N	X= 1173.50	Y= 105.80
14	PRT14[0]	X= -1115.20	Y= -991.50	42	FXO	X= 1173.50	Y= 221.20
15	SEG[11]	X= -999.80	Y= -991.50	43	FXI	X= 1173.50	Y= 336.80
16	SEG[10]	X= -884.20	Y= -991.50	44	TSTP_P	X= 1173.50	Y= 452.20
17	SEG[9]	X= -768.80	Y= -991.50	45	SXO	X= 738.40	Y= 991.60
18	SEG[8]	X= -653.20	Y= -991.50	46	SXI	X= 622.90	Y= 991.60
19	SEG[7]	X= -537.80	Y= -991.50	47	VDD	X= 507.40	Y= 991.60
20	SEG[6]	X= -422.20	Y= -991.50	48	PRTD[7]	X= 391.90	Y= 991.60
21	SEG[5]	X= -306.80	Y= -991.50	49	PRTD[6]	X= 276.40	Y= 991.60
22	SEG[4]	X= -191.20	Y= -991.50	50	PRTD[5]	X= 160.80	Y= 991.60
23	SEG[3]	X= -75.80	Y= -991.50	51	PRTD[4]	X= 45.40	Y= 991.60
24	SEG[2]	X= 39.80	Y= -991.50	52	PRTD[3]	X= -70.20	Y= 991.60
25	SEG[1]	X= 155.20	Y= -991.50	53	PRTD[2]	X= -185.70	Y= 991.60
26	SEG[0]	X= 270.80	Y= -991.50	54	PRTD[1]	X= -301.10	Y= 991.60
27	COM[3]	X= 386.20	Y= -991.50	55	PRTD[0]	X= -416.60	Y= 991.60
28	COM[2]	X= 501.80	Y= -991.50				

Version A2:

PIN Number	PIN Name	X Coordinate	Y Coordinate	PIN Number	PIN Name	X Coordinate	Y Coordinate
1	PRTC[3]	X= -485.65	Y= 1024.20	29	COM[1]	X= 637.85	Y= -1009.00
2	PRTC[2]	X= -601.75	Y= 1024.20	30	COM[0]	X= 753.35	Y= -1009.00
3	PRTC[1]	X= -717.50	Y= 1024.20	31	LC1	X= 868.85	Y= -1009.00
4	PRTC[0]	X= -833.50	Y= 1024.20	32	LC2	X= 985.35	Y= -1009.00
5	PWMP	X= -1115.90	Y= 259.30	33	LV1	X= 1100.85	Y= -1009.00
6	PWMN	X= -1115.90	Y= 95.95	34	LV2	X= 1135.70	Y= -717.30
7	PRT14[7]	X= -1115.75	Y= -47.85	35	LV3	X= 1135.70	Y= -601.50
8	PRT14[6]	X= -1115.75	Y= -163.35	36	GND	X= 1135.70	Y= -486.00
9	PRT14[5]	X= -1115.75	Y= -279.70	37	VO	X= 1135.70	Y= -370.50
10	PRT14[4]	X= -1115.75	Y= -395.15	38	OPIN	X= 1135.70	Y= -254.00
11	PRT14[3]	X= -1115.75	Y= -510.65	39	OPIP	X= 1135.70	Y= -137.80
12	PRT14[2]	X= -1115.75	Y= -627.60	40	OPO	X= 1135.70	Y= -21.90
13	PRT14[1]	X= -1115.75	Y= -743.10	41	RSTP_N	X= 1135.70	Y= 93.60
14	PRT14[0]	X= -1101.25	Y= -1009.00	42	FXO	X= 1135.70	Y= 209.95
15	SEG[11]	X= -985.75	Y= -1009.00	43	FXI	X= 1135.70	Y= 325.45
16	SEG[10]	X= -869.45	Y= -1009.00	44	TSTP_P	X= 1135.70	Y= 440.95
17	SEG[9]	X= -753.95	Y= -1009.00	45	SXO	X= 789.00	Y= 1024.20
18	SEG[8]	X= -637.60	Y= -1009.00	46	SXI	X= 673.20	Y= 1024.00
19	SEG[7]	X= -522.10	Y= -1009.00	47	VDD	X= 558.00	Y= 1024.20
20	SEG[6]	X= -405.95	Y= -1009.00	48	PRTD[7]	X= 441.80	Y= 1023.80
21	SEG[5]	X= -290.45	Y= -1009.00	49	PRTD[6]	X= 325.75	Y= 1023.90
22	SEG[4]	X= -173.85	Y= -1009.00	50	PRTD[5]	X= 209.75	Y= 1023.85
23	SEG[3]	X= -58.35	Y= -1009.00	51	PRTD[4]	X= 94.00	Y= 1023.90
24	SEG[2]	X= 57.15	Y= -1009.00	52	PRTD[3]	X= -22.00	Y= 1024.20
25	SEG[1]	X= 173.80	Y= -1009.00	53	PRTD[2]	X= -138.05	Y= 1024.20
26	SEG[0]	X= 289.30	Y= -1009.00	54	PRTD[1]	X= -253.95	Y= 1024.20
27	COM[3]	X= 405.45	Y= -1009.00	55	PRTD[0]	X= -369.70	Y= 1024.20
28	COM[2]	X= 520.95	Y= -1009.00				

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

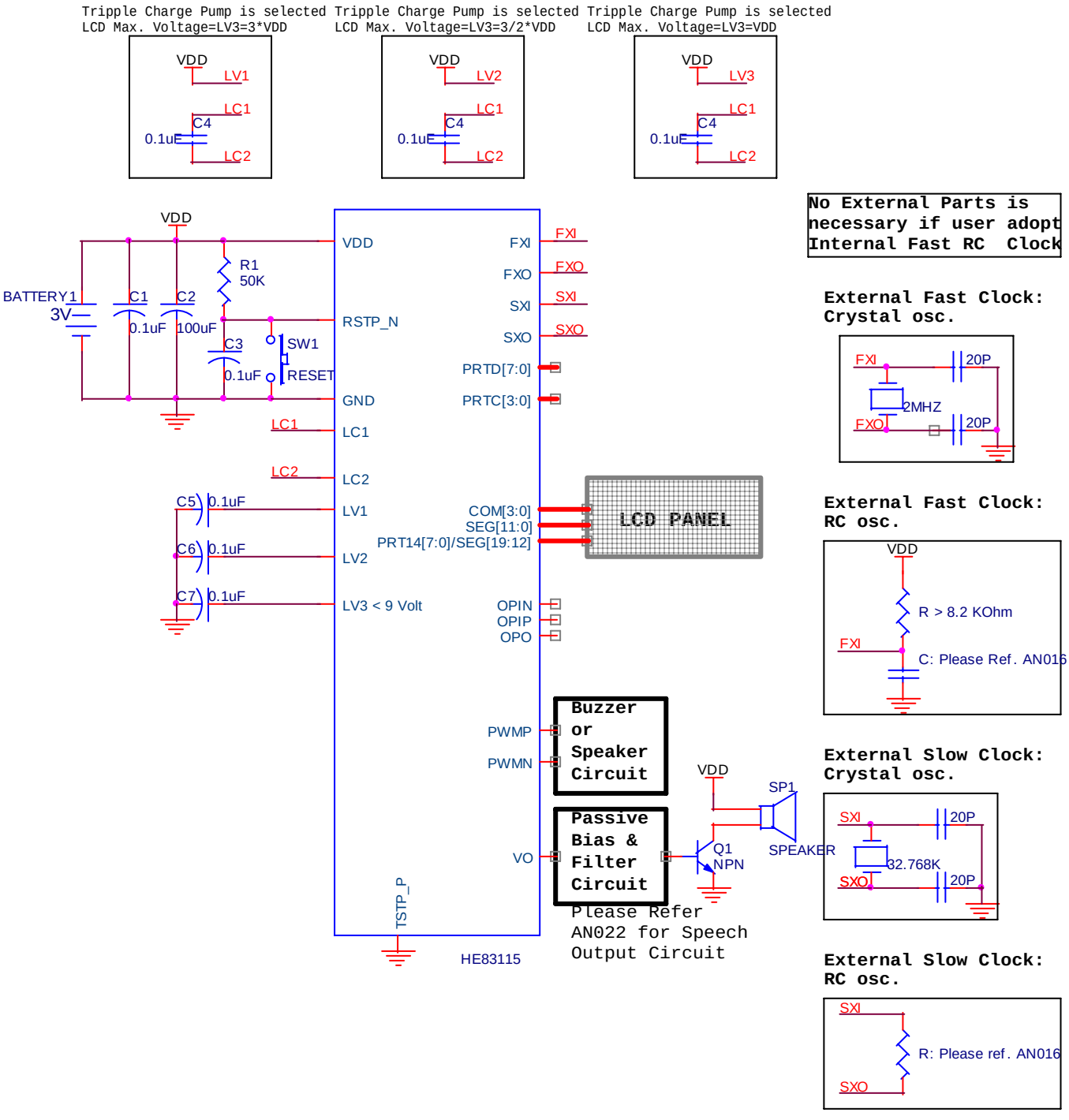
Item	Sym.	Rating	Condition
Supply Voltage	V_{dd}	2.4V ~ 5.5V	
Input Voltage	V_{ih}	0.9 V_{dd} ~ V_{dd}	
	V_{il}	0.0V ~ 0.1V_{dd}	
Operating Frequency	Fmax	8MHz	V_{dd} =5.0V
		4MHz	V_{dd} =2.4V
Operating Temperature	T_{op}	0^0C ~ 70^0C	
Storage Temperature	T_{st}	-50^0C ~ 100^0C	

Testing 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		6	9	μA
I_{Idle}	IDLE Mode Current	System	32.769K X'tal LCD Disable		4	7	μA
I_{LCD}	Extra Current if LCD ON	System	LCD Enable		2	3	μA
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	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)

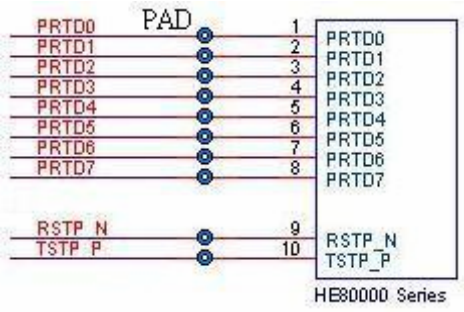
I. Application Circuit



J. Important Note

1. LCD driving circuit must be turn off before IC goes into sleep mode.

2. Please bonds the TSTP_P, RSTP_N and PRTD[7:0] with test point on PCB (can be soldered and probed) as you can, then KB can do some IC testing job on PCB. Neither VDD nor GND connection is necessary for TSTP_P. The following figure is an example (Testing point with through hole).



K. Updated Record

Version	Date	Section	Original Content	New Content
V3.3	Nov 28, 2001	B, H	2.2V (VDD operation voltage)	2.4V
		J, K	New Section	