A. HE83750 Introduction

HE83750 is a member of 8-bit Micro-controller series developed by King Billion Electronics Ltd. Users can chose any one of combination among 【2048 dots LCD Driver + 16 Bit I/O Port】…【1792 dots LCD Driver + 24 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 built-in DTMF generator can generate the PSTN dialing tone directly. The 512K ROM Size can be used in the storage of large speech data, graphic, text etc. It can be applicable to the medium systems such as Small-Scale Dictionary, Data Bank, Pocket Dialer, Automatic Dialer Machine, Medium Level Educational Toy, Lower Second Voice Recording System and connect external SRAM or Flash RAM for Higher Second Voice Recording etc..

The instruction set of HE83750 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. HE83750 Feature

- Operation Voltage： 2.4V – 5.5V
- System Clock： DC ~ 8MHz @ 5.0V
  DC ~ 4MHz @ 2.4V
- Internal ROM： 512K Bytes(64K Program ROM, 448K Data ROM)
- Internal RAM： 16K 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.
- 16~24 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.。
- 2048~1792 dots LCD driver (B TYPE selectable).
- One 7-bit current-type DAC output.
- PWM device.
- Built-in DTMF Generator.
- Two external interrupts and three internal timer interrupts.
- Three 16-bit timer.
- Instruction set： 32 instructions, 4 addressing mode. 14-bit DATA POINTER for RAM and 19-bit TABLE POINTER for ROM.

C. Internal Block

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	448KB	19-bit	◎	16KB	6-bit	8-bit	16~24	◎	◎	T1,T2,TB

VO	DAO	OP	PWM	LCD	COM*SEG	Bias	Rgr	ChrgPmp	LV2	LR	LVG	REC	S.R.
◎	◎	◎	◎	2048~1792	32*64	1/7	—	1,3/2,2,3	◎	4:0	◎	E/I	I/D

D. Pin Description

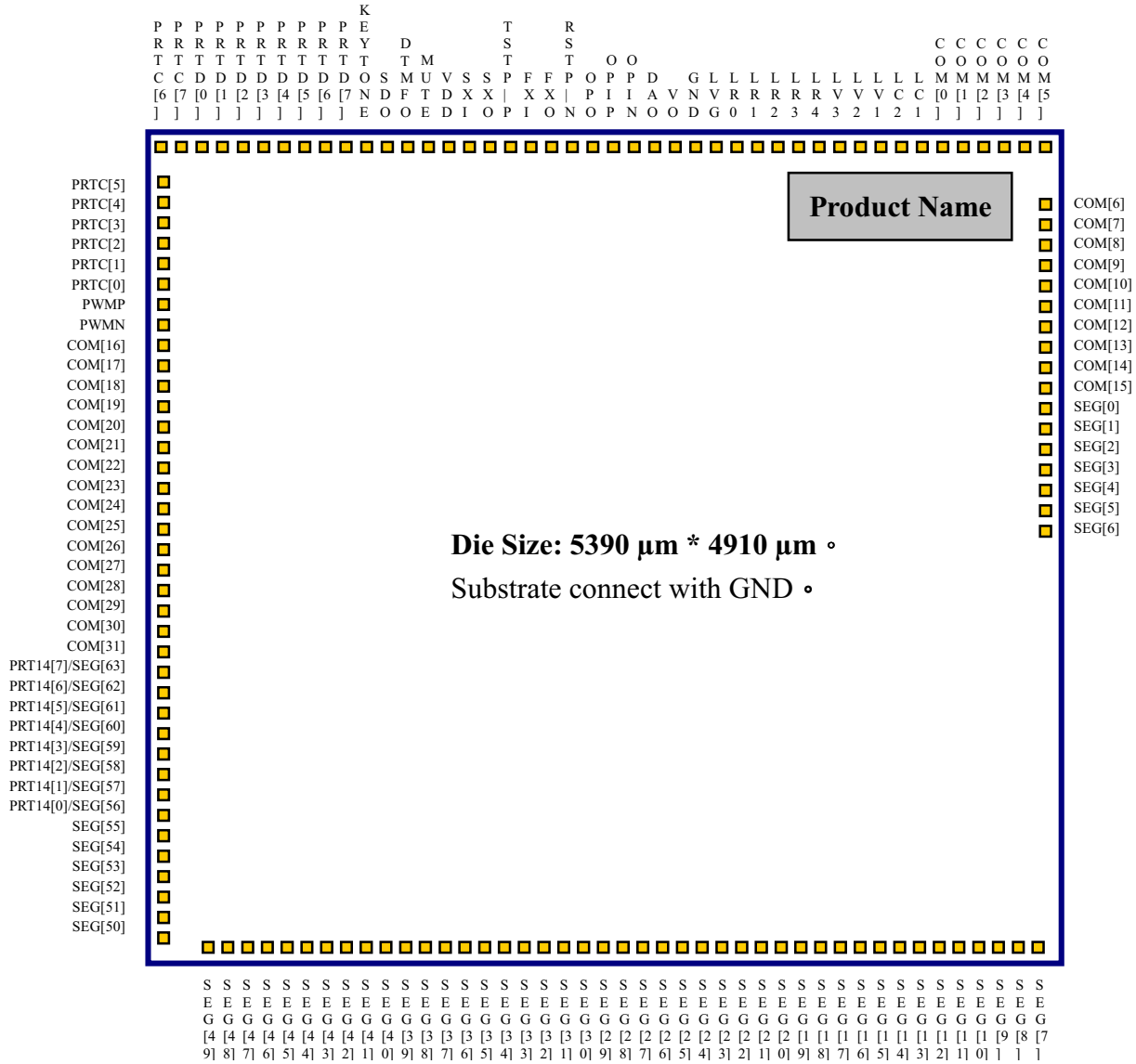
Pin #	Pin name	I/O	Function	Description
122 121	**FXI,** **FXO**	B, O	External fast clock pin. Connecting to crystal or RC to generate 32.768 kHz ~ 8MHz frequency.	Mask option setting： MO_FCK/SCKN= 00：Slow Clock only 01：Illegal 10：Dual Clock 11：Fast Clock only MO_FOSCE = 0：Internal fast osc. = 1：External 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.
125 124	**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.	
120	**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
123	**TSTP_P**	I	Test Pin	Please bond this pin and add a test point on PCB for debugging. Leave this pin floating is OK.
139.. 142 1..4	**PRTC[7:0]**	B	8-pin bi-directional I/O port.	Mask options： MO_CPP[7..0]=1 ~ Push-pull. =0 ~ Open-drain. Output must be "1" before reading whenever use them as input (No tri-state structure).
131.. 138	**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).
23..30	**PRT14[7:0]/** **SEG[63:56]**	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).

Pin #	Pin name	I/O	Function	Description
22..7 87..102	**COM[31:0]**	O	LCD COMmon Output	LCD Data filled from page1 00H, please refer the LCD RAM map.
31..86	**SEG[55:0]**	O	LCD SEGment Output	
104	**LC2**	B	Charge Pump Switch 1	Add one 0.1 μF capacitor between LC1 and LC2. Please refer the application circuit.
103	**LC1**	B	Charge Pump Switch 2	
107	**L V3**	B	Charge Pump V3	LV3< 9 Volts. Please refer the application circuit.
106	**L V2**	B	Charge Pump V2	
105	**L V1**	B	Charge Pump V1	
108..112	**LR[4..0]**	B	LCD Resister level 4 ~ 1	Please refer the application circuit.
113	**L VG**	I	LCD Virtual Ground	Please refer the application circuit.
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.
115	**VO**	O	D/A output.	Bit 1 of VOC = '1' , Turn on DA
116	**DAO**	O	DAC Voice Output	Set the bit1(DA=1) of VOC register to turn on DAC with VO output.
117	**OPIN**	I	OPAMP negative input pin.	Built-in OP comparator. Set Bit 0 of VOC = '1' , Turn on OP
118	**OPIP**	I	OPAMP positive input pin.	
119	**OPO**	O	OPAMP output pin.	
128	**DTMFO**	O	DTMF Output	Through PRT12 we can turn on/off DTMF and write data. Using Mask Option MO_DTMFSCK set the clock source of DTMF block. MO_DTMFSCK=0；Clock Source=3.579545 MHz =1；Clock Source=32768 Hz
127	**MUTE**	O	MUTE Output for Dialer	User can turn on/off MUTE pin by port12.
129	**SDO**	O	Serial Data Output	We can turn on/off SDO block or write data by port12.
130	**KEYTONE**	O	1024-Hz 50% duty square wave	User can turn on/off key tone by port12.
126	**VDD**	P	Positive Power Input	
114	**GND**	P	Power Ground Input	

E.LCD RAM Map

Page 1	SEG [7:0]	SEG [15:8]	SEG [23:16]	SEG [31:24]	SEG [39:32]	SEG [47:40]	SEG [55:48]	SEG [63:56]
COM0	00H	20H	40H	60H	80H	A0H	C0H	E0H
COM1	01H	21H	41H	61H	81H	A1H	C1H	E1H
COM2	02H	22H	42H	62H	82H	A2H	C2H	E2H
:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:
COM29	1DH	3DH	5DH	7DH	9DH	BDH	DDH	FDH
COM32	1EH	3EH	5EH	7EH	9EH	BEH	DEH	FEH
COM31	1FH	3FH	5FH	7FH	9FH	BFH	DFH	FFH

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[3]	X= -2605.85	Y= 1821.45	72	SEG[14]	X= 1740.25	Y= -2377.45
2	PRTC[2]	X= -2605.85	Y= 1705.95	73	SEG[13]	X= 1855.75	Y= -2377.45
3	PRTC[1]	X= -2605.85	Y= 1590.45	74	SEG[12]	X= 1971.25	Y= -2377.45
4	PRTC[0]	X= -2605.85	Y= 1474.95	75	SEG[11]	X= 2086.75	Y= -2377.45
5	PWMP	X= -2605.85	Y= 1335.20	76	SEG[10]	X= 2202.25	Y= -2377.45
6	PWMN	X= -2605.85	Y= 1171.85	77	SEG[9]	X= 2317.75	Y= -2377.45
7	COM[16]	X= -2605.85	Y= 1032.75	78	SEG[8]	X= 2433.25	Y= -2377.45
8	COM[17]	X= -2605.85	Y= 917.25	79	SEG[7]	X= 2548.75	Y= -2377.45
9	COM[18]	X= -2605.85	Y= 801.75	80	SEG[6]	X= 2607.10	Y= 179.25
10	COM[19]	X= -2605.85	Y= 686.25	81	SEG[5]	X= 2607.10	Y= 294.75
11	COM[20]	X= -2605.85	Y= 570.75	82	SEG[4]	X= 2607.10	Y= 410.25
12	COM[21]	X= -2605.85	Y= 455.25	83	SEG[3]	X= 2607.10	Y= 525.75
13	COM[22]	X= -2605.85	Y= 339.75	84	SEG[2]	X= 2607.10	Y= 641.25
14	COM[23]	X= -2605.85	Y= 224.25	85	SEG[1]	X= 2607.10	Y= 756.75
15	COM[24]	X= -2605.85	Y= 108.75	86	SEG[0]	X= 2607.10	Y= 872.25
16	COM[25]	X= -2605.85	Y= -6.75	87	COM[15]	X= 2607.10	Y= 987.75
17	COM[26]	X= -2605.85	Y= -122.25	88	COM[14]	X= 2607.10	Y= 1103.25
18	COM[27]	X= -2605.85	Y= -237.75	89	COM[13]	X= 2607.10	Y= 1218.75
19	COM[28]	X= -2605.85	Y= -353.25	90	COM[12]	X= 2607.10	Y= 1334.25
20	COM[29]	X= -2605.85	Y= -468.75	91	COM[11]	X= 2607.10	Y= 1449.75
21	COM[30]	X= -2605.85	Y= -584.25	92	COM[10]	X= 2607.10	Y= 1565.25
22	COM[31]	X= -2605.85	Y= -699.75	93	COM[9]	X= 2607.10	Y= 1680.75
23	PRT14[7]	X= -2605.85	Y= -815.25	94	COM[8]	X= 2607.10	Y= 1796.25
24	PRT14[6]	X= -2605.85	Y= -930.75	95	COM[7]	X= 2607.10	Y= 1911.75
25	PRT14[5]	X= -2605.85	Y= -1046.25	96	COM[6]	X= 2607.10	Y= 2027.25
26	PRT14[4]	X= -2605.85	Y= -1161.75	97	COM[5]	X= 2532.05	Y= 2376.10
27	PRT14[3]	X= -2605.85	Y= -1277.25	98	COM[4]	X= 2416.55	Y= 2376.10
28	PRT14[2]	X= -2605.85	Y= -1392.75	99	COM[3]	X= 2301.05	Y= 2376.10
29	PRT14[1]	X= -2605.85	Y= -1508.25	100	COM[2]	X= 2185.55	Y= 2376.10
30	PRT14[0]	X= -2605.85	Y= -1623.75	101	COM[1]	X= 2070.05	Y= 2376.10
31	SEG[55]	X= -2605.85	Y= -1739.25	102	COM[0]	X= 1954.55	Y= 2376.10
32	SEG[54]	X= -2605.85	Y= -1854.75	103	LC1	X= 1839.05	Y= 2376.10
33	SEG[53]	X= -2605.85	Y= -1970.25	104	LC2	X= 1723.55	Y= 2376.10
34	SEG[52]	X= -2605.85	Y= -2085.75	105	LV1	X= 1608.05	Y= 2376.10
35	SEG[51]	X= -2605.85	Y= -2201.25	106	LV2	X= 1492.55	Y= 2376.10
36	SEG[50]	X= -2605.85	Y= -2316.75	107	LV3	X= 1377.05	Y= 2376.10
37	SEG[49]	X= -2302.25	Y= -2377.45	108	LR4	X= 1261.55	Y= 2376.10
38	SEG[48]	X= -2186.75	Y= -2377.45	109	LR3	X= 1146.05	Y= 2376.10

PIN Number	PIN Name	X Coordinate	Y Coordinate	PIN Number	PIN Name	X Coordinate	Y Coordinate
39	SEG[47]	X= -2071.25	Y= -2377.45	110	LR2	X= 1030.55	Y= 2376.10
40	SEG[46]	X= -1955.75	Y= -2377.45	111	LR1	X= 915.05	Y= 2376.10
41	SEG[45]	X= -1840.25	Y= -2377.45	112	LR0	X= 799.55	Y= 2376.10
42	SEG[44]	X= -1724.75	Y= -2377.45	113	LVG	X= 684.05	Y= 2376.10
43	SEG[43]	X= -1609.25	Y= -2377.45	114	GND	X= 568.55	Y= 2376.10
44	SEG[42]	X= -1493.75	Y= -2377.45	115	VO	X= 434.90	Y= 2376.10
45	SEG[41]	X= -1378.25	Y= -2377.45	116	DAO	X= 283.10	Y= 2376.10
46	SEG[40]	X= -1262.75	Y= -2377.45	117	OPIN	X= 149.45	Y= 2376.10
47	SEG[39]	X= -1147.25	Y= -2377.45	118	OPIP	X= 33.95	Y= 2376.10
48	SEG[38]	X= -1031.75	Y= -2377.45	119	OPO	X= -81.55	Y= 2376.10
49	SEG[37]	X= -916.25	Y= -2377.45	120	RSTP_N	X= -197.05	Y= 2376.10
50	SEG[36]	X= -800.75	Y= -2377.45	121	FXO	X= -312.55	Y= 2376.10
51	SEG[35]	X= -685.25	Y= -2377.45	122	FXI	X= -428.05	Y= 2376.10
52	SEG[34]	X= -569.75	Y= -2377.45	123	TSTP_P	X= -543.55	Y= 2376.10
53	SEG[33]	X= -454.25	Y= -2377.45	124	SXO	X= -659.05	Y= 2376.10
54	SEG[32]	X= -338.75	Y= -2377.45	125	SXI	X= -774.55	Y= 2376.10
55	SEG[31]	X= -223.25	Y= -2377.45	126	VDD	X= -890.05	Y= 2376.10
56	SEG[30]	X= -107.75	Y= -2377.45	127	MUTE	X= -1005.55	Y= 2376.10
57	SEG[29]	X= 7.75	Y= -2377.45	128	DTMFO	X= -1121.05	Y= 2376.10
58	SEG[28]	X= 123.25	Y= -2377.45	129	SDO	X= -1236.55	Y= 2376.10
59	SEG[27]	X= 238.75	Y= -2377.45	130	KEYTONE	X= -1364.95	Y= 2376.10
60	SEG[26]	X= 354.25	Y= -2377.45	131	PRTD[7]	X= -1493.95	Y= 2376.10
61	SEG[25]	X= 469.75	Y= -2377.45	132	PRTD[6]	X= -1609.45	Y= 2376.10
62	SEG[24]	X= 585.25	Y= -2377.45	133	PRTD[5]	X= -1724.95	Y= 2376.10
63	SEG[23]	X= 700.75	Y= -2377.45	134	PRTD[4]	X= -1840.45	Y= 2376.10
64	SEG[22]	X= 816.25	Y= -2377.45	135	PRTD[3]	X= -1955.95	Y= 2376.10
65	SEG[21]	X= 931.75	Y= -2377.45	136	PRTD[2]	X= -2071.45	Y= 2376.10
66	SEG[20]	X= 1047.25	Y= -2377.45	137	PRTD[1]	X= -2186.95	Y= 2376.10
67	SEG[19]	X= 1162.75	Y= -2377.45	138	PRTD[0]	X= -2302.45	Y= 2376.10
68	SEG[18]	X= 1278.25	Y= -2377.45	139	PRTC[7]	X= -2417.95	Y= 2376.10
69	SEG[17]	X= 1393.75	Y= -2377.45	140	PRTC[6]	X= -2533.45	Y= 2376.10
70	SEG[16]	X= 1509.25	Y= -2377.45	141	PRTC[5]	X= -2605.85	Y= 2052.45
71	SEG[15]	X= 1624.75	Y= -2377.45	142	PRTC[4]	X= -2605.85	Y= 1936.95

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		1	1.5	mA
I_{Slow}	SLOW Mode Current	System	32.768K X'tal LCD Disable		15	25	μA
I_{Idle}	IDLE Mode Current	System	32.769K X'tal LCD Disable		10	20	μA
I_{LCD}	Extra Current if LCD ON	System	LCD Enable, LCD option=300Kohm LV3=6 Volt		40	45	μA
			LCD Enable, LCD option=30Kohm, LV3=6 Volt		300	330	
I_{Sleep}	Sleep Mode Current	System				1	μA
I_{PWM}	PWM Output Current	PWMP, PWMN*2	With 32Ω Loading	10	14		mA
			With 64Ω Loading	6	8		mA
			With 100Ω Loading	4	5		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_{PWM} * N; N=0,1,2,3,4,5)

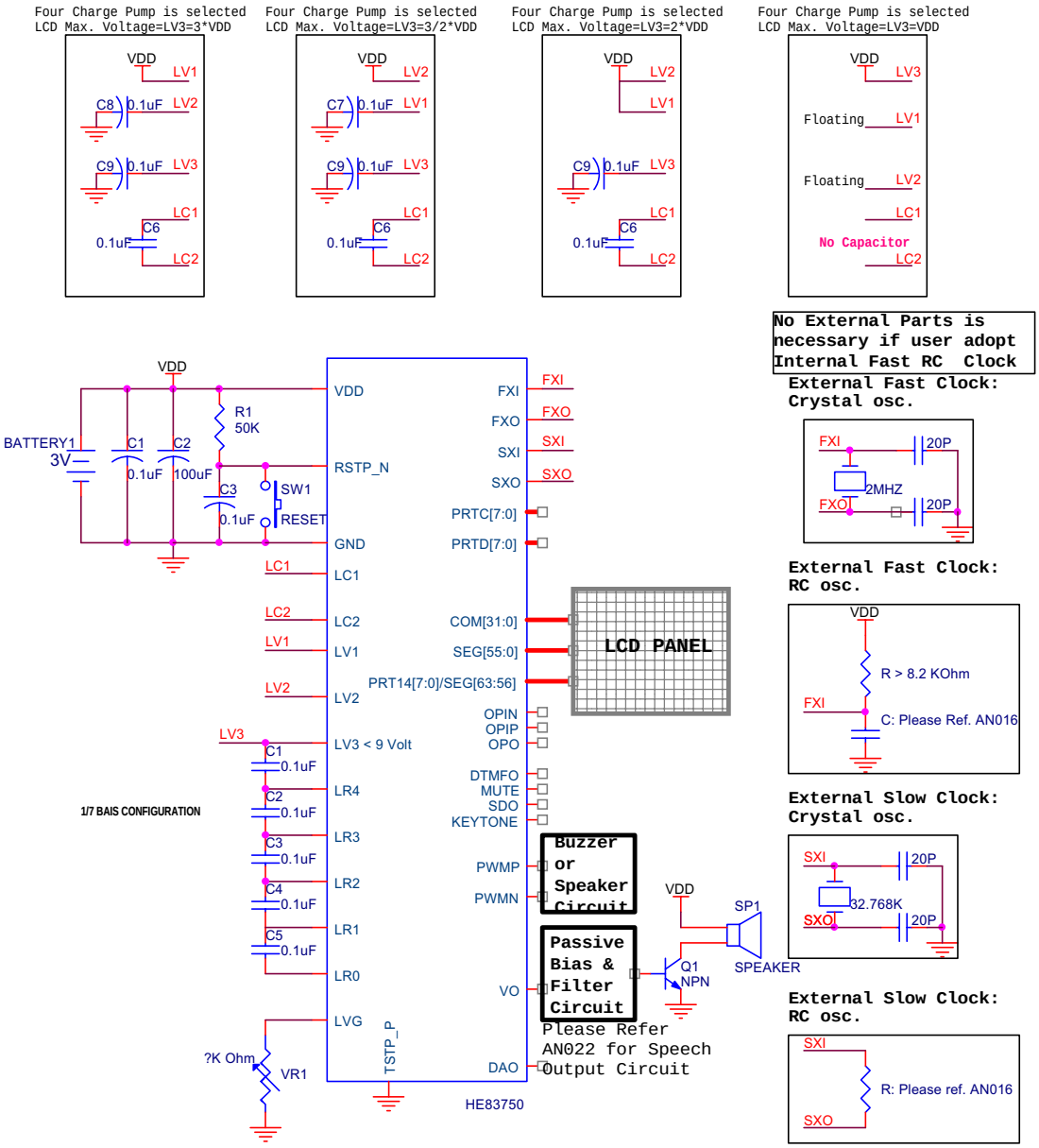
Testing condition: TEMP=25℃, VDD=4.5V+/-10%, GND=0V

	PARAMETER		CONDITION	MIN	TYP	MAX	UNIT
I_{Fast}	NORMAL Mode Current	System	2M ext. R/C		2	3	mA
I_{Slow}	SLOW Mode Current	System	32.768K X'tal LCD Disable		35	40	μA
I_{Idle}	IDLE Mode Current	System	32.769K X'tal LCD Disable		25	35	μA
I_{LCD}	Extra Current if LCD ON	System	LCD Enable, LCD option=300Kohm LV3=3/2VDD=6.75 Volt		40	50	μA
			LCD Enable, LCD option=30Kohm, LV3=3/2VDD=6.75 Volt		340	400	
I_{Sleep}	Sleep Mode Current	System				5	μA
I_{PWM}	PWM Output Current	PWMP, PWMN*2	With 32Ω Loading	40	50		mA
			With 64Ω Loading	30	40		mA
			With 100Ω Loading	25	30		mA
I_{oVO}	DAC Output Current	VO, DAO	V_{DD}=3V; VO=0~3.5V, 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	150			μA
I_{oL_1}	Output Sink Current	I/O pull-low*1	V_{oL}=0.4V	1.5			mA
I_{iL_1}	Input Low Current	RSTP_N	V_{iL}=GND, pull high Internally		60		μA
I_{iL_2}	Input Low Current	I/O	V_{iL}=GND, if pull high Internally by user		200		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.

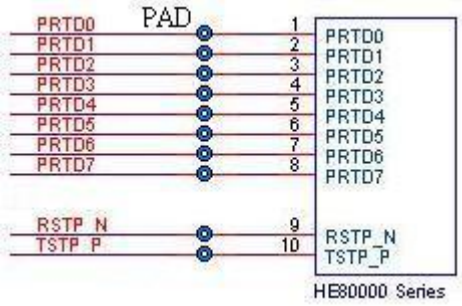
*2: This Spec. base on one driver only. There are five build-in driver, so user just multiply the number of driver he used to one driver current to get the total amount of current. (I_{PWM} * N; N=0,1,2,3,4,5)

I. Application Circuit



H. Important Note

1. For accessing any address large than 64KB, users must update TPP first, TPH then TPL. Only by this order, the pre-charge circuit of ROM will work correctly. 5us waiting is necessary before LDV instruction is executed since Data ROM is a low speed ROM. Users can not emulate this accessing process in ICE. So 5us delay should be added by firmware.
2. LCD driving circuit must be turn off before IC goes into sleep mode.
3. 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).



4. LV3 must small than 9.0 Volt. Otherwise IC may breakdown.

K. Updated Record

Version	Date	Section	Original Content	New Content
V3.2	Dec 14,2001	B, H	2.2V (VDD operation voltage)	2.4V