FINAL SPECIFICATION

FOR

BALL & RACE
LCD GAME

HCS-G001-0

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SPECIFICATION FOR BALL & RACE LCD GAME

PROJECT CODE : HCS-G001-0
MCU SELECTED : LC573202A
DATE : MARCH 2, 1998.

I. GENERAL DESCRIPTION

A 4-bit single chip microcomputer is implemented into a two-LCD game. It can be used as one single game or 2 games with 2 changeable LCD modules. Specific features are as follows :-

1.1 2 games in one chip by bonding option (refer to circuit) - Soccer game or Car race game.

1.2 Bonding option (refer to circuit) to select time function or without time function.

1.3 Checker option to select Car game when bonding option is Soccer game.
Change LCD module correspondingly.

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Change LCD module correspondingly.

1.5 Clock with 12 / 24 hour format by key selection.

1.6 Daily alarm time. Stop by any key when the alarm melody is playing.

1.7 Sound on or off by key. Default sound is enabled.

1.8 Demo mode is available.

1.9 Test alarm (melody) a) when power is reset.
b) in alarm mode by pressing S4

1.10 Operation Voltage: 1.5 volts

1.11 R C oscillation.

1.12 Direct drive LCD 1/4 duty 1/2 bias at 3 volt.

1.13 4 Operation buttons

II) GAME DESCRIPTIONS

2.1 Soccer Game

2.1.1 Game 1 and 2 are available with difference in speed only.

2.1.2 Player controls S3 and S4 buttons to shift the goalkeeper left or right correspondingly for catching or guarding the ball.

2.1.3 Balls are falling along various paths as shown in the LCD pattern. The player needs to guard the ball at positions 10, 27, 7 and 17 by moving goalkeeper at corresponding positions P1, P2, P3 and P4. Ball may bounce at those positions to the next path.
At successful guard, a symbol (W1, W2, W3 and W4) will be shown.

2.1.4 If fail to guard, the ball will go behind the keeper shown by F1 to F4. A MISS will be registered. 5 MISSes will become a game over.

2.1.5 Every 500 points will regain one life. That is, a MISS will be reduced.

2.1.6 As ball reaches position 23, player will score 10 points.
The game speed will be even faster for score ranging 1000 to 1990, 3000 to 3990, 5000 to 5990, 7000 to 7990 and 9000 to 9990.
Maximum score is 9,990.

2.1.7 Maximum no. of balls appearing is 5.

2.1.8 C1 and C2 are animation only.
D1 is on all the time during game action or demo for representing any character. For instance, a ball generating machine, a referee etc.

2.2 Car Race Game

2.2.1 Game 1 and 2 available with difference in speed only.

2.2.2 Player controls S3 and S4 buttons to move his car left or right to avoid being hit by coming opponent cars.

2.2.3 Occasionally, on the left edge, there will be a flag man coming. Pick up the flag by moving the car to the left side. A score of 30 points will be awarded. To score more points, player needs to carry this flag to the right edge of the screen. As the traffic light appears, move one more step to the right in order to score 70 points.
If 3 passes of the flag to the right is successful, a fuel station appears. A random number for the bonus from 1 to 9 will be generated as S2 button is pressed. Press again to stop. The bonus score is the number generated times 10 points.

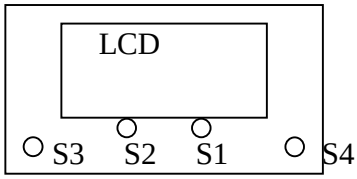
2.2.4 Crash to opponent car (in front of the player car) is a MISS. 3 MISS becomes a game over.

2.2.5 Passing each opponent car scores 10 points.

2.2.6 After the car picks up the flag or passes to the extreme right position, 8 step counter will be initiated to force the car back to track.

2.2.7 The game speed will be even faster for score ranging 1000 to 1990, 3000 to 3990, 5000 to 5990, 7000 to 7990 and 9000 to 9990.
Maximum score is 9,990.

III) KEY OPERATION DESCRIPTIONS



2.1 S1
Mode change - Demo to Game 1. Game 1 to Game 2. Game 2 back to Demo.
Toggle alarm on or off in alarm display mode. *
Increment one step of selected digit in time setting mode. *

2.2 S2
Enter and exit alarm display mode in Demo mode. *
Select 12 or 24 hour display format in time setting mode. *
Start game in game standby mode or game over mode.
Press in Car race game to start and stop the random number in Fuel station.

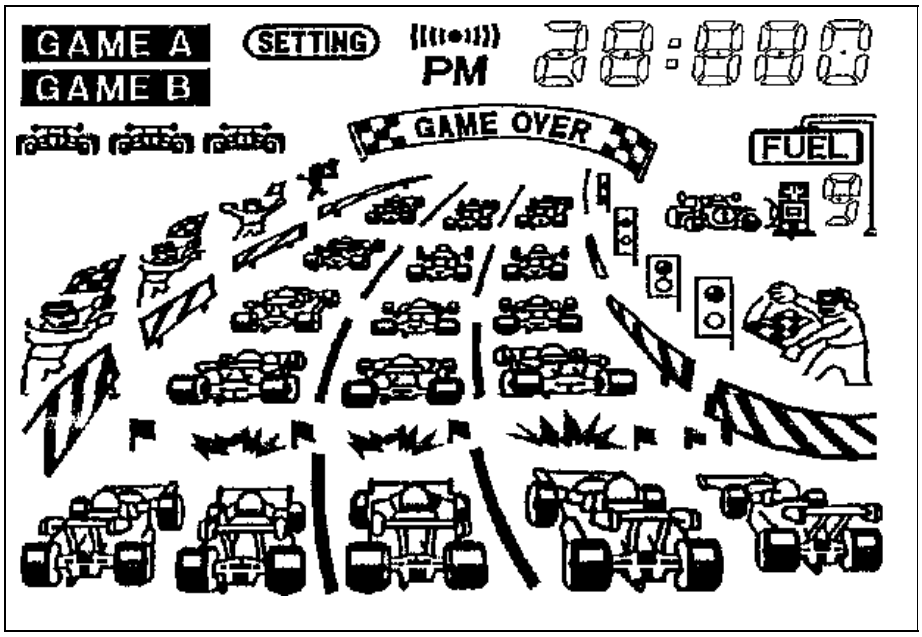
2.3 S3
Enter and exit time setting mode. *
Move player left one step in game playing mode.

2.4 S4
Toggle game sound on /off in game standby mode.
Test alarm or melody in Alarm Display mode. *
Select hour and minute in time setting mode. *
Shift player character right in playing mode.

Note: Pressing S1, S2, S3 and S4 simultaneously will reset the unit.
* = invalid when bonding option is selected as without time function.

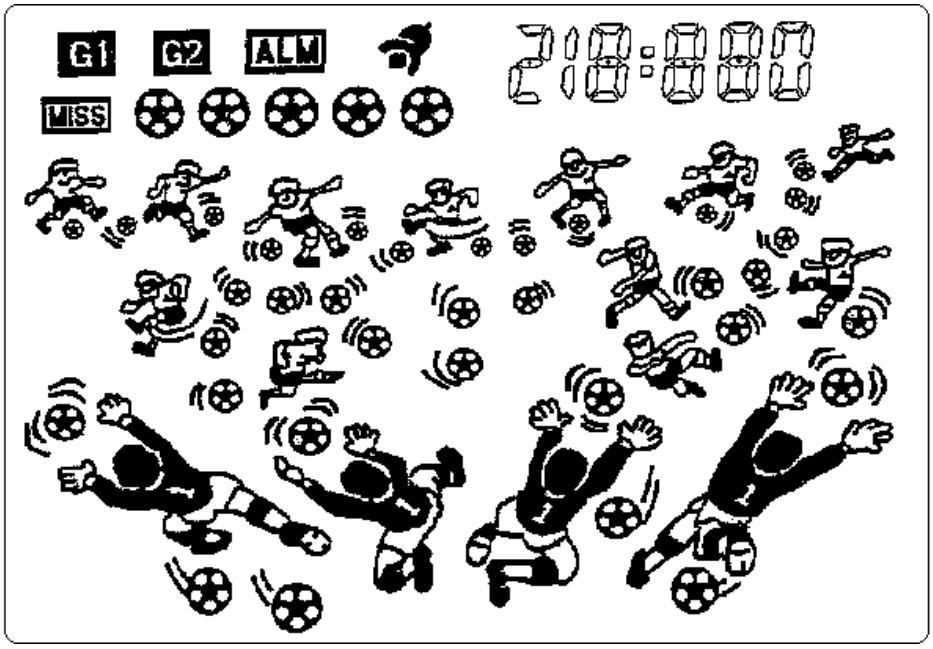
IV) LCD PATTERN

4.1 Car race



Bottom Terminal Connector

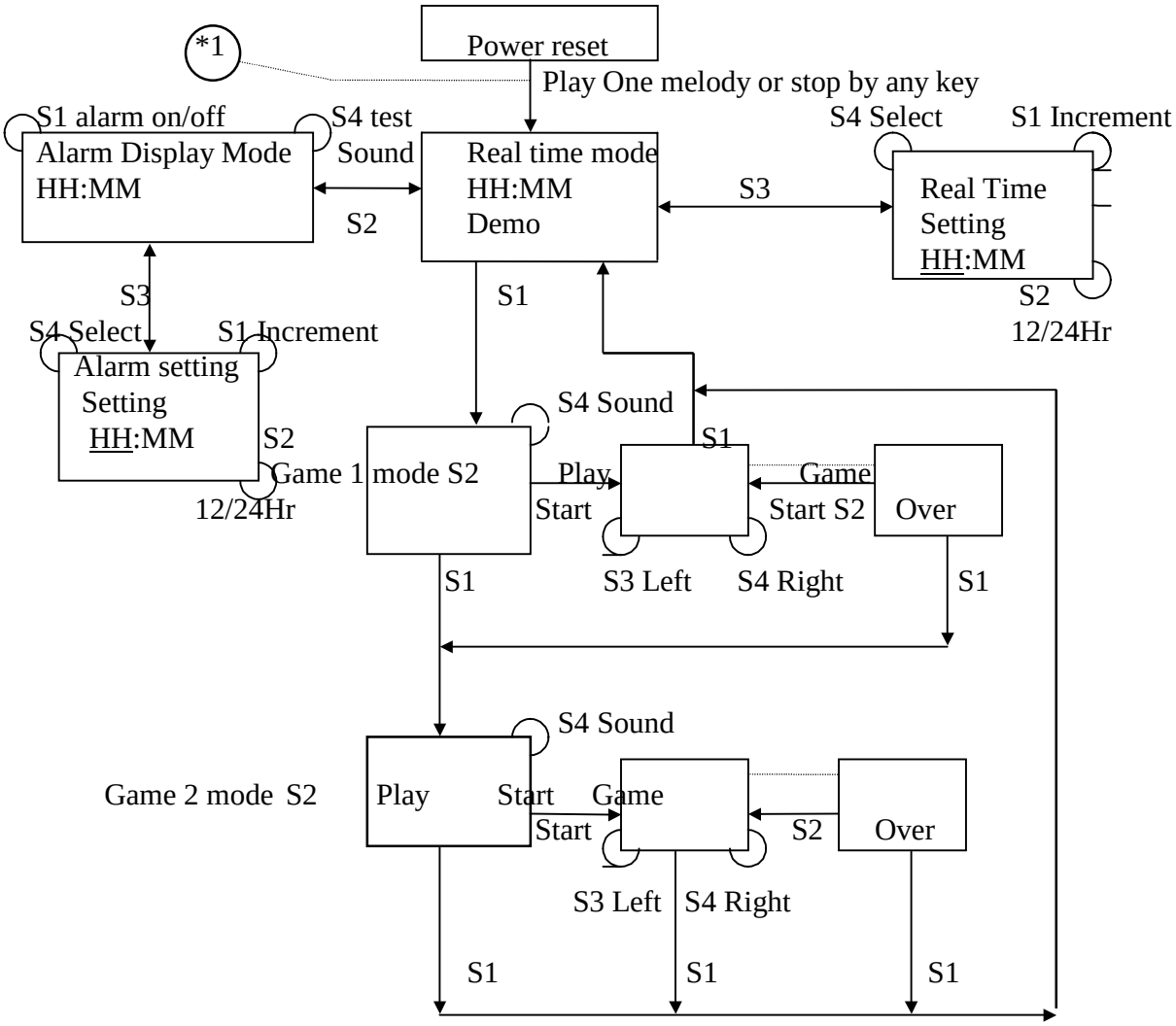
4.2 Soccer



Bottom terminal Connector

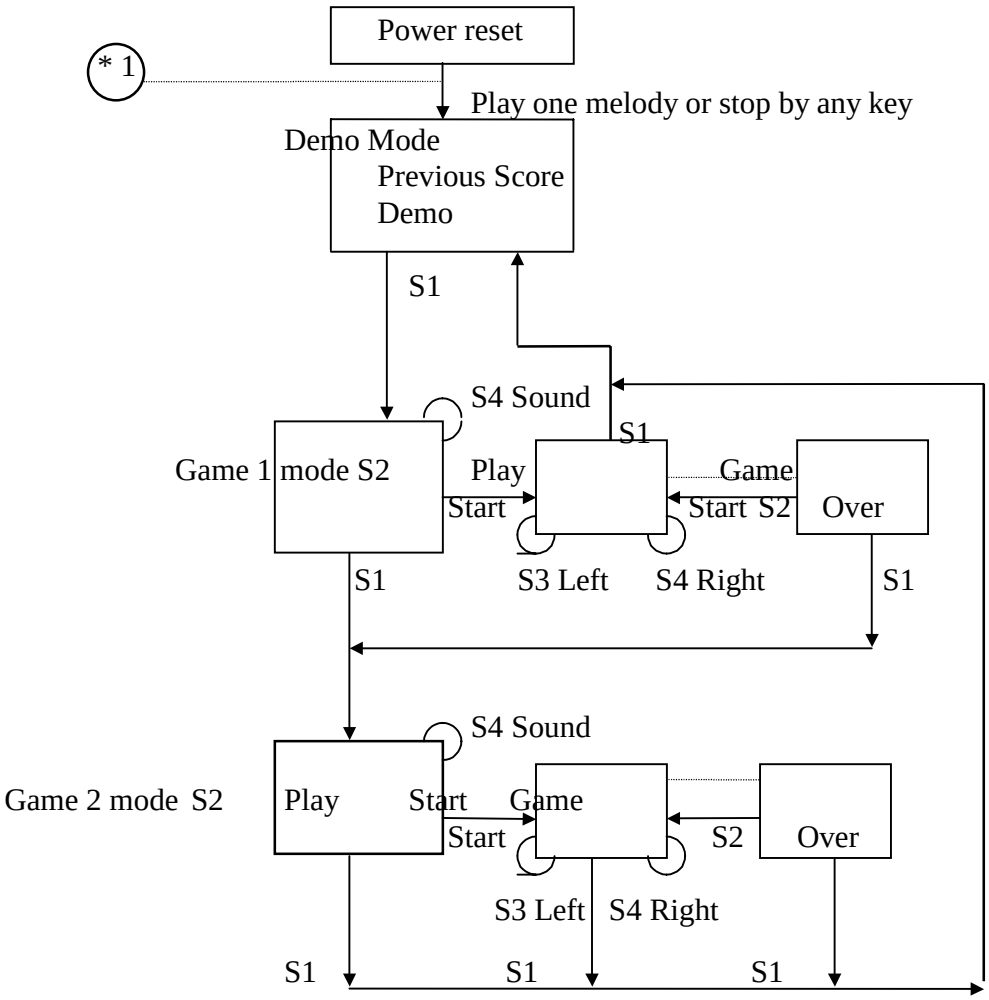
V) OPERATION FLOW DIAGRAM:

5.1 With Time Function



Note: Auto return to Real Time mode in 1 to 2 min if no key is pressed in all other modes.
__ -- underlined digits mean blinking.
Alarm will only be played in Real Time mode if alarm arrives.

5.2 Without Time Function



Note: Auto return to Real Time mode in 1 to 2 min if no key is pressed in all other modes.

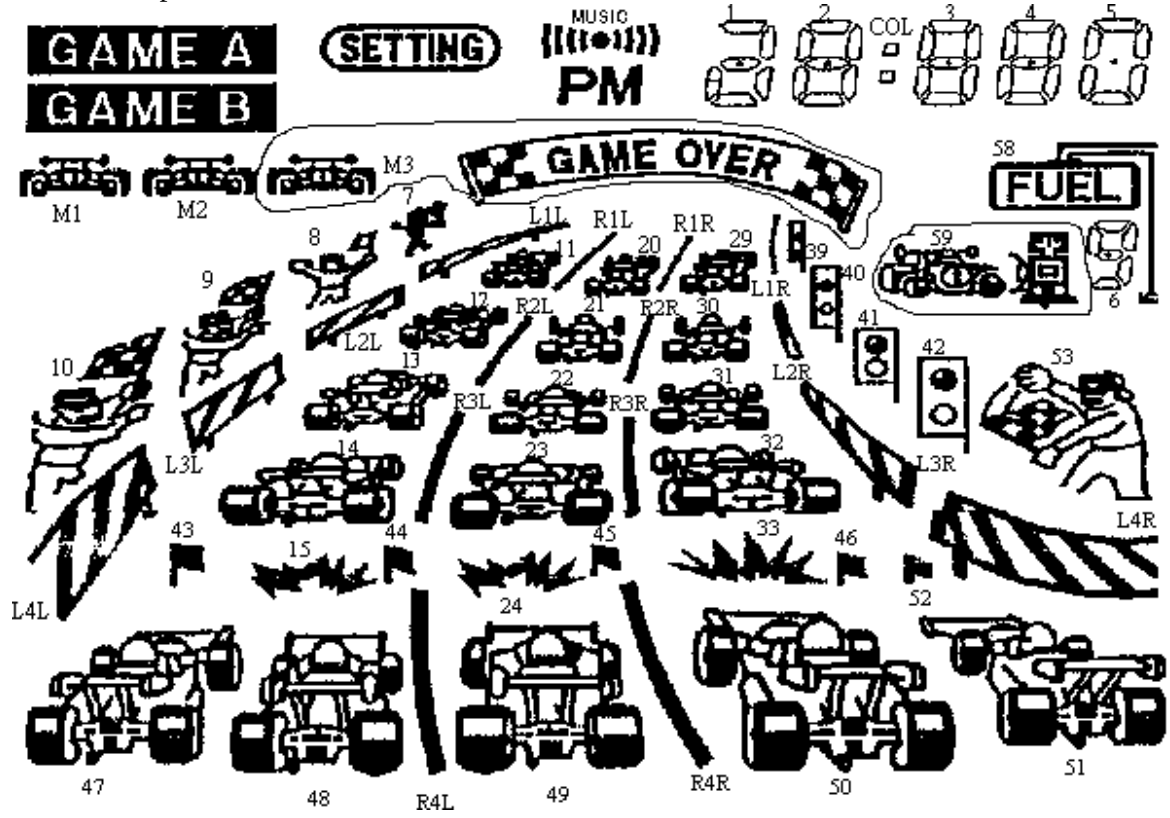
(*1) Hold S1 when power is reset (same as pressing S1 to S4 simultaneously), **bonded option Car Game** will change to Soccer game. Change LCD to play the Soccer game. To change back to Car game, reset the unit without holding S1.

Hold S1 when power is reset (same as pressing S1 to S4 simultaneously), **bonded option Soccer Game** will change to Car Game. Change LCD to play the Car game. To change back to Soccer game, reset the unit without holding S1.

VI) LCD ASSIGNMENT

6.1 Car race

6.1.1 LCD pattern with labels



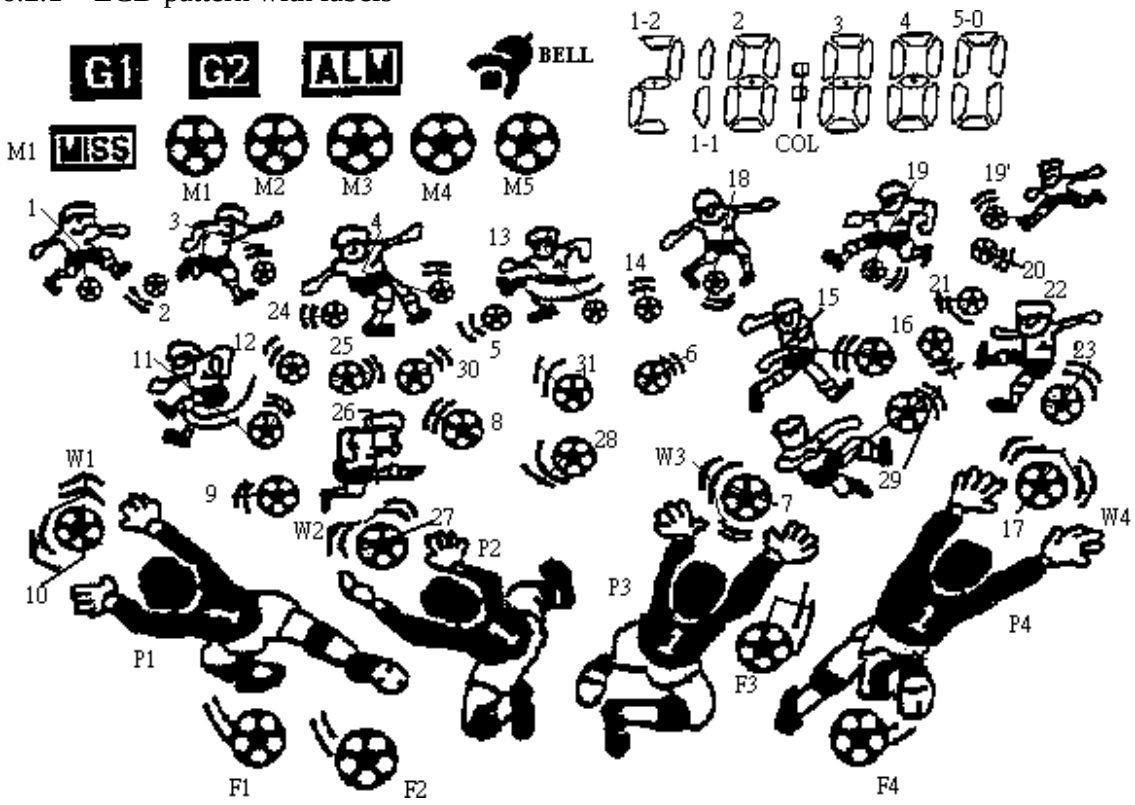
Bottom Terminal Pad No. 1 -----→ 28

6.1.2 Car Race LCD Assignment Table

Pad No.	LSI Name	COM 1	COM 2	COM 3	COM 4 (SEG 13)
23	SEG 1	4C	5A,5B,5C 5D,5E,5F	4G	4B
24	SEG 2	4E	58	4F	4A
25	SEG 3	3C	4D	3G	3B
26	SEG 4	3E	3D	3F	3A
27	SEG 5	2C	2D	2G	COL
28	SEG 6	2E	SETTING	2F	2B
1	SEG 7	---	---	---	---
2	SEG 8	1C	39	1A,1D,1E,1G	2A
3	SEG 9	29	LIR	PM	1B
4	SEG 10	20	RIR	M3	MUSIC
5	SEG 11	11	RIL	M2	GAME B
6	SEG 12	7	LIL	M1	GAME A
7	COM 3	---	---	COM 3	---
8	SEG 13 (COM 4)	---	---	---	COM 4
9	SEG 14	9	8	10	43
10	SEG 15	L3L	L2L	L4L	47
11	SEG 16	13	12	15	48
12	SEG 17	R3L	R2L	14	44
13	SEG 18	22	21	24	R4L
14	SEG 19	R3R	R2R	23	49
15	SEG 20	31	30	R4R	45
16	SEG 21	41	L2R	33	50
17	SEG 22	59	40	32	46
18	SEG 23	6G	6F	L3R	51
19	SEG 24	6D	6A	42	52
20	SEG 25	6C	6B	53	L4R
21	COM 1	COM 1	---	---	---
22	COM 2	---	COM 2	---	---

6.2 Soccer

6.2.1 LCD pattern with labels

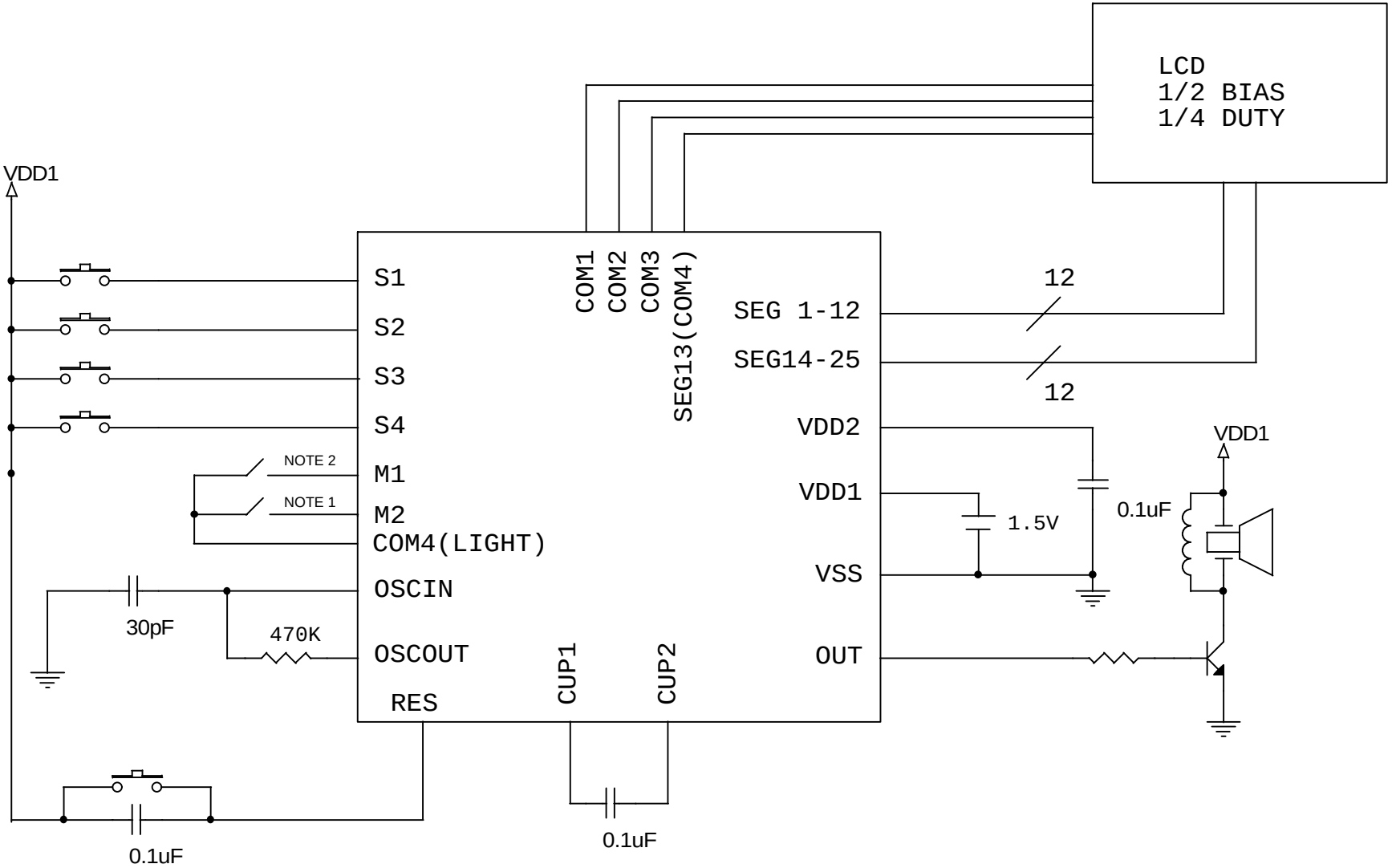


Bottom Terminal Pad No. 1 ---→ No. 28

6.2.2 Soccer LCD assignment table

Pad No.	LSI name	COM 1	COM 2	COM 3	COM 4 (SEG 13)
23	SEG 1	4C	5-0	4G	4B
24	SEG 2	4E	---	4F	4A
25	SEG 3	3C	4D	3G	3B
26	SEG 4	3E	3D	3F	3A
27	SEG 5	2C	2D	2G	COL
28	SEG 6	2E	---	2F	2B
1	SEG 7	---	---	---	---
2	SEG 8	1-1	---	1-2	2A
3	SEG 9	M4	18	M5	---
4	SEG 10	---	ALM	M3	BELL
5	SEG 11	13	31	M2	G2
6	SEG 12	4	5	M1	G1
7	COM 3	---	---	COM 3	---
8	SEG 13 (COM 4)	---	---	---	COM 4
9	SEG 14	12	24	9	---
10	SEG 15	---	D1*	---	---
11	SEG 16	2	1	W1	P1
12	SEG 17	11	3	10	F1
13	SEG 18	25	30	W2	---
14	SEG 19	26	8	27	P2
15	SEG 20	6	14	28	F2
16	SEG 21	29	15	W3	P3
17	SEG 22	16	19	7	F3
18	SEG 23	21	20	22	P4
19	SEG 24	23	19’	W4	F4
20	SEG 25	C2*	C1*	17	---
21	COM 1	COM 1	---	---	---
22	COM 2	---	COM 2	---	---

NOTE: Depending on individual LCD pattern, D1, C1 and C2 may not be existed on the drawing.



SUBSTRATE MUST BE CONNECTED TO VSS OR LEFT OPEN

NOTE 1

OPEN = DEFAULT RACE GAME; CLOSE = DEFAULT BALL GAME

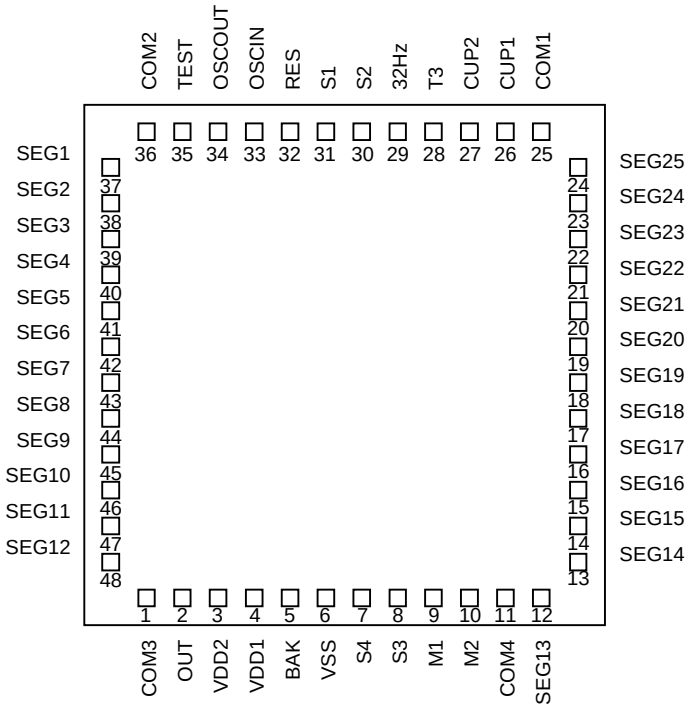
NOTE 2

OPEN = TIME FUNCTION; CLOSE = NO TIME FUNCTION

HICO INDUSTRIAL CO		
Title: BALL & RACE		
Size: A	Document Number: HCS-G001-0	Rev: 1
Date: Friday, March 13, 1998	Sheet 1 of 1	

Pad assignment

Chip thickness : 480μm
Chip size (X × Y) : 2.54mm × 2.27mm
Pad size : 120μm × 120μm
Pad pitch : 140μm minimum



Note:
When a Lithium battery has been selected as the power supply, please note the following points.
There are two modes of use for the lithium battery: Backup mode and Normal mode (backup flag off). In backup mode, the battery potential is applied directly to the oscillation circuit, whereas in Normal mode only half the battery potential is applied.
Because of the different voltage applied to the oscillation circuit in each mode, there may be a difference in the generated oscillation frequency. When entering backup mode a corresponding error will arise. If timing accuracy is required (for clocks, etc), please bear in mind the above in the program design.

Pad name and coordinates

QFP64 PIN No.	Pad No.	Pad Name	Coordinates Xμm	Coordinates Yμm
1	1	COM3	-700	-1030
2	2	OUT	-560	-1030
3	3	VDD2	-420	-1030
4	4	VDD1	-275	-1030
5	5	BAK	-135	-1030
6	6	VSS	5	-1030
7	7	S4	145	-1030
8	8	S3	285	-1030
9	9	M1	425	-1030
10	10	M2	565	-1030
11	11	COM4	705	-1030
12	12	SEG13	845	-1030
13	13	SEG14	895	-775
14	14	SEG15	895	-635
15	15	SEG16	895	-495
16	16	SEG17	895	-355
17	17	SEG18	895	-215
18	18	SEG19	895	-75
19	19	SEG20	895	65
20	20	SEG21	895	205
21	21	SEG22	895	345
22	22	SEG23	895	485
23	23	SEG24	895	625
24	24	SEG25	895	765

QFP64 PIN No.	Pad No.	Pad Name	Coordinates Xμm	Coordinates Yμm
25	25	COM1	840	1030
26	26	CUP1	700	1030
27	27	CUP2	560	1030
28	28	T3	420	1030
29	29	32HZ	280	1030
30	30	S2	140	1030
31	31	S1	0	1030
32	32	RES	-140	1030
33	33	OSCIN	-280	1030
34	34	OSCOUT	-420	1030
35	35	TEST	-560	1030
36	36	COM2	-700	1030
37	37	SEG1	-895	765
38	38	SEG2	-895	625
39	39	SEG3	-895	485
40	40	SEG4	-895	345
41	41	SEG5	-895	205
42	42	SEG6	-895	65
43	43	SEG7	-895	-75
44	44	SEG8	-895	-215
45	45	SEG9	-895	-355
46	46	SEG10	-895	-495
47	47	SEG11	-895	-635
48	48	SEG12	-895	-775

- The pad coordinates are such that the chip center is taken as the origin and the values for (X, Y) represent the coordinates of the center point of each pad.
- Substrate must be connected to VSS or left open.

LC573202A Terminal Description

Pin Name	Pad No. Pin No.	I/O	Function description	Option
VSS	6	-	Power terminal(-)	-
VDD1	4	-	•Power terminal(+) (Ag battery version) •Voltage supply to LCD driver (Li battery & EXTV ver.) (C is connected between VDD1 and VSS.) •Voltage supply to logic unit (Ag battery version, Back up flag OFF at Li battery version.)	Battery version Ag/Li/EXTV
VDD2	3	-	•Power terminal(+) (Li battery & EXTV version) •Voltage supply to LCD driver (Ag battery version) (C is connected between VDD2 and VSS.) •Voltage supply to logic unit (EXTV version, Back up flag ON at Li battery version.)	Battery version Ag/Li/EXTV
BAK	5	-	•Power terminal(+) •For Li battery version, a capacitor must be connected across BAK and VSS to prevent logic unit from malfunctioning.	-
CUP1, 2	26, 27	-	Capacitor connecting terminals for step-up/step-down.	-
S PORT S1 to S4	31 30 8 7	I	•4-bit input port •Input for HALT release •LSI system is reset by applying VDD* to S1 to S4 simultaneously. (Mask option) 〔*Ag version : VDD1 Li/EXTV version : VDD2〕 •Programmable pull-down resistor •"L"-level hold Tr. (Mask option)	•"L"-level hold Tr. Provided/Not provided •Reset by setting S1-S4 Enable/disable
M-PORT M1, M2	9 10	I	•2-bit input port •Input for HALT release •Programmable pull-down resistor •"L"-level hold Tr.	•"L"-level hold Tr. Provided/Not provided
OUT	2	O	•Output terminal •Selectable general output or buzzer output by mask option (1) As using general output port •The output level is controlled by executing the SLGT and RLGT instructions. (2) As using buzzer output •Melody signal or 9 kinds of modulated signal is controlled by executing the SAS or TMEL instructions.* (Possible to output non-modulated signal) •Possible to output 3 octave melody signal.	•Output data Melody(Buzzer) /General output
SEG1 to SEG25	37 to 48 12 to 24	O	•LCD output terminals for segment •Possible to use output port for SEG13 to SEG25 (Pad No.12 to 24) by mask option. •SEG13 can be used as COM4 output by mask option.	•Output form segment/CMOS (SEG13-SEG25) •Output data SP=0-FH, DBUS=a/b/c/d/e/f/g/h •SEG13/COM4
COM1 to COM4	25, 36 1, 11	O	•LCD output terminals for common •COM4 can be used as normal output terminal by mask option.	•LCD duty 1/1,1/2,1/3,1/4 •COM4/LIGHT

Continue.

Pin Name	Pad No. Pin No.	I/O	Function description	Option
OSCIN	33	I	•Input for 32.768kHz crystal oscillation •Input for RC oscillation •R is connected between OSCIN and OSCOUT and C is connected between OSCIN and VSS.	•Oscillation circuit X'tal oscillation /external RC oscillation
OSCOUT	34	O	•Output for 32.768kHz crystal oscillation •Output for RC oscillation •R is connected between OSCIN and OSCOUT.	•Oscillation circuit X'tal oscillation /external RC oscillation
RES	32	I	Reset	
TEST	35	-	•Test terminal •This terminal should be left unconnected.	
T3	28	-	•Test terminal •This terminal should be left unconnected.	
32Hz	29	-	•Test terminal •This terminal should be left unconnected.	

* 9 kinds of modulated output : For 32.768kHz crystal oscillation, proportional to oscillation frequency.
Please refer to User's manual for more detail.

(Note) There are two operation modes, back-up mode (back up flag on) and normal mode (back up flag off), in Li battery specification. In normal operation mode, the internal circuit of CPU is operated on 1/2 of Li battery voltage (it can be monitored as external capacitor voltage of voltage step down circuit).
The power consumption can be saved in normal mode operation. However, the large current flown into/from the buzzer output or output port will generate a voltage drop-down and it might be a cause of abnormal CPU operation. If the microcontroller has to drive a large current, switch the CPU into the back up mode before driving the current.
CPU consumes the relatively large current in back up mode. When the Li battery voltage has recovered, you should change the CPU into the normal mode.
CPU is in the back up mode at reset.

Ag battery version

1. Absolute Maximum Ratings at Ta=25±2°C, VSS=0V

Parameter	Symbol	Pin & Conditions	Ratings	Unit
Supply voltage	VDD1		-0.3 to +4.0	V
	VDD2		-0.3 to +4.0	
Input voltage	VIN	S1-S4, M1, M2, TEST, OSCIN, RES	-0.3 to VDD1+0.3	
Output voltage	VOUT1	CUP2, OSCOUT, OUT	-0.3 to VDD1+0.3	
	VOUT2	SEG1-SEG25, COM1-COM4, CUP1	-0.3 to VDD2+0.3	
Peak output current (at each pins)	IOUT1	OUT	4	mA
	IOUT2	COM4 (As using LIGHT)	1	
	IOUT3	Output except OUT and COM4	500	μA
Total output current	IALL	Total output pins.	10	mA
Maximum power dissipation	Pdmax	QFP48	430	mW
Operating temperature range	Topr		-30 to +70	°C
Storage temperature range	Tstg		-40 to +125	

2. Recommended Operating Range at Ta=-30°C to + 70°C, VSS=0V

Parameter	Symbol	Conditions	Ratings			Unit
			min.	typ.	max.	
Operating supply voltage	VDD1		1.30		1.65	V
	VDD2		2.4		3.3	
Input high voltage	VIH	S1-S4, RES, M1, M2	VDD1-0.2		VDD1	
Input low voltage	VIL	S1-S4, RES, M1, M2	0		0.2	
Oscillation frequency range	fOPG1	•32.768kHz (crystal oscillation) •VDD1=1.30 - 1.65V •Refer to figure 1	32	32.768	33	kHz
	fOPG2	•RC oscillation •VDD1=1.30 - 1.65V •Refer to figure 2	30		40	

[Note]
These specified value herein are based on the QIP48E packaged parts. The specification for the die is basically the same as the one for package part. However, it will be affected by the many factors such as the mounting board, bonding pressure, cover up epox etc.
Therefore the value specified here are only applied in Ta=25°C±2°C operating temperature range.

3. Electrical Characteristics at Ta=-30°C to + 70°C, VSS=0V

Parameter	Symbol	Conditions	Ratings			Unit
			min.	typ.	max.	
Pull-down transistor	RIN1A	VDD1=1.55V, VIL=0.2V, Low level hold Tr. Fig.3 *1	150	300	1000	kΩ
	RIN1B	VDD1=1.55V, Low level pull in Tr. Fig.3 *1	100	300	1000	
	RIN2	VDD1=1.55V, TEST, RES	10		300	
Output high voltage	VOH1	VDD1=1.55V, IOH=-0.4μA *2	VDD2-0.2			V
Output low voltage	VOL1	VDD1=1.55V, IOL=0.4μA *2			0.2	
Output high voltage	VOH2	VDD1=1.55V, IOH=-4μA, COM1-4	VDD2-0.2			
Output middle voltage	VOM	VDD1=1.55V, IOH=-4μA, IOL=4μA, COM1-4	VDD1-0.2		VDD1+0.2	
Output low voltage	VOL2	VDD1=1.55V, IOL=4μA, COM1-4			0.2	
Output high voltage	VOH3	VDD1=1.35V, IOH=-250μA, OUT, COM4 (As using LIGHT)	VDD1-0.65			
Output low voltage	VOL3	VDD1=1.35V, IOL=150μA, OUT, COM4 (As using LIGHT)			0.65	
Output high voltage	VOH4	VDD1=1.55V, IOH=-20μA *3	VDD1-0.2			
Output low voltage	VOL4	VDD1=1.55V, IOL=20μA *3			0.2	
Step-up voltage	VDD2	VDD1=1.35V, C1=C2=0.1μF, fopg=32.768kHz, Fig.4	2.5		2.7	V
Current dissipation (In Halt mode)	IDD1	VDD1=1.55V, C1=C2=0.1μF, Fig.4, Cg=16pF, Crystal osc (CI≤25kΩ), Back-up flag OFF, Ta≤50°C		1.0	4.0	μA
	IDD2	VDD1=1.55V, C1=C2=0.1μF, Fig.5, RC osc (Rext=470kΩ, Cext=30pF), Ta≤50°C		5.0	15.0	
Current dissipation (In Operating mode)	IDD3	VDD1=1.55V, C1=C2=0.1μF, Fig.4, Cg=16pF, Crystal osc (CI≤25kΩ), Back-up flag OFF, Ta≤50°C		3.0	12.0	
	IDD4	VDD1=1.55V, C1=C2=0.1μF, Fig.5, RC osc (Rext=470kΩ, Cext=30pF), Ta≤50°C		7.0	20.0	
Oscillator start-up voltage	Vstt	Cg=16pF, Crystal osc (CI≤25kΩ), Back-up flag ON, Ta=25°C, Fig.6	1.30			V
Oscillator sustaining voltage	VHOLD	Cg=16pF, Crystal osc (CI≤25kΩ), Back-up flag OFF, Ta=25°C, Fig.6	1.30			
Oscillator start-up time	tstt	VDD1=1.35V Cg=16pF, Crystal osc(CI≤25kΩ), Back-up flag ON, Ta=25°C, Fig.6			10	s

(Notes) •Since the circuit pattern affects the oscillation frequency, place the oscillation-related parts as close to the oscillation pins as possible with the shortest possible pattern length.
•If you use other oscillators herein, we provide no guarantee for the characteristics.

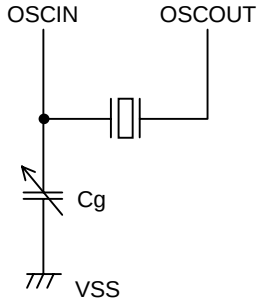


Figure1 Crystal oscillation circuit

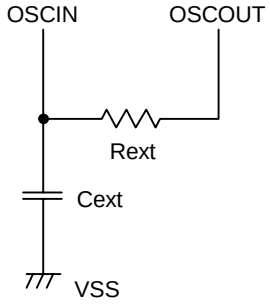


Figure 2 RC oscillation circuit

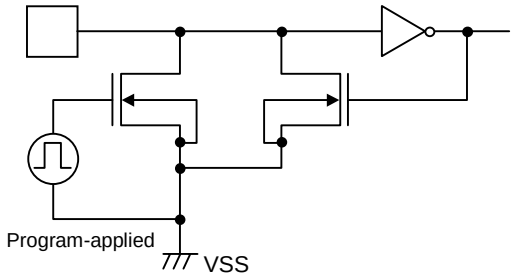


Figure3 Input configuration of S1-4, M1, M2

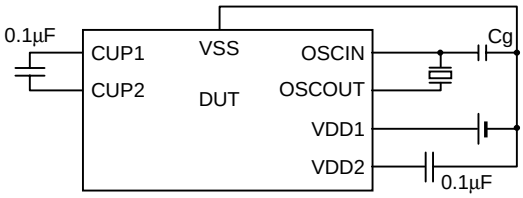


Figure 4 Current dissipation, step-up voltage measurement

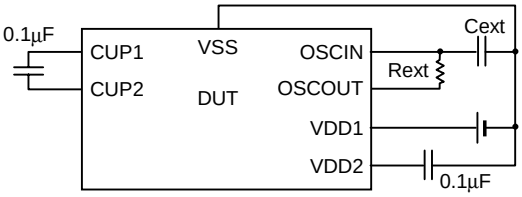


Figure5 Current dissipation, step-up voltage measurement

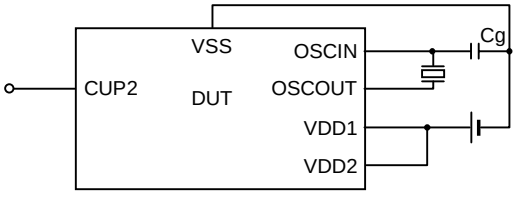


Figure 6 Oscillator start-up voltage, oscillator start-up time, oscillator sustaining voltage measurement

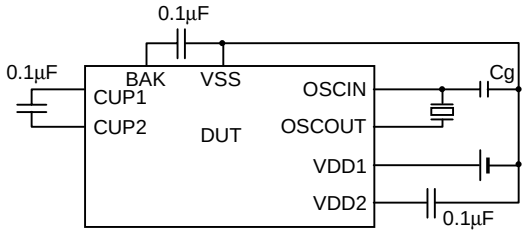


Figure7 Current dissipation, step-down voltage measurement

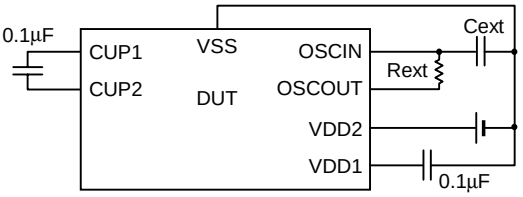


Figure 8 Current dissipation, step-down voltage measurement

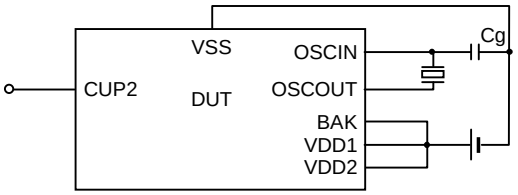


Figure9 Oscillator start-up voltage, oscillator start-up time, oscillator sustaining voltage measurement