DELTA OPTO
DELTA OPTOELECTRONICS, INC.

Title： PLED 16x2 Characters Module PDC1602M03 Specifications

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	Control Document ☐ Yes ☐ No	
	Confidential Document ☐	

PLED 16x2 Characters Module PDC1602M03 Specifications

1. Features

1. *2 lines of 16 characters of 5x8 (dots)*
2. *Low power consumption*
3. *High contrast ratio and wide viewing angle*
4. *Compatible with LCD 16x2 type*
5. *Controller is compatible with HD44780*

2. Absolute maximum ratings

Symbol	*Parameter*	*Min*	*Typ*	*Max*	*Unit*
VDD	*Supply voltage for Logic*	*4.5*	*5.0*	*5.5*	*V*
Topr	*Operating temperature*	*-20*	*25*	*50*	*°C*
Tstg	*Storage temperature*	*-30*		*70*	*°C*
Vbt	*Brightness control voltage*	*2.5*	*3*	*5*	*V*
Tsolder	*Soldering Temperature*	*260°C for 5 seconds*			
Pd	*Module power consumption @Vbt=3V (Note 1)*	*50*	*63*	*113*	*mW*
Ps	*Power saving mode @Vbt=2.5V (Note 2)*	*38*	*50*	*63*	*mW*

Item	*Operating*		*Storage*	
	Min.	*Max.*	*Min.*	*Max.*
Ambient Temperature	*-20°C*	*50°C*	*-30°C*	*70°C*
Humidity	*45°C 85%RH*		*45°C 85%RH*	
Corrosive gas	*Not Acceptable*		*Not Acceptable*	

Note 1. Power consumption was measured with VBT=3V, VDD=5V and 3 test patterns (all pixels off, random texts, all pixels on)
Note 2. Power consumption was measured with VBT=2.5V, VDD=5V and 3 test patterns (all pixels off, random texts, all pixels on)
.

3 Electrical Characteristics

3.1 DC Electrical Characteristics

(Ta= -20 to 50 *°C*)

Item	*Symbol*	*Condition*	*Min*	*Typ*	*Max*	*Unit*
Power supply voltage	*VDD*		*4.5*	*5*	*5.5*	*V*
Brightness control voltage	*VBT*		*2.5*	*3*	*5*	*V*
Power supply current	*Icc*	*VDD=5V, (Logical only)*		*0.35*	*0.6*	*mA*
High level input voltage	*Vih*		*0.7VDD*		*VDD*	*V*
Low level input voltage	*Vil*		*-0.3*		*0.55*	*V*
Leakage current	*Il*		*-1*		*1*	*uA*

3.2 AC Electrical Characteristics

(Ta= -20 to 50 ^{o}C)

Write operation

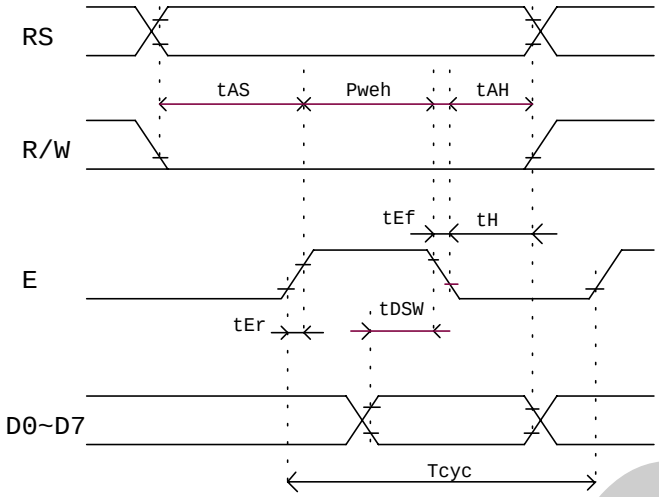
Item	*Symbol*	*Min*	*Typ*	*Max*	*Unit*
Enable Cycle Time	*Tcyc*	*500*			*ns*
Enable Pulse Width (High level)	*Pweh*	*230*			*ns*
Enable Rise/ Fall Time	*tEf, tEr*			*20*	*ns*
Address Set-up Time	*tAS*	*40*			*ns*
Address Hold Time	*tAH*	*10*			*ns*
Data Set-up Time	*tDSW*	*80*			*ns*
Data Hold Time	*tH*	*10*			*ns*

Read operation

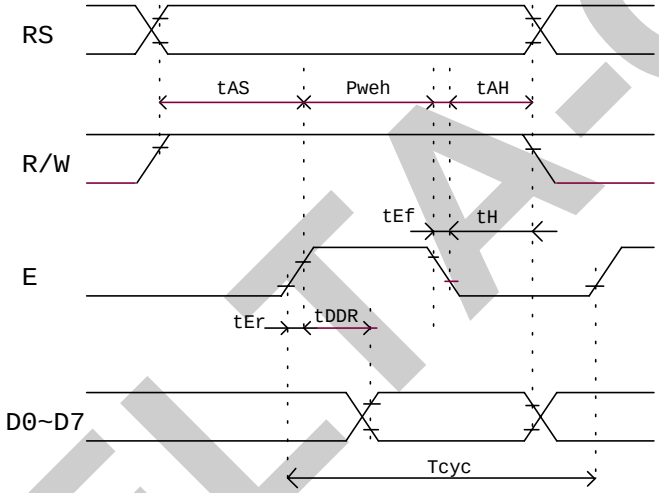
Item	*Symbol*	*Min*	*Typ*	*Max*	*Unit*
Enable Cycle Time	*Tcyc*	*500*			*ns*
Enable Pulse Width (High level)	*Pweh*	*230*			*ns*
Enable Rise/ Fall Time	*tEf, tEr*			*20*	*ns*
Address Set-up Time	*tAS*	*40*			*ns*
Address Hold Time	*tAH*	*10*			*ns*
Data Delay Time	*tDDR*			*160*	*ns*
Data Hold Time	*tH*	*5*			*ns*

3.3 Timing Chart

Write operation



Read operation



3.4 Display Data RAM (DDRAM)

Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DDRAM Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

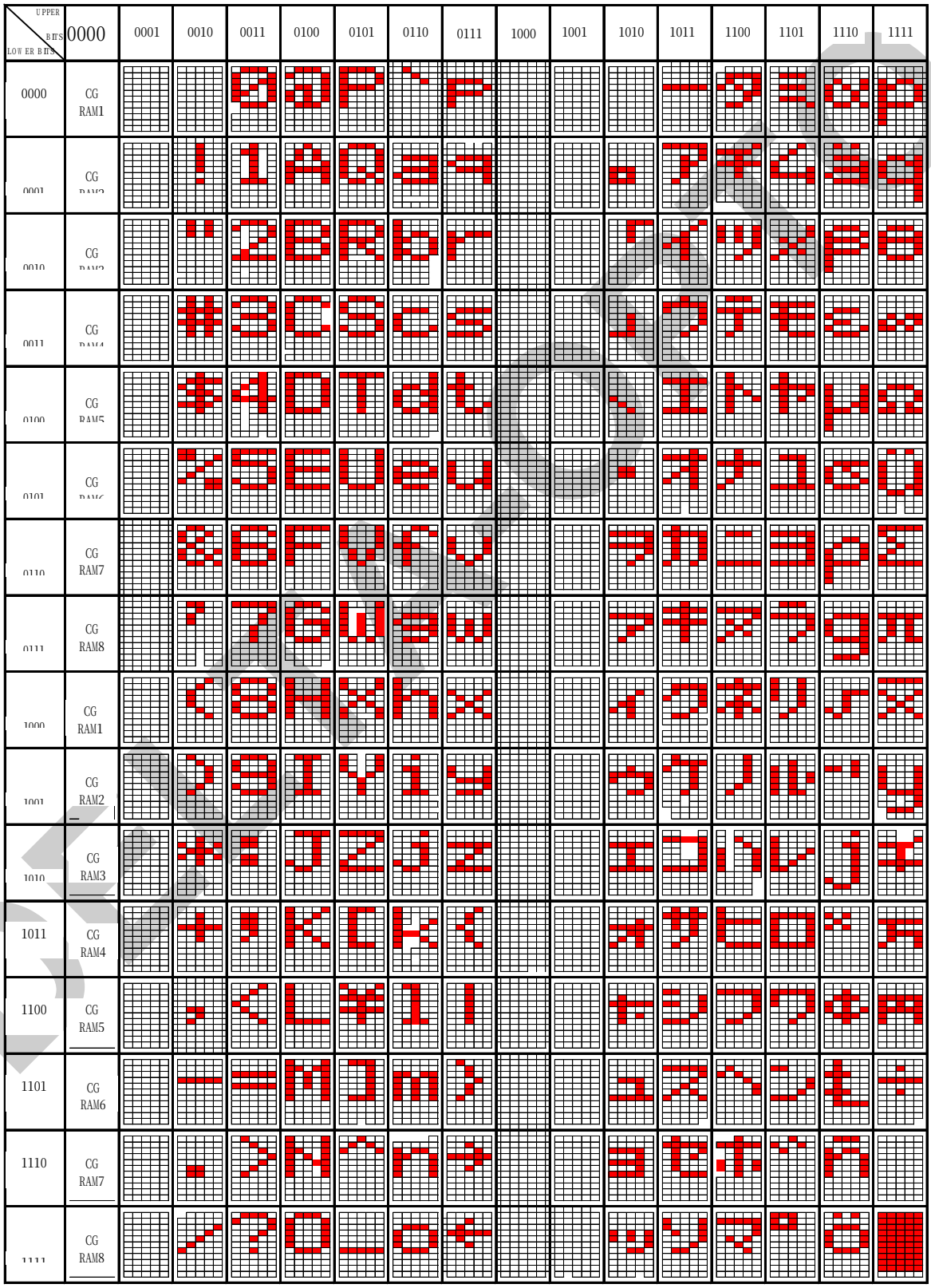
For shift left

01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10
41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50

For shift right

27	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E
67	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E

3.5 Correspondence between character codes and char patterns



3.6 Instruction set

Instruction	Code										Description	Execution time
	RS	R/W	D7	D6	D5	D4	D3	D2	D1	D0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clear entire display. Sets DDRAM address 0 into address counter	1.52ms
Return home	0	0	0	0	0	0	0	0	1	X	Sets DDRAM address 0 into address counter DDRAM contents remain unchanged	1.52ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift	37us
Display On/Off control	0	0	0	0	0	0	1	D	C	B	Sets entire display (D) On/Off Sets cursor (C) On/Off Sets Blinking (B) of cursor position character	37us
Cursor/display shift	0	0	0	0	0	1	S/C	R/L	X	X	Moves cursor & shifts display without changing DDRAM contents	37us
Function set	0	0	0	0	1	DL	N	F	X	X	Sets interface data length (DL) Sets number of display lines (N) Sets character font (F)	37us
Set CGRAM address	0	0	0	1	ACG	ACG	ACG	ACG	ACG	ACG	Sets CGRAM address. CGRAM data is sent and received after this setting.	37us
Set DDRAM address	0	0	1	ADD	ADD	ADD	ADD	ADD	ADD	ADD	Sets DDRAM address. The DDRAM data bus sent and received after this setting	37us
Read busy flag & address	0	1	BF	AC	AC	AC	AC	AC	AC	AC	Reads busy flag (BF) indicating that internal operation is being performed Reads address counter contents	0us
Write data into the CGRAM or DDRAM	1	0	Write data								Write data into the CGRAM or DDRAM	37us
Read data into the CGRAM or DDRAM	1	1	Read data								Read data from the CGRAM or DDRAM	37us
	I/D =1: Increment I/F=0:Decrement S =1: Display shift on D =1: Display on C =1: Cursor display on B =1: Cursor blink on S/C =1: Shift display S/C=0: Move cursor R/L =1: Shift right R/L=0:Shift left DL =1: 8-bit DL=0:4-bit N =1:Dual line N =0:Single line F =1:5x10 dots F =0:5x8 dots BF =1:Internal operation BF =0:Ready for instruction										DDRAM: Display Data RAM CGRAM: Character Generator RAM ACG: Character Generator RAM Address ADD: Display Data RAM Address AC: Address Counter	

3.7 Initialization via Instruction

8-BIT INTERFACE

The procedures of the initialization of an 8-bit MPU as follows.

Power ON

WAIT FOR MORE THAN 15ms AFTER THE VDD RISES TO 4.5V

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

BF CANNOT BE CHECKED BEFORE THIS INSTRUCTION.
FUNCTION SET (INTERFACE IS 8 BITS LONG)

WAIT FOR MORE THAN 4.1ms

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

BF CANNOT BE CHECKED BEFORE THIS INSTRUCTION.
FUNCTION SET (INTERFACE IS 8 BITS LONG)

WAIT FOR MORE THAN 100 us

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

BF CANNOT BE CHECKED BEFORE THIS INSTRUCTION.
FUNCTION SET (INTERFACE IS 8 BITS LONG)

BF CAN BE CHECKED AFTER THE FOLLOWING INSTRUCTIONS. WHEN BF IS NOT CHECKED, THE WAITING TIME BETWEEN THE INSTRUCTIONS IS LONGER THAN THE EXECUTION TIME OF THE INSTRUCTION

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	N	F	*	*
0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	I/D	S

END OF INITIALIZATION
FUNCTION SET (INTERFACE IS 8 BITS LONG) SPECIFY THE NUMBER OF DISPLAY LINES AND CHARACTER FONT)
THE NUMBER OF CHARACTER LINES AND CHARACTER FONT CANNOT BE CHANGED AFTER THIS POINT.
DISPLAY OFF
DISPLAY CLEAR
ENTRY MODE

END OF INITIALIZATION

4-BIT INTERFACE

The procedures of the initialization of an 4-bit MPU as follows.

Power ON

WAIT FOR MORE THAN 15ms AFTER THE VDD RISES TO 4.5V

RS	R/W	DB7	DB6	DB5	DB4	
0	0	0	0	1	1	BF CANNOT BE CHECKED BEFORE THIS INSTRUCTION. FUNCTION SET (INTERFACE IS 8 BITS LONG.)

WAIT FOR MORE THAN 4.1ms

RS	R/W	DB7	DB6	DB5	DB4	
0	0	0	0	1	1	BF CANNOT BE CHECKED BEFORE THIS INSTRUCTION. FUNCTION SET (INTERFACE IS 8 BITS LONG.)

WAIT FOR MORE THAN 100 us

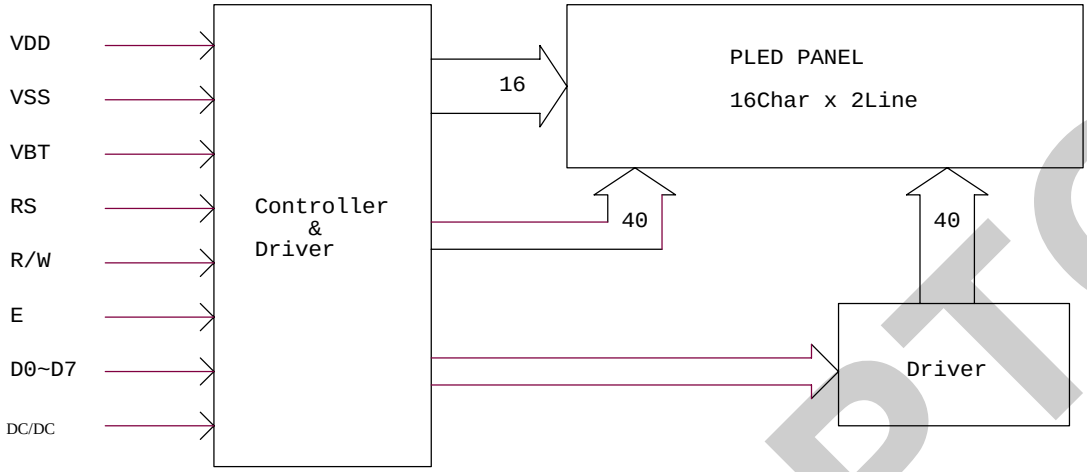
RS	R/W	DB7	DB6	DB5	DB4	
0	0	0	0	1	1	BF CANNOT BE CHECKED BEFORE THIS INSTRUCTION. FUNCTION SET (INTERFACE IS 8 BITS LONG.)

RS	R/W	DB7	DB6	DB5	DB4	
0	0	0	0	1	0	BF CAN BE CHECKED AFTER THE FOLLOWING INSTRUCTIONS.
0	0	0	0	1	0	WHEN THE BF IS NOT CHECKED, THE WAITING TIME BETWEEN
0	0	N	F	*	*	THE INSTRUCTIONS IS LONGER THAN THE TIME IT TAKES FOR THE INSTRUCTION TO BE EXECUTED.
0	0	0	0	0	0	FUNCTION SET (SET INTERFACE IS 4 BIT LONG)
0	0	1	0	0	0	INTERFACE IS 8 BITS LONG
0	0	0	0	0	0	FUNCTION SET (INTERFACE IS 4 BIT LONG. SPECIFY THE
0	0	0	0	0	1	NUMBEROF DISPLAY LINES AND CHARACTER FONT).
0	0	0	0	0	0	THE NUMBER OF DISPLAY LINES AND CHARACTER FONT
0	0	0	1	I/D	S	CANNOT BE CHANGED AFTER THIS POINT.
						DISPLAY OFF
						DISPLAY CLEAR

END OF INITIALIZATION

END OF INITIALIZATION ENTRY MODE SET

3.8 Block Diagram



3.9 Brightness Control

VBT	Brightness (nits)	Power consumption (measured with random texts)
2.5V	18(typical)	50 mW
3.0V	38(typical)	63 mW

Note: 1. When randon texts pattern is running, averagely, at any instance, about 1/4 of pixels will be on.
2. If VBT is not operated within 2.5V and 3V, non-uniformity display may occur.
3. **You have to use the saving mode by VBT 2.5-V in order to make long life.**

4 Interface Pin Function

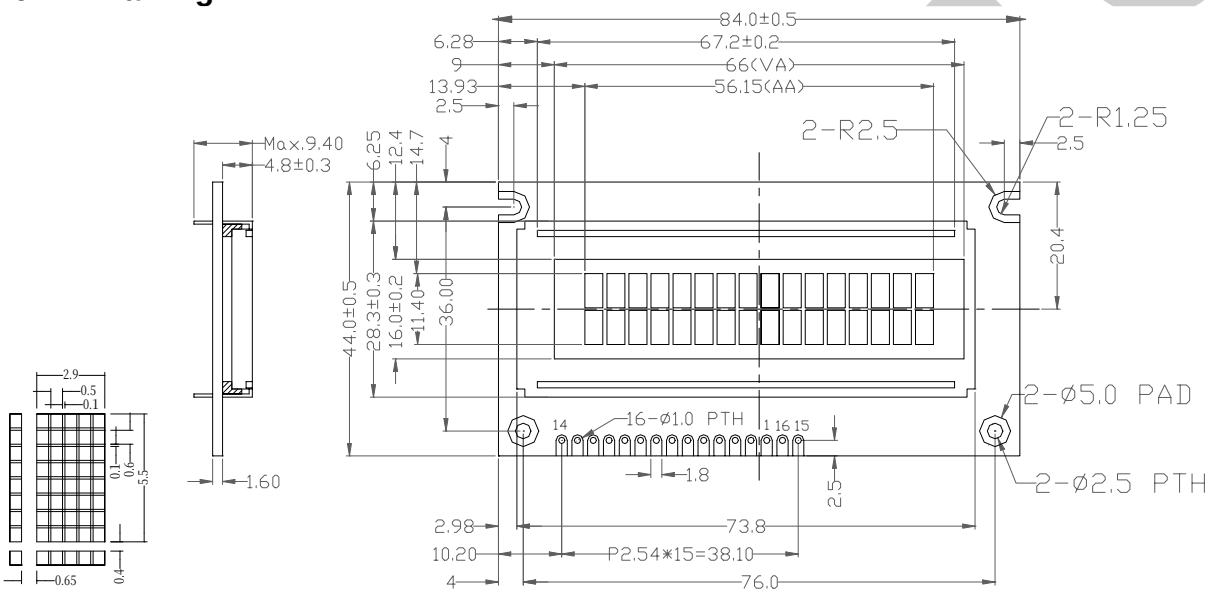
Pin No.	Symbol	I/O	Function
1	VSS	I	Ground
2	VDD	I	Power supply for logic
3	VBT	I	Brightness adjustment
4	RS	I	H: Data L: Instruction code
5	R/W	I	H: Read L: Write
6	E	I	H→L: Enable
7	D0	I	Data bus
8	D1	I	
9	D2	I	
10	D3	I	
11	D4	I	
12	D5	I	
13	D6	I	
14	D7	I	
15	NC		
16	NC		

6 Physical specifications

6.1 Mechanical specifications

NO.	Item	Specification	Unit
1	Active display area	56.15x11.4	mm
2	Viewing area	66.0x16.0	mm
3	Module dimension	84.0x44.0x9.4	mm
4	Dot size	0.5x0.6	mm
5	Weight	27	g

6.2 Drawing



7 Optical specifications

Item		Condition	Min.	Typ.	Max.	Unit
Response time	Rise		-	10	-	us
	Fall		-	10	-	us
Contrast ratio		100 lux	-	100	-	
Viewing angle	Top		-	80	-	deg
	Bottom		-	80	-	deg
	Left		-	80	-	deg
	right		-	80	-	deg
Brightness		With polarizer	-	40	-	nits
Color			-	YG[1]	-	

Note 1. YG=yellow green

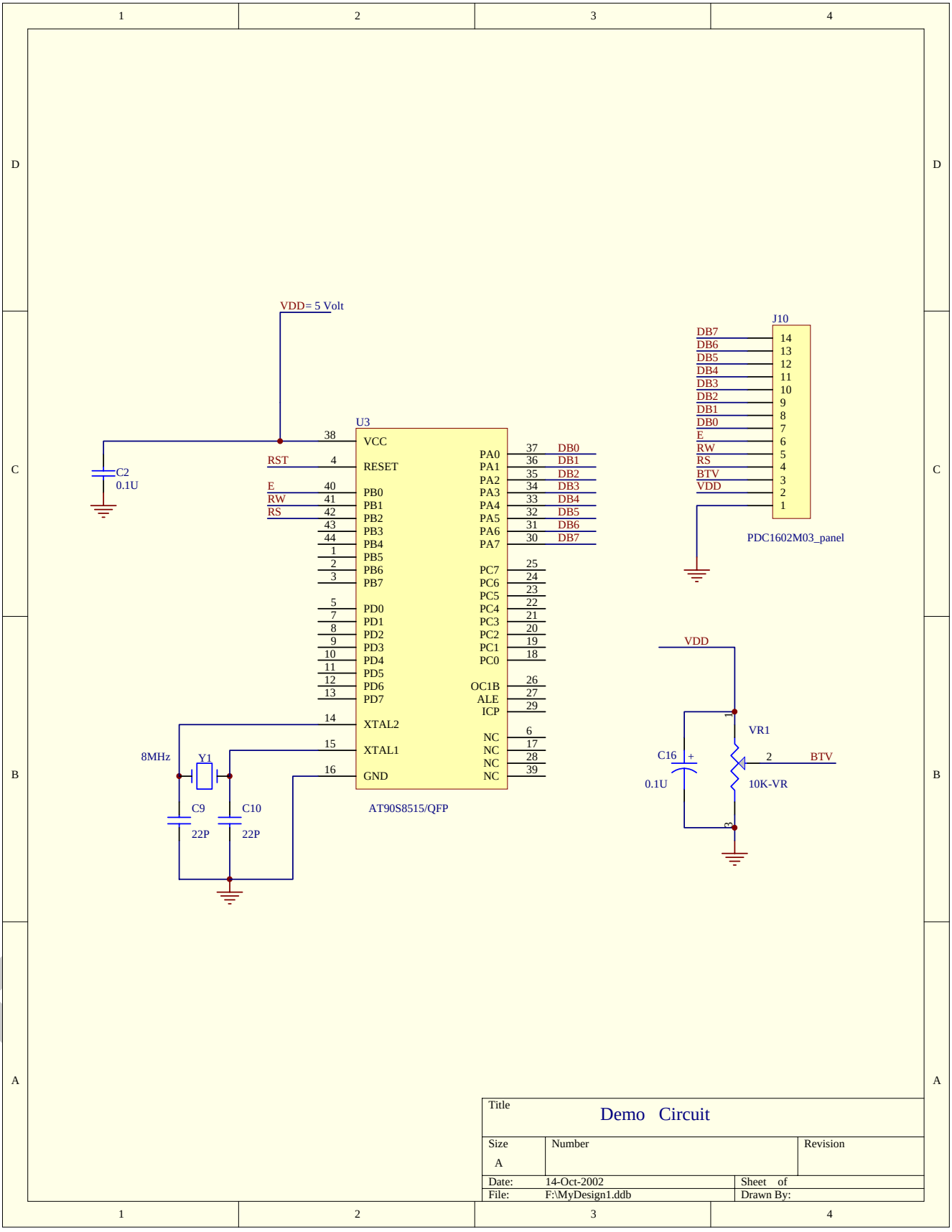
8 Reliability test items

NO.	*Test items*	*Conditions*
1	*High temperature storage*	*70°C , 120 hrs*
2	*Low temperature storage*	*-30°C,120 hrs*
3	*High temperature operation*	*50°C,120 hrs*
4	*Low temperature operation*	*-20°C, 120 hrs*
5	*High temperature and high humidity storage test*	*40°C, 90% RH, 120 hrs*
6	*Temperature Shock (operating)*	*-20°C (30 mins.) -->25°C(5 mins.) --> +70°C (30 mins.) --> 25°C(5 mins.) --> -20°C (30 mins.), 20 Cycles*
7	*ESD test (IEC61000-4-2)*	*1. Static (contact: level 2 , air: level 2)* *2. Operation (contact: level 2 , air: level 2)*

9 Application Note

(1) Ref. Circuit

(see Demo-circuit drawing on next page)


VDD= 5 Volt
C2
0.1U
U3
VCC
RESET
PB0
PB1
PB2
PB3
PB4
PB5
PB6
PB7
PD0
PD1
PD2
PD3
PD4
PD5
PD6
PD7
XTAL2
XTAL1
GND
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PC7
PC6
PC5
PC4
PC3
PC2
PC1
PC0
OC1B
ALE
ICP
NC
NC
NC
NC
RST
E
RW
RS
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
AT90S8515/QFP
8MHz
Y1
C9
22P
C10
22P
J10
PDC1602M03_panel
VDD
VR1
C16
0.1U
10K-VR
BTV
Title
Demo Circuit
Size
A
Number
Revision
Date: 14-Oct-2002
Sheet of
File: F:\MyDesign1.ddb
Drawn By:

(2) Ref. Program (The program use language-C to run Random-texts.)

```
//LCD display test Rounting 2002/04/15

#include <io8515.h>

//-----SET 1602LCD MODULE CONTROL I/O PORT---------
#define     RS      0x04
#define     RW      0x02
#define     EN      0x01

#define     P0          PORTA
#define     P0_IO       DDRA
#define     P0_in       PINA

//end of SET 1602LCD MODULE CONTROL I/O PORT---------


void delay(void)     // functin of delay time
{
float j,k;
for ( j=0;j<1;j++)
{
  for ( k=0;k<1;k++)
  {
  j=j;
  k=k;
  }
}
}

void setRS(void)          // Set RS High
{
PORTB |= RS;
delay();
}
void clrRS(void)     // Set RS Low
{
PORTB &=(~RS);
delay();
}
void setRW(void)     // Set RW High
{
PORTB |= RW;
delay();
}
void clrRW(void)     // Set RS Low
```

```
{
PORTB &=(~RW);
delay();
}
void setEN(void)      // Set EN High
{
PORTB |= EN;
delay();
}
void clrEN(void)      // Set RS Low
{
PORTB &=(~EN);
delay();
}



void write_command(unsigned char command)    //function of write instruction to LCD
{

unsigned char in;

 while (1)    //check the busy flag
 {
      P0_IO=0xff;
      P0= 0xFF ;
      clrRS();
      setRW();
      setEN();
      P0_IO=0x00;
      in = P0_in;
      clrEN();
      if( (in & 0x80) == 0 )
      {
      break;
      }
 }

delay();

P0_IO=0xff;
PORTA = command;
clrRW();
clrRS();
setEN();
clrEN();

}

void write_data(unsigned char DD)    // function of write the data to Display RAM of LCD
```

```
{
unsigned char in1;

  while (1)    //check the busy flag
  {
       P0_IO=0xff;
       P0 = 0xFF ;
       clrRS();
       setRW();
       setEN();
       P0_IO=0x00;
       in1 = P0_in;
       clrEN();
       if( (in1 & 0x80) == 0 )
       {
       break;
       }
  }
P0_IO=0xff;
P0 = DD;
clrRW();
setRS();
setEN();
clrEN();

}

void initial_LCD(void)    // function of intial the LCD
{
write_command(0x38); // 8 bits data length ; 2 Line display; 5x7 dots per word
write_command(0x08); //display off; no cursor;
write_command(0x01); //clear display
write_command(0x06); // display Insert mode: cursor shift right and AC++
}

void main(void)           //the main function start
{
int i;

// initial I/O port----------

DDRB = 0xff;
DDRA = 0xff;
DDRC = 0xff;
DDRD = 0xff;

//---------------------------

clrEN();
```

```
for (;;)
{
initial_LCD();

write_command(0x02);// cursor to zero
write_command(0x81); // display data adress = 0;

   for ( i = 0 ; i    < 96    ; i ++ )
   {
   write_data(0xA0+i); // show the some character on LCD
   delay2(delaytime3);
   }

 }//end of for(;;)

}// void main(void)
```

10 Precaution in Design

(1) Please do not expose the module to mechanical stress, which will cause damage to the metal, plastic, and PLED glass.
(2) Polarizer is easily scratched and should be carefully handled. Please do not touch the polarizer use hard material, such as tweezers, pencil lead and glass. Please do not touch it by barehand.
(3) This module is easily damaged when exposed to static discharge, please take care of static electricity and insure human body grounding.
(4) The Half-Brightness Decay life will longer than 10K hours in room temp.