

通用 LCD 驱动与控制电路 BL55066

BL55066 是一款通用型液晶控制和驱动单芯片，具有 4 背极和 24 段极共 96 位元的输出能力，适用于常用低占空比的字符/图形式液晶屏幕。BL55066 具有兼容多数微机系统的双向二线式串行总线通讯接口，可以级联使用。具备自动地址增量功能。

特点

- 单片集成 LCD 控制器/驱动器
- 可选择背极驱动方式：静态或 2、3、4 复合
- 可选择显示偏置电压：静态、1/2 或 1/3
- 宽工作电压范围：2.5~5.5V
- 二线串行总线接口
- 24 段驱动，可驱动高达 12 个 8 段数字字符、6 个 15 段字母数字字符、或任何高达 96 个点素的图形
- 24 × 4 共 96 位的显示数据存储器
- 静态和多极驱动方式中的显示存储空间的自动切换
- 通用闪烁方式
- 器件子地址显示数据的自动增量
- 较低的电源功耗，约为同类产品的 80%
- LCD 电源和逻辑电路电源可分别供应
- 能和任何 4 位、8 位、16 位微处理器/微控制器兼容
- 可级联大屏幕 LCD 使用(可达 1536 段)
- 可级联 40 段的 BL55076
- 兼容 TTL/COMS 电平
- 先进的低压硅栅 CMOS 工艺制造
- LQFP-44 封装形式

应用领域

- 电表、水表、汽表或其他以电池供电的仪表
- 玩具、学习机
- 手持仪表或其他低功耗便携仪表
- 闹钟

管脚说明

| 编号 | 名称 | 定义 | I/O |
|-----------------|---------------------|----------------------------|-----|
| 6 | SDA | 二线串行总线数据信号 | I/O |
| 7 | SCL | 二线串行总线时钟信号 | I |
| 8 | SYNC | 级联同步信号 (OSC=0:输出;OSC=1:输入) | I/O |
| 9 | CLK | 外部时钟信号 (OSC=0:输出;OSC=1:输入) | I/O |
| 10 | Vdd | 电源正级 | I |
| 12 | OSC | 晶振选择信号 (0:晶振;1:外部时钟) | I |
| 13-15 | A0、A1、A2 | 总线子地址信号 | I |
| 16 | SA0 | 总线从地址 bit0 信号 | I |
| 17 | Vss | 电源负极 | I |
| 18 | Vlcd | 液晶工作低电位电压 | I |
| 19-21、23 | Com0、Com2、Com1、Com3 | 液晶板 COM 输出 | 0 |
| 24-32、34-43、1-5 | Seg0—Seg23 | 液晶板 SEG 输出 | 0 |
| 11、22、33、44 | NC | 未使用 | - |

表 1

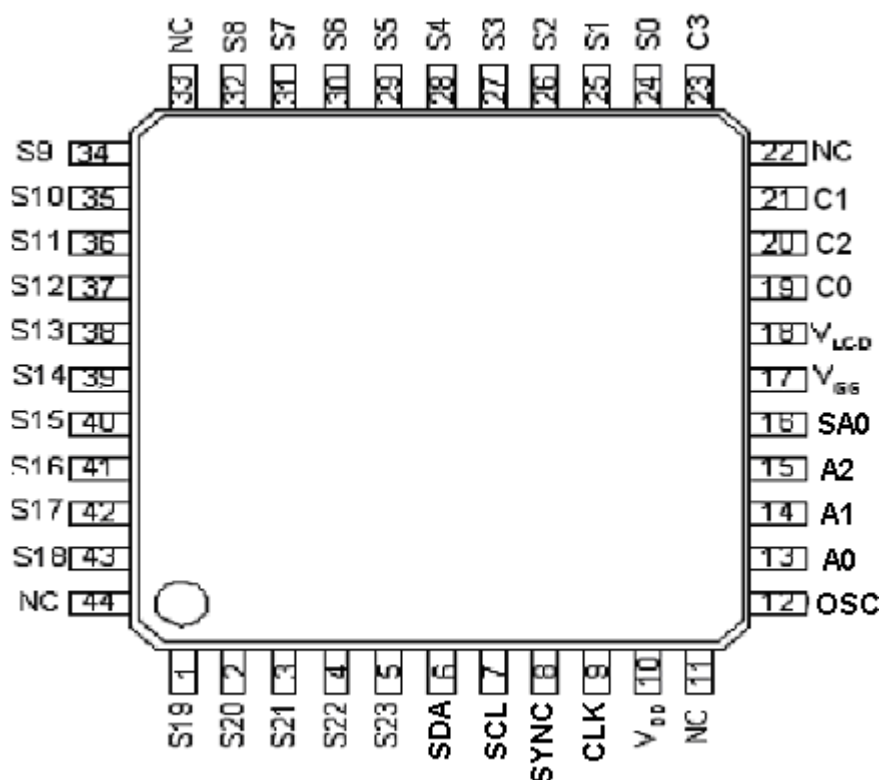
管脚排列


图 1

功能描述

1. 功能电路

BL55066内部集成了LCD驱动器所必需的所有功能电路。这些电路包括:LCD偏置电压发生器、LCD电压选择器、内部时钟、显示RAM、显示锁存器、移位寄存器、段/背极输出电路、输入/输出存储体选择器、闪烁电路、数据指针和子地址计数器。

2. 显示驱动原理:

BL55066有24个段输出S0—S23和4个背极输出Com0--Com3,它们和LCD直接相连,当少于24个段输出和少于4个背极输出应用时,不用的段或背极可空出。BL55066共有静态1:2、1:3、1:4四种背极输出方式,允许使用1/2或1/3两种偏置电压。

显示内容和 RAM 地址之间的关系可见下表:

| 显示 RAM 地址和 SEGMENT (S0~S23) 输出 | | | | | | | | | | | | |
|----------------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------|
| COM | 0 | 1 | 2 | 3 | . | . | . | . | 21 | 22 | 23 | Ram 数据 填充次序 |
| (Com0- Com3) 输出 | 0 | | | | | | | | | | | 3 |
| | 1 | | | | | | | | | | | 2 |
| | 2 | | | | | | | | | | | 1 |
| | 3 | | | | | | | | | | | 0 |

表 2

当要显示的数据传送给BL55066后, BL55066将接收到的字节数据按照所选择的LCD驱动方式填充在显示RAM中。图2示出了在不同的驱动方式下7段显示器的显示填充顺序。

| 方式 | LCD 段 | LCD 背极 | 显示 RAM 填充顺序 | 发送的显示字节 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|-------|--------|---|---------|-----|-----|-----|-----|-----|-----|-----|-----|----|---|---|---|----|----|--|-----|----|---|-----|---|-----|---|----|---|---|-----|----|---|---|---|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|--|-----|--|--|--|--|--|--|--|-----|---|---|---|---|---|---|---|----|
| 静态 | | | <table border="1"> <tr> <th>BP</th> <th>n</th> <th>n+1</th> <th>n+2</th> <th>n+3</th> <th>n+4</th> <th>n+5</th> <th>n+6</th> <th>n+7</th> </tr> <tr> <td>0</td> <td>c</td> <td>b</td> <td>a</td> <td>f</td> <td>g</td> <td>e</td> <td>d</td> <td>DP</td> </tr> <tr> <td>1</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> </tr> <tr> <td>2</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> </tr> <tr> <td>3</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> </tr> </table> | BP | n | n+1 | n+2 | n+3 | n+4 | n+5 | n+6 | n+7 | 0 | c | b | a | f | g | e | d | DP | 1 | * | * | * | * | * | * | * | * | 2 | * | * | * | * | * | * | * | * | 3 | * | * | * | * | * | * | * | * | <table border="1"> <tr> <th>MSB</th> <th colspan="7"></th> <th>LSB</th> </tr> <tr> <td>c</td> <td>b</td> <td>a</td> <td>f</td> <td>g</td> <td>e</td> <td>d</td> <td>DP</td> </tr> </table> | MSB | | | | | | | | LSB | c | b | a | f | g | e | d | DP |
| BP | n | n+1 | n+2 | n+3 | n+4 | n+5 | n+6 | n+7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | c | b | a | f | g | e | d | DP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | * | * | * | * | * | * | * | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | * | * | * | * | * | * | * | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | * | * | * | * | * | * | * | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MSB | | | | | | | | LSB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| c | b | a | f | g | e | d | DP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1:2 多极 | | | <table border="1"> <tr> <th>BP</th> <th>n</th> <th>n+1</th> <th>n+2</th> <th>n+3</th> </tr> <tr> <td>0</td> <td>a</td> <td>f</td> <td>e</td> <td>d</td> </tr> <tr> <td>1</td> <td>b</td> <td>g</td> <td>c</td> <td>DP</td> </tr> <tr> <td>2</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> </tr> <tr> <td>3</td> <td>*</td> <td>*</td> <td>*</td> <td>*</td> </tr> </table> | BP | n | n+1 | n+2 | n+3 | 0 | a | f | e | d | 1 | b | g | c | DP | 2 | * | * | * | * | 3 | * | * | * | * | <table border="1"> <tr> <th>MSB</th> <th colspan="4"></th> <th>LSB</th> </tr> <tr> <td>a</td> <td>b</td> <td>f</td> <td>g</td> <td>e</td> <td>d</td> </tr> </table> | MSB | | | | | LSB | a | b | f | g | e | d | | | | | | | | | | | | | | | | | | | | | | | | | |
| BP | n | n+1 | n+2 | n+3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | a | f | e | d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | b | g | c | DP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | * | * | * | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | * | * | * | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MSB | | | | | LSB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| a | b | f | g | e | d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1:3 多极 | | | <table border="1"> <tr> <th>BP</th> <th>n</th> <th>n+1</th> <th>n+2</th> </tr> <tr> <td>0</td> <td>b</td> <td>a</td> <td>f</td> </tr> <tr> <td>1</td> <td>DP</td> <td>d</td> <td>e</td> </tr> <tr> <td>2</td> <td>c</td> <td>g</td> <td>*</td> </tr> <tr> <td>3</td> <td>*</td> <td>*</td> <td>*</td> </tr> </table> | BP | n | n+1 | n+2 | 0 | b | a | f | 1 | DP | d | e | 2 | c | g | * | 3 | * | * | * | <table border="1"> <tr> <th>MSB</th> <th colspan="3"></th> <th>LSB</th> </tr> <tr> <td>b</td> <td>DP</td> <td>c</td> <td>a</td> <td>d</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>g</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>f</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>e</td> </tr> </table> | MSB | | | | LSB | b | DP | c | a | d | | | | | g | | | | | f | | | | | e | | | | | | | | | | | | | | | | | |
| BP | n | n+1 | n+2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | b | a | f | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | DP | d | e | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | c | g | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | * | * | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MSB | | | | LSB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| b | DP | c | a | d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | g | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | f | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | e | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1:4 多极 | | | <table border="1"> <tr> <th>BP</th> <th>n</th> <th>n+1</th> </tr> <tr> <td>0</td> <td>a</td> <td>f</td> </tr> <tr> <td>1</td> <td>c</td> <td>e</td> </tr> <tr> <td>2</td> <td>b</td> <td>g</td> </tr> <tr> <td>3</td> <td>DP</td> <td>d</td> </tr> </table> | BP | n | n+1 | 0 | a | f | 1 | c | e | 2 | b | g | 3 | DP | d | <table border="1"> <tr> <th>MSB</th> <th colspan="2"></th> <th>LSB</th> </tr> <tr> <td>a</td> <td>c</td> <td>b</td> <td>DP</td> </tr> <tr> <td></td> <td></td> <td></td> <td>f</td> </tr> <tr> <td></td> <td></td> <td></td> <td>e</td> </tr> <tr> <td></td> <td></td> <td></td> <td>g</td> </tr> <tr> <td></td> <td></td> <td></td> <td>d</td> </tr> </table> | MSB | | | LSB | a | c | b | DP | | | | f | | | | e | | | | g | | | | d | | | | | | | | | | | | | | | | | | | | | | | |
| BP | n | n+1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | a | f | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | c | e | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | b | g | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | DP | d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MSB | | | LSB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| a | c | b | DP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | f | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | e | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | g | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

图 3

二线-串行通信总线协议

两个受控于BL55066的二线-串行通信总线受控器地址（0111110和0111111）。受控器最重要的最低位由输入SA0的连线决定，因此，如下的两种在相同二线-串行通信总线上的BL55066能被区别：

- (1) 在大型LCD应用中相同的二线-串行通信总线上达到16片BL55066；
- (2) 两种不同类的LCD复合在相同的二线-串行通信总线上使用。

二线-串行通信总线如图4。发送第一个起始条件后，紧接着发送两个BL55066从地址中的一个。所有SA0电平相同的BL55066同时响应从地址，但所有与SA0电平不同的BL55066则与二线-串行通信总线的通讯无关。在寻址之后为一个或多个（ $m \geq 1$ 个字节）指令字节（COMMAND），用来定义所寻址的BL55066状态，指令字节中的最高位“C”用以标明是否是最后一个指令字节，当C=“1”时表示后面的字节仍是指令字节；当C=“0”时则表明该字节为最后一个指令字节。最后一个指令字节之后为一系列显示数据字节（DISPLAY DATA），这些显示数据存放在显示RAM中，由数据指针和子地址计数器指示的地址上。数据指针和子地址计数器可自动变更，数据直接装载到指定的BL55066上，在每个字节之后的应答位由A2、A1、A0寻址的BL55066提供，在主控器发送完最后一个字节后产生一个终止条件P。

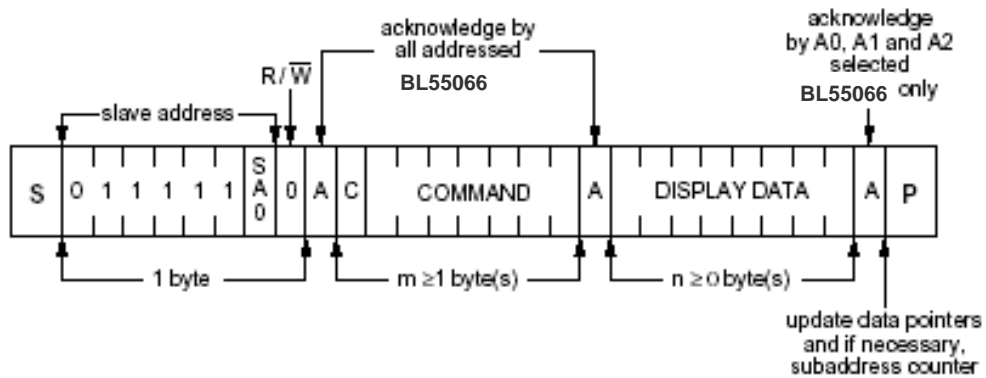
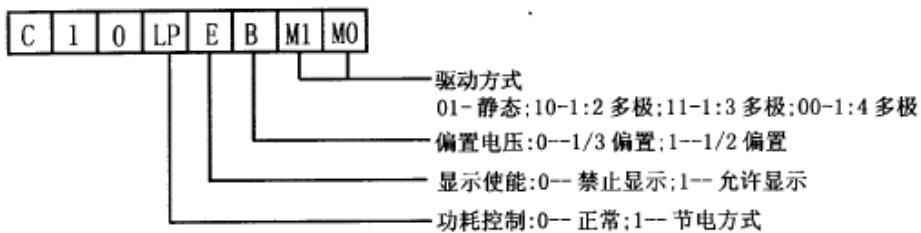


图 4

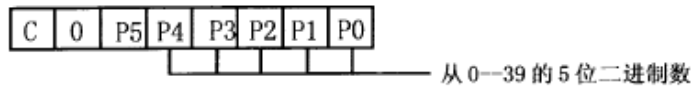
3 BL55066的控制命令

BL55066 共有 5 个控制命令字。命令和数据都是以字节的形式发送到 BL55066，它们的区别在于传送字节的最高位 C，当 C=1 时表示其后传送的字节仍是命令；C=0 表示其后传送的字节是最后一个命令，接下来传送的是一系列数据。下面列出了常用的 4 个命令的细节：

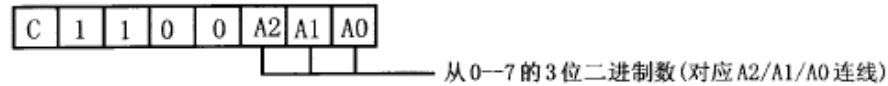
A. 方式设定



B. 数据指针(要显示的起始地址, 对应段输出 S0--S39 的某一段)



C. 器件选择



D. 闪烁控制

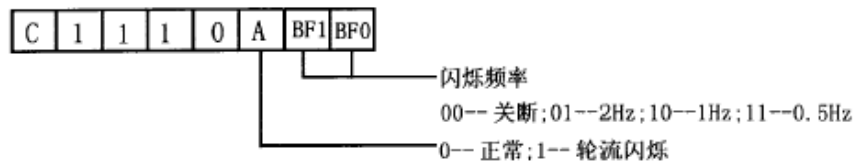


图 5

极限参数

| 参数 | 符号 | 最小 | 最大 | 单位 |
|---|--|-----------------|----------------|----|
| 电源电压范围 | V_{DD} | -0.5 | +6.0 | V |
| LCD 电源电压范围 | V_{LCD} | $V_{DD} - 6.0$ | V_{DD} | V |
| 输入电压范围(SCL、SDA、A0 ~ A2、OSC、CLK、 \overline{SYNC} 、SA0) | V_{I1} | $V_{SS} - 0.5$ | $V_{DD} + 0.5$ | V |
| 输出电压范围(S0 ~ S23、BP0 ~ BP3) | V_o | $V_{LCD} - 0.5$ | $V_{DD} + 0.5$ | V |
| DC 输入电流 | $\pm I_i$ | -20 | +20 | mA |
| DC 输出电流 | $\pm I_o$ | -25 | +25 | mA |
| V_{DD} 、 V_{SS} 或 V_{LCD} 电流 | $\pm I_{DD}$ 、 $\pm I_{SS}$ 、 $\pm I_{LCD}$ | -50 | +50 | mA |
| 每片功耗 | P_{tot} | - | 400 | mW |
| 每个输出功耗 | P_o | - | 100 | mW |
| 存储温度范围 | T_{atg} | -65 | +150 | |

表 6

直流电参数 (除非特别指明, $T_a=25^\circ\text{C}$)

| 参数 | 符号 | 最小值 | 典型值 | 最大值 | 单位 |
|--|-----------|-----|-----|----------------|-------|
| 工作电源电压 | V_{DD} | 2.5 | - | 5.5 | V |
| LCD 电源电压 | V_{LCD} | 0 | - | $V_{DD} - 2.5$ | V |
| 工作电源电流, $V_{DD}=5V$, $V_{LCD}=0V$, $f_{CLK}=200kHz$ 时 (1) | I_{DD} | - | 25 | 50 | μ |
| 节电方式电源电流, $V_{DD}=3.3V$, $V_{LCD}=0V$, $f_{CLK}=35kHz$ 时 (1) | I_{LP} | - | 9 | 15 | μ |
| 逻辑电平 | | | | | |

| | | | | | |
|---|--------------|-----------------|----|--------------|-------|
| 输入电压低 | V_{IL} | V_{SS} | - | $0.3 V_{DD}$ | V |
| 输入电压高 (SDA, SCL, CLK, SYNC, SA0, OSC, A0 to A2) | V_{IH1} | $0.7V_{DD}$ | - | V_{DD} | V |
| 输出电压低 (IO=0mA) | V_{OL} | - | - | 0.05 | V |
| 输出电压高 (IO=0mA) | V_{OH} | $V_{DD} - 0.05$ | - | - | V |
| 输出电流低 (CLK, SYNC), $V_{OL}=1V$, $V_{DD}=5V$ 时 | I_{OL1} | 1 | - | - | mA |
| 输出电流高 (CLK), $V_{OH}=4V$, $V_{DD}=5V$ 时 | I_{OH} | - | - | -1 | mA |
| 输出电流低 (SDA, SCL), $V_{OL}=0.4V$, $V_{DD}=5V$ 时 | I_{OL2} | 3 | - | - | mA |
| 泄漏电流 (SA0, A0 ~ A2, CLK, SCL, SDA), $V_i=V_{SS}$ 或 V_{DD} 时 | $\pm I_{L1}$ | -1 | - | +1 | μ |
| 泄漏电流 (OSC), $V_i=V_{DD}$ | $\pm I_{L2}$ | -1 | - | +1 | μ |
| 下拉电流 (A0, A1, A2, OSC) $V_i=1V$; $V_{DD}=5V$ | I_{pd} | 15 | 50 | 150 | μ |
| 上拉电阻 (SYNC) | R_{SYNC} | 15 | 25 | 60 | k |
| 总线上允许尖峰脉冲宽度 | t_{SW} | - | - | 100 | ns |

1: 输出开路, 内部振荡时钟

表7
交流电参数 (除非特别指明, $T_a=25^\circ C$)

| 参数 | 符号 | 最小值 | 典型值 | 最大值 | 单位 |
|---------------------------------|------------------------|-----|-----|-----|---------|
| 振荡器频率 (标准方式) $V_{DD}=5V$ | f_{CLK} | 125 | 200 | 315 | kHz |
| 振荡器频率 (节电方式) $V_{DD}=3.5V$ | f_{CLKP} | 21 | 31 | 48 | kHz |
| CLK 高周期 | t_{c1KH} | 1 | - | - | μs |
| CLK 低周期 | t_{c1KL} | 1 | - | - | μs |
| SYNC传输延迟 | t_{PSYNC} | - | - | 400 | ns |
| SYNC周期 测试负载为VLCD=VDD-5V 时驱动器的延迟 | $t_{\overline{SYNCL}}$ | 1 | - | - | μs |
| | t_{PLCD} | - | - | 30 | μs |
| 二线串行总线时序规范 | | | | | |
| 总线空闲时间 | t_{BUF} | 4.7 | - | - | μs |
| “开始”状态保持时间 | $t_{HD;STA}$ | 4.0 | - | - | μs |
| 进入二次“开始”状态的建立时间 | $t_{SU;STA}$ | 4.7 | - | - | μs |
| SCL低周期 | t_{LOW} | 4.7 | - | - | μs |
| SCL高周期 | t_{HIGH} | 4.0 | - | - | μs |
| SCL/SDA上升时间 | t_r | - | - | 1 | μs |
| SCL/SDA下降时间 | t_f | - | - | 0.3 | μs |
| 线载电容 | C_B | - | - | 400 | pF |

| | | | | | |
|------------|--------------|-----|---|---|---------|
| 数据建立时间 | $t_{SU;DAT}$ | 250 | - | - | ns |
| 数据保持时间 | $t_{HD;DAT}$ | 0 | - | - | μs |
| “结束”状态建立时间 | $t_{SU;STO}$ | 4.0 | - | - | μs |

表8

时序图

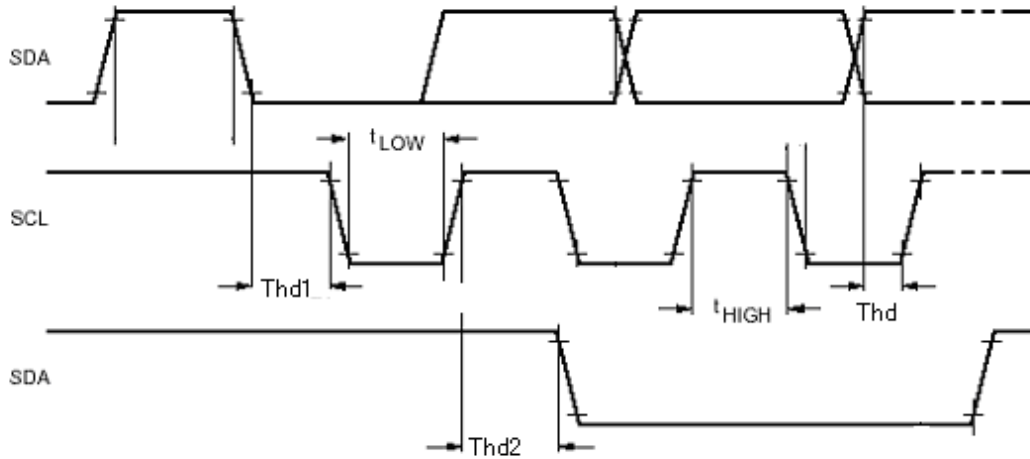


图6

典型应用

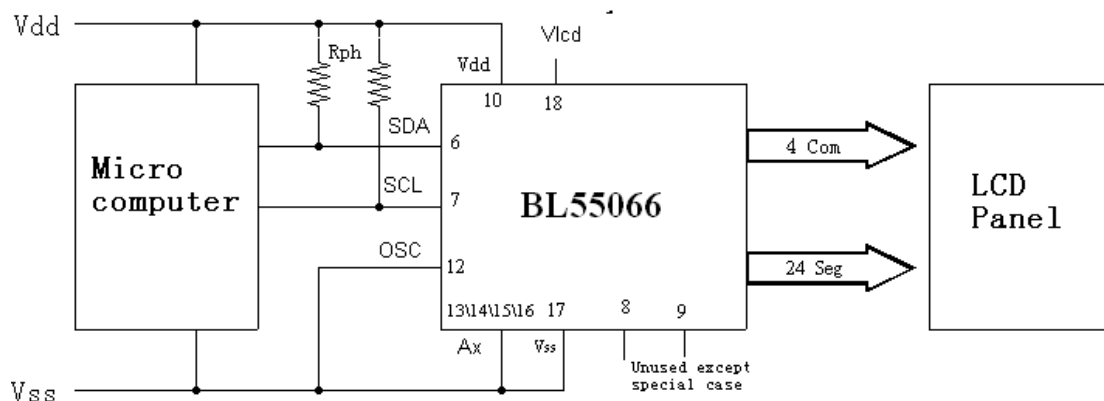


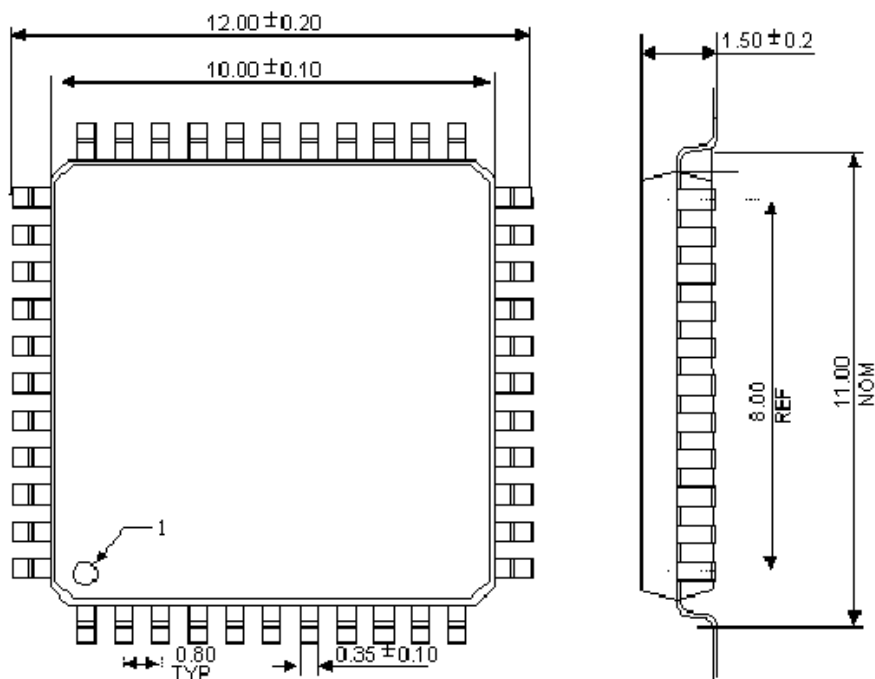
图7

注：1. Vlcd 必须接一恒定电压，可由电阻分压获得，或直接接地。

2. I2C 通讯空闲状态下，SDA、SCL 管脚需拉高，否则可能无法进入节电功耗模式

封装描述 (单位: mm)

LQFP44



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