



## 基本特性

1. 全自动测量
2. 3 3/4 位显示
3. 频率测量 (400MHz)
4. 旋转或按键
5. 自动关机并锁定最后数据
6. 旋转或按键重新开机
7. 测值锁定、最大/最小值锁定、相对值锁定
8. 电池低电量检测 (3V & 9V)
9. 片上蜂鸣器驱动器
10. 背光功能
11. 3V 直流电源
12. 利用外部参考电压测 ADP
13. 内部交流到直流转换运算放大器
  - \* 如果在非交流模式, 运算将成为单元增益缓冲器
14. 串行数据输出(RS232 格式)
15. LCD 段检测
16. 100 脚扁平封装

## 描述

ES51960 是一种具有 3 3/4 位和 42 段位的条形 LCD 显示, 自动量程选择和 3V 直流电源供电功能的集成模拟-数字转换器。它提供了交/直流电压测量、电阻测量、电流测量( $\mu\text{A}$  和 A)和频率计数器的自动量程选择。ES51960 也提供了串行数据输出功能。它不需要昂贵而庞大的机械量程转换开关。ES51960 提供的其它功能包括: 最大/最小值锁定、当前值显示、测值锁定、相对数及参考值的显示、低电量检测、自动关机、二极管测量、通断检测。

## 绝对最大额定值

| Characteristics                | Ratings        |
|--------------------------------|----------------|
| Supply Voltage (V- to AGND)    | -4V            |
| Analog Input Voltage           | V+ to V-       |
| Digital Input                  | V- to DGND     |
| Power Dissipation Flat Package | 500mW          |
| Operating Temperature          | 0°C to 70°C    |
| Storage Temperature            | -40°C to 125°C |



电气特性

TA=25°C, V- = -3V

| Symbol          | Parameter  | Test Condition  | Min. | Typ.       | Max.  | Count  |
|-----------------|--|---|------|------------|-------|--------|
| V-              | Power Supply   |   | -3.5 | -3.0       | -2.2  | Volt   |
| I <sub>dd</sub> | Operating Supply Current                             | Normal Power On   | -    | 1.0        | 1.5   | mA     |
| I <sub>ss</sub> |  | Auto-power-off  | -    | 5          | 10    | uA     |
| REV             | Rollover Error (Voltage)                             | 10M input Resistor  | -    | -          | ± 0.1 | % F.S. |
| REB             | Rollover Error (Bargraph)                            |   | -    | -          | ± 0.5 | % F.S. |
| NLV             | Nonlinearity (Voltage)                               | Best Case Straight Line                                   | -    | -          | ± 0.1 | % F.S. |
| NLB             | Nonlinearity (Bargraph)                              |   | -    | -          | ± 0.5 | % F.S. |
|                 | Input Leakage  |   | -    | 1          | 10    | pA     |
|                 | Low Battery Flag Voltage                             | V- to AGND  | -2.5 | -2.3       | -2.1  | V      |
|                 | Zero Input Reading                                   | 10M Ω Input Resistor                                      | -000 | 000        | +000  | Count  |
| VREF            | Reference Voltage and 400 Ω measurement              | 100K Ω Between VRH and AGND                               | -1.3 | -1.2       | -1.1  | V      |
|                 | Peak to Peak Backplane Drive Voltage                 | -3.2 ≤ V- ≤ -2.2  | 2.85 | 3.0        | 3.15  | V      |
|                 | Counter Time Base Period                             | fosc=4MHz   | -    | 1          | -     | Sec    |
|                 | Open Circuit Voltage for Ω Measurement(except 400 Ω) | Ω and Continuity Function                                 | -0.5 | -0.45      | -0.4  | V      |
|                 | Pull High to 0V Resistance                           | FC1,FC2,FC3,FC4<br>FC5,RANGE,HOLD<br>MAX/MIN,BKLIT<br>REL | -    | 2.5        | -     | MΩ     |
|                 | Pull High to 0V Resistance                           | KEY, SET, BUZIN   | -    | 250        | -     | KΩ     |
|                 | AC Frequency Response (4V range)                     | ± 1% Error  | -    | 40 to 500  | -     | HZ     |
|                 |  | ± 5% Error  | -    | 40 to 2000 | -     |        |
| TCRF            | Reference Voltage Temperature Coefficient            | 100K Ω Between VRH and AGND<br>0°C < TA < 70°C            | -    | 50         | -     | ppm/°C |



引脚描述

| Pin No. | Symbol | Description   |
|---------|--------|---|
| 1       | V+     | Positive supply voltage, output of on-chip DC-DC converter.                                     |
| 2       | V+     | Positive supply voltage, output of on-chip DC-DC converter.                                     |
| 3       | CH+    | High speed positive connection for reference capacitor.   |
| 4       | CH-    | High speed negative connection for reference capacitor.   |
| 5       | CIH    | High speed integrator output. Connected to integration capacitor.                               |
| 6       | BUFH   | Integration resistor connection for high speed buffer output.                                   |
| 7       | CAZH   | High speed auto-zero capacitor connection   |
| 8       | CL+    | High resolution positive connection for reference capacitor.                                    |
| 9       | CL-    | High resolution negative connection for reference capacitor.                                    |
| 10      | CIL    | High resolution integrator output. Connected to integration capacitor.                          |
| 11      | CAZL   | High resolution auto-zero capacitor connection.   |
| 12      | BUFL   | Integration resistor connection for high resolution buffer output.                              |
| 13      | IVSH   | High level current measurement input.   |
| 14      | IVSL   | Low level current measurement input   |
| 15      | OVX    | Input high voltage for resistance measurement.  |
| 16      | OVH    | Output connection for resistance measurement.   |
| 17      | OVSG   | Sense low voltage for resistance measurement.   |
| 18      | OR1    | Reference resistor connection for 399.9Ω range.   |
| 19      | VR5    | Voltage measurement ÷ 10000 attenuator (3999V).   |
| 20      | VR4    | Voltage measurement ÷ 1000 attenuator (399.9V).   |
| 21      | VR3    | Voltage measurement ÷ 100 attenuator (39.99V).  |
| 22      | VR2    | Voltage measurement ÷ 10 attenuator (3.999V).   |
| 23      | TEST5  | Test pin 5.   |
| 24      | ACVL   | Negative output of AC to DC converter.  |
| 25      | ACVH   | Positive output of AC to DC converter.  |
| 26      | ADI    | Negative input of internal AC to DC OP AMP.   |
| 27      | ADO    | Output of internal AC to DC OP AMP.   |
| 28      | VA+    | For ADP use. Deintegrating voltage input. The pin voltage should be more positive than VA- pin. |
| 29      | VA-    | For ADP use. Deintegrating voltage input.   |
| 30      | ADP    | Adapted input for other application measurement.  |
| 31      | SGND   | Signal ground.  |
| 32      | VR1    | Unknown voltage input .   |
| 33      | ADODC  | Optional pin.   |
| 34      | VR     | Reference input voltage connection. Typically -100 mV.  |
| 35      | VRH    | Output of band-gap voltage reference. Typically -1.2 V.   |
| 36      | ACVR   | Optional pin. When connected to -3V, ACV without 400mV range.                                   |
| 37      | BKLIT  | Back light function. Pulse low to set BKOUT pin output.   |



| Pin. No | Symbol. | Description  |
|---------|---------|--|
| 38      | SLEEP   | When auto-power-off happen, this pin output will change from +3V to -3V. When re-power on happens, this pin output will change back to +3V.  |
| 39      | TEST1   | Test pin 1.  |
| 40      | TEST2   | Test pin 2   |
| 41      | FREQ    | Frequency counter input, offset to 1/2(V-).  |
| 42      | SET     | Input to set serial data output. Pulse low to make this function active.   |
| 43      | F100    | 100 HZ square wave output.   |
| 44      | SEG24   | LCD Segment line 24.   |
| 45      | SEG23   | LCD Segment line 23.   |
| 46      | SEG22   | LCD Segment line 22.   |
| 47      | SEG21   | LCD Segment line 21.   |
| 48      | SEG20   | LCD Segment line 20.   |
| 49      | SEG19   | LCD Segment line 19.   |
| 50      | SEG18   | LCD Segment line 18.   |
| 51      | SEG17   | LCD Segment line 17.   |
| 52      | SEG16   | LCD Segment line 16.   |
| 53      | SEG15   | LCD Segment line 15.   |
| 54      | SEG14   | LCD Segment line 14.   |
| 55      | SEG13   | LCD Segment line 13.   |
| 56      | SEG12   | LCD Segment line 12.   |
| 57      | SEG11   | LCD Segment line 11.   |
| 58      | SEG10   | LCD Segment line 10.   |
| 59      | SEG9    | LCD Segment line 9.  |
| 60      | SEG8    | LCD Segment line 8.  |
| 61      | SEG7    | LCD Segment line 7.  |
| 62      | SEG6    | LCD Segment line 6.  |
| 63      | SEG5    | LCD Segment line 5.  |
| 64      | SEG4    | LCD Segment line 4.  |
| 65      | SEG3    | LCD Segment line 3.  |
| 66      | SEG2    | LCD Segment line 2.  |
| 67      | SEG1    | LCD Segment line 1.  |
| 68      | ANNUNC  | Square-wave output at the backplane frequency, synchronized to BP1. ANNUNC can be used to control display annunciator. Connecting an LCD segment to ANNUNC and turns it on; connecting an LCD segment to its backplane and turns it off. |
| 69      | BP4     | LCD Backplane 4.   |
| 70      | BP3     | LCD Backplane 3.   |
| 71      | BP2     | LCD Backplane 2.   |
| 72      | BP1     | LCD Backplane 1.   |



| Pin. No | Symbol. | Description.  |
|---------|---------|---|
| 73      | BUZIN   | Buzzer control input. When Connected BUZIN to -3V turns the buzzer on.(2.0 KHZ continue signal)   |
| 74      | BUZOUT  | Buzzer output. Audio frequency (2.0KHz) output which drives a piezoelectric buzzer.   |
| 75      | PH1     | Phase output 1,for capacitance measurement.   |
| 76      | PH2     | Phase output 2,for capacitance measurement.   |
| 77      | PH3     | Phase output 3,for capacitance measurement.   |
| 78      | PH4     | Phase output 4,for capacitance measurement.   |
| 79      | OSC1    | Crystal oscillator (input) connection.  |
| 80      | OSC2    | Crystal oscillator (output) connection.   |
| 81      | BKOUT   | If BKLIT function is enabled , this pin output will change from -3V to +3V for 60 sec, once pressed BKLIT pin again within the 60 sec, this pin output will change back to -3V.   |
| 82      | KEY     | Mode change pin.  |
| 83      | REL     | Input to get relative display. Pulse low to make this function active.  |
| 84      | MAX/MIN | Input to set MAX/MIN display. Pulse low to make this function active.   |
| 85      | HOLD    | Input to hold display. Pulse low to make this function active.  |
| 86      | RANGE   | Input to set automatic/manual mode and manual range selection. Pulse low to make this function active.  |
| 87      | FC5     | Switch 5 for function selection.  |
| 88      | FC4     | Switch 4 for function selection.  |
| 89      | FC3     | Switch 3 for function selection.  |
| 90      | FC2     | Switch 2 for function selection.  |
| 91      | FC1     | Switch 1 for function selection.  |
| 92      | LBAT9   | Low battery voltage setting. If used 3V battery, connected this pin to AGND, the default low battery voltage will be -2.3V. If used 9V battery, when the input voltage is small than VRH(-1.2V), the low battery annunciator will be display. |
| 93      | SDO     | Serial data output.   |
| 94      | C+      | Positive capacitor connection for on-chip DC-DC converter.  |
| 95      | C-      | Negative capacitor connection for on-chip DC-DC converter.  |
| 96      | V-      | Negative supply voltage. Connecting to battery negative terminal.   |
| 97      | V-      | Negative supply voltage. Connecting to battery negative terminal.   |
| 98      | DGND    | Digital ground, connected to battery positive terminal.   |
| 99      | AGND    | Analog ground.  |
| 100     | AGND    | Analog ground.  |



## 工作模式

### (1) 测量说明

#### 电压测量

电阻分压器可以从 399.9mV ~3999V 的全标度量程中自动地选择合适的量程。下表显示了不同的全标度量程。

| Range | Full scale | Resistive Ratio        |
|-------|------------|------------------------|
| VR1   | 399.9 mV   | 1, 1/1                 |
| VR2   | 3.999 V    | $R2/(R1+R2)$ , 1/10    |
| VR3   | 39.99 V    | $R3/(R1+R3)$ , 1/100   |
| VR4   | 399.9 V    | $R4/(R1+R4)$ , 1/1000  |
| VR5   | 3999 V     | $R5/(R1+R5)$ , 1/10000 |

#### 电阻测量

电阻分压器自动地选择合适的量程。下表显示了不同的全标度量程。

| Range | Full Scale       | Reference Resistor    |
|-------|------------------|-----------------------|
| OR1   | 399.9 $\Omega$   | R6(100 $\Omega$ )     |
| OR2   | 3.999 K $\Omega$ | R5(1K $\Omega$ )      |
| OR3   | 39.99 K $\Omega$ | R4(10K $\Omega$ )     |
| OR4   | 399.9 K $\Omega$ | $R1/R3(=100K \Omega)$ |
| OR5   | 3.999 M $\Omega$ | $R1/R2(=1M \Omega)$   |
| OR6   | 39.99 M $\Omega$ | R1(10M $\Omega$ )     |

#### 电流测量

电流测量模式有三种量程选择:

| Mode             | Range Selection | Full Scale    |
|------------------|-----------------|---------------|
| Automatic Mode 1 | $\mu$ A         | 399.9 $\mu$ A |
|                  |                 | 3999 $\mu$ A  |
| Automatic Mode 2 | mA              | 39.99 mA      |
|                  |                 | 399.9 mA      |
| Manual Mode      | A               | 39.99 A       |

当电流模式在 $\mu$ A、mA 和 A 之间转换时, 原来的交/直流状态保持不变。



*通断检测*

通断检测与电阻测量模式(手动模式)下 399.9Ω 量程是相同的。如果条形数≤3, BUZOUT 引脚会产生 2.0KHz 的信号; 如果条形数>=4, 不会有声音信号输出。

*二极管测量*

使用电压测量模式(手动模式)直流电压 3.999V 的量程。如果测试线路是开路, 或者在测试情况下, 二极管两端的电压降超过 2V, LCD 显示“OL”, 但条形将显示实际检测电压。

*频率计数器*

ES51960 的时基是从时钟振荡器获得的, 计数器的时基是

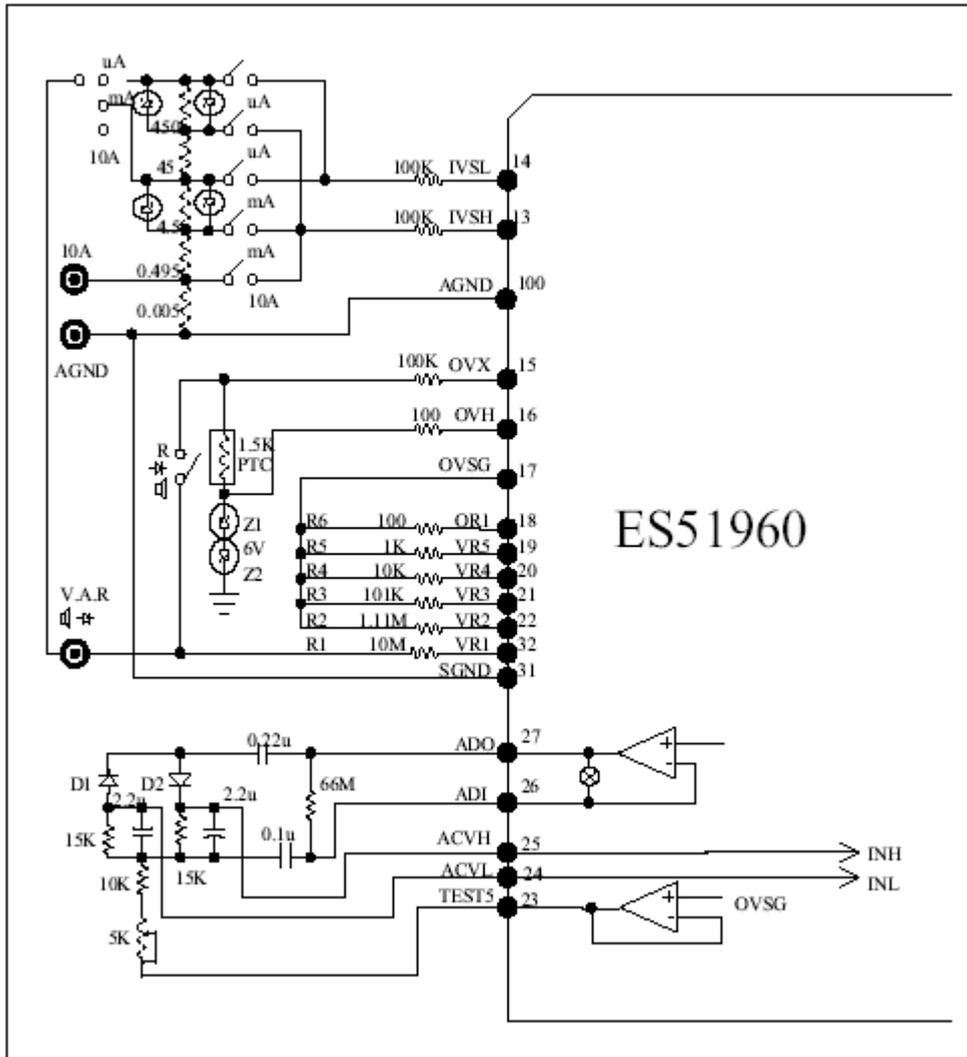
$$T_{\text{counter}} = \frac{F_{\text{osc}}}{4000000}$$

这样, 当使用 4MHz 的振荡器时, 计数器以 1 秒的时基工作。对于精确的频率测量, 推荐用晶振。频率计数器可以自动或手动选择合适的量程。自动量程操作可以从 1Hz 扩展到 399.9MHz。

| Range | Full Scale |
|-------|------------|
| FR1   | 3.999 KHZ  |
| FR2   | 39.99 KHZ  |
| FR3   | 399.9 KHZ  |
| FR4   | 3.999 MHZ  |
| FR5   | 39.99 MHZ  |
| FR6   | 399.9 MHZ  |



模拟开关选择



注释:

1. 多数引脚是受 ESD 保护线路保护的, 然而因为附加效应必须减少, 所以引脚 V+, V、AGND、DGND、VR1 就没有受到足够的保护。因此汇编、传送和保持需要足够的外部保护。另外, 与这些未受保护的引脚相连接的组件必须在 IC 焊接之前就焊接在板上。
2. Z1、Z2、D1、D2 引脚光屏蔽。

(2) 转换说明

旋转模式: FC1, FC2, FC3, FC4, FC5

测量模式依赖 FC1, FC2, FC3, FC4, FC5 和 KEY 的逻辑电平。

当 FC5=1 时, 测量模式如下表所示:

| FC1 | FC2 | FC3 | FC4 | Mode       | Push mode(KEY)                |
|-----|-----|-----|-----|------------|-------------------------------|
| 1   | 1   | 0   | 0   | DC V       | DC V — AC V                   |
| 1   | 1   | 1   | 0   | DC uA      | DC uA — AC uA                 |
| 1   | 1   | 0   | 1   | DC mA      | DC mA — AC mA                 |
| 1   | 1   | 1   | 1   | DC A       | DC A — AC A                   |
| 0   | 1   | 1   | 1   | $\Omega$   | $\Omega$ — Continuity         |
| 0   | 1   | 1   | 0   | Continuity | Continuity — Diode            |
| 1   | 0   | 1   | 1   | $\Omega$   | $\Omega$ — Continuity — Diode |
| 1   | 0   | 1   | 0   | Frequency  |                               |

当 FC5=0 时, KEY 无效。

| FC1 | FC2 | FC3 | FC4 | Mode       |
|-----|-----|-----|-----|------------|
| 1   | 1   | 0   | 0   | ACV        |
| 1   | 1   | 1   | 0   | AC uA      |
| 1   | 1   | 0   | 1   | AC mA      |
| 1   | 1   | 1   | 1   | ACA        |
| 0   | 1   | 1   | 1   | $\Omega$   |
| 0   | 1   | 1   | 0   | Continuity |
| 1   | 0   | 1   | 1   | Diode      |
| 1   | 0   | 1   | 0   | Frequency  |

ADP 模式下

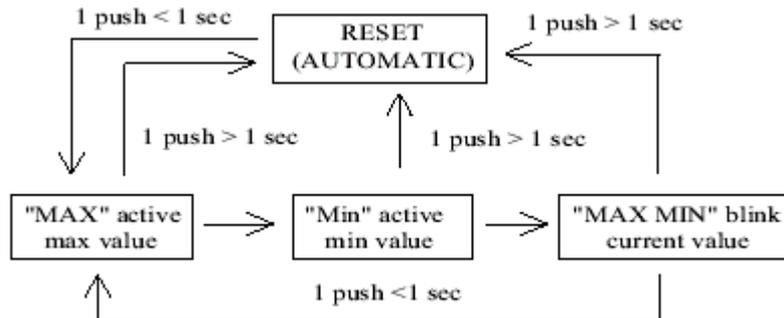
- (1) FC5=1, 当输入值溢出时, 蜂鸣器发出声响。
- (2) FC5=0, 当输入值溢出时, 蜂鸣器不发声。

| FC1 | FC2 | FC3 | FC4 | Mode         |
|-----|-----|-----|-----|--------------|
| 0   | 1   | 0   | 1   | ADP0         |
| 1   | 0   | 0   | 1   | ADP1         |
| 0   | 0   | 1   | 1   | ADP2         |
| 0   | 0   | 0   | 1   | ADP3         |
| 0   | 1   | 0   | 0   | ADP0(no bar) |
| 1   | 0   | 0   | 0   | ADP1(no bar) |
| 0   | 0   | 1   | 0   | ADP2(no bar) |
| 0   | 0   | 0   | 0   | ADP3(no bar) |



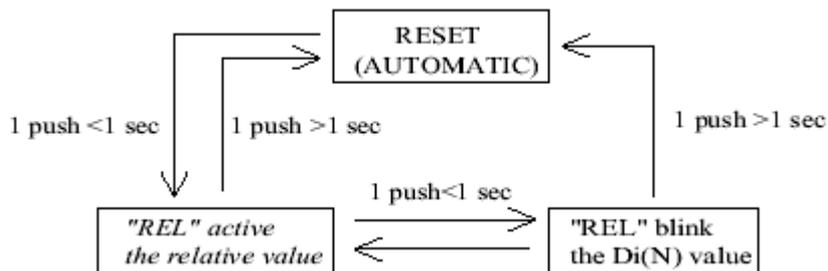
按键模式

最大/最小值



- (1) 如果最大/最小值锁定功能是有用的, 那么 REL 功能无效; 或者如果 REL 功能有效, 那么最大/最小值锁定功能无效。
- (2) 顺序是最大值, 最小值, 当前值。

相对值



\* 当 REL 功能有效时:

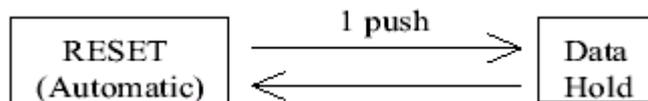
$$\text{显示} = D_i(N+K) - D_i(N), K=0,1,2,3,\dots$$

$D_i(N)$  :输入读数。

$D_i(N+K)$ : 下一个 K 步输入读数。

\* 如果输入值  $D_i(N)$  或  $D_i(N+K)$  ( $\pm 4000$ ), 相对值将显示“0L”。

锁定

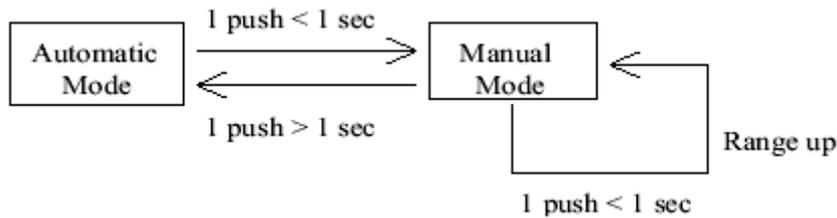


- (1) 在自动模式下, 按锁定功能, 模式将切换到手动模式并停留在相同的量程。
- (2) 如果锁定功能有效, 最大/最小值、相对值功能就无效。但如果先按最大/最小值、相对值功能, 锁定功能仍然是有效的。
- (3) 如果持续按住 HOLD 引脚(低电平), 接通 ES51960, 所有段闪烁直到释放 HOLD 脚。



量程

自动模式和手动模式的选择是由 RANGE 引脚决定的。下图是自动模式和手动模式的操作流程图：



\* 如果锁定、最大/最小值、相对值功能有效，当按下量程功能时，锁定、最大/最小值、相对值功能清除。

\* 条形不受锁定、最大/最小值、相对值功能影响。

| Function                     | Auto      | Manual  | Control Range             | Initial Range                   |
|------------------------------|-----------|---|---------------------------|---------------------------------|
| Voltage (AC/DC)              | R1 – R5   | R <sub>i</sub> → R <sub>i+1</sub><br>(R5→R1)    | 399.9mV<br> <br>3999V     | 399.9mV(DC)<br>3.999V (AC)      |
| uA(AC/DC)                    | R1 – R2   | R <sub>i</sub> → R <sub>i+1</sub><br>(R2→R1)    | 399.9uA<br> <br>3999uA    | 399.9uA                         |
| mA(AC/DC)                    | R1 – R2   | R <sub>i</sub> → R <sub>i+1</sub><br>(R2→R1)    | 39.99mA<br> <br>399.9mA   | 39.99mA                         |
| A(AC/DC)                     | Fix       | Fix   | 39.99A                    | 39.99A                          |
| Ω                            | R1 – R6   | R <sub>i</sub> → R <sub>i+1</sub><br>(R6→R1)    | 399.9Ω<br> <br>39.99MΩ    | "OL"<br>399.9 Ω                 |
| Continuity                   | Fix       | Fix   | 399.9Ω                    | "OL"<br>399.9 Ω                 |
| Diode                        | Fix       | Fix   | 3.999V                    | "OL"<br>3.999V                  |
| Frequency                    | FR1 – FR6 | FR <sub>i</sub> →FR <sub>i+1</sub><br>(FR6→FR1) | 3.999KHZ<br> <br>399.9MHZ | 3.999MHZ                        |
| ADP0<br>ADP1<br>ADP2<br>ADP3 | Fix       | Fix   | NOTE                      | XXXX<br>XXX.X<br>XX.XX<br>X.XXX |



*自动关机功能*

一旦打开 ES51960, 自动关机功能就是有效的。如果某项功能在 30 分钟内未改变, 就会发生自动关机现象, 并且 SLEEP 引脚输出将在+3V~-3V 范围内改变。当发生关机现象时, 最后的数据会保存起来。当持续按住任意功能引脚(HOLD 引脚除外)时, 都可以打开 ES51960, 自动关机功能无效, LCD 段“AP0”关闭。

*BKLIT*

当按下 BKLIT 引脚时, BKOUT 引脚输出将在范围内变化持续 60 秒, 然后再自动返回到 V-, 但如果在 60 秒内再次按 BKLIT 引脚, 这个功能会取消。

*睡眠模式*

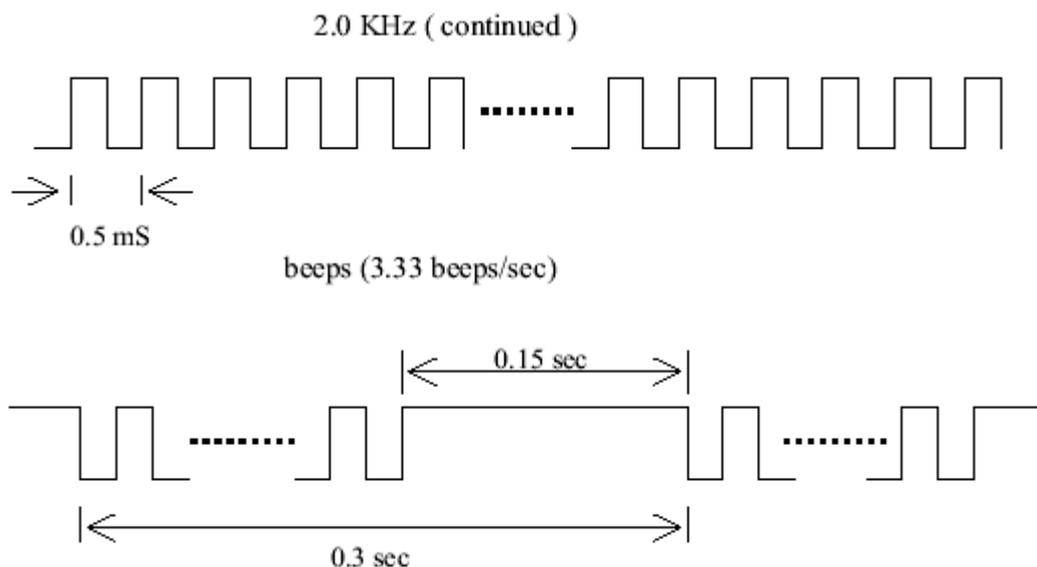
当发生自动关机时, SLEEP 引脚输出将会在 V+ ~ V- 之间变化, 一旦发生重新开机现象, SLEEP 引脚输出将会在 V+ ~ V- 之间变化。

(3) BUZZER

*蜂鸣器发声的条件:*

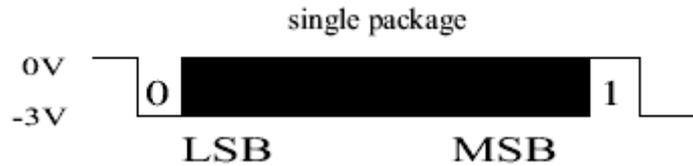
- \* 鸣叫一声: 改变测量模式, 按下开机、重新开机、RANGE、HOLD、MAX/MIX、REL、SET、BKLIT、KEY 功能引脚会发出一声鸣叫。
- \* 鸣叫 3.3 声: 输入读数超过量程(除了用二极管、电阻、通断检测、频率功能外)
- \* 以 2.0KHz 的频率持续鸣叫: 通断检测 (条形数 <= 3 )
- \* 以 2.0KHz 的频率持续鸣叫 1.5 秒: 自动关机

*BUZZER 输出波形*

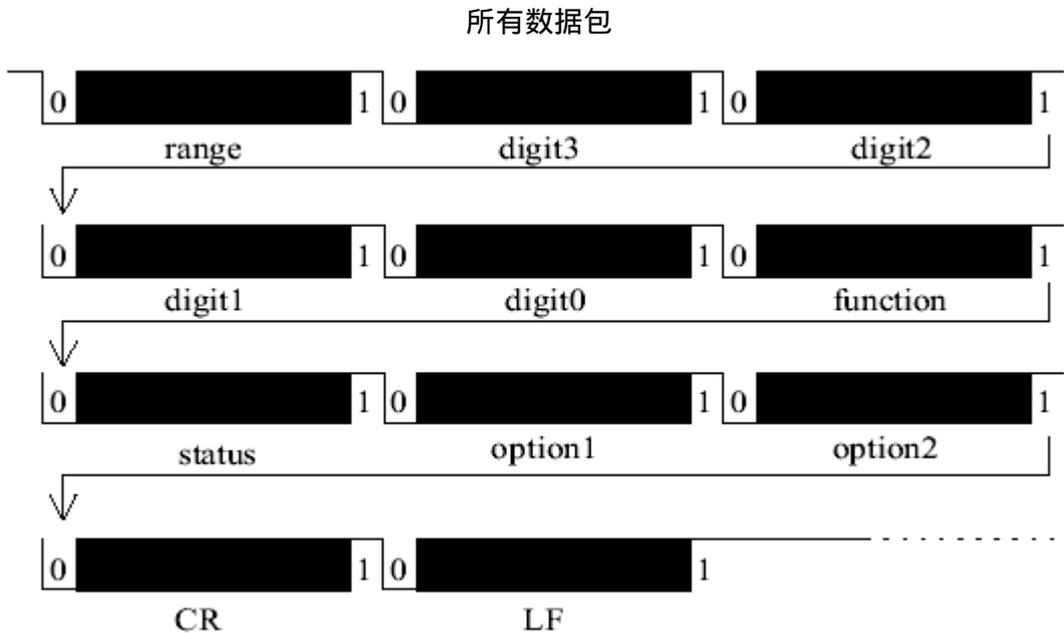


(4) 串行数据输出

在每个 A/D 转换周期里, 串行数据从 SDO 引脚输出两次。数据格式要满足 JIS 7 位传输码, 其波特率为 2400。也就是说, 接收器终端可以使用 RS232 接口读取数据。



一个数据包包括一个起始位 (0), 7 个数据位(D0~D6), 一个奇偶校验位(奇数)和一个终止位(1)。所有数据流是由 110 × 2 位组成的。



数字 0 到数字 3 正是接收器显示的数字, 但状态、功能、量程、选项 1 和选项 2 的所有需要写入程序的数据需要判断数据的含义。

注释: LSB 位首先被发送, 然后是 MSB 位被发送。

RS232 总是输出当前测量值。当自动关机时, 不会输出最后的数据。



RANGE

| Range   | V     | mA    | uA     | Ohm      | Frequency |
|---------|-------|-------|--------|----------|-----------|
| 0110000 | 400mV | 40mA  | 400uA  | 400 Ohm  | 4K HZ     |
| 0110001 | 4V    | 400mA | 4000uA | 4K Ohm   | 40K HZ    |
| 0110010 | 40V   |       |        | 40K Ohm  | 400K HZ   |
| 0110011 | 400V  |       |        | 400K Ohm | 4M HZ     |
| 0110100 | 4000V |       |        | 4M Ohm   | 40M HZ    |
| 0110101 |       |       |        | 40M Ohm  | 400M HZ   |

因为通断检测、二极管、电流、ADP 测量范围是固定的, 所以它们的起始代码都是 0110000。

数字 0~3:

| Digit   | Display data |
|---------|--------------|
| 0110000 | 0            |
| 0110001 | 1            |
| 0110010 | 2            |
| 0110011 | 3            |
| 0110100 | 4            |
| 0110101 | 5            |
| 0110110 | 6            |
| 0110111 | 7            |
| 0111000 | 8            |
| 0111001 | 9            |

如果输入值超过量程(OL), 读数据 DIGIT3=4, DIGIT2=0, DIGIT1=0, DIGIT0=0,但在频率模式下, DIGIT0~3 输出测量值。

功能: 定义码不同于 FC 1 ~ FC 5。

| Function | Measurement mode |
|----------|------------------|
| 0111111  | A                |
| 0111110  | uA               |
| 0111101  | mA               |
| 0111100  | Voltage          |
| 0110111  | Ω                |
| 0110110  | Continuity       |



|         |           |
|---------|-----------|
| 0111011 | Diode     |
| 0111010 | Frequency |
| 0110101 | ADP0      |
| 0111001 | ADP1      |
| 0110011 | ADP2      |
| 0110001 | ADP3      |
| 0110100 | ADP0*     |
| 0111000 | ADP1*     |
| 0110010 | ADP2*     |
| 0110000 | ADP3*     |

在 ADP 模式下，不显示条形。

状态：

|      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|
| 0    | 1    | 1    | -    | BATT | ACOL | OL   |
| BIT7 | BIT6 | BIT5 | BIT4 | BIT3 | BIT2 | BIT1 |

-: “1”代表负号。

BATT: “1”代表电池电压低于  $2.3V \pm 0.2V$ 。

OL: “1”代表输入电压超过量程。

ACOL: “1”代表在交流模式下，输入信号的偏移值太大。

选项1:

|      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|
| 0    | 1    | 1    | 0    | 0    | 0    | 0    |
| BIT7 | BIT6 | BIT5 | BIT4 | BIT3 | BIT2 | BIT1 |

选项2:

|      |      |      |       |      |      |      |
|------|------|------|-------|------|------|------|
| 0    | 1    | 1    | DC/AC | AUTO | MAN  | APO  |
| BIT7 | BIT6 | BIT5 | BIT4  | BIT3 | BIT2 | BIT1 |

DC/AC: “1”代表直流模式和电阻、二极管、通断检测、ADP、频率功能，“0”代表交流模式

AUTO: “1”代表自动量程。

MAN: “1”代表手动量程。

APO: “1”代表自动关机功能有效。

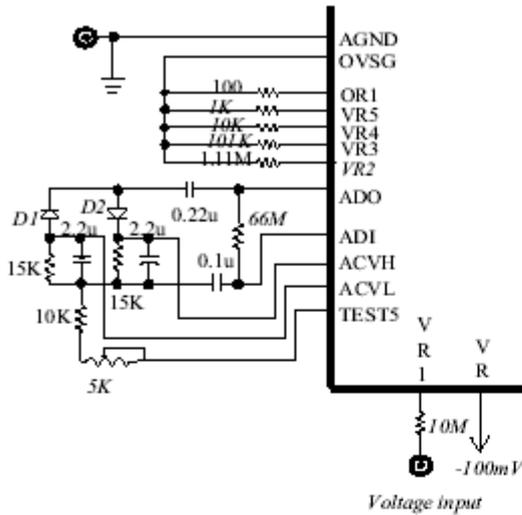
CR(BACK):传输码是“0001101”。

LF(LINE FEED): 传输码是“0001010”。

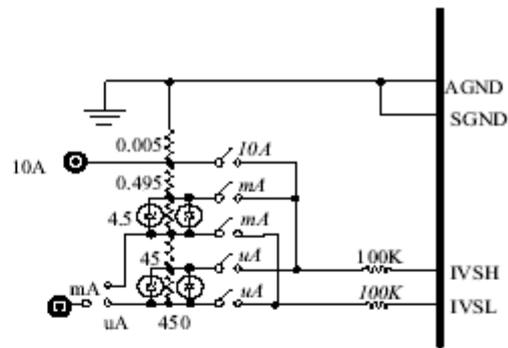


测试线路图

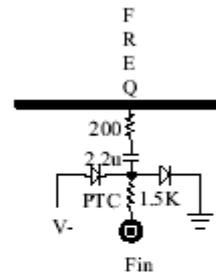
1 Voltage test



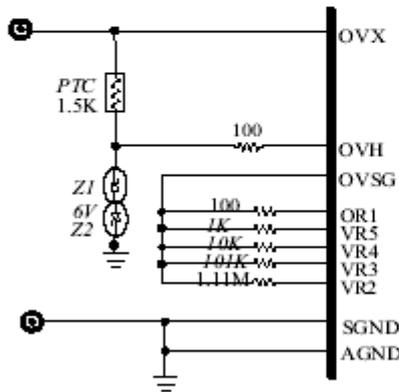
4 Current test



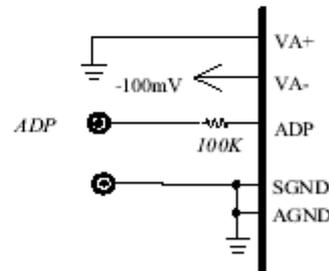
5 Frequency test



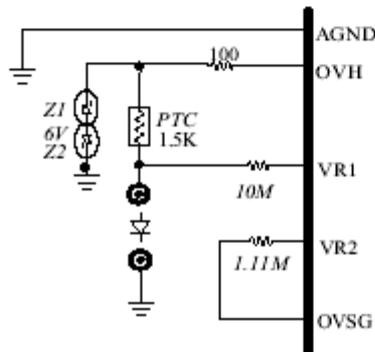
2 Resistor test



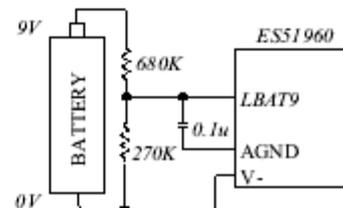
6 ADP test



3 Diode test

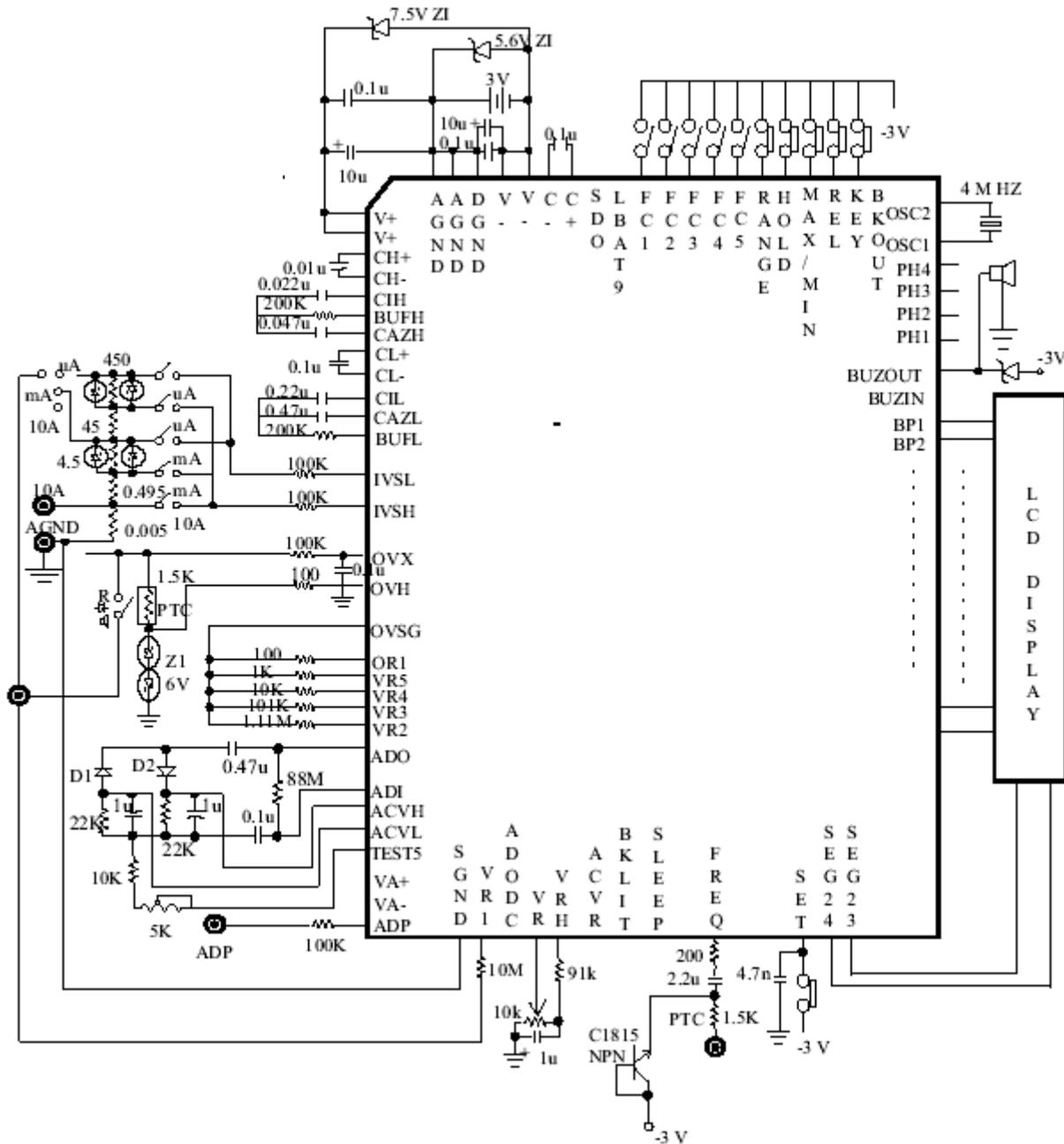


7 Low battery test(9V)





应用线路图





其他

(1) LCD 引脚分配

|     | SEG1  | SEG2 | SEG3 | SEG4 | SEG5 | SEG6 | SEG7  |
|-----|-------|------|------|------|------|------|-------|
| BP1 | RS232 | bar2 | bar4 | bar6 | bar8 | bar9 | bar11 |
| BP2 | bar0  | bar1 | bar3 | bar5 | bar7 | d3   | bar10 |
| BP3 | bar-  | —    | AUTO | MANU | e3   | g3   | c3    |
| BP4 | DC    | BATT | f3   | AC   | AP0  | a3   | b3    |

|     | SEG8  | SEG9  | SEG10 | SEG11 | SEG12 | SEG13 | SEG14 |
|-----|-------|-------|-------|-------|-------|-------|-------|
| BP1 | bar13 | bar15 | bar16 | bar18 | bar20 | bar22 | bar24 |
| BP2 | bar12 | bar14 | d2    | bar17 | bar19 | bar21 | bar23 |
| BP3 | p3    | e2    | g2    | c2    | px    | p2    | e1    |
| BP4 | REL   | f2    | a2    | b2    | HOLD  | MAX   | f1    |

|     | SEG15 | SEG16 | SEG17 | SEG18 | SEG19 | SEG20 | SEG21 |
|-----|-------|-------|-------|-------|-------|-------|-------|
| BP1 | bar25 | bar27 | bar29 | bar31 | bar32 | bar34 | bar36 |
| BP2 | d1    | bar26 | bar28 | bar30 | d0    | bar33 | bar35 |
| BP3 | g1    | c1    | p1    | e0    | g0    | c0    | M     |
| BP4 | a1    | b1    | MIN   | f0    | a0    | b0    | u     |

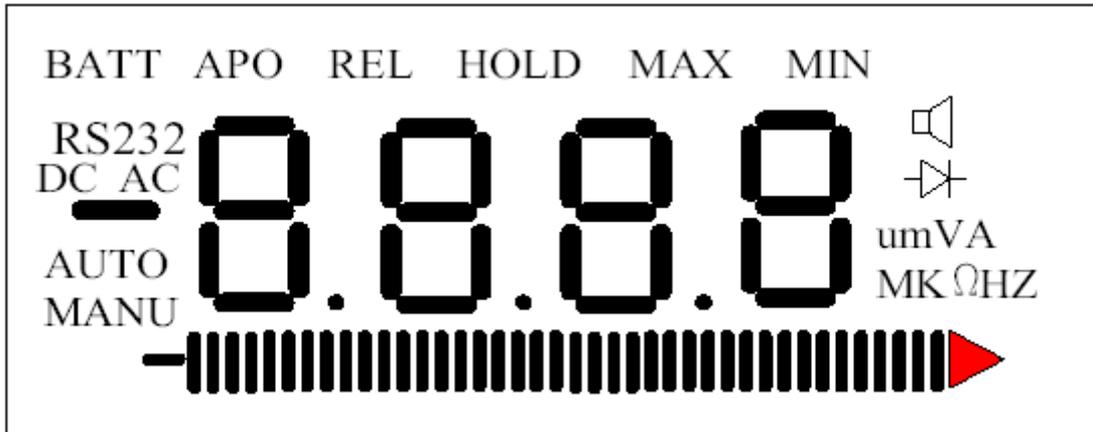
|     | SEG22 | SEG23 | SEG24 |
|-----|-------|-------|-------|
| BP1 | bar38 | bar40 | HZ    |
| BP2 | bar37 | bar39 | Ω     |
| BP3 | K     | V     | A     |
| BP4 | m     |       |       |

注释:

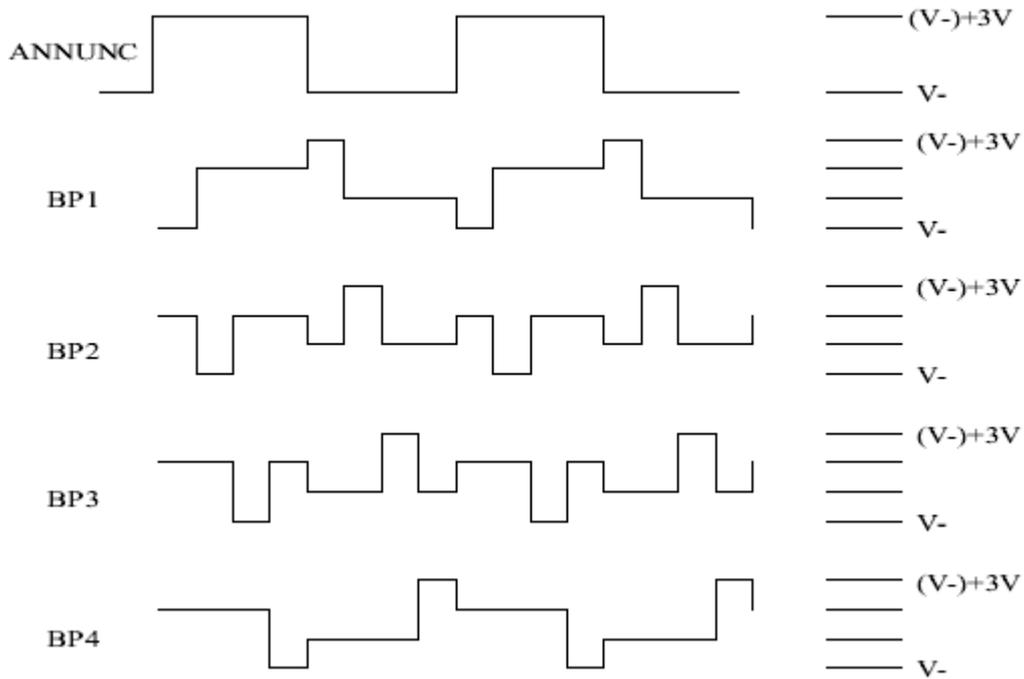
1. “bar0” 通常是打开的。
2. 当用 ADP1 功能时, “p1” 是打开的。
3. 当用 ADP2 功能时, “p2” 是打开的。
4. 当用 ADP3 功能时, “p3” 是打开的。
5. “px” 总是关闭的(不使用)。
6. 当 SDO 功能有效时(选项), RS232 是打开的。



LCD 全图



底板波形(频率=62.5Hz)





(2) 接通状态时 LCD 显示

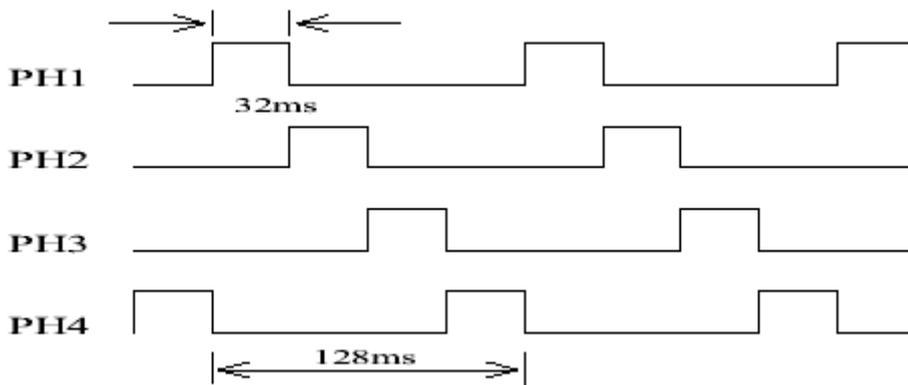
| LCD Annunciator |  |
|-----------------|--|
| "BATT"          | Low battery is detected.                               |
| "DC"            | DC voltage and DC current functions are used.          |
| "AC"            | AC voltage and AC current functions are used.          |
| "_."            | DC voltage and current function.                       |
| "AUTO"          | Automatic mode is used.                                |
| "MANU"          | Manual mode is used.                                   |
| "REL"           | REL function is used.                                  |
| "HOLD"          | HOLD function is used.                                 |
| "MAX"           | MAX function is used.                                  |
| "MIN"           | MIN function is used.                                  |
| "Ω" & "Ω"       | Continuity-check is used.                              |
| "▶" & "V"       | Diode measurement is used.                             |
| "mV"            | AC/DC voltage function is used.                        |
| "umA"           | AC/DC current function is used.                        |
| "MKΩ"           | Ω measurement function is used.                        |
| "MKHZ"          | Frequency counter is used.                             |
| "APO"           | Auto-power-off function is used.                       |
| "RS232"         | Serial data output is used.                            |
| Bargraph        | Bargraph annunciator is only depend on input reading . |



(3) 交流电压下直流偏移值

通常当我们测量交流电压时, 交流电压是偏向直流电平的。当偏压太大时, 测量值就不正确。有一种方法可以提醒用户注意这种情况。当发生上述情况时, 连接 ADODC (引脚 33)到-3V, LCD 符号“dc”闪烁, 并显示“OL”, 用户可以按 RANGE 引脚进入下一个量程并得到一个适当的值。如果这种功能是有效的, 用户也可以从 RS232 输出格式(状态)读这个条件。

(4) PH1、PH2、PH3、PH4 四个相位输出



(5) 高解析度和高速率(条形)时间

| Mode  | High Resolution        |                         | High Speed             |                         |
|-------|------------------------|-------------------------|------------------------|-------------------------|
|       | Current(I) Measurement | Other Measurement (V,R) | Current(I) Measurement | Other Measurement (V,R) |
| ZI    | 100m sec               | 100m sec                | 10m sec                | 10m sec                 |
| AZ    | 150m sec               | 150m sec                | 15m sec                | 15m sec                 |
| INT   | 100m sec               | 100m sec                | 10m sec                | 10m sec                 |
| DEINT | 200m sec               | 400m sec                | 20m sec                | 40m sec                 |