ES51986

6000 Count AUTO DMM

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Features

- 6000 count display
- Full automatic measurement
  - *Voltage measurement
  - *Current measurement
  - *Resistor measurement
- Capacitor measurement (Auto range: 6n to 6mF)
  (**Taiwan patent no.: 453443**)
- 60MHz Frequency counter
- Range change function
- Data hold function
- MAX/MIN function
- Diode measurement
- ADP mode with external reference voltage
- Serial data output (RS232 format)
- Auto power off (10 mins) and re-power on
- Low battery detect (3V and 9V)
- 3V DC power supply
- Back light function

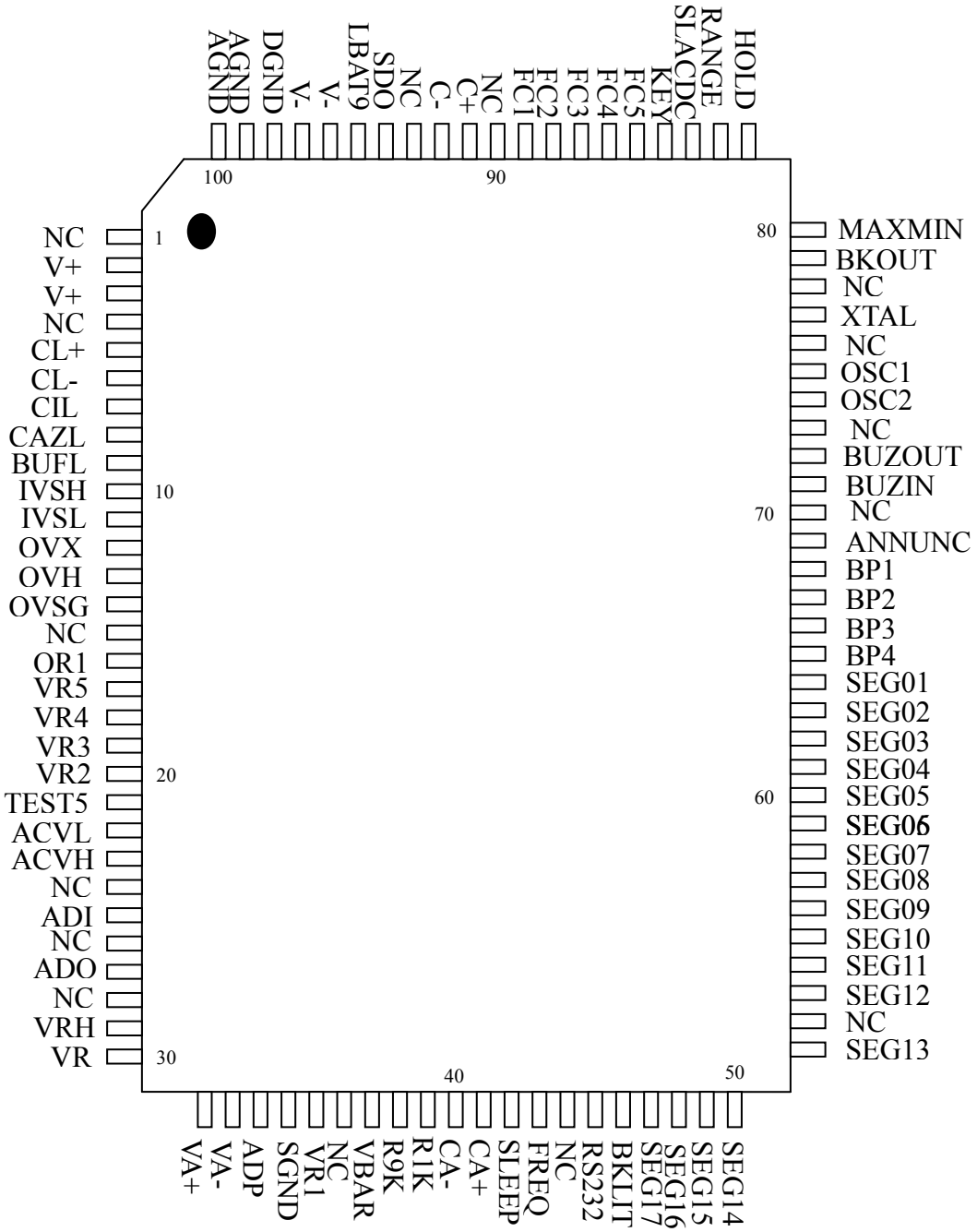
Description

ES51986 is an integrated analog-to-digital Converter(ADC) with 6000 counts LCD display ,automatic range selection, and 3V DC power supply. Automatic range selection is provided for voltage(AC/DC) measurement, resistor measurement, current measurement, capacitor measurement, frequency counter. Expensive and bulky mechanical range switches are not required. Other features include data holding, MAX and MIN holding, diode measurement, temperature measurement, continuity checking, low battery detection, auto- power off, re-power on, and RS232 data output.

Application

Digital Multimeter

Pin Assignment



Pin Description

Pin No	Symbol	Type	Description
1	**NC**		
2	V+	P	Positive supply voltage, output of on-chip DC-DC converter.
3	V+	P	Positive supply voltage, output of on-chip DC-DC converter.
4	NC		
5	CL+	IO	High resolution positive connection for reference capacitor.
6	CL-	IO	High resolution negative connection for reference capacitor.
7	CIL	O	High resolution integrator output. Connected to integral capacitor
8	CAZL	O	High resolution auto-zero capacitor connection.
9	BUFL	O	Integral resistor connection for high resolution buffer output
10	IVSH	I	High current measurement input.
11	IVSL	I	Low current measurement input
12	OVX	I	Input high voltage for resistance measurement
13	OVH	I	Output connection for resistance measurement
14	OVSG	I	Sense low voltage for resistance measurement
15	NC		
16	OR1	O	Reference resistor connection for 600.0Ω range
17	VR5	O	Voltage measurement ÷10000 attenuator(6000V)
18	VR4	O	Voltage measurement ÷1000 attenuator(600.0V)
19	VR3	O	Voltage measurement ÷100 attenuator(60.00V)
20	VR2	O	Voltage measurement ÷10 attenuator(6.000V)
21	TEST 5	I/O	Test pin
22	ACVL	O	Negative output of AC to DC converter
23	ACVH	O	Positive output of AC to DC converter.
24	NC		
25	ADI	I	Negative input of internal AC to DC Opamp.
26	NC		
27	ADO	O	Output of internal AC to DC Opamp.
28	NC		
29	VRH	O	Output of band-gap voltage reference .Typically –1.2V
30	VR	I	Reference input voltage connection. Typically –100mV
31	VA+	I	For ADP. Deintegrating voltage positive input. The input should be higher than VA-.
32	VA-		For ADP. Deintegrating voltage negative input. The input should be lower than VA+.
33	ADP	I	ADP input
34	SGND	G	Signal Ground
35	VR1	I	Measurement input
36	NC		
37	VBAR	I	In capacitance mode, a compensation capacitance is connected In temperature mode, it is used to control decimal point. See page 11
38	R9K	O	Connect to a 9KΩ resister for capacitor measurement.
39	R1K	O	Connect to a 1KΩ resister for capacitor measurement.
40	CA-	IO	Negative auto-zero capacitor connection for capacitor measurement
41	CA+	IO	Positive auto-zero capacitor connection for capacitor measurement
42	SLEEP	O	Asserts low in the sleep mode. See page 9, function description
43	FREQ	I	Frequency counter input, offset V-/2 internally by the chip.
44	NC		
45	RS232	I	Pulse low to enable serial data output.
46	BKLIT	I	Back light function. Pulse low to set BKOUT pin output
47~51	SEG17~SEG13	O	LCD segment line 17~13

…continued from previous page			
52	NC		
53~64	SEG12~SEG01	O	LCD segment line 12~01
65	BP4	O	LCD backplane 4
66	BP3	O	LCD backplane 3
67	BP2	O	LCD backplane 2
68	BP1	O	LCD backplane 1
69	ANNUNC	O	Square wave output at the backplane frequency, synchronized to BP1. ANNUNC can be used to control display annunciator. Connect an LCD segment to ANNUNC to turn it on; connect an LCD segment to its backplane to turn it off.
70	NC		
71	BUZIN	I	Enables the buzzer. Low active.
72	BUZOUT	O	Outputs an 2KHz audio frequency signal for driving piezoelectric buzzer when BUZIN is low.
73	NC		
74	OSC2	O	Crystal oscillator output connection
75	OSC1	I	Crystal oscillator input connection
76	NC		
77	XTAL	I	The chip uses internal RC oscillator if pin is connected to V-, and uses external crystal oscillator if this pin is floating or connected to DGND
78	NC		
79	BKOUT	O	If BKLIT function is enabled, this pin will change from –3V to +3V for 60 sec, once press BKLIT pin again within 60 sec, this pin will change back to –3V.
80	MAXMIN	I	Max/Min input pin. Pulse to V- to enable function.
81	HOLD	I	Pulse low to enable HOLD mode.
82	RANGE	I	Pulse low to enable manual mode and manual range selection.
83	SLACDC	I	Select AC/DC initial state. This pin is pull low. Please refer to page 10
84	KEY	I	Pulse low to change mode. In ADP mode, if this pin is connected to V-, the buzzer output will be off when the ADP input overflows.
85	FC5	I	Switch 5 for function selection.
86	FC4	I	Switch 4 for function selection.
87	FC3	I	Switch 3 for function selection.
88	FC2	I	Switch 2 for function selection.
89	FC1	I	Switch 1 for function selection.
90	NC		
91	C+	O	Positive capacitor connection for on-chip DC-DC converter.
92	C-	O	Negative capacitor connection for on-chip DC-DC converter.
93	NC		
94	SDO	O	RS232 compliant serial data output.
95	LBAT9	I	Low battery configuration. If 3V battery is used, connect it to AGND. The default low-battery threshold voltage is –2.3V. If 9V battery is used, the low battery annunciator is displayed when the voltage of this pin is less than VRH (-1.2V)
96	V-	P	Negative supply voltage. Connecting to battery negative terminal.
97	V-	P	Negative supply voltage. Connecting to battery negative terminal.
98	DGND	G	Digital ground, connected to battery positive terminal.
99	AGND	G	Analog ground.
100	AGND	G	Analog ground.

Absolute Maximum Ratings

Characteristic	Rating
Supply Voltage (V- to AGND)	-4V
Analog Input Voltage	V- -0.6 to V+ +0.6
V+	V+ ≥ (AGND/DGND+0.5V)
AGND/DGND	AGND/DGND ≥ (V- -0.5V)
Digital Input	V- -0.6 to DGND +0.6
Power Dissipation. Flat Package	500mW
Operating Temperature	0℃ to 70℃
Storage Temperature	-25℃ to 125℃

Electrical Characteristics

TA=25℃, V- = -3V

Parameter	Symbol	Test Condition	Min.	Typ.	Max	Units
Power supply	V-		-3.5	-3.0	-2.2	V
Operating supply current In DCV mode	I_{DD}	Normal operation	—	0.9	1.4	mA
	I_{SS}	In sleep mode	—	2.5	5	µA
Voltage roll-over error	REV	10MΩ input resistor	—	—	±0.1	%F.S
Voltage nonlinearity	NLV	Best case straight line	—	—	±0.1	%F.S
Input Leakage			-10	1	10	PA
Low battery flag voltage		V- to AGND	-2.5	-2.3	-2.1	V
Zero input reading		10MΩ input resistor	-000	000	+000	counts
Reference voltage and open circuit voltage for 600Ω measurement	V_{REF}	100KΩ resistor between VRH and AGND	-1.3	-1.2	-1.1	V
Peak to peak backplane drive voltage		-3.5V≤ V ≤-2.2V	2.90	3.1	3.3	V
Counter time base period		f_{OSC} = 4MHZ	—	1	—	sec
Open circuit voltage for Ω measurement (except 600Ω)		Ω and Continuity Mode	-0.54	-0.47	-0.4	V
Internal pull-high to 0V current		Between V- pin and HOLD, RANGE, KEY, FC1, FC2, FC3, FC4, FC5, XTAL, BKLIT,MAXMIN	—	1.2	—	µA
		Between V- pin and RS232	—	11	—	
Internal pull-low to V- current		Between GND Pin and SLACDC		1.5		µA
AC frequency response at 6V range 6.000V range		±1%	—	40-400	—	HZ
		±5%	—	40-2000	—	

Reference voltage temperature Coefficient	TC_{RF}	100KΩ resister Between VRH 0℃<TA<70℃	—	50	—	ppm/℃
Capacitance Measurement accuracy		6nF range	-1.5	—	1.5	%F.S
			-2	—	2	counts
		60nF – 6μF	-0.8	—	0.8	%F.S
			-2	—	2	counts
		6μF~6mF	-1.1*	—	1.1*	%F.S
			-2	—	2	counts

***The accuracy of 60uF range is 1.5% F.S**

Function Description

1. Operating Modes

1.1 Voltage Measurement

A reconfigurable voltage divider automatically provides a suitable range in voltage measurement mode. The following table summarizes the full scale ranges in each configuration.

Configuration	Full Scale Range	Divider Ratio	Resister Connection
VR1	600.0mV	1	-
VR2	6.000V	1/10	R2 / (R1+R2)
VR3	60.00V	1/100	R3 / (R1+R3)
VR3	600.0V	1/1000	R4 / (R1+R4)
VR5	6000V	1/10000	R5 / (R1+R5)

1. 600.0mV range only exist in manual mode.
2. In the 6000V range, if the digit number is larger than 1000V, LCD will display "OL".

The measurement of true RMS using ES636

If ES636 (or other true RMS-to-DC converter chip) is used for true RMS measurement, the suggested application circuit is shown in Figure 1. When ES636 is used for true RMS, make ADO and ADI pin short, keep TEST5 pin float, and connect ACVL pin to SGND. And connect OVSG pin to AGND through a switch in ACV mode.

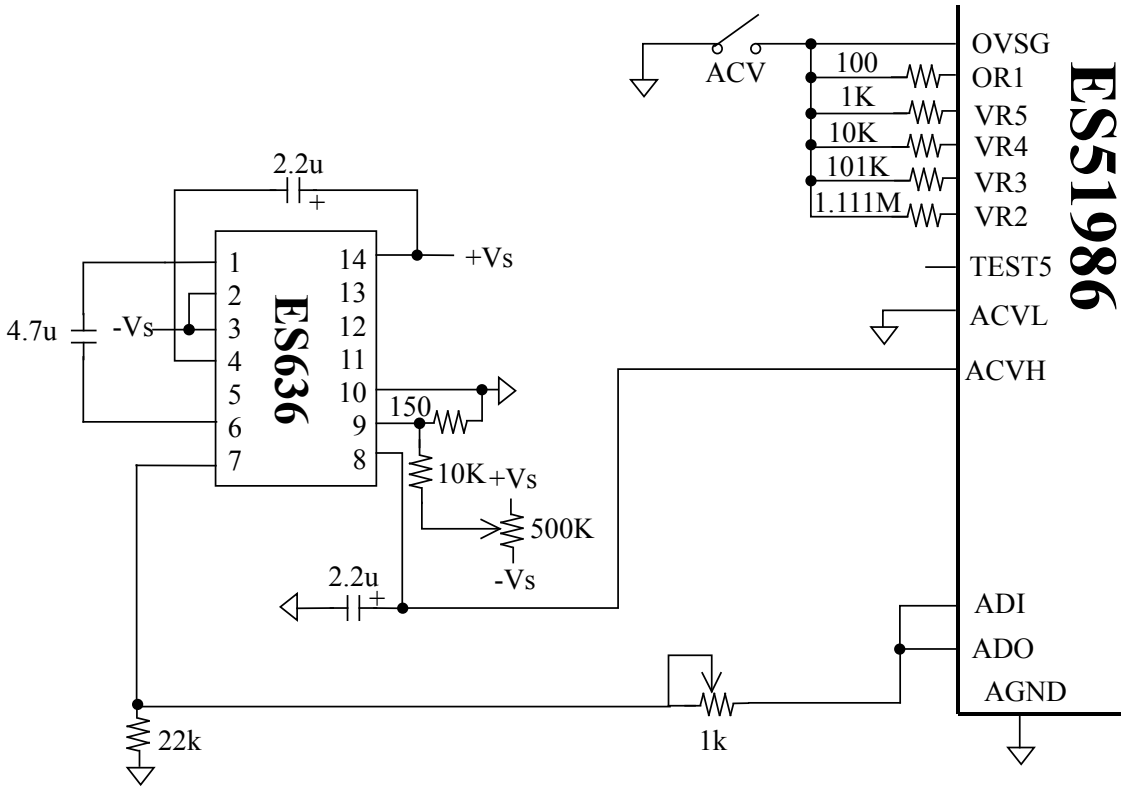


Figure 1. Ture RMS measurement using ES636

1.2 Resistance Measurement

A reconfigurable divider automatically provides a suitable full scale range in resistance measurement mode. The following table summarizes the full scale ranges and the reference resistors in each configuration.

Configuration	Full Scale Range	Divider Ratio	Resister Connection
OR1	600.0Ω	R6	100Ω
OR2	6.000KΩ	R5	1KΩ
OR3	60.00KΩ	R4	10KΩ
OR4	600.0KΩ	R1 // R3	100KΩ
OR5	6.000MΩ	R1 // R2	1MΩ
OR6	60.00MΩ	R1	10MΩ

1.3 Current measurement

Current measurement has three modes. The following table summarizes the full scale range of each mode.

Mode	Range Selection	Full Scale
Automatic Mode 1	μA	600.0μA / 6000μA
Automatic Mode 2	mA	60.00mA / 600.0mA
Automatic Mode 3	A	60.00A / 6.000A
Manual Mode	A	60.00A

1.4 Capacitance Measurement

The following table summarizes the eight ranges of capacitance measurement mode.

Configuration	Full Scale Range	Resistance Ratio
C1	6.000nF	R1
C2	60.00nF	R1 // R2
C3	600.0nF	R1 // R3
C4	6.000μF	R4
C5	60.00μF	-
C6	600.0μF	-
C7	6mF	-

Note:

1. In order to obtain an accurate reading, a capacitor must be discharged before measurement begins. The chip has a built-in discharge mode to automatically discharge the capacitor. In discharge mode, the LCD displays **DS.C**
2. Discharging through the chip is quite slow. We recommend the user to discharge the capacitor with some other apparatus.

1.5 Continuity Check

Continuity check shares the same configuration with 600.0Ω manual resistance measurement mode, but with buzzer output to indicate continuity. The buzzer generates a 2KHz sound whenever the digit number less than 25Ω. Because the cycle time of measurement is only 90ms, the least significant digit will not display.

1.6 Diode Measurement

Diode measurement mode shares the same configuration with 6.000V manual voltage measurement mode. If the test circuit is open or the voltage drop between the two ports of the device (diode) under test is larger than 2V, the LCD panel will show “OL”. The buzzer generates a 2KHz sound whenever the digit number is less than 0.25V. Because the cycle time of measurement is only 90ms, the least significant digit will not display.

1.7 Frequency counter

The time base of the frequency counter is derived from an external crystal oscillator by

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

where f_{osc} is the frequency of the crystal oscillator. Thus, the counter has a 1 second time base when a 4MHz oscillator is used. The frequency counter can select the proper range automatically or manually. Auto-range operation extends over five decades, from 6KHz to 60MHz The following table summarizes the full scale range of the frequency counter.

Range	Full Scale
FR1	6.000KHz
FR2	60.00KHz
FR3	600.0KHz
FR4	6.000MHz
FR5	60.00MHz

1.8 Auto power off

ES51986 has a default auto power off function. If the meter idles for more than 10 minutes, the chip automatically turns the power off. When this happens, the state of the meter is saved. In order to disable auto power off function, power on the meter when any of the push function, except for HOLD, is pressed down. In addition, when RS232 output is active, the auto power-off function is also disabled. The APO sign on the LCD panel indicates whether the auto power-off is enabled or not.

Note: Powering on the meter while pressing HOLD turns on all LCD segment until HOLD is pressed again.

1.9 Sleep

The meter enters sleep mode after auto power off. The SLEEP pin asserts low (-3V) in the sleep mode, and asserts high (+3V, not 0V) after re-power on.

1.10 Re-power on

After auto power-off, pushing any of the push function or changing the rotary mode can turn on the meter again. If the meter is re-powered on by changing the rotary mode, the saved state is cleared. If the meter is re-powered on by push functions, the chip restores the saved state and enters HOLD mode. The LCD displays the saved value.

2. Measurement Mode Switching

Measurement mode depends on the logic level of FC1, FC2, FC3, FC4, FC5, and KEY. When FC5 is HIGH, the measurement modes are listed in the following table.

SLACDC	FC1	FC2	FC3	FC4	Mode	Function of KEY
0	1	0	1	1	Voltage Measurement	DCV(initial) ↔ACV
0	1	1	0	1	Current Measurement(μA)	DCA(initial) ↔ACA
0	1	1	1	1	Current Measurement(mA)	DCA(initial) ↔ ACA
0	1	0	0	1	Manual Current Measurement(A)	DCA (initial) ↔ACA
0	0	0	0	0	Auto Current Measurement(A)	DCA (initial)
1	1	0	1	1	Voltage Measurement	ACV (initial) ↔DCV
1	1	1	0	1	Current Measurement(μA)	ACuA(initial) ↔DCuA
1	1	1	1	1	Current Measurement(mA)	ACmA (initial) ↔DCmA
1	1	0	0	1	Manual Current Measurement(A)	ACA (initial) ↔DCA
1	0	0	0	0	Auto Current Measurement(A)	ACA (initial)
X	0	0	1	1	Resistance Measurement	Ω ↔ Continuity
X	0	1	0	1	Resistance Measurement	Ω ↔ Diode
X	0	0	0	1	Continuity Check	Continuity Diode
X	0	1	1	1	Resistance Measurement	Ω ↔ Continuity ↔Diode
X	0	0	1	0	Frequency Measurement	—
X	0	1	1	0	Capacitance Measurement	—
X	0	1	0	0	Temperature(℃)	—

Ps. X means “don’t care”

When FC5 is LOW, KEY is disable. The corresponding measurement modes are list below

SLACDC	FC1	FC2	FC3	FC4	Mode
0	1	0	1	1	AC Voltage Measurement
0	1	1	0	1	AC Current Measurement(μA)
0	1	1	1	1	AC Current Measurement(mA)
0	1	0	0	1	Manual AC Current Measurement(A)
0	0	0	0	0	Auto AC Current Measurement(A)
1	1	0	1	1	DC Voltage Measurement
1	1	1	0	1	DC Current Measurement(μA)
1	1	1	1	1	DC Current Measurement(mA)
1	1	0	0	1	Manual DC Current Measurement(A)
1	0	0	0	0	Auto DC Current Measurement(A)
X	0	0	1	1	Resistance Measurement
X	0	1	0	1	Resistance Measurement
X	0	0	0	1	Continuity Check
X	0	1	1	1	Diode Measurement
X	0	0	1	0	Frequency Measurement
X	0	1	1	0	Capacitance Measurement
X	0	1	0	0	Temperature(℉)

Ps. X means “don’t care”

1.SLACDC pin is used to set initial mode (AC or DC) for voltage and current measurement. Using SLACDC pin to switch AC or DC will not reset enabled functions like max/min, manual/auto range….etc. If you want to have reset function during the change between AC and DC, please use FC1~FC5 and KEY.

The other combinations of FC1, FC2, FC3, and FC4 are for ADP modes. In ADP modes , if FC5 is LOW, the minus sign on the LCD panel will not be displayed. And if KEY pin is floating, the buzzer beeps when the input signal is overflow. The ADP mode function is summarized below.

FC1	FC2	FC3	FC4	Mode
1	1	1	0	ADP0
1	1	0	0	ADP1
1	0	0	0	ADP2
1	0	1	0	ADP3

Note: Temperature measurement mode takes input signal from ADP pin. In temperature measurement mode, VBAR pin is used to control the right most digit point on the LCD panel. When VBAR is LOW, this digit point is displayed.

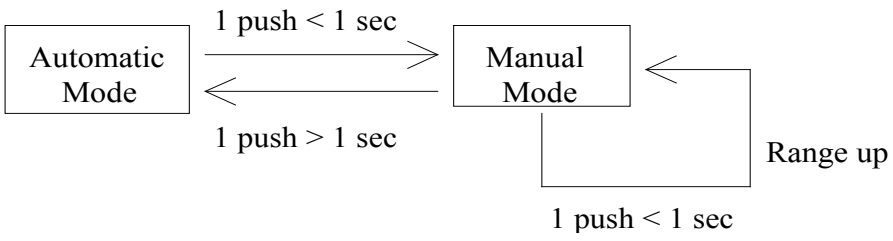
3. Push function

3.1 HOLD

HOLD mode makes the meter stop updating the LCD panel. This mode can be nested in most of the special modes. Enabling HOLD function in automatic mode makes the meter switch to manual mode, but the full scale range remains the same. HOLD function can be cancelled by changing the measurement mode, pressing RANGE, or push HOLD again.

3.2 Range

RANGE pin switches to and from automatic and manual mode, and while in manual mode, changes the full scale range. The following figure shows the state transition.



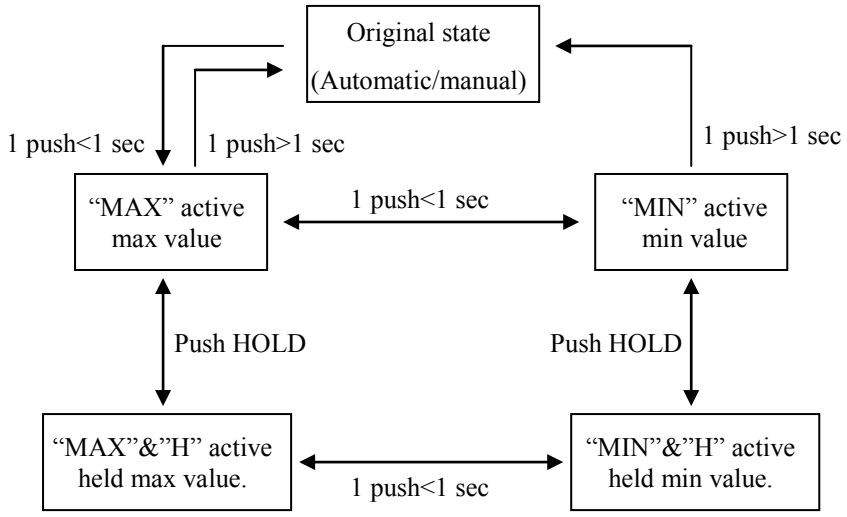
Measurement Mode	Auto	Manual	Control Range	Initial Range
V(DC/AC)	VR2 – VR5	VRi → VRi + 1, VR5 → VR1	600.0mV – 6000V	6.000V
µA(DC/AC)	R1 – R2	R1 → R2, R2 → R1	600.0µA - 6000µA	600.0µA
mA (AC/DC)	R1 – R2	R1 → R2 R2 → R1	60.00mA – 600.0mA	60.00mA
Auto A(DC/AC)	R1 – R2	R1 → R2, R2 → R1	6.000A – 60.00A	6.000A
Manual A(DC/AC)	fixed	fixed	60.00A	60.00A
Ω	OR1- OR6	ORi → ORi + 1, OR6 → OR1	600.0Ω – 60.00MΩ	600.0Ω
Capacitor	C1-C7	Ci → Ci+1, C7 → C1	6.000nF – 6.000mF	6.000nF
Continuity	fixed	fixed	600.0Ω	600.0Ω
Diode	fixed	fixed	6.000V	6.000V
Frequency	FR1 – FR5	FRi→ FRi+1 FR5→ FR1	6.000KHz – 60.00MHz	6.000KHz

Note: Pushing RANGE resets all existing special modes.

3.3 KEY

See Section “Measurement Mode Switching” for the function of this pin.

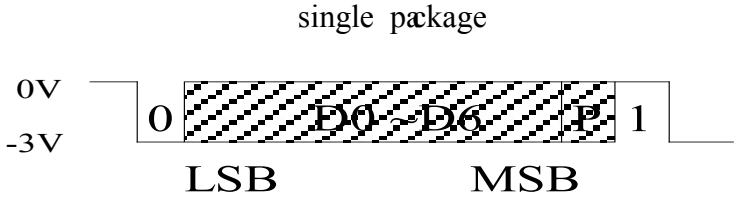
3.4 Max/Min + HOLD



The meter displays the maximum or minimum value of the input in MAX/MIN mode. When MAX/MIN is pressed for the first time, the meter displays the maximum value. When MAX/MIN is pressed again, the meter displays the minimum value. When MAX/MIN is pressed for the third time, the meter displays max value. The meter returns to normal operation if MAX/MIN is pressed and held for longer than one second. Pressing HOLD in MAX/MIN mode makes the meter stop updating the maximum or the minimum value.

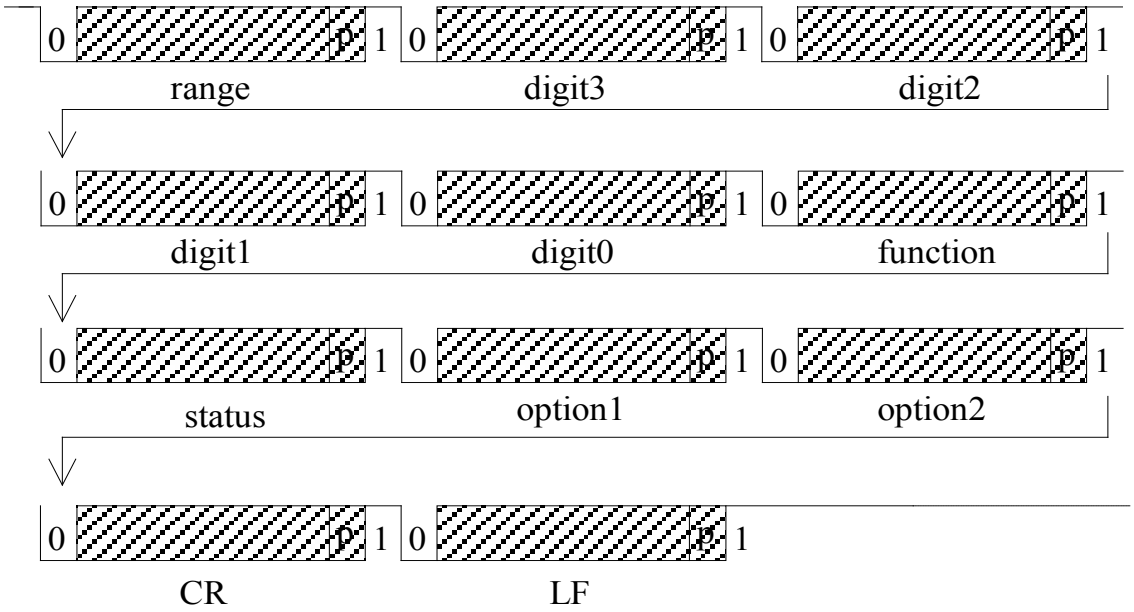
4. Serial Data Output

The serial data sent to SDO pin twice every A/D conversion cycle. The data format complies with JIS 7Bits transmission code with a baud rate of 19230. The host can use RS232 interface to read the data. A single data packet includes a start bit (always 0), 7 data bits, an odd parity check bit, and a stop bit (always 1). The high and low voltage levels correspond to DGND and V- respectively. SDO remains at 1 (high) when it is inactive. Hence the start bit (0) could be used as the triggering signal to begin the reading process. The following figure shows the data format of a single packet. The LSB is sent first and the MSB is sent last.



One data block consists of 11 packets, or 110 bits. The following figure shows the format of a data block. The range packet indicates the full scale range of the meter. Digit 3 through digit 0 are just the digits on the LCD panel. The function packet indicates the measurement mode of the meter. Status, option 1 and option 2 give the status of the meter. CR and LF are delimiters used to separate the blocks.

all package



The meter always outputs the current input value to the serial port in spite of HOLD mode. Each block is repeated twice in one conversion cycle. The detailed data format of each packet is listed below.

4.1 FUNCTUON

This packet indicates the measurement mode of the meter. The following table summarizes the transmitted code for each mode. Note that the encoding of this packet is different from the encoding of FC1-FC4 switch.

Code	Measurement Mode
0111011	Voltage
0111101	μA Current
0111111	mA Current
0110000	Auto A current
0111001	Manual A Current
0110011	Ω
0110101	Continuity
0110001	Diode
0110010	Frequency
0110110	Capacitor
0110100	1*Temperature
0111110	ADP0
0111100	ADP1
0111000	ADP2
0111010	ADP3

Note: 1*.The judge bit in the Status packet determines whether the unit is Celcius or Fahrenheit.

4.2 RANGE

This packet indicates the full scale range of the meter. When the meter operates in continuity mode, diode mode, or current (A) mode, this packet is always 0110000 since the full scale range in these modes are fixed. The following table lists the code for each range in each measurement mode.

Code	V	mA	μA	Auto A	Ω	Frequency	Capacitor
0110000	6.000V	60.00mA	600.0μA	6.000 A	600.0Ω	6.000KHz	6.000nF
0110001	60.00V	600.0mA	6000μA	60.00 A	6.000KΩ	60.00KHz	60.00nF
0110010	600.0V				60.00KΩ	600.0KHz	600.0nF
0110011	6000V				600.0KΩ	6.000MHz	6.000μF
0110100	600.0mV				6.000MΩ	60.00MHz	60.00μF
0110101					60.00MΩ		600.0μF
0110110							6.000mF

4.3 DIGIT 3 – DIGIT 0

Digit 3 is the most significant digit on the LCD panel, and digit 0 is the least significant digit. When the LCD panel shows OL, the serial port outputs 6000.

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

Because the cyle time of measurement for continuity/diode mode is only 90ms, the least significant digit may not be accurate

4.4 STATUS

The format of this shown below. The Judge field is meaningful only when the Function packet indicates Temperature mode. In Temperature mode, judge is 1 if the unit is ℃ and is 0 of the unit is ℉ . Sign field indicates whether the minus sign on the LCD panel is on or off. BATT field is one of battery low condition is true. OL indicates input overflow.

0	1	1	Judge	Sign	BATT	OL
	BIT 5	BIT 4	BIT 3	BIT 2	BIT1	BIT 0

4.5 OPTION 1

This packet is not used.

0	1	1	HOLD	MAX	MIN	0
BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT1	BIT 0

If Hold field is 1, Hold function is active. Hold function will not influence Digital 3~0 which is related to current measured value.

If MAX field is 1, MAX/MIN is active and LCD panel display max value.

If MIN field is 1, MAX/MIN is active and LCD panel display min value.

4.6 OPTION 2

This packet contains information on the operation mode of the meter. The format is shown below. The DC field indicates that the meter operates in DC measurement mode, either voltage or current. The AC field indicates that the meter operates in AC measurement mode, either voltage or current. The AUTO field is set to one if the meter operates in automatic mode, and is set to zero when the meter operates in manual mode.

0	1	1	DC	AC	AUTO	0
BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT1	BIT 0

4.7 CR

Carrage return. The transmitted code is 0001101.

4.8 LF

Line feed. The transmitted code is 0001010.

5. Miscellaneous

The conditions on which the meter turn on the buzzer include:

(1) Changing measurement mode generates one beep.

(2) Pressing any of the push junctions generates one beep, if the function is valid.

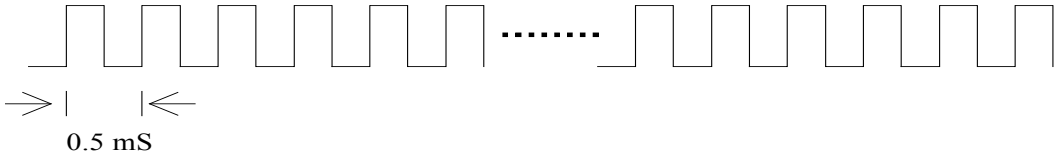
(3) Power on and re-power on generate one beep.

(4) Input overflow in voltage and current mode generates one beep every 0.3 seconds (or 3.33 beeps per second.)

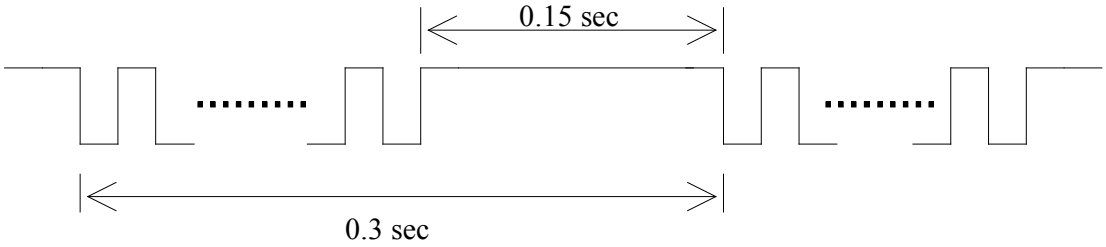
(5) Continuity(diode) check generates a continuous 2KHz beep whenever the measurement is less then 25Ω(0.25V)

(6) Auto power off generates a 2KHz beep which lasts for 1.5 seconds.

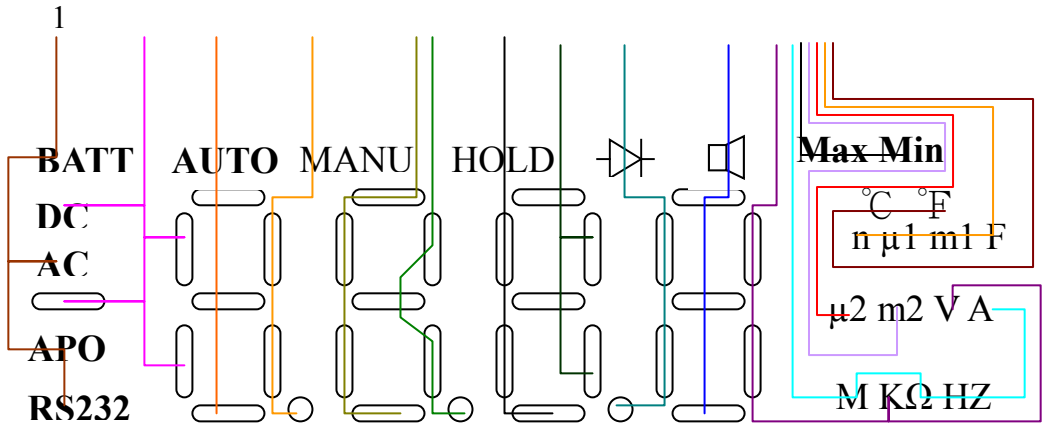
The following figures shows the output waveform from the BUZOUT pin.



(a) Continuous 2KHz beep



(b) 3.33 beep/sec

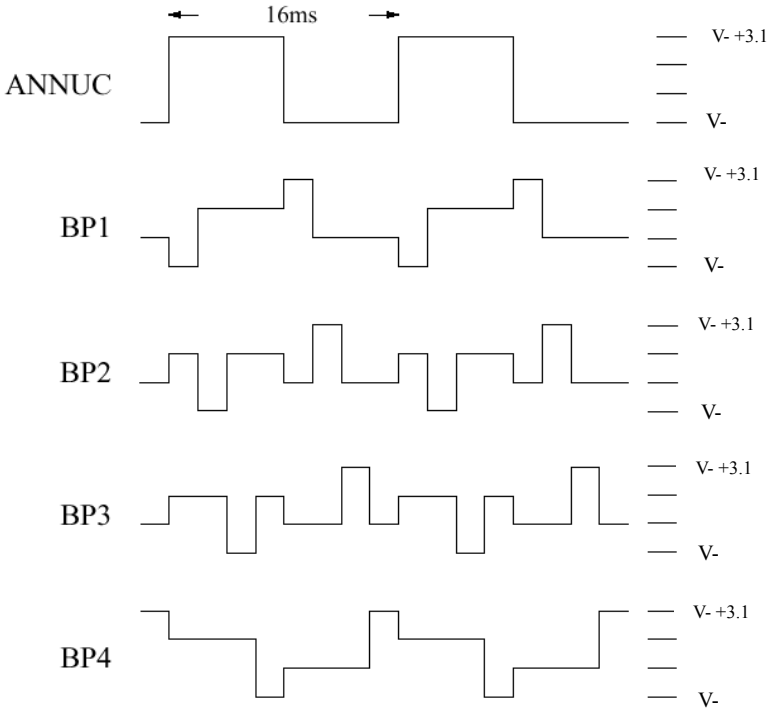


5.1 LCD Panel

	SEG01	SEG02	SEG03	SEG04	SEG05	SEG06	SEG07	SEG08
BP1	LBATT	DC	AUTO	MANU	A3	B3	HOLD	A2
BP2	AC	F4	A4	B4	F3	G3	F2	B2
BP3	APO	—	G4	C4	E3	C3	E2	G2
BP4	RS232	E4	D4	DP3	D3	DP2	D2	C2

SEG09	SEG10	SEG11	SEG12	SEG13	SEG14	SEG15	SEG16	SEG17
⊣▷⊢	◁□	V	A	MIN	m2	u2	n	℃
F1	A1	B1	M	MAX	×	×	u1	℉
E1	G1	C1	Hz		×	×	m1	×
DP1	D1	K	Ω		×	×	F	×

5.1 LCD Backplane Waveform



5.2 LCD display on condition

LCD Annunciator	Condition
V	In voltage measurement mode, and diode measurement mode.
A	In current measurement mode.
Ω	In resistance measurement mode, and continuity mode.
F	In capacitance measurement mode.
	In continuity check mode.
	In diode mode.
Hz	In frequency mode.
DC	In DC voltage or DC current mode.
AC	In AC voltage or AC current mode.
AUTO	When automatic full scale range selection is enabled.
MANU	In manual mode.
HOLD	When HOLD function is enabled.
m1	In capacitor measurement mode and the full scale range is in the order of mF.
u1	In capacitor measurement mode and the full scale range is in the order of uF.
n	In capacitor measurement mode and the full scale range is in the order of nF.
m2	In voltage or current measurement mode and the full scale range is in the order of 10^{-3}.
u2	In current measurement mode and the full scale range id in the order of uA.
M	In resistance measurement mode and the full scale range is in the order of MΩ
K	In resistance measurement mode and the full scale range is in the order of KΩ
℃	In temperature measurement mode and when the unit is ℃
℉	In temperature measurement mode and when the unit is ℉
APO	When auto power off function is enabled.
-	In voltage or current measurement mode and when the input is negative.

5.3 Operating Timing

ES51986 incorporates a dual slope ADC with four phases: ZI, AZ, INT and DINT. The timing of each phase of the two parts are listed below.

*Voltage /ohm /ADP measurement:

Phase	Time
ZI	100ms
AZ	100ms
INT	100ms
DINT	600ms

Ps. In the voltage and ohm measurement with auto mode, if the range is changed, the internal clock rate will increase ten times and the new measurement cycle becomes 1/10 times of the original cycle until the range is stable.

*Current mode

Phase	Time
ZI	100ms
AZ	100ms
INT	100ms
DINT	300ms

*Continuity/diode measurement

Phase	Time
ZI	10ms
AZ	10ms
INT	10ms
DINT	60ms

*Capacitance measurement:

Range	Total Measurement Time
6.000nF	0.9sec
60.00nF	0.9sec
600.0nF	0.9sec
6.000uF	0.9sec
60.00uF	0.9sec
600.0uF	1.8sec
6.000mF	4.5sec

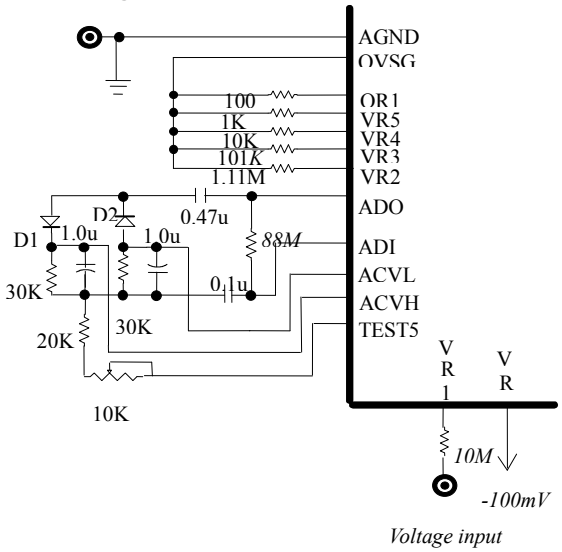
*.Frequency measurement

one measurement cycle = 1.05 sec

ps. In the frequency measurement with auto mode, if the range is changed, the internal clock rate will increase ten times and the new measurement cycle becomes 1/10 times of the original cycle until the range is stable.

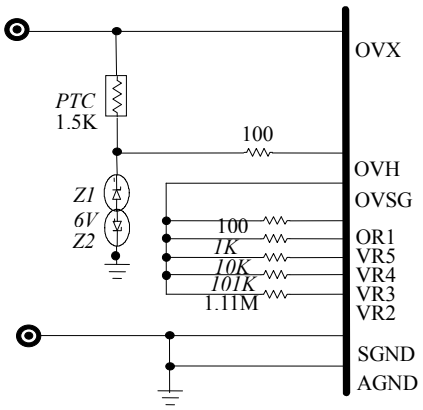
6. Test circuit

1. Voltage test

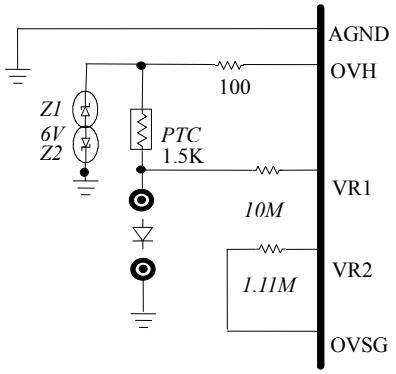


Voltage input

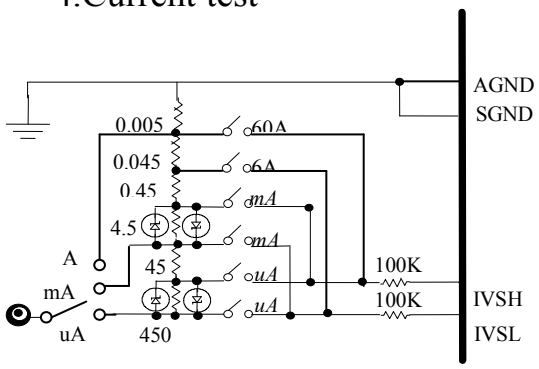
2.Resistor test



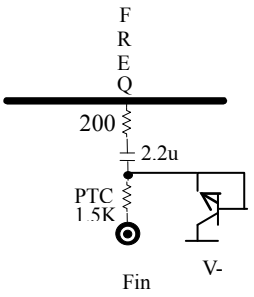
3.Diode test



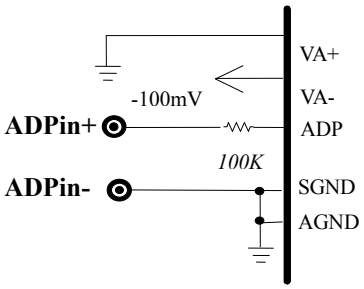
4.Current test



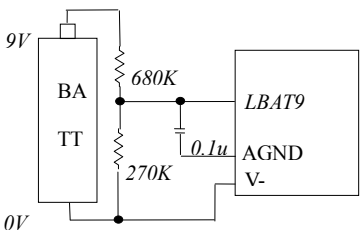
5.Frequency test



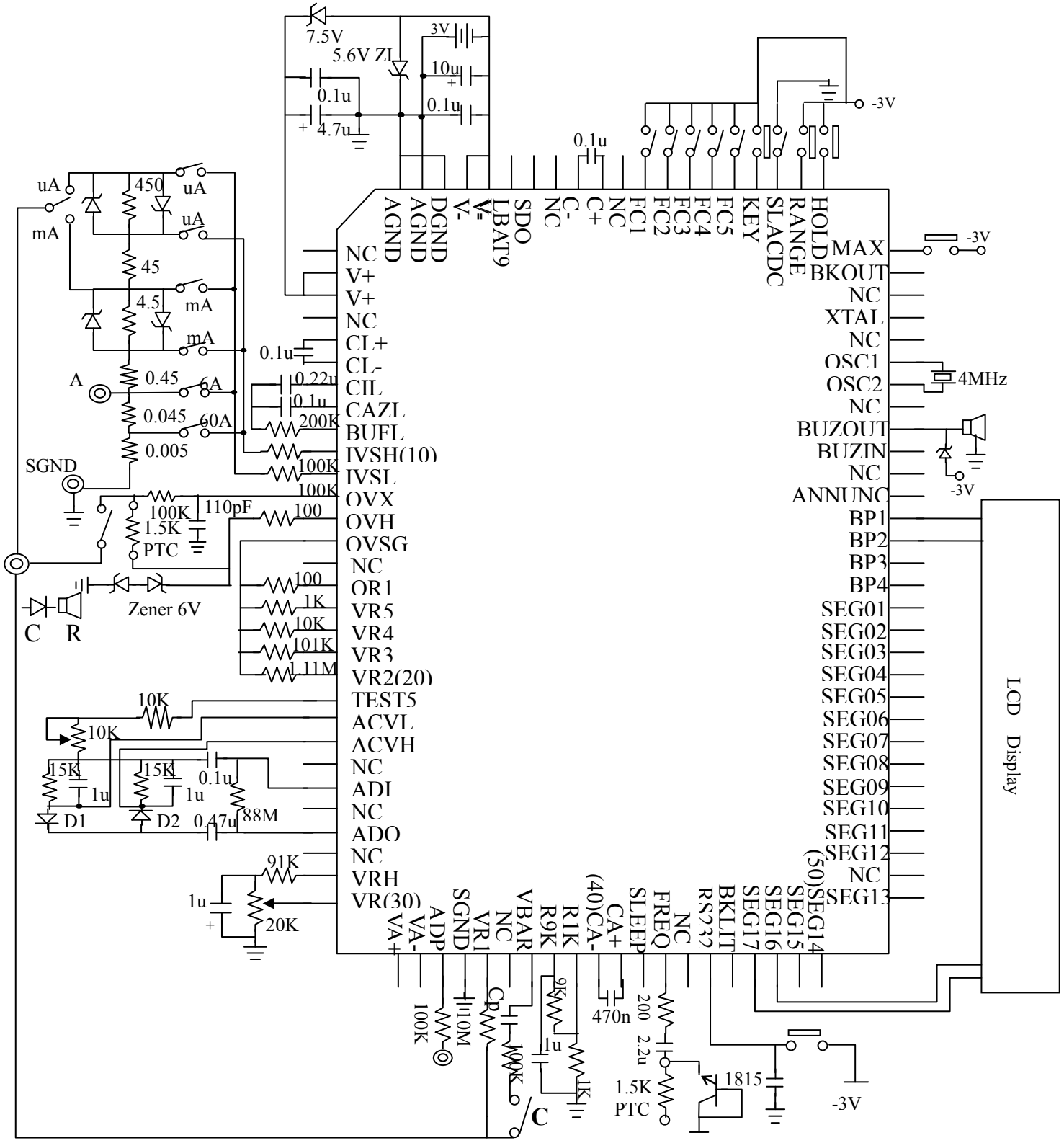
6.ADP test



7. Low battery



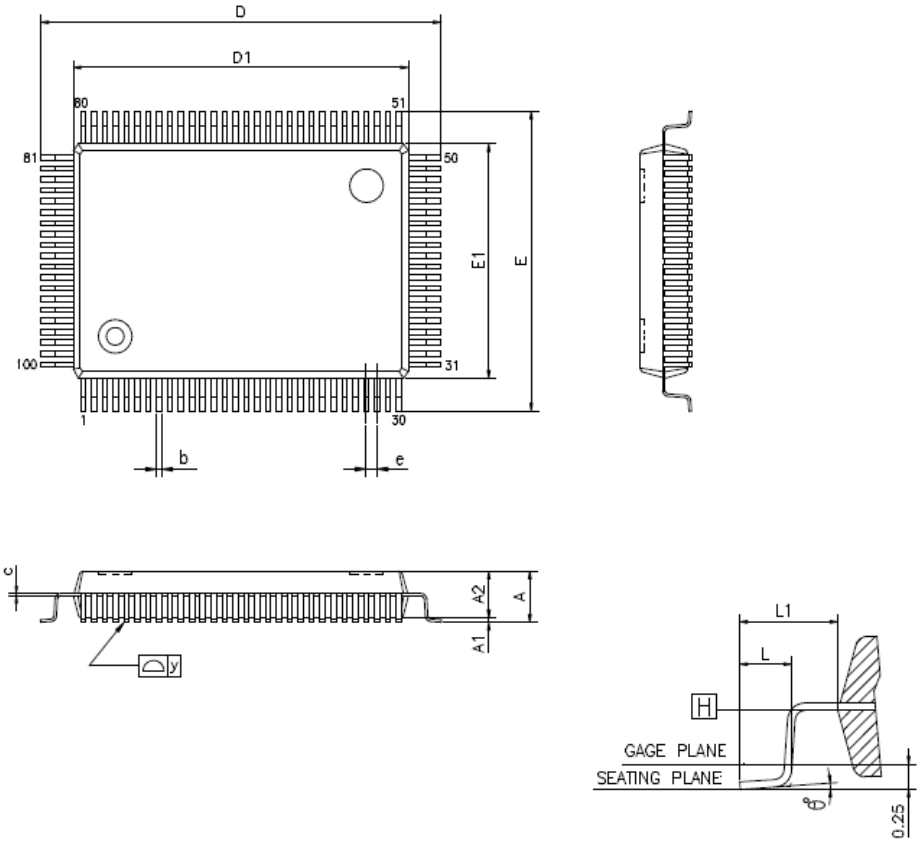
7. Application circuit



Note: In order to prevent IC from damaging by inappropriate operation, the Zener diodes **MUST** be required as protection.

Package

1 100 Pin QFP Package



2 Dimension Paramenters

SYMBOLS	MIN.	NOM	MAX.
A	–	–	–
A1	0.25	–	0.50
A2	2.50	–	2.90
b	0.20	0.30	0.40
c	0.10	0.15	0.20
D	24.60	24.80	25.00
D1	19.90	20.00	20.10
e	0.498	0.65	0.802
E	18.60	18.80	19.00
E1	13.90	14.00	14.10
L	1.00	1.20	1.40
L1	–	2.40	–
θ°	0	–	7
y	–	–	0.10

UNIT : mm

NOTES:
1. JEDEC OUTLINE:MO-112 CC-1
2. DATUM PLANE H IS LOCATED AT THE BOTTOM OF THE MOLD PARTING LINE COINCIDENT WITH WHERE THE LEAD EXITS THE BODY.
3. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 mm PER SIDE. DIMENSIONS D1 AND E1 DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H .
4. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION .