



## Features

- 6000counts LCD display
- 3V DC power supply
- Conversion rate: 3 times/s (voltage mode)
- V, A, C, R, Diode, Cont. automatically detection and measurement (Scan mode).  
(Taiwan patent no.:334931)  
(China patent no.:ZL 2007 1 0106703.2)
- Combo keys:  
**SELKey**: change measuring mode or power on/off  
**BKLight**: back light or flash  
**EF**: non-contact electric field detection.  
**MMX**: maximum or minimum  
**Hold**: hold or delay hold  
**Range**: manual range
- Voltage measurement (ACV/DCV):  
500.0mV-1000V (scan mode)  
0.000-1000V (Non-scanning)
- Current measurement (ACA/DCA):  
Multi-meter mode,  
In AC/DC detecting mode.  
0.00mA-600.0mA (DCA@mAin)  
0.000A-20.00A (DCA@Ain)  
6.00mA-600.0mA (ACA@mAin)  
0.6A-20.00A (ACA@Ain)  
In Non-AC/DC detecting mode  
0.00mA-600.0mA (DCA@mAin)  
0.000A-20.00A (DCA@Ain)  
0.00mA-600.0mA (ACA@mAin)  
0.00A-20.00A (ACA@Ain)  
Clamp meter mode, only for ACA  
6.00A-600.0A (scan mode)  
0.00A-600.0A (Non-scanning)
- Resistance measurement:  
0.0-6.000MΩ (scan mode, including continuity)  
0.0-60.00 MΩ (Non-scanning)
- Capacitance measurement:  
0.000nF-600.0uF (Non-scanning)  
0.200nF-60.00mF (auto scanning)  
(Taiwan patent no.:323347, 453443)  
(China patent no.:ZL 200710106702.8)
- Continuity test: 30ohm/50ohm selectable.

- Diode test
- VAHz measurement: 5.00Hz-60.00kHz  
(automatically measuring frequency in ACV/ACA)
- Switch to A/mA measurement as a probe is inserted to A/mA slot. (Non-clamp model)
- Non-contact electric field detection
- High voltage (> 30V) indication.
- Voltage mode overflow selection  
(600V/1000V)
- Band-gap reference voltage output
- Auto power off (10min. or 20min.) & re-power on
- Sleep state indicative signal output
- On-chip buzzer driver
- Low battery detection
- Built-in automatic calibration
- Serial data output (RS232 format)

## General description

ES269 is an integrated ADC with 6,000 counts LCD display driver. It could support fully automatic DMM function measurement. Voltage, current, resistance (including continuity), capacitance or diode measurements are allowed by fully automatic detection. A non-contact electric field detector (EF function) is built-in for ac voltage measurement also. Other features including data hold, maximum, minimum and back light function are available. For power saving, an auto power off & re-power on scheme are built in. A sleep output is the indication of entering auto power off mode.



## Application

- Smart digital multi-meter
- Smart clamp meter Content

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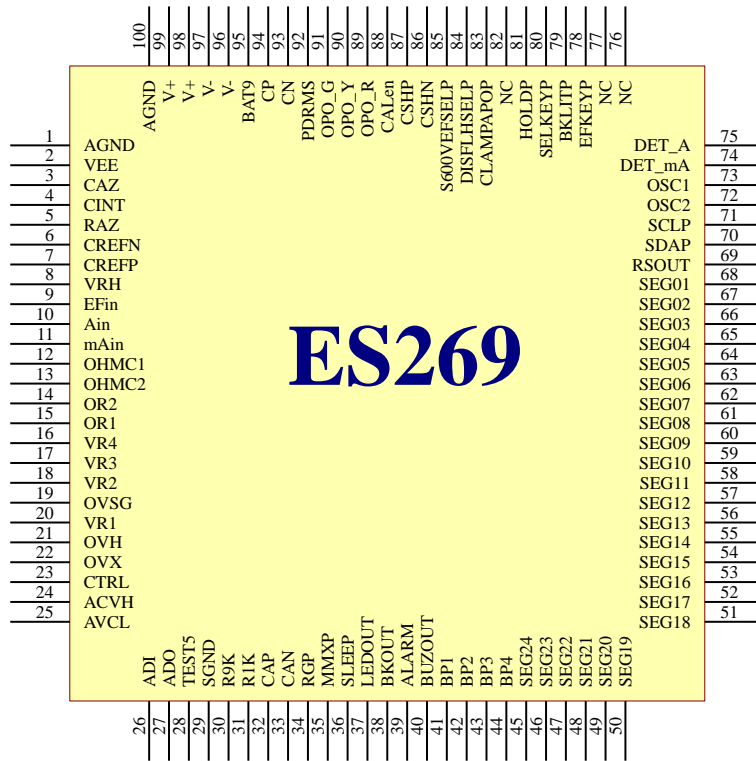


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## Pin Assignment



## Pin Description

Pin No	Symbol	Type	Description
1	AGND	P	Analog ground.
2	VEE	P	Analog ground.
3	CAZ	I	Auto-zero capacitor connection.
4	CINT	O	Integrator output. Connect to integral capacitor
5	RAZ	O	Buffer output pin in high-speed mode. Connect to high-speed integral resistor.
6	CREFN	I/O	Negative connection for reference capacitor.
7	CREFP	I/O	Positive connection for reference capacitor.
8	VRH	O	Output of band-gap voltage reference. Typically -1.2V
9	EFin	I	Electric field input
10	Ain	I	Current measurement input
11	mAin	I	Current (milli ampere) measurement input
12	OHMC1	O	Filter capacitor connection for resistance mode
13	OHMC2	O	Filter capacitor connection for resistance mode
14	OR2	O	Reference resistor connection for 60.00MΩ range
15	OR1	O	Reference resistor connection for 600.0Ω range
16	VR4	O	Voltage measurement ÷1000 attenuated (600.0V/1000V)
17	VR3	O	Voltage measurement ÷100 attenuated (60.00V)
18	VR2	O	Voltage measurement ÷10 attenuated (6.000V)
19	OVSG	O	Sense low voltage for resistance measurement
20	VR1	I	Measurement input.
21	OVH	O	Output connection for resistance/capacitor measurement



Pin No	Symbol	Type	Description
22	OVX	I	Input high voltage for resistance/capacitor measurement
23	CTRL	O	Connect to “- (LED Catode)” of OptoMOS-relay.
24	ACVH	I	DC signal high input in ACV/ACA mode. Connect to positive output of external AC to DC converter.
25	ACVL	I	DC signal low input in ACV/ACA mode. Connect to negative output of external AC to DC converter.
26	ADI	I	Negative input of internal AC to DC OP Amp.
27	ADO	O	Output of internal AC to DC OP Amp.
28	TEST5	I/O	Buffer output of OVSG
29	SGND	I	Signal Ground.
30	R9K	O	Connect to a precise 9KΩ resistor for capacitor measurement.
31	R1K	O	Connect to a precise 1KΩ resistor for capacitor measurement.
32	CAP	I/O	Positive auto-zero capacitor connection for capacitor measurement
33	CAN	I/O	Negative auto-zero capacitor connection for capacitor measurement
34	RGP	O	RANGE key. Input a negative pulse of less than 1 second to change the measurement range.
35	MMXP	O	MAX. and MIN. key. Input a negative pulse of less than 1 seconds to enter or exit MAX.&MIN function.
36	SLEEP	O	Sleep mode indicator, it asserts low in SLEEP mode.
37	LEDOUT	O	Flash driver.
38	BKOUT	O	Backlight driver.
39	ALARM	O	HV signal detection, short circuit indication and EF indication output.
40	BUZOUT	O	Outputs a 2KHz audio frequency signal for driving piezoelectric buzzer
41	BP1	O	LCD backplane 1
42	BP2	O	LCD backplane 2
43	BP3	O	LCD backplane 3
44	BP4	O	LCD backplane 4
45-68	SEG24-SEG01	O	LCD segment line 01 – 24
69	RSOUT	O	RS232 output
70	SDAP	I/O	Input / Output from to EEPROM 24LC02 data. Open drain output.
71	SCLP	O	Output to EEPROM 24LC02 clock
72	OSC2	I	Crystal oscillator input connection
73	OSC1	O	Crystal oscillator output connection
74	DET_mA	I	Connect to GND to enter mA measurement.
75	DET_A	I	Connect to GND to enter A measurement.
76	NC	-	Not connected
77	NC	-	Not connected
78	EFKEYP	I	Input a less than 1 second negative pulse (GND to V-) to enter EF function.
79	BKLITP	I	Input a less than 1 second negative pulse (GND to V-) to turn on Back light. Input an over 1 second negative pulse (GND to V-) to turn on Flashlight.
80	SELKEYP	I	Input a less than 1 second negative pulse to switch to manual mode. Input an over 1 second negative pulse to switch the power on/off.
81	HOLDP	I	Input a less than 1 second negative pulse (GND to V-) to enable HOLD function. Input an over 1 second negative pulse (GND to V-) to enable DELAY HOLD function.
82	NC	-	Floating.
83	CLAMPAPOP	I	The option pin is used to select clamp mode or meter mode, and to change the automatically power off time.



Pin No	Symbol	Type	Description
84	DISFLHSELP	I	The option pin is used to select flashlight and SEL key enable or disable.
85	S600VEFSELP	I	The option pin is used to select the OL value as 600V or 1000V.
86	CSHN	O	Negative sample & hold capacitor
87	CSHP	O	Positive sample & hold capacitor
88	CALen	I	Pulled to V- to enable calibration scheme.
89	OPO_R	O	LED output driver
90	OPO_Y	O	LED output driver
91	OPO_G	O	LED output driver
92	PDRMS	O	Power control for root mean square circuit (RMS).
93	CN	O	Negative capacitor connection for on-chip DC-DC converter.
94	CP	O	Positive capacitor connection for on-chip DC-DC converter.
95	BAT9	I	Low battery configuration. If 3V battery is used, connect it to AGND. The default low-battery thres hold voltage is -2.3V. If 9V battery is used, the low battery enunciator is displayed when the voltage of this pin is less than VRH (-1.2V)
96	V-	P	Digital negative supply voltage.
97	V-	P	Analog negative supply voltage.
98	V+	O/P	Digital positive supply voltage.
99	V+	O/P	Analog positive supply voltage.
100	AGND	P/G	Digital ground.

## Absolute Maximum Ratings

Table 1. Absolute maximum ratings

Characteristic	Rating
Supply Voltage (V- to AGND)	-4V
Analog Input Voltage	V- -0.6 to V+ +0.6
V+	V+ ≥ (AGND +0.5V)
AGND/AGND	AGND ≥ (V- -0.5V)
Digital Input	V- -0.6 to AGND +0.6
Power Dissipation. Flat Package	500mW
Operating Temperature	-20°C to 70°C
Storage Temperature	-45°C to 125°C



## Electrical Characteristics

Table 2. Electrical characteristics, TA=25°C, V- = -3V

Parameter	Symbol	Test Condition	Min.	Typ.	Max	Units
Power supply	V-		-3.3	-3.0	-2.5	V
Operating supply current	I <sub>DD</sub>	Normal operation	—	4.2	—	mA
In Scan AC/DC mode	I <sub>SS</sub>	In sleep mode	—	13.7	14	μA
Voltage roll-over error	REV	2MΩ input resistor	—	—	±0.1	%F.S <sup>1</sup>
Voltage nonlinearity	NLV	Best case straight line	—	—	±0.1	%F.S <sup>1</sup>
Input Leakage			-10	1	10	PA
Low battery flag voltage		V- to AGND	-2.4	-2.3	-2.2	V
Zero input reading		2MΩ input resistor	-000	000	+000	counts
Peak to peak backplane drive voltage		-3.5V ≤ V ≤ -2.2V	3.0	3.15	3.3	V
Counter time base period		f <sub>OSC</sub> = 4MHZ	—	1	—	sec
Reference voltage and open circuit voltage for 600Ω measurement	V <sub>REF</sub>	100KΩ resistor between VRH and AGND	-1.33	-1.23	-1.13	V
Open circuit voltage for Ω measurement (except 600Ω)		Ω Mode	-0.98	-0.93	-0.88	V
Open circuit voltage for 600Ω measurement		Ω and Continuity Mode		V-		V
Internal pull-high to 0V current		Between V- pin and HOLDP, SELKEYP, BKLITP, EFKEYP, CLAMP, RGP, MMXP.	—	1.2	—	μA
AC frequency response at 6.000V Range		±1%	—	40-400	—	Hz
		±5%	—	400-2000	—	
AC input response for scan mode			10	—	50000	Hz
DCV sensitivity (scan mode)		VR1(2MΩ input impedance)	—	400	—	mV
ACV sensitivity (scan mode)		VR1(2MΩ input impedance) @50Hz	—	500	—	mV <sub>RMS</sub>
ACA sensitivity (scan mode)		mAin or Ain input @50Hz	—	60	—	mV <sub>RMS</sub>
Resistance sensitivity (scan mode)		Parasitic capacitance allowed in 6.000MΩ range	600.1	—	6.000M	Ω
Continuity sensitivity (scan mode)			0	—	600.0	Ω
DIODE sensitivity (scan mode)		Forward voltage	—	—	0.9	V
Capacitance sensitivity (scan mode)			—	0.2n	600.0μ	F
Reference voltage temperature coefficient	TC <sub>RF</sub>	-20°C < TA < 70°C	—	75	—	ppm/°C
Capacitance measurement accuracy		6nF – 600nF	-1.5	—	1.5	%F.S
			-5	—	5	counts
		6.0μF ~ 60mF	-2.5	—	2.5	%F.S
						counts

<sup>1</sup>Full Scale



## Functional Description

### Operation Modes

#### Voltage Measurement

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

In scan mode, ES269 can automatically detect ACV/DCV input signal. The input voltage must exceed  $500mV_{RMS}^2$  to switch to ACV measurement and 350mV to switch to DCV measurement.

In auto mode, ES269 can automatically switch to appropriate range for measurement.

In manual mode, User can switch range by Range key.

ES269 has an OL display selection feature achieved by configuring a S600VEFSEL pin. If pin S600VEFSEL is floating or is connected to V+, the DCV and ACV overflow level is 600.0V. If pin S600VEFSEL is connected to AGND or V-, the DCV and ACV overflow level is 1000.0V. When the measuring signal reaches the overflow level, OL will be showed on the LCD, and the buzzer will sound an alarm. The configuration of S600VEFSEL is listed below. See Table 12 for details.

Table 3. Voltage ranges

Configuration	Full Scale Range	Divider Ratio	Resister Connection
VR1	6.000V	1/10	VR2 (220K $\Omega$ )
VR2	60.00V	1/100	VR3 (20K $\Omega$ )
VR3	600V/1000V	1/1000	VR4 (2K $\Omega$ )

<sup>2</sup> The threshold is not a consistent value, it depends on the frequency of test signal.  $500mV_{RMS}$  at 50Hz test condition.





**Current Measurement**

**For multi-meter application**

Connect CLAMPAPO pin to V- or AGND for multi-meter model. See to Table 13 for details. There are 2 automatic current measurement modes for multi-meter. The following table summarizes the full-scale range of each mode. When ES269 operates in the current measurement modes for multi-meter, it takes high input from pin Ain or mAin, low input from pin SGND.

Connecting DET\_mA or DET\_A pin to AGND to switch automatically to mA or A measurement, respectively.

In scan mode, both mA/A can automatically detect DCA or ACA. Alternatively, it can switch manually to DCA or ACA measurement by SELKEY.

In auto mode, ES269 can automatically switch to appropriate range for measurement.

In manual mode, user can switch range by Range key.

Table 4. milli-Ampere ranges for multi-meter

Mode	Full Scale	Input Terminal	Full scale
mAR1	60.00mA	mAin V.S. SGND	60.00mV
mAR2	600.0mA	mAin V.S. SGND	600.0mV

Table 5. Ampere ranges for multi-meter

Mode	Full Scale	Input Terminal	Full scale
AR1	6.000A	Ain V.S. SGND	60.00mV
AR2	20.00A	Ain V.S. SGND	200.0mV

Table 6. The sensitivity value in DC(m)A/AC(m)A auto detecting mode

	Sensitivity	Test range
mA	6mA	6.00mA – 600.0mA
A	0.6A	0.600A – 20.00A

**For clamp meter application**

Leave the CLAMPAPO pin floating or connected it to V+ for clamp meter model. See to Table 13 for details. The following table summarizes the full-scale range of each mode. It takes high input from Ain, low input from SGND.

In scan mode, ES269 can automatically switch to AC current measurement when the signal level on the Ain pin exceeds 6mV. Since V and A are detected, the voltage measurement will take precedence.

Table 7. Current range for clamp meter

Mode	Full Scale	Input Terminal	Full scale
AR1	60.00A	Ain V.S. SGND	60.00mV
AR2	600.0A	Ain V.S. SGND	600.0mV



**VAHz function**

ES269 can automatically measure frequency of ACV or ACA and show the value on sub-display. The maximum frequency range is 60KHz. For correct readings, the signal input level must exceed 10% of full scale. The reading value will be shown on the sub-display in voltage or current mode.

Table 8. frequency range

Mode	Full Scale
FR1	600.0Hz
FR2	6.000KHz
FR3	60.00KHz

**Resistance Measurement**

A 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.

In scan mode, it automatically switches to resistance measurement as the resistance value exceed 600.1  $\Omega$ .

In auto mode, ES269 can automatically switch to appropriate range for measurement.

In manual mode, User can switch range by Range key.

Table 9. Resistance ranges

Configuration	Full Scale Range	Reference Resistor	Equivalent value
R1	600.0 $\Omega$ <sup>3</sup>	OR1	200 $\Omega$
R2	6.000K $\Omega$	VR4	2K $\Omega$
R3	60.00K $\Omega$	VR3    VR1	20K $\Omega$
R4	600.0K $\Omega$	VR2    VR1	200K $\Omega$
R5	6.000M $\Omega$	VR1	2M $\Omega$
R6	60.00M $\Omega$ <sup>4</sup>	OR2	20M $\Omega$

<sup>3</sup> continuity check is implemented in this range

<sup>4</sup> 60M $\Omega$  range is only available in non-scan mode.



## Continuity test

Continuity test shares the same configuration with 600.0 $\Omega$  manual resistance measurement mode and has buzzer output to indicate continuity. The buzzer generates 2KHz beep whenever the reading is less than 30 $\Omega$  or 50 $\Omega$ . The boundary can be selected by S600VEFSEL pin. See Table 12 for details.

In scan mode, it automatically switches to continuity test as resistance value is lower than 600.0 $\Omega$ .

In EF unit, OPO\_R, OPO\_G, and OPO\_Y are LED outputs. OPO\_G is high if a complete path resistor is less than 50 $\Omega$ /30 $\Omega$ . Otherwise OPO\_R is high.

## Diode Measurement

Diode measurement mode shares the same configuration with 6.000V manual voltage measurement mode and has buzzer output to indicate continuity. The buzzer generates a 2KHz sound whenever the reading is less than 30mV. If the test circuit is open or the voltage drop between the two ports of the DUT is larger than 2V, the LCD panel will show “OL”.



### Capacitance Measurement

In scan mode, it automatically switches to capacitance measurement as capacitance exceeds 200pF. It can be manually switched to capacitance measurement by SELKey to measure larger or smaller capacitance. The 60.00mF range supports only non-scan mode.

In EF unit, the OPO\_Y is high if the capacitor is charging. The OPO\_G is high after capacitor is charged.

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

Table 10. Capacitance ranges

Configuration	Full Scale Range	Relative component	Measurement period
C1	6.000nF	Ratio to C2	0.363s
C2	60.00nF	Ratio to CAL	0.363s
C3	600.0nF	Ratio to C2	0.753s
C4	6.000uF	R9K / R1K	0.26s
C5	60.00uF	R9K / R1K	1.3s
C6	600.0uF	R9K / R1K	2.6s (max)
C7	6.000mF <sup>5</sup>	R9K / R1K	2.6s (max)
C8	60.00mF <sup>5</sup>	R9K / R1K	13s (max)

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 “dIS.C” Discharging through the chip is quite slow. We recommend users to discharge the capacitor with some other apparatus.

<sup>5</sup> The C7-C8 both range is not available for auto scan mode



**Electrical field detection test**

ES269 supports a non-contact AC voltage measurement, which is called electric field measurement also.

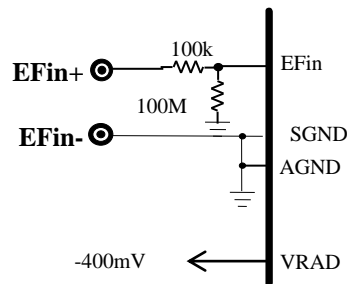
Press the EF key to enter EF test and press it again to exit EF test.

The ADC input is configured from *EFin* pin vs. *SGND*. When no or less electric field is detected, the LCD display shows “EF”. If the electric field is detected, the strength will be showed on the LCD display by “-“ not digits type. Level 1 (equivalent to 12.5% full scale of ADC) is “-“ and the level 4 (equivalent to 100% full scale of ADC) is “----“. Additional beeper (*BUZOUT* pin) and LED alarm (*ALARM* pin) will be active from ES269. The frequency of buzzer and LED alarm depends on the strength of electric field also. The faster beeper means the stronger electric field (AC voltage) is sensed.

In EF unit, *OPO\_R*, *OPO\_G*, and *OPO\_Y* are LED outputs. *OPO\_G*, *OPO\_Y*, and *OPO\_R* outputs high which represent the detected weak, medium, and strong signal, respectively.

In EF normal, the three pin is not used.

**EF test circuit**





**Auto power off mode (APO)**

**Idle Time selection**

ES269 has a default auto power-off function. If the meter is idle for more than the given Idle Time, it automatically turns the power off. The idle time can be selected by pin 'CLAMPAPO'. See Table 13 for details.

**Sleep output**

The meter enters sleep mode after auto power-off or push SEL key to last for 2s. The SLEEP pin asserts low (-3V) in the sleep mode, and asserts high (+3V, not 0V) after re-power on.

**Re-power on**

After auto power-off is active, press SEL key over 2 seconds can turn on the meter again.

**Hazardous Voltage Indication**

The ES269 could provide the AC/DC hazardous voltage indication for voltage/resistor/ diode modes. Of course, the indication could support LCD symbol / LED (ALARM pin) /Buzzer driving simultaneously. Especially ES269 could detect the AC voltage in DCV mode and detects the DC voltage in ACV mode. It means if not proper AC or DC voltage signal exists on the device under test when DCV or ACV measurement mode is set, the HV indication will be active

**HV indication criterion**

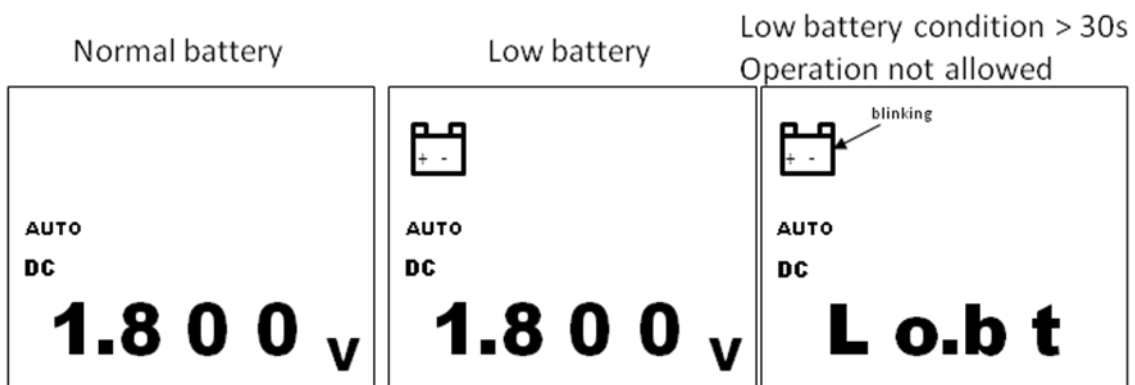
Function / Range	DC voltage (typ.)	AC voltage (typ.)
AC 6V	> <u>+30V</u>	OL
AC 60V – 1000V	> <u>+60V</u>	> 30Vrms
DC 6V	OL	> 20Vrms (40-1kHz)
DC 60V-1000V	> <u>+30V</u>	> 70Vrms (40-1kHz)
Res/Cap/Diode modes	> <u>+10V</u>	> 10Vrms (40-1kHz)

**Note: If AC+DC signal is applied, the voltage criterion will be changed.**

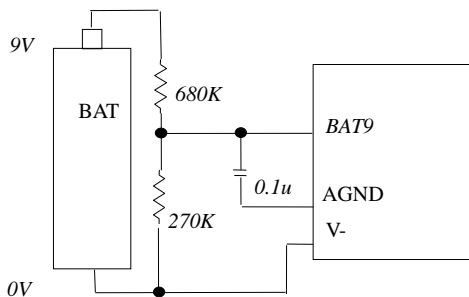


**Low Battery Voltage Detection**

ES269 provides a voltage detection input (pin 95: *BAT9*) for non-3V battery application. When *BAT9* is less than *VRH* terminal voltage, the LCD segment of low battery will appear. For 3V battery application, pull *BAT9* to AGND directly and the same detection will be made when *V-* is less than 2.3V typ.. When the Low battery status lasts for 10 seconds, the LCD segment of low battery will be blinking. When the symbol is blinking for 20 seconds, the operation of meter will be inhibited and LCD panel will show “Lo.bt”. In this case, it is suggested to replace a new battery immediately. After “Lo.bt” appears and lasts for 60 seconds, ES269 will enter to auto power off mode.



**Low battery test ( 9V battery)**





**Push Function**

All the enabled push functions will be reset when the measurement mode is changed. Change measurement mode by *SEL* function will reset *HOLD* function. The following table lists the available function versus every measurement mode.

Table 11. The function keys are available in each measurement mode.

Key name	<i>EF</i>	<i>RGP</i>	<i>MMXP</i>	<i>SEL</i>		<i>HOLD</i>		<i>BKLIT</i>	
Key function	<1s	<1s	<1s	<1s	≥1s	<1s	≥1s	<1s	≥1s
	<i>EF function</i>	<i>Range Change</i>	<i>MAX.&amp;MIN. function</i>	<i>Switch measurement</i>	<i>Power ON/OFF</i>	<i>Hold</i>	<i>Delay Hold</i>	<i>Backlight control</i>	<i>Flashing control</i>
Scan	O	X	X	O	O	O <sup>6</sup>	O <sup>6</sup>	O	O
V <sub>AC</sub>	O	O	O	O	O	O	O	O	O
V <sub>DC</sub>	O	O	O	O	O	O	O	O	O
EF	O	O	O	O	O	X	X	O	O
I <sub>AC</sub>	O	O	O	O	O	O	O	O	O
I <sub>DC</sub>	O	O	O	O	O	O	O	O	O
Resistance	O	O	O	O	O	O	O	O	O
Continuity	O	O	O	O	O	O	O	O	O
Diode	O	O	O	O	O	O	O	O	O
Capacitance	O	O	O	O	O	O	O	O	O

**SEL key function**

In auto scan mode, the ES269 automatically selects the appropriate measurement mode and range.

Press the *SEL* key for less than one second to cycle through the measurement functions. Press the key over 1 second, the ES269 will enter power down mode. If power down mode is entered, only press *SEL* key to last for 2 seconds or apply the power to V- terminal could re-power on the ES269. The following figure shows the state transition.

When the DISFLHSEL pin is left floating or connected to V-, the *SEL* key function will be enabled.

Otherwise, the *SEL* key function will be disabled. See Table 14 for details.

<sup>6</sup> When input terminal is floating, and LCD shows “----“, *HOLD* function is not available.



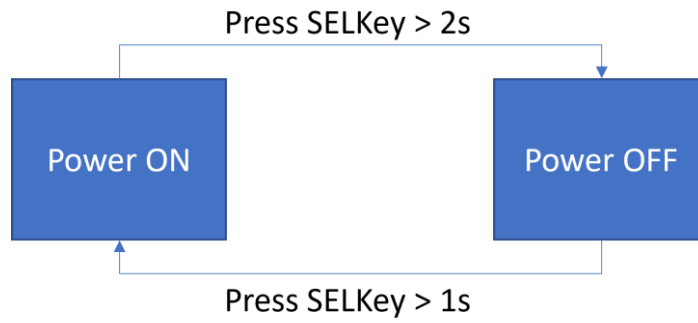


Figure 1. Power control

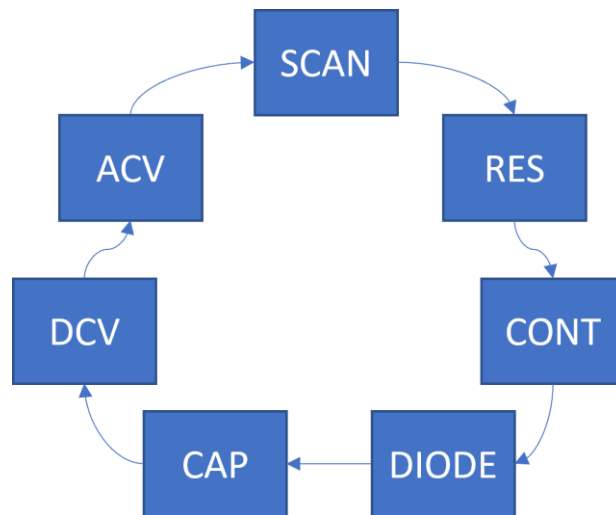


Figure 2. Press SELKey to cycle through functions for multi-meter model

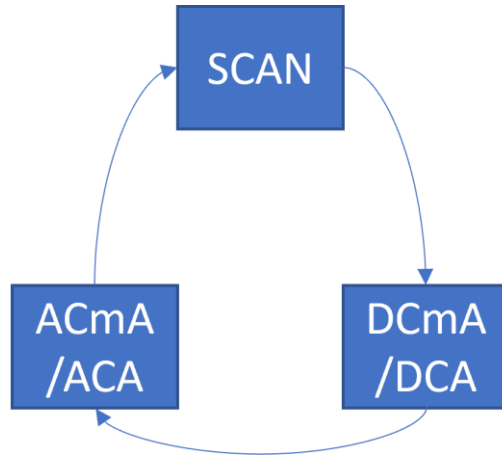


Figure 3. Press SEL key to cycle through functions for current measurement of multi-meter model

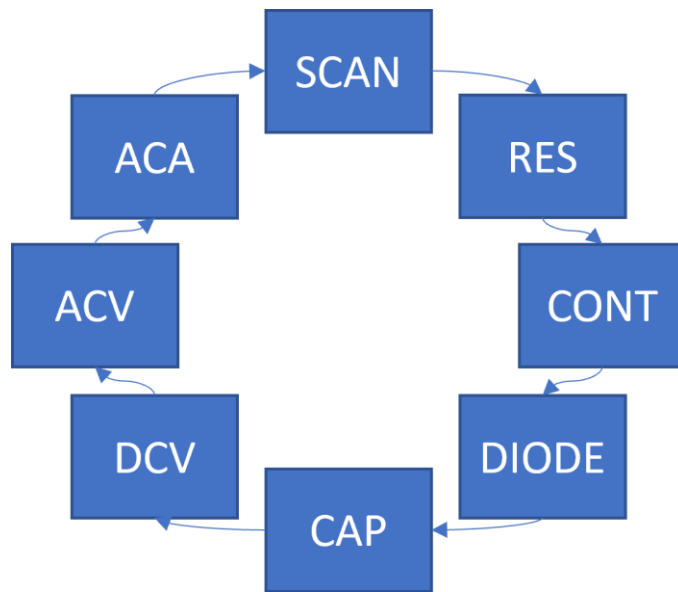


Figure 4. Press SELKey to cycle through functions for clamp-meter model



**Hold and delay-hold key function**

The data 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. Hold function can be cancelled by changing the measurement mode, pressing *SEL*, or pressing *HOLD* again.

The delay-hold function is enabled when *HOLD* key is pressed over 2 seconds. When delay-hold function is entered successfully, the meter will stop to update the LCD data after six seconds delayed. During the six seconds waiting, the *HOLD* symbol on LCD panel will be blinking.

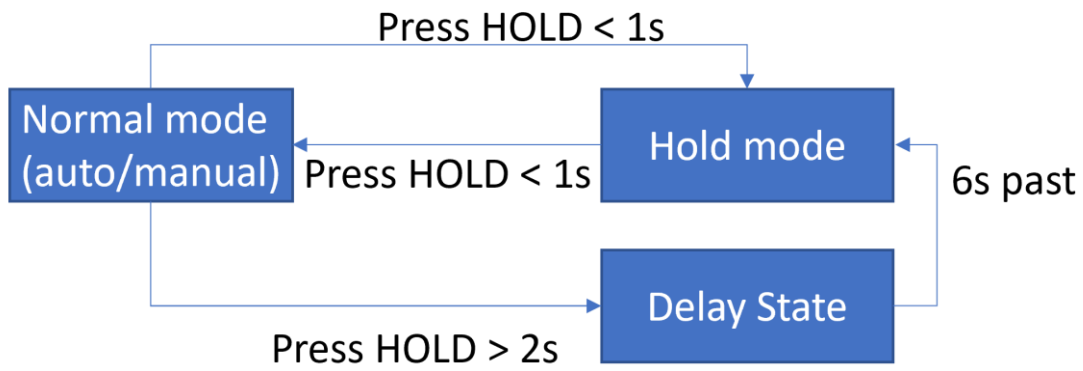


Figure 5. The state diagram of pressing HOLD

**Back light / Flashlight key function**

Press the *BKLIT* key less than 1 second to toggle the back light output driving ON/OFF. Press the *PKLIT* key over 1 second to toggle the flashlight output driving ON/OFF.

When the *DISFLHSEL* pin is connected *AGND/V-*, the flashlight function will be enabled. Otherwise, the flashlight function will be disabled. See Table 14 for details.

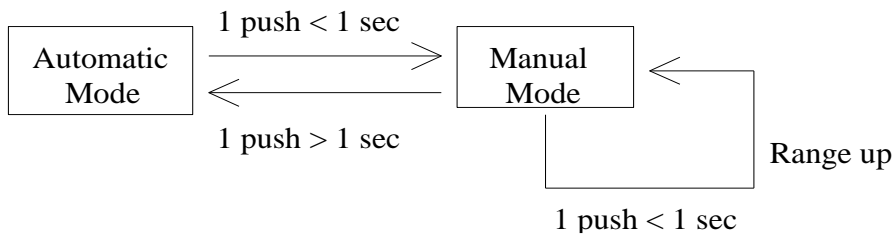


**EF key function**

ES269 supports a non-contact ac voltage measurement, which is called electric field measurement also. Press EFKEYP less than 1 second to enter EF function. When press it again to exit EF function. The ADC input is configured from EFin pin vs. SGND. When no or less electric field is detected, the LCD shows “EF”. If the detector senses electric field, the strength will be showed on LCD by “-“ not digits type. Level 1(weak) is “-“ and the level 4(strong) is “----“. Additional beeper will be output from BUZOUT pin. The buzzer frequency depends on the strength of electric field also. The Faster beeper means the stronger electric field (ac voltage) is sensed. The buzzer can be disabled through S600VEFSEL pin. See Table 12 for details.

**Range key function.**

Push RANGE key to switch from automatic to manual mode, and while in manual mode, changes the full-scale range. The following figure shows the state transition.



Measurement Mode	Control Range	Initial Range
V	6.000V – 1000V	6.000V
mA	60.00mA – 600.0mA	60.00mA
A	6.000A – 20.00A	6.000A
60A/600A (clamp)	60.00A – 600.0A	60.00A
Capacitance	6.000nF– 60.00mF <sup>7</sup>	6.000nF
Ω	600.0Ω – 60.00MΩ	600.0Ω

<sup>7</sup> 60.00mF supply only in non-scan mode.



## **MAX. and MIN. key function.**

The meter displays the maximum and minimum value of the input in MAX&MIN mode. When key is pressed the meter displays the maximum and minimum value. When it is pressed again, it will exit MAX&MIN mode. Pressing HOLD in MAX&MIN mode makes the meter stop updating the maximum and minimum value.



**Selection pin**

**S600VEFSEL selection**

The S600VEFSEL pin can be used to set boundary of voltage measurement or continuity measurement, or to enable or disable the beep of EF function.

Table 12 S600VEFSEL pin selection

<i>S600VEFSEL</i>	DCV	ACV	Continuity beep	EF
V+	600V	600V	50Ω	EF Unit
AGND	1000V	1000V	50Ω	EF Unit
Float	600V	600V	30Ω	EF Normal
V-	1000V	1000V	30Ω	EF Normal

In EF unit, OPO\_R, OPO\_G, and OPO\_Y are LED outputs.

In EF normal, the three pin is not used.

**CLAMPAPO selection**

The CLAMPAPO pin can be used to select multimeter or clamp meter for current measurement.

And it also can be used to select the idle Time before going to sleep.

Table 13. CLAMPAPO pin selection

CLAMPAPO	CLAMP	APO
V+	O	20 min.
AGND	X	20 min.
Float	O	10 min.
V-	X	10 min.

**DISFLHSEL selection**

The DISFLHSEL pin can be used to enable or disable the SEL key or flashing key.

Table 14. DISFLHSEL pin selection

DISFLHSEL	SEL key	Flashlight key
V+	X	X
AGND	X	O
Float	O	X
V-	O	O



### Calibration Scheme

DMM manufacturers need the calibration process in production. The traditional solution needs the variable resistors for calibration by manual adjustment. ES269 provide another calibration scheme and the most variable resistors could be ignored. When ES269 is at OFF-state, pull CALen (pin 88) to V- to active the calibration scheme after re-power on. When calibration scheme is active, the LCD segment of Unit of related measurement will be blinking.

The calibration steps are as follows:

1. Press SEL key to select a measurement, and then input the reference value according to Table 15.
2. Press HOLD or MMX to start the calibration process.
3. The calibration parameter is automatically stored<sup>8</sup> to external EEPROM for measurement mode. And the buzzer will announce a beep.
4. Repeat the process until all calibrations are complete.

Table 15. Calibration parameters

	Terminal	Default Range For CAL	Reference input	Remark
DCV	VR1	6.000V	5.500V	All range of DCV is the same parameter
ACV	VR1	6.000V	5.500V	All range of ACV is the same parameter
DCA	mAin	600.0mA	550.0mA	All range of mA <sub>DC</sub> is the same parameter
	Ain	20.00A for multimeter	15.00A	All range of A <sub>DC</sub> is the same parameter
600.0A for clamp meter		550.0A		
ACA	mAin	600.0mA	550.0mA	All range of mA <sub>AC</sub> is the same parameter
	Ain	20.00A for multimeter	15.00A	All range of A <sub>AC</sub> is the same parameter
600.0A for clamp meter		550.0A		
Capacitance	VR1	60.00nF	55.00nF	6nF-6uF is the same parameter.
Capacitance	VR1	60.00uF	55.00uF	60uF-60mF is the same parameter

After calibration procedure is finished, set ES269 to OFF-state and set CALen (pin88) to AGND or kept floating to return to normal mode operation after re-power on.

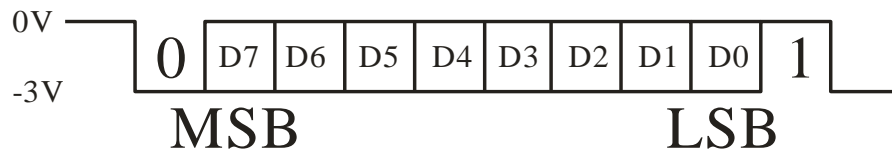
<sup>8</sup> In manual adjustment mode, press the HOLD key and the BKLIT key simultaneously to store the value in the external EEPROM.



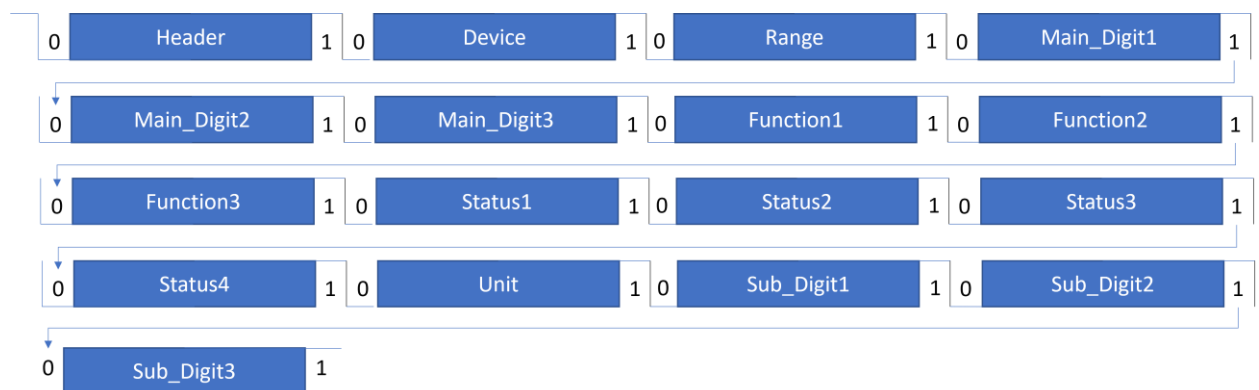
## Serial Data Output

The serial data sent to RSOUT pin periodically at every A/D conversion cycle by 3 times per second. The data format complies with 8Bits transmission code with a baud rate of 9600. The host can use RS232 interface to read the data. A single data packet includes a start bit (always 0), 8 data bits with no parity check bit, and a stop bit (always 1). The high and low voltage levels correspond to AGND and V- respectively. RSOUT 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.

Single packet



One data block consists of 17 packets. The following figure shows the format of a data block. The Header and Device code leads the whole packets. The range packet indicates the decimal point position on LCD panel of meter. M\_Digit1-3 consists of the readings on the main display of LCD panel. The function packet indicates the measurement mode of the meter. Status1-4, Unit gives the other status of the meter. S\_Digit1-3 consists of the readings on the sub display of LCD panel.



All packets





The meter always outputs the current value shown on LCD screen to the serial port. The detailed data format of each packet is listed below.

	D0	D1	D2	D3	D4	D5	D6	D7	
a01	0	0	0	0	1	1	1	1	Header
a02	1	0	0	0	0	0	1	1	Device
a03	S_DP1	S_DP2	S_DP3	X	M_DP1	M_DP2	M_DP3	X	Range
a04	M_SIGN	X	X	X	X	X	X	X	Main_Digit
a05	M_Digit3 <sub>3</sub>	M_Digit3 <sub>2</sub>	M_Digit3 <sub>1</sub>	M_Digit3 <sub>0</sub>	M_Digit2 <sub>3</sub>	M_Digit2 <sub>2</sub>	M_Digit2 <sub>1</sub>	M_Digit2 <sub>0</sub>	Main_Digit
a06	M_Digit1 <sub>3</sub>	M_Digit1 <sub>2</sub>	M_Digit1 <sub>1</sub>	M_Digit1 <sub>0</sub>	M_Digit0 <sub>3</sub>	M_Digit0 <sub>2</sub>	M_Digit0 <sub>1</sub>	M_Digit0 <sub>0</sub>	Main_Digit
a07	V	A	Ohm	Continuity	Diode	Capacitance	Hz	X	Function1
a08	X	X	X	X	EFmode	SCAN	X	X	Function2
a09	X	X	X	X	X	X	X	X	Function3
a10	AUTO	MANU	AC	DC	OL	X	1	APO	Status1
a11	X	X	LBAT	LBAT30s	X	X	X	X	Status2
a12	X	X	X	X	X	X	MAX	MIN	Status3
a13	Danger	OPEN	SHORT	DISCH	X	X	X	X	Status4
a14	Mega	M_Kilo	S_Kilo	Mili	X	Micro	X	Nano	Unit
a15	S_SIGN	X	X	X	X	X	X	X	Sub_Digit1
a16	S_Digit3 <sub>3</sub>	S_Digit3 <sub>2</sub>	S_Digit3 <sub>1</sub>	S_Digit3 <sub>0</sub>	S_Digit2 <sub>3</sub>	S_Digit2 <sub>2</sub>	S_Digit2 <sub>1</sub>	S_Digit2 <sub>0</sub>	Sub_Digit2
a17	S_Digit1 <sub>3</sub>	S_Digit1 <sub>2</sub>	S_Digit1 <sub>1</sub>	S_Digit1 <sub>0</sub>	S_Digit0 <sub>3</sub>	S_Digit0 <sub>2</sub>	S_Digit0 <sub>1</sub>	S_Digit0 <sub>0</sub>	Sub_Digit3

Note :

1. X → undefind.
2. Whole packet is shown by LSB first.

### RANGE

This packet indicates range state of the meter. The DP1(S) – DP3(S) corresponding DP1(S) – DP3(S) of LCD segment (see **section 5**). In DCV 6.000V range, this **a03** packet will set **xxxx001x**. If change to 60.00V the packet will be **xxxx010x**. In 600.0Hz range this a03 packet will set 100xxxxx. If change to 6.000kHz range the packet will be 001xxxxx.

	D0	D1	D2	D3	D4	D5	D6	D7
a03	DP1S	DP2S	DP3S	X	DP1	DP2	DP3	X



**Main\_Digit1 –Main\_Digit3**

Main\_Digit1 – Main\_Digit3 is the readings of measurement result shown on LCD panel.

M\_DigitN<sub>3</sub> – M\_DigitN<sub>0</sub> consist of 4-bit BCD code. The M\_SIGN is the sign bit of readings.

	D0	D1	D2	D3	D4	D5	D6	D7
a04	M_SIGN	X	X	X	X	X	X	X
a05	M_Digit3 <sub>3</sub>	M_Digit3 <sub>2</sub>	M_Digit3 <sub>1</sub>	M_Digit3 <sub>0</sub>	M_Digit2 <sub>3</sub>	M_Digit2 <sub>2</sub>	M_Digit2 <sub>1</sub>	M_Digit2 <sub>0</sub>
a06	M_Digit1 <sub>3</sub>	M_Digit1 <sub>2</sub>	M_Digit1 <sub>1</sub>	M_Digit1 <sub>0</sub>	M_Digit0 <sub>3</sub>	M_Digit0 <sub>2</sub>	M_Digit0 <sub>1</sub>	M_Digit0 <sub>0</sub>

**FUNCTION**

The packets of **a07-a09** indicate the measurement mode of the meter. The following table summarizes the transmitted bit for each mode.

For example, if the meter operates in Voltage mode, this **a07** packet is **10000000**.

	D0	D1	D2	D3	D4	D5	D6	D7
a07	V	A	Ohm	Continuity	Diode	Capacitance	Hz	X
a08	X	X	X	X	EFmode	SCAN	X	X
a09	X	X	X	X	X	X	X	X

**STATUS**

The a10-a13 packets indicate the whole status when ES258 is in normal operation. For example, if meter is operated at ACV / MANU range, then **a10** packet will set **011000xx**.

The format of the four packets is shown below.

	D0	D1	D2	D3	D4	D5	D6	D7
a10	AUTO	MANU	AC	DC	OL	X	1	APO
a11	X	X	LBAT	LBAT30s	X	X	X	X
a12	X	X	X	X	X	X	MAX	MIN
a13	Danger	OPEN	SHORT	DISCH	X	X	X	X

**AUTO:** When auto range is selected.

**MANU:** When manual mode is selected.

**AC:** When AC mode is selected.

**DC:** When DC mode is selected.

**OL:** When 'OL' is displayed on LCD.

**APO:** When APO is displayed on LCD.

**LBAT:** When battery voltage is too low.

**LBAT30s:** When 'Lobt' is shown on LCD.



**MAX/MIN:** When MAX/MIN mode is active.

**Danger:** Abnormal applied voltage warning symbol is active on LCD.

**DISC:** The 'DisC' is shown on LCD. It means the DUT is necessary to be discharged on Cap mode.

**OPEN:** When it detects the test lead is open in continuity test

**SHORT:** When it detects the test lead is short in continuity test.

### Unit

This packet indicates the measurement unit of the LCD display.

	D0	D1	D2	D3	D4	D5	D6	D7
a14	Mega	Kilo	X	Mille	X	Micro	X	Nano

Mega = 1E6, Kilo=1E3, Mille=1E-3, Micro=1E-6, Nano=1E-9

Carriage return: The transmitted code is **00001101**

### Sub\_Digit1 –Sub\_Digit3

Sub\_Digit1 – Sub\_Digit3 is the readings of measurement result shown on LCD panel.

S\_DigitN<sub>3</sub> – S\_DigitN<sub>0</sub> consist of 4-bit BCD code. The S\_SIGN is the sign bit of readings.

	D0	D1	D2	D3	D4	D5	D6	D7
a15	S_SIGN	X	X	X	X	X	X	X
a16	S_Digit <sub>33</sub>	S_Digit <sub>32</sub>	S_Digit <sub>31</sub>	S_Digit <sub>30</sub>	S_Digit <sub>23</sub>	S_Digit <sub>22</sub>	S_Digit <sub>21</sub>	S_Digit <sub>20</sub>
a17	S_Digit <sub>13</sub>	S_Digit <sub>12</sub>	S_Digit <sub>11</sub>	S_Digit <sub>10</sub>	S_Digit <sub>03</sub>	S_Digit <sub>02</sub>	S_Digit <sub>01</sub>	S_Digit <sub>00</sub>

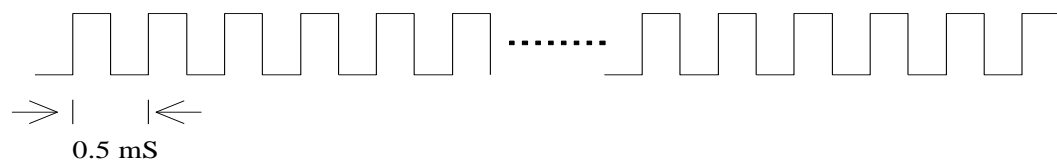


## Miscellaneous

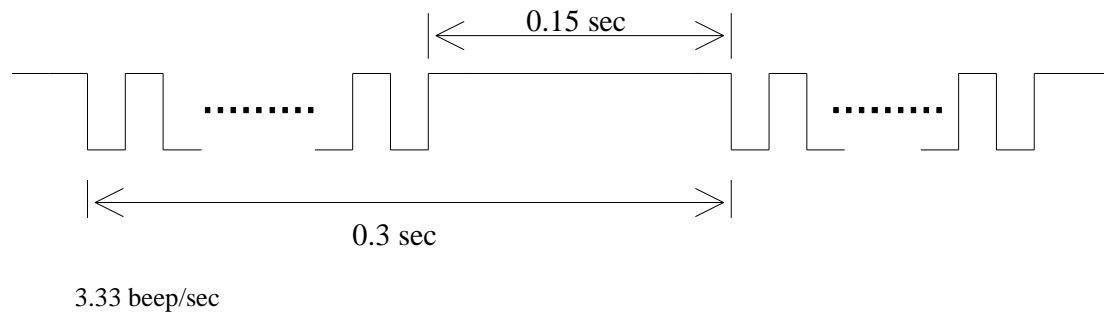
The conditions which the meter turns on the buzzer include:

- Changing measurement mode generates one beep.
- Pressing any of the push functions generates one beep, if the function is valid.
- Power on and re-power on generate one beep.
- Input overflow in voltage and current mode generates one beep every 0.3 seconds (or 3.33 beeps per second.)
- Continuity (diode) check generates a continuous 2KHz beep whenever the measurement is less than  $30\Omega(30mV)$
- Auto power off or power down by *SEL* key generates a 2KHz beeper that lasts for 1.5 seconds.

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



Continuous 2KHz beep





LCD configuration

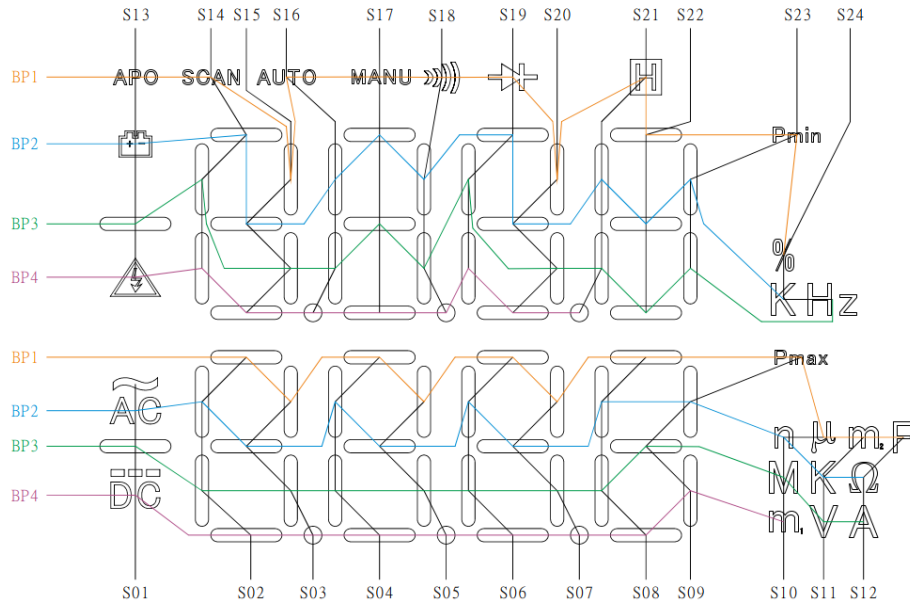


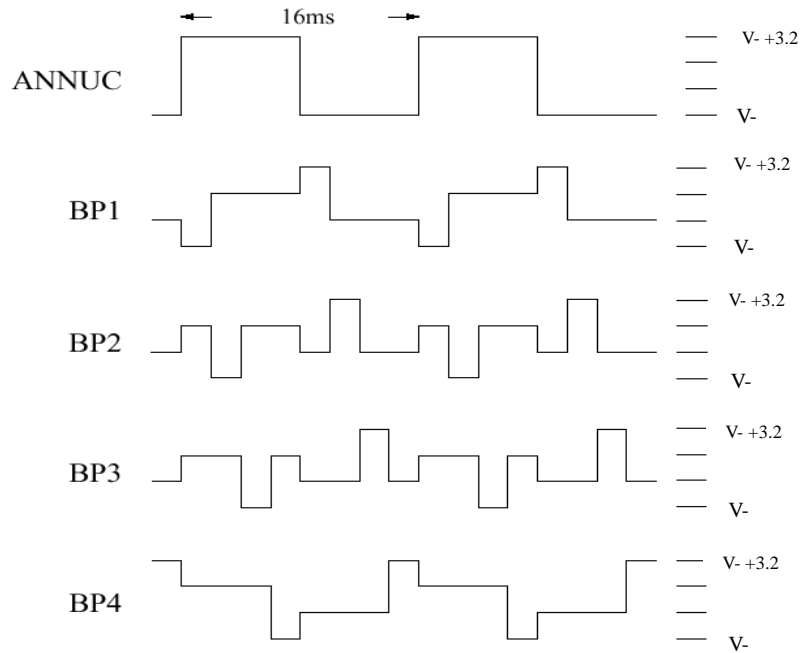
Table 16. LCD truth table

	SEG01	SEG02	SEG03	SEG04	SEG05	SEG06	SEG07	SEG08	SEG09	SEG10	SEG11	SEG12
BP1	<del>AC</del>	A4	B4	A3	B3	A2	B2	A1	PMAX	$\mu$	m2	F
BP2	AC	F4	G4	F3	G3	F2	G2	F2	B1	n	K2	$\Omega$
BP3	MINUS (main)	E4	C4	E3	C3	E2	D2	E1	G1	M	V	A
BP4	DC	D4	DP3	D3	DP2	D2	DP1	D1	C1	m1	<del> </del>	<del> </del>

	SEG13	SEG14	SEG15	SEG16	SEG17	SEG18	SEG19	SEG20	SEG21	SEG22	SEG23	SEG24
BP1	APO	SCAN	B4S	AUTO	MANU	BUZZER	DIODE	B2S	HOLD	A1S	Pmin	%
BP2	LBAT	A4S	G4S	F3S	A3S	B3S	A2S	G2S	F1S	G1S	B1S	K1
BP3	MINUS (sub)	F4S	C4S	E3S	G3S	C3S	F2S	C2S	E1S	D1S	C1S	Hz
BP4	ALARM	E4S	D4S	DP3S	D3S	DP2S	E2S	D2S	DP1S	<del> </del>	<del> </del>	<del> </del>



LCD Backplane Waveform



LCD display on condition

LCD annunciates	Condition
AC	In AC voltage or AC current mode.
MINUS (MAIN)	Main minus symbol.
DC	In DC voltage or DC current mode.
An-Gn	Main display digits
DPn	Main display dots
PMAX	When MAX&MIN function is enabled
μ	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.
M	In resistance measurement mode and the full scale range is in the order of MΩ
m <sub>1</sub>	In voltage or current measurement mode and the full scale range is in the order of 10 <sup>-3</sup> .
m <sub>2</sub>	In capacitor measurement mode and the full scale range is in the order of mF.
K2	In resistance measurement mode and the full scale range is in the order of KΩ
V	In voltage measurement mode.
F	In capacitance measurement mode.
Ω	In resistance measurement mode.
A	In current measurement mode.
APO	Automatic power off is enabled
LBAT	Low battery voltage indicator
MINUS(SUB)	Sub minus symbol.
ALARM	When the reading is exceeding default hazardous live voltage or OL in DCV or ACV, the HV warning symbol will be display. It will be active also when abnormal voltage applied at R/C/D/F modes.
SCAN	When auto scan mode is selected
AnS-GnS	Sub display digits
DPnS	Sub display dots
AUTO	When automatic full scale range selection is enabled.
MANU	In manual mode.
BUZZER	In continuity check mode.
DIODE	In diode mode.



HOLD	When HOLD function is enabled. When delay-hold is selected, the HOLD symbol will be blinking for 6 seconds.
PMIN	When MAX&MIN function is enabled
K1	In VAHZ frequency mode and the full scale range is in the order of KHz
Hz	In VAHZ frequency mode.



Application Circuit

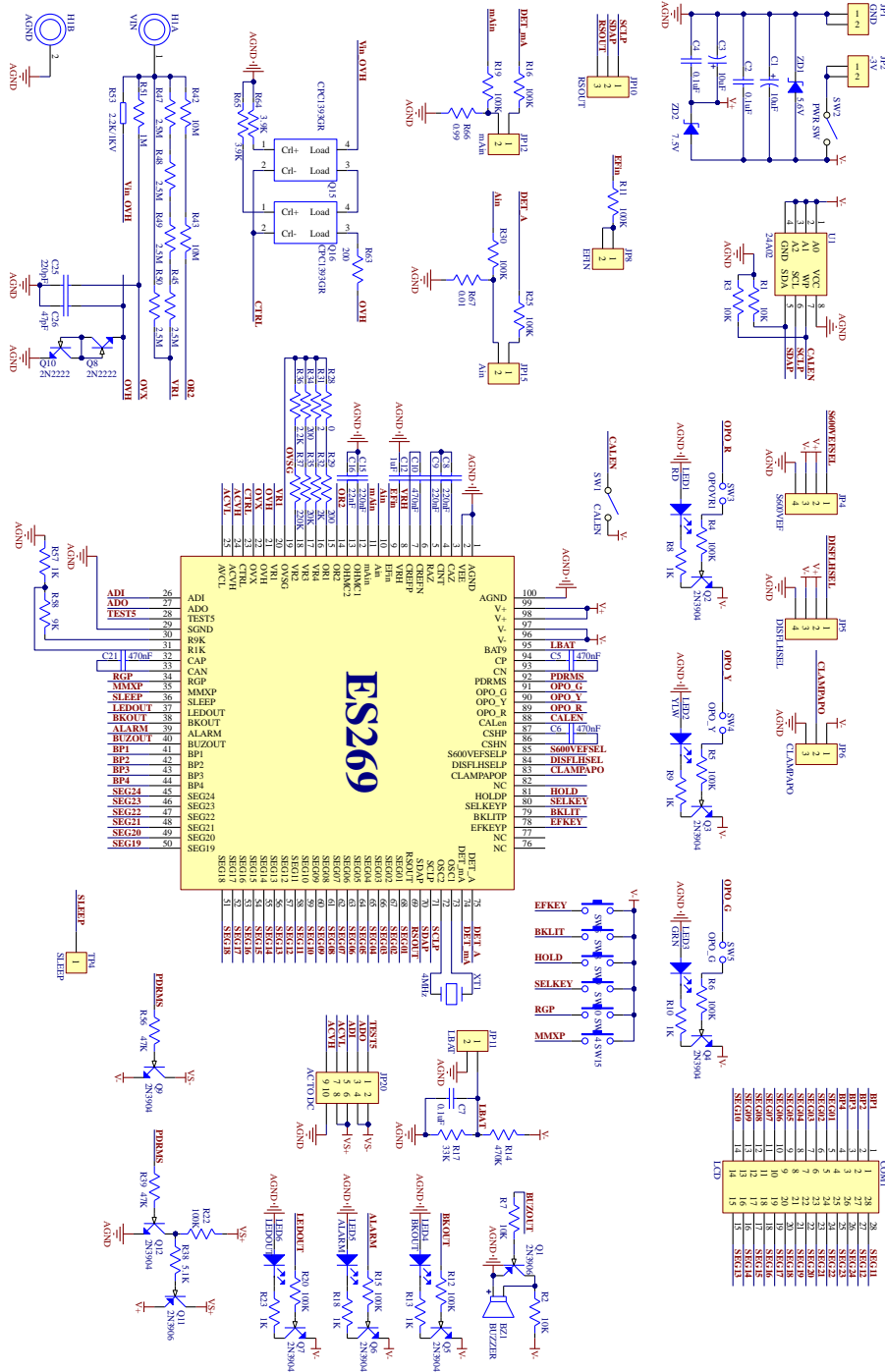


Figure 6. DMM model



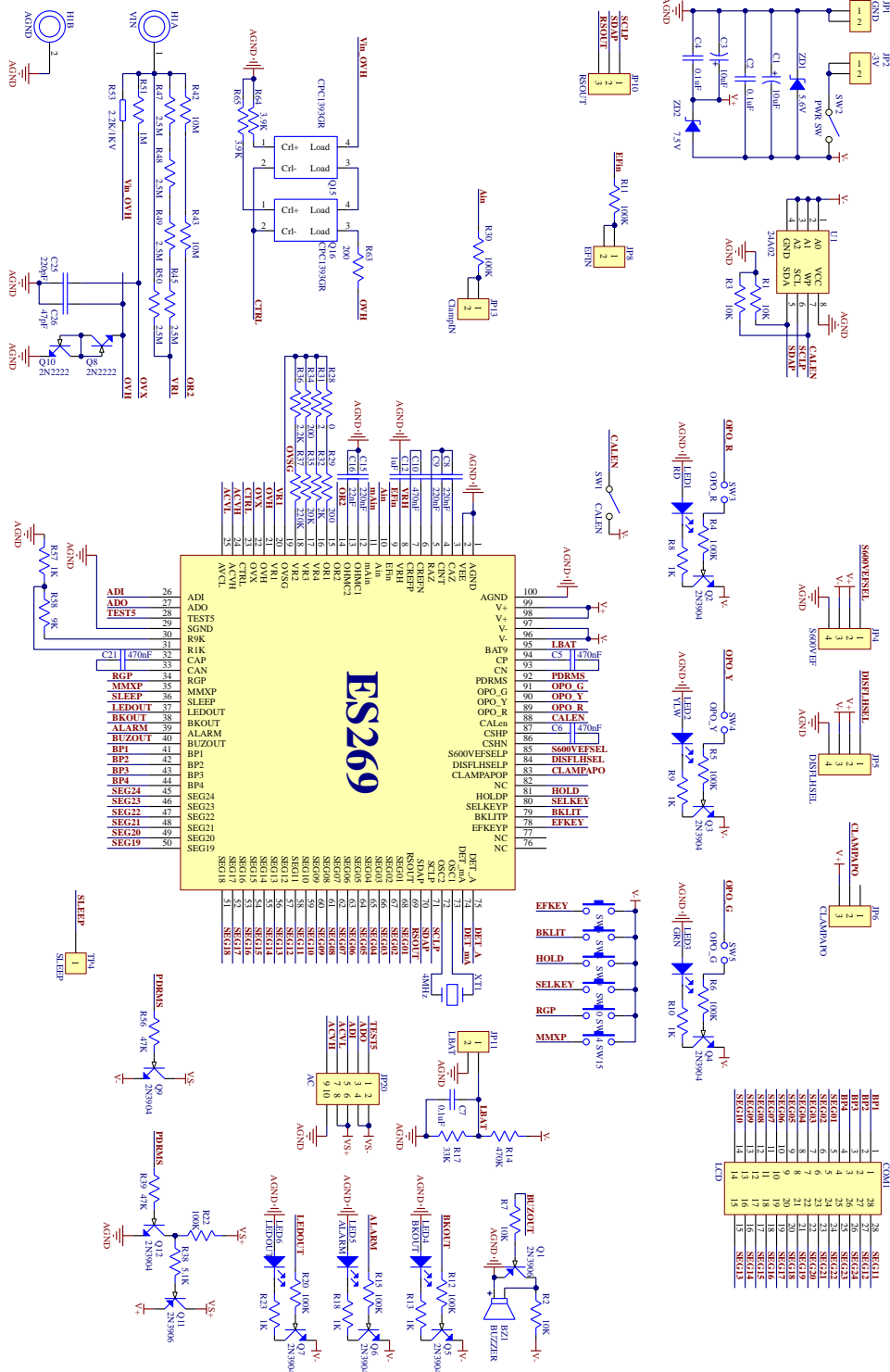


Figure 7. Clamp model



**Notes:**

- The ESD protection circuits protect most of pins. However, V+, V-, AGND, AGND and VR1 are not protected enough because the parasitic effect must be decrease. Therefore, enough external protection is needed for assembling, carrying, and keeping. In addition, components connecting to these unprotected pins must be soldered on board before the IC is soldered.
- All the **zener diodes** above are used for **IC protection**. These protections are needed and these zener diodes must be soldered on PCB first before soldering ES269 on.
- In order to automatically switch the measurement to A/mA in DMM mode, the input terminal must be designed to connect the DET\_A/DET\_mA pin to AGND when the test lead is inserted.



AC to DC circuit

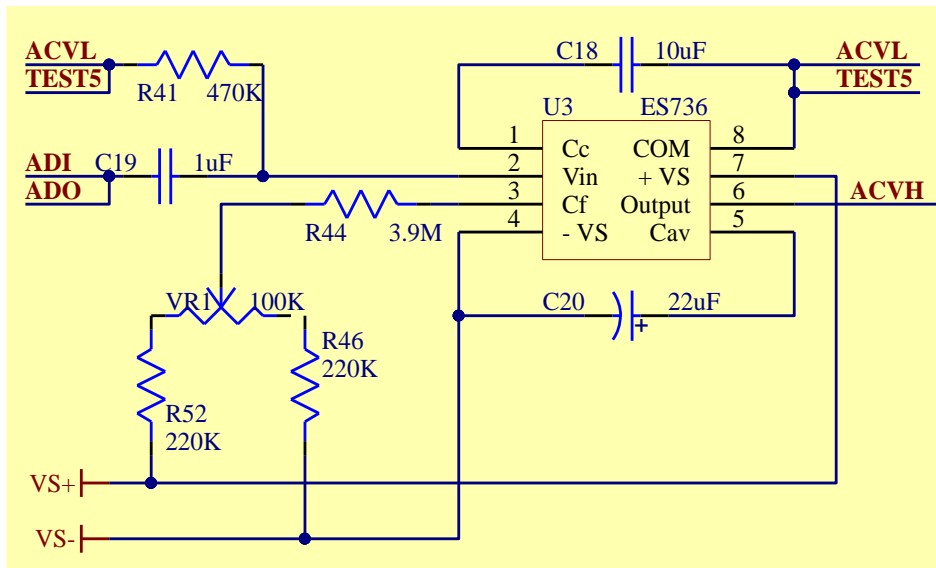


Figure 8. RMS IC (ES736)

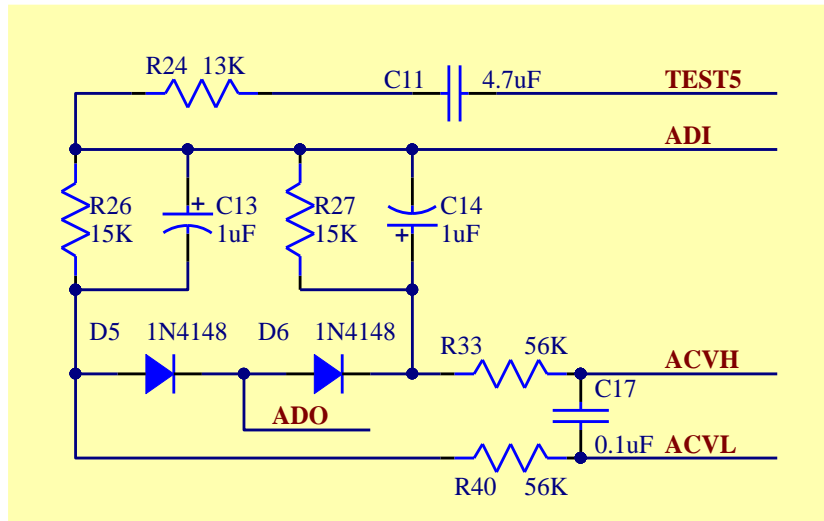
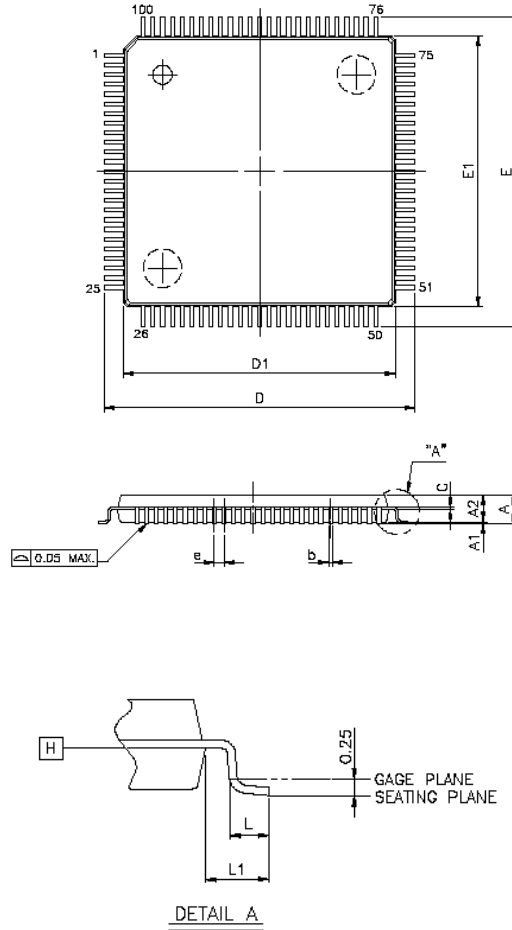


Figure 9. Rectifier circuit



**Package Information**  
**100 Pin LQFP Package**



**Dimension Parameters**

VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	--	--	1.60
A1	0.05	--	0.15
A2	1.35	1.40	1.45
b	0.17	0.20	0.27
c	0.09	0.127	0.20
D	16.00 BSC		
D1	14.00 BSC		
E	16.00 BSC		
E1	14.00 BSC		
e	0.50 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		