Datasheet

FS9721B

2,400 counts auto range DMM IC,

FORTUNE' Properties For Reference Only

Fortune SEMICONDUCTOR CORPORATION

Fortune Semiconductor Corporation
富晶電子股份有限公司
23F., No.29-5, Sec. 2, Zhongzheng E. Rd.,
Danshui Town, Taipei County 251, Taiwan
Tel.：886-2-28094742
Fax：886-2-28094874
www.ic-fortune.com

FORTUNE' Properties For Reference Only

This manual contains new product information. **Fortune Semiconductor Corporation** reserves the rights to modify the product specification without further notice. No liability is assumed by **Fortune Semiconductor Corporation** as a result of the use of this product. No rights under any patent accompany the sale of the product.

1 Description

FS9721B is a high performance, low power consumption, 3⅔ digits (2400 Counts) Analog/Digital Converter (ADC+MCU) that is embedded microprocessor. It contains 8 bit microprocessor, low noise and high stability operation amplifier, AC conmutation operation amplifier, voltage promotion and voltage regulated power source, high stability bandgap, auto measurement switch and function control circuit, buzzer driver circuit, clock oscillator circuit, Backlight display control circuit, LCD display driver circuit and so on.

Due to FS9721B is embedded microprocessor so that it can control the logic function during passing I/O. Measurement functions can be combined differently by using MEA1～MEA4 pins code; through the setting to the code can build the fully auto measurement meter. There are Range, Select, Hold/BLCTR, Rel, Hz/Duty, RS232 and Reset keys so that you can fulfil measurement selection, functions switch, data hold, Backlight display, relative value, frequency and duty cycle measurement, data transmission, reset and so on functions through these keys.

FS9721B has series data output function. User can connect the meter to computer to record, analysis, process and print the measured data.

With regard to the auto power off function, when there is no action within 30 minutes on the switch or keys of the meter, the system will enter the sleep mode automatically to save the power. In the process of using the meter, if it is not necessary to power off automatically, the function can also be cancelled in use.

FS9721B is manufacted by large intergrated circuit technology that has rised hugely the reliability of product and made the design be easy and the volume be small; the system takes low power voltage so as to be low power consumption and is convenient to use the power supply of battery, especially is proper for the use on the palm mode meter.

FS9721B is a multi-measurement AC/DC converter that embedded the microprocessor. Only less addition of external components, you can constitute a high accuracy, mult-function and low cost meter.

2 Features

Maximum Display: 2400 (3⅔ digits).
Converter Rate: 3 times/sec.
The Negative Instruction: Auto.
Power Voltage Range: 2.4V～3.6V.
Chip Power Consumption: ≤6mW.
Low Battery Warning: About 2.4 V.
Buzzer Driver Circuit (Frequency is about 2.7kHz).
RS232 Serial Data Output.
Embedded OPAMP for DC/AC switch.
Function Keys: Range, Select, Hold/BLCTR, Rel, Hz/Duty, RS232, Reset.
Unit Symbol and Backlight Display.
Auto Power-off.

3 Measurable Modes

DC Voltage: 240.0mV, 2.400V, 24.00V, 240.0V, 1000V.
AC Voltage: 240.0mV, 2.400V, 24.00V, 240.0V, 1000V.
DC: 240.0μA/ 2400μA,24.00mA/ 240.0mA,2.400A, 10.00A.
AC: 240.0μA/ 2400μA,24.00mA/ 240.0mA,2.400A, 10.00A.
Resistance: 240.0Ω,2.400kΩ,24.00kΩ,240.0kΩ,2.400MΩ,24.00MΩ.
Capacitance: 2.500nF,25.00nF,250.0nF,2.500μF,25.00μF.
Frequency: 5.000Hz, 50.00Hz, 500.0Hz, 5.000kHz, 50.00kHz, 500.0kHz, 5.000MHz
Duty Cycle: 0.1%～99.9%.
Diode: 0V～1.5 V.
Short Circuit Testing: Sound when lower than 50Ω.

FORTUNE Properties
For Reference Only

4 Application

Auto-Measurement Palm Mode Digital Multi-Function Meter.
Auto-Measurement Card Digital Multi-Function Meter.
Auto-Measurement Pen Digital Multi-Function Meter.
Auto-Measurement Clinch Meter (Hook Meter, Clamp Meter, etc.)
Number Panel Meter.

5 Block Diagram

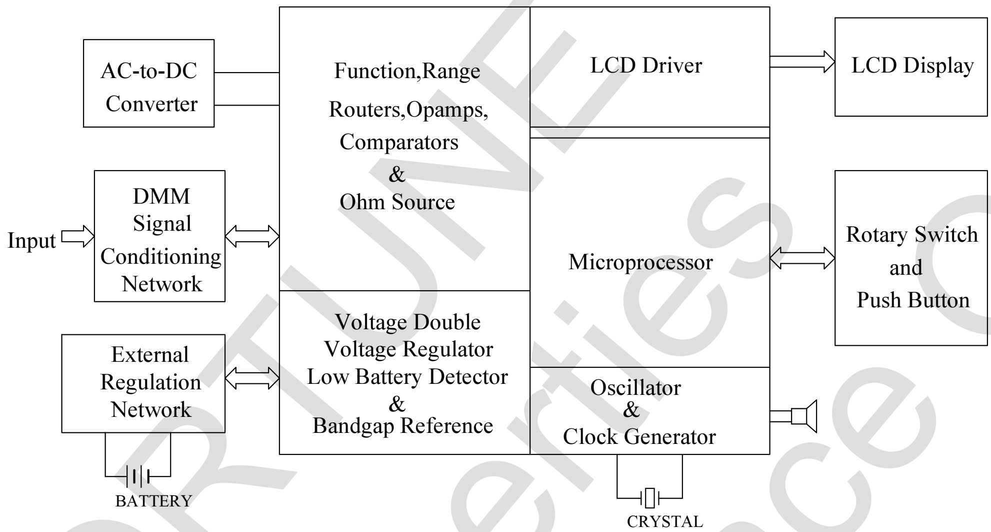


Diagram 1 Block Diagram

6 Pin Diagram

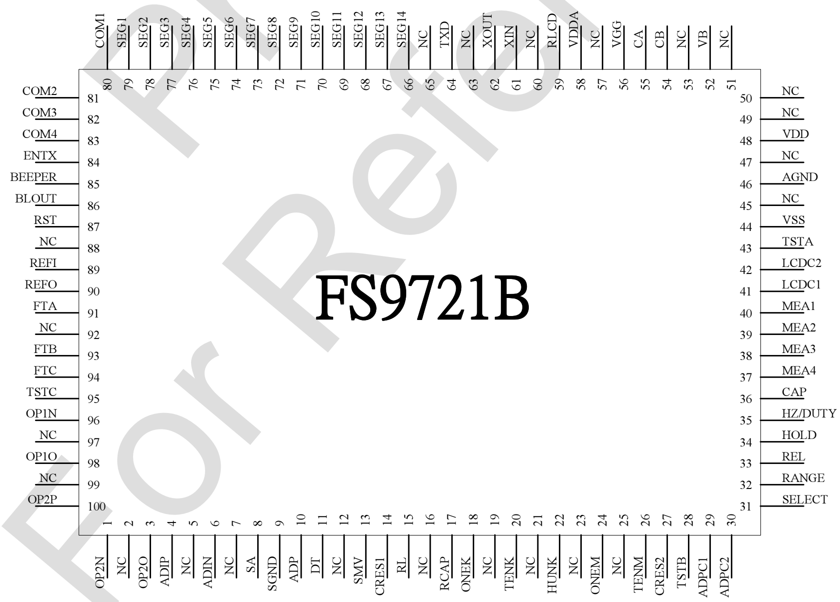


Diagram 2 100 PIN Package

FORTUNE' Properties For Reference Only

7 Pin Description

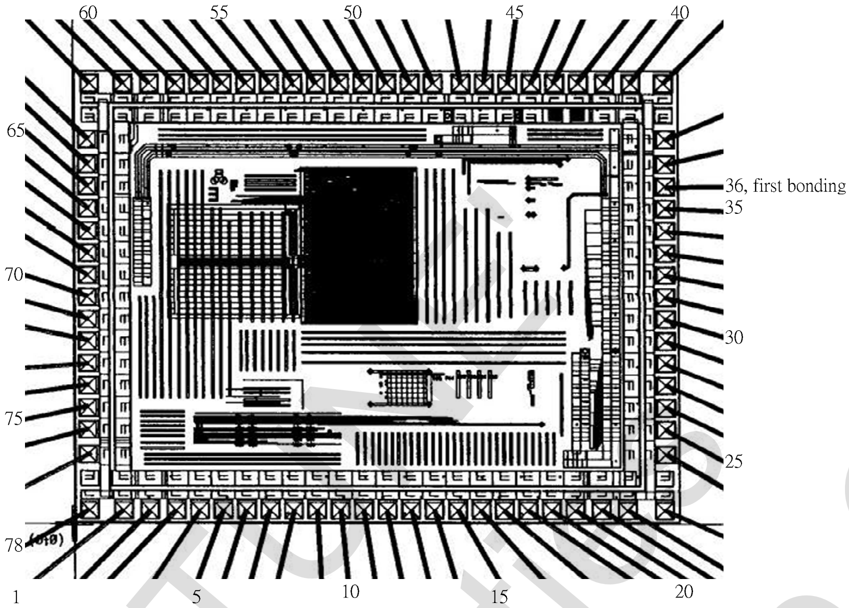
Package 100	Pad 78	SYMBOL	I/O	Description
1	1	OP2N	I	Negative Input of DC/AC Converter Operation Amplifier
2		NC		Empty Pin
3	2	OP2O	O	Output of DC/AC Converter Operation Amplifier
4	3	ADIP	I	ADC Positive Input of AC Measurement
5		NC		Empty Pin
6	4	ADIN	I	ADC Negative Input of AC Measurement
7		NC		Empty Pin
8	5	SA	I	ADC Input of Current Measurement
9	6	SGND	I	ADC Negative Input of Analog Ground Connection
10	7	ADP	I	Extra ADC Positive Input
11	8	DT	I/O	Voltage Division Resistance Connect Point of Diode Measurement
12		NC		Empty Pin
13	9	SMV	I	High Resistance Voltage Input/ ADC Positive Input of Resistance Measurement/ Voltage Division Resistance Connect Point of Diode Measurement
14	10	CRES1	I/O	Wave Filter Capacitance Connect Point of Measuring Point of Resistance Measurement
15	11	RL	I	Reference Voltage Negative Input of Resistance Measurement
16	12	NC		Empty Pin
17	13	RCAP	I/O	Calibrating Resistance Connect Point of Capacitance Measurement
18	14	ONEK	I/O	Resistance 1.001kΩ Connect Point of Voltage and Resistance Measurement
19		NC		Empty Pin
20	15	TENK	I/O	Resistance 10.010kΩ Connect Point of Voltage and Resistance Measurement
21		NC		Empty Pin
22	16	HUNK	I/O	Resistance 101.010kΩ Connect Point of Voltage and Resistance Measurement
23		NC		Empty Pin
24	17	ONEM	I/O	Resistance 1.111MΩ Connect Point of Voltage and Resistance Measurement
25		NC		Empty Pin
26	18	TENM	I/O	Resistance 10.000MΩ Connect Point of Voltage and Resistance Measurement
27	19	CRES2	I/O	Regulating Capacitance Connect Point of Voltage and Resistance Measurement
28	20	TSTB	I	Not Used
29	21	ADPC1	I	Maximum Input Voltage 240mV/24mV Selection (See 10.4)
30	22	ADPC2	I	DC/AC Selection of Measurement Signal (See 10.4)
31	23	SELECT	I	Measurement Function Selection
32	24	RANGE	I	Auto/Manual Measurement Selection
33	25	REL	I	Relative Value Measurement
34	26	HOLD	I	Display Hold/Backlight Control
35	27	HZ/DUTY	I	Frequency/Duty Cycle Measurement Selection
36	28	CAP	I	Capacitance Measurement Function Selection (See 10.1)
37	29	MEA4	I	Measurement Function Selection
38	30	MEA3	I	Measurement Function Selection
39	31	MEA2	I	Measurement Function Selection
40	32	MEA1	I	Measurement Function Selection
41	33	LCDC1	I	Segment 14 LCD Symbol Control 1 (See 10.3)
42	34	LCDC2	I	Segment 14 LCD Symbol Control 2 (See 10.3)
43	35	TSTA	I	Test Terminal
44	36	VSS	I	Negative Input of Power
45		NC		Empty Pin
46	37	AGND	I	Ground Connect Point of Analog Signal

FORTUNE Properties
For Reference Only

47		NC		Empty Pin
48	38	VDD	I	Positive Input of Power
49		NC		Empty Pin
50		NC		Empty Pin
51		NC		Empty Pin
52	39	VB	I	Bias Current Input
53		NC		Empty Pin
54	40	CB	I/O	Negative Connect Point of Charge Pump Capacitance
55	41	CA	I/O	Positive Connect Point of Charge Pump Capacitance
56	42	VGG	O	Output of Charge Pump Circuit
57		NC		Empty Pin
58	43	VDDA	O	Output of the Regulated Voltage Power/ Power Source of the Analog Circuit
59	44	RLCD	I	Connect Point of Adjust Resistance of the LCD Driver Voltage
60		NC		Empty Pin
61	45	XIN	I	Oscillator Connect Point
62	46	XOUT	O	Oscillator Connect Point
63		NC		Empty Pin
64	47	TXD	O	RS232 Serial Data Output
65		NC		Empty Pin
66	48	SEG14	O	Segment 14
67	49	SEG13	O	Segment 13
68	50	SEG12	O	Segment 12
69	51	SEG11	O	Segment 11
70	52	SEG10	O	Segment 10
71	53	SEG9	O	Segment 9
72	54	SEG8	O	Segment 8
73	55	SEG7	O	Segment 7
74	56	SEG6	O	Segment 6
75	57	SEG5	O	Segment 5
76	58	SEG4	O	Segment 4
77	59	SEG3	O	Segment 3
78	60	SEG2	O	Segment 2
79	61	SEG1	O	Segment 1
80	62	COM1	O	Backplane 1 of LCD Display
81	63	COM2	O	Backplane 2 of LCD Display
82	64	COM3	O	Backplane 3 of LCD Display
83	65	COM4	O	Backplane 4 of LCD Display
84	66	ENTX	I	Enable RS232 Output
85	67	BEEPER	O	Beeper Driver Output
86	68	BLOUT	O	Backlight Driver Output
87	69	RST	I	CPU Reset Input
88		NC		Empty Pin
89	70	REFI	I	ADC Reference Voltage Input
90	71	REFO	O	Bandgap Reference Voltage Output
91	72	FTA	O	Positive Output of the ADC Wave Pre-filter
92		NC		Empty Pin
93	73	FTB	I	Positive Input of the ADC Wave Pre-filter
94	74	FTC	I/O	Negative Point of the ADC Wave Pre-filter
95	75	TSTC	I	Test Pin
96	76	OP1N	I	Negative Input of the AC Buffer Operation Amplifier
97		NC		Empty Pin
98	77	OP1O	O	Output of the AC Buffer Operation Amplifier
99		NC		Empty Pin
100	78	OP2P	I	Positive Input of the AC/DC Converter Operation Amplifier

For Reference Only For Fortune Properties

8 Dice Pad Layout & Pad Coordinate



Substrate should be connected to VSS.
Pad opening: 90μm.
Chip size: 3.24mm×2.58mm.

Diagram 3 78PIN Dice

Pad No.	Name	X[mm]	Y[mm]	***Pad No.***	Name	X[mm]	Y[mm]
1	OP2N	0.264	0.077	40	CB	2.974	2.495
2	OP2O	0.404	0.077	41	CA	2.834	2.495
3	ADIP	0.544	0.077	42	VGG	2.694	2.495
4	ADIN	0.669	0.077	43	VDDA	2.569	2.495
5	SA	0.794	0.077	44	RLCD	2.444	2.495
6	SGND	0.919	0.077	45	XIN	2.319	2.495
7	ADP	1.044	0.077	46	XOUT	2.194	2.495
8	DT	1.169	0.077	47	TXD	2.069	2.495
9	SMV	1.294	0.077	48	SEG14	1.923	2.495
10	CRES1	1.419	0.077	49	SEG13	1.798	2.495
11	RL	1.544	0.077	50	SEG12	1.673	2.495
12	N.C	1.669	0.077	51	SEG11	1.548	2.495
13	RCAP	1.794	0.077	52	SEG10	1.423	2.495
14	ONEK	1.919	0.077	53	SEG9	1.298	2.495
15	TENK	2.044	0.077	54	SEG8	1.173	2.495
16	HUNK	2.169	0.077	55	SEG7	1.048	2.495z
17	ONEM	2.294	0.077	56	SEG6	0.923	2.495

FORTUNE Properties For Reference Only

18	TENM	2.419	0.077	57	SEG5	0.798	2.495
19	CRES2	2.544	0.077	58	SEG4	0.673	2.495
20	TSTB	2.669	0.077	59	SEG3	0.548	2.495
21	ADPC1	2.809	0.077	60	SEG2	0.408	2.495
22	ADPC2	2.949	0.077	61	SEG1	0.268	2.495
23	SELECT	3.147	0.077	62	COM1	0.091	2.495
24	RANGE	3.157	0.396	63	COM2	0.077	2.176
25	REL	3.157	0.536	64	COM3	0.077	2.036
26	HOLD	3.157	0.661	65	COM4	0.077	1.911
27	HZ/DUTY	3.157	0.786	66	ENTX	0.077	1.786
28	CAP	3.157	0.911	67	BEEPER	0.077	1.661
29	MEA4	3.157	1.036	68	BLOUT	0.077	1.536
30	MEA3	3.157	1.161	69	RST	0.077	1.411
31	MEA2	3.157	1.286	70	REFI	0.077	1.286
32	MEA1	3.157	1.411	71	REFO	0.077	1.161
33	LCDC1	3.157	1.536	72	FTA	0.077	1.036
34	LCDC2	3.157	1.661	73	FTB	0.077	0.911
35	TSTA	3.157	1.786	74	FTC	0.077	0.786
36	VSS	3.157	1.911	75	TSTC	0.077	0.661
37	AGND	3.157	2.036	76	OP1N	0.077	0.536
38	VDD	3.157	2.176	77	OP1O	0.077	0.396
39	VB	3.148	2.495	78	OP2P	0.083	0.077

FORTUNE Properties For Reference Only

9 Technical Specification (VDD=3V, Ta=25℃)

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
VDD	Recommend Operation Power Voltage		2.4		3.6	V
IDD	Supply Current	At DCV Mode		1.5	2	mA
IPO	Power Supply Current	At Power Off			10	μA
VIH	Digital Input High Voltage		VDD-0.5			V
VIL	Digital Input Low Voltage				0.5	V
Ipu	Pull up Current	Vin=0		5	10	μA
AGND	Analog Ground Voltage		VDD/2 -3%	VDD/2	VDD/2 +3%	V
VDDA	Analog Power		3.4	3.7	4	V
VBAND	Build in Reference Voltage	Relative to AGND	1.1	1.25	1.4	V
	Build in Reference Voltage Output Voltage Coefficient	VDD=2.4~3.6	-2000		+2000	ppm/V
REFI	Recommend Reference input Voltage	Relative to AGND		0.44		V
VBATT	Low Battery Detector Voltage		2.25	2.4	2.55	V
FLCD	LCD Frame Frequency			32		Hz
VLCD	LCD Pk-Pk Driver Voltage		2.8	3	3.2	V
FBEEP	Beeper Frequency			2.7		kHz
FRS232	RS232 Baud Rate			2400		Hz
IRSOUT	RS232 Output High Current	VOH=2V	2			mA
	Zero Input Reading	DC ADPxl Input=0V	-0.001	0.000	0.001	
	Linearity (Max. Deviation From Best Straight Line Fit	DC ADPxl Input,Full Scale±240.0mV	-1	0	+1	Counts
	AC Measurement Bandwidth Error	AC ADPxl Input240mVrms 20Hz~1kHz			0.2	%
Rcc	Continuity Check Value		10		60	Ohm
	ADC Measurement O.L Display Count			2500		Counts
	Autorange Up Counts			2400		Counts
	Autorange Down Counts			230		Counts
VFREA	Frequency Counter Input Level (Hz/Duty Control)	VIL(Relative to AGND)	-60			mV
		VIH(Relative to AGND)			60	mV
FMAXA	Frequency Counter Max Input frequency (Hz/Duty Control)	Vpp=±100mV Square Wave Input	500k			Hz
*1	Duty Measurement Min Pulse Width Error (Hz/Duty Control)	Vpp=±100mV Square Wave Input			1	μS
VFRED	Frequency Counter Input Level (MEAS=0101)	VIL(Relative to AGND)	-600			mV
		VIH(Relative to AGND)			600	mV
FMAXD	Frequency Counter Input Level (MEAS=0101)	Vpp=±600mV Square Wave Input	5M			Hz
*1	Duty Measurement Min Pulse Width Error(MEAS=0101)	Vpp=±600mV Square Wave Input			100	nS

FORTUNE Properties For Reference Only

	Capacitor Measurement Accuracy after Zero Input Relative To Adjust by 250.0nF Mode	2.500nF Mode			5%+25	Counts
		25.00 nF Mode			2%+10	Counts
		250.0 nF Mode			0.5% +3	Counts
		2.500 μF Mode			1%+2	Counts
		25.00 μF Mode			1.5% +2	Counts

*1 In the duty cycle measurement, we have to input square waves. The main error of the measurement is due to the error of the pulse width that the comparator can resolve. Suppose the error is 100ns and the input frequency is 100KHz. We can divide the square wave into 1000 segments (1000 counts), and thus each count takes 10 ns. Therefore the maximum error in Duty Cycle measurement is (100ns/10ns)=10 Counts. 50% duty cycle signal can be measured to 50.0%±1.0%. The signal may not be measured if the duty cycle is more than 99% or less than 1%, and the measurement will display 0.00%.

10 Measurement Mode Selection

10.1 Measurement Mode Selection (MEA1～MEA4 is “1” for empty, and “0” for connect to VSS)

MEA4	MEA3	MEA2	MEA1	Measurement Function and Select Key Function Switch		Hz/Duty	Rel	Hold	Range	Select	Jump
1	1	1	1	DCV/ACV ②	DCV/ACV Switch	Hz/Duty Voltage Switch	●	●	●	●	J4
1	1	0	1	Ohm/Diode/ Continuity /Cap.	CAP=1: Ohm/Diode/ Cont. Switch CAP=0: Ohm/Diode/ Cont./Cap. Switch		●	●	Ohm●	●	J3, J5
1	0	1	0	DCV No mV Mode		V/Hz/Duty Switch	●	●	●		J4
1	0	0	1	ACV		V/Hz/Duty Switch	●	●	●		J4
1	0	1	1	DCmV		mV/Hz/Duty/ Switch	●	●			J3
1	0	0	0	10A	DCA/ACA Switch	A/Hz/Duty Switch	●	●	●	●	
1	1	1	0	mA	DCmA/ACmA Switch	mA/Hz/Duty Switch	●	●	●	●	J1
1	1	0	0	μA	DCμA/AcμA Switch	μA/Hz/Duty Switch	●	●	●	●	J2
0	1	1	1	Cap			●	●			J3, J5
0	1	0	1	Hz/Duty ③		Hz/Duty Switch		●			J6
0	0	1	1	Input from ADP							
0	0	1	0								
0	0	0	1								

FORTUNE' Properties For Reference Only

0	0	0	0	Please Refer to Form 10.2								
0	1	1	0	Input from ADP ④								

Note: ① The "JX" in Jump column means the JX of the measurement function is open circuit in the diagram that common used by diagram 6 and 7.

② In Auto mode, the ACmv Measurement of ACV mode can be selected only when the Range key is pressed.

③ This mode uses ADP path input to measure Hz/Duty.

④ ADP can auto-range for 240.0mV/24.00mV, and display 2400 and 240.0, respectively.

10.2 Determination of ADP Input and Self-defined Symbol and Decimal Location

(MEA1～MEA4 is "1" for empty, and "0" for connect to VSS)

MEA4	MEA3	MEA2	MEA 1	Range of Input Voltage	Input Channel	Decimal Location	Symbol Location	Symbol
0	0	1	1	±240mV	ADP	2400	Set by LCDC1 and LCDC2	User-Defined
0	0	1	0			240.0		
0	0	0	1			24.00		
0	0	0	0			2.400		

10.3 Use the Combination of LCDC1 and LCD2 to Determine the Self-defined Symbol Location in LCD

(LCDC1 and LCDC2 is "1" for empty, and "0" for connect to VSS)

LCDC1	LCDC2	Symbol Location	Description
0	0	COM1, SEG14	User Defines Symbol
1	0	COM2, SEG14	
0	1	COM3, SEG14	
1	1	COM4, SEG14	

10.4 The Function of ADPC1 and ADPC2 in ADP Input

(ADPC1 and ADPC2 is "1" for empty, and "0" for connect to VSS)

ADPC1	ADPC2	DC/AC Status	ADP Maximum Input Voltage
1	1	DC	240mV
1	0	AC	
0	1	DC	24mV
0	0	AC	

FORTUNE Properties For Reference Only

11 Keys Definition

Range (Auto/Manual Measurement Switch)

Range key is the key to switch Auto/Manual Measurement and it acts in activation. The default is Auto Measurement when power is on. To press one time, the system will switch to Manual Measurement. In Manual Measurement mode, the system will jump one range up when the key is pressed one time. If continue to press the key in the top range, the system will jump to the lowest range, and recircle orderly. If press and hold the key over 2 seconds, the system will switch to Auto Measurement mode. The Hz/Duty Cycle cannot be measured by Manual Measurement.

Hold/BLCTR (Display Hold/Backlight Control)

Hold/BLCTR key is the key to control Display Hold/Backlight and it acts in activation. The functions are: hold the display data/Backlight control. When the key is pressed, the display data will be locked and keep unchanged; if press the key again, the system will be unlocked and enter the normal measurement mode.
When press and hold the key over 2 seconds will enable Backlight.

Rel (Relative Value Measurement)

Rel key is the key to measure Relative Value and it acts in activation. All controls can measure Relative Value except Hz/Duty, Diode and Continuity functions.

Select (Function Switch)

Select is the key to select the functions and it acts in activation. Use the key to select the function to measure.

RS232 (Series Output Control)

RS232 is the key to control the Series Output and it acts in lock mode. When the key is close, LCD displays RS232 symbol that means the meter is in the data transmission status and can transmit the data outside; when the key is open, the system will secede and the data transmission will be stop.

Hz/Duty(Frequency/Duty Cycle)

Hz/Duty is the key to select Frequency/Duty Cycle and it acts in activation. In Frequency Measurement Mode, press the key is to select Hz or Duty Measurement; in AC/DC Mode, press the key is to select Voltage /Hz/Duty or Current/Hz/Duty Measurement Mode.

Reset (Reset Key)

Reset is the key to reset the system and it acts in activation. Press the key is to reset the microprocessor.

12 Other Functions

Auto Power-off

In the process of measurement, if no any action is operated in 30 minutes for function keys or function switch, the meter will be "Auto Power-Off" (Standby Mode). In Auto Power-Off status, if the function keys are pressed or the function switch is activated, the meter will be "Auto Power-On" (Working Mode).
If press and hold Select key to power on, Auto Power-Off function will be disabled.
In RS232 working status, Auto Power-Off function will be disabled.

Buzzer

In short testing, if the resistance is lower than 50Ω, the beeper will sound.

Backlight

The system has the Backlight driver output function to control the Backlight circuit open so as to provide the convenience of reading the value when in the dim light and poor vision. When press the Hold/BLCTR key over 2 seconds, Backlight will open; when press the key again over 2 seconds, Backlight will close.

Series Data Output

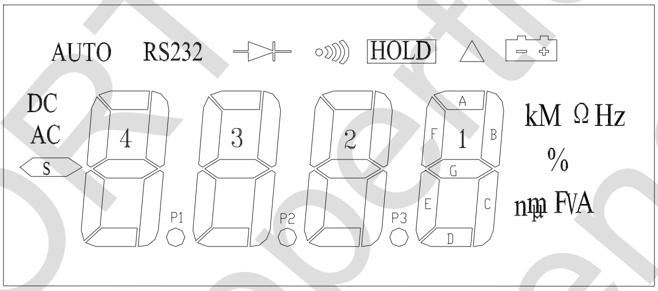
The system has the series data output function. When the meter connect to the equipment with series data interface (RS232) such as computer, it can output the measured data (including symbols) for the convenience to record, analysis, process and print the measured result.

FORTUNE Properties For Reference Only

13 RS232 Transmission Protocol

Direction: One-way to computer.
Series Transmission Rate: 2400 bps
Data Bit: 8 bit.
Odd and Even Calibration: None
Data Decimal: Hex
Data Length: 14 Bytes.
Data Information: LCD table on-off information.
Data Format: 1st byte → 1X (X is seg1, 4 bits represent the data on the LCD table)
2nd byte→ 2X (X is seg2, 4 bits represent the data on the LCD table)
3rd byte → 3X (X is seg3, 4 bits represent the data on the LCD table)
and so on.
1X → 4 bit, 2X→ 4 bit, 3X→ 4 bit
……………
EXH→ 4it
X means: Bit3～Bit 0→ segn (COM4—COM1)
Sampling Rate: 40KHz
ADC Output Frequency: 40Hz
ADC Output Frequency after Average: 10Hz
Output Frequency after Auto-Zero: 4Hz

14 LCD Display -- FS9721B/Q100(C2=LCDC2, C1=LCDC1)



FS9711B/FS9721B LCD DISPLAY AND FORMAT

PIN / COM	1 COM4	2 COM3	3 COM2	4 COM1	5 SEG1	6 SEG2	7 SEG3	8 SEG4	9 SEG5	10 SEG6	11 SEG7	12 SEG8	13 SEG9	14 SEG10	15 SEG11	16 SEG12	17 SEG13	18 SEG14
COM1				COM1	RS232	A1	A2	B1	B2	C1	C2	D1	D2			HOLD		C2_C1 0_0
COM2			COM2		AUTO	A6	A7	B6	B7	C6	C7	D6	D7	k	M	△	Hz	C2_C1 0_1
COM3		COM3			DC	A5	A3	B5	B3	C5	C3	D5	D3	n	%	Ω	V	C2_C1 1_0
COM4	COM4				AC	S	A4	P1	B4	P2	C4	P3	D4	µ	m	F	A	C2_C1 1_1

Notes: 1. Working Voltage: 3V.
2. Drive Method: 1/4 Duty, 1/3 Bias.

Diagram 4 LCD Display Structure

FORTUNE Properties For Reference Only

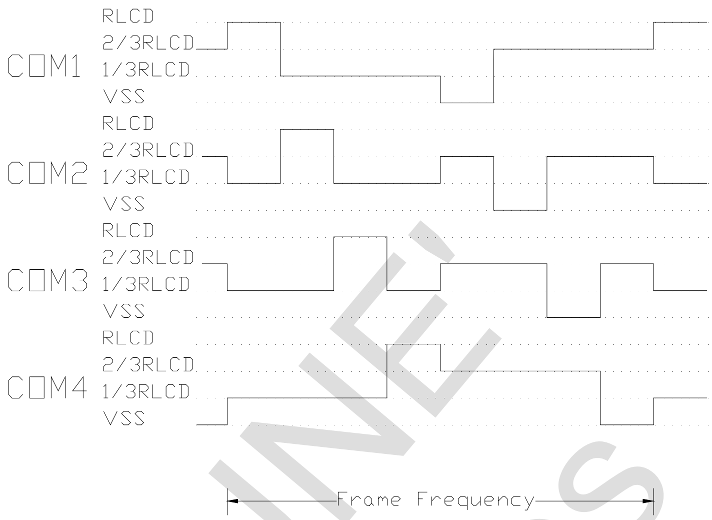


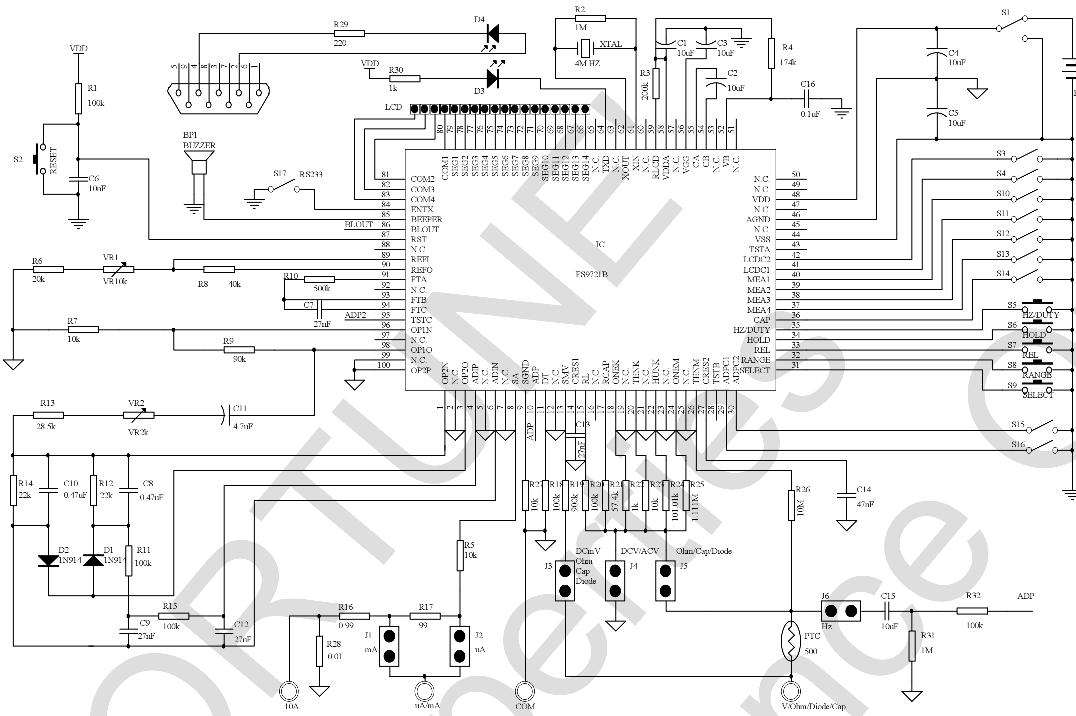
Diagram 5 LCD Display COM Drive Wave

FORTUNE Properties For Reference Only

15 Application Description

15. 1 Common Use Circuit Diagram

A · 100 PIN Package IC

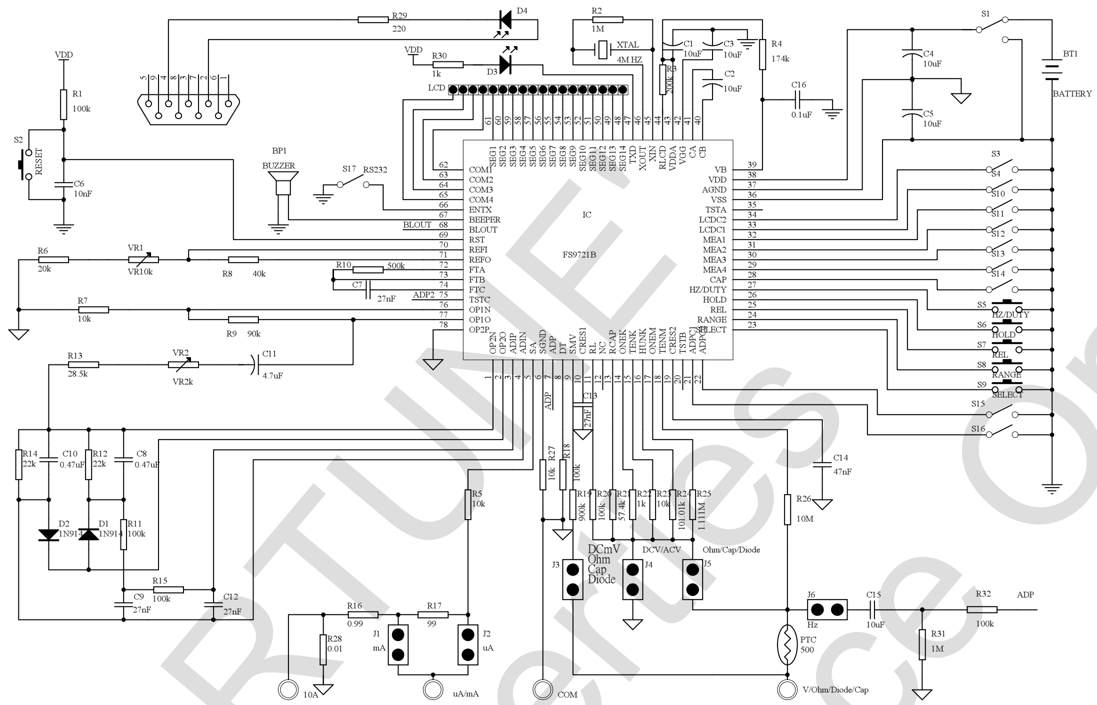


VSS		Battery Negative Terminal and IC Negative Power Input
VDD		Battery Positive Terminal and IC Positive Power Input
VGG		VDD Charge Pump voltage about 2*VDD
VDDA		IC Analog Power about 3.9V
AGND		Analog Common about VDD/2

Diagram 6 100 PIN Common Use Circuit Diagram

FORTUNE Properties For Reference Only

B. 78 PIN Dice IC



VSS	Battery Negative Terminal and IC Negative Power Input
VDD	Battery Positive Terminal and IC Positive Power Input
VGG	VDD Charge Pump voltage about 2*VDD
VDDA	IC Analog Power about 3.9V
AGND	Analog Common about VDD/2

Diagram 7 78 PIN Common Use Circuit Diagram

FORTUNE Properties For Reference Only

15.2 FS9721B Technical Pointer and Components Relationship

	Network	Current Mode×10 (R9:R7=9:1)	AC Measurement (R13+VR2,R12=R14)	Voltage Reference (R8,R6,VR1)
DC 240mV	R26	No	No	Yes
DC 2.4V	R25/(R26+R25)=1/10	No	No	Yes
DC 24V	R24/(R26+R24)=1/100	No	No	Yes
DC 240V	R23/(R26+R23)=1/1000	No	No	Yes
DC 1000V	R22/(R26+R22)=1/10000	No	No	Yes
AC 240mV	R25/(R26+R25)=1/10, R9:R7=9:1	No	Yes	Yes
AC2.4V	R25/(R26+R25)=1/10	No	Yes	Yes
AC 24V	R24/(R26+R24)=1/100	No	Yes	Yes
AC 240V	R23/(R26+R23)=1/1000	No	Yes	Yes
AC 1000V	R22/(R26+R22)=1/10000	No	Yes	Yes
R 240Ω	R26//R22=1kΩ	No	No	No
R 2.4kΩ	R26//R22=1kΩ	No	No	No
R 24kΩ	R26//R23=10kΩ	No	No	No
R 240kΩ	R26//R24=100kΩ	No	No	No
R 2.4MΩ	R26//R25=1MΩ	No	No	No
R 24MΩ	R26=10MΩ	No	No	No
DC 240μA	R17+R16+R28=100Ω	Yes	No	Yes
DC 2400μA	R17+R16+R28=100Ω	No	No	Yes
DC 24mA	R16+R28=1Ω	Yes	No	Yes
DC 240mA	R16+R28=1Ω	No	No	Yes
DC 10A	R28=0.01Ω	Yes	No	Yes
AC 240μA	R17+R16+R28=100Ω	Yes	Yes	Yes
AC 2400μA	R17+R16+R28=100Ω	No	Yes	Yes
AC 24mA	R16+R28=1Ω	Yes	Yes	Yes
AC 240mA	R16+R28=1Ω	No	Yes	Yes
AC 10A	R28=0.01Ω	Yes	Yes	Yes
CAP	R21	No	No	No
Diode		No	No	Yes

HOT-UNE Properties For Reference Only

15.3 FS9721B (Diagram 6 and Diagram 7) Components List

NO.	SPEC.	NO.	SPEC.	NO.	SPEC.	NO.	SPEC.	NO.	SPEC.
R1	100kΩ	R13	28.5kΩ	R25	1.111MΩ	C5	10μF	D1	1N914
R2	1MΩ	R14	22kΩ	R26	10.000MΩ	C6	10nF	D2	1N914
R3	200kΩ	R15	100kΩ	R27	10kΩ	C7	27nF	D3	DioS
R4	100kΩ	R16	9.99Ω	R28	0.01Ω	C8	0.47μF	D4	DioR
R5	10kΩ	R17	990Ω	R29	1kΩ	C9	27nF	VR1	10kΩ
R6	20kΩ	R18	100kΩ	R30	220Ω	C10	0.47μF	VR2	2kΩ
R7	10kΩ	R19	900kΩ	R31	1MΩ	C11	4.7μF	LCD	LCD
R8	40kΩ	R20	100kΩ	R32	100kΩ	C12	27nF	XTAL	4MHz
R9	90kΩ	R21	57.4kΩ	C1	10μF	C13	27nF	IC	FS9721B
R10	500kΩ	R22	1.001kΩ	C2	10μF	C14	47nF	Battery	1.5V×2
R11	100kΩ	R23	10.010kΩ	C3	10μF	C15	10μF	BP1	Buzzer
R12	22kΩ	R24	101.010kΩ	C4	10μF	C16	0.1μF	PTC	500Ω

Note: The technical instructions such as the accuracy, duty and press-proof of resistance and capacitance components are not marked in the common use circuitry and the components list, they depends on users' actual needs when designing the products.

15.4 Power System

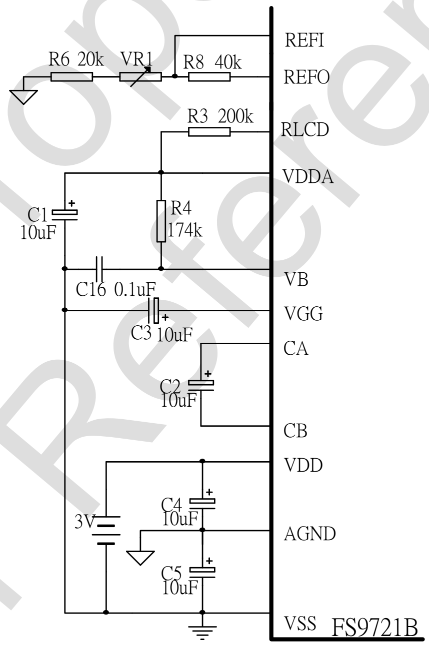


Diagram 8 Power Circuit

FORTUNE Properties For Reference Only

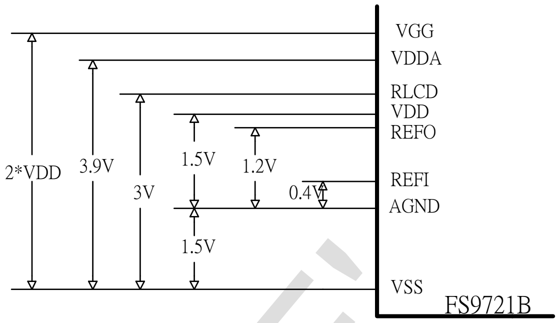


Diagram 9 Relative Voltage of Each Point

VB is the bias current input point in IC. The increase of R4 will reduce the current consumption in IC, but the shortage of bias current will affect the input range of AC measurement.

AGND is the analog ground connection. Its value is equal to the middle point of battery voltage. The point value is generated in the IC and cannot connect to the middle point of battery.

C4 and C5 are bypath capacitance, and also to make AGND regulated to VDD and VSS. C2 is power pump capacitance. IC makes VDD voltage pass C3 to charge/discharge to rise VGG being about double voltage of VDD.

VDDA is the output voltage after the regulation of VGG in the IC. It is about 3.9V that relative to VSS.

REFO is the bandgap power source in the IC. It is about 1.2V that relative to AGND and has 100ppm/℃ stability.

15.5 Power Supply Circuit

The different applications of user make different power supply methods. In some measurements, sensor requires higher voltage such as OPAMP, Hale components and so on that it is difficult to supply the power by 3V, then you can take some power supply methods as below.

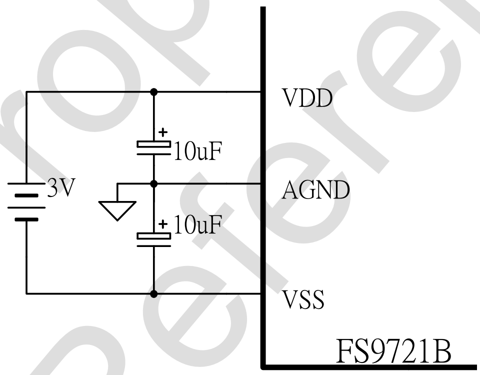


Diagram 10 3V Power Supply

FORTUNE' Properties For Reference Only

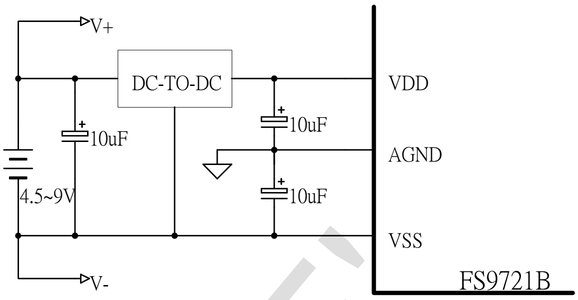


Diagram 11　 4.5V～9V Power Supply

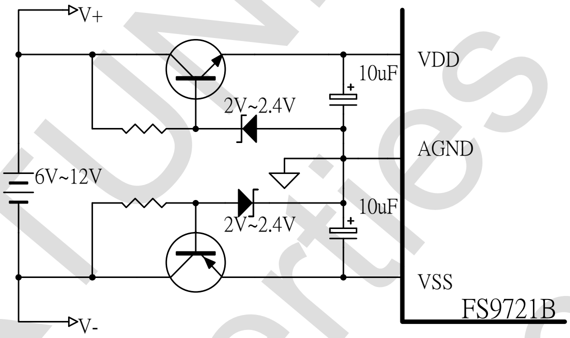


Diagram 12　 6V～12V Power Supply

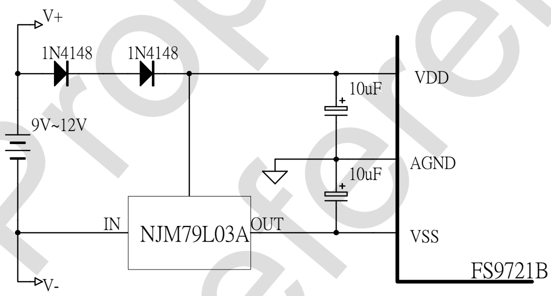


Diagram 13　 9V～12V Power Supply

15.6　Basic Power Source

FORTUNE's Properties For Reference Only

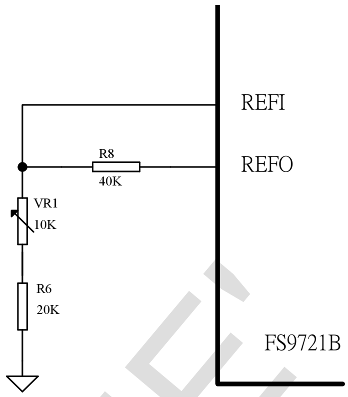


Diagram 14 Utility of Internal Basic Power Source

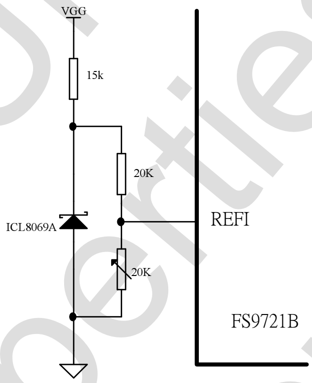


Diagram 15 Utility of External Basic Power Source

15.7 Activated Reset Circuit

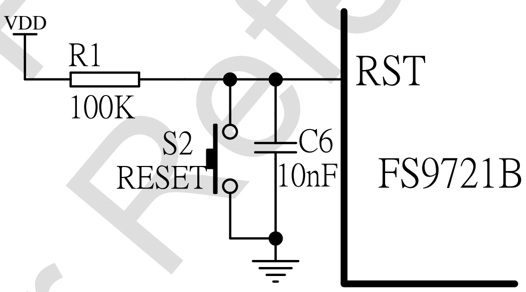


Diagram 16 Reset Circuit

FORTUNE Properties For Reference Only

15.8 Crystal Oscillator Circuit

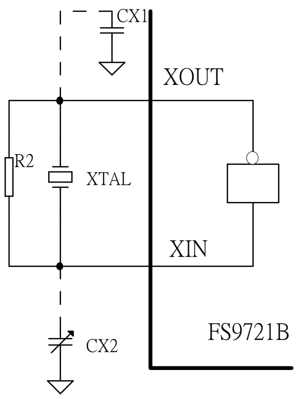


Diagram 17 Crystal Oscillator Circuit

In the diagram, R2 provides the statical working point for the revisor; CX2 is for tiny adjustment of frequency; CX1 is temperature compensation. In less requirements situation, CX1 and CX2 can be unused.

15.9 Buzzer Driver Circuit

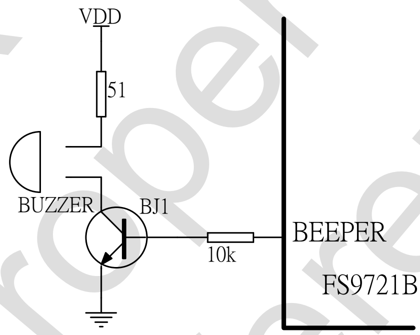


Diagram 18 Low Resistance Beeper Connection

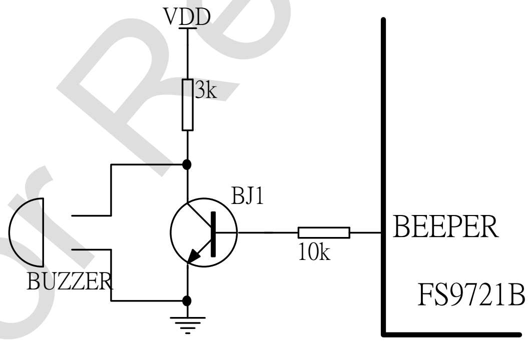


Diagram 19 High Resistance Beeper Connection

FORTUNE' Properties For Reference Only

15.10 Mode Switch and Function Control Circuit

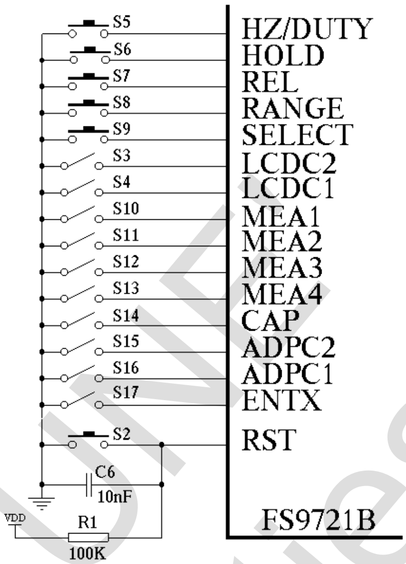


Diagram 20 Mode Switch and Function Control Circuit

S3～S4 andS10～S17 are Lock switch. The function of S3～S4, please refer to 10.3. The function of S15～S16, please refer to 10.4. The function of S10～S13, please refer to 10.1. The selection of doing the capacitance measurement when S14 is the same mode in Ohm/Diode/Continuity/Cap., please refer to 10.1. S17 is the control switch of RS232 output. S2 and S5～S9 are function selection switch and act in activation. For their functions, please refer to "Keys Definition" and "Other Functions".
In actual application, the utility of switch and keys should be taken according to the real situation.

FORTUNE Properties For Reference Only

15.11 AC Commutation Circuit

Diagram 21 is the average commutation circuit diagram of FS9711B. In the circuit, AC signals enter IC through R26, and then in the process of voltage division through R26, R25, R24, R23 and R22. The divided AC signals are out from OP1O pin and enter IC through ADIP pin and ADIN pin after commutation. VR2 can adjust the voltage of the signals to do the calibration of AC measurement.

240mV mode is amplified 10 times through OP.

Diagram 22 is the peak commutation circuit diagram. Diagram 23 is the true validity commutation circuit diagram, the user can determine by self according to the need to select which commutation circuit.

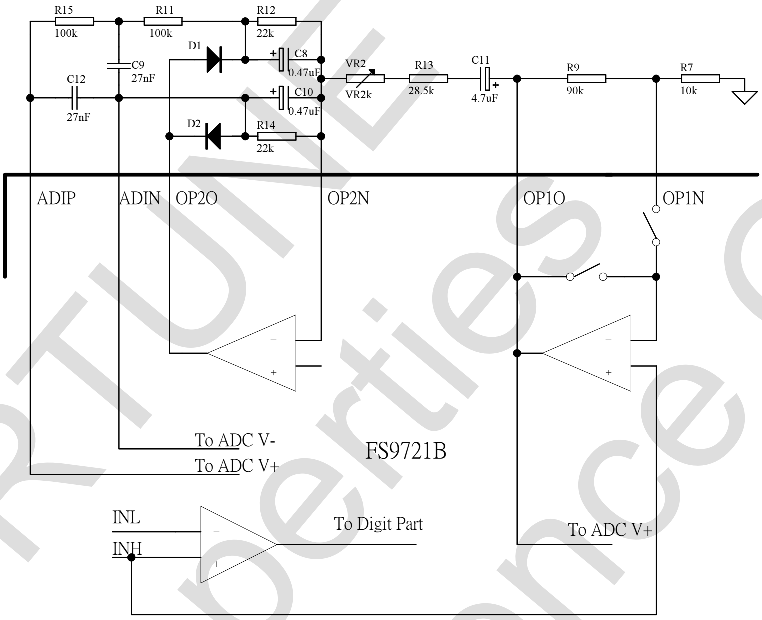


Diagram 21 Average Commutation Circuit Diagram

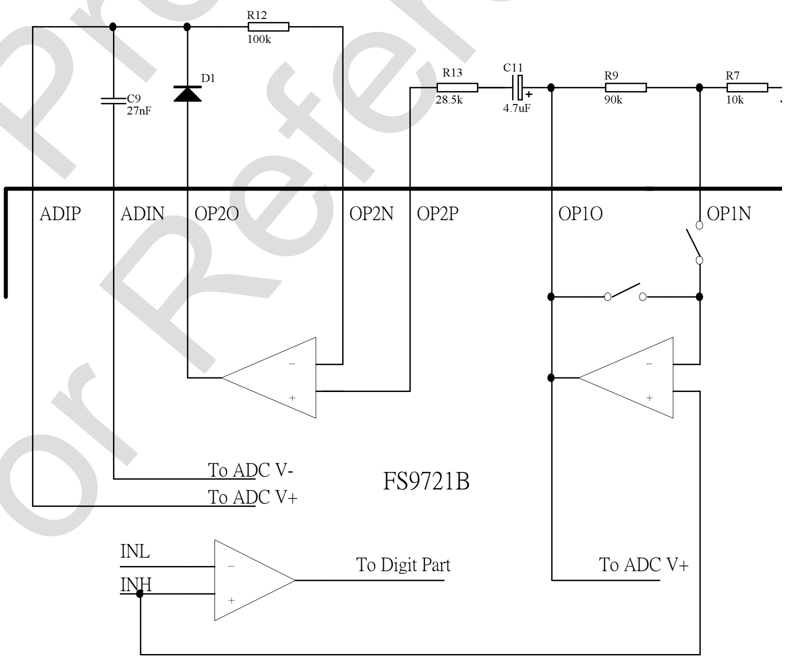


Diagram 22 Peak Commutation Circuit

FORTUNE' Properties For Reference Only

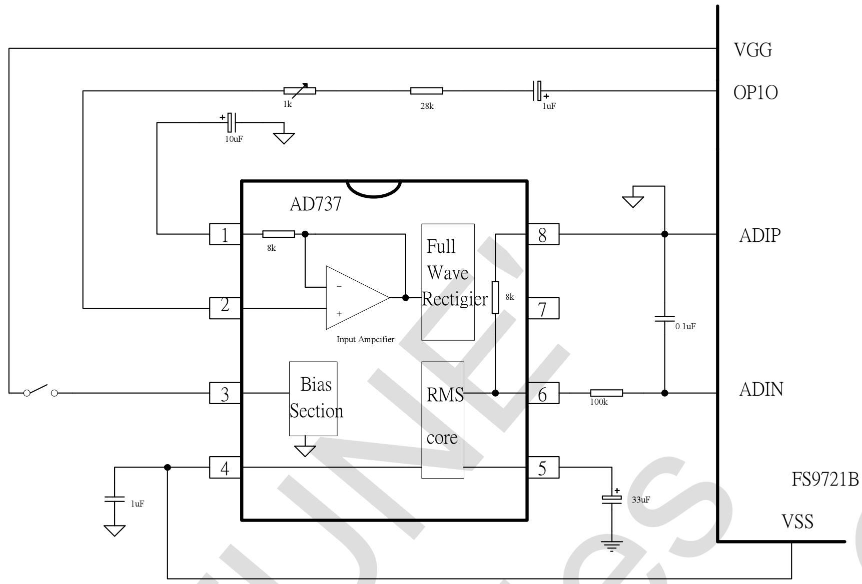


Diagram 23 True Validity Commutation Circuit

FORTUNE' Properties For Reference Only

15.12 Voltage Measurement

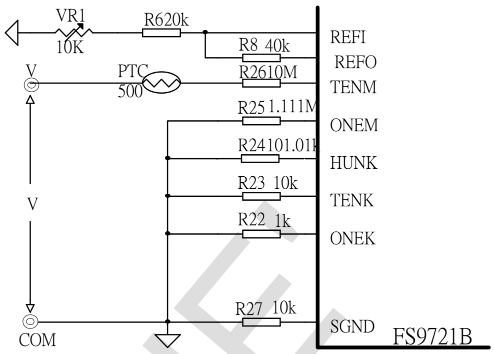


Diagram 24 Voltage Measurement

When doing the voltage measurement, the measuring voltage is input from resistance R26, and DCmV is not divided, but enter IC directly; 2.4V, 24V, 240V, 1000V mode is divided by R25, R24, R23, R22 and R26 to gain 1/10, 1/100, 1/1000, 1/10000 voltage, then enter IC. To adjust the resistance value of VR1 can do the calibration of measurement.

Voltage Division of Voltage Measurement Diagram is as below:

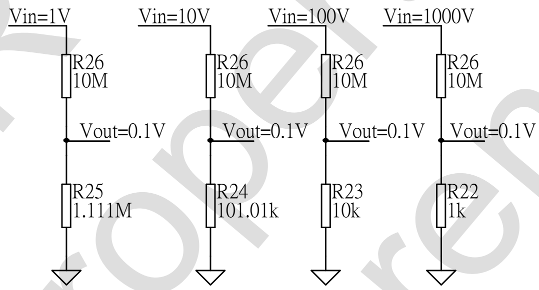


Diagram 25 Voltage Division Circuit Diagram

The formula of voltage division is:

Vout=Vin × [Rs/ (R26+Rs)]

Rs is R25, R24, R23 or R22

Therefore, the accuracy of R22, R23, R24, R25 and R26 determine the accuracy of the measurement.

AcmV enter IC through R26 and is divided by R25 and R26 to get 1/10 voltage, then is amplified 10 times internal to fulfill the measurement, so the accuracy of R9 and R7 is also determine the measuring accuracy of ACmV.

15.13 Current Measurement

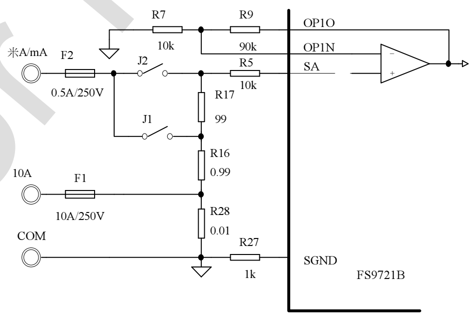


Diagram 26 Current Measurement

FORTUNE Properties For Reference Only

When doing the current measurement, the current signals enter IC through R5.

The sampling resistance of μA mode is (R16+R17+R28), the sampling resistance of mA mode is (R16+R28) and the sampling resistance of 10A mode is R28. They are measured respectivly through the mode switch. When measuring μA, J1 is open and J2 is close; when measuring mA, J2 is open and J1 is close; the large current enters through 10A port.

The maximum reduced voltage for μA, mA and 10A modes is 0.24V. These voltages are input voltage comparator to compare. If the voltage is smaller than 24mV, it will be sent to 10 times amplifier to amplify, then sent to A/D converter; if the voltage is larger than 24mV, the system will work the auto-ranging signal, and jump up one mode under the control of microprocessor and send the current signal directly to the A/D converter.

15.14 Resistance Measurement

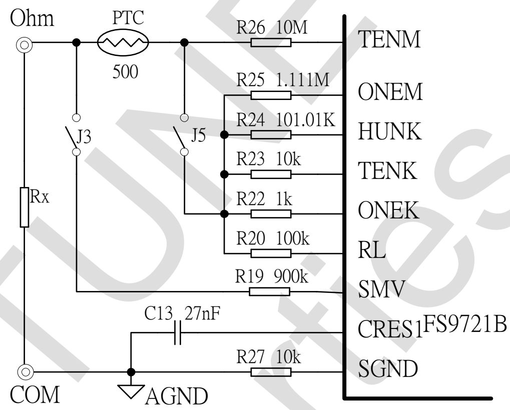


Diagram 27 Resistance Measurement

Resistance measurement refers to standard resistance, and then takes a comparison between measuring resistance and standard resistance to get the measuring resistance value. The standard resistance of 24MΩ mode is 10MΩ (R26). The standard resistance of other modes are to parallel respectively R26 and R25, R24, R23, R22 to get 1MΩ, 100kΩ, 10kΩ, 1kΩ resistance. When doing resistance measurement, internal IC will generate 0.4V voltage (relative to AGND), the voltage is output respectively to measuring resistance through resistance R26 and R25, R24, R23, R22 to proceed the measurement comarison.

R20 connects to RL. It is the negative end through the standard resistance to get the voltage reference. J3 and J5 are mode switch. When doing resistance measurement, J3 and J5 are close. C13 is the wave filter capacitance of measuring point in resistance measurement.

15.15 Diode Test

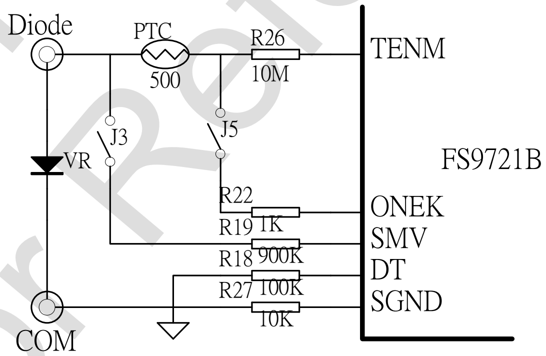


Diagram 28 Diode Measurement

Diode test is to generate 1.5V voltage from internal IC and output through R22, then add to the positive of diode through PTC. The positive voltage reduction VD generated by diode is about 0.5V-0.7V. VD is divided by R18 and R19, and get 1/10 VD, then is amplified 10 times by internal OP to display VD value. J3 and J5 are mode switch. When doing diode measurement, J3 and J5 are close.

For FORTUNE Reference Only

15.16 Short Circuit Testing

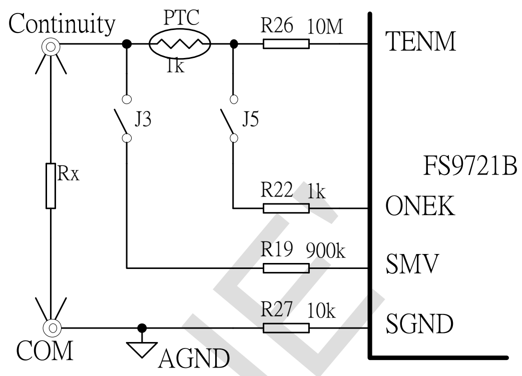


Diagram 29 Short Circuit Testing

Short circuit testing is proceeded in 240Ωresistance mode. 0.4V voltage (relative to AGND) is generated by internal IC and output through R22, then add to short measuring point through PTC. J3 and J5 are mode switch and are close during doing short circuit testing. Rx gets voltage V_{Rx}, and input IC through R19. If Rx smaller than 50Ω, the beeper will sound.

15.17 Capacitance Measurement

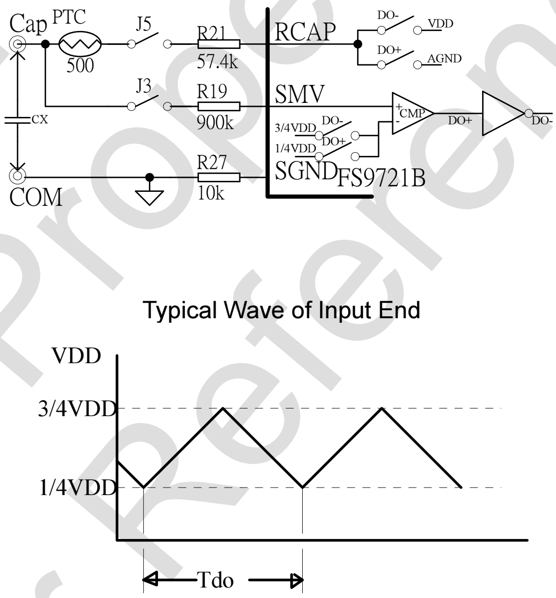


Diagram 30 Capacitance Measurement

Capacitance measurement is to charge/discharge to measuring capacitance through R21 to form a oscillation, then calculate the cycle of oscillation to get the capacitance value. To adjust R21 can calibrate the value in capacitance measurement. J3 and J5 are mode switch. When doing capitance measurement, J3 and J5 are close.
(In actual application, if the linearity is worse when doing 2.5nF measurement, you can take a consideration of paralleling a proximate 1000pF capacitance in input end of capacitance measurement during design. When doing the measurement, to press REL key and make the value be zero before measuring. The linearity of the smaller measurement in capacitance mode will be better.)

FORTUNE Properties For Reference Only

15.18 Frequency Measurement

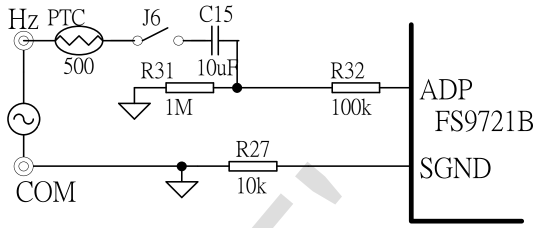


Diagram 31 Frequency Measurement

16 Package Outline

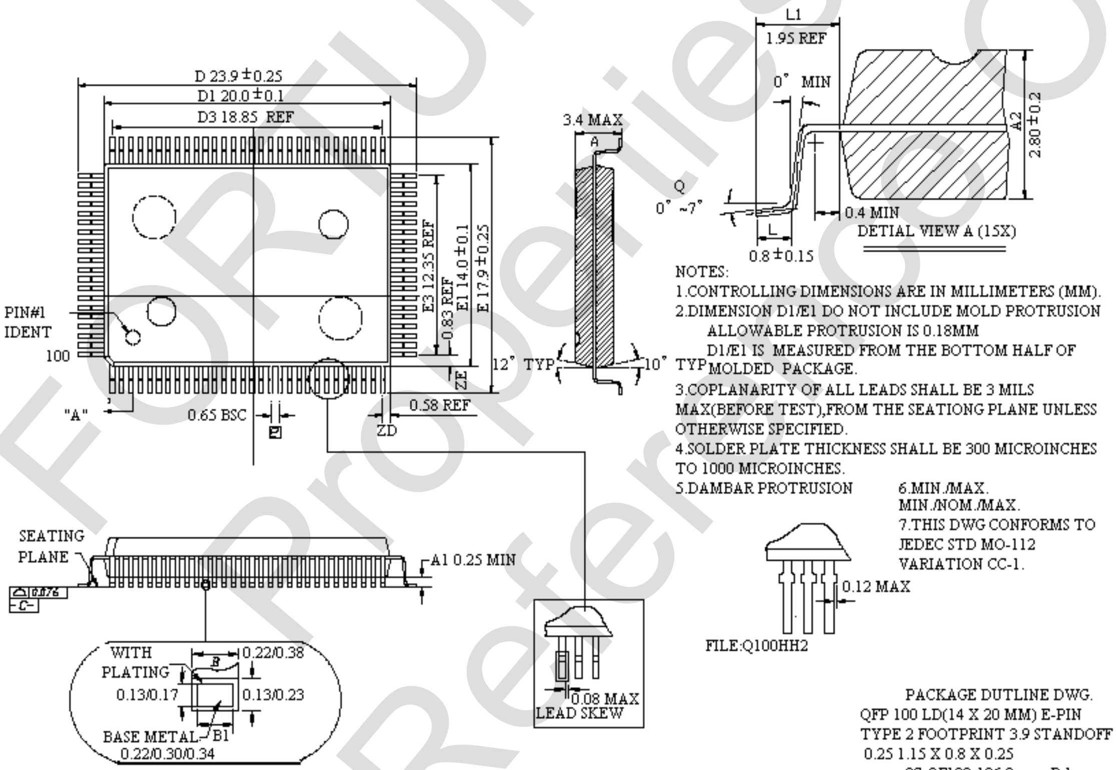


Diagram 32 Package Outline

FORTUNE Properties For Reference Only

17 Demo Board

Demo Board Schematic

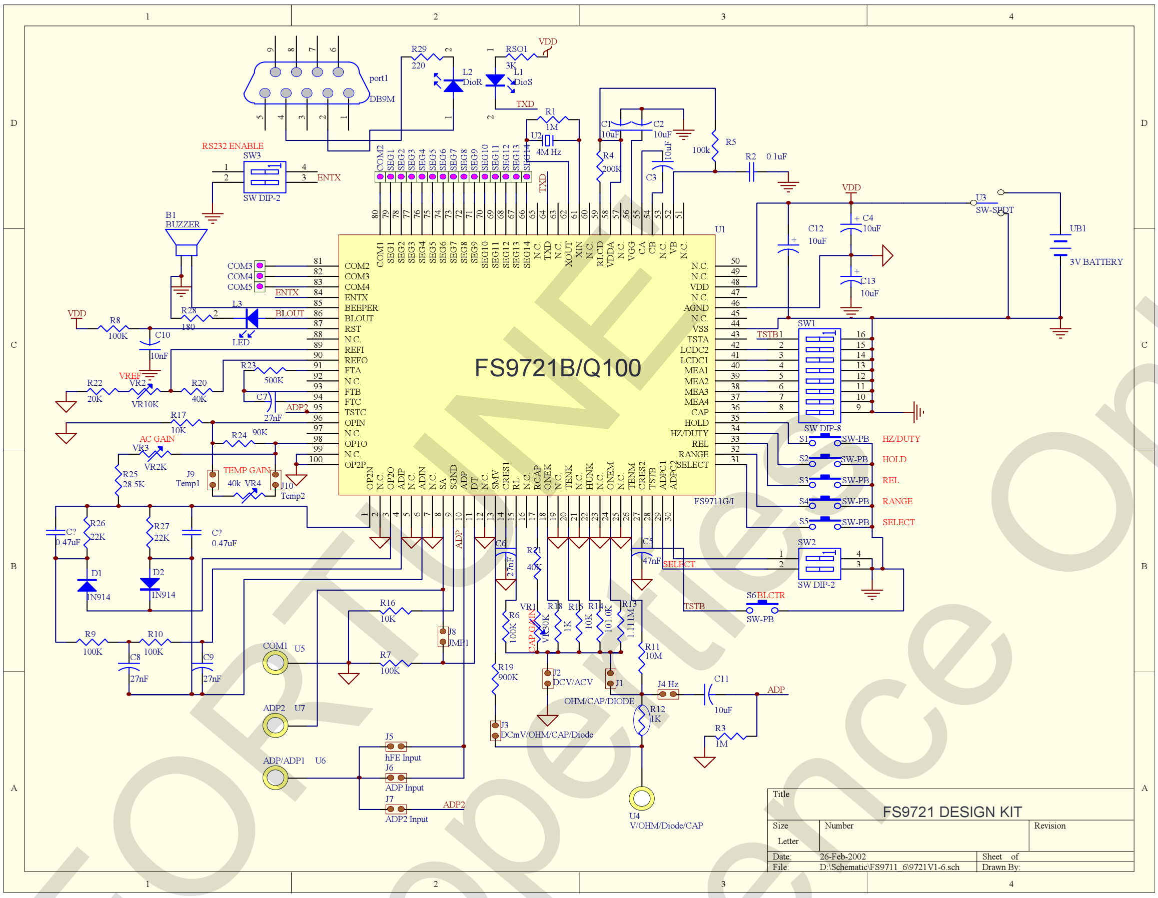


Diagram 33 Demo Board Schematic

FORTUNE Properties For Reference Only

Demo Board Location

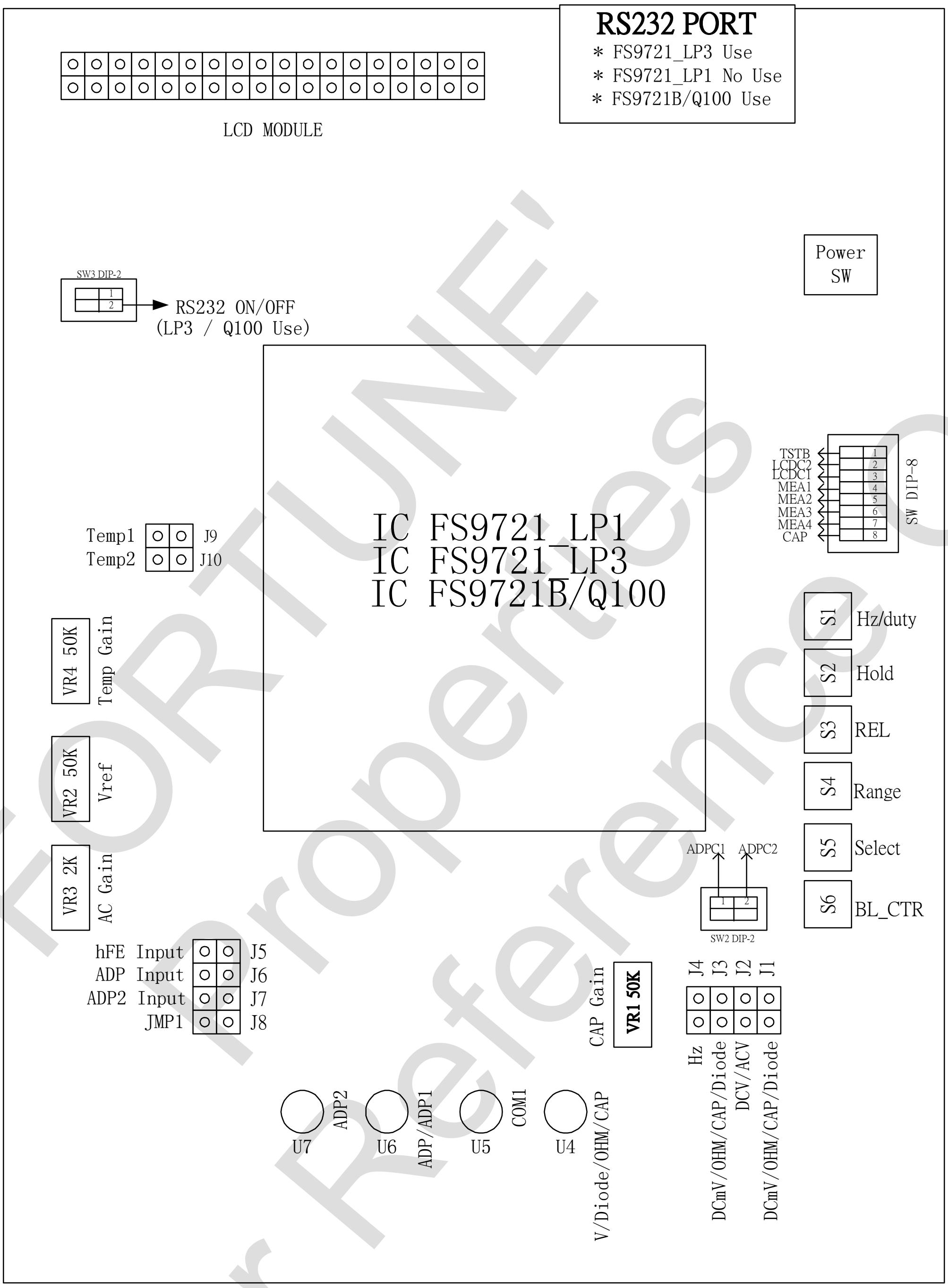


Diagram 34 Demo Board Location

17.2.1 U4: Input Voltage, Resistance, Diode and Capacitance.
17.2.2 U5: Analog Signal to Ground.
17.2.3 U6: Input Voltage (mV), Hz and Duty Cycle.
17.2.4 U7: Current Mode Measuring Terminal. (Input Voltage)
17.2.5 J1~J10: Please refer to “FS9721B/Q100 Measurement Mode and Jumper Setup”.
17.2.6 S1~S6: Please refer to “FS9721B/Q100 Demo Board Schematic”.

FORTUNE' Properties For Reference Only

17.2.7 SW-DIP8: (If switch SW to ON, it is Low Level)

CAP	Function mode (MEAS → 1101)
1	Ohm / Diode / Cont.
0	Ohm / Diode / Cont. / CAP

MEA4	MEA3	MEA2	MEA1	Function mode
1	1	1	1	DC/AC Voltage (including DC mV mode)
1	1	0	1	Resistance/Diode /Cont./Capacitance
1	0	1	0	DC Voltage (no DC mV mode)
1	0	0	1	AC Voltage
1	0	1	1	DC mV mode
1	0	0	0	10A
1	1	1	0	mA
1	1	0	0	uA
0	1	1	1	Capacitance Mode
0	1	0	1	Hz/Duty
0	0	D1	D0	ADP
0	1	1	0	ADP

* LCDC1 and LCDC2 can control LCD symbol. It shows as below in demo board:

LCDC1	LCDC2	LCD Symbol
0	0	T1
1	0	hFE
0	1	℃
1	1	T2

17.2.8 SW2-DIP2: (If switch SW to ON, it is Low Level)

ADPC1	Function mode (MEAS → 0 0 D1 D0)
1 Pin = 1	Input (25m~250mV)
1 Pin = 0	Input (2mV~25mV)

ADPC2	Function mode (MEAS → 0 0 D1 D0)
2 Pin = 1	DC measurement
2 Pin = 0	AC measurement

17.2.9 SW3-DIP2: (If switch SW to ON, it is Low Level) ∗ Pin2 Don't care

1 Pin	Function
1 Pin = 1	RS232 mode off
1 Pin = 0	RS232 mode on

FORTUNE Properties For Reference Only

FS9721B/Q100 Measurement Mode Select:

MEA4	MEA3	MEA2	MEA1	Mode	Select (1➔0➔1)	Hz/duty (1➔0➔1)
1	1	1	1	DC/AC Voltage (including DC mV mode)	DC/AC Switch	Hz/Duty/Voltage Switch
1	1	0	1	Resistance/Diode /Cont./Capacitance	CAP=1: Resistance/Diode /Cont.	
					CAP=0: Resistance/Diode /Cont./Capacitance	
1	0	1	0	DC Voltage (no DC mV voltage mode)		Hz/Duty/Voltage Switch
1	0	0	1	AC Voltage		Hz/Duty/Voltage Switch
1	0	1	1	DC mV mode		Hz/Duty/Current Switch
1	0	0	0	10A ∗4	AC/DC Switch	Hz/Duty/ Current Switch
1	1	1	0	mA ∗4	AC/DC Switch	Hz/Duty/ Current Switch
1	1	0	0	uA ∗4	AC/DC Switch	Hz/Duty/ Current Switch
0	1	1	1	Capacitance Mode		
0	1	0	1	Hz/Duty Cycle ∗1		Hz/Duty
0	0	D1	D0	ADP ∗2		
0	1	1	0	ADP ∗3		

1. Hz and Duty Cycle measurements take ADP measuring path as input terminal.
2. ADP is single ADC positive input point. The range of measuring voltage is ±200mV. LCD decimal location is decided by D1 and D0. 11 means no decimal, 01 means 20.00, 10 means 200.0 and 00 means 2.000 that display with one unit.
3. ADP can be 200.0mV/20.00mV autoranging to display respectively 2000 and 200.0.

FORTUNE Properties For Reference Only

FS9721B/Q100 Measurement Mode and Jumper Setup:

MEA4	MEA3	MEA2	MEA1	Mode	Jumper	Input
1	1	1	1	DC/AC Voltage (including DC mV mode)	J2	V/Diode/OHM/CAP, COM
1	1	0	1	Resistance/Diode /Cont./Capacitance	J1,J3	V/Diode/OHM/CAP, COM
1	0	1	0	DC Voltage (no DC mV voltage mode)	J2	V/Diode/OHM/CAP, COM
1	0	0	1	AC Voltage	J2	V/Diode/OHM/CAP, COM
1	0	1	1	DC mV mode	J1	V/Diode/OHM/CAP, COM
1	0	0	0	10A ∗4	X	ADP2, COM
1	1	1	0	mA ∗4	X	ADP2, COM
1	1	0	0	uA ∗4	X	ADP2, COM
0	1	1	1	Capacitance Mode	J1,J3	V/Diode/OHM/CAP, COM
0	1	0	1	Hz/ Duty Cycle ∗1	J4,J6	ADP/ADP1,COM
0	0	D1	D0	ADP ∗2	J6	ADP/ADP1, COM
0	1	1	0	ADP ∗3	J6	ADP/ADP1, COM

18 Ordering Information

Product Number	Description	Package Type
FS9721B		Die form (78 pins)
FS9721B		100-pin QFP (Not Pb free package)
FS9721B-PCE	Pb free package part number.	100-pin QFP (Pb free package)

FORTUNE Properties For Reference Only

19 Revision History

Ver.	Date	Page	Description
1.3	2004/04/29	-	1. Change file name format from "FS9721B Data Sheet_V1.2.doc" to "FS9721B_DataSheet_V13.doc". 2. Change page top and bottom space format. 3. Add CR-004 on the bottom space on the cover page. 4. Add ordering information.
1.4	2004/11/19	8	1. Revise the Diagram 3 78PIN Dice.
		31	2. Add revision history on the last page of the data sheet.
1.5	2005/07/13	8	1. Diagram 3 78PIN Dice in Ver. 1.4 is not correct. Revise it to the right one.
		31	1. Revise ordering information. Add Pb-free package part number.
1.6	2005/08/10	12,29	1. In the 10.3, LCDC1 and LCDC2=10 display COM2 and SEG14 (hFE). LCDC1 and LCDC2=01 display COM3 and SEG14 (℃).
		19	1. Delete diagram 11 "4.5V power supply "and diagram 12 "6.0V power supply", and modify serial number after them.
		24	1. Revise the Diagram 26 Current Measurement.
		29-30	1. In the 17.2.7,and 17.2.9, correct MEAS=1111 AC/DC voltage for DC/AC voltage .Correct MEAS=1011 DCmA mode for DCmV mode.
1.7	2014/05/22	2	Revised company address

FORTUNE Properties For Reference Only