

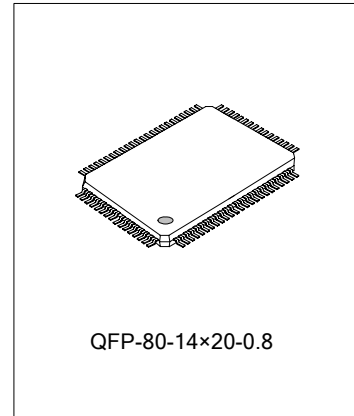
3^{3/4} DIGITS LCD DISPLAY ,3260-COUNT A/D FOR DMM

DESCRIPTION

The SC7001Q is a low power CMOS dual-slope A/D converter with 3 3/4-digit numeric and 33-segment bar-graph LCD display driver, auto-ranging, and single 3V battery operation.

It is ideal for high performance auto-range DMM applications with 3260 counts full-scale.

The SC7001Q provides many user function: Manual Range Hold/Data Hold/Auto Power-off/Voltage/Current/Resistance measurement/Diode Test/Continuity Check(Beeper). The built-in high temperature-stable CMOS bandgap reference and a CMOS Op Amp for ac-to-dc conversion are economical of saving external components. In addition, the voltage doubler enables a high performance digital multimeter to be built with single 3V power supply operation.



FEATURES

- * Auto range function
- Voltage (DC/AC):326.0mV(NA for AC), 3.260V, 326.0V, 3260V
- Resistance: 326.0Ω,3.260kΩ, 32.60kΩ, 326.0kΩ, 3.260MΩ, 32.60 MΩ
- Current (DC/AC): 326.0μA, 3260μA, 32.60mA, 326.0mA, 10A
- * Triplex LCD driver including decimal points, bargraph, and annunciators
- * Low power consumption: less than 1.8mW.
- * 3V battery operation.
- * Internal voltage doubler, ac-to-dc conversion Op Amp.
- * Range Selection/Display Hold/Auto Power-off/Diode Test/Continuity Check(Beeper) function
- * Built-in CMOS bandgap reference.

ORDERING INFORMATION

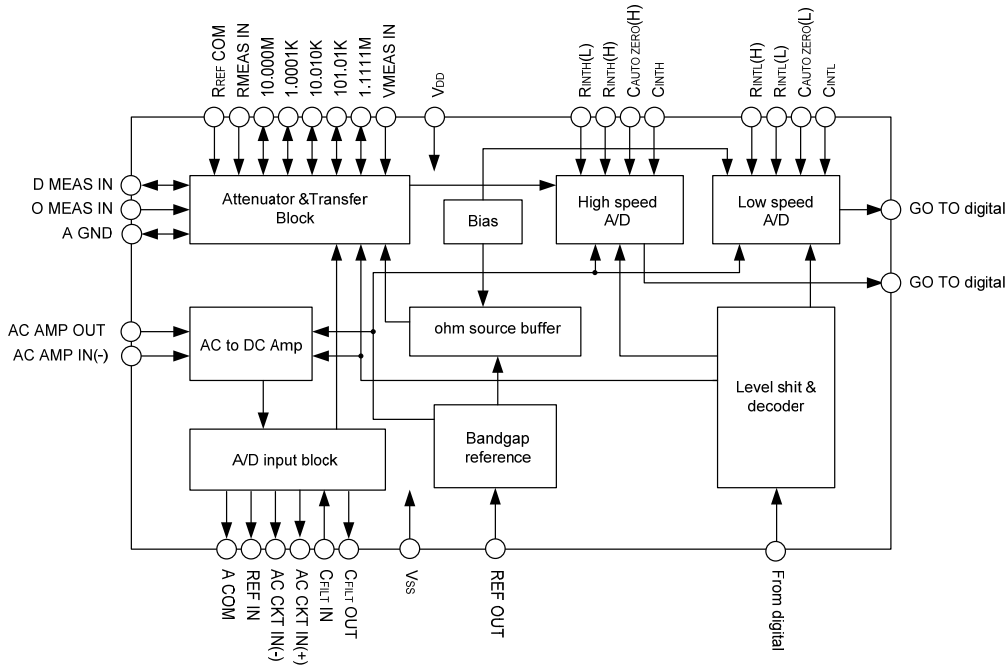
Part no.	Package
SC7001Q	QFP-80-14X20-0.8

APPLICATIONS

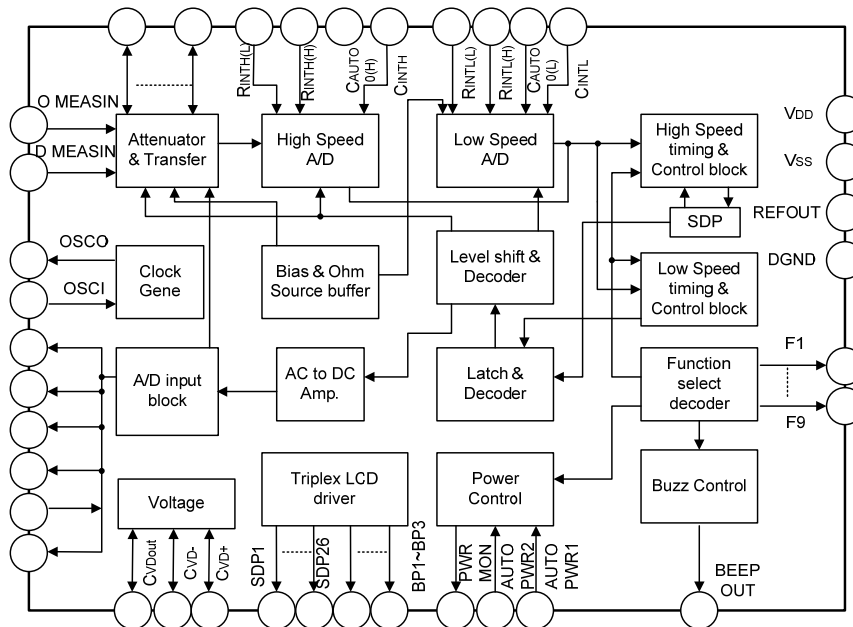
- * Hand-held DMM
- * Pocket DMM
- * Pen-type DMM

BLOCK DIAGRAM

1. Analog block



2. Digital block



ABSOLUTE MAXIMUM RATING (note1)

Characteristics	Symbol	Value	Unit
Supply Vltage (VDD to A COM)	VDD	4	V
Supply Vltage (VSS to A COM)	VSS	-4	V
Digital Input Voltage	DVIN	-0.3~VDD+0.3	V
Analog Input Voltage	AVIN	VSS-0.3~VDD+0.3	V
Digital Output Current	DIOUT	-1~+1	mA
Analog Output Current	AIOUT	-3~+3	mA
Beep Output Current	IBEEP	-1~+1	mA
LCD Output Current	ILCD	-0.1~+0.1	mA
Operating Temperature Range	TOPR	0~+50	°C
Storage Temperature Range	TSTG	-40~+125	°C

Note: 1. All voltage are measure with respect to the A COM, unless otherwise noted. The separate A GND, D GND and A COM should always be wired together.

RECOMMENDED OPERATING CONDITIONS

Characteristics	Symbol	Value			Unit
		Min.	Typ.	Max.	
Supply voltage	VDD	2.4	3.0	3.6	V
Supply voltage	VSS	-2.4	-3.0	-3.6	V
Digital input "L" voltage	DVIL			0.5	V
Digital input "H" voltage	DVIH	VDD-0.5			V
Reference input voltage	REF IN		0.32768		V
LCD-ON drive voltage	VLCD-ON	2.5			V
LCD-OFF drive voltage	VLCD-OFF			1.3	V
Operating temperature range	T _{opr}	0		50	°C
Clock frequency	f		32.768		KHz

ELECTRICAL CHARACTERISTICS (T_{amb}=25°C, VDD=3V, REF IN=0.32768V, f =32.768KHz, unless otherwise specified)

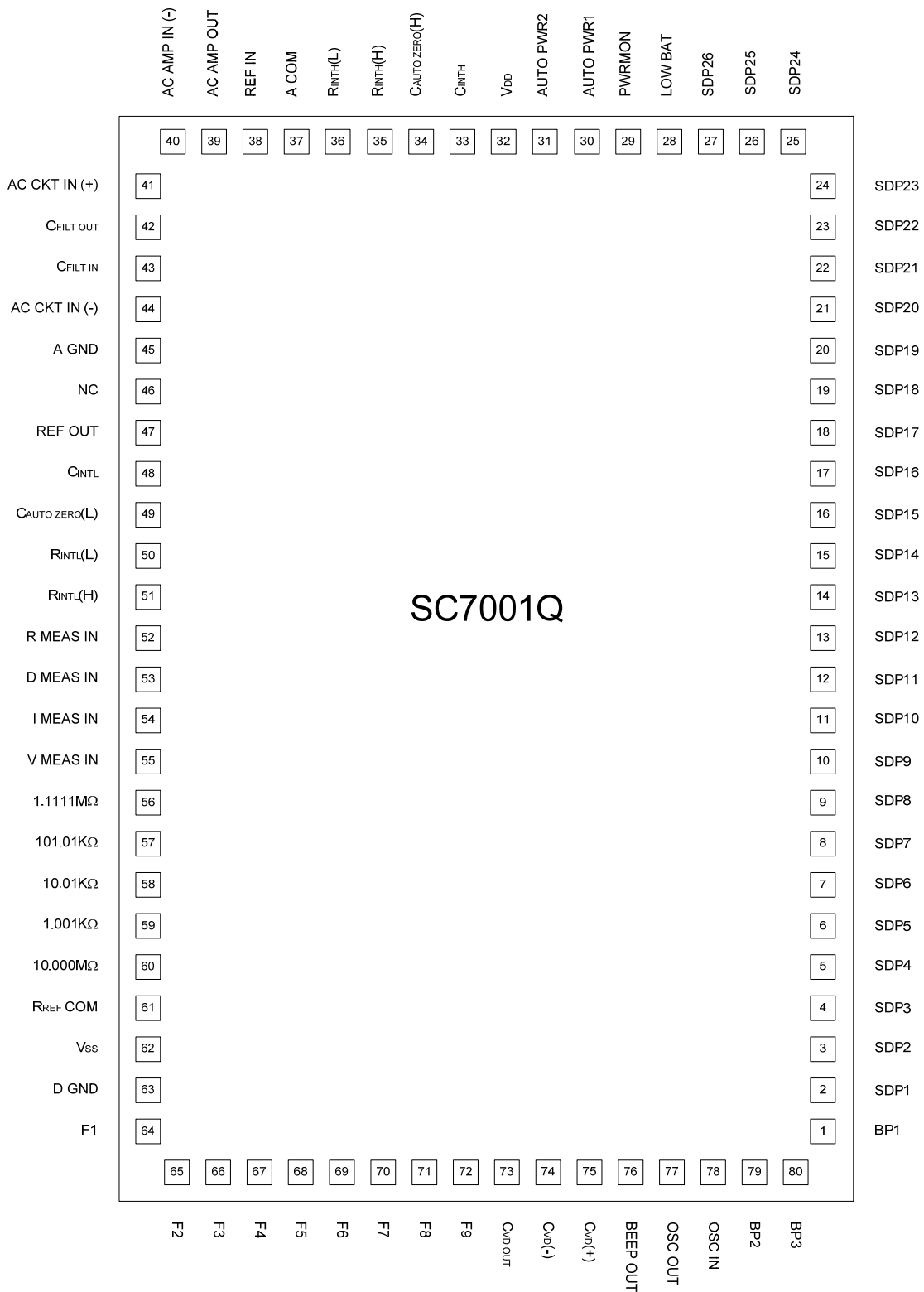
Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Supply current	IDD	At DCV mode, VIN=0mV with voltage doubler operated			600	μA
Power-off supply current	IPO	At power off(down)		0	4.0	μA
Digital input "H" current	I _{IH}	V _{IH} =3V	-1.0		+1.0	μA
Digital input "L" current	I _{IL}	V _{IL} =0V	-10			μA
Measuring pin leakage	I _{LEAK}		-10		+10	pA
Digital input "H" voltage	V _{IH}		2.5			V
Digital input "L" voltage	V _{IL}				0.5	V

(To be continued)

(Continued)

Characteristics		Symbol	Test conditions	Min.	Typ.	Max.	Unit
Built-in reference voltage output range		REF OUT		1.1	1.28	1.4	V
Built-in reference voltage output voltage coefficient		Δ REF OUT	VDD=2.4~3.6V	-2000		+2000	ppm/V
Battery check internal comparator off-set voltage		VBATT	On pin 47 voltage	-60		+60	mV
LCD-on drive voltage		VLCD-ON		2.5			V
LCD-off drive voltage		VLCD-OFF				1.3	V
Linearity	DCV measurement	ERR-DCV		-0.08		+0.08	%/FS
	DCA measurement	ERR-DCA		-0.15		+0.15	%/FS
	ACV measurement	ERR-ACV		-0.1		+0.1	%/FS
	ACA measurement	ERR-ACA		-0.2		+0.2	%/FS
	Resistance measurement	ERR-R	Except 32.6M Ω	-0.08		+0.08	%/FS
			32.6M Ω range	-0.5		+0.5	%/FS
	Diode test	ERR-D	Full-scale =2.0V	-0.2		+0.2	%/FS
Option measurement	ERR-OPT		-0.08		+0.08	%/FS	
Beep out frequency		fBEEP		4095	4096	4097	Hz
Continuity check value		RCC		18.3		20.7	Ω
AC-to-DC conversion Amp gain		AV	Input range = -1~1v	70			dB
O.L display count		D O.L		3240		3290	count

PIN CONFIGURATION



PIN DESCRIPTION

PIN No.	Symbol	Description
1	BP1	Backplane 1 of LCD display
2~27	SDP1~SDP26	Segment display
28	LOWBAT	Low battery check voltage input
29	PWRMON	Power monitor output
30	AUTO PWR1	Auto power ON/OFF selection 1
31	AUTO PWR2	Auto power ON/OFF selection 2
32	VDD	Supply voltage
33	CINTH	High-speed A/D integrating capacitor connection
34	CAUTO ZERO(H)	High-speed A/D auto zero capacitor connection
35	RINTH(H)	High-speed A/D integrating resistor connection(H)
36	RINTH(L)	High-speed A/D integrating resistor connection(L)
37	A COM	Analog circuit reference voltage
38	REF IN	Reference voltage input
39	AC AMP OUT	Built-in AC Amp output
40	AC AMP IN(-)	Built-in AC Amp negative input
41	AC CKT IN (+)	AC measurement position input
42	CFILT OUT	Output pin for external filter
43	CFILT IN	Input pin for external filter
44	AC CKT IN(-)	AC measurement negative input
45	A GND	Analog ground
46	NC	No connection. This pin should be open in normal operation
47	REF OUT	Built -in bandgap reference voltage output
48	CINTL	Low-speed A/D integrating capacitor connection
49	CAUTO ZERO(L)	Low-speed A/D auto zero capacitor connection
50	RINTL(L)	Low-speed A/D integrating resistor connection (L)
51	RINTL(H)	Low-speed A/D integrating resistor connection (H)
52	R MEAS IN	Resistor and current measurement input
53	D MEAS IN	Diode and current of high range measurement pin
54	I MEAS IN	Input for current measurement
55	V MEAS IN	Input for voltage measurement
56	1.1111M Ω	Voltage measurement \div 10 attenuator(326.0k Ω range)
57	101.01K Ω	Voltage measurement \div 100 attenuator(32.60k Ω range)
58	10.010 K Ω	Voltage measurement \div 1000 attenuator(3.260k Ω range)
59	1.0001K Ω	Voltage measurement \div 1000 attenuator(326.0 Ω range)
60	10.000M Ω	Resistance measurement 3.260M Ω range
61	RREF COM	Attenuator resistor common connection
62	VSS	Negative supply voltage connection of analog circuit

(To be continued)

(Continued)

PIN No.	Symbol	Description
63	D GND	Digital ground
64~72	F1~F9	Function input pin 1~9
73	CVD OUT	Voltage double output
74	CVD(-)	Voltage double capacitor connection (-)
75	CVD(+)	Voltage double capacitor connection(+)
76	OUT	Beep frequency output (4096Hz)
77	OSC OUT	X-tal connection (32.768KHz)
78	OSC IN	X-tal connection
79	BP2	Backplane 2 of LCD display
80	BP3	Backplane 3 of LCD display

FUNCTIONAL DESCRIPTION

1. SC7001Q INTEGRATING DUAL-SLOPE A/D CONVERTER

The SC7001Q consists of a low-speed A/D and a high-speed A/D conversion circuit.

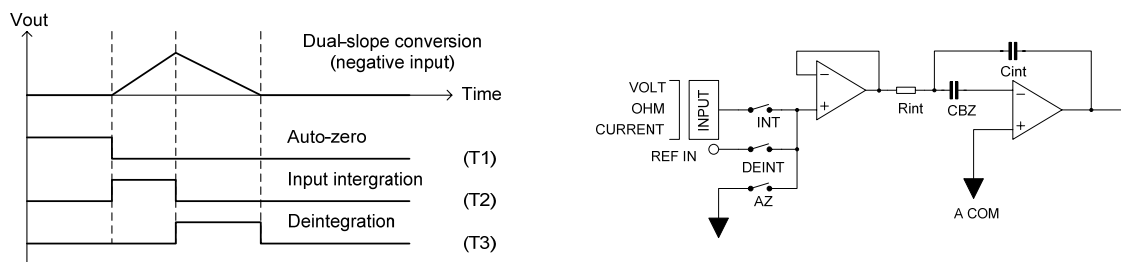
Low-speed A/D conversion circuit

When an analog DC input signal under 320mV is applied, the low-speed conversion proceeds like a sequence of AUTO ZERO (A.Z)→INTEGRATION (INT) →DEINTEGRATION (DEINT) → AUTO ZERO. One conversion takes 519.7ms is the voltage measurement mode.

The counter data of DEINTEGRATION interval is transferred to the LCD and the output value is determined.

High-speed A/D conversion circuit

Range selection and barograph display operate by the high-speed conversion which is like that of low-speed A/D conversion. One conversion takes 80ms in the voltage measurement mode.



Waveform and block diagram of dual-slope A/D converter (Negative input)

Conversion time

Speed	Tim	T1	T2	T3	Conversion time T1+T2+T3
Low-speed A/D		100ms	200ms	219.7ms(109.8ms)*	519.7ms(409.8ms)
High-speed A/D		40ms	20ms	20ms(10ms)	80ms(70ms)

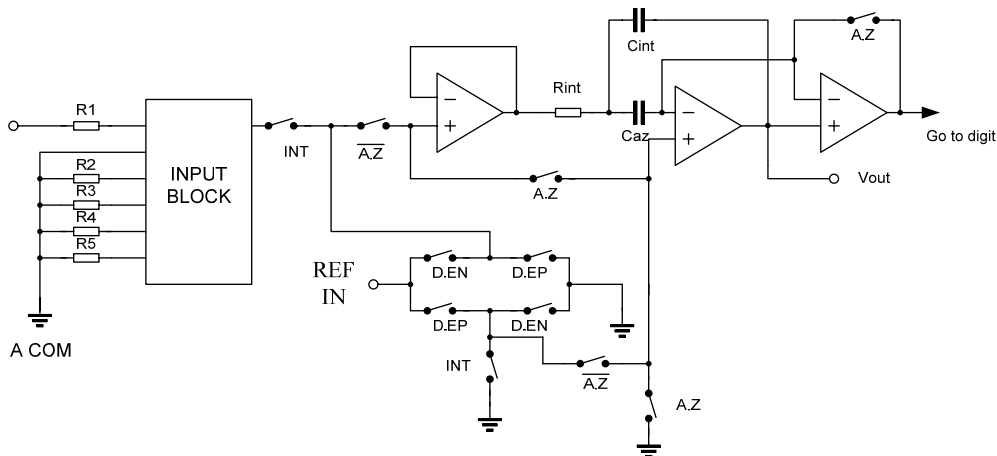
* : The value of parenthesis is for current measurement mode.

2. VOLTAGE MEASUREMENT

In the voltage measurement mode, input impedance is very high because input signal is applied to the integrator through a internal buffer amplifier.

Ranges are automatically changed by internal switch select a proper route and attenuate an unknown voltage input to the ratio of 1/1, 1/10, 1/100, 1/1000, 1/10000. 1.1111M Ω , 101.10K Ω , and 1.0001K Ω of attenuator resistors are connected to 10M Ω resistor tandemly.

Range	Attenuator (in tandem)	Attenuation ratio	Resolution
326.0(R1)	10	1	0.1mV
3.260(R2)	10M&1.1111M Ω	1/10	1 mV
32.60(R3)	10M&101.01K Ω	1/100	10 mV
326.0(R4)	10M&10.01K Ω	1/1000	100 mV
3260(R15)	10M&1.0001K Ω	1/10000	1V

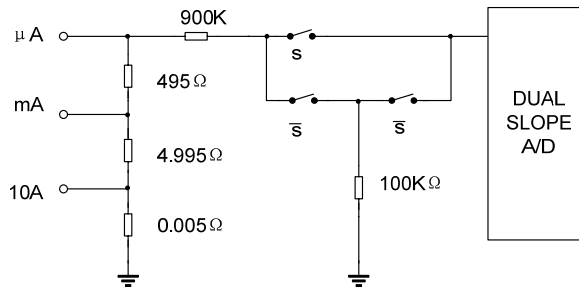


	Counter	Timer	Rint	Vout
INT	3277	200.0ms	327k Ω	$(V_{in} \cdot T_{int}) / (R \cdot C_{int})$
DEINT	3600	219.7ms	327 k Ω	$V_{OUT} - (V_{ref} \cdot T_{deint}) / (R \cdot C_{int})$

3. CURRENT MEASUREMENT

Input terminals consist of μ A, mA, and 10A ranges consist of two auto ranges according to the level of the input.

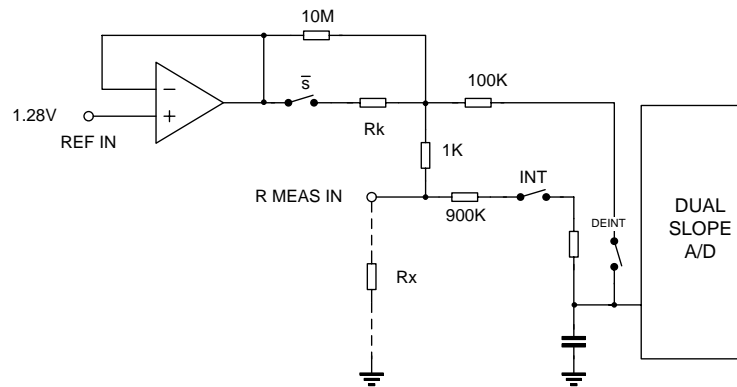
Input terminal	Range	Internal switch	Attenuation ratio	Resolution
μ A	326.0 μ A	S	1	0.1 μ A
	3260 μ A	\bar{S}	1/10	1 μ A
mA	32.60 mA	S	1	10 μ A
	326.0 mA	\bar{S}	1/10	1 μ A
10A	10A	S		



	Counter	Timer	Rint	Vout
INT	3277	200.0ms	327kΩ	
DEINT	3600	109.8ms	327kΩ	$V_{OUT} - (V_{ref} \cdot T_{deint} / 2) / (R \cdot C_{int})$

4. RESISTANCE CONTINUITY MEASUREMENT

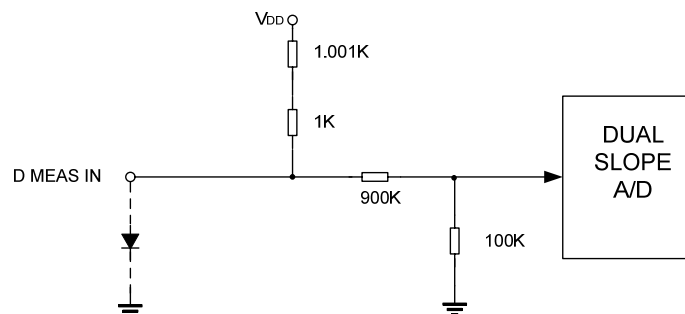
In the resistance measurement mode, each attenuation resistor is connected to a 10MΩ resistor parallelly.



Range			Counter	Time	Rint
Resistance	Except 32.60MΩ	INT	3277	200.0ms	327 kΩ
		DEINT	3600	129.7ms	1 MΩ
	32.60 MΩ	INT	3050	186.0ms	1 MΩ
		DEINT	3600	219.7ms	327 kΩ
Continuity		Same as 326.0Ω range			

5. DIODE TEST

In the diode test mode, if an input voltage is over 2.01V(201counts) then "O.L" is displayed in the LCD and any more measurement is impossible.



FUNCTION AND RANGE TABLE
1. When F5=0

No	F2	F1	F4	F3	F9=1/ F9=0	R1, DP1	R2, DP3	R3, DP2	R4, DP1	R5, DP3	R32M, DP2	Remark
1	0	0	0	0	DC/AC VOLT	•	•	•	•	•	×	TPD
2	0	0	0	1	DC/AC VOLT	•	•	•	•	•	×	
3	0	0	1	0	DC/AC VOLT	•	•	•	•	•	×	
4	0	0	1	1	OHM/Contiuity	•	•	×	×	×	×	F8=0,F9:T
5	0	1	0	0	OPTION only	×	×	×	×	×	×	326m VOLT
6	0	1	0	1	DC VOLT	•	•	•	•	•	×	
7	0	1	1	0	DC VOLT	•	•	•	•	•	×	
8	0	1	1	1	Contiuity /Diode	•))	▶					F9=1, F7:T
9	1	0	0	0	LCD test	×	×	×	×	×	×	Display 1999
10	1	0	1	0	CD/AC VOLT	•	•	•	•	•	×	
11	1	0	1	1	OHM	•	•	•	•	•	•	F6=1
						•	•	•	•	•	×	F6=0
12	1	1	0	0	OPTION	×	×	×	×	×	×	326m VOLT
13	1	1	0	1	DC/AC mA	×	×	•	•	×	×	
14	1	1	1	0	DC/AC μ A	×	×	×	•	•	×	
15	1	1	1	1	DC/AC VOLT	•	•	•	•	•	×	

* R1~R5: Range 1~Range 5.

* R32M: R32M is 32M Ω range of resistance measurement.

* DP1~DP3: Dot point 1, 2, 3 on the LCD.

* F7: Manual Range Hold (to release 'RH', F7=0 during over 1sec).

* F8: Data Hold (by toggling).

* F5: Mode can be changed by a toggle switch with F9 (F9=1 \rightarrow 0) when F5=0.

Mode can be changed by a touch switch with F9 (F9=1 \rightarrow 0 \rightarrow 1).

* TPD: Auto power off time (10 minutes).

* F1~F9: Initial state using internal pull up (DC 326.0mV Range) . So every function pin (F1~F9) is "1" state unless certain input is given.

* T: Toggle.

2. When F5=1

No	F2	F1	F4	F3	F9=1/ F9=0	R1, DP1	R2, DP3	R3, DP2	R4, DP1	R5, DP3	R32M, DP2	Remark	
16	0	0	0	0	DC/AC VOLT	•	•	•	•	•	×	TPD	
17	0	0	0	1	DC/AC VOLT	•	•	•	•	•	×		
18	0	0	1	0	DC/AC VOLT	•	•	•	•	•	×		
19	0	0	1	1	OHM	•	•	•	•	•	•		
					CONTINUITY	•	×	×	×	×	×	×	F9:T
					DIODE	×	•	×	×	×	×	×	F9:T
20	0	1	1	1	CONTINUITY	•	×	×	×	×	×		
					DIODE	×	•	×	×	×	×	×	F9:T

3. Auto power off function

Power turned off by 10 minutes unless input value changed within a defined time.

* This function selected as follows.

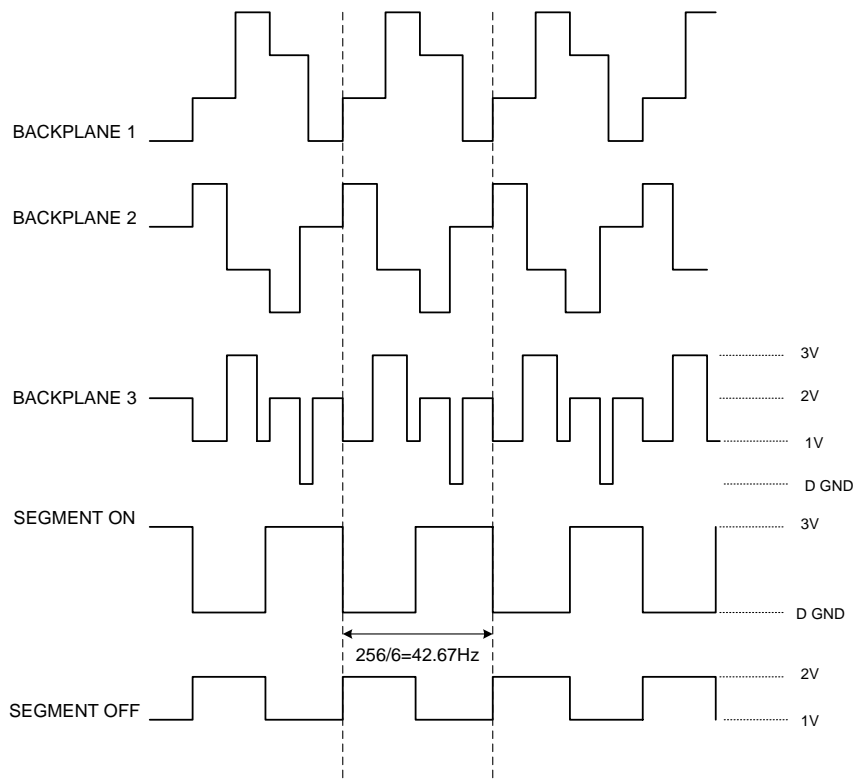
Auto PWR1(Pin30) + Auto PWR2(PIN31)	0+0	1+0	0+1	1+1
POWER	Power on	Auto power off	Off	Off

4.Full display value according to mode

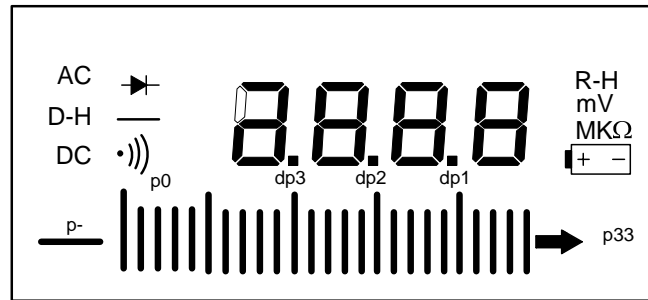
Mode		R1	R2	R3	R4	R5	R32M
Voltage	DC	326.0mV	3.260V	32.60V	326.0V	3260V	
	AC		3.260V	32.60V	326.0V	3260V	
Current (AC/CD)	mA			32.60mA	326.0mA		
	μ A				326.0 μ A	3260 μ A	
Resistance(Ω)		326.0	3.260K	32.60K	326.0K	3.260M	32.60M

DP3 of R4 is not displayed under voltage, current mode.

LCD DRIVE WAVEFORM



LCD DISPLAY

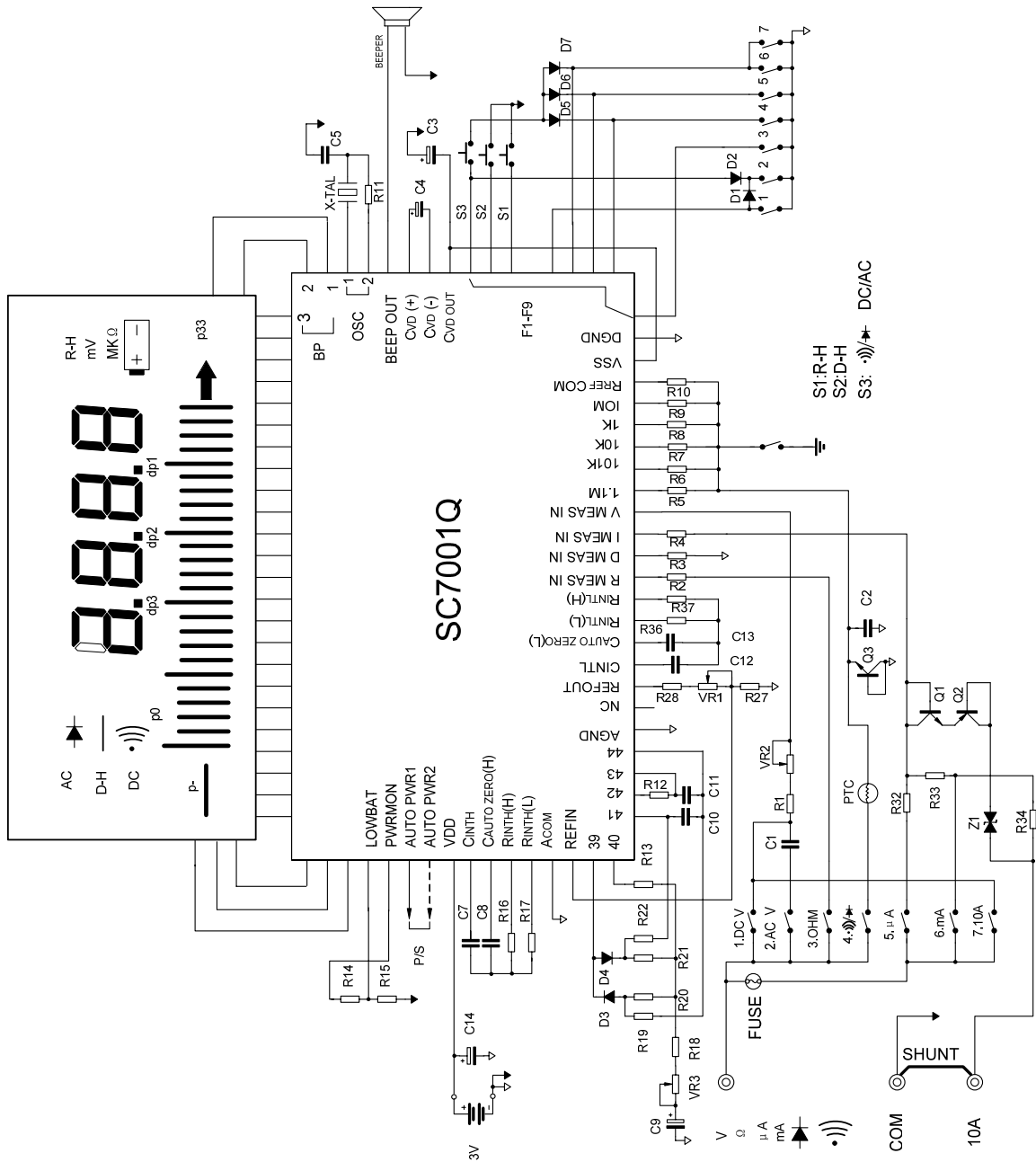


TRIPLEXED LCD DISPLAY FORMAT

BP NO \ IC PIN NO	2	3	4	5	6	7	8	9	10	11	12	13	14	
BP2	79	p31	Ω	K	\pm	d0	p30	dp1	d1	p29	dp2	d2	p28	dp3
BP3	80	p32	V	M	c0	g0	e0	c1	g1	e1	c2	g2	e2	c3
BP1	1	p33	R-H	m	b0	a0	f0	b1	a1	f1	b2	a2	f2	b3

BP NO \ IC PIN NO	15	16	17	18	19	20	21	22	23	24	25	26	27	
BP2	79	d3	\rightarrow	AC	p27	p22	p21	p16	p15	p10	p9	p4	p3	p-
BP3	80	e3	—	D-H	p26	p23	p20	p17	p14	p11	p8	p5	p2	p0
BP1	1	a3, g3	•)))	DC	p25	p24	p19	p18	p13	p12	p7	p6	p1	

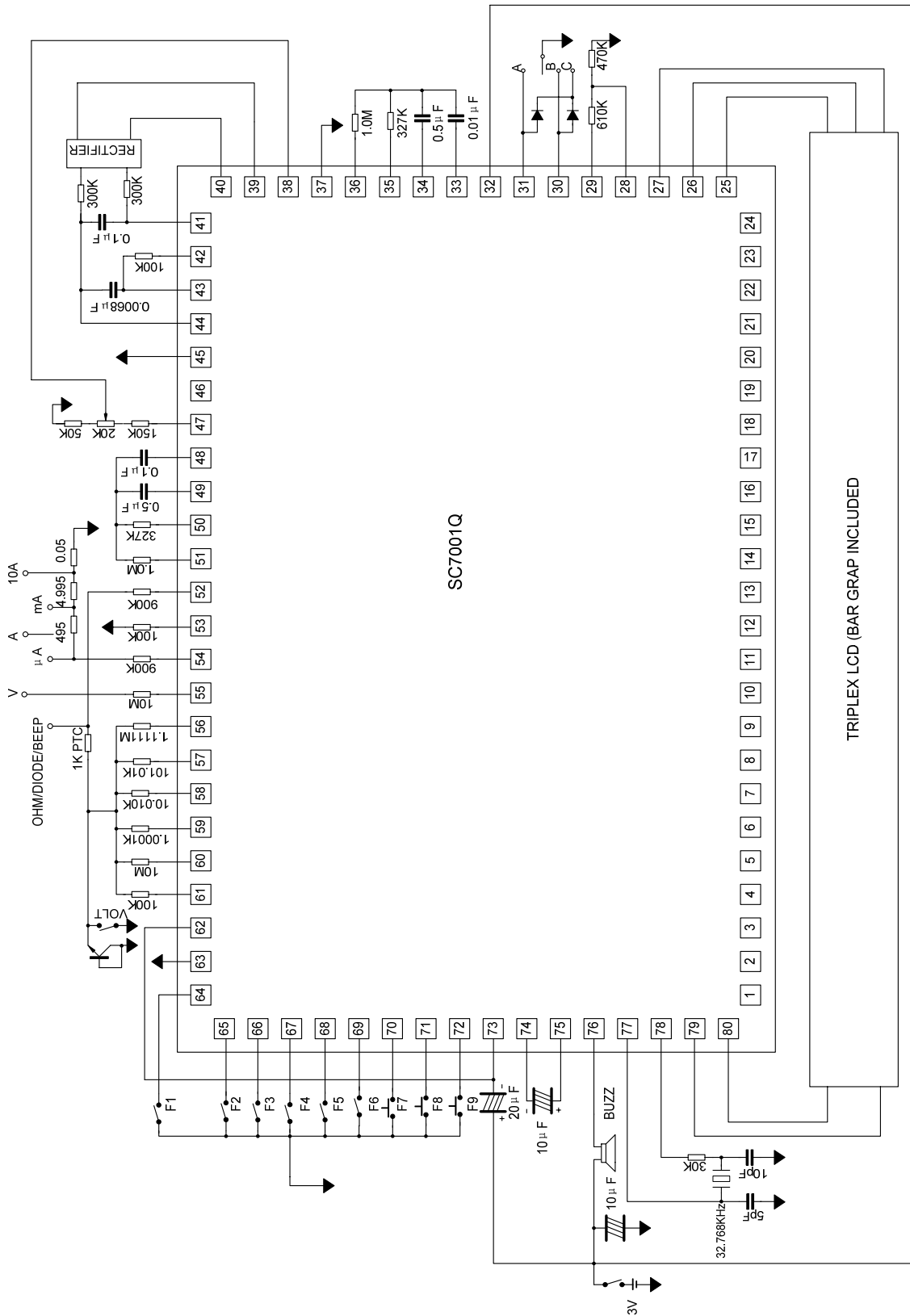
TYPICAL APPLICATION CIRCUIT



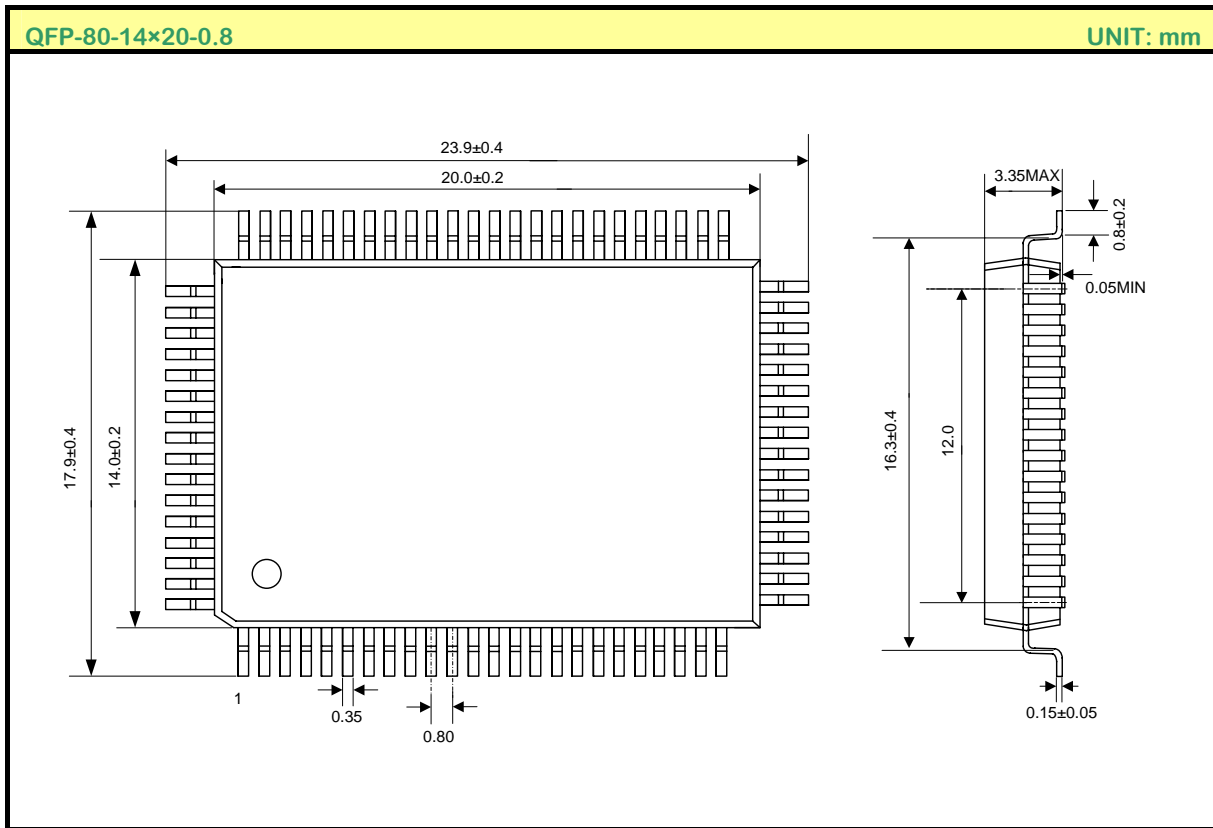
COMPONENT VALUE

No	Value	Unit	No	Value	Unit
R1	9900	K Ω	C1	0.022	μ F
R2	909	K Ω	C2	0.022	μ F
R3	100	K Ω	C3	10	μ F
R4	900	K Ω	C4	10	μ F
R5	1.1	M Ω	C5	10	pF
R6	101.01	K Ω	C7	0.015	μ F
R7	10.01	K Ω	C8	0.22	μ F
R8	1.001	K Ω	C9	10	μ F
			C10	0.1	μ F
R9	10	M Ω	C11	0.0068	μ F
R10	100	K Ω	C12	0.15	μ F
R11	470	K Ω	C13	1	μ F
R12	0.1	M Ω	C14	10	μ F
R13	100	K Ω			
			VR1	20	K Ω
R14	160	K Ω	VR2	200	K Ω
R15	150	K Ω	VR3	500	Ω
R16	324	K Ω			
R17	1	M Ω	D1	1N4148	
R18	8.2	K Ω	D2	1N4148	
R19	100	K Ω	D3	1N4148	
R20	10	K Ω	D4	1N4148	
R21	10	K Ω	D5	1N4148	
R22	100	K Ω	D6	1N4148	
			D7	1N4148	
R27	50	K Ω			
R28	150	K Ω	Q1	C2500	
R32	39	Ω	Q2	C2500	
R33	495	Ω	Q3	C945	
R34	4.995	Ω	X-Tal	32768	Hz
R36	324	K Ω			
R37	990	K Ω	Z1	ZENAMIC 220	

TEST CIRCUIT



PACKAGE OUTLINE



HANDLING MOS DEVICES:

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic discharge but they can be damaged if the following precautions are not taken:

- Persons at a work bench should be earthed via a wrist strap.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed for dispatch in antistatic/conductive containers.