High Efficiency, Low noise, Automatic Dead Time Adjustment Control IC for Half-Bridge LLC Off-line Switching Regulators

SSC9522S

June 28, 2012

General Description

The SSC9522S is a controller IC (SMZ* method) for half-bridge resonant type power supply, incorporating a floating drive circuit for High-side MOSFET drive.
*SMZ = Soft-switched Multi-resonant Zero Current switch, all switching periods work with soft switching operation.
The IC is suitable for high performance power supply system with small size, high efficiency and low noise, because for various power supply specifications, more effective and easier design works are achievable with effective functions as the Automatic Dead Time Adjustment, the Uncontrollable Operation Detection and so on.

Package

SOIC18

Not to scale

Features and Benefits

- Built-in floating drive circuit for High-side MOSFET
- Soft Start Function, reducing of power MOSFET stress and preventing Uncontrollable Operation, at startup
- Uncontrollable Operation Detection Function on pulse-by-pulse basis, improving the ability of transformer output wattage because the frequency range is available up to the resonant frequency, f_O, and reducing power MOSFET stress
- Automatic Dead Time Adjustment Function, not being necessary to make the dead time adjustment for each power supply specification
- Line Undervoltage Protection Function
  (Brown-In／Brown-Out Function)
  Prevention of excessive input current and overheat at low input voltage
- Protection Functions
  External Latch Function ---------- Latch shutdown by external signal input
  Overcurrent Protection (OCP) ----- Pulse-by-pulse
  Overvoltage Protection (OVP) ---- Latch shutdown
  Overload Protection (OLP) -------- Latch shutdown
  Thermal Shutdown (TSD)---------- Latch shutdown

Electrical Characteristics

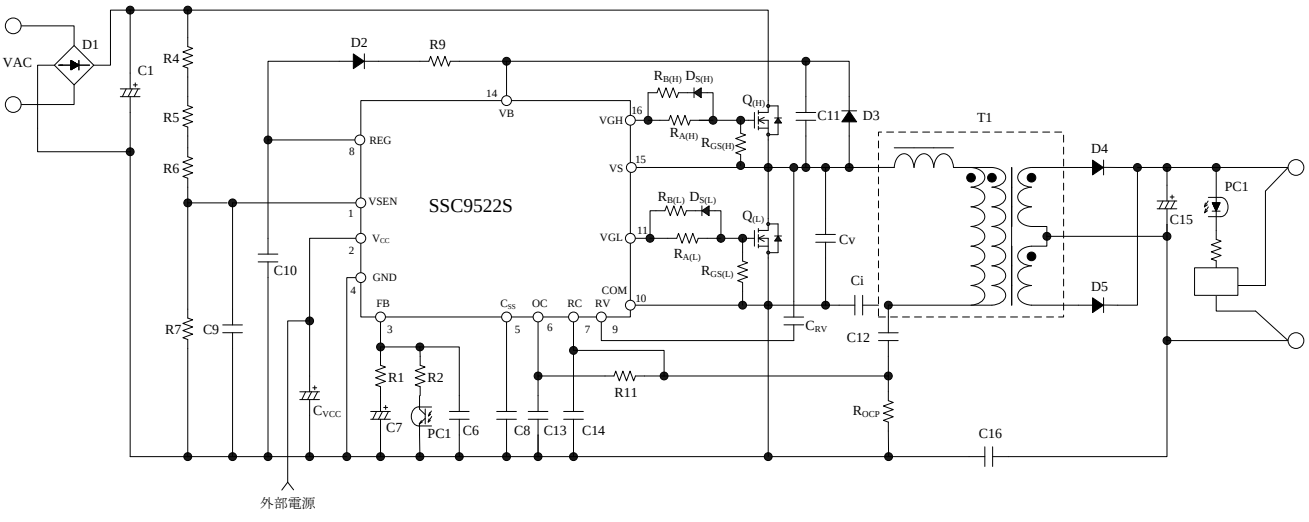
- Maximum rating of V_{CC} : 35V(MAX)
- Minimum frequency, $F_{(MIN)}$: 28.3kHz(TYP)
- Maximum frequency, $F_{(MAX)}$: 300kHz(TYP)
- Maximum dead - time, $t_{d(MAX)}$: 2.45μs(TYP)
- Minimum dead - time , $t_{d(MIN)}$: 0.50μs(TYP)

Applications

Switching power supplies for electronic devices such as:

- LCD and PDP TV
- Sarver
- Multi Function Printer
- Industrial Equipment
- Communications Equipment

Typical Application Circuit



Absolute Maximum Ratings * Valid at Ta = 25°C, unless otherwise specified

Characteristic	Pins	Symbol	Ratings	Units	Notes
VSEN pin voltage	1−4	V_{SEN}	−0.3 to V_{REG}	V	
V_{CC} pin voltage	2−4	V_{CC}	−0.3 to +35	V	
FB pin voltage	3−4	V_{FB}	−0.3 to +10	V	
C_{SS} pin voltage	5−4	V_{Css}	−0.3 to +12	V	
RC pin voltage	7−4	V_{RC}	−6 to +6	V	
RV pin current	9−4	I_{RV}	−2 to +2	mA	DC
			−100 to +100	mA	Pulse 40ns
OC pin voltage	6−4	V_{OC}	−6 to +6	V	
VGL pin voltage	11−4	V_{GL}	−0.3 to V_{REG}+0.3	V	
REG pin source current	8−4	I_{REG}	−20.0	mA	
Voltage between VB and VS pin	14−15	V_B−V_S	−0.3 to +15.0	V	
VS pin voltage	15−4	V_S	−1 to +600	V	
VGH pin voltage	16−4	V_{GH}	V_S−0.3 to V_B+0.3	V	
Operating ambient temperature	—	T_{OP}	−20 to +85	°C	
Storage temperature	—	T_{stg}	−40 to +125	°C	
Junction temperature	—	T_j	+150	°C	

*The polarity value for current specifies a sink as "+", and a source as "−", referencing the IC.

Note: Surge voltage withstand (Human body model) of No.14 to No.16 pin is guaranteed 1000V.
Other pins are guaranteed 2000V.

Electrical Characteristics* Valid at V_{CC} = 20 V, Ta = 25°C, unless otherwise specified

Parameter	Pin	Symbol	Ratings MIN	Ratings TYP	Ratings MAX	Unit	Notes
Start／Circuit current							
Operation start voltage	2−4	$V_{CC(ON)}$	10.2	11.8	13.0	V	$V_{CC(OFF)}$ <$V_{CC(ON)}$
Operation stop voltage	2−4	$V_{CC(OFF)}$	8.8	9.8	10.9	V	
Circuit current in operation	2−4	$I_{CC(ON)}$	—	—	20.0	mA	
Circuit current in non-operation	2−4	$I_{CC(OFF)}$	—	—	1.2	mA	V_{CC}=9V
Circuit current in latch-operation	2−4	$I_{CC(L)}$	—	—	1.2	mA	V_{CC}=11V
OLP latch／External Latch							
FB pin source current	3−4	I_{FB}	−30.5	−25.5	−20.5	μA	
FB pin threshold voltage	3−4	V_{FB}	6.55	7.05	7.55	V	
C_{SS} pin threshold voltage(1)	5−4	$V_{Css(1)}$	7.0	7.8	8.6	V	
Latch circuit release V_{CC} voltage	2−4	$V_{CC(La.Off)}$	6.7	8.2	9.5	V	$V_{CC(La.OFF)}$ <$V_{CC(OFF)}$
Oscillator							
Minimum frequency	11−10 16−15	$F_{(MIN)}$	26.2	28.3	31.2	kHz	
Maximum frequency	11−10 16−15	$F_{(MAX)}$	265	300	335	kHz	
Maximum dead-time	11−10 16−15	$t_{d(MAX)}$	1.90	2.45	3.00	μs	
Minimum dead-time	11−10 16−15	$t_{d(MIN)}$	0.25	0.50	0.75	μs	
Control							
Burst mode start FB pin source current	3−4	$I_{CONT(1)}$	−2.9	−2.5	−2.1	mA	
Oscillation stop FB pin source current	3−4	$I_{CONT(2)}$	−3.7	−3.1	−2.5	mA	
Soft start							
C_{SS} pin charge current	5−4	$I_{Css(C)}$	−0.21	−0.18	−0.15	mA	
C_{SS} pin reset current	5−4	$I_{Css(R)}$	1.0	1.8	2.4	mA	V_{CC}=9V
Overvoltage protection／Thermal protection							
OVP operating V_{CC} voltage	2−4	V_{OVP}	28.0	31.0	34.0	V	
Thermal shutdown operating temperature	—	$T_{j\ (TSD)}$	150	—	—	°C	
Detection of current resonant／Overcurrent protection							
Uncontrollability detection voltage	7−4	V_{RC}	0.055	0.155	0.255	V	
			−0.255	−0.155	−0.055	V	
RC pin threshold voltage (Hi speed)	7−4	$V_{RC(S)}$	2.15	2.35	2.55	V	
			−2.55	−2.35	−2.15	V	
OC pin threshold voltage(Low)	6-4	$V_{OC(L)}$	1.42	1.52	1.62	V	
OC pin threshold voltage (High)	6-4	$V_{OC(H)}$	1.69	1.83	1.97	V	
OC pin threshold voltage (Hi speed)	6-4	$V_{OC(S)}$	2.15	2.35	2.55	V	
C_{SS} pin sink current	5−4	I_{Css} (L)	1.0	1.8	2.4	mA	
		I_{Css} (H)	12.0	20.0	28.0	mA	
		I_{Css} (S)	11.0	18.3	25.0	mA	

* The polarity value for current specifies a sink as "+", and a source as "−", referencing the IC.

Electrical Characteristics* Valid at V_{CC} = 20 V, Ta = 25°C, unless otherwise specified

Parameter	Pin	Symbol	Ratings			Unit	Notes
			MIN	TYP	MAX		
Detection of voltage resonant							
RV pin voltage detect Resonance voltage(1)	9−4	$V_{RV(1)}$	3.8	4.9	5.4	V	
RV pin voltage detect Resonance voltage(2)	9−4	$V_{RV(2)}$	1.20	1.77	2.30	V	
Stand by							
Burst oscillation frequency	5−4	f_{Css}	70	105	130	Hz	
ON／OFF							
C_{SS} pin threshold voltage (2)	5−4	$V_{Css(2)}$	0.50	0.59	0.68	V	
Input voltage detect function							
VSEN pin threshold voltage (ON)	1−4	$V_{SEN(ON)}$	1.32	1.42	1.52	V	
VSEN pin threshold voltage (OFF)	1−4	$V_{SEN(OFF)}$	1.08	1.16	1.24	V	
Supply of driver circuit							
REG pin output voltage	8−4	V_{REG}	9.9	10.5	11.1	V	
High-side driver							
High-side drive operation start voltage	14−15	$V_{BUV(ON)}$	6.3	7.3	8.3	V	
High-side drive operation stop voltage	14−15	$V_{BUV(OFF)}$	5.5	6.4	7.2	V	
Drive circuit							
VGL,VGH pin source current 1	11−10 16−15	$IGL_{SOURCE1}$ $IGH_{SOURCE1}$	—	−515	—	mA	V_{REG}=10.5V V_B=10.5V V_{GL}=0V V_{GH}=0V
VGL,VGH pin sink current 1	11−10 16−15	IGL_{SINK1} IGH_{SINK1}	—	685	—	mA	V_{REG}=10.5V V_B=10.5V V_{GL}=10.5V V_{GH}=10.5V
VGL,VGH pin source current 2	11−10 16−15	$IGL_{SOURCE2}$ $IGH_{SOURCE2}$	−120	−85	−50	mA	V_{REG}=12V V_B=12V V_{GL}=10.5V V_{GH}=10.5V
VGL,VGH pin sink current 2	11−10 16−15	IGL_{SINK2} IGH_{SINK2}	70	113	160	mA	V_{REG}=12V V_B=12V V_{GL}=1.5V V_{GH}=1.5V
Thermal characteristics							
Junction to ambient thermal resistance	—	θ_{j-a}	—	—	95	°C/W	

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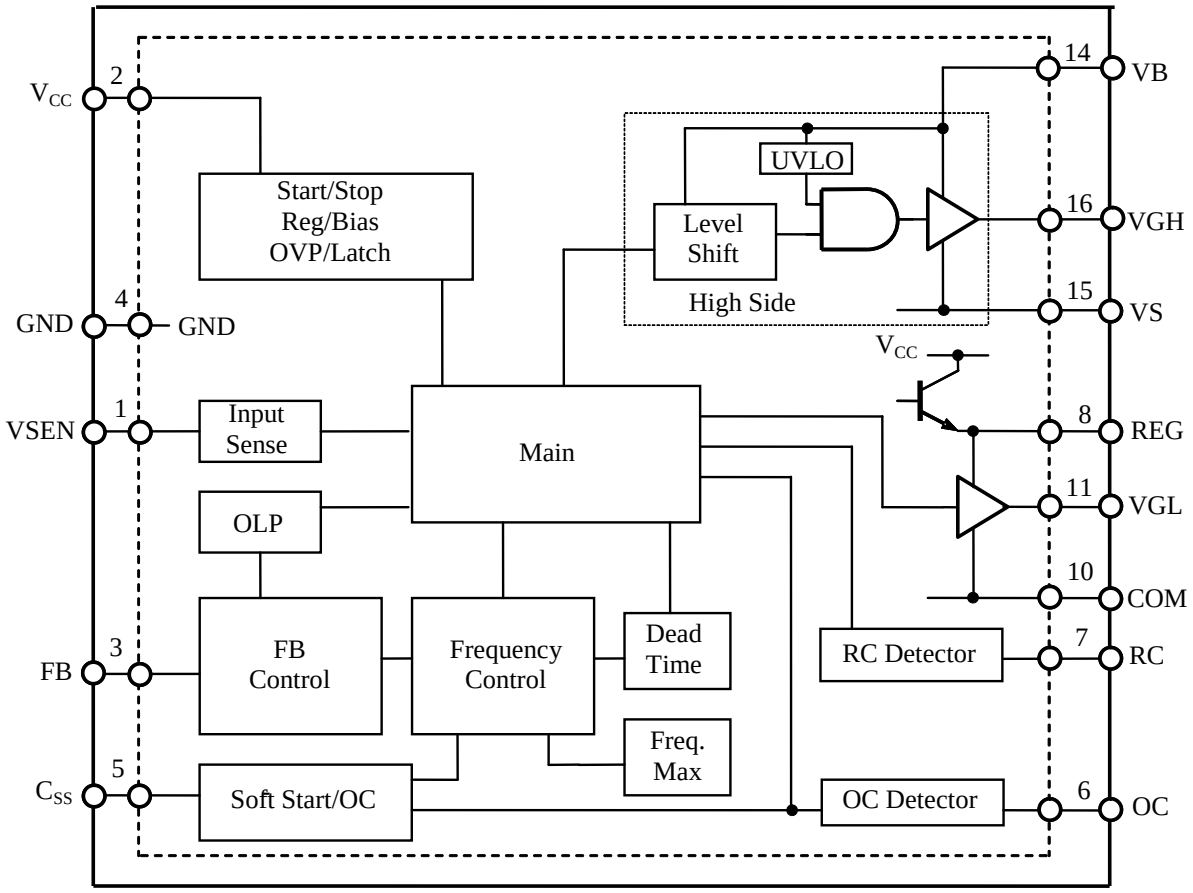
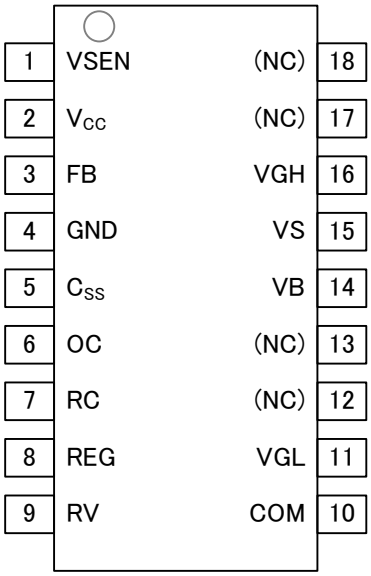
Functional Block Diagram

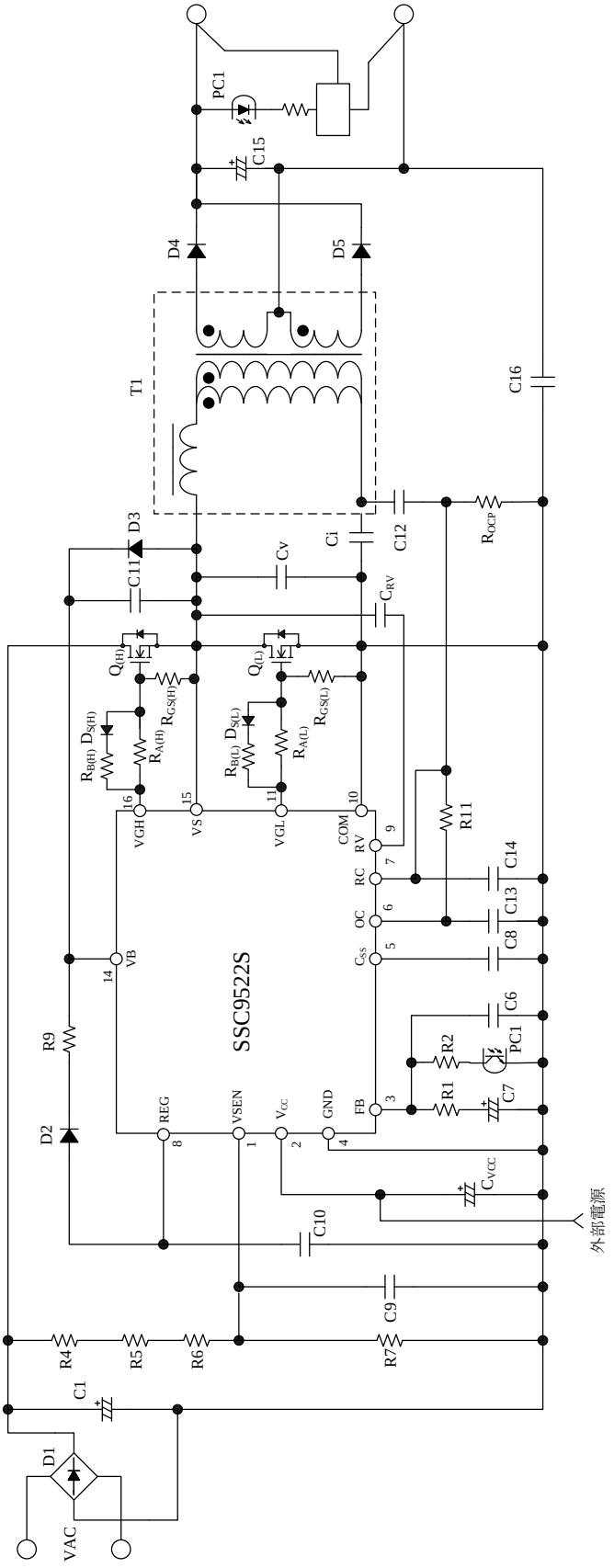


Pin List Table



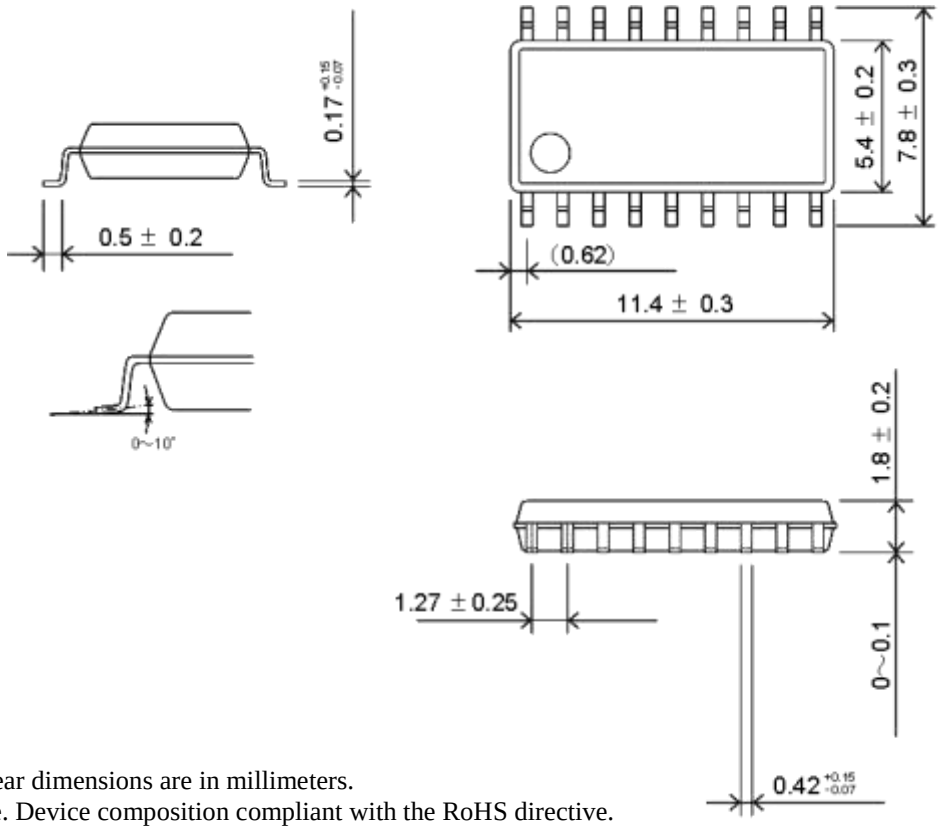
Terminal	Symbol	Functions
1	VSEN	AC line input voltage detection
2	V_{CC}	Power supply input for control circuit and Overvoltage protection signal input
3	FB	Constant voltage control signal input and Overload protection signal input
4	GND	Ground for control part
5	C_{SS}	Soft start capacitor connection and external latch shutdown signal input
6	OC	Overcurrent protection signal input
7	RC	Resonant current signal input
8	REG	Power supply output for gate drive
9	RV	Resonant voltage signal input
10	COM	Ground for power part
11	VGL	Low-side gate drive output
12	(NC)	(No connection)
13	(NC)	(No connection)
14	VB	High-side gate drive voltage input
15	VS	High-side drive floating ground
16	VGH	High-side gate drive output
17	(NC)	(No connection)
18	(NC)	(No connection)

Typical Application Circuit



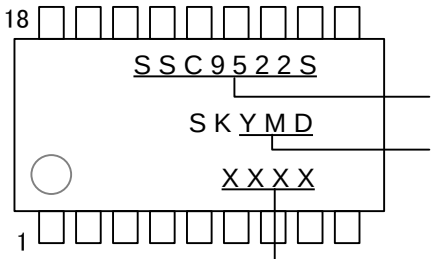
Package Outline Dimensions

SOP18



NOTES:
1) All linear dimensions are in millimeters.
2) Pb-free. Device composition compliant with the RoHS directive.

Marking Diagram



Part Number

Lot Number

Y = Last digit of year (0 to 9)

M = Month (1 to 9,O,N or D)

D = Period of days (1 to 3)

1 : 1st to 10th

2 : 11th to 20th

3 : 21st to 31st

Sanken Control Number

OOPERATING PRECAUTIONS

Because reliability can be affected adversely by improper storage environments and handling methods, please observe the following cautions.

Cautions for Storage

- Ensure that storage conditions comply with the standard temperature (5 to 35°C) and the standard relative humidity (around 40 to 75%); avoid storage locations that experience extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present and avoid direct sunlight.
- Reinspect for rust on leads and solderability of the products that have been stored for a long time.

Cautions for Testing and Handling

When tests are carried out during inspection testing and other standard test periods, protect the products from power surges from the testing device, shorts between the product pins, and wrong connections. Ensure all test parameters are within the ratings specified by Sanken for the products.

Soldering

- When soldering the products, please be sure to minimize the working time, within the following limits:
  260 ± 5 °C 10 ± 1 s (Flow, 2 times)
  380 ± 10 °C 3.5 ± 0.5 s (Soldering iron, 1 time)

Electrostatic Discharge

- When handling the products, the operator must be grounded. Grounded wrist straps worn should have at least 1MΩ of resistance from the operator to ground to prevent shock hazard, and it should be placed near the operator.
- Workbenches where the products are handled should be grounded and be provided with conductive table and floor mats.
- When using measuring equipment such as a curve tracer, the equipment should be grounded.
- When soldering the products, the head of soldering irons or the solder bath must be grounded in order to prevent leak voltages generated by them from being applied to the products.
- The products should always be stored and transported in Sanken shipping containers or conductive containers, or be wrapped in aluminum foil.

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