LC5513D

Single-Stage Power Factor Corrected Off-Line Switching Regulator IC

Features and Benefits

- Integrated on-width control circuit (it realizes high power factor by average current control)
- Integrated startup circuit (no external startup circuit necessary)
- Integrated soft-start circuit (reduces power stress during start-up on the incorporated power MOSFET and output diode)
- Integrated bias assist circuit (improves the startup performance, suppresses V_{CC} voltage droop during operation, allows reduction of VCC capacitor value as well as use of a ceramic capacitor)
- Integrated Leading Edge Blanking (LEB) circuit
- Integrated maximum on-time limit circuit
- Dual-chip structure, with an avalanche-guaranteed power MOSFET (allows simplified surge suppressing circuits)
- Protection features:
  - Overcurrent protection (OCP): pulse-by-pulse
  - Overvoltage protection (OVP): pins VCC, ISENSE, and OCP, intermittent oscillation operation
  - Overload protection (OLP): intermittent oscillation operation
  - Thermal shutdown (TSD): halts switching operation and latches in the off-state

Package: 8-pin DIP

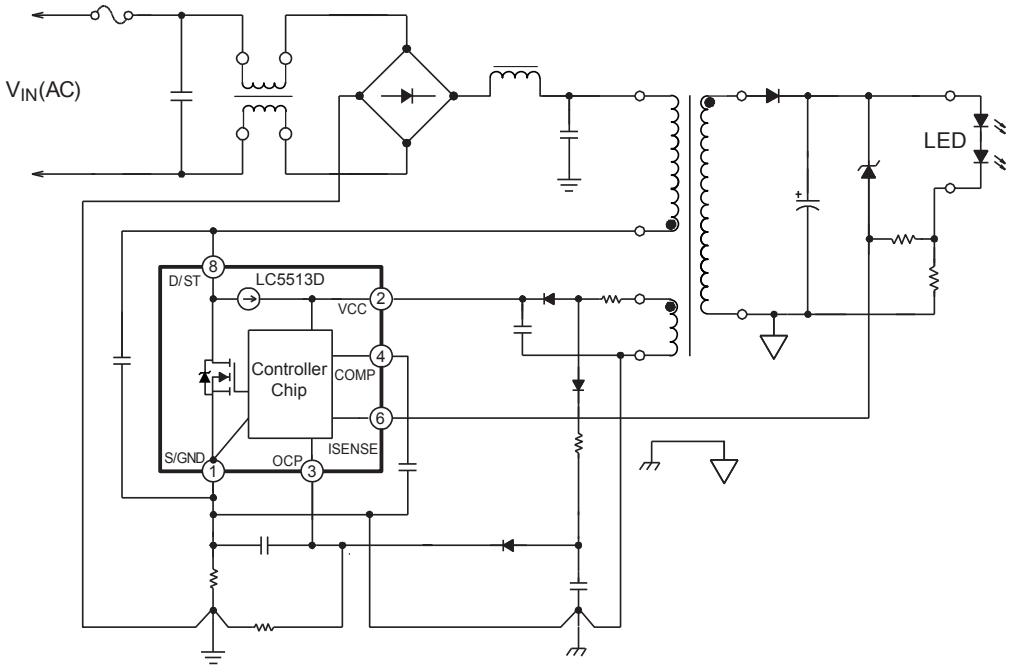
Not to scale

Description

The LC5500 series is a quasi-resonant topology switching power supply IC, designed for input capacitorless applications, and making it possible for systems to comply with the harmonics standard (IEC61000-3-2 class C). It incorporates separate controller and power MOSFET chips. The controller adapts the average current control method for realizing high power factors, and the quasi-resonant topology contributes to high efficiency and low EMI noise. The rich set of protection features helps to realize low component counts, and high performance-to-cost power supply.

The LC5513D is intended for non-isolated designs. The incorporated MOSFET has a V_{DSS}(min) rating of 650 V and $R_{DS(on)}$(max) of 1.9 Ω. It is capable of a maximum output power of 20 W on 230 VAC supply and 16 W on universal supply based on the thermal rating. Note that the maximum output power can be up to 120% to 140% of this value. However, it may be limited in applications with low output voltage or short duty cycle.

Typical Application



Selection Guide

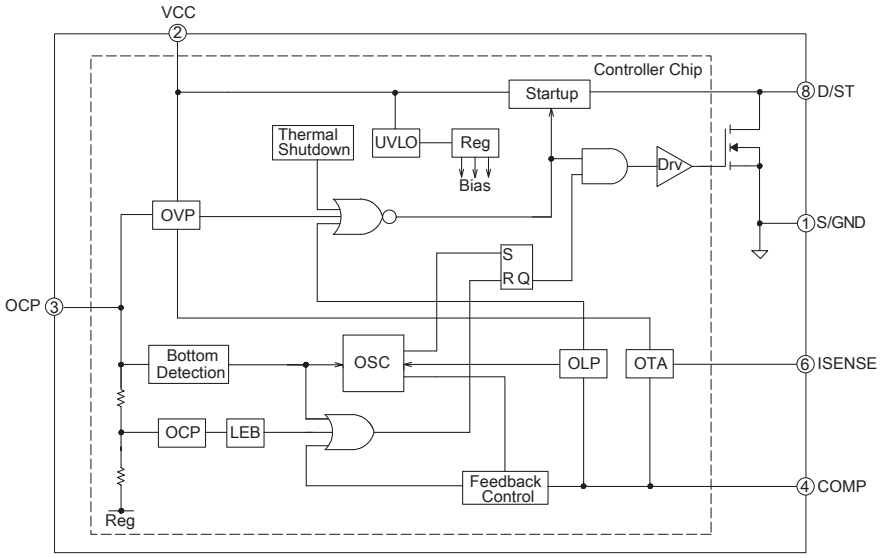
Part Number	Package	Packing
LC5513D	DIP8 with pin 7 removed	50 pieces per tube

Absolute Maximum Ratings T_A = 25°C, unless otherwise specified

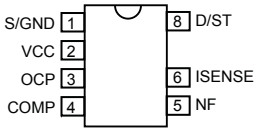
Characteristic	Symbol	Notes	Pins	Rating	Unit
Drain Current[1]	I_{DPeak}	Single pulse	8 – 1	4.0	A
Single Pulse Avalanche Energy[2]	E_{AS}	I_{LPeak} = 2.7 A, V_{DD} = 99 V, L = 20 mH	8 – 1	86	mJ
Input Voltage in Control Part	V_{CC}		2 – 1	35	V
OCP Terminal Voltage	V_{OCP}		3 – 1	−2.0 to 5.0	V
COMP Terminal Voltage	V_{COMP}		4 – 1	−0.3 to 7.0	V
ISENSE Terminal Voltage	V_{ISEN}		6 – 1	−0.3 to 5.0	V
Power Dissipation in MOSFET[3]	P_{D1}	When embedding this hybrid IC onto the printed circuit board (board size 15 mm ×15 mm)	8 – 1	0.97	W
Operating Ambient Temperature	T_{OP}		—	−55 to 125	°C
Storage Temperature	T_{stg}		—	−55 to 125	°C
Channel Temperature	T_{ch}		—	150	°C

[1]Refer to MOSFET Safe Operating Area Curve.
[2]Refer to MOSFET Avalanche Energy Derating Coefficient Curve.
[3]Refer to MOSFET Temperature versus Power Dissipation Curve.

Functional Block Diagram



Pin-out Diagram



LC5513D Terminal List Table

Number	Name	Function
1	S/GND	MOSFET source and GND terminal for the Controller chip
2	VCC	Supply voltage input
3	OCP	Overcurrent Protection and quasi-resonant signal input terminal
4	COMP	Feedback phase-compensation input
5	NF	No function; must be externally connected to S/GND pin with as short a trace as possible, for stable operation of the device
6	ISENSE	Output current sensing voltage input
7	–	Pin removed
8	D/ST	MOSFET drain terminal and input of the startup current

ELECTRICAL CHARACTERISTICS (Controller Chip)[1] T_A = 25°C, V_{CC} = 20 V, unless otherwise specified

Characteristics	Symbol	Test Conditions	Pins	Min.	Typ.	Max.	Unit
Power Supply Start-up Operation							
Operation Start Voltage	$V_{CC(ON)}$		2 – 1	13.8	15.1	17.3	V
Operation Stop Voltage	$V_{CC(OFF)}$		2 – 1	8.4	9.4	10.7	V
Circuit Current in Operation	$I_{CC(ON)}$		2 – 1	–	–	3.7	mA
Startup Circuit Operation Voltage	$V_{STARTUP}$		8 – 1	42	57	72	V
Startup Current	$I_{CC(STARTUP)}$	$V_{D/ST}$ = 100 V, V_{CC} = 13 V	2 – 1	−5.5	−3.0	−1.0	mA
Startup Current Supplying Start Voltage-1	$V_{CC(BIAS)1}$	$V_{D/ST}$ = 100 V	2 – 1	9.5	11.0	12.5	V
Startup Current Supplying Start Voltage-2	$V_{CC(BIAS)2}$	$V_{D/ST}$ = 100 V	2 – 1	14.4	16.6	18.8	V
Normal Operation							
Oscillation Minimum Frequency	f_{OSC}		8 – 1	11.0	14.0	18.0	kHz
Maximum On Time	$t_{ON(MAX)}$		8 – 1	30.0	40.0	50.0	µs
COMP Terminal Minimum Voltage in Feedback Operation	$V_{COMP(MIN)}$		4 – 1	0.55	0.90	1.25	V
Error Amplifier Reference Voltage	$V_{SEN(th)}$		6 – 1	0.27	0.30	0.33	V
Error Amplifier Source Current	$I_{SEN(SOURCE)}$		4 – 1	−11	−7	−3	µA
Error Amplifier Sink Current	$I_{SEN(SINK)}$		4 – 1	3	7	11	µA
Leading Edge Blanking Time	t_{BW}		3 – 1	–	500	–	ns
Quasi-Resonant Operation Threshold Voltage-1	$V_{BD(TH1)}$		3 – 1	0.14	0.24	0.34	V
Quasi-Resonant Operation Threshold Voltage-2	$V_{BD(TH2)}$		3 – 1	0.12	0.17	0.22	V
Protection Operation							
Over-Current Detection Threshold Voltage	V_{OCP}		3 – 1	−0.54	−0.60	−0.66	V
OCP Terminal Source Current	I_{OCP}		3 – 1	−120	−40	−10	µA
OVP Operation Voltage of OCP Terminal	$V_{OCP(OVP)}$		3 – 1	2.2	2.6	3.0	V
OLP Threshold Voltage	$V_{COMP(OLP)1}$		4 – 1	5.0	5.5	6.0	V
OLP Threshold Voltage	$V_{COMP(OLP)2}$		4 – 1	4.1	4.5	4.9	V
ISENSE Terminal OVP Threshold Voltage	$V_{ISEN(OVP)}$		6 – 1	1.6	2.0	2.4	V
OVP Operation Voltage of VCC Terminal	$V_{CC(OVP)}$		2 – 1	28.5	31.5	34.0	V
Thermal Shutdown Operating Temperature	$T_{J(TSD)}$		–	135	–	–	°C

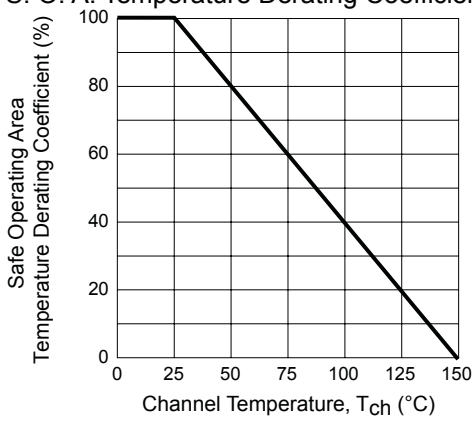
[1]The current ratings are based on those of the IC, and plus (+) represents sink and minus (-) represents source.
[2]The relation of $V_{CC(BIAS)1} > V_{CC(OFF)}$ is applied for each product.

ELECTRICAL CHARACTERISTICS (MOSFET) T_A = 25°C, V_{CC} = 20 V, unless otherwise specified

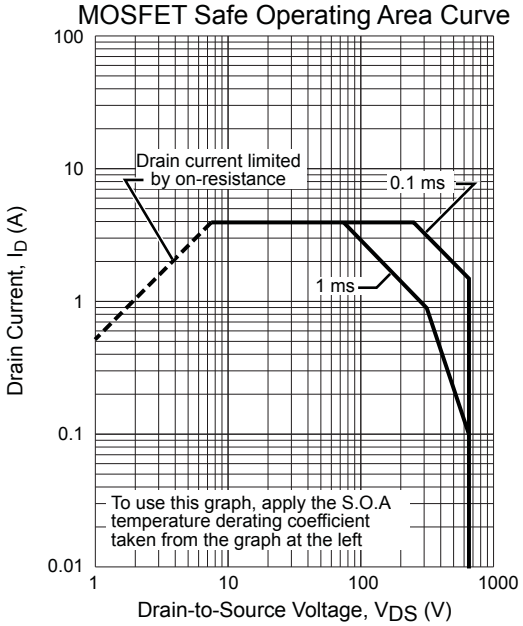
Characteristics	Symbol	Test Conditions	Pins	Min.	Typ.	Max.	Unit
Drain-to-Source Breakdown Voltage	V_{DSS}	I_{DSS} = 300 µA	8 – 1	650	—	—	V
Drain Leakage Current	I_{DSS}	V_{DSS} = 650 V	8 – 1	—	—	300	µA
Circuit Current in Operation	$R_{DS(on)}$	I_{DS} = 0.4 A	8 – 1	—	—	1.9	Ω
Switching Time	t_r		8 – 1	—	—	400	ns
Thermal Resistance	$R_{\theta ch-c}$	Between channel and case; case temperature, T_C, measured at the center of the marking side	—	—	—	35.5	°C/W

Characteristic Performance

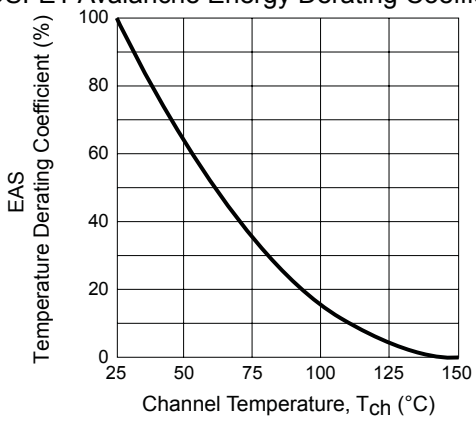
S. O. A. Temperature Derating Coefficient Curve



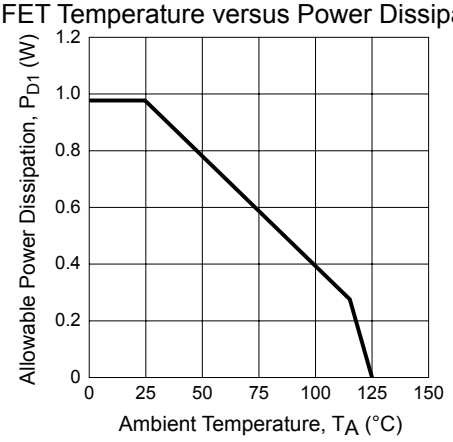
MOSFET Safe Operating Area Curve



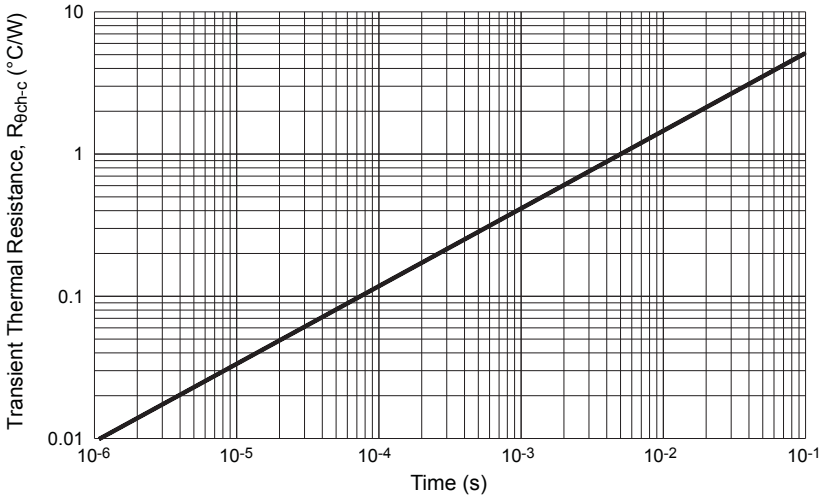
MOSFET Avalanche Energy Derating Coefficient Curve



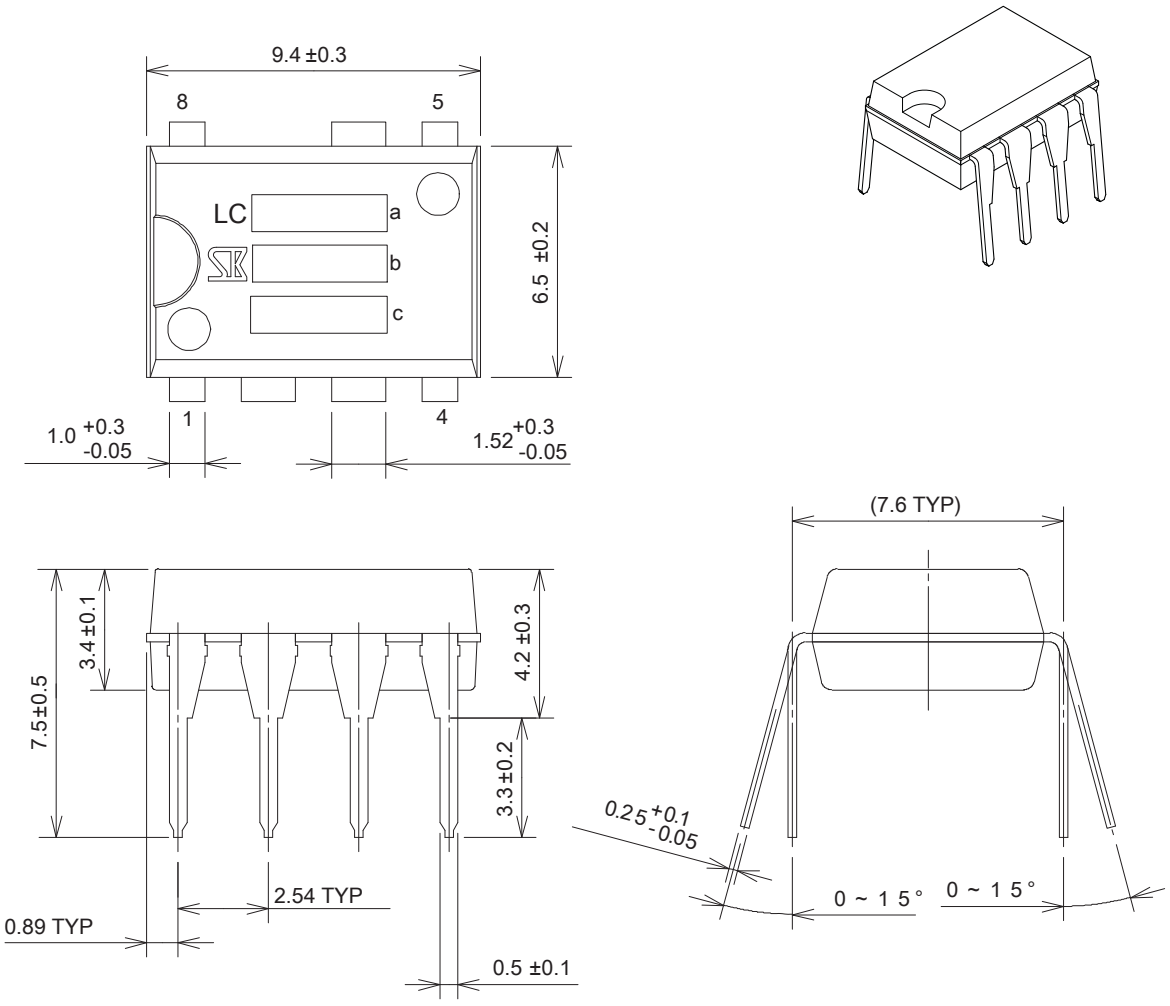
MOSFET Temperature versus Power Dissipation Curve



Transient Thermal Resistance Curve



Package Outline Drawing, DIP8

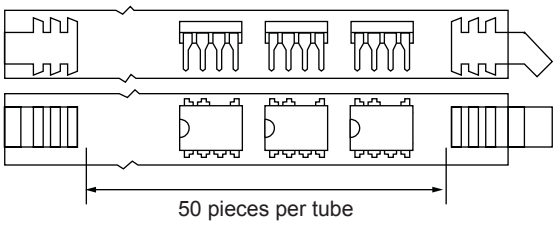


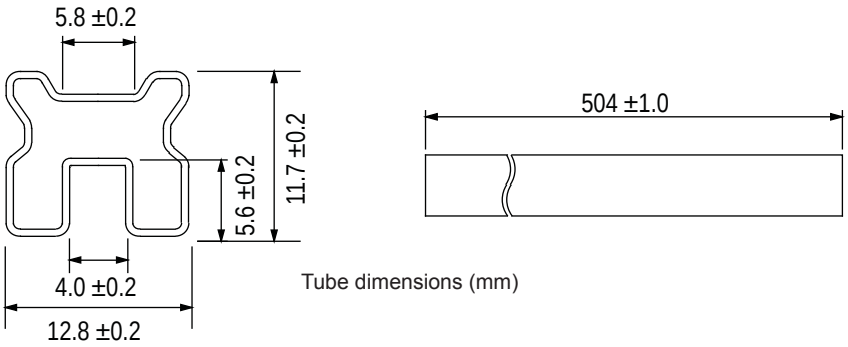
Unit: mm
Leadframe Material: Cu
Pin plating : Solder Plating
Weight: Approximately 0.51g

a: Part #: 5513
b: Lot number 3 digits, plus D
1st letter: Last digit of year
2nd letter: Month
Jan to September: Numeric
October: O
November: N
December: D
3rd letter: Week
Date 1 to 10: 1
Date 11 to 20: 2
Date 21 to 31: 3
c: Internal use control number

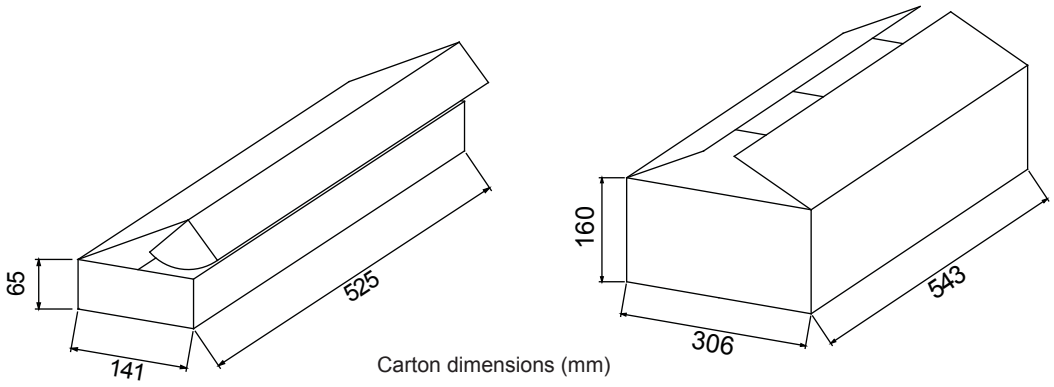
Leadframe plating Pb-free. Device composition compliant with the RoHS directive.

Packing Specifications





Tube dimensions (mm)



Carton dimensions (mm)

50 tubes per inner carton (maximum)
2500 pieces maximum per inner carton

4 inner cartons per outer carton (maximum)
10,000 pieces maximum per outer carton

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°C 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 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.

Remarks About Using Silicone Grease with a Heatsink

- When silicone grease is used in mounting this product on a heatsink, it shall be applied evenly and thinly. If more silicone grease than required is applied, it may produce excess stress.
- Volatile-type silicone greases may crack after long periods of time, resulting in reduced heat radiation effect. Silicone grease with low consistency (hard grease) may cause cracks in the mold resin when screwing the product to a heatsink.
- Our recommended silicone greases for heat radiation purposes, which will not cause any adverse effect on the product life, are indicated below:

Type	Suppliers
G746	Shin-Etsu Chemical Co., Ltd.
YG6260	Momentive Performance Materials Holding, Inc.
SC102	Dow Corning Toray Co., Ltd.

Soldering

- When soldering the products, please be sure to minimize the working time, within the following limits:
  260±5°C 10 s
  350±5°C 3 s (solder iron)
- Soldering iron should be at a distance of at least 1.5 mm from the body of the products

Electrostatic Discharge

- When handling the products, the operator must be grounded. Grounded wrist straps worn should have at least 1 MΩ 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 other 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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