

## 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  $V_{CC}$  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, OVP, and OCP, intermittent oscillation operation
  - Overload protection (OLP): intermittent oscillation operation
  - Thermal shutdown (TSD): halts switching operation and latches in the off-state

### Description

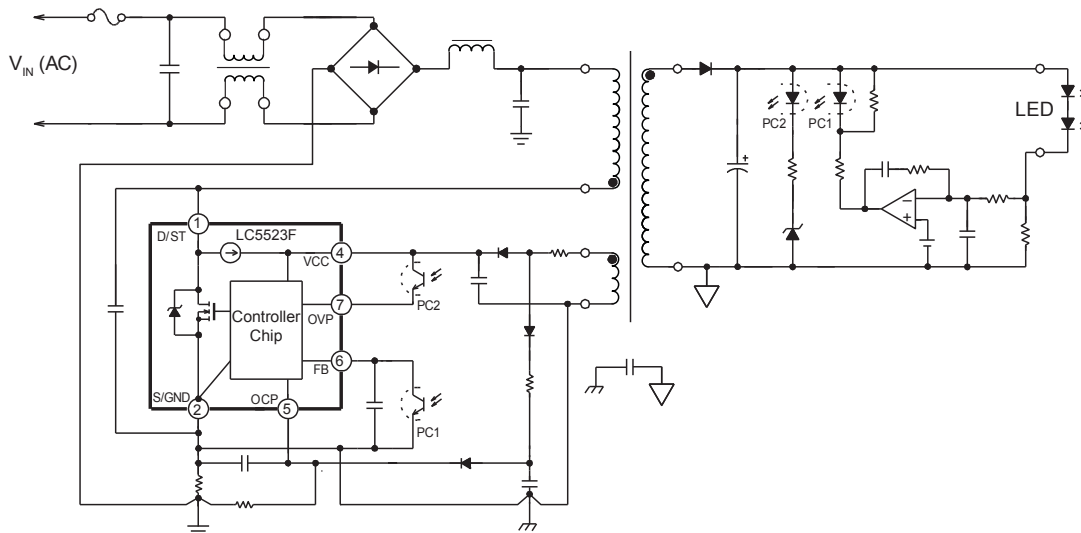
The LC5500 series is a quasi-resonant topology switching power supply IC, designed for input capacitorless applications, and making it possible for systems to comply with the harmonics standard (IEC61000-3-2 class C). It incorporates separate controller and power MOSFET chips. The controller adapts the 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 LC5523F is intended for isolated designs. The incorporated MOSFET has a  $V_{DSS(min)}$  rating of 650 V and  $R_{DS(on)(max)}$  of 1.9  $\Omega$ . It is capable of a maximum output power of 60 W on 230 VAC supply and 40 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.

### Package: 7-pin TO-220F



### Typical Application



# LC5523F

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

### Selection Guide

Part Number	Package	Packing
LC5523F	TO-220F (specify leadform when ordering)	50 pieces per tube

### Absolute Maximum Ratings $T_A = 25^\circ\text{C}$ , unless otherwise specified

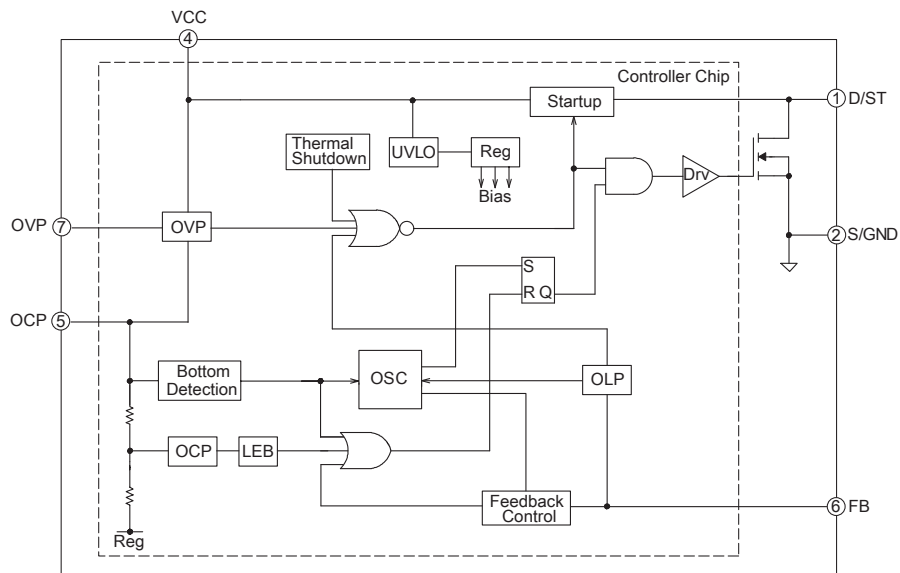
Characteristic	Symbol	Notes	Pins	Rating	Unit
Drain Current <sup>1</sup>	$I_{DPeak}$	Single pulse	1 – 2	9.2	A
Single Pulse Avalanche Energy <sup>2</sup>	$E_{AS}$	$I_{LPeak} = 2.9\text{ A}$ , $V_{DD} = 99\text{ V}$ , $L = 20\text{ mH}$	1 – 2	99	mJ
Input Voltage in Control Part	$V_{CC}$		4 – 2	35	V
OCP Terminal Voltage	$V_{OCP}$		5 – 2	-2.0 to 5.0	V
FB Terminal Voltage	$V_{FB}$		6 – 2	-0.3 to 7.0	V
OVP Terminal Voltage	$V_{OVP}$		7 – 2	-0.3 to 5.0	V
Power Dissipation of MOSFET <sup>3</sup>	$P_{D1}$	With infinite heatsink	1 – 2	20.2	W
		Without heatsink	1 – 2	1.8	W
Internal Leadframe Temperature in Operation	$T_F$		—	-20 to 115	$^\circ\text{C}$
Operating Ambient Temperature	$T_{OP}$		—	-55 to 115	$^\circ\text{C}$
Storage Temperature	$T_{stg}$		—	-55 to 125	$^\circ\text{C}$
Channel Temperature	$T_{ch}$		—	150	$^\circ\text{C}$

<sup>1</sup>Refer to MOSFET Safe Operating Area Curve.

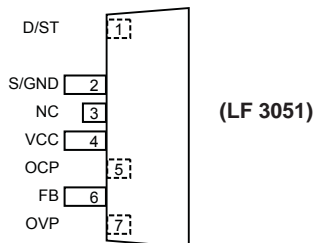
<sup>2</sup>Refer to MOSFET Avalanche Energy Derating Coefficient Curve.

<sup>3</sup>Refer to MOSFET Temperature versus Power Dissipation Curve.

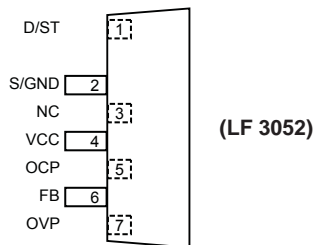
## Functional Block Diagram



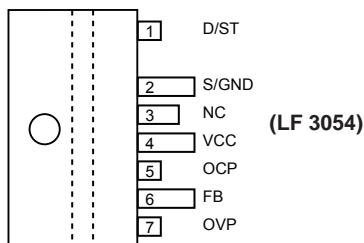
### Pin-out Diagrams



(LF 3051)



(LF 3052)



(LF 3054)

### LC5523F Terminal List Table

Number	Name	Function
1	D/ST	MOSFET drain terminal and input of the startup current
2	S/GND	MOSFET source and GND terminal for the Controller chip
3	NC	No connection
4	VCC	Supply voltage input
5	OCP	Overcurrent protection and quasi-resonant signal input terminal
6	FB	Feedback signal input and Overload Protection (OLP) signal input
7	OVP	Overvoltage Protection (OVP) signal input

### ELECTRICAL CHARACTERISTICS (Controller Chip)<sup>1</sup> T<sub>A</sub> = 25°C, V<sub>CC</sub> = 20 V, unless otherwise specified

Characteristics	Symbol	Test Conditions	Pins	Min.	Typ.	Max.	Unit
<b>Power Supply Startup Operation</b>							
Operation Start Voltage	V <sub>CC(ON)</sub>		4 – 2	13.8	15.1	17.3	V
Operation Stop Voltage	V <sub>CC(OFF)</sub>		4 – 2	8.4	9.4	10.7	V
Circuit Current in Operation	I <sub>CC(ON)</sub>		4 – 2	–	–	3.7	mA
Startup Circuit Operation Voltage	V <sub>STARTUP</sub>		1 – 2	42	57	72	V
Startup Current	I <sub>CC(STARTUP)</sub>	V <sub>D/ST</sub> = 100 V, V <sub>CC</sub> = 13 V	4 – 2	–5.5	–3.0	–1.0	mA
Startup Current Supplying Threshold Voltage-1	V <sub>CC(BIAS)1</sub>	V <sub>D/ST</sub> = 100 V	4 – 2	9.5	11.0	12.5	V
Startup Current Supplying Threshold Voltage-2	V <sub>CC(BIAS)2</sub>	V <sub>D/ST</sub> = 100 V	4 – 2	14.4	16.6	18.8	V
<b>Normal Operation</b>							
Oscillation Minimum Frequency	f <sub>OSC</sub>		1 – 2	11.0	14.0	18.0	kHz
Maximum On Time	t <sub>ON(MAX)</sub>		1 – 2	30.0	40.0	50.0	μs
FB Terminal Minimum Voltage in Feedback Operation	V <sub>FB(MIN)</sub>		6 – 2	0.55	0.90	1.25	V
Maximum Feedback Current	I <sub>FB(MAX)</sub>		6 – 2	–10	–25	–40	μA
Leading Edge Blanking Time	t <sub>BW</sub>		5 – 2	–	500	–	ns
Quasi-Resonant Operation Threshold Voltage-1	V <sub>BD(TH1)</sub>		5 – 2	0.14	0.24	0.34	V
Quasi-Resonant Operation Threshold Voltage-2	V <sub>BD(TH2)</sub>		5 – 2	0.12	0.17	0.22	V
<b>Protection Operation</b>							
Overcurrent Detection Threshold Voltage	V <sub>OCP</sub>		5 – 2	–0.54	–0.60	–0.66	V
OCP Terminal Source Current	I <sub>OCP</sub>		5 – 2	–120	–40	–10	μA
OVP Operation Voltage of OCP Terminal	V <sub>OCP(OVP)</sub>		5 – 2	2.2	2.6	3.0	V
OLP Threshold Voltage	V <sub>FB(OLP)1</sub>		6 – 2	5.0	5.5	6.0	V
OLP Threshold Voltage	V <sub>FB(OLP)2</sub>		6 – 2	4.1	4.5	4.9	V
OVP Terminal Threshold Voltage	V <sub>OVP</sub>		7 – 2	1.6	2.0	2.4	V
OVP Operation Voltage of VCC Terminal	V <sub>CC(OVP)</sub>		4 – 2	28.5	31.5	34.0	V
Thermal Shutdown Operating Temperature	T <sub>J(TSD)</sub>		–	135	–	–	°C

<sup>1</sup>The current ratings are based on those of the IC, and plus (+) represents sink and minus (-) represents source.

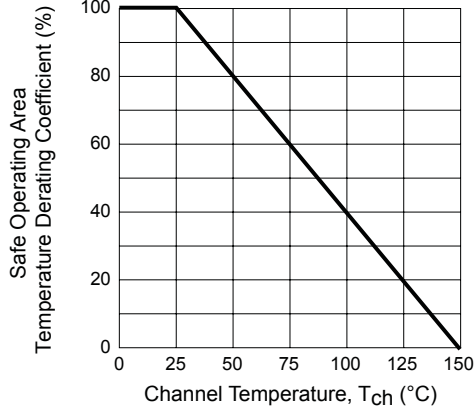
<sup>2</sup>The relation of V<sub>CC(BIAS)1</sub> > V<sub>CC(OFF)</sub> is applied for each product.

**ELECTRICAL CHARACTERISTICS (MOSFET)**  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 20\text{ V}$ , unless otherwise specified

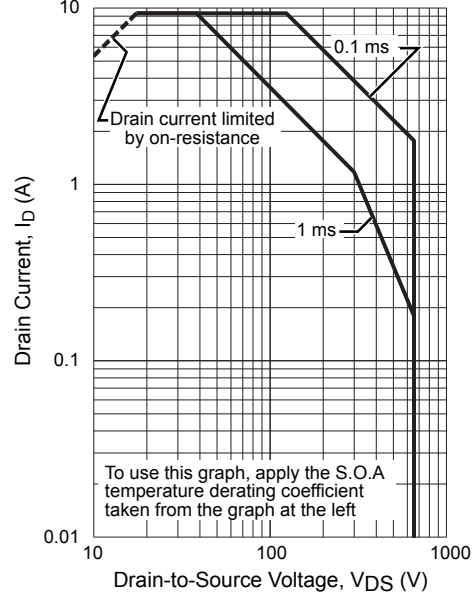
Characteristics	Symbol	Test Conditions*	Pins	Min.	Typ.	Max.	Unit
Drain-to-Source Breakdown Voltage	$V_{DSS}$	$I_{DSS} = 300\ \mu\text{A}$	1 – 2	650	—	—	V
Drain Leakage Current	$I_{DSS}$	$V_{DSS} = 650\text{ V}$	1 – 2	—	—	300	$\mu\text{A}$
Circuit Current in Operation	$R_{DS(on)}$	$I_{DS} = 1.1\text{ A}$	1 – 2	—	—	1.9	$\Omega$
Switching Time	$t_r$		1 – 2	—	—	400	ns
Thermal Resistance	$R_{\theta ch-F}$	Between channel and internal leadframe	—	—	—	3.1	$^\circ\text{C/W}$

## Characteristic Performance

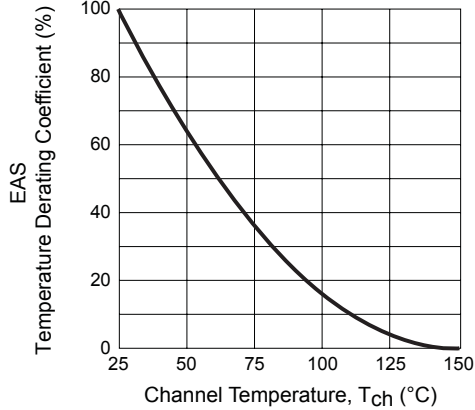
S. O. A. Temperature Derating Coefficient Curve



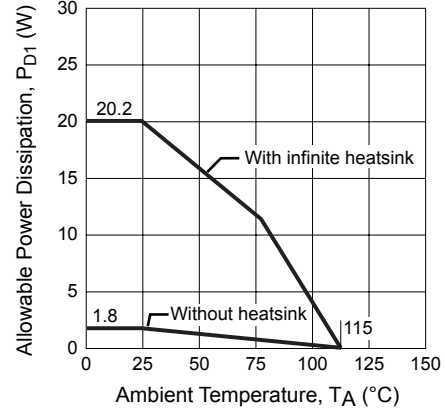
MOSFET Safe Operating Area Curve



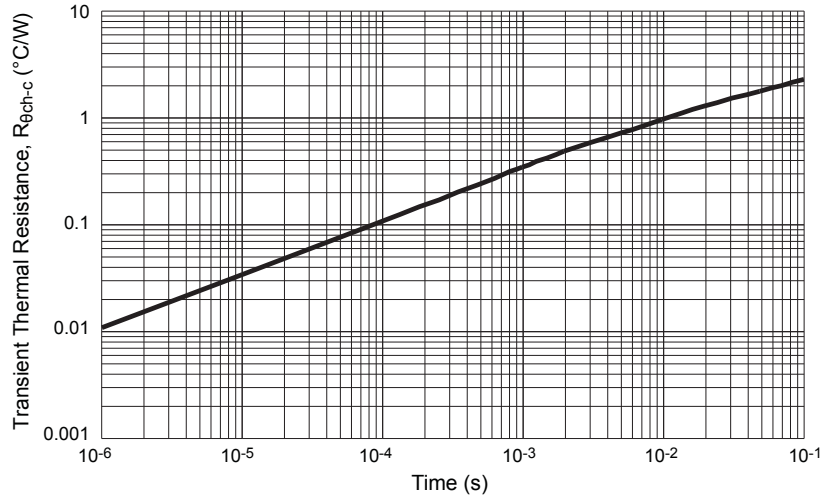
MOSFET Avalanche Energy Derating Coefficient Curve



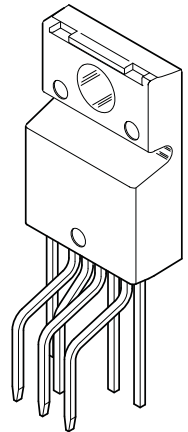
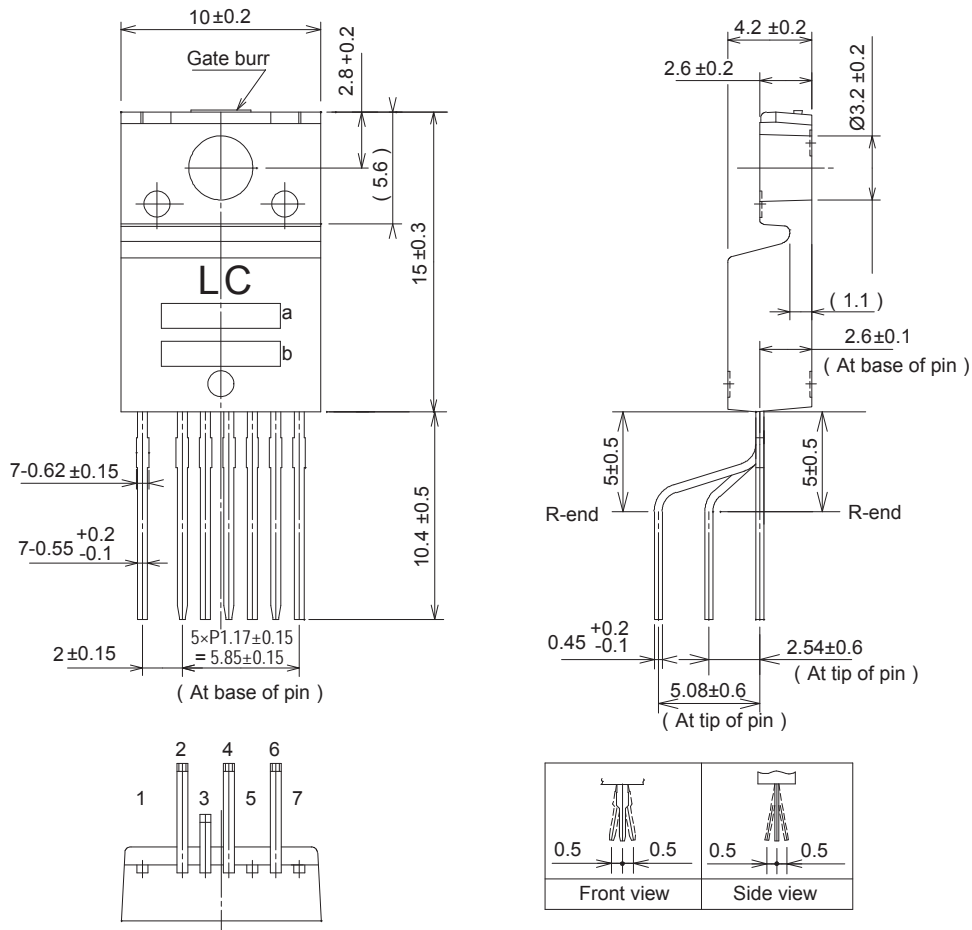
MOSFET Temperature versus Power Dissipation Curve



Transient Thermal Resistance Curve



## Package Outline Drawing, TO-220F Leadform 3051



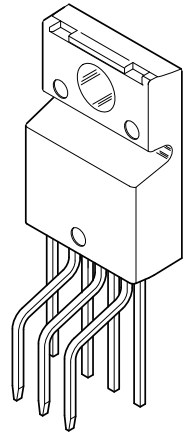
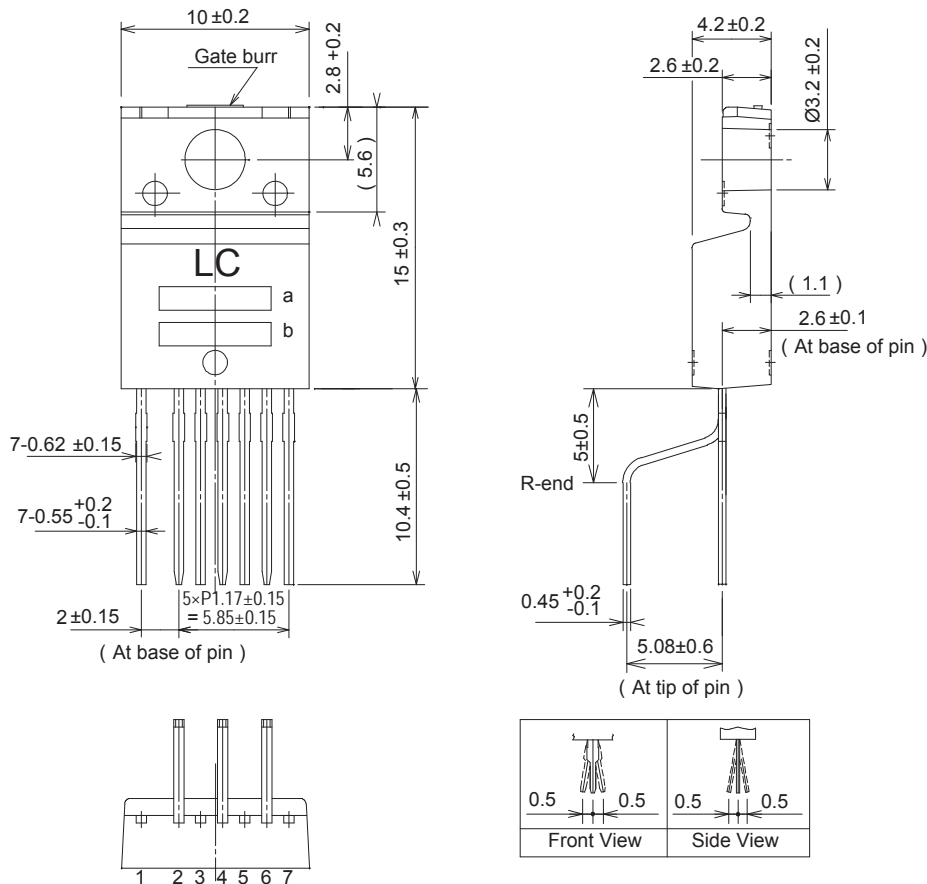
Unit: mm  
 Package: TO-220F-7L  
 (Sanken designator FMY207)  
 (Sanken leadform #3051)  
 Leadframe material: Cu  
 Pin plating: Solder Plating  
 Weight: Approximately 1.45 g

a: Part # 5523F  
 b: Lot number  
 1<sup>st</sup> letter: Last digit of year  
 2<sup>nd</sup> letter: Month  
 Jan to September: Numeric  
 October: O  
 November: N  
 December: D  
 3<sup>rd</sup> and 4<sup>th</sup> letter: Date  
 01 to 31: Numeric  
 5<sup>th</sup> letter: Internal use control number



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

## Package Outline Drawing, TO-220F Leadform 3052



Unit: mm  
 Package: TO-220F-7L  
 (Sanken designator FMY207)  
 (Sanken leadform #3052)  
 Leadframe material: Cu  
 Pin plating: Solder Plating  
 Weight: Approximately 1.45 g

a: Part # 5523F  
 b: Lot number  
 1<sup>st</sup> letter: Last digit of year  
 2<sup>nd</sup> letter: Month  
 Jan to September: Numeric  
 October: O  
 November: N  
 December: D  
 3<sup>rd</sup> and 4<sup>th</sup> letter: Date  
 01 to 31: Numeric  
 5<sup>th</sup> letter: Internal use control number



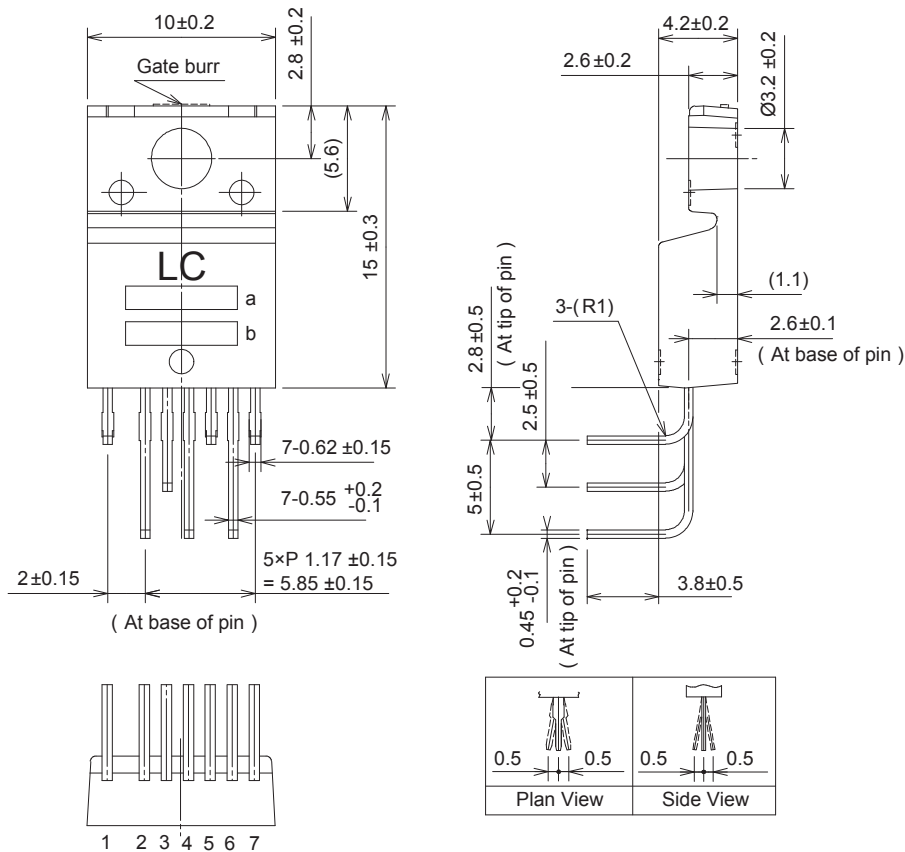
Leadframe plating Pb-free. Device composition compliant with the RoHS directive.



# LC5523F

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

### Package Outline Drawing, TO-220F Leadform 3054



Unit: mm

Package: TO-220F-7L  
(Sanken designator FMY207)  
(Sanken leadform #3054)

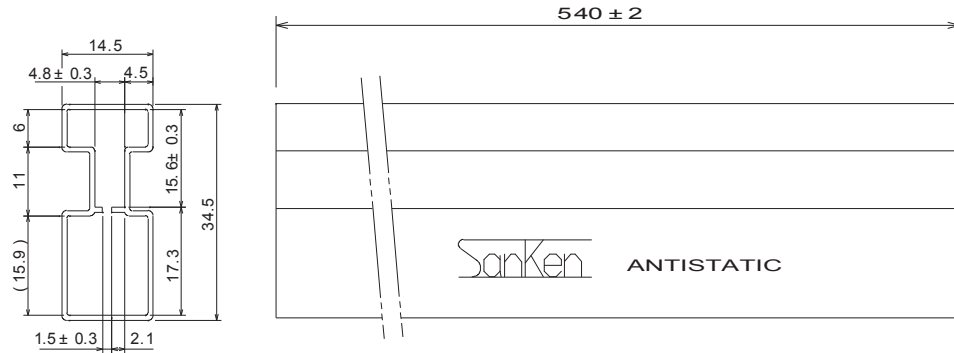
Leadframe material: Cu  
Pin plating: Solder Plating  
Weight: Approximately 1.45 g

a: Part # 5523F  
b: Lot number  
1<sup>st</sup> letter: Last digit of year  
2<sup>nd</sup> letter: Month  
    Jan to September: Numeric  
    October: O  
    November: N  
    December: D  
3<sup>rd</sup> and 4<sup>th</sup> letter: Date  
    01 to 31: Numeric  
5<sup>th</sup> letter: Internal use control number

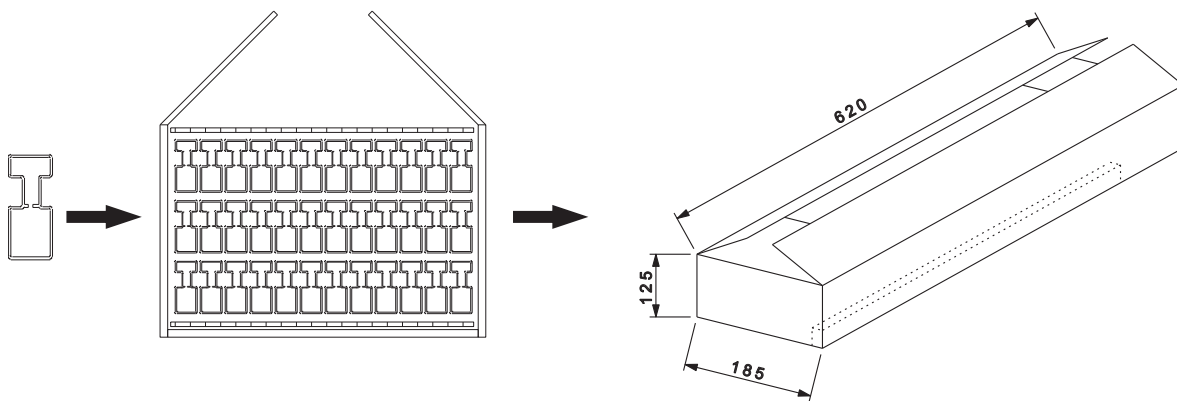


Leadframe plating Pb-free. Device composition compliant with the RoHS directive.

### Packing Specifications, TO-220F Leadforms 3051 and 3052



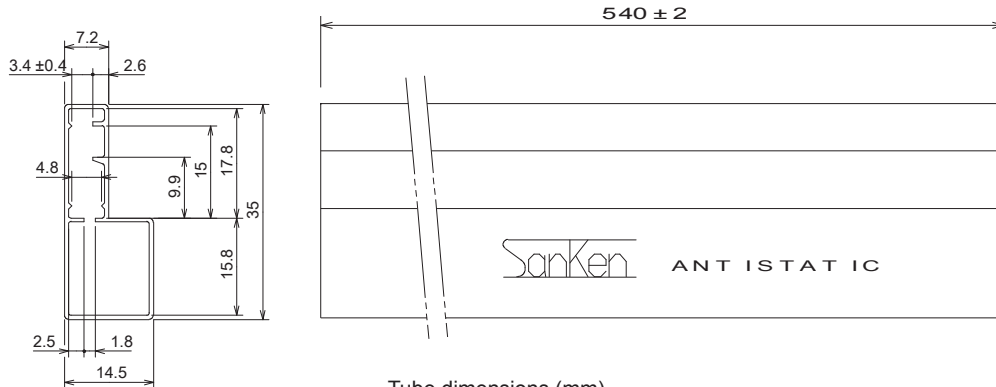
Tube dimensions (mm)  
50 pieces per tube



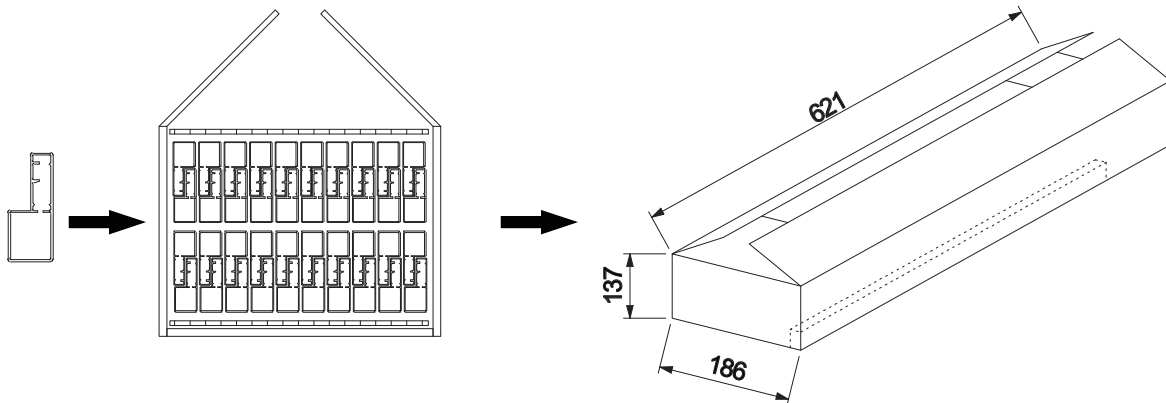
Carton dimensions (mm)

36 tubes per carton (maximum)  
1800 pieces maximum per carton

## Packing Specifications, TO-220F Leadform 3054



Tube dimensions (mm)  
50 pieces per tube



Carton dimensions (mm)

40 tubes per carton (maximum)  
2000 pieces maximum per 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 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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