LED lighting IC with high power factor using one converter

LC5523F

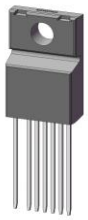
02 November 2011

◆Outline

LC5523F is single stage, power factor corrected off-line LED driver ICs. It incorporates controller and power MOSFET in package of FMY-207, and met the Class-C of harmonics regulation using one converter method.
The controller adopts the average current control method for high power factor. In addition, with the quasi-resonant topology, a system can realize a high efficiency converter with low EMI noise. It has various protection features, which reduce peripheral component count, helping the system designer to improve power supply cost performance and reduce overall system size.

◆Package

Package name：TO-220F-7L



◆Application

- LED lighting apparatus
- LED bulb

◆Main Spec.

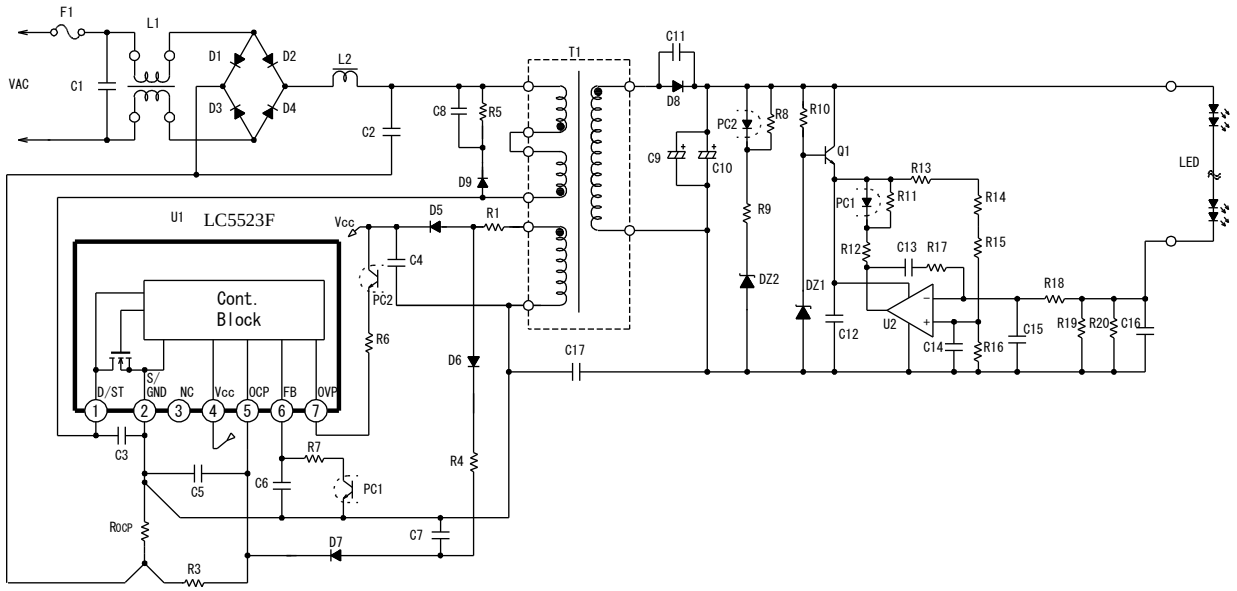
- Pout：60W／40W(AC230V／Universal)
- MOSFET　V_{DS}(MIN)：650V
- $R_{DS(ON)}$(MAX)：1.9Ω

◆Feature

- TO-220F-7L Package（Sanken FMY-207）
- On-width control circuit
- Integrated startup circuit
- Soft-start function
- Bias assist function
- Built-in an avalanche-guaranteed power MOSFET
- Leading Edge Blanking (LEB) timer
- Fixed maximum on-time.
- Protection feature
  - ---- Over current protection (OCP) ,pulse by pulse
  - ---- Over voltage protection (OVP)with latch shutdown
  - ---- Over load protection (OLP)with latch shutdown
  - ---- Thermal shutdown (TSD) with latch shutdown

*Latch shutdown・・・Operation which protects by continuing an oscillation stop.

The example of an application circuit



1 Scope

The present specifications shall apply to a hybrid IC type LC5523F for switching regulators.

2 Outline

T y p e	Hybrid IC
S t r u c t u r e	Plastic mold package (Transfer mold)
A p p l i c a t i o n s	Switching regulators

3 Absolute maximum ratings(Ta=25℃)

Parameter	Terminal	Symbol	Ratings	Units	Conditions
Drain Current	1－2	I_{Dpeak}※1	9.2	A	Single Pulse
Single pulse avalanche energy	1－2	E_{AS}※2	99	mJ	Single Pulse V_{DD}=99V, L=20mH I_{Lpeak}=2.9A
Input voltage in control part	2 – 1	V_{CC}	35	V	
OCP terminal voltage	3 – 1	V_{OCP}	−2.0～+5.0	V	
FB terminal voltage	4 – 1	V_{FB}	−0.3～+7.0	V	
OVP terminal voltage	6 – 1	V_{OVP}	−0.3～+5.0	V	
Power Dissipation in MOSFET	8 – 1	P_{D1}※3	20.2	W	With infinite heat sink
			1.8	W	Without heat sink
Internal frame temperature in operation	—	T_F	-20～+115	℃	
Operating ambient temperature	—	Top	−55～+125	℃	
Storage temperature	—	Tstg	−55～+125	℃	
Channel temperature	—	Tch	+150	℃	

※1 Refer to MOS FET A.S.O. curve ※2 Refer to MOS FET Tch-EAS curve
※3 Refer to MOS FET Ta-PD1 curve
※4 When embedding this hybrid IC onto the printed circuit board（board size 15mm×15mm）

4 Electrical characteristics

4.1 Electrical characteristics in Control Part (Ta=25℃, V_{CC}=20V, unless otherwise specified)

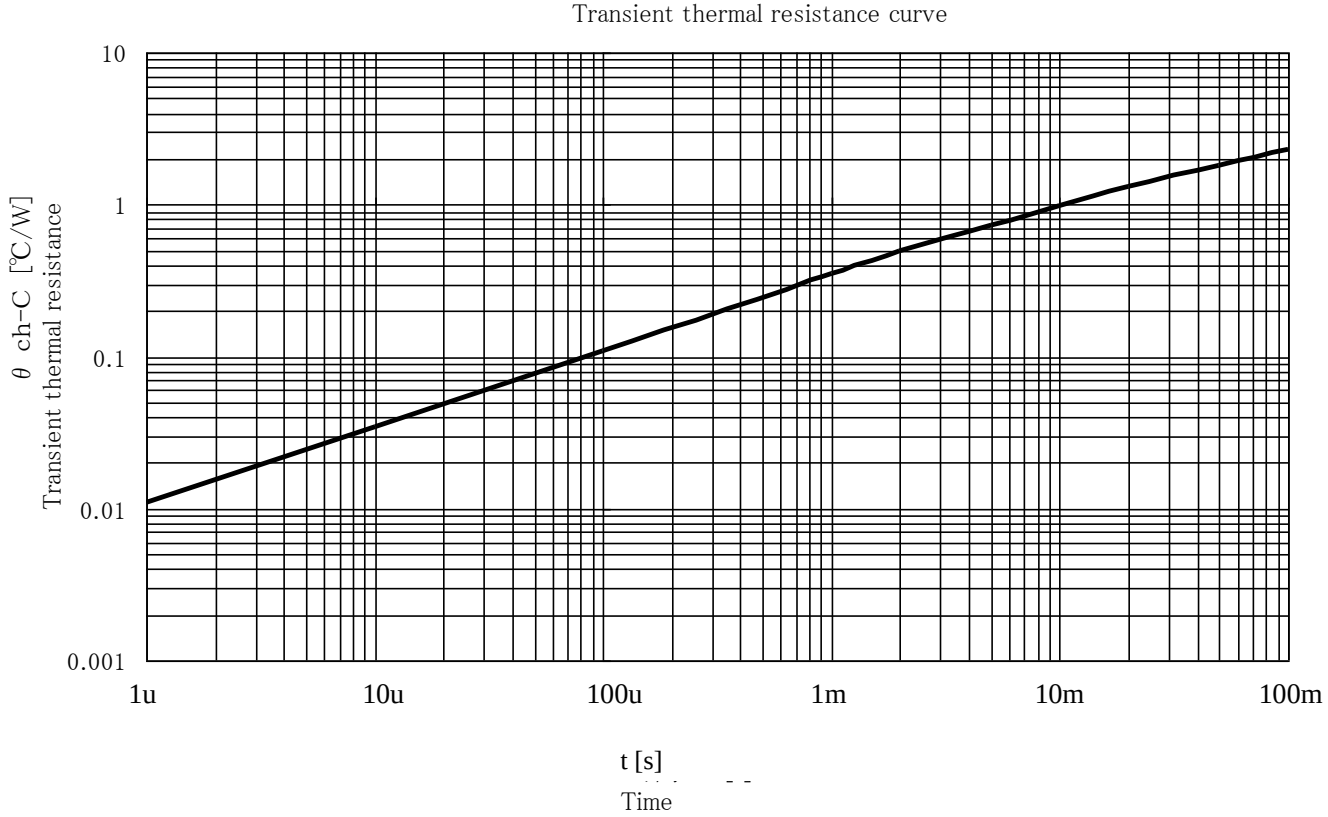
Parameter	Terminal	Symbol	Ratings			Units	Measurement Conditions
			MIN	TYP	MAX		
Power Supply Start-up Operation							
Operation start voltage	2 – 1	$V_{CC(ON)}$	13.8	15.1	17.3	V	
Operation stop voltage*5	2 – 1	$V_{CC(OFF)}$	8.4	9.4	10.7	V	
Circuit current in operation	2 – 1	$I_{CC(ON)}$	—	—	3.7	mA	
Startup circuit operation voltage	8 – 1	$V_{STARTUP}$	42	57	72	V	
Startup current	2 – 1	$I_{CC(STARTUP)}$	-5.5	-3.0	-1.0	mA	Vcc=13V
Startup current supplying threshold voltage 1*5	2 – 1	$V_{CC(BIAS)1}$	9.5	11.0	12.5	V	
Startup current supplying threshold voltage 2	2 – 1	$V_{CC(BIAS)2}$	14.4	16.6	18.8	V	
Normal Operation							
Oscillation minimum frequency	8 – 1	f_{OSC}	11	14	18	kHz	
Maximum ON time	8 – 1	$T_{ON(MAX)}$	30	40	50	μs	
FB terminal minimum voltage in feedback operation	4 – 1	$V_{FB(MIN)}$	0.55	0.9	1.25	V	
Maximum feedback current	4 – 1	$I_{FB(MAX)}$	-40	-25	-10	μA	
Leading edge blanking time	3 – 1	$T_{ON(LEB)}$	—	500	—	ns	
Quasi-resonant operation threshold voltage 1	3 – 1	$V_{BD(TH1)}$	0.14	0.24	0.34	V	
Quasi-resonant operation threshold voltage 2	3 – 1	$V_{BD(TH2)}$	0.12	0.17	0.22	V	
Protection Operation							
Over-current detection threshold voltage	3 – 1	V_{OCP}	-0.66	-0.60	-0.54	V	
OCP terminal source current	3 – 1	I_{OCP}	-120	-40	-10	μA	
OVP operation voltage of OCP terminal	3 – 1	$V_{BD(OVP)}$	2.2	2.6	3.0	V	
OLP threshold voltage1	4 – 1	$V_{COMP(OLP)1}$	5.0	5.5	6.0	V	
OLP threshold voltage2	4 – 1	$V_{COMP(OLP)2}$	4.1	4.5	4.9	V	
ISENSE terminal threshold voltage	6－1	$V_{ISEN(OVP)}$	1.6	2.0	2.4	V	
OVP operation voltage of Vcc terminal	2 – 1	$V_{CC(OVP)}$	28.5	31.5	34.0	V	
Thermal shutdown operating temperature	—	$Tj_{(TSD)}$	135	—	—	℃	

※5 The relation of $V_{CC(BIAS)} > V_{CC(OFF)}$ is applied for each product.

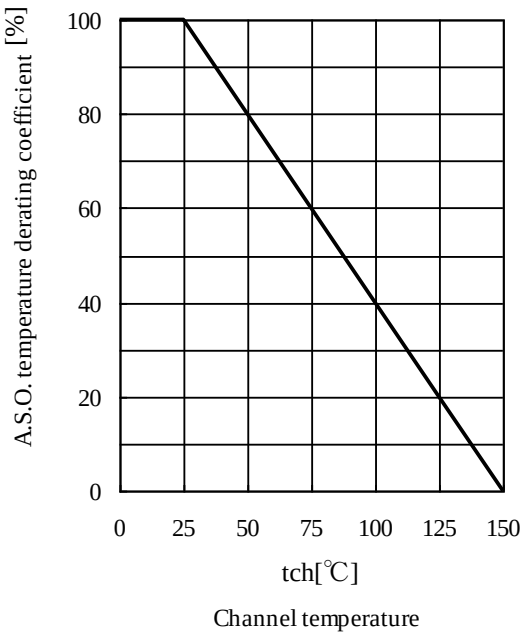
※ The current ratings are based on those of the IC, and plus (+) represents sink and minas (-) represents source.

4.2 Electrical characteristics for MOSFET (Ta=25℃)

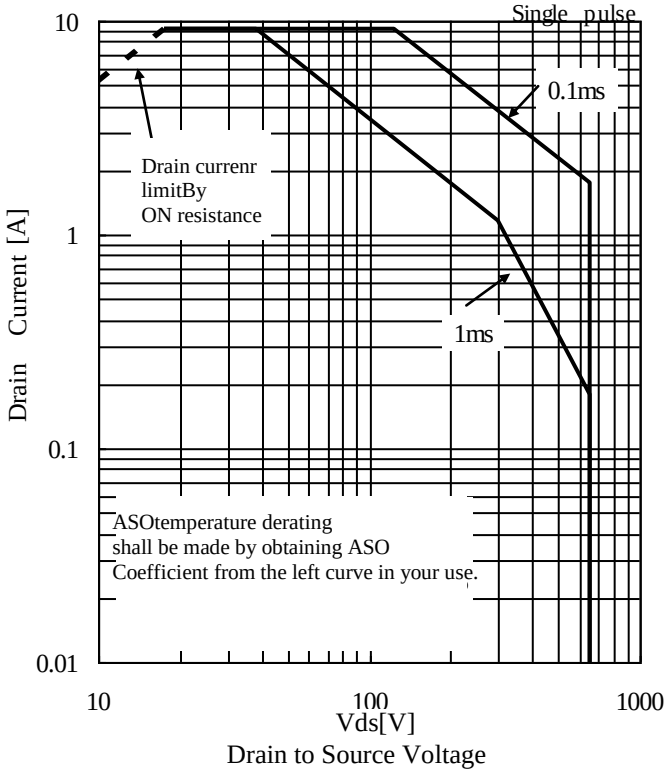
Parameter	Terminal	Symbol	Ratings			Units	Measurement Conditions
			MIN	TYP	MAX		
Drain-to-Source breakdown voltage	8 – 1	V_{DSS}	650	—	—	V	
Drain leakage current	8 – 1	I_{DSS}	—	—	300	μA	
Circuit current in operation	8 – 1	$R_{DS(ON)}$	—	—	1.9	Ω	
Switching time	8 – 1	tf	—	—	400	ns	
Thermal resistance	—	θ_{ch-F}	—	—	3.1	℃/W	



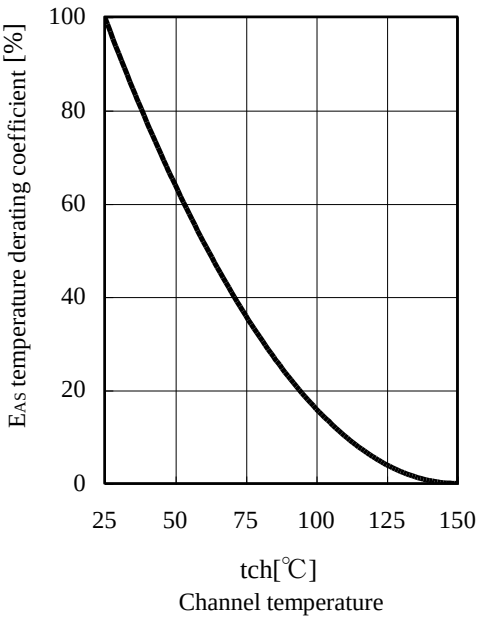
A.S.O. temperature derating coefficient curve



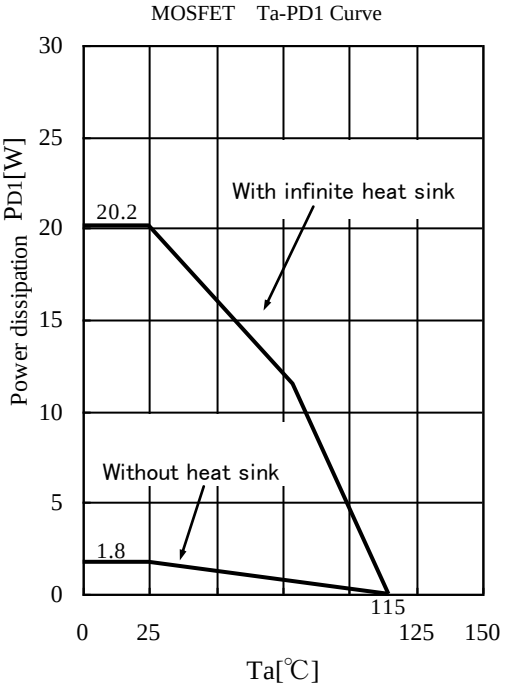
MOSFET A.S.O Curve Ta＝25℃



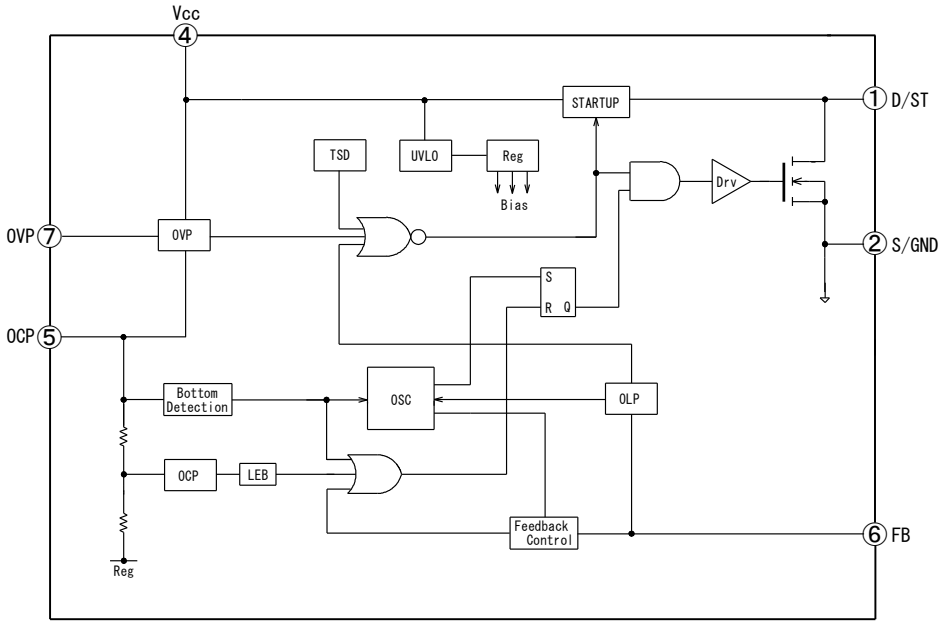
Avalanche energy derating curve



MOSFET Ta-PD1 Curve



5 Block diagram (Connection diagram)



Functions of Each Terminal

Terminal No.	Symbols	Descriptions	Functions
1	S/GND	Source / GND terminal	MOSFET Source / Control GND
2	V_{CC}	Power supply terminal	Input of power supply for control circuit
3	OCP	OCP terminal	Over current protection /Quasi-resonant signal input
4	FB	FB terminal	Constant voltage control signal input / Overload protection signal input
5	NF	NF	—
6	OVP	OVP terminal	Over voltage protection signal input
8	D/ST	D/ST terminal	MOSFET Drain / Input of startup current

Other Functions

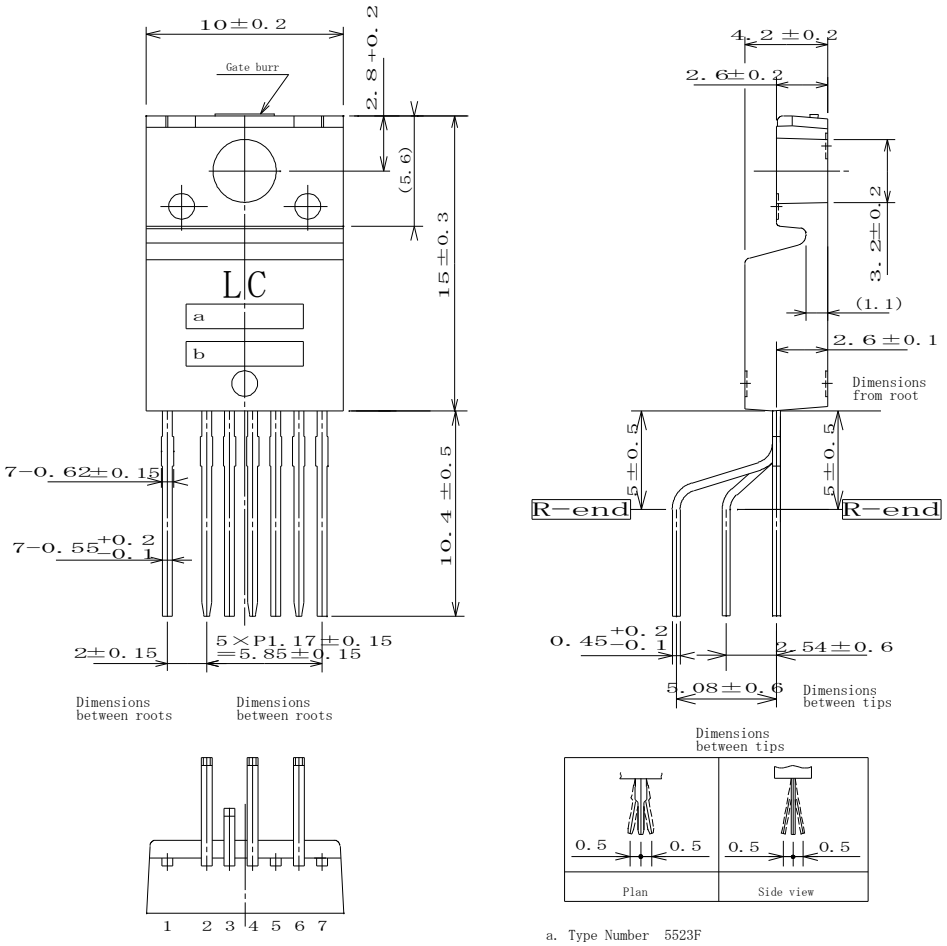
Symbols	Functions
T.S.D.	Thermal shutdown circuit（Latch shutdown）

6 Package information

6.1 Package type, physical dimensions and material

LF3051

Outline Drawings of Lead Forming No.3051



Package: TO220F (Sanken FMY207)

Material of terminal: Cu

Treatment of terminal: Solder dip

Weight: Approx. 1.45g

Note

shows a point where 0.3max gate burr is produced.

DWG. No. : TG3A-2651

Dimensions in mm

a. Type Number 5523F

b. Lot Number

1st letter The last digit of year

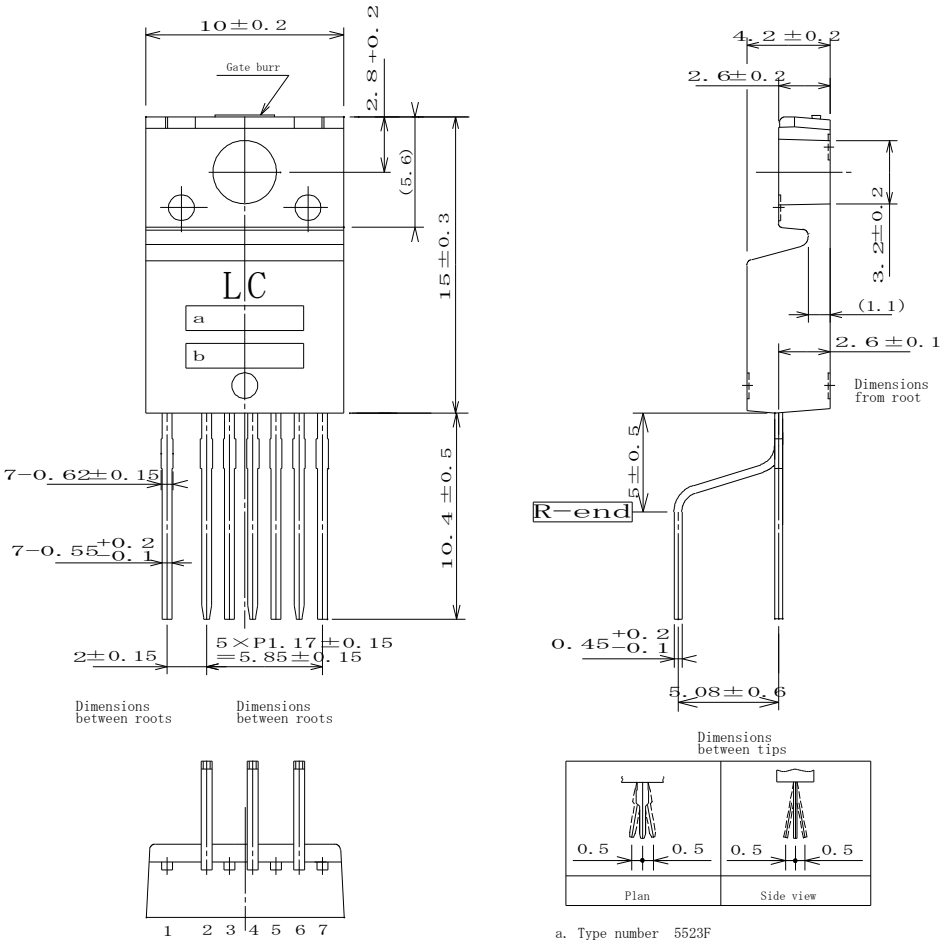
2nd letter Month
January～September Arabic numerals
October O
Novenber N
December D

3rd & 4th letter Day
01～31 Arabic numerals

5th letter Sanken Registration Symbol

LF3052

Outline Drawings of Lead Forming No.3052



Package: TO220F (Sanken FMY207)

Material of terminal: Cu

Treatment of terminal: Solder dip

Weight: Approx. 1.45g

Note
shows a point where 0.3max gate burr is produced.

DWG. No. : TG3A-2652

Dimensions in mm

a. Type number 5523F

b. Lot number

1st letter The last digit of year

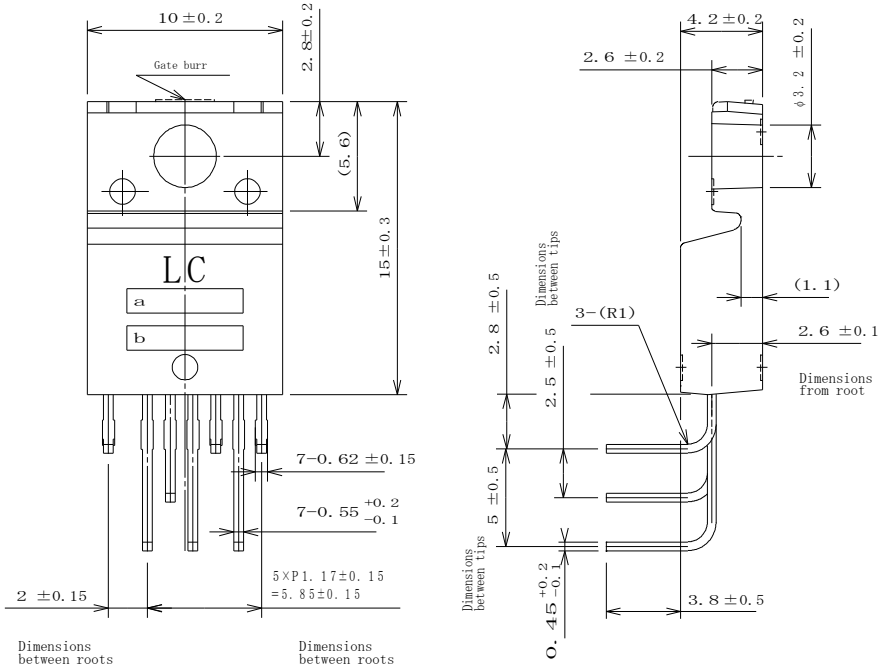
2nd letter Month
January～September Arabic numerals
October O
November N
December D

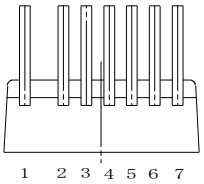
3rd & 4th letter Day
01～31 Arabic numerals

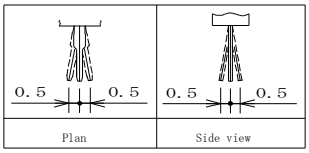
5th letter Sanken Registration Symbol

LF3054

Outline Drawings of Lead Forming No.3054







Package: TO220F (Sanken FMY207)

Material of terminal: Cu

Treatment of terminal: Solder dip

Weight: Approx. 1.45g

Note

shows a point where 0.3max gate burr is produced.

DWG. No. : TG3A-2651

Dimensions in mm

a. Type Number 5523F

b. Lot number

1st letter The last digit of year

2nd letter Month
January～September Arabic numerals
October O
Nobember N
December D

3rd & 4th letter Day
01～31 Arabic numerals

5th letter Sanken Registration Symbol

6.2 Appearance

The body shall be clean and shall not bear any stain, rust or flaw.

6.3 Marking

The type number and lot number shall be marked on the body by laser which shall not be unreadable easily.

7 Cautions and warnings

・Since reliability can be affected adversely by improper storage environment and handling methods during Characteristic tests, please observe the following cautions.

7.1 Cautions for Storage

・Ensure that storage conditions comply with the standard temperature (5 to 35℃) and the standard relative humidity (around 40 to 75%) and 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 in leads and solderability that have been stored for a long time.

7.2 Cautions for characteristic Tests and Handling

・When characteristic tests are carried out during inspection testing and other standard tests periods, protect the devices from surge of power from the testing device, shorts between the devices and the heatsink.

7.3 Remarks in using silicone grease for 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 forced stress.
・Volatile type silicone grease may produce cracks after elapse of long term, resulting in reducing heat radiation effect. Silicone grease with low consistency (hard grease) may cause cracks in the mold resin when screwing the product to a heatsink.

Out recommended silicone grease for heat radiation purpose, which will not cause any adverse effect on the product life is indicated below:

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

7.4 Recommendation operation temperature

It is inner flame temperature at the time of operation. T_F=115℃(MAX)

7.5 Recommendation bolting torque

0.588～0.785 N・m（6～8 kgf・cm）

7.6 Soldering

When soldering the products, please be sure to minimize the working time, within the following conditions.
・260±5℃ 10sec.
・350±5℃ 3sec.（Soldering iron）
At a distance of 1.5mm from the main body of the Products

7.7 Considerations to protect the Products from Electrostatic Discharge

・When handling the devices, operator must be grounded. Grounded wrist straps be worn and should have at least 1MΩ of resistance near operators to ground to prevent shock hazard.
・Workbenches where the devices 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 also be grounded.
・When soldering the devices, the head of a soldering iron or a solder bath must be grounded in other to prevent leak voltage generated by them from being applied to the devices.
・The devices should always be stored and transported in our shipping containers or conductive containers, or be wrapped up in aluminum foil.

Others

- The contents in this document are subject to changes, for improvement and other purposes, without notice. Make sure that this is the latest revision of the document before use.
- Application and operation examples described in this document are quoted for the sole purpose of reference for the use of the products herein and Sanken can assume no responsibility for any infringement of industrial property rights, intellectual property rights or any other rights of Sanken or any third party which may result from its use.
- Although Sanken undertakes to enhance the quality and reliability of its products, the occurrence of failure and defect of semiconductor products at a certain rate is inevitable. Users of Sanken products are requested to take, at their own risk, preventative measures including safety design of the equipment or systems against any possible injury, death, fires or damages to the society due to device failure or malfunction.
- Sanken products listed in this document are designed and intended for the use as components in general purpose electronic equipment or apparatus (home appliances, office equipment, telecommunication equipment, measuring equipment, etc.).
  When considering the use of Sanken products in the applications where higher reliability is required (transportation equipment and its control systems, traffic signal control systems or equipment, fire/crime alarm systems, various safety devices, etc.), and whenever long life expectancy is required even in general purpose electronic equipment or apparatus, please contact your nearest Sanken sales representative to discuss, prior to the use of the products herein.
  The use of Sanken products without the written consent of Sanken in the applications where extremely high reliability is required (aerospace equipment, nuclear power control systems, life support systems, etc.) is strictly prohibited.
- In the case that you use our semiconductor devices or design your products by using our semiconductor devices, the reliability largely depends on the degree of derating to be made to the rated values. Derating may be interpreted as a case that an operation range is set by derating the load from each rated value or surge voltage or noise is considered for derating in order to assure or improve the reliability. In general, derating factors include electric stresses such as electric voltage, electric current, electric power etc., environmental stresses such as ambient temperature, humidity etc. and thermal stress caused due to self-heating of semiconductor devices. For these stresses, instantaneous values, maximum values and minimum values must be taken into consideration.
  In addition, it should be noted that since power devices or IC's including power devices have large self-heating value, the degree of derating of junction temperature (Tj) affects the reliability significantly.
- When using the products specified herein by either (i) combining other products or materials therewith or (ii) physically, chemically or otherwise processing or treating the products, please duly consider all possible risks that may result from all such uses in advance and proceed therewith at your own responsibility.
- Anti radioactive ray design is not considered for the products listed herein.
- Sanken assumes no responsibility for any troubles, such as dropping products caused during transportation out of Sanken's distribution network.
- The contents in this document must not be transcribed or copied without Sanken's written consent.