

# SPECIFICATION

Device Name : Intelligent power MOSFET

Type Name : F5020-S

Spec. No. : MS5F06898

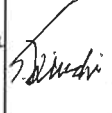

Date : Aug.-08-2007

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Fuji Electric Device Technology Co., Ltd.  
Semiconductors Group

	DATE	NAME	APPROVED	Fuji Electric Device Technology Co., Ltd.		
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CHECKED	Aug.-08-2007	S. Hiyoshi				
CHECKED	Aug.-08-2007	M. Aruga				

# Revised Records

Date	Classi- fication	Ind.	Content	Applied date	Drawn	Check- ed	Check- ed	Ap- proved
Aug. - 08-2007	Enactment	—	_____	Issued date	S. Yamashina  H. Fujisawa		M. Aruga	

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## 0. Cautions

- Although Fuji Electric Device Technology is continually improving product quality and reliability, a small percentage of semiconductor products may become faulty. When using Fuji Electric Device Technology semiconductor products in your equipment, you are requested to take adequate safety measures to prevent the equipment from causing physical injury, fire, or other problem in case any of the products fail. It is recommended to make your design fail-safe, flame retardant, and free of malfunction.
- The products described in this specification are designed and manufactured in order to use automotive switching applications. If you're considering a special use of these products in case of equipment or system for ship, aerospace, medical, nuclear control, submarine repeater and the like, contact Fuji Electric Device Technology and obtain our consent.

### 0-1. Warnings

- The MOSFETs shall be used in products within their absolute maximum rating (voltage, current, temperature, and so forth). The MOSFETs may be destroyed if used beyond the absolute maximum rating, or may cause dynamic destruction by means of unexpected mechanical stress.
- We only guarantee the non-repetitive and repetitive avalanche capability and not for the continuous avalanche capability which can be assumed as abnormal condition. Please note the device may be destructed from the avalanche over the specified maximum rating.
- Do not directly touch the leads or package of the MOSFETs while power is supplied or during operation, in order to avoid electric shock and burns.
- The MOSFETs are made of incombustible material. However, if a MOSFET fails, it may emit smoke or flame. Also, operating the MOSFETs near any flammable place or material may cause the MOSFETs to emit smoke or flame in case the MOSFETs become even hotter during operation. Design the arrangement to prevent the spread of fire.
- The MOSFETs should not be used in an environment in the presence of acid, organic matter, or corrosive gas (hydrogen sulfide, sulfurous acid gas, and other corrosive gas).
- The MOSFETs should not be used in an irradiated environment since they are not radiation-proof.

### 0-2. Warnings for designing

- Design the MOSFETs to be operated within the specified absolute maximum ratings (voltage, current, temperature, and so forth) to prevent possible failure or destruction of devices.
- Consider the possible temperature rise not only for the channel and case but also for the outer leads.
- The equipment containing MOSFETs should have adequate fuses or circuit breakers to prevent the equipment from causing secondary destruction such as fire and explosion.
- Use the MOSFETs within their reliability and lifetime under certain environments or conditions. The MOSFETs may fail before the target lifetime of your products if not used under certain reliability conditions, especially in the severe condition with corrosive gas or of high temperature and high humidity.
- Be careful when handling MOSFETs for ESD damage (It is an important consideration.).
- When handling MOSFETs, hold them by the case (package) and do not touch the leads and terminals.
- It is recommended that any handling of MOSFETs is done on grounded electrically conductive floor and tablemats.


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- Before touching a MOSFET terminal, discharge any static electricity from your body and clothes by grounding out through a high impedance resistor (about  $1M\Omega$ ).
- When soldering, in order to protect the MOSFETs from static electricity, ground the soldering iron and soldering bath through a low impedance resistor.

#### 0-3. Warnings for installation

- Soldering involves temperatures which exceed the device storage temperature rating. To avoid device damage and to ensure reliability, follow the description of resistance to soldering heat for surface mounting devices as stated in 12 reliability test items.
- Devices shall not be exposed by any chemicals or physical damage.

#### 0-4. Warnings for storage

- The MOSFETs must be stored at a standard temperature of 5 to  $35^{\circ}\text{C}$  and relative humidity of 45 to 75%.
- The MOSFETs should not be subjected to rapid changes in temperature to avoid condensation on the surface of the MOSFETs. Therefore store the MOSFETs in a place where the temperature is steady.
- The MOSFETs should not be stored on top of each other, since this may cause excessive external force on the case.
- The MOSFETs should be stored with the lead terminals remaining unprocessed. Rust may cause presoldered connections to fail during later processing.
- The MOSFETs should be stored in antistatic containers or shipping bags.

#### 0-5. Compliance towards restricted substances

- This products do not contain PBBs (polybrominated biphenyls), and PBDEs (polybrominated diphenyl ethers).
- This products do not contain Class-I ODS (Ozone-Depleting Substances) and Class-II ODS substances set force by "Clean Air Act of U.S." law.

• If you have any questions about any part of this specification, please contact Fuji Electric Device Technology or its sales agent before using the product.

• Neither Fuji nor its agents shall be held liable for any injury caused by using the products not in accordance with the instructions.

• The application examples described in this specification are merely typical uses of Fuji Electric Device Technology products.

• This specification does not confer any industrial property rights or other rights, nor constitute a license for such rights.

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- 1. Scope** This specifies Fuji Electric Device Technology Intelligent power MOSFET F5020-S.
- 2. Construction** Silicon planer type  
 Circuit part ; Self isolation structure  
 Output part ; N-channel enhancement mode power MOSFET
- 3. Application** For switching
- 4. Outview** K-PACK S-type (EIAJ SC-63) Outview See to 17/18 Page  
 Taping specification See to MS5C8435  
 Packing specification See to MS5Q0025  
 See the internal structure on Page 18/18.

**5. Absolute maximum ratings (at Tc=25°C, unless otherwise specified.)**

Descriptions	Symbols	Characteristics	Units	Conditions
Drain-Source Voltage	$V_{DSS}$	40	V	DC
Gate-Source Voltage	$V_{GSS}$	-0.3 ~ 7.0	V	DC
Continuous Drain Current	$I_D$	3	A	-
Maximum Power Dissipation	$P_D$	10	W	-
Operating Junction Temperature	$T_j$	150	°C	-
Storage Temperature Range	$T_{stg}$	-55 ~ 150	°C	-
Single Pulse Inductive Load Switch-Off Energy Dissipation	$E_{CL}$	50	mJ	$T_j=150^\circ\text{C}$ , L=10mH Single Pulse, $dv/dt \leq 10\text{V}/\mu\text{s}$

**6. Electrical characteristics (at Tc=25°C, unless otherwise specified.)**

Descriptions	Symbols	Conditions	Characteristics			Units
			min.	typ.	max.	
Drain-Source Clamp Voltage	$V_{DSS}$	$I_D=1\text{mA}$ $V_{GS}=0\text{V}$	40	-	60	V
Gate Threshold Voltage	$V_{GS(th)}$	$I_D=10\text{mA}$ $V_{DS}=13\text{V}$	1.0	-	2.8	V
Operation Gate Voltage (protection circuit operates)	$V_{GS(p)}$	—————	3.5	-	7.0	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS}=13\text{V}$ $V_{GS}=0\text{V}$	-	-	100	$\mu\text{A}$
Gate-Source Leakage Current	$I_{GS(n)}$	$V_{GS}=5\text{V}$	*	-	500	$\mu\text{A}$
	$I_{GS(un)}$		**	-	800	$\mu\text{A}$
Drain-Source On-State Resistance	$R_{DS(on)}$	$I_D=1\text{A}$ $V_{GS}=5\text{V}$	-	-	400	m $\Omega$
		$I_D=1\text{A}$ $V_{GS}=3\text{V}$	-	-	600	

\* Under normal operation

\*\* Under self protection

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Descriptions	Symbols	Conditions	Characteristics			Units
			min.	typ.	max.	
Turn-On Time	$t_{on}$	$V_{DS}=13V$ $R_L=13\Omega$	-	-	100	$\mu s$
Turn-Off Time	$t_{off}$	$V_{GS}=5V$	-	-	100	$\mu s$
Over-Temperature Protection	$T_{trip}$	$V_{GS}=5V$	150	-	-	$^{\circ}C$
Short Circuit Protection	$I_{oc}$	$V_{GS}=5V$	5	-	-	A

### 7. Electrical characteristics (at $T_c=-40\sim 105^{\circ}C$ , unless otherwise specified.)

Descriptions	Symbols	Conditions	Characteristics			Units
			min.	typ.	max.	
Drain-Source Clamp Voltage	$V_{DSS}$	$I_D=1mA$ $V_{GS}=0V$	38	-	62	V
Gate Threshold Voltage	$V_{GS(th)}$	$I_D=10mA$ $V_{DS}=13V$	0.9	-	3.0	V
Operation Gate Voltage	$V_{GS(p)}$	—————	3.5	-	6.7	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS}=13V$ $V_{GS}=0V$	-	-	170	$\mu A$
Gate-Source Leakage Current	$I_{GS(n)}$	$V_{GS}=5V$ *	-	-	600	$\mu A$
	$I_{GS(un)}$	$V_{GS}=5V$ $T_j < 150^{\circ}C$ **	-	-	960	$\mu A$
Drain-Source On-State Resistance	$R_{DS(on)}$	$I_D=1A$ $V_{GS}=5V$	-	-	600	m $\Omega$
		$I_D=1A$ $V_{GS}=3V$	-	-	900	m $\Omega$
Turn-On Time	$t_{on}$	$V_{DS}=13V$ $R_L=13\Omega$	-	-	120	$\mu s$
Turn-Off Time	$t_{off}$	$V_{GS}=5V$	-	-	120	$\mu s$
Short Circuit Protection	$I_{oc}$	$V_{GS}=13V$	3.4	-	-	A

\* Under normal operation

\*\* Under self protection (Short Circuit ~ Short Circuit Protection ~ Over-Temperature Protection)

### 8. Thermal resistance

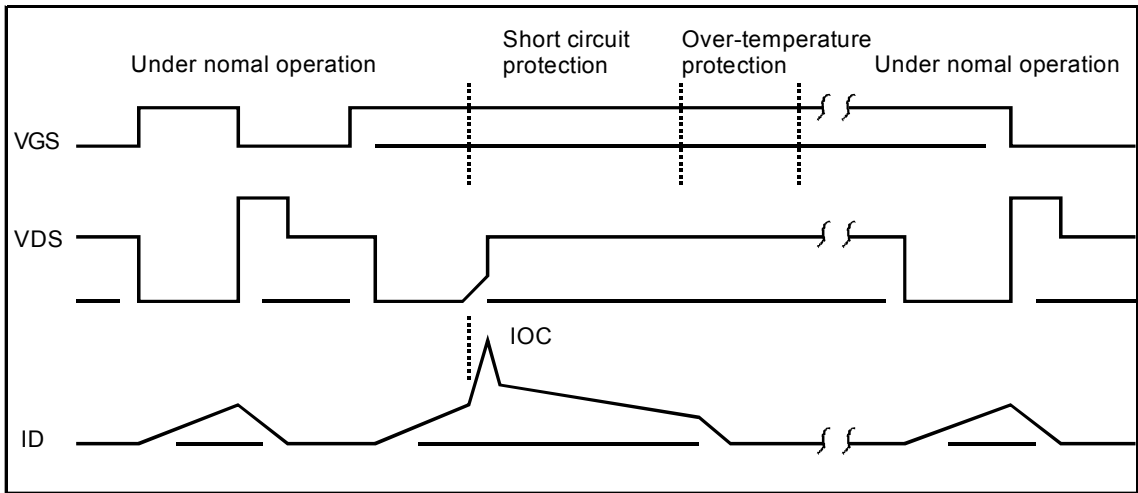
Description	Symbol	Condition	Characteristics			Unit
			min.	typ.	max.	
Thermal Resistance	$R_{th(j-c)}$	Junction - case	-	-	12.5	$^{\circ}C/W$
Thermal Resistance	$R_{th(j-a)}$	Junction - Ambient	-	-	125	$^{\circ}C/W$

### 9. Electrostatic discharge

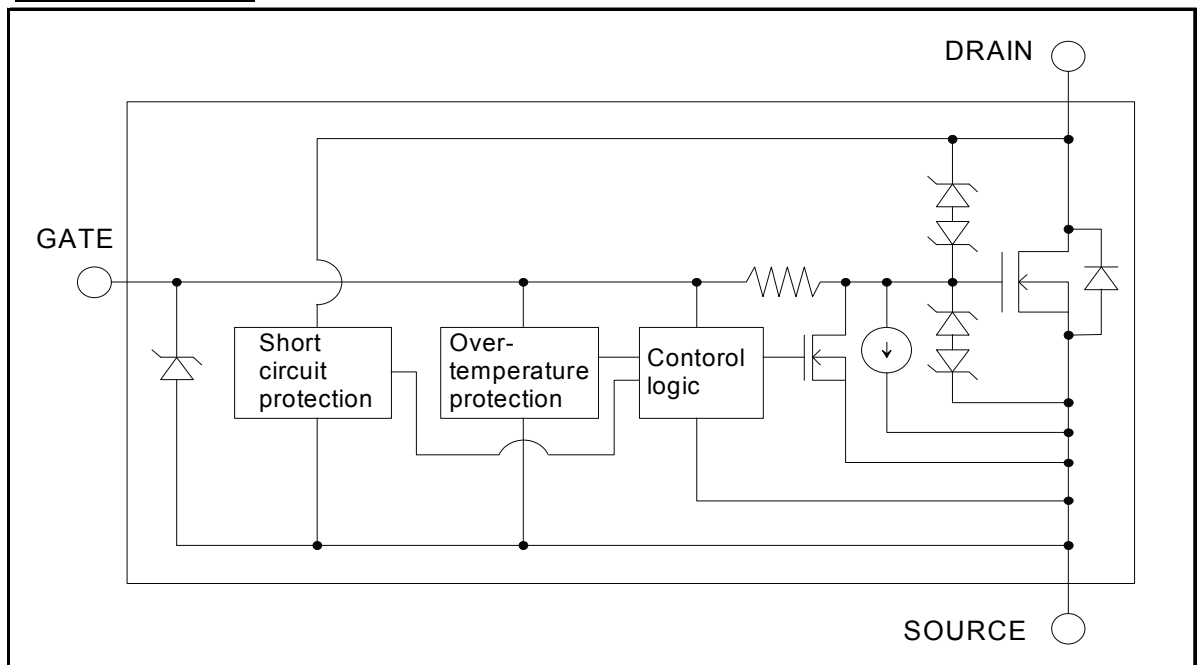
Descriptions	Conditions	Characteristics			Units
		min.	typ.	max.	
Drain-Source	150pF, 150 $\Omega$	$\pm 15$	-	-	kV
Gate-Source		$\pm 0.5$	-	-	kV

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### 10. Timing chart



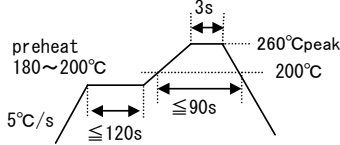
### 11. Block diagram




## 12. Reliability test items

\*\*\*\* Carry out following preparations in the test items of "※" mark

- (1) Baking treatment : 150±5°C, 24hours
- (2) Humidification treatment : 85±2°C, 85±5%RH, 168±24hours
- (3) Soldering heat for surface mounting : reflow soldering, temperature profile is shown in environmental test item No.1, Number of times : 2 times

Test categories	No.	Descriptions	Testing method and conditions	Reference norms EIAJ ED-4701	Sampling number	Acceptance number
Environmental tests	1	Resistance to soldering heat for surface mounting devices	Reflow, Number of times : 2 times  Preparation : ①Baking 150°C, 24hours ②Humidification treatment : 85°C, 85%RH, 24 hours	-	15	(0:1)
	2	Solderability	Number of times : 1time Solder temperature : 245±3°C Immersion time : 3s Preparation : ①Baking 150°C, 24hours ②Humidification treatment : 85°C, 85%RH, 24 hours	-	15	
	3 ※	Thermal shock	Used liquid : Water with ice and boiling water. 0 <sup>+5</sup> <sub>-0</sub> ~ 100 <sup>+0</sup> <sub>-5</sub> °C (5min.) (≤10s) (5min.) Number of cycles : 1000cycles	B-141A	22	
	4 ※	Temperature cycle	-55±3-5°C ~ 150±5°C (30min.) (30min.) Number of cycles : 1000cycles	B-131A	22	
	5	Vibration	Frequency range : 100 ~ 2000Hz Acceleration : 200m/s <sup>2</sup> (20G) 4 cycles of each X,Y,Z directions Sweeping time : 48min	A-121A	15	
	6	Shock	Acceleration : 15000m/s <sup>2</sup> Pulse width : 0.5ms 3 times for each X1,Y1,Y2,Z1 directions Times : 3times/direction	A-122A	15	
	7	Drop	Height : 75 cm, Number of times : 3 times The test specimens are dropped on a wood plate on the prescribed direction and times.	A-124A	15	
	8	Terminal strength	Force to be applied : 10N in a lead terminal axis direction. Force maintaining duration : 10±1sec.	A-111A	15	

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Test categories	No.	Descriptions	Testing method and conditions	Reference norms EIAJ ED-4701	Sampling number	Acceptance number
Endurance tests	9 ※	High temperature storage	Storage temperature : 150±5°C Test duration : 1000hours	B-111	22	(0:1)
	10 ※	Low temperature storage	Storage temperature : -55±5°C Test duration : 1000hours	B-112A	22	
	11 ※	Intermittent operating life (Thermal cycling load)	$T_j \leq T_j(\text{max.})$ $\Delta T_c = 90^\circ\text{C}$ (Drain terminal temperature) Number of cycles : 10000cycles	-	22	
	12 ※	Pressure cooker (Saturated pressurized vapour)	Test temperature : 121°C Pressure : $2.0 \times 10^5$ Pa Test duration : 96hours	-	22	
	13 ※	Temperature humidity storage	Test temperature : 85±2°C Relative humidity : 85±5%RH Test duration : 1000hours	B-121	22	
	14 ※	Steady state operating life	VDS=16V, VGS=5V Test temperature : 150°C Test duration : 1000hours		22	
	15 ※	High temperature bias (D-S)	VDS=28V Test temperature : 150°C Test duration : 1000hours	-	22	
	16 ※	High temperature bias (G-S)	VGS=7V Test temperature : 150°C Test duration : 1000hours	-	22	
	17 ※	Temperature humidity bias (D-S)	VDS=28V Test temperature : 85±2°C Relative humidity : 85±5%RH Test duration : 1000hours	B-122	22	
	18 ※	Temperature humidity bias (G-S)	VGS=7V Test temperature : 85±2°C Relative humidity : 85±5%RH Test duration : 1000hours	B-122	22	

### 13. Failure criteria

	Descriptions	Symbols	Failure criteria		Units
			Lower limits	Upper limits	
Electrical characteristics	Drain-Source Clamp Voltage	$V_{DSS}$	S x 0.8	-	V
	Gate Threshold Voltage	$V_{GS(th)}$	S x 0.8	S x 1.2	V
	Zero Gate Voltage Drain Current	$I_{DSS}$	-	S x 2	$\mu A$
	Gate-Source Leakage Current	$I_{GS(n)}$	-	S x 2	$\mu A$
	Drain-Source On-State Resistance	$R_{DS(on)}$	S x 0.8	S x 1.2	m $\Omega$
	Short Circuit Protection	$I_{oc}$	S x 0.8	S x 1.2	A
	Thermal Resistance	$R_{th}$	-	S x 1.2	$^{\circ}C/W$
Outview		-	Normal		-

S : First Characteristics

### 14. Marking


The lot number is made up of five characters. The first is the last digit of the year.

The next is the month, October through December are indicated by the first initial letter of the month, O, N, and D.

The last three are digits indicating the assembly lot number.

Upper two of five underlined in the products signifies Lead-free external terminals.

### 15. Labeling

 symbol represents "Lead-free" external terminals.

### 16. Environmental issues

Complete elimination of specified CFCs and trichloroethane.

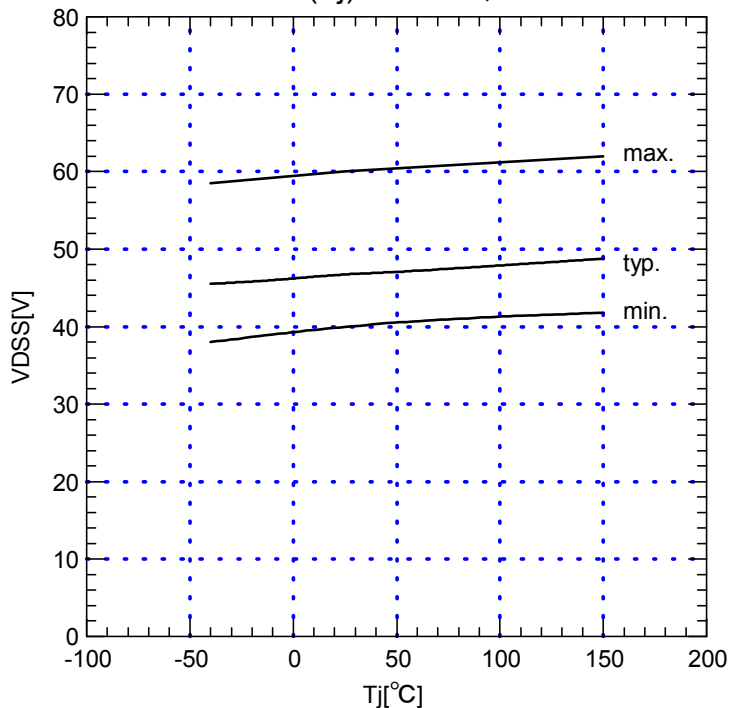
### 17. Recommended reflow profile

See the temperature profile in the test No.1 on Page 8/18.

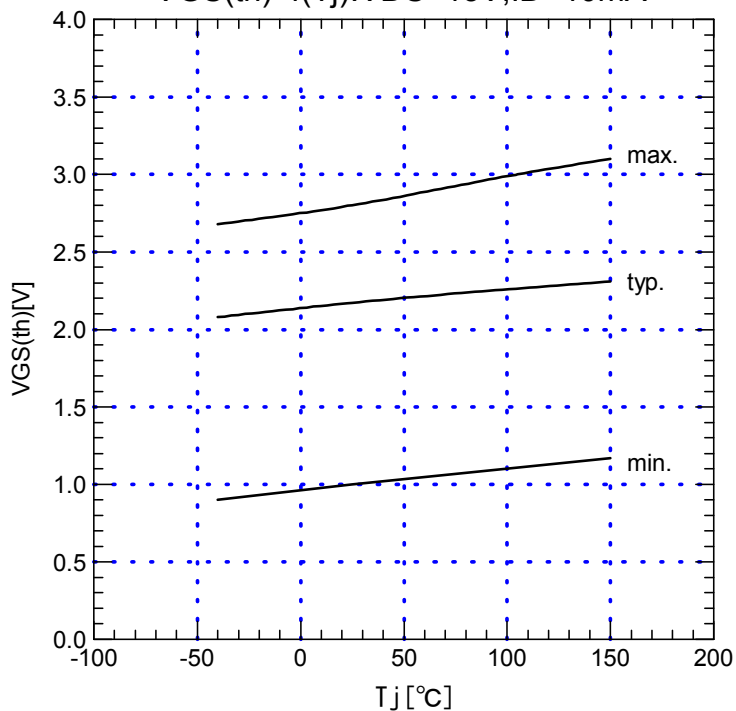
## 18. Characteristics

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Drain-source clamp voltage  
 $V_{DSS}=f(T_j): I_D=1\text{mA}, V_{GS}=0\text{V}$

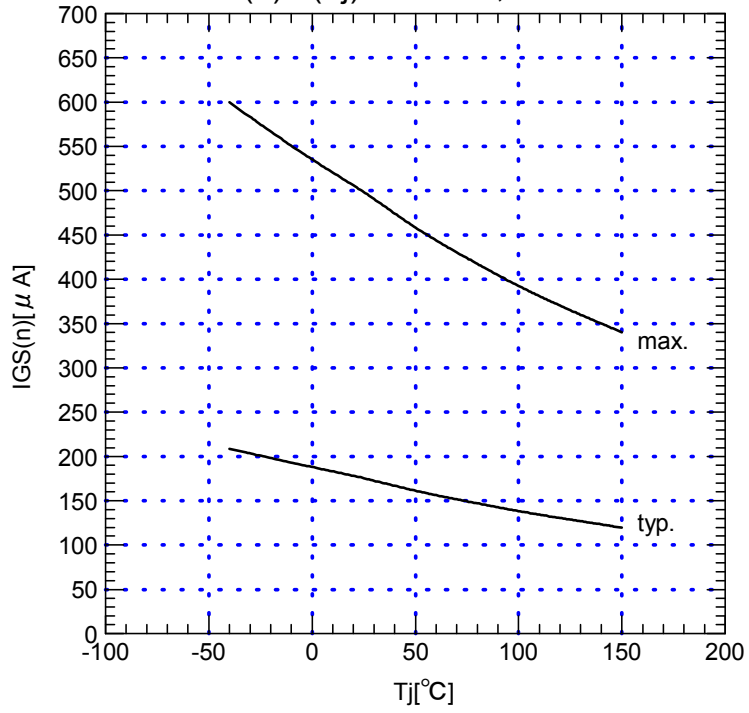


Gate threshold voltage  
 $V_{GS(th)}=f(T_j): V_{DS}=13\text{V}, I_D=10\text{mA}$

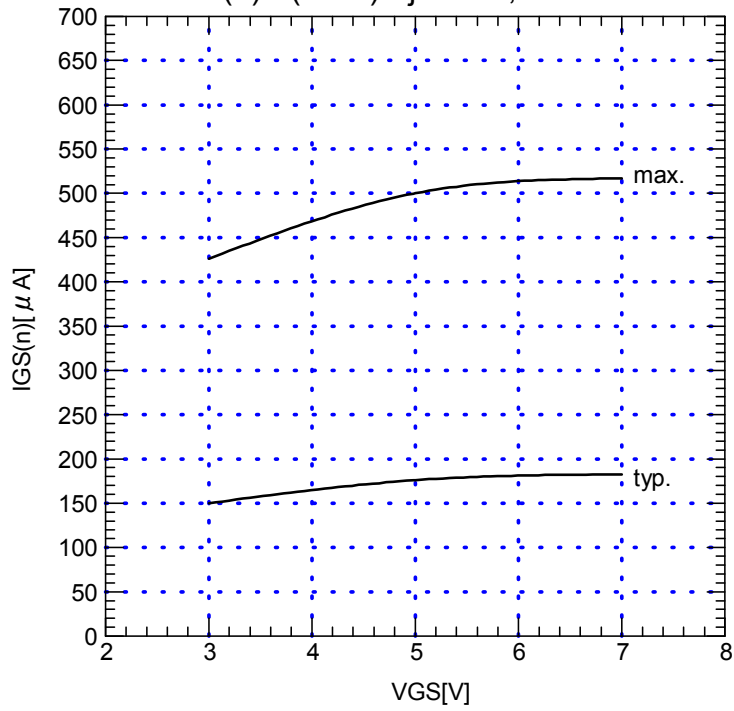


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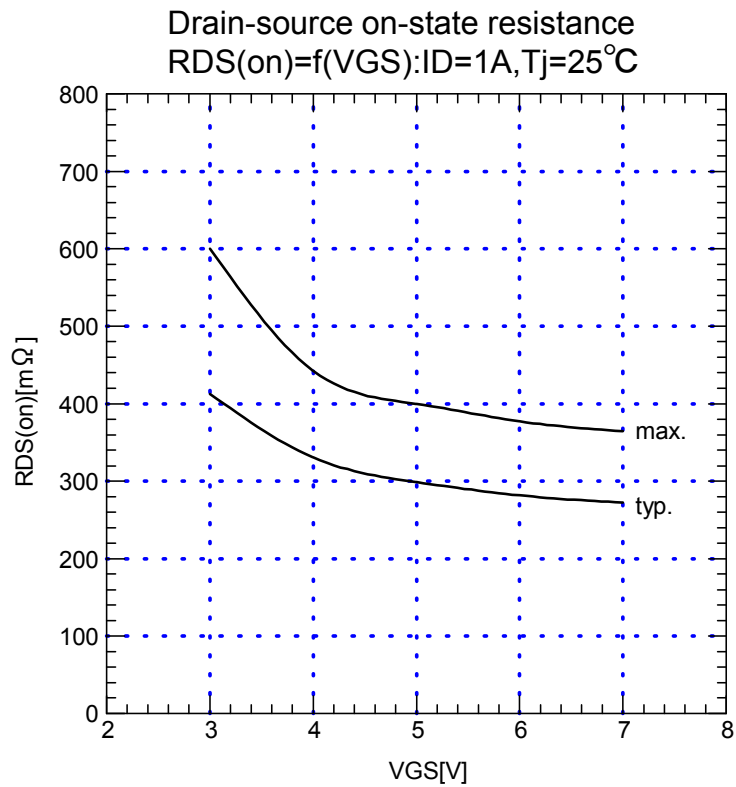
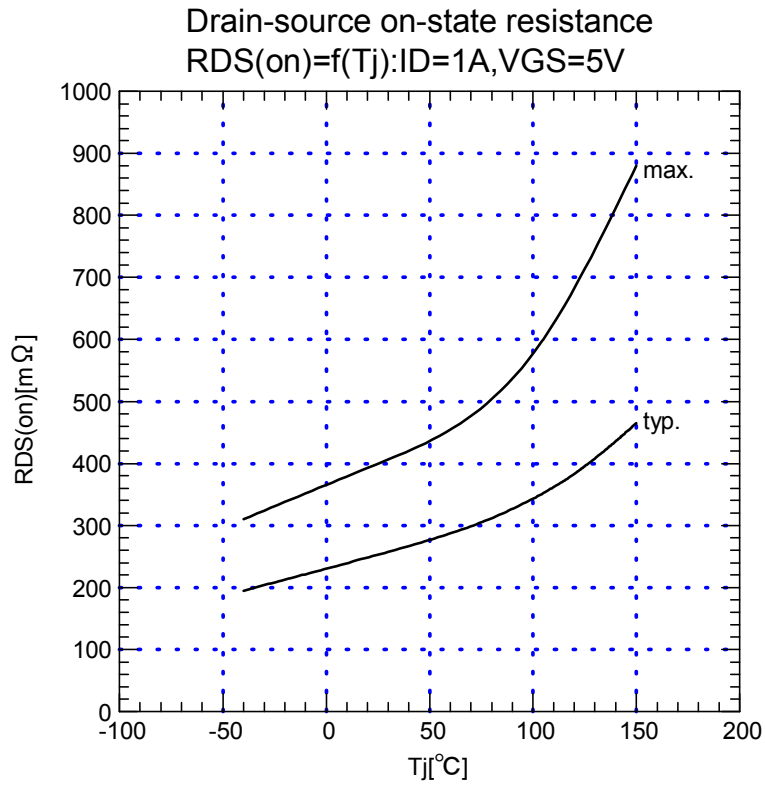
Gate-source leakage current  
 $I_{GS}(n)=f(T_j):V_{GS}=5V, V_{DS}=0V$



Gate-source leakage current  
 $I_{GS}(n)=f(V_{GS}):T_j=25^{\circ}C, V_{DS}=0V$



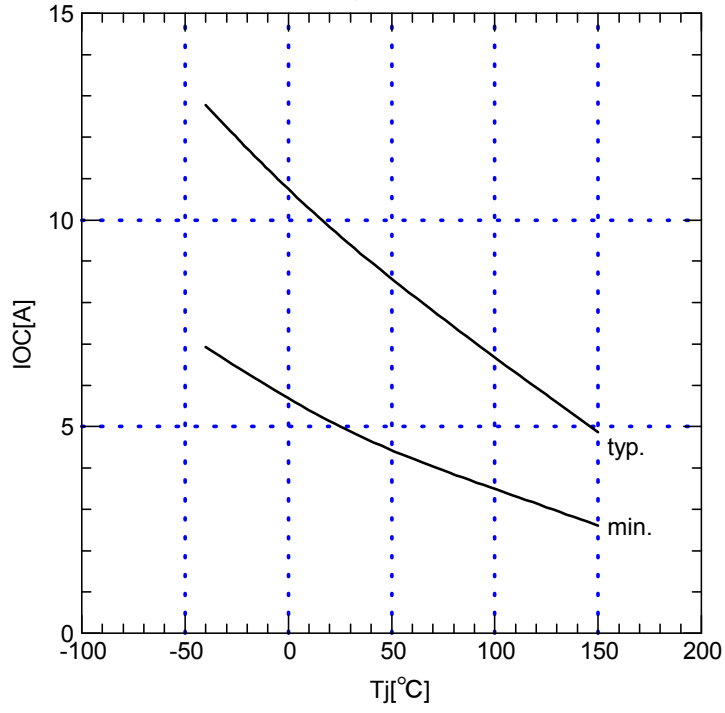
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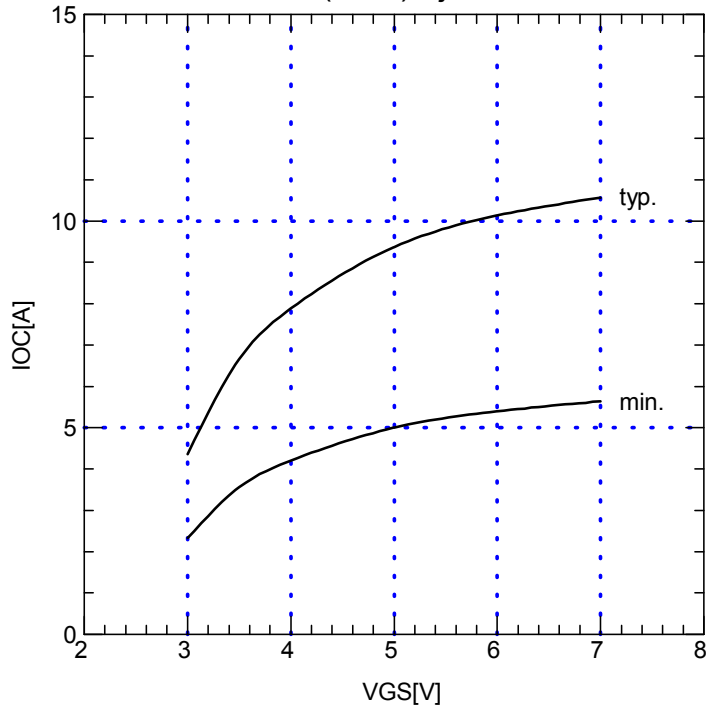
Short circuit protection

$IOC=f(Tj):VGS=5V$



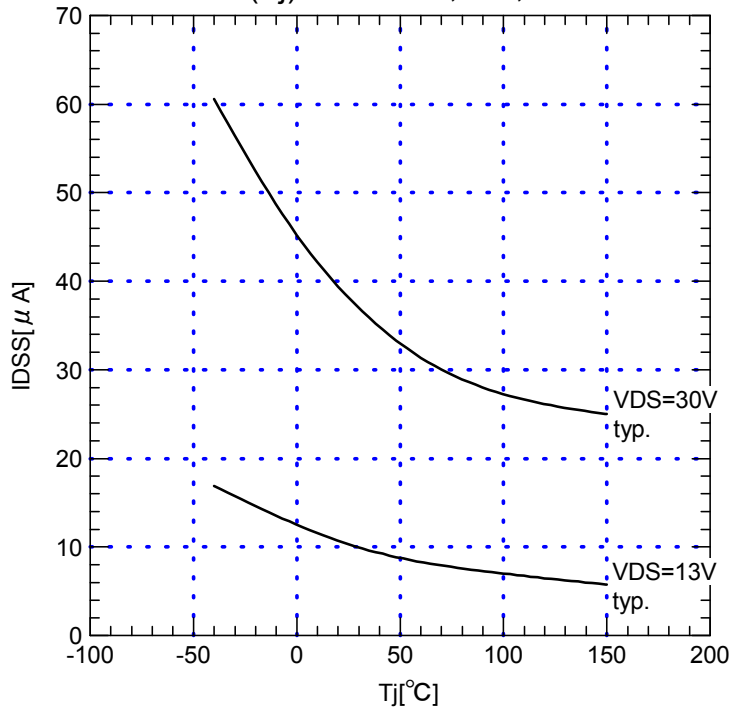
Short circuit protection

$IOC=f(VGS):Tj=25°C$

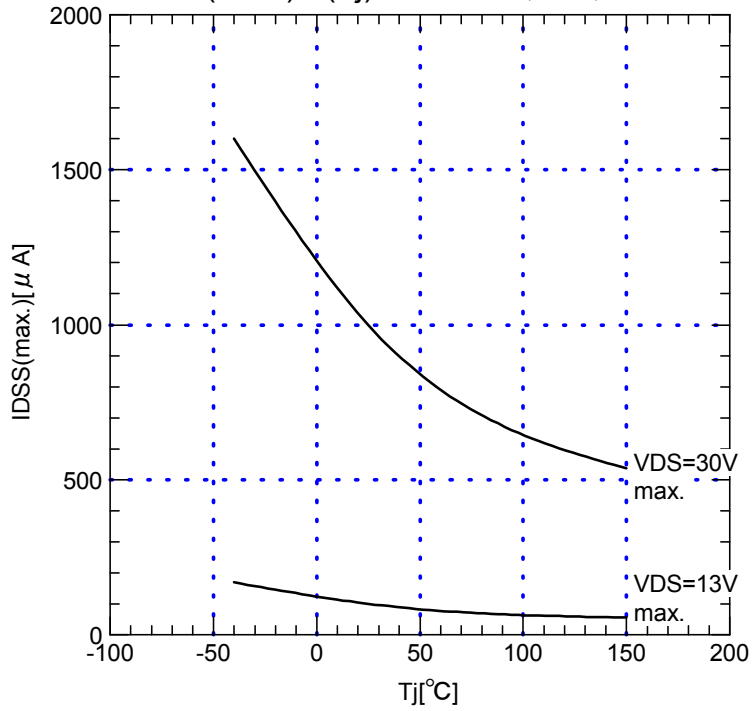



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Zero gate voltage drain current  
 $ID_{SS}=f(T_j):V_{DS}=13V,30V,V_{GS}=0V$

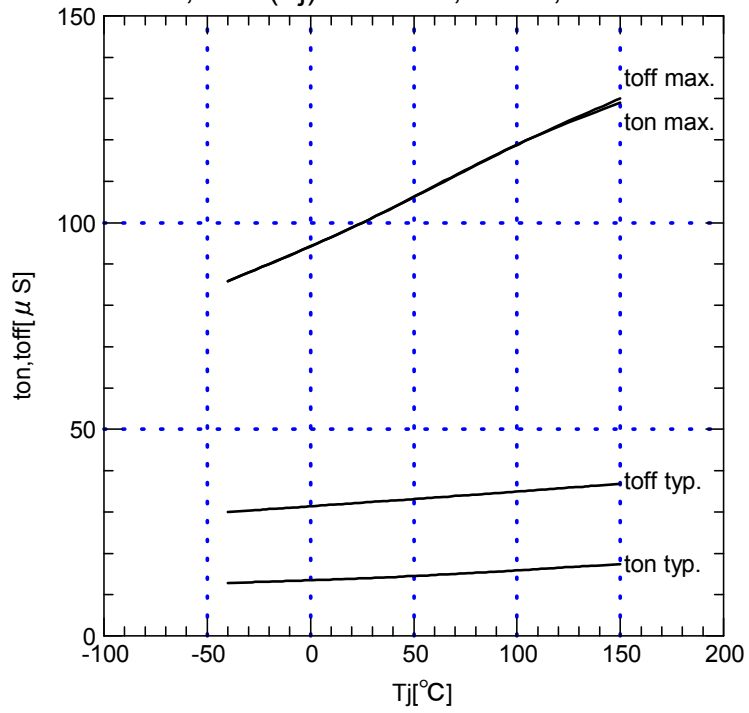


Zero gate voltage drain current  
 $ID_{SS(max.)}=f(T_j):V_{DS}=13V,30V,V_{GS}=0V$

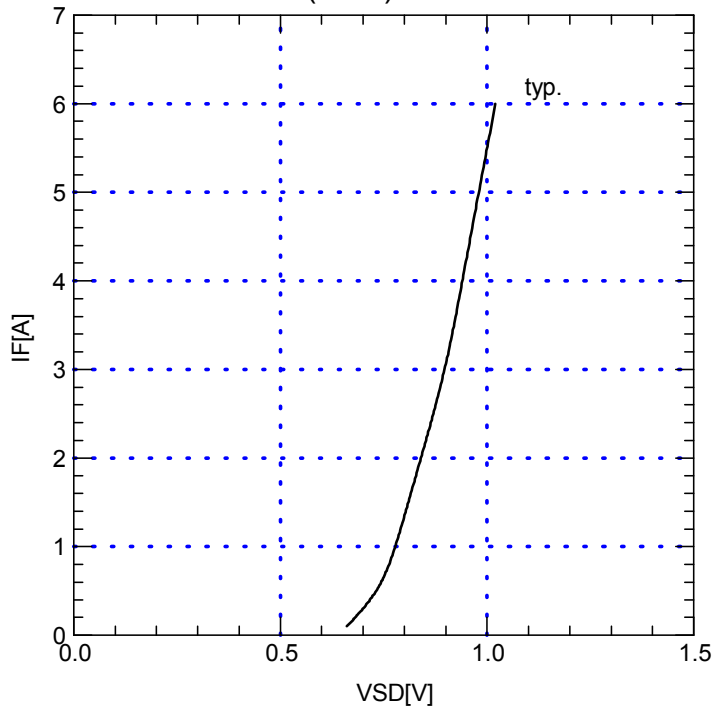


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Turn-on time, Turn-off time  
 $ton, toff = f(Tj): VGS = 5V, ID = 1A, VDS = 13V$



Forward on voltage  
 $IF = f(VSD)$






# FUJI INTELLIGENT POWER MOS FET

## Type: F5020-S□□SC

### OUT VIEW

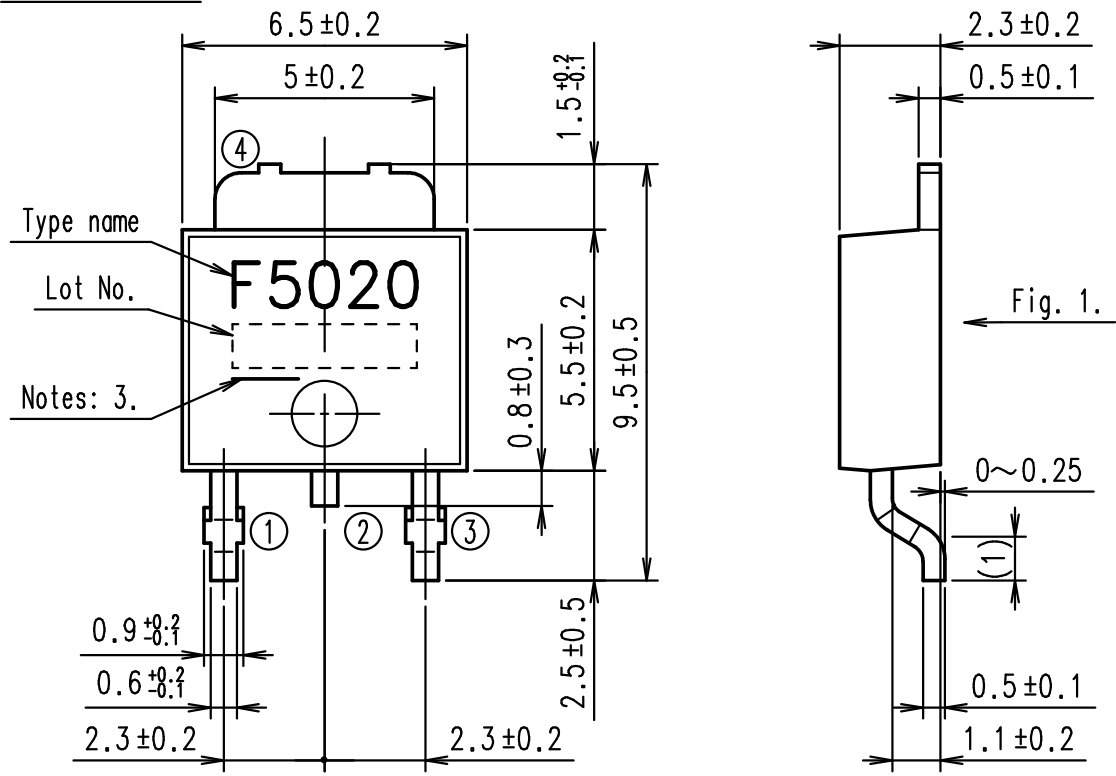
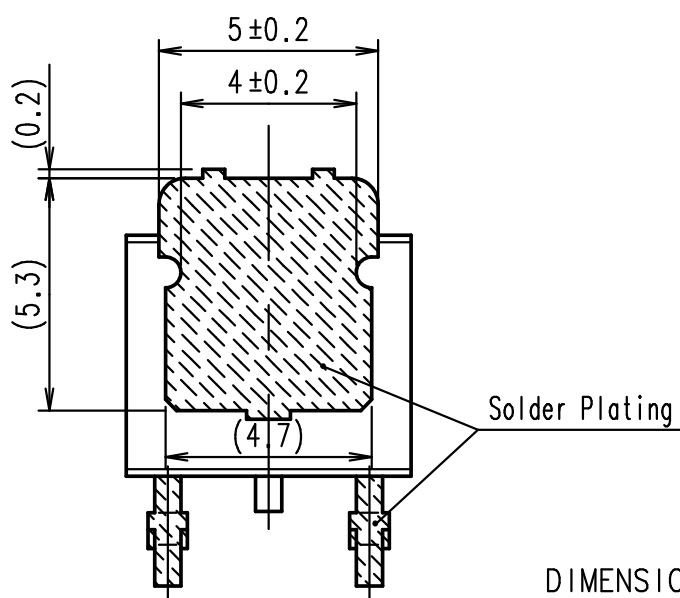


Fig. 1.



### CONNECTION

- ① GATE
- ②④ DRAIN
- ③ SOURCE

JEDEC: TO-252  
EIAJ: SC-63

DIMENSIONS ARE IN MILLIMETERS.

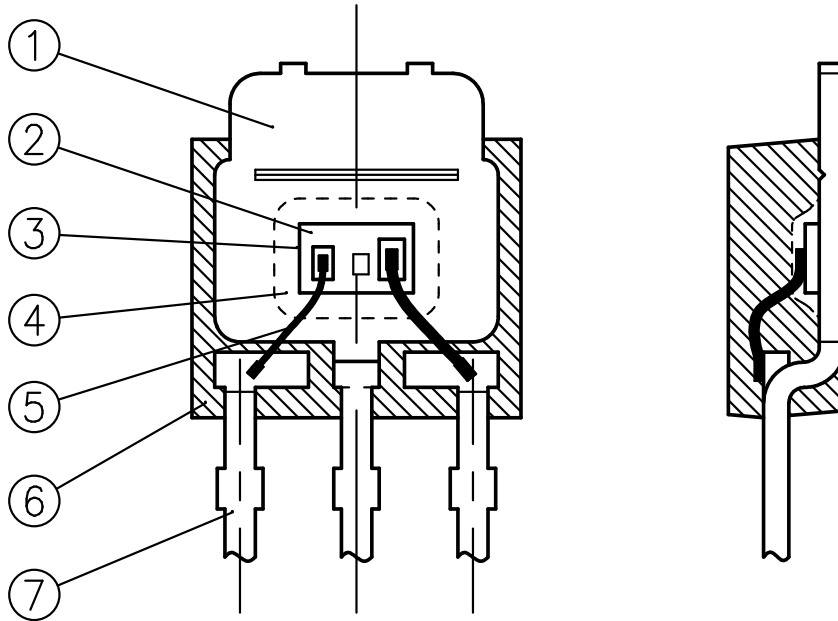
- Notes: 1. ( ) : Reference dimensions.  
 2. The metal part is covered with the solder plating, part of cutting is without the solder plating.  
 3. Mark of the Lead-Free Solder. (Solder plating which covers the metal)

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# MOS FET

## TYPE : F5020-S/-L[ ]SC

### STRUCTURE & MATERIALS



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No.	Parts Name	Material	Dimension etc
1	Lead Frame	Copper	—————
2	MOS FET Chip	Silicon	2.248×1.366 mm
3	Solder	Pb-Sn-Ag	—————
4	Junction Coating Resin	Silicone	—————
5	Inner Lead Wire	Aluminum	Gate--- $\phi 150\mu\text{m} \times 1\text{wire}$ Source- $\phi 200\mu\text{m} \times 1\text{wire}$
6	Resin	Epoxy Resin	UL Flame Class V-0
7	Pre-Solder	Sn-Ag	Lead-Free Type