Introduction to Silan MOSFET

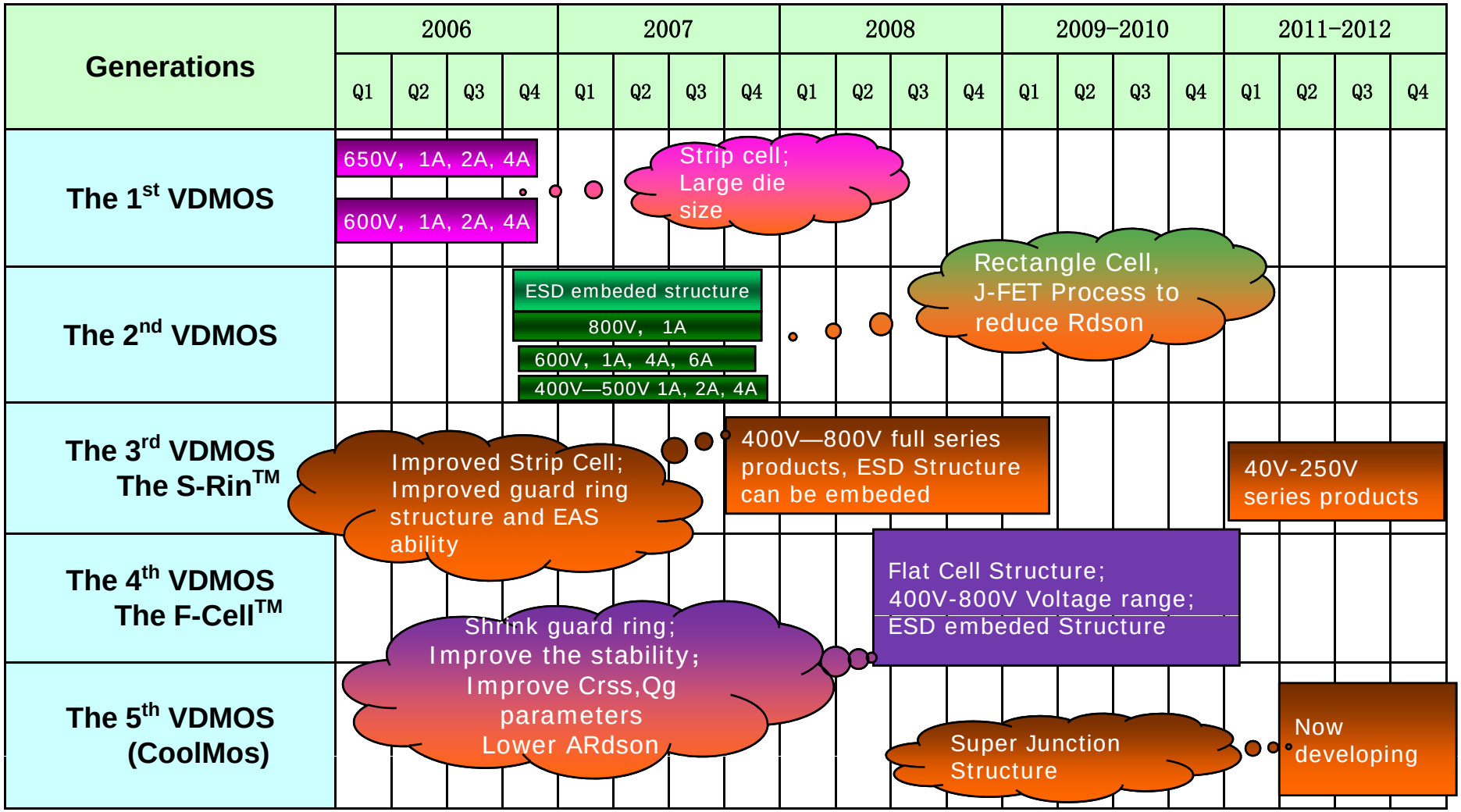
First Scene

Road Map & Process

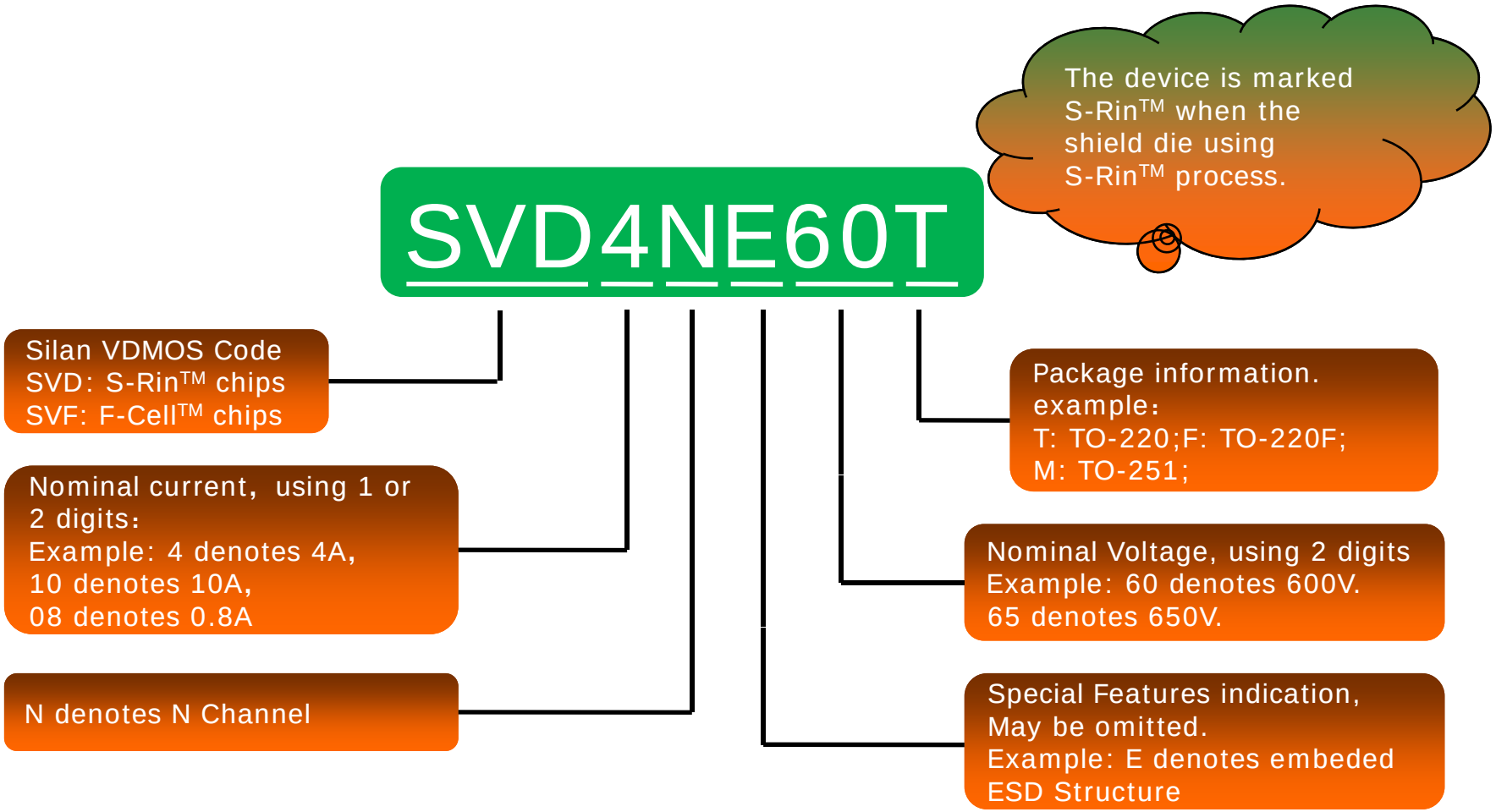
Brief Introduction to Silan MOSFET

- Silan has developed 4 generations of planar structure Power MOSFET device in Fab2.
- All the parameters and cost are improved in the new generations.
- The S-Rin™ is the registered trade mark of Silan's 3rd Generation MOSFET.
- The S-Rin™ series HV-MOSFET are mass-production and suitable for most applications.
- The development of the F-Cell™ was successful at the end of 2009,and it is the 4th generation MOSFET of SILAN. Many advanced technics are used to improve the electrical parameters in the 4th generation.

Silan MOSFET Roadmap



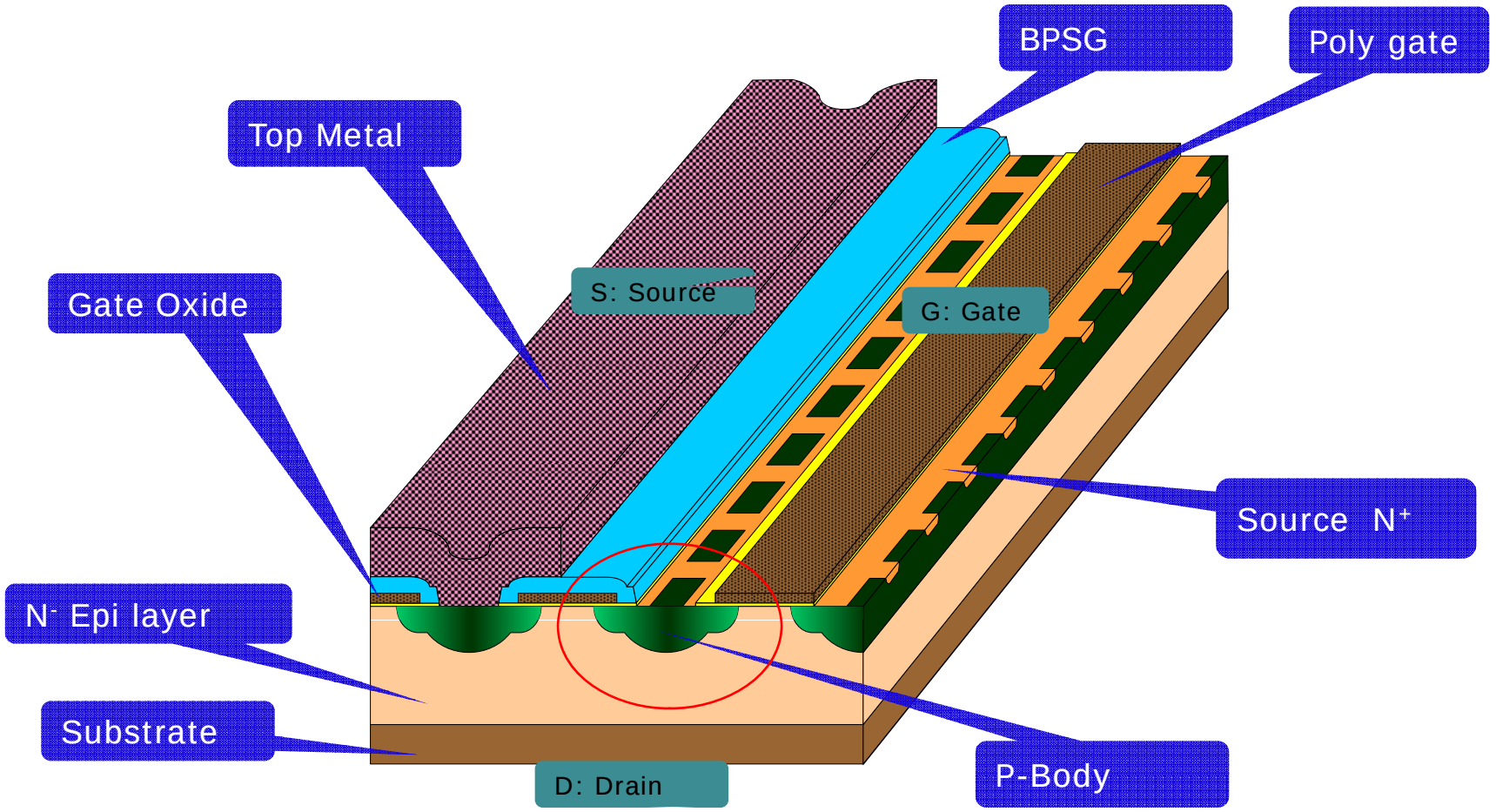
Nomenclature of Silan MOSFET Devices



The meaning of S-Rin^{TM} and its main structure characteristic

- S-Rin^{TM} denotes the series of MOSFET that use a smaller guard ring size compared with the 1st and the 2nd generations of SILAN company.
- Additionally, the S-Rin^{TM} series MOSFET adopt the optimized strip cell to enhance the EAS ability.
- We control the J-FET P^+ driven depth and concentration to improve the R_{dson} parameter.

Cell Structure of S-Rin™ Series



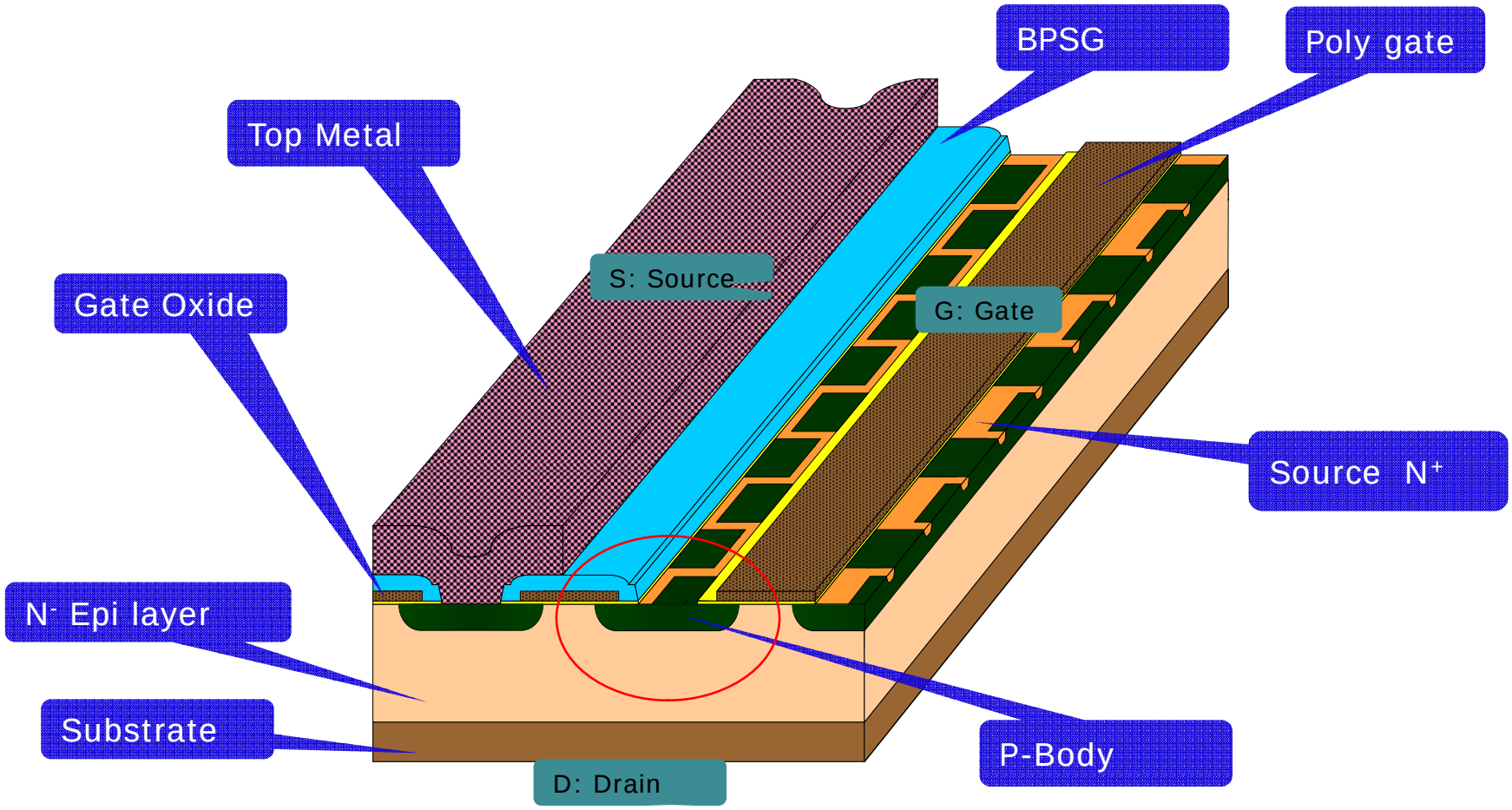
S-Rin™ Features and Benefits

- Robust performance by using improved guard ring structure. It also improves the stability of device.
- Enhanced gate oxide breakdown voltage by using optimized oxide thickness design.
- Faster Switching Speed response through highly doped poly silicon.
- Improved EAS and R_{dson} parameters by using optimized strip cells.
- Operating voltage covers from 40V to 800V.
- To improve the ESD parameters of the device, the poly silicon Zener diode structure can be embeded.

The meaning of F-Cell™ and its main structure characteristic

- F-Cell™ denotes the series of MOSFET that use a flat bottom of P-body in the cells.
- Optimizing the sizes of Gate poly width and open to enhance the density of cells.
- The F-Cell™ series use the new well-designed guard ring ,which is much more smaller than the former ones .

Cell Structure of F-Cell™ Series



F-Cell™ Features and Benefits

- Shrinked chip size in a same specification compared with the former generation series results from the smaller width guard ring.
- The new well-designed guard ring used in F-Cell™ also improves the stability of device.
- High breakdown voltage with the design of the flat bottom of P-body in the cells .
- Low AR_{dson} with the optimized design of the unit cell size, which is determined by Gate width and open sizes.
- Faster Switching response Speed due to the smaller capacitances especially the low Crss.
- Improved EAS ability by using the optimized design of the channel distribution.

The 2nd,S-Rin™ and F-Cell™ parameters comparison

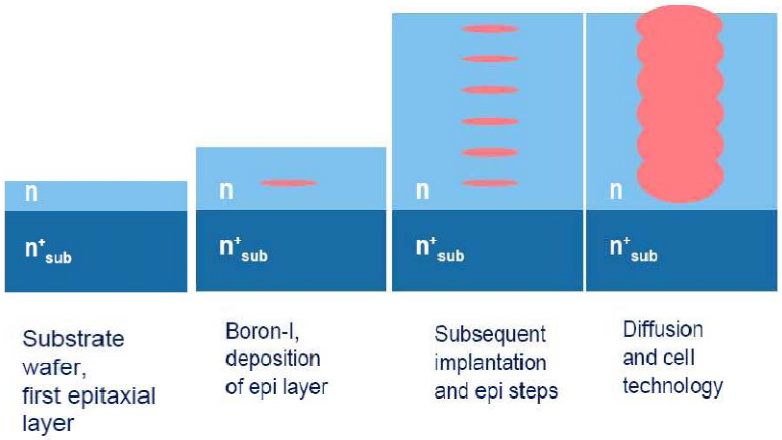
GEN.	SPE.	AR_{DSON} (ohm*mm2)	C_{iss} (pf)	C_{oss} (pf)	C_{rss} (pf)	Q_g (nC)	EAS (mJ)	RDS(on)
The 2nd	4A/600V	9.098	-	-	-	-	-	2.0 ohm@VGS=10V
S-Rin™	4A/600V	10.259	672	66	4.7	19.8	276	2.0 ohm@VGS=10V
F-Cell™	4A/600V	8.225	461	57	1.47	8.16	217	2.0 ohm@VGS=10V

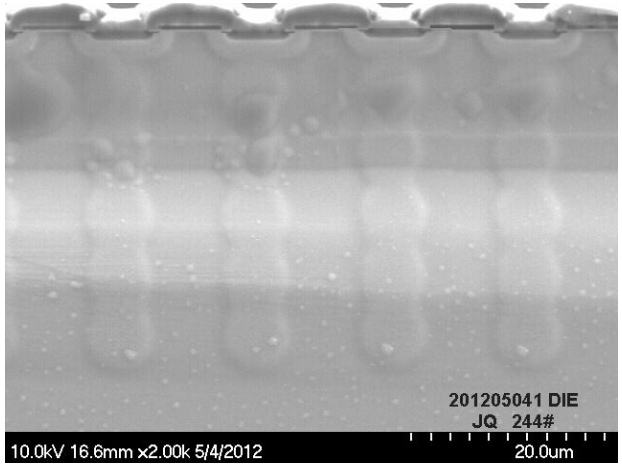
S-Rin™ and F-Cell™ photomask number comparison

GEN.	photomask number
S-Rin™	7 layers
S-Rin™ With ESD structure	9 layers
F-Cell™	8 layers
F-Cell™ With ESD structure	10 layers

Current status of Super Junction MOSFET

Super Junction adopts multilayer EPI process solution:





Parameter comparison for typical products:

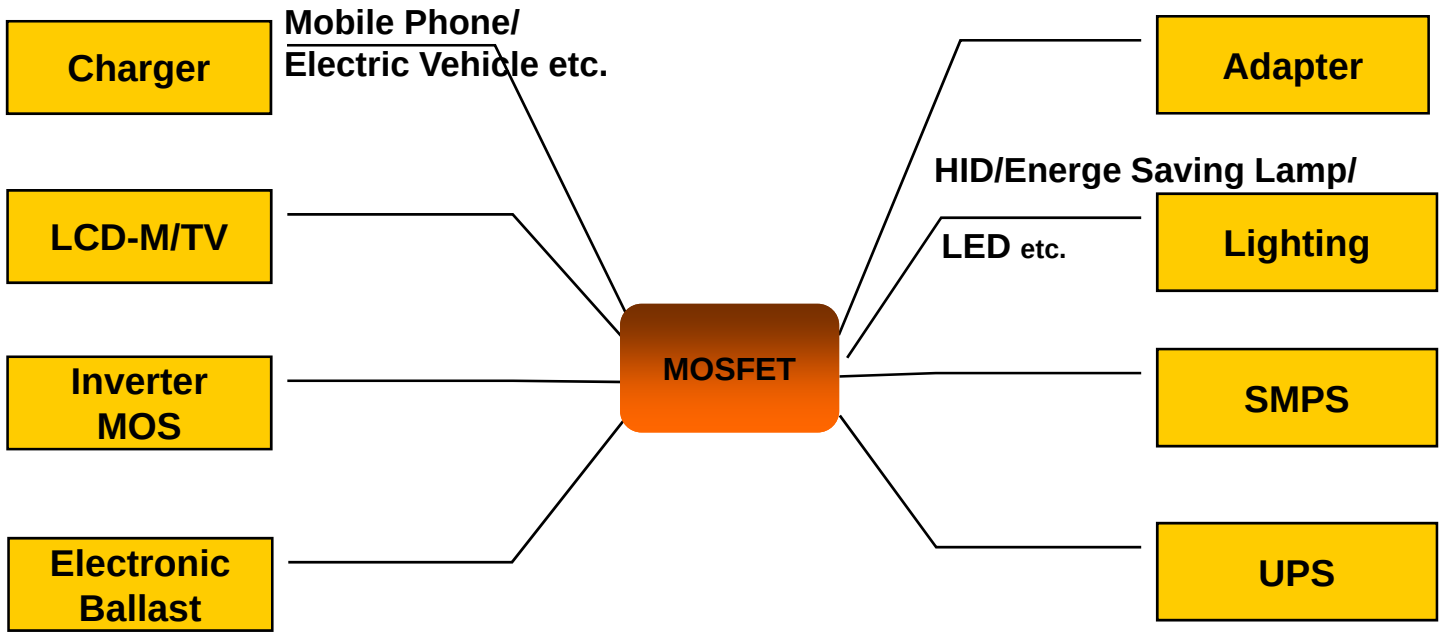
Process platform	Voltage	Parameter	Typical products	Chip area (mm2)	Ciss (pf)	Coss(pf)	Crss (pf)	Qg (nC)	Rds (on typ)
S-Rin	600V	4A/600V	SVD4N60F	8.832	672	66	4.7	19.8	2.0Ω@VGS=10V
F-CELL	600V	4A/600V	SVF4N60F	7.134	461	57	1.47	8.16	2.0Ω@VGS=10V
Superjunction*	600V	4A/600V	—	3.6	189	36.8	0.7	7	2.0Ω@VGS=10V

* engineering data

Super Junction R&D schedule:

2012	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Engineering lot produced								
Parameter qualification on engineering lot								
500Hr aging test on engineering lot								
First PP lot								
500Hr aging test								
1000Hr aging test								
Second PP lot								
500Hr aging test								
1000Hr aging test								
Third PP lot								
500Hr aging test								
1000Hr aging test								

Application Fields of MOSFET



Capacity of Silan MOS

Products Category	Output Capacity (Wafer: pcs)
➢ MOSFET	40K/M

The List of Silan S-Rin™ Series HV MOSFET (1)

Vds	Part Number	Parameter		Package	Status
		ID	RDSON (max)	Symbol : Package type	
400V	SVD730T/F/M	6A	0.95Ω	T: TO-220-3L ; F: TO-220F-3L; M: TO-251-3L;	MP
	SVD740T/F	10A	0.55Ω	T: TO-220-3L ; F: TO-220F-3L	MP
450V	SVD2NE45T/F	2A	2.45Ω	T: TO-220-3L ; F: TO-220F-3L	Sample
500V	SVD830T/F	5A	1.5Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD840T/F	8A	0.9Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD13N50T/F	13A	0.52Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD15NE50PN	15A	0.4Ω	PN: TO-3PN	MP
600V	SVD1N60DB	0.5A	15Ω	B: TO-92-3L	MP
	SVD1N60T/D/M/B	1A	11Ω	T: TO-220-3L ; D: TO-252-2L; M: TO-251-3L; B: TO-92-3L	MP
	SVD2N60T/F/D/M	2A	4.6Ω	T: TO-220-3L ; F: TO-220F-3L;D: TO-252-2L; M: TO-251-3L;	MP
	SVD4N60T/F/D	4A	2.4Ω	T: TO-220-3L ; F: TO-220F-3L;D: TO-252-2L	MP
	SVD5N60T/F	5A	2.1Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD7N60T/F	7A	1.2Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD8N60T/F	8A	1.2Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD10N60T/F	10A	1.0Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD12N60T/F	12A	0.8Ω	T: TO-220-3L ; F: TO-220F-3L	MP

The List of Silan S-Rin™ Series HV MOSFET (2)

Vds	Part Number	Parameter		Package	Status
		ID	RDSON (max)	Symbol : Package type	
650V	SVD2N65T/F	2A	5.6Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD4N65T/F	4A	3.0Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD7N65AF	7A	1.4Ω	F: TO-220F-3L	MP
	SVD8N65T/F	8A	1.4Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD9N65F	9A	1.2Ω	F: TO-220F-3L	MP
	SVD10N65T/F	10A	1.0Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVD12N65T/F	12A	0.8Ω	T: TO-220-3L ; F: TO-220F-3L	MP
700V	SVD2N70T/F/M	2A	6.5Ω	T: TO-220-3L ; F: TO-220F-3L; M: TO-251-3L;	MP
800V	SVD1N80T/M/B	1A	16Ω	T: TO-220-3L; M: TO-251-3L; B: TO-92-3L	MP

The List of Silan S-Rin™ Series LV MOSFET

Vds	Part Number	Parameter		Package	Status
		ID	RDSON (max)	Symbol : Package type	
40V	SVD1404T	162A	4 mΩ	T: TO-220-3L ;	Sample
55V	SVD3205T	110A	9 mΩ	T: TO-220-3L ;	MP
60V	SVD50N06T/D/M	50A	23 mΩ	T: TO-220-3L ; D: TO-252-2L; M: TO-251-3L;	MP
75V	SVD75N08T	75A	12 mΩ	T: TO-220-3L ;	MP
100V	SVD3710T	57A	23 mΩ	T: TO-220-3L ;	Sample
200V	SVD630T/F	9A	0.4Ω	T: TO-220-3L ; F: TO-220F-3L ;	Sample
	SVD640T/F	18A	0.18Ω	T: TO-220-3L ; F: TO-220F-3L ;	Sample
250V	SVD634T	8A	0.45Ω	T: TO-220-3L ; F: TO-220F-3L ;	Sample

Silan 士兰微电子

The List of Silan F-Cell™ Series HV MOSFET (1)

Vds	Part Number	Parameter		Package	Status
		ID	RDSON (max)	Symbol : Package type	
400V	SVF730T/F/D/M	6A	0.95Ω	T: TO-220-3L ; F: TO-220F-3L;D: TO-252-2L;M:TO-251-3L;	Developing
	SVF740T/F	10A	0.55Ω	T: TO-220-3L ; F: TO-220F-3L	Developing
500V	SVF5NE50T/F	5A	1.25Ω	T: TO-220-3L ; F: TO-220F-3L	MP
	SVF830T/F/D	5A	1.5Ω	T: TO-220-3L ; F: TO-220F-3L;D: TO-252-2L;	MP
	SVF840T/F/D	8A	0.9Ω	T: TO-220-3L ; F: TO-220F-3L;D: TO-252-2L;	MP
	SVF13N50T/F	13A	0.52Ω	F: TO-220F-3L; T:TO-220-3L	MP
	SVF16N50/F	16	0.38Ω	F: TO-220F-3L;	Developing
	SVF18N50F/T/PN	18	0.265Ω	F: TO-220F-3L; T: TO-220-3L; PN:TO-3PN	MP
	SVF20N50F/T/PN	20	0.26Ω	F: TO-220F-3L; T: TO-220-3L; PN:TO-3PN	MP
	SVF20NE50PN	20	0.27Ω	PN:TO-3PN	MP
600V	SVF1N60D/M/B/N	1A	11Ω	D: TO-252-2L;M:TO-251-3L;B:TO-92-3L;N:TO-126-3L	MP
	SVF2N60T/F/D/M/N	2A	4.6Ω	T: TO-220-3L ; F: TO-220F-3L;D: TO-252-2L;M:TO-251-3L;N:TO-126-3L	MP
	SVF4N60T/F/D/M/K	4A	2.4Ω	T: TO-220-3L ; F: TO-220F-3L;D: TO-252-2L;M:TO-251-3L;K:TO-262-3L	MP
	SVF5N60T/F/D	5A	2.15Ω	T: TO-220-3L ; F: TO-220F-3L;D: TO-252-2L;	MP
	SVF6N60F/D	6A	1.5Ω	F: TO-220F-3L;D: TO-252-2L;	MP
	SVF7N60T/F/K	7A	1.2Ω	T: TO-220-3L ; F: TO-220F-3L;K:TO-262-3L	MP
	SVF8N60T/F	8A	1.2Ω	T: TO-220-3L ; F: TO-220F-3L;	MP

The List of Silan F-Cell™ Series HV MOSFET (2)

Vds	Part Number	Parameter		Package	Status
		ID	RDSON (max)	Symbol : Package type	
600V	SVF10N60T/F/K	10A	1.0Ω	T: TO-220-3L ; F: TO-220F-3L;K:TO-262-3L	MP
	SVF12N60T/F/K	12A	0.8Ω	T: TO-220-3L ; F: TO-220F-3L;K:TO-262-3L	MP
	SVF1N60AT/D/M/B	1A	7.7Ω	T: TO-220-3L ; D: TO-252-2L;M:TO-251-3L;B:TO-92-3L	MP
	SVF4N60AT/F/D	4A	2.2Ω	T: TO-220-3L ; F:TO-220F-3L;D: TO-252-2L;	MP
	SVF5N60AF	5A	1.5Ω	F:TO-220F-3L	MP
	SVF6N60AD	6A	1.25Ω	D: TO-252-2L;	MP
	SVF8N60AF	8A	1.0Ω	F:TO-220F-3L	MP
	SVF10N60AF	10A	0.8Ω	F:TO-220F-3L	MP
	SVF13N60AF	13A	0.43Ω	F:TO-220F-3L	MP
	SVF20N60T/F/PN	20A	0.43Ω	T: TO-220-3L ; F:TO-220F-3L;PN: TO-3PN;	MP
650V	SVF2N65F/N/MJ	1A	11Ω	F:TO-220F-3L;N: TO-126-3L; MJ:TO-251J-3L	MP
	SVF4N65T/F/D/M	4A	2.7Ω	T: TO-220-3L ; F:TO-220F-3L;D: TO-252-2L;M:TO-251-3L;	MP
	SVF7N65T/F	7A	1.4Ω	T: TO-220-3L ; F:TO-220F-3L;	MP
	SVF8N65T/F	8A	1.4Ω	T: TO-220-3L ; F:TO-220F-3L;	MP
	SVF10N65T/F	10A	1.0Ω	T: TO-220-3L ; F:TO-220F-3L;	MP
	SVF12N65T/F	12A	0.8Ω	T: TO-220-3L ; F:TO-220F-3L;	MP

The List of Silan F-Cell™ Series HV MOSFET (3)

Vds	Part Number	Parameter		Package	Status
		ID	RDSON (max)	Symbol : Package type	
700V	SVF1N70M/B	1A	13.5Ω	M:TO-251-3L;B:TO-92-3L	MP
	SVF2N70F/D/M	2A	6.5Ω	F:TO-220F-3L;D: TO-252-2L;M:TO-251-3L	MP
	SVF4N70F	4A	2.7Ω	F:TO-220F-3L	MP
	SVF6N70F	6A	1.7Ω	F:TO-220F-3L	MP
	SVF8N70F	6A	1.2Ω	F:TO-220F-3L	MP
800V	SVF2N80AD	2A	2.7Ω	D: TO-252-2L	MP
	SVF3N80T/F/D/M	3A	4.8Ω	T: TO-220-3L ; F:TO-220F-3L;D: TO-252-2L;M:TO-251-3L	MP
	SVF4N80F/D	4A	3.6Ω	F:TO-220F-3L; D: TO-252-2L	MP
	SVF5N80F	5A	2.6Ω	F:TO-220F-3L	MP
	SVF7N80T/F	7A	1.55Ω	T: TO-220-3L ; F:TO-220F-3L	MP
	SVF8N80T/F	8A	1.55Ω	T: TO-220-3L ; F:TO-220F-3L	MP
900V	SVF4N90F	4A	3.5Ω	F:TO-220F-3L	Sample
	SVF9N90F/PN	9A	1.4Ω	F:TO-220F-3L;PN:TO-3PN	MP

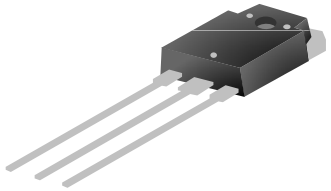
Second Scene

Package Capability

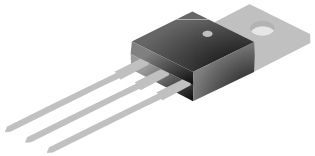
Assembly House & Package Type

	Assembly House	Package Type	Status
Self	**SLIC** (Silan Integrated Circuit Company)	TO-220/ TO-220F/ TO-3PN	Mass Production
		TO-252/ TO-251D-3L	Qualification (Release in Aug.2012)
Subcon	**JCET** (Jiangsu Changjiang Elec. Tech. Co.,Ltd)	TO-252/ TO-251D-3L/ TO-126-3L/ TO-92-3L	Mass Production
		SOT-223-3L/ TO-263-2L	Qualification (Release in Sep.2012)
	FUJITSU (NanTong Fujitsu Microelec. Co.,Ltd)	TO-252/ TO-251J-3L	Mass Production
		TO-262-3L	Mass Production
	FSLJ (Foshan Blue Rocket Elec. Co.,Ltd)	TO-220F	Mass Production
		TO-126-3L/ TO-126F-3L	Qualification (Release in Sep.2012)

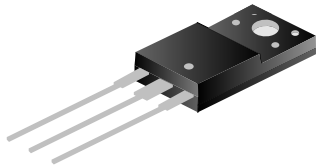
Package Outline



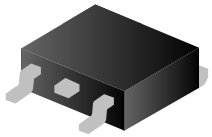
TO-3PN



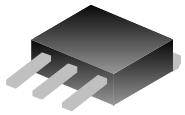
TO-220-3L



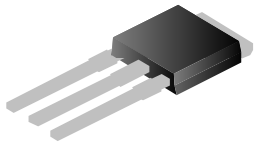
TO-220F-3L



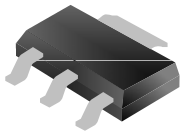
TO-252-2L



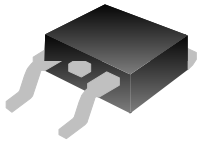
TO-251D-3L



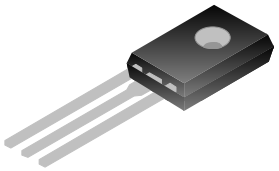
TO-251J-3L



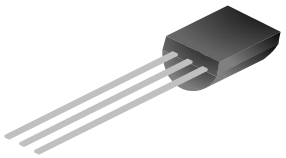
SOT-223-3L



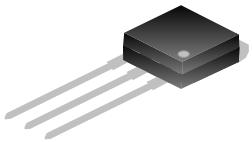
TO-263-2L



TO-126-3L



TO-92-3L



TO-262-3L

Introduction to Assembly House of Silan-self

- At present, the assembly house of discrete devices (MOSFET/FRD/SBD/IGBT, etc) is in **SLIC foundry**; The current package capacity is as below :

Package	Volume/M
TO-220	6KK
TO-220F	12KK
TO-252/251	5.4KK
TO-3P	1KK

- Chengdu Factory is under construction now, the clean-room construction is scheduled to finish in the end of 2012. The capacity can reach to 30kk units/M per market demand by the end of 2013.

Introduction to SilanIC Assembly House

- Have the world class package equipment:

Process	Equipment
Die Attach	ESEC2007/2009
Wire Bonding	OE7200
Molding	MBP Mold
Trim/Form	Fully Automatic System

- Have the ability and technology to settle such as delamination & solder void problem. Also can get the lower thermal resistor performance. Strictly control methods to assure high quality.
- At he same time and under same condition, do the reliability for Fairchild/ST/Silan products,all pass;

Third Scene

Quality Evaluation

Reliability Test Plan of MOSFET

1. Wafer reliability test (wafer is supported by the supplier)

1.1 All the products are divided into different types according to the withstand voltage, such as: type A: 400V~500V, type B: 600V~700V, type C: 800V~900V, and so on.

1.2 Monthly take HTRB and HTGB tests on the products with high withstand voltage sampled in every type for 168 hours.

1.3 Take HTRB and HTGB tests on the products with high withstand voltage sampled in everytype for 1000hours each season.

1.4 Monthly test can be replaced by seasonal test when they are in the same month.

2. Package reliability test (package is supported by the supplier)

2.1 Take all the tests (shown in next page) on the products with high withstand voltage sampled in every type each year, and HTRB and HTGB tests will last for 1000 hours.

2.2 Wafer reliability test can be replaced by package reliability test when they are in the same month.

Reliability Test Plan of MOSFET

3. Reliability Test Plan of MOSFET

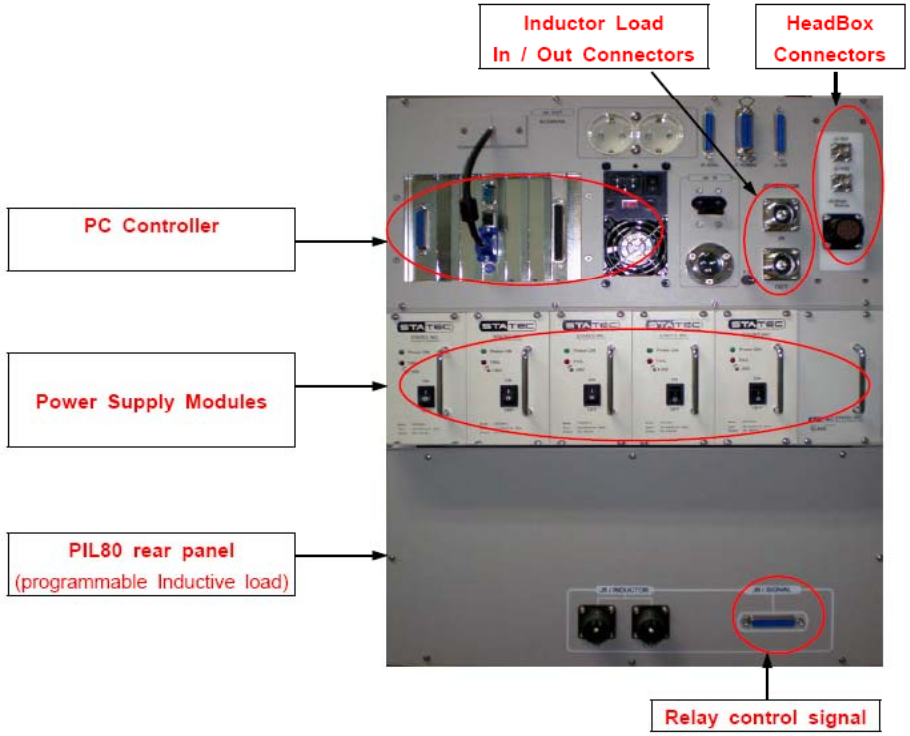
Subcontractor		Jan-2010	Feb-2010	Mar-2010	Apr-2010	May-2010	Jun-2010	Jul-2010	Aug-2010	Sep-2010	Oct-2010	Nov-2010	Dec-2010
FAB2 (silan VDMOS)	class1	√	√	√*	√	√	√*	√	√	√*	√	√	√*
	class2	√	√	√*	√	√	√*	√	√	√*	√	√	√*
	class3	√	√	√*	√	√	√*	√	√	√*	√	√	√*
	Assembly1 (SLIC& FSLJ)			√ ☆class1				√ ☆class2				√ ☆class3	
	Assembly2 (JCET& FujiTsu)		√ ☆class2				√ ☆class3				√ ☆class1		

Note: 1, "√" --Indicate that the reliability test items include NO.1-2（168HRS）;
2, "√*" --Indicate that the reliability test items include NO.1-2（1000HRS）;
3, "√☆class1-3"-- Indicate that the reliability test items include NO.1-10.

Reliability Test Items(AEC-Q101)

	Test Item	Test Condition	Failure Criterion	Sample Qty	A/R
1	High Temperature Reverse Bias	150℃,Vds=80%Spec 168Hrs or 1000Hrs	If meet the spec?	77or 45	0/1
2	High Temperature Gate Bias	150℃,Vgs=100%Spec 168Hrs or 1000Hrs	If meet the spec?	77or 45	0/1
3	Temperature Cycling Test	-65℃~150℃； Air to Air Lasting time：30Min For 1000 times	If meet the spec?	77or 45	0/1
4	Highly Accelerated Stress ester (HAST)	130℃； 85% RH ； Vgs=80%Spec 200Hrs	If meet the spec?	77or 45	0/1
5	Autoclave	121℃,2atm, 100%RH,96Hrs	If meet the spec?	77or 45	0/1
6	High Humidity, High Temperature Reverse Bias (H3TRB)	85℃； 85% RH； Vgs=80%spec 1000Hrs	If meet the spec?	77or 45	0/1
7	High Temperature Storage	150℃， 1000Hrs	If meet the spec?	77or 45	0/1
8	Solderability Test Method	245℃,5s, solder area>95%	If tin climbing area is over 95% of Immersion area?	22	0/1
9	Resistance to Soldering Temperature for Devices	Peak temperature 260℃,keep10±1S	If meet the spec?	22	0/1
10	ESD Test	Spec， HBM Gate (+/-)to Source(-/+)	No pin open and short	22	0/1

TEST equipment—EAS



EAS2100V

TEST equipment－EAS

ITC55X00

TEST equipment—Switch time、gate charge、Trr；

Thermal Resistance Test：

ITC57300

DM2000B

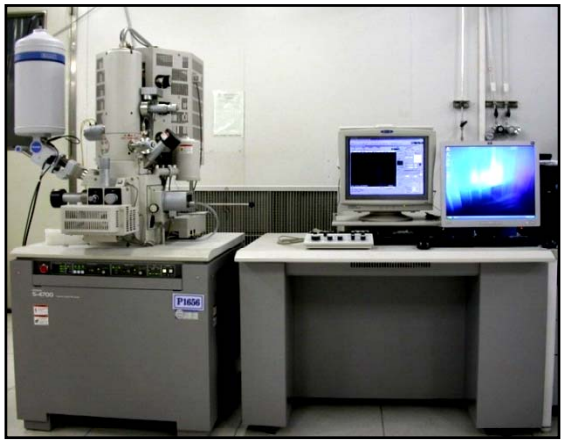
Silan In-House Reliability Test Equipments

Silan In-House Reliability Test Equipments – (continued)

30KV ESD Generator

Electricity of metal contact line speedup transfer life system

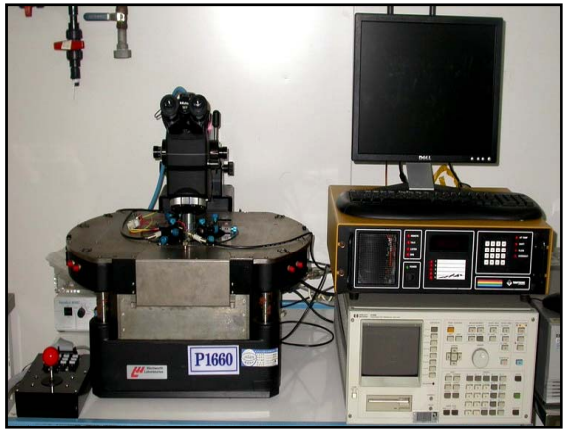
Silan in-house Failure Analysis Equipments



SEM + EDX (Hitachi S-4700)

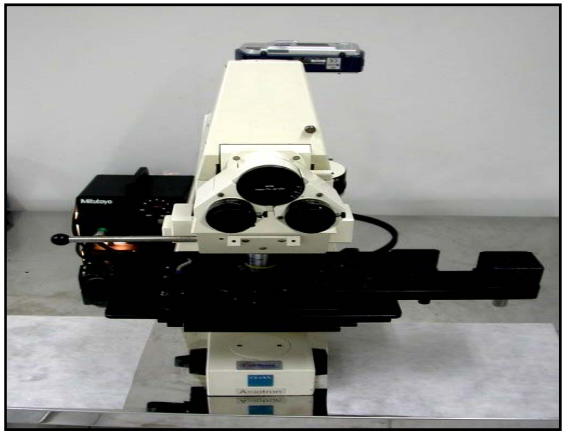
FIB (FEI FIB-200)

Etch and Staining station



4 channal Prober (HP 4145B)

VAC/SPUTTER COATER



Microscope (With DC)

Thanks!

http://www.silan.com.cn