



Fairchild Products Update for FY03

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Fairchild Discrete ranking in HK/China

Top 19 Companies' Vendor Revenue From Shipments of **Total Discrete** to China/Hong Kong (Millions of U.S. Dollars)

Rank 2000	Rank 2001	Company	Revenue 2000	Revenue 2001	Growth 2000-2001	Market Share 2001
4	1	Fairchild Semiconductor	124	150	21.0%	12.1%
1	2	Toshiba	178	143	-19.8%	11.5%
5	3	Philips Semiconductor	123	110	-10.9%	8.9%
2	4	Rohm	137	109	-20.4%	8.8%
13	5	Infineon Technologies	43	106	143.8%	8.6%
6	6	STMicroelectronics	120	98	-18.5%	7.9%
3	7	Hitachi	126	89	-29.3%	7.2%
8	8	ON Semiconductor	103	80	-22.3%	6.5%
7	9	Sanyo	111	64	-42.3%	5.2%
15	10	Vishay	37	62	67.6%	5.0%
10	11	KEC	84	56	-33.3%	4.5%
12	12	International Rectifier	45	53	17.8%	4.3%
9	13	NEC	93	42	-55.3%	3.4%
16	14	Matsushita	25	23	-6.5%	1.9%
11	15	Motorola	50	23	-54.0%	1.9%
14	16	Mitsubishi	42	20	-52.4%	1.6%
18	17	Agilent Technologies	14	5	-64.3%	0.4%
19	18	Fujitsu	8	3	-54.5%	0.3%
20	19	Sony	4	3	-37.5%	0.2%
Included Companies' Total*			1,467	1,238	-15.6%	100.0%

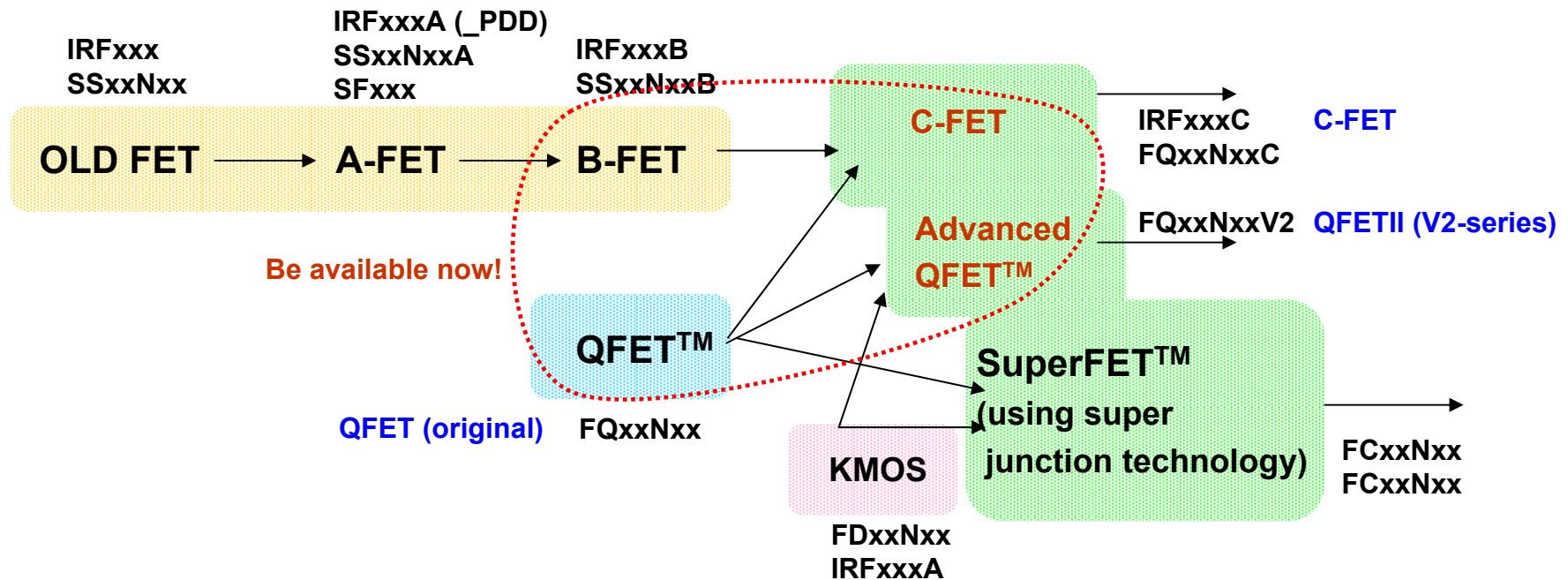
*Includes only 19 companies' shipments into China/Hong Kong. Total for the 19 companies is less than total China/Hong Kong market.

Source: Gartner Dataquest (April 2002)

HV Products Portfolio Depth & Breadth

		◎ : Excellent ○ : Good △ : Reasonable X : Poor				
	Fairchild	IR	Hitachi	ST Micro	Infineon	Toshiba
Power Supply	◎	◎	◎	◎	◎	◎
Ballast	◎	◎	○	◎	◎	◎
Monitor	◎	○	○	◎	○	◎
Charger	◎	◎	◎	◎	◎	◎
Motor	◎	○	X	○	X	○
PDP	◎	○	◎	○	◎	◎
Car Amp.	◎	○	△	○	○	◎
IH Appl.	◎	△	X	△	◎	○
DSC	◎	X	X	X	X	◎

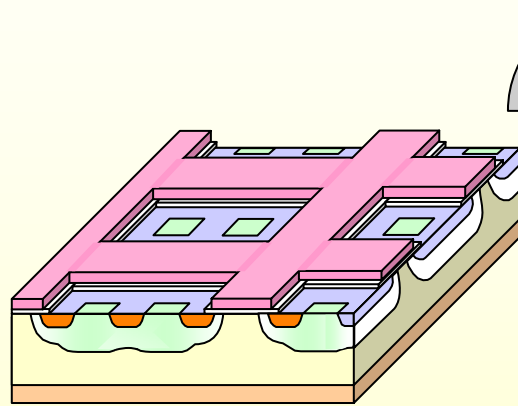
HV MOSFET Portfolio



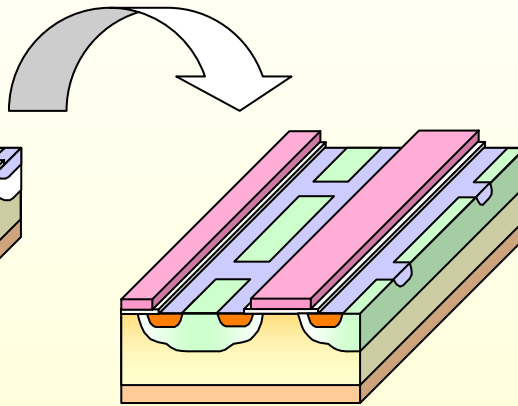
Directions of FSC's MOSFET

- Introduces new technology to gain the market leadership
- Meets industrial standard and FSC's originality
- Meets market' requirement for performance and cost

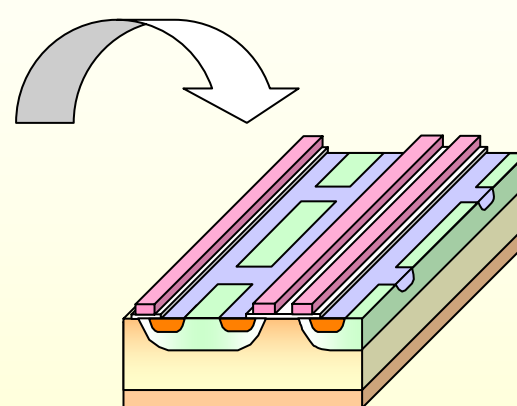
MOSFET Design Technology Trend



AFET / BFET
8-Shape Cellular
Deep P+ Junction
No JFET implant / JFET implant
6-Mask / Perkin Elmer



QFET
Ladder-Shape Stripe
Deep P+ Junction
JFET implant
No JFET Drive-in
7-Mask / Mix & Match Photo



Advanced Q-FET
Ladder-Shape Stripe
Flat Bottom Junction
JFET implant
JFET Drive-in
8-Mask / Mix & Match Photo
* IGBT II : No Poly cut
7-Mask / Perkin Elmer

Active Design Comparison

Design Technology and Feature

Design Technology	Figures of merit	Competitors		FSC (PDD)	FSC (DPP)
P+ self align implantation using a spacer sidewall	Higher ruggedness Higher cell density Reduced mask steps Reduced process variation	STM Infineon	StripFET™ “NE” “NF” SIPMOST™	Advanced QFET IGBT II (etched spacer)	KMOS SMPS2 IGBT (unetched spacer)
Flat bottom shallow active body junctions	Higher BV efficiency Higher cell density ~> Lower $R_{DS(on)}$	IR STM Infineon	Benchmark SuperMESH™ “NK” SFET, SIPMOST™, OptiMOS™	Advanced QFET IGBT II	KMOS SMPS2 IGBT
JFET implantation	Lower JFET resistance ~> Lower $R_{DS(on)}$	IR STM Toshiba	Benchmark PowerMESH™ “NC” Pi-MOS V	Advanced QFET IGBT II	KMOS SMPS2 IGBT
JFET drive-in	Lower drain resistance ~> Lower $R_{DS(on)}$ Reduced poly pitch ~> Lower Q_{GD}/Q_G ~> Higher BV efficiency ~> Lower $R_{DS(on)}$	IR STM Toshiba	Benchmark SuperMESH™ “NK” Pi-MOS V	Advanced QFET IGBT II	KMOS SMPS2 IGBT
Polycut	Simple cutting the center of poly gate ~> Lower Q_{GD}/Q_G	-	-	Advanced QFET	
Split poly gate	Center poly field plate disconnected from gate & shorted to source ~> Lower Q_{GD}/Q_G	-	-	-	KMOS SMPS2 IGBT

New HV MOSFET Definition

New Family	Feature	Target Market	Release Plan*
C-Series in advanced QFET™	- Fairchild's proprietary technology - Product ranges 200V to 1000V Lower FOM 15% compared with B-FET 100% avalanche screen in package - Guaranteed the 1000hrs QA test	monitor, ballast, adaptor, SMPS, General purposed	Q1.03 ~ (200~900V)
V2-Series in advanced QFET™	- Fairchild's proprietary technology - Product ranges 60V to 500V Lower FOM 35% compared with QFET 100% avalanche screen in package - Guaranteed the 1000hrs QA test	PDP, high-end SMPS, DC/DC, motor, automotive	Q3. 02 ~ (200~500V) Q2. 03 ~ (60~150V)
SuperFET™	- Fairchild's proprietary technology - Product ranges 600V to 900V Lower $R_{DS(on)}$ 30% compared with QFET 100% avalanche screen in package - Guaranteed the 1000hrs QA test	PFC, high-end SMPS	Q2. 03 ~ (600V) Q3. 04 ~ (8/900V)

* Can be changed by specific marketing targeting

Performance Comparison

Advanced QFET

Series			QFET	B-FET	C-series	V2-series	SuperFET
			FQP19N20	IRF640B	FQP640C	FQP18N20V2	
200V	R _{DS(on)}	A*R _{DS(on)}	11.8mΩcm ²	12.0mΩcm ²	10.8mΩcm ²	9mΩcm ²	
		RDS(on),typ	0.12Ω	0.145Ω	0.14Ω	0.12Ω	
		RDS(on),max	0.15Ω	0.18Ω	0.17Ω	0.14Ω	
	Qg	Qg,typ	31.0	45.0	43.0	20.0	
		Qgd,typ	13.5	22		10	
	FOM		3.7	6.5	6.0	2.4	
			FQA16N50	IRFP450B	FQA450C	FQP18N50V2	
500V	R _{DS(on)}	A*R _{DS(on)}	80mΩcm ²	78.7mΩcm ²	58.4mΩcm ²	57.5mΩcm ²	
		RDS(on),typ	0.25Ω	0.31Ω	0.31Ω	0.225Ω	
		RDS(on),max	0.32Ω	0.39Ω	0.37Ω	0.265Ω	
	Qg	Qg,typ	60.0	87.0	46.0	42.0	
		Qgd,typ	28	39	20.0	14.0	
	FOM		15.0	27.0	14.3	9.5	
			FQP12N60	SSP10N60B	FQP10N60C		FCP11N60
600V	R _{DS(on)}	A*R _{DS(on)}	110mΩcm ²	113mΩcm ²	87mΩcm ²		34mΩcm ²
		RDS(on),typ	0.55Ω	0.65Ω	0.63Ω		0.38Ω
		RDS(on),max	0.7Ω	0.8Ω	0.75Ω		0.32Ω
	Qg	Qg,typ	42.0	54.0	49.0		45.0
		Qgd,typ	21.0	21.0			
	FOM		23.1	35.1	30.9		17.1
			FQP7N80		FQP7N80C		FCP6N80
800V	R _{DS(on)}	A*R _{DS(on)}	210mΩcm ²		197mΩcm ²		53mΩcm ²
		RDS(on),typ	1.2Ω		1.44Ω		0.77Ω
		RDS(on),max	1.5Ω		1.7Ω		0.9Ω
	Qg	Qg,typ	40.0		35.5		27.0
		Qgd,typ	20.0				
	FOM		48.0		51.1		20.8

Product Cross-reference

C-FET	Id	Rds(on) Max	Rds(on) Typ.	Fairchild	Id	Rds(on) Max	Competitor		PKG	Id	Rds(on) Max
FQP3N80C	3.0	4.80	4.00	FQP3N80	3.0	5.00	STP3NA80	ST	TO-220	3.1	4.50
FQP6N80C	5.0	2.50	2.10	FQP5N80	4.8	2.60	STB4NC80Z	ST	D2-PAK	4.0	2.80
							2SK2605	TSB	TO-220F	5.0	2.20
							2SK2397-01MR	FUJI	TO-220F	5.0	2.30
FQP7N80C	7.0	1.90	1.57	FQA6N80	6.3	1.95	2SK2765-01	FUJI	TO-3P	7.0	2.00
FQA8N80C	8.0	1.55	1.30	FQA7N80	7.2	1.50	2SK2648-01	FUJI	TO-3P	9.0	1.50
							STP7NB80	ST	TO-220	6.5	1.50
FQA10N80C	10.0	1.10	0.91	FQA8N80	8.4	1.20	2SK2607	TSB	TO-3P	9.0	1.20
				FQA10N80	9.8	1.05	FS10SM-16A	MIT	TO-3P	10.0	0.98
FQP4N90C	4.0	4.20	3.50	FQP3N90	3.6	4.25	2SK2608	TSB	TO-220	3.0	4.30
							2SK1983-01	FUJI	TO-220	3.0	4.00
FQP6N90C	6.0	2.30	1.92	FQP5N90	5.4	2.30	STP5NC90Z	ST	TO-220	4.6	2.50
				FQA6N90	6.4	1.90	2SK2850-01	FUJI	TO-220	6.0	2.50
FQA8N90C	7.0	1.90	1.60	FQA7N90M	7.0	1.80	2SK2749	TSB	TO-3P	7.0	2.00
				FQA7N90	7.4	1.55	2SK2654-01	FUJI	TO-3P	8.0	2.00
FQA9N90C	9.0	1.40	1.12	FQA9N90	8.6	1.30	STW8NB90	ST	TO-247	8.0	1.45
							2SK2611	TSB	TO-3P	9.0	1.40
FQA11N90C	11.0	1.10	0.91	SSH10N90A	10.0	1.20	2SK2968	TSB	TO-3P	10.0	1.25
							FS10SM-18A	MIT	TO-3P	10.0	1.20
							STW9NB90	ST	TO-247	9.7	1.00

Product Schedule

(C-series in Advanced QFET)

Year	2002		2003			
Function	4Q	1Q	2Q	3Q	4Q	
200V 250V	FQP630C*, FQA60N25CPWD		FQU210C, FQP620C, FQP650C FQD214C, FQD224C, FQA254C			
Logic		FQP640C, FQP634C, FQP644C,	FQD220LC, FQP640LC, FQA250LC			
400V 500V	FQP730C, FQP830C,		FQU320C, FQP820C			
	FQPF13N50C	FQP740C, FQP840C, FQD6N50C		FQA350C, FQA450C, FQA24N50C, FQA40N50C		
600V 700V		FQN1N60C, FQPF4N60C, FQPF6N60C, FQPF8N60C				
		FQPF12N60C				
800V 900V	FQA11N90C	FQP3N80C, FQP6N80C, FQP4N90C				
	FQA8N90C, FQA9N90C					
		FQP7N80C, FQP8N80C, FQA10N80C, FQP6N90C				

* Currently, red products are developing and blue products are complete to develop

* The package is shown only major package

Analog Discrete Interface & Logic Optoelectronics



Product Schedule

(V2-series in Advanced QFET & SuperFET)

Year Function	2002	2003			
	4Q	1Q	2Q	3Q	4Q
100V 150V 200V	FQD18N20V2	FQP90N10V2, FQP40N15V2, FQP32N12V2 FQP62N10V2			
400V 500V	FQP18N50V2				
600V (SuperFET)		FCP11N60 FCP20N60 FCP7N60 using SuperFET II			

* Currently, red products are developing and blue products are complete to develop

* The package is shown only major package

Analog Discrete Interface & Logic Optoelectronics



EOL Schedule

	2000	2001	2002	2003	2004	line-up	Target Application
Old FET						-200V ~ 900V (N/P-ch)	General perpose monitor, ballast, charger, smps, etc
A-FET (800~900V)						800V ~ 900V (N-ch)	General perpose pc smps, ballast power supply, etc
A-FET (200~600V)						200V ~ 600V (N-ch)	General perpose monitor, ballast, charger, smps, etc
A-FET (others)						-400V ~-60V 100V (N/P-ch)	General perpose monitor, ballast, power supply, etc
B-FET						200V ~ 500V (N-ch)	General perpose monitor, ballast, charger, smps, etc
Adv. QFET (C-series)						-500~-60V 200V~1kV (N/P-ch)	General perpose great demand market
QFET						-500V ~ 1000V (N/P-ch)	High performance PDP, power supply, UPS, DC/DC, etc
Adv. QFET (V2-series)						60V ~ 500V (N-ch.)	High performance PDP, power supply, UPS, DC/DC, etc
SuperFET						600V ~ (N-ch.)	High performance power supply, ballast , UPS

* Can be excluded some of 8/900V products

Analog Discrete Interface & Logic Optoelectronics

Ordering System (1)

IR F S 6 1 0 C

Device Type (1)

Package Type (2)

Voltage Rating (3)

Relative Die Size (4)

Voltage Designation (5)

Generation Suffix (6)

1. Device Type

F : Standard
L : Logic

2. Package Type

M : SOT-223
R : D-PAK
W : D²-PAK
U : I-PAK
I : I²-PAK
Empty : TO-220
S : TO-220F & TO-3PF
P : TO-3P

3. Voltage Rating

2 & 6 : 200V
3 & 7 : 400V
4 & 8 : 500V

4. Relative Die Size

1 : 36W
2 : 54W
3 : 100W
4 : 180W
5 : 205W
6 : 278W

5. Voltage Designation

0 : 200V, 400V, 500V
4 : 250V

6. Generation Suffix

C : C-FET
B : B-FET

Order

F	Q	P	11	N	90	C
						Series
						Optional
						Voltage Rating
						Channel Polarity
						Current Rating (Primary)
						Package Type (1)
						Base Technology

(1) Package Type

T : S0T-223 D : D-PAK
B : D²-PAK U : I-PAK
I : I²-PAK P : TO-220
PF : TO-220F A : TO-3P
AF : TO-3PF L : TO-264

(2) Channel Polarity

N : N-Channel
P : P-Channel

(3) Optional Suffix

Empty : Standard Product
L : Logic Level Product
F : Fast recovery MOSFET

(4) Series

C : C-FET
Empty : previous version of QFET
V2 : version 2 of QFET



Performance Benchmarking and Evaluation

FQPF13N50C in 200W DCM PFC

FQP18N50V2 in 250W CCM PFC

FQPF12N60C in 60W Notebook-PC Adaptor

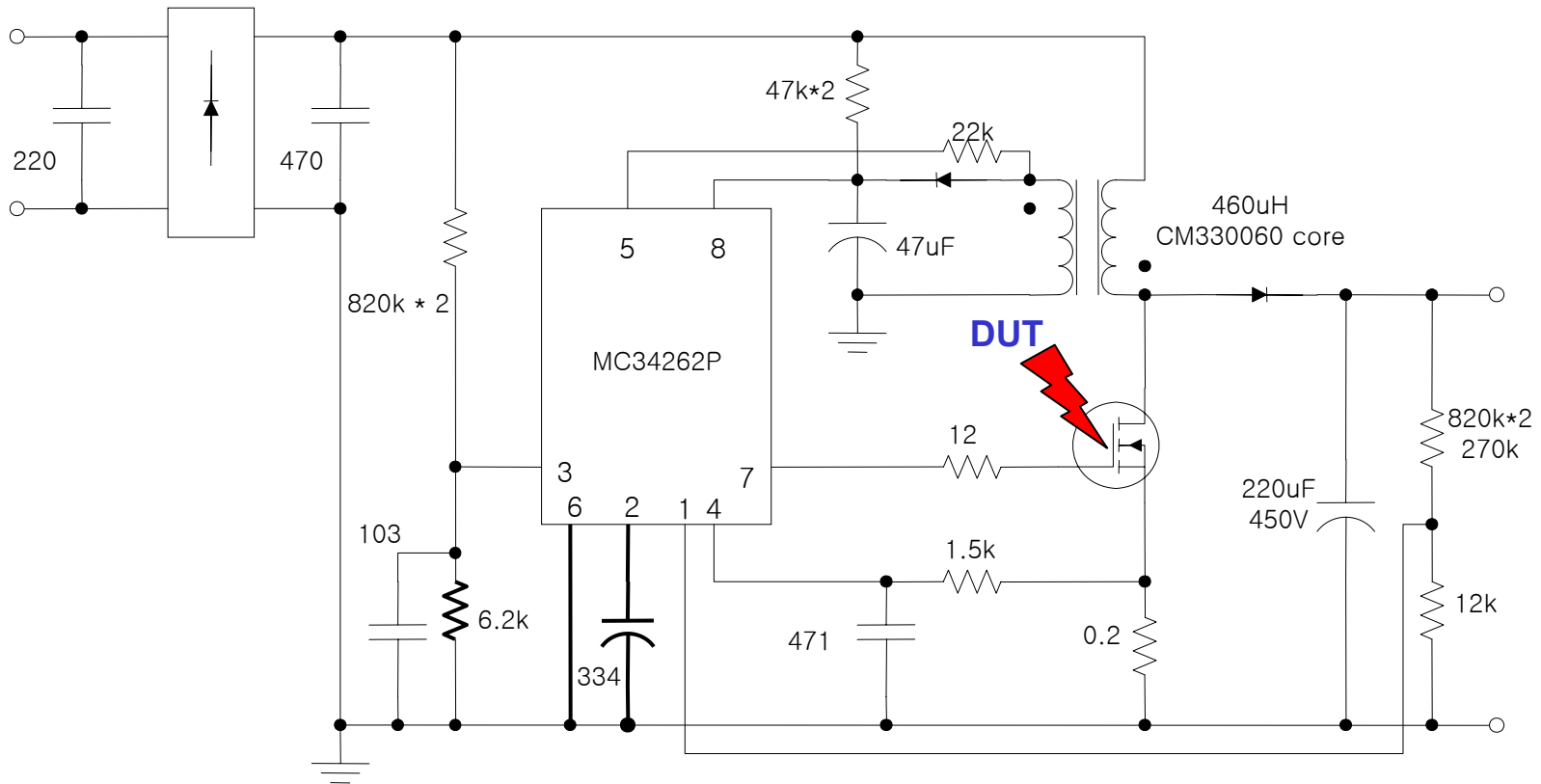
FQA8N90C and **FQA11N90C** in 300W Desktop-PC Power Supply

FQA9N90C in 270W Desktop-PC Power Supply

FQD18N20V2 in 20W DC/DC Converter

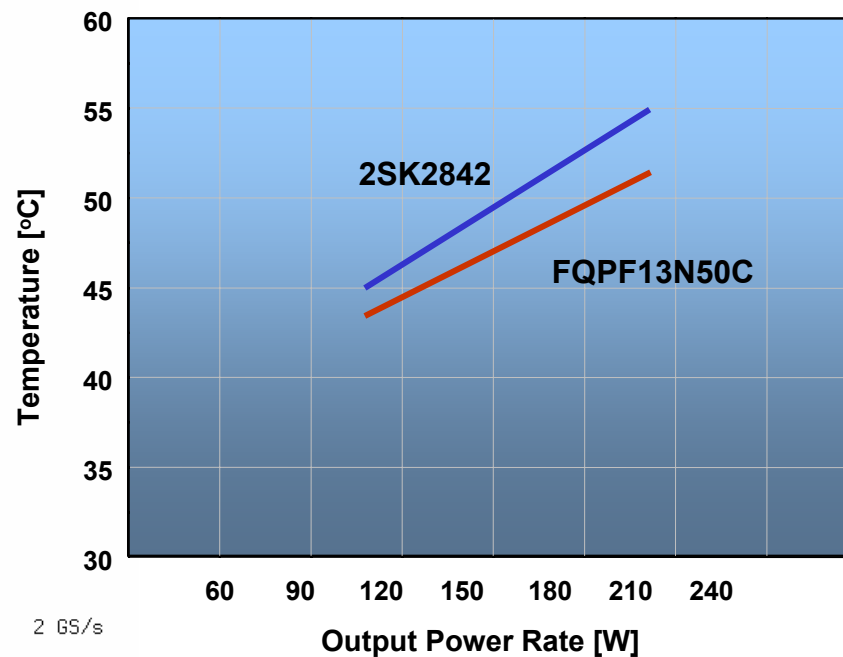
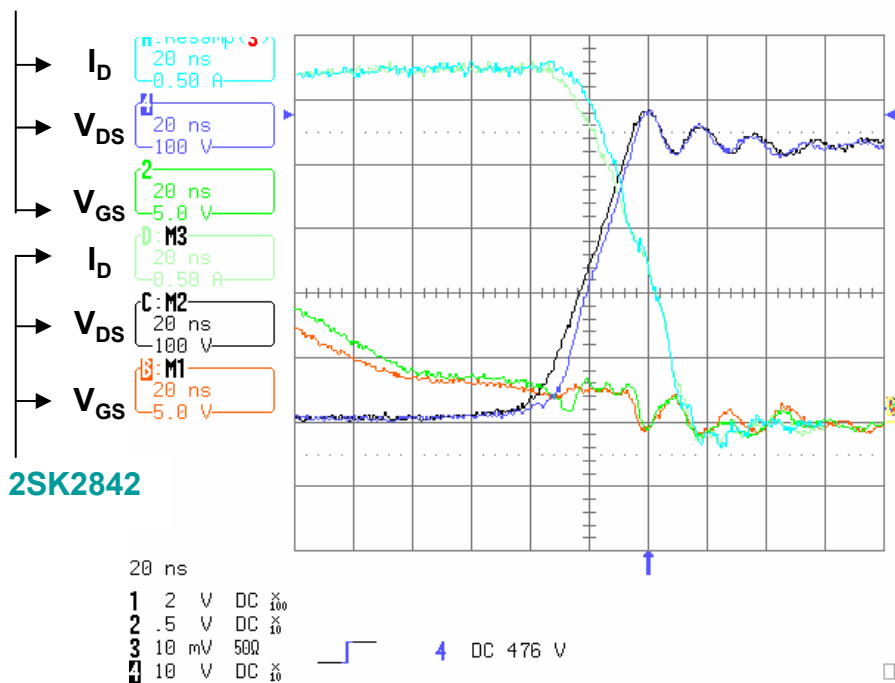
200W Power Factor Correction (DCM)

- **FQPF13N50C** is applied in 200W discontinuous PFC block
(conditions : input 220V/60Hz AC and gate resistor 0Ω)
- DUT : **FQPF13N50C** of FSC, **2SK2842** of Toshiba



Test Results in 200W PFC

FQPF13N50C



Part#	BV	I_D	$R_{DS(on)}^*$	$Q_{g,type}$	$Q_{gd,type}$
FQPF13N50C	500V	13A	0.41 / 0.48 Ω	43 nC	18 nC
2SK2842	500V	12A	0.4 / 0.52 Ω	45 nC	20 nC

* means typ. / max. values

Analog

Discrete

Interface & Logic

Optoelectronics

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FAIRCHILD
SEMICONDUCTOR

250W PFC Application (CCM)

- Products

FQP18N50V2 **18A/500V/240mΩ(typ)**

SPW20N60S5 20A/600V/?mΩ(typ)

IRFB18N50K 17A/500V/260mΩ(typ)

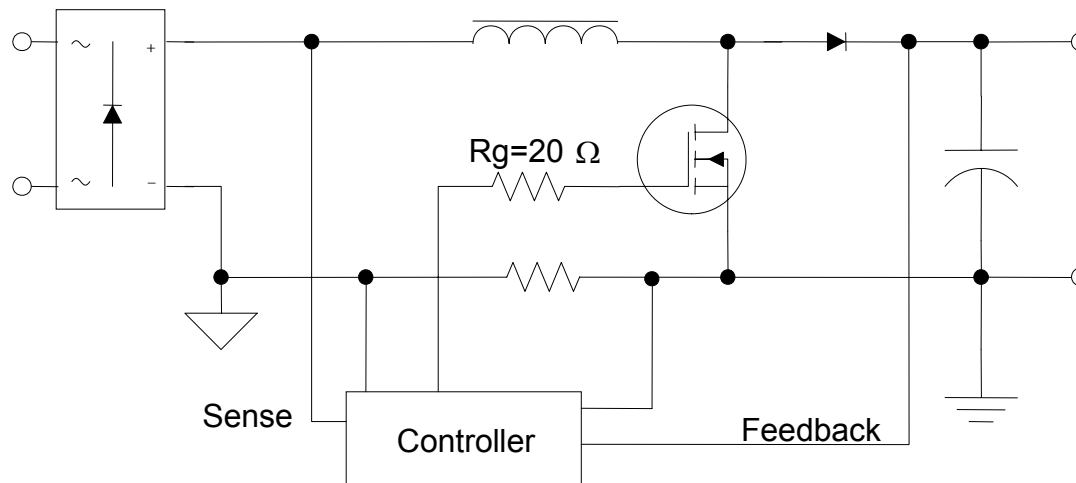
V2-series of QFET

CoolMOS of Infineon

Benchmark Series of IR

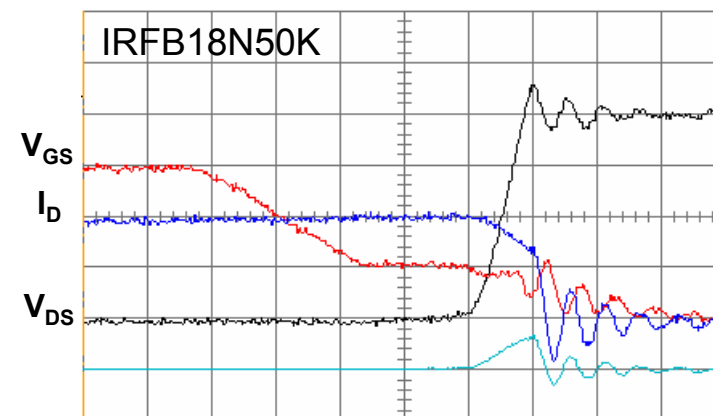
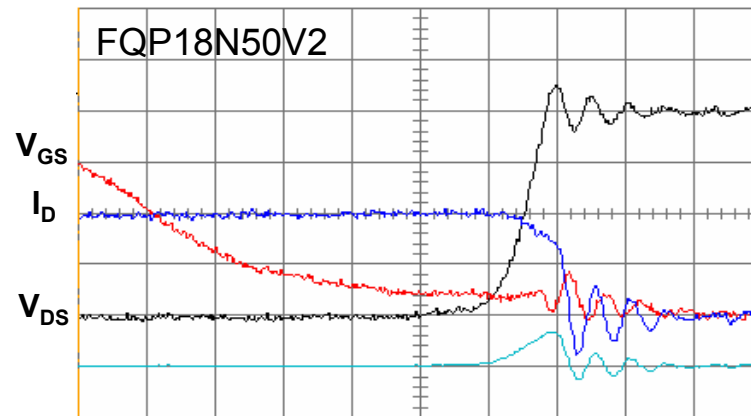
- Conditions

Evaluated as Boost switch of 250W Continuous-mode PFC



Input : 220VAC, 60Hz
DC Output Voltage : 400V
Output Power : 240W
Operating Frequency : 100kHz
Power Factor : 0.997
Boost FRD : ISL9R860P2

Test Results in 250W PFC (CCM)



(V_{DS} :100V/div, I_D :1A/div, V_{GS} :5V/div, Loss:1kW/div, Time:50ns/div)

FQP18N50V2

61°C*

IRFB18N50K

62°C

SPW20N60S5

59°C

* T_{CASE} in closed area during operating

Analog Discrete Interface & Logic Optoelectronics

60W Notebook-PC Adaptor

- maker : Lite-on Technology
- End-set : Notebook-PC Adapter
- Model : PA-1600-XXXX (Rev. F)
output 60W, operation
frequency 67kHz
- DUT in Fly-back Topology
FQPF12N60C of FSC
2SK2843 of Toshiba

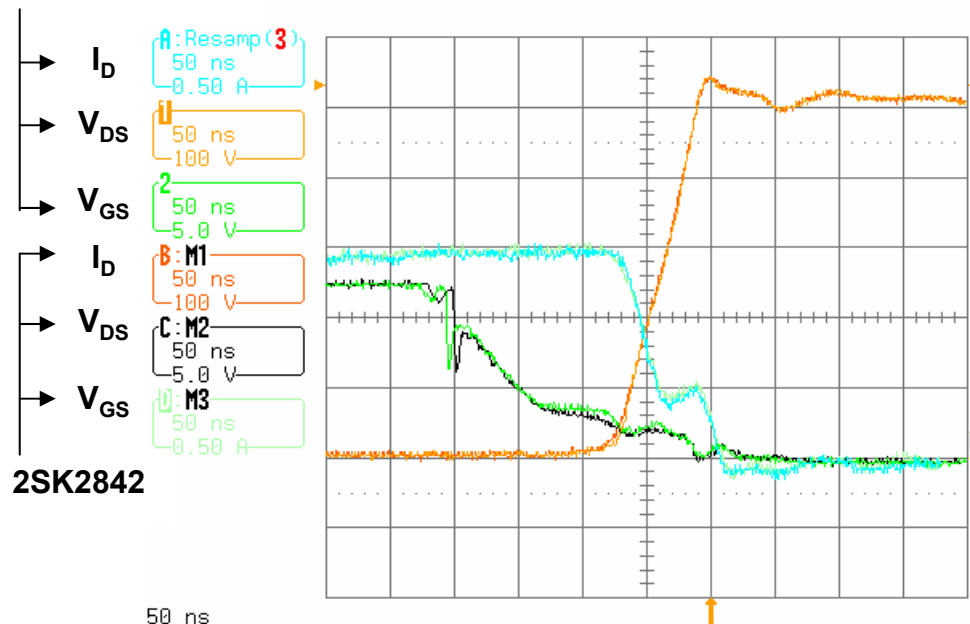


Part#	BV	I _D	R _{DS(on)} *	Q _{g,typ}	Q _{gd,typ}
FQPF12N60C	600V	12A	0.60 / 0.7 Ω	48 nC	21 nC
2SK2843	600V	10A	0.65 / 0.8 Ω	54 nC	21 nC

* means typ. / max. values

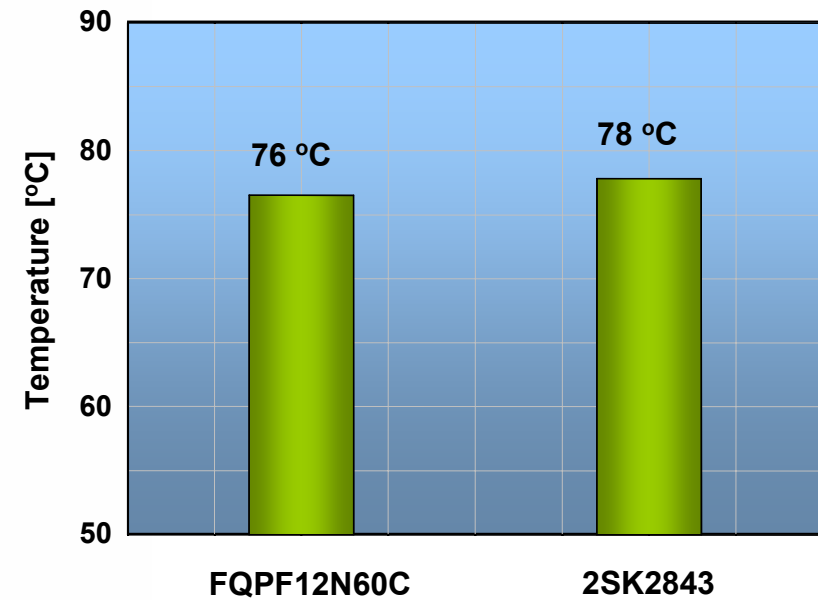
Test Results in 60W Adaptor

FQPF12N60C



2SK2842

50 ns
 1 1 V DC 100
 2 .5 V DC 10
 3 10 mV 500
 4 10 V DC 10



2 GS/s

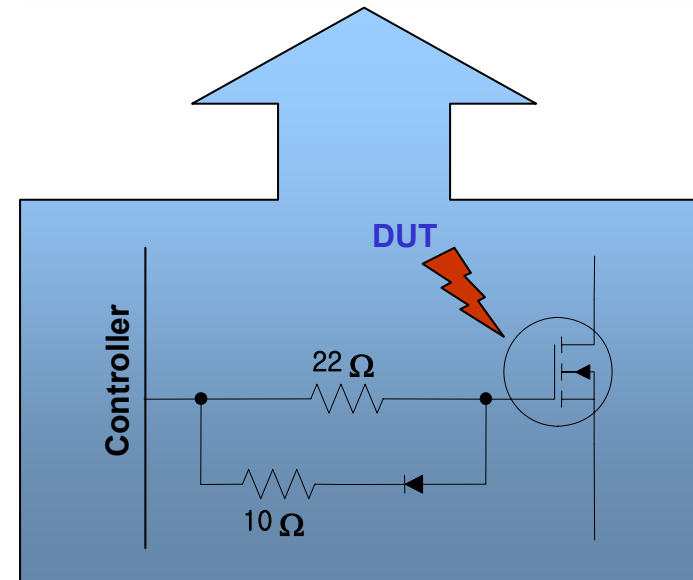
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300W Desktop-PC Power Supply

- maker : Delta Electronics
- End-set : Desktop PC
- Model : DPS-300KB-1
output 300W, operation
frequency 100kHz

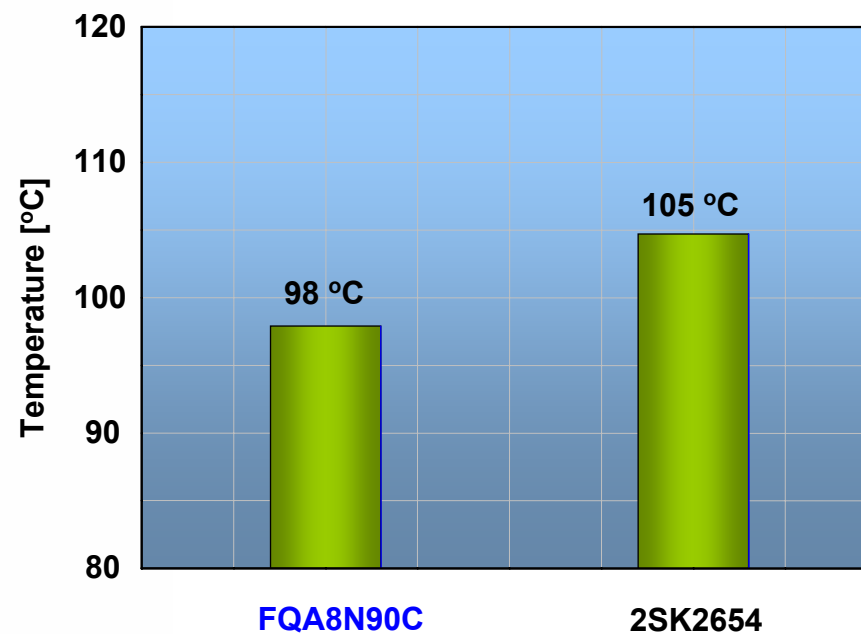
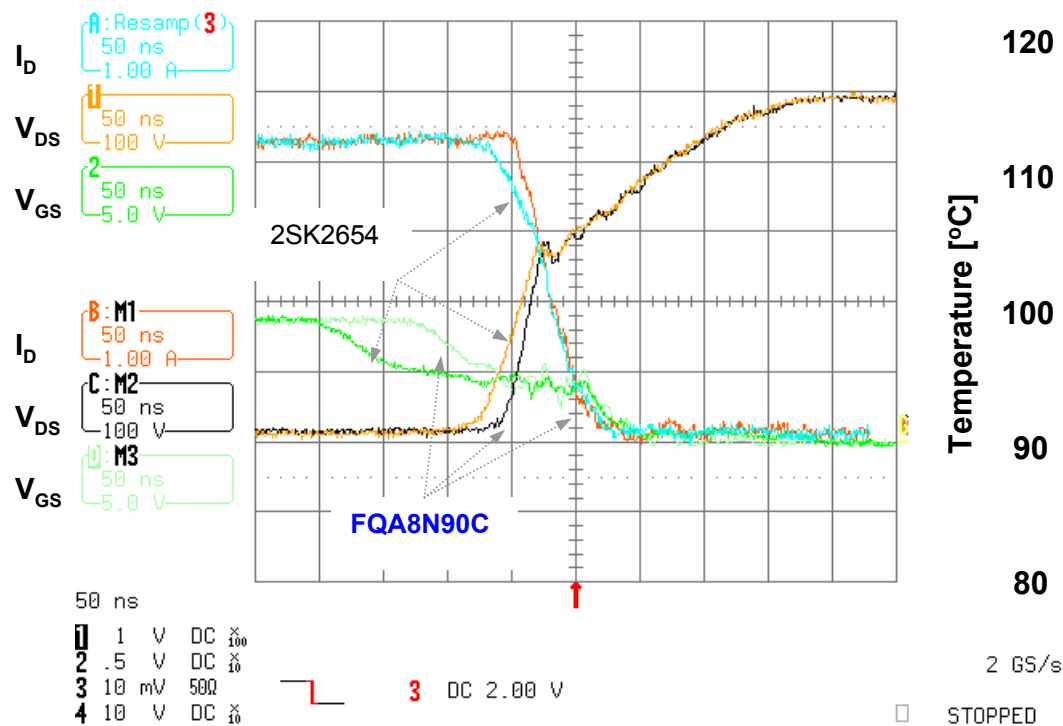


- DUT in Single-Switching
Forward Topology
 - Output load 250W
FQA8N90C of FSC (900V/8A, 1.9Ω)
2SK2654 of Fuji (900V/8A, 2.0Ω)
 - Output load 300W
FQA11N90C of FSC (900V/11A, 1.1Ω)
STW9NB90 of STM (900V/9.7A, 1.0Ω)



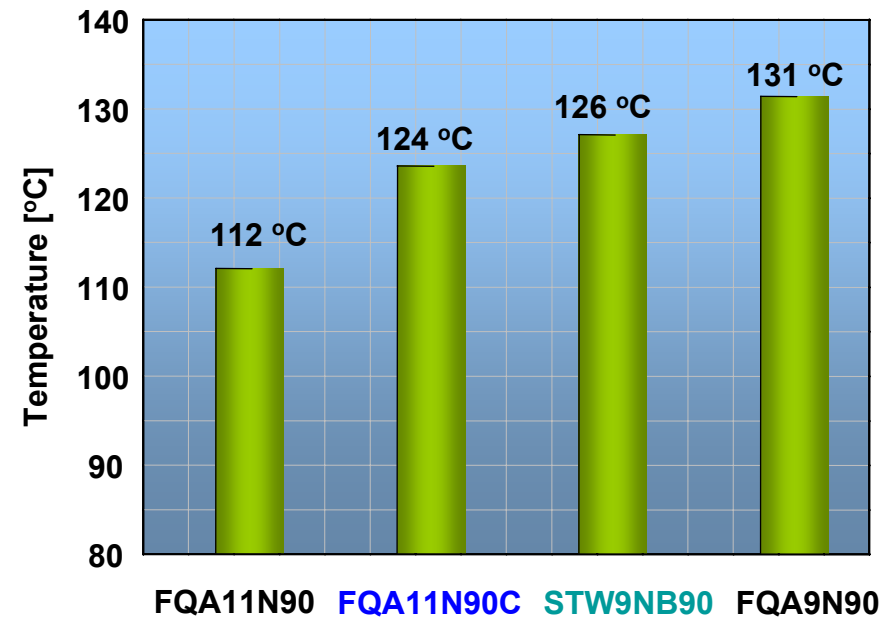
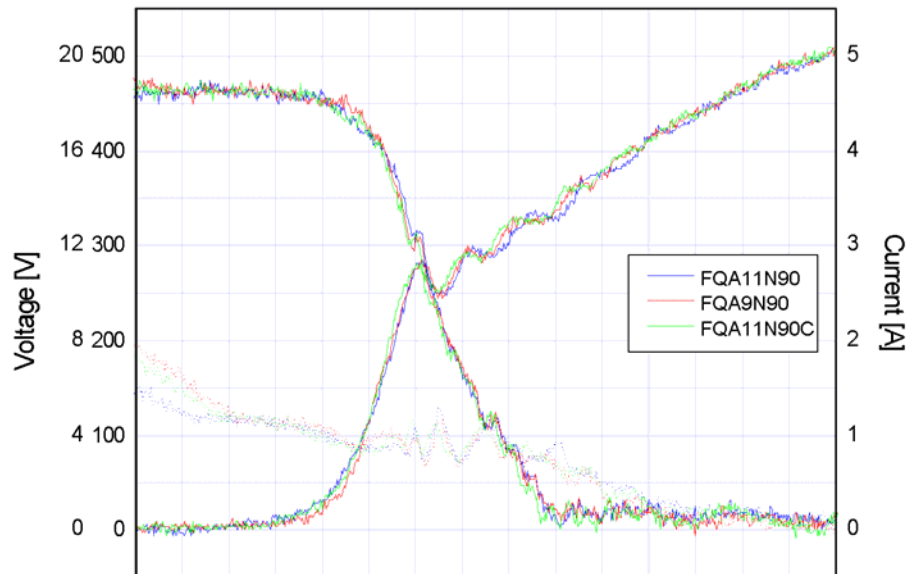
Test Results in 300W Power Supply (1)

- DUT in Single-Switching Forward Topology
 - Output load 250W
 - FQA8N90C** of FSC and 2SK2654 of Fuji



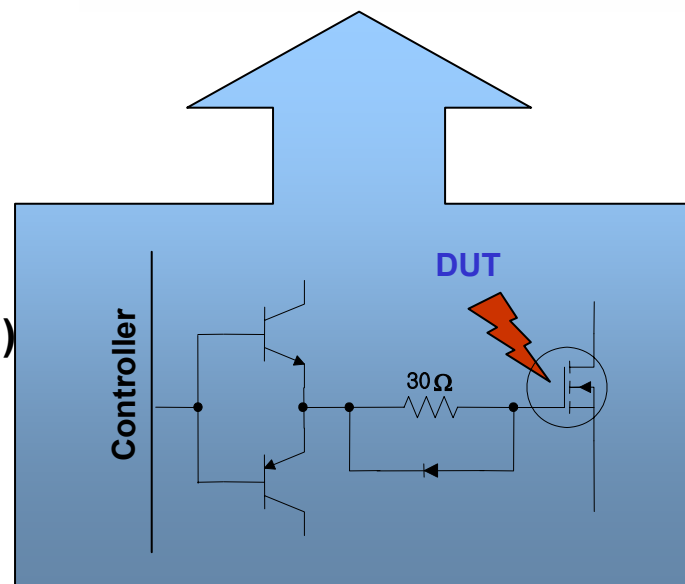
Test Results in 300W Power Supply (2)

- DUT in Single-Switching Forward Topology
 - Output load 300W
 - ; **FQA11N90C** of FSC and **STW9NB90** of STM



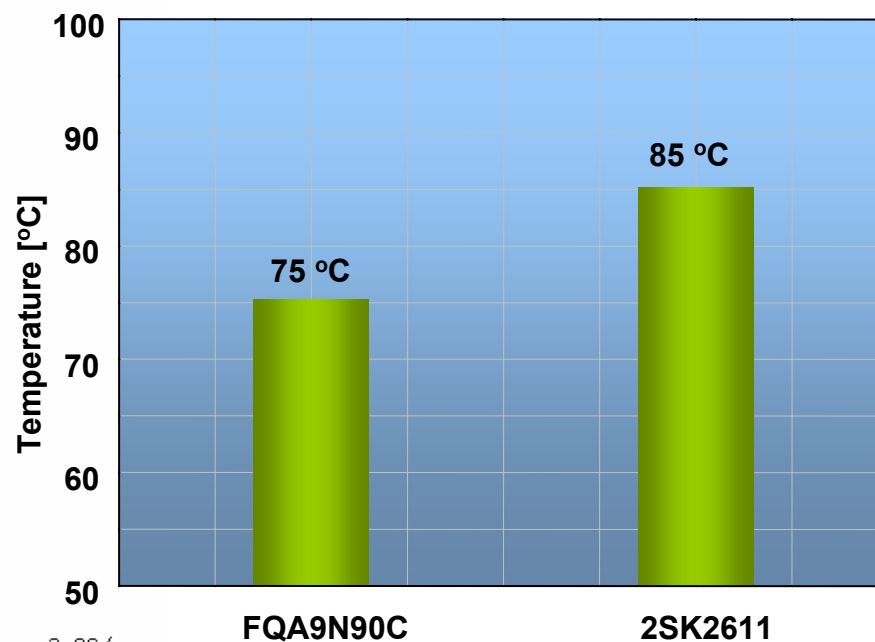
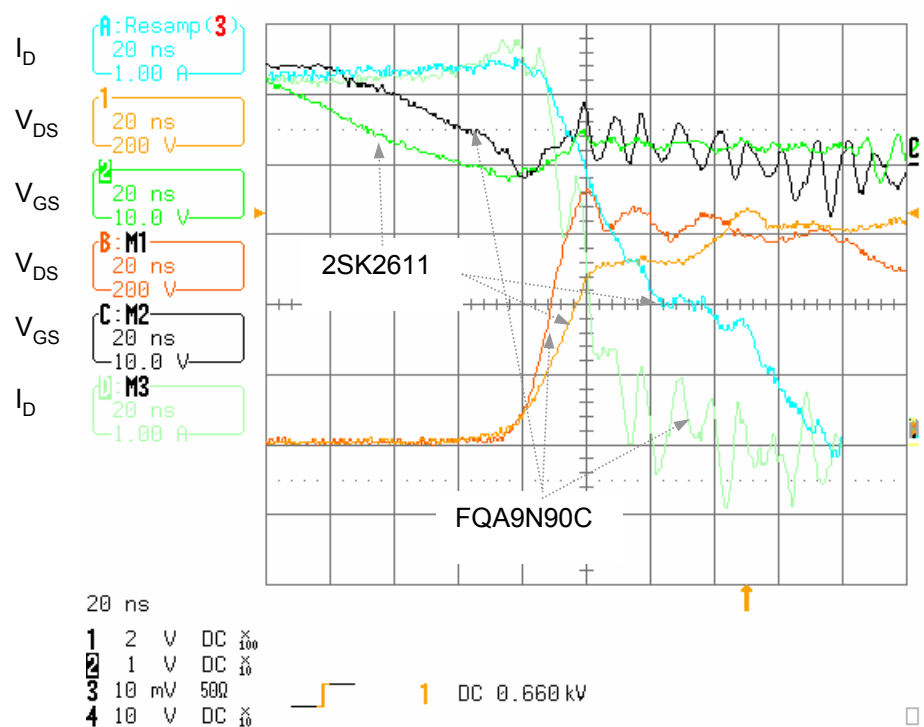
270W Desktop-PC Power Supply

- maker : Samsung Electronics
- End-set : Desktop PC
- Model : PSD-300DHG1
output 270W, operation
frequency 64kHz
- DUT in Single-Switching
Forward Topology
 - Output load 270W
 - FQA9N90C** of FSC (900V/9A, 1.4Ω)
 - 2SK2611 of Toshiba (900V/9A, 1.4Ω)



Test Results in 270W Power Supply

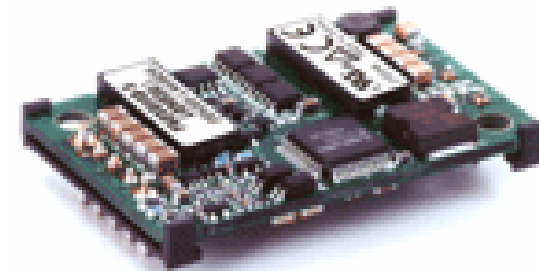
- DUT in Single-Switching Forward Topology
 - Output load 270W
 - ; **FQA9N90C** of FSC and 2SK2611 of Toshiba



20W DC/DC Converter

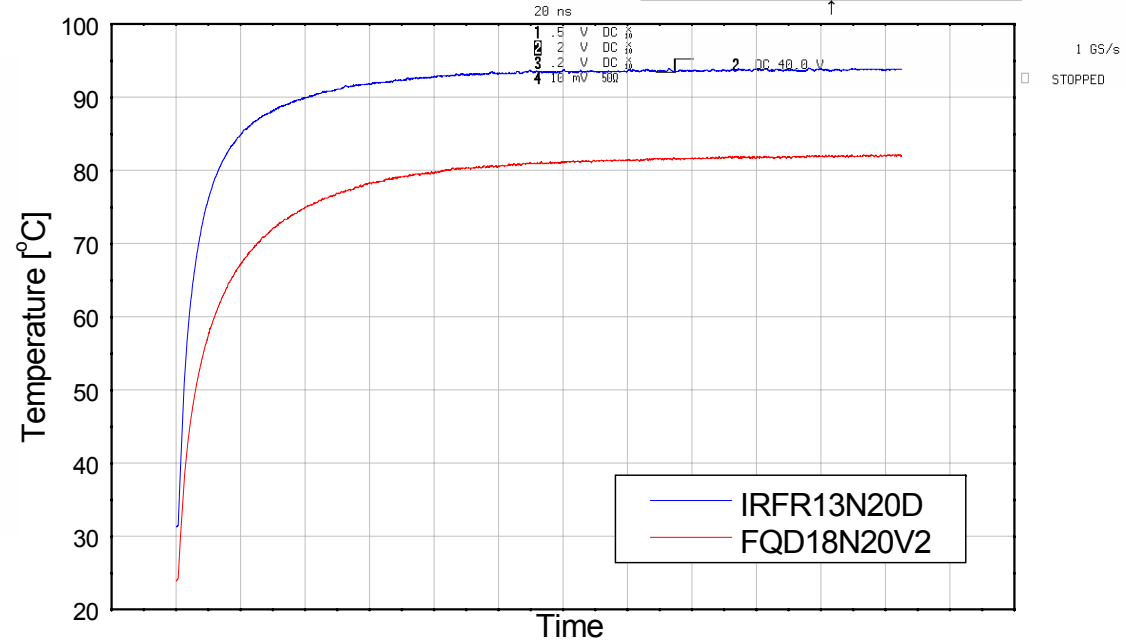
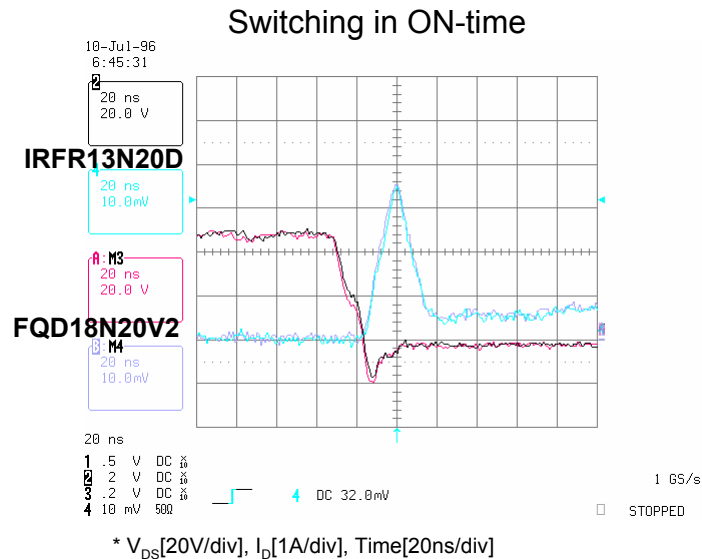
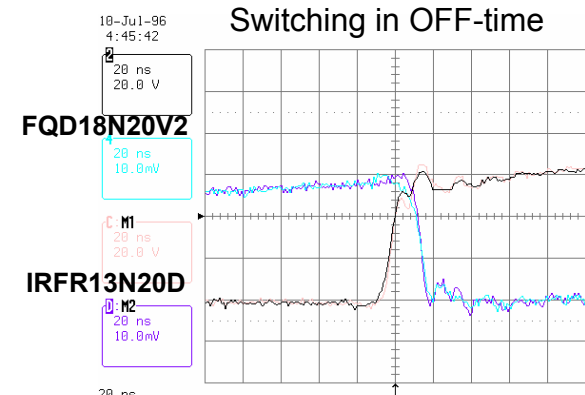
- **Topology**
 - single-ended forward topology
 - synchronous rectification in secondary side
- **Conditions**
 - Input voltage : 48 VDC
 - Output voltage : 3.3 VDC
 - Output voltage : 20W
 - Operating frequency : 330kHz
- **Products**

FSC	FQD18N20V2	QFETII
IR	IRFR13N20D	SMPS MOSFET



Test Results in 20W DC/DC

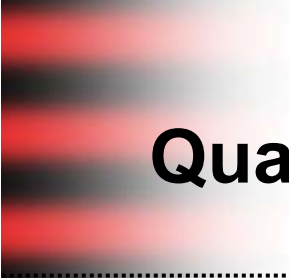
Part #	BV [V]	$R_{DS(on)}$ [ohm]	$Q_{g,typ}$ [nC]	$Q_{gd,typ}$ [nC]
FQD18N20V2	200V	0.147	19	5
IRFR13N20D	200V	0.235	25	12



* T_{CASE} in closed area during operating

Analog Discrete Interface & Logic Optoelectronics

FAIRCHILD
SEMICONDUCTOR



Quality and Reliability

Reliability Test Condition

100% Eas Screen Test in Production Line Test

Reliability Test Condition and Result

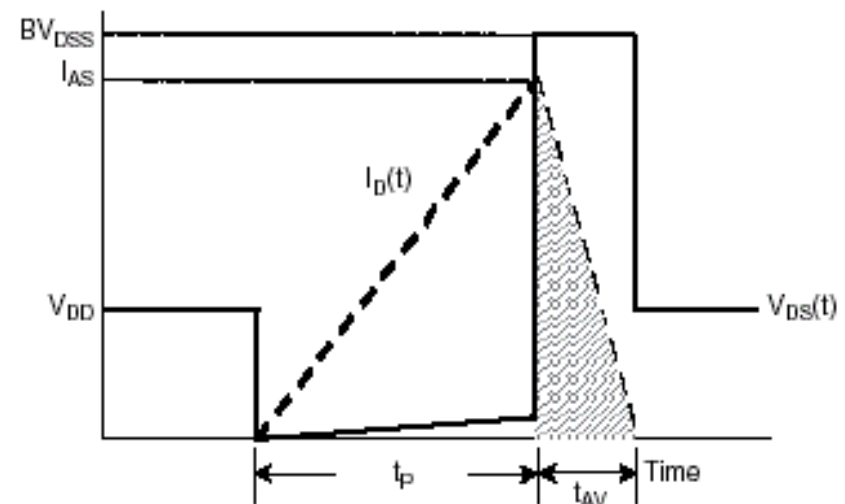
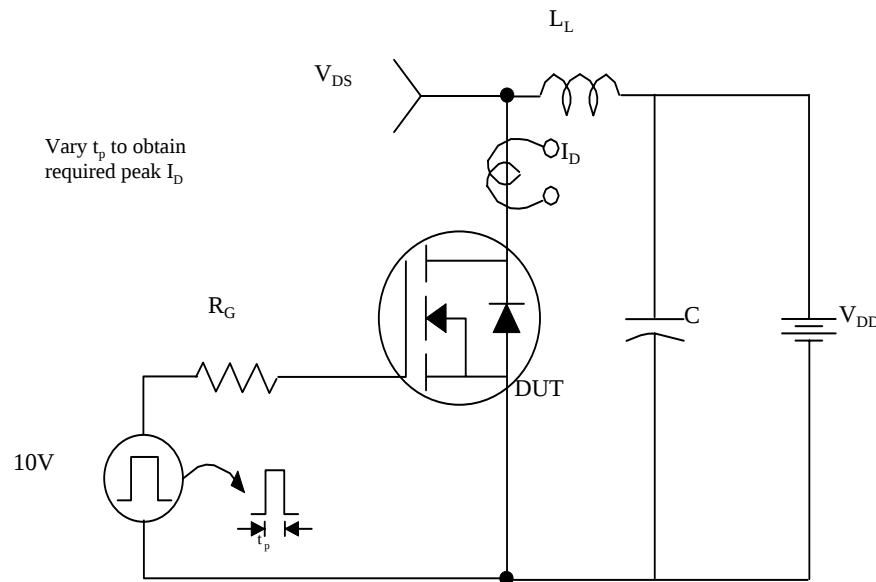
Test Item	Test Item	Criteria	S/S	Test Duration & Limit	Referenced standard
HTRB	Ta=Tj(max), Vdd=0.8*BV	C=0	77 ea	168/500/1000HRS	JESD22-A108
HTOL	Ta=Tj(max), Vopr(max)	C=0	77 ea	168/500/1000HRS	JESD22-A108
HTGB	Ta=Tj(max), Vdd=VGS(max)	C=0	77 ea	168/500/1000HRS	JESD22-A108
THBT	85 °C/85%RH, Vdd=0.8*BV (max 100V)	C=0	77 ea	168/500/1000HRS	JESD22-A101
HTSL	Ta=Tstorage(max)	C=0	77 ea	168/500/1000HRS	JESD22-A103
WHTS	85 °C/85%RH	C=0	77 ea	168/500/1000HRS	JESD22-A103
ACLV	121 °C/100%RH, 15PSIG	C=0	77 ea	48/96HRS	JESD22-A102
TMCL	-65 °C ~ 150 °C(AIR to AIR)	C=0	77 ea	200/500Cycles	JESD22-A104
TS	-65 °C ~ 150 °C(Liquid to Liquid)	C=0	77 ea	200/500Cycles	JESD22-A104

- Minimum test duration and sample size are determined with the Qualification Class and the reliability test purpose.

Eas

➤ Single pulsed avalanche energy(E_{AS})

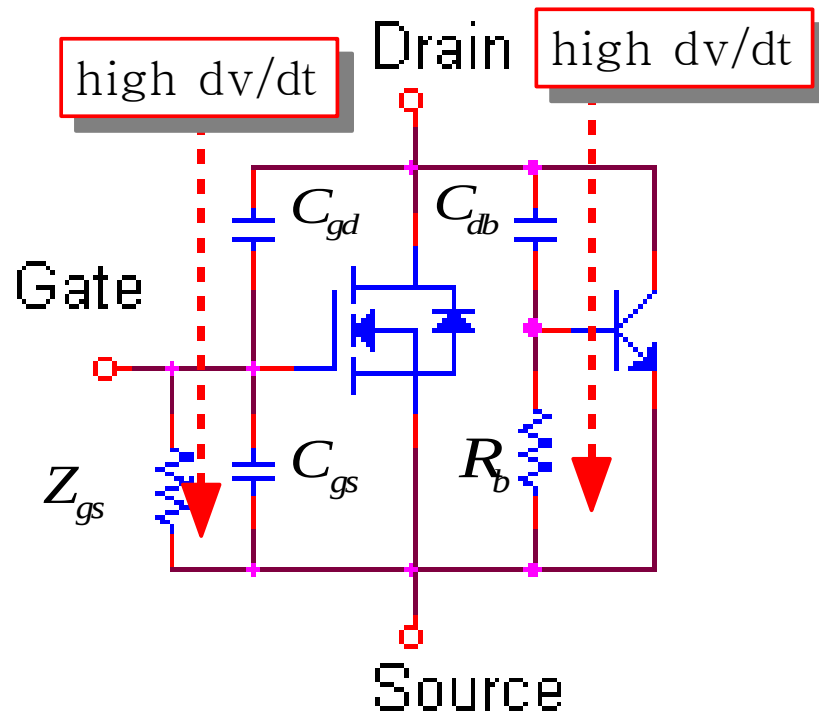
✓ Energy level to endure without fail



$$E_{AS} = \frac{1}{2} L_L I_{AS}^2 \frac{BV_{DSS}}{BV_{DSS} - V_{DD}}$$

Static dv/dt

➤ dv/dt ratings



✓ False turn on

- Possible to control externally

$$V_{GS} = Z_{gs} C_{gd} \left[\frac{dv}{dt} \right]$$

✓ Parasitic transistor turn-on

- Dependent on device design

$$V_{be} = R_b C_{db} \left[\frac{dv}{dt} \right]$$

Power Supply Block Diagram

