

Renesas Power MOS FETs, IGBTs, Triacs, and Thyristors Products

April, 2004
Standard Product Business Group
Discrete and Standard IC Business Unit
Renesas Technology Corp.

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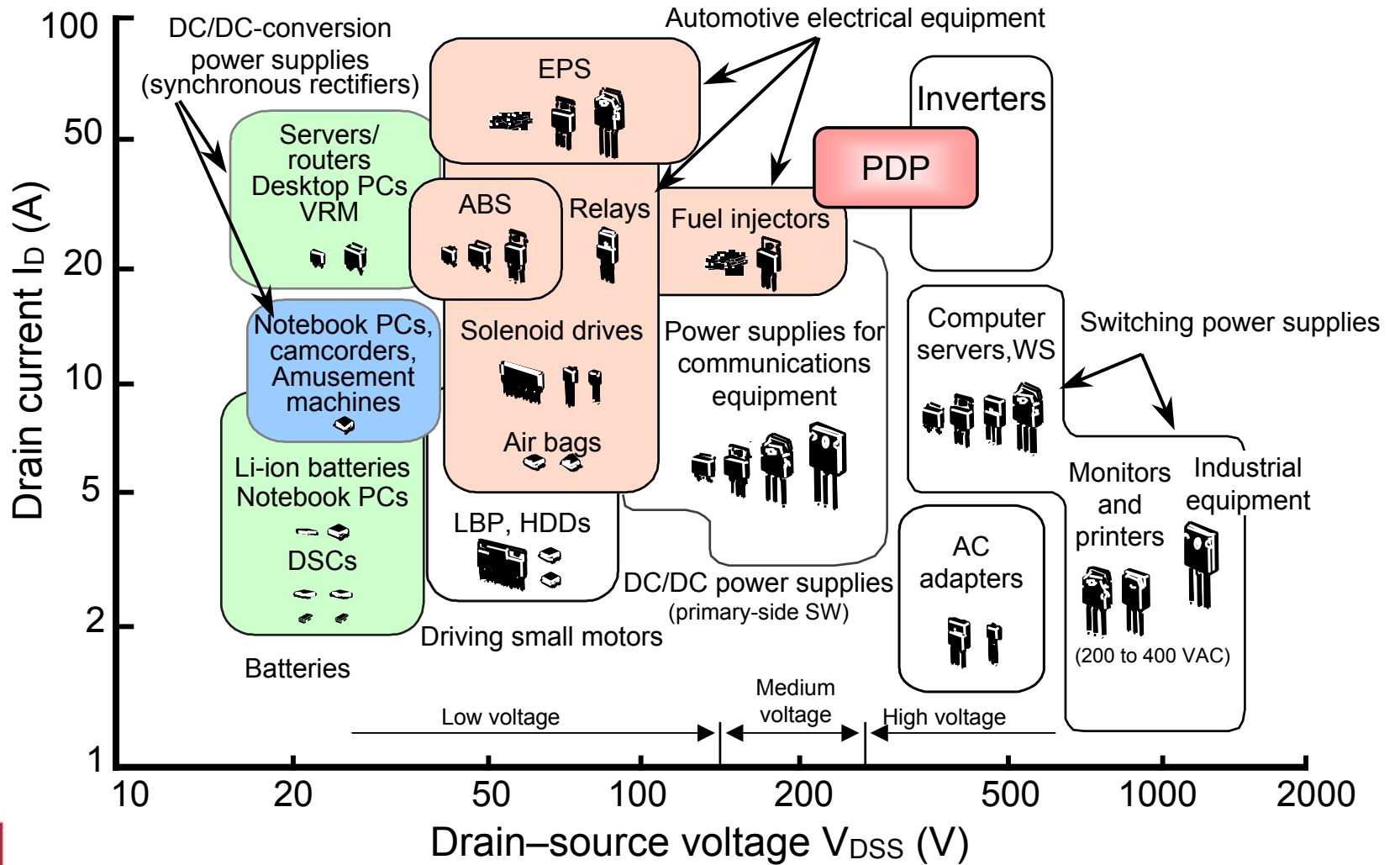
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Power MOS FETs

- Applications, technical trends
- Low-voltage power MOS FETs
- Medium- and high-voltage power MOS FETs
- Power MOS FETs for automotive applications

Power MOS FET Application Map



Power MOS FET Trend by Applications

Field	Applications	Device trend	How the power MOS FET suits the task	
AV	PDP	<ul style="list-style-type: none"> • Low power consumption, high brightness • Sustained trend for compact modules, bridge method (HIC) 	<ul style="list-style-type: none"> • Medium, high voltage of 200 to 600 V: Low input capacitance, development of 6th gen. high voltage series • Wafer supply 	
Switching power supplies	Network-related devices, AC/DC power supplies	<ul style="list-style-type: none"> • Harmonic regulation supported Power-factor correction (PFC) circuit included • Soft-switching method (ZVS) • Secondary synchronous rectification 	<ul style="list-style-type: none"> • Medium-, high voltage of 250 to 600 V: Low input capacitance, development of 6th gen. high voltage series Avalanche tolerance guaranteed, built-in high-speed diode (UPS) • Ultra-low on-resistance, low Qg, low Qgd, development of 8th gen. high voltage series • Low voltage of 30 V to 100 V 	
	Servers, routers, telecomm., communications devices, DC/DC power supplies	Isolated type	<ul style="list-style-type: none"> • 2-device/4-device bridge method • Active ramp method • Secondary synchronous rectification 	<ul style="list-style-type: none"> • Low, medium voltage of 100 to 200 V, driven by 4.5 to 10 V • Low Ron, low Qgd, development of 8th gen. low-voltage series • Ultra-low on-resistance, low Qg, low Qgd, development of 8th gen. low voltage of 30 to 100 V series
	Distributed power-supply systems	Non-isolated type	<ul style="list-style-type: none"> • Synchronous rectification converter • Multi-phase adopted • Small and thin • POL (point of load) 	<ul style="list-style-type: none"> • Low voltage of 12 to 30 V, driven by 2.5 to 10 V • Ultra-low on-resistance, low Qg, development of 8th gen. low-voltage series • Composite and integration (built-in SBD and drive circuit) MOS FET development (SOP-8, HSOP-11, WPAK (under development) support) • Small, thin, low-resistance, low-inductance PKG (LFPAK, WPAK wireless (under development))
Batteries	Mobile phones, Notebook PCs, DSCs	<ul style="list-style-type: none"> • Li-ion battery used • Highly functional → • Quick response → • Small and thin <div style="border: 1px solid black; padding: 2px; display: inline-block;">Increased current capacity</div>	<ul style="list-style-type: none"> • P-ch 8th gen. Ultra-low Ron, two devices in one chip (WPAK) • Low-voltage drive: 1.8 V to 2.5 V ultra-small and thin PKG (CMFPAK-6) • Wafer supply 	
Motor control	Small motors (PPCs, printers, HDDs), inverters, high-functional robots	<ul style="list-style-type: none"> • Small, low power consumption • High precision, quick response • Low noise • Directly driven by microcomputer 	<ul style="list-style-type: none"> • Power MOS FET arrays (six devices) • Development of 5th to 6th, 7th gen. low-voltage SOP-8 (including 2-device packages) series • Built-in high-speed diode • Development of 3rd to 4th, 5th, 6th gen. high-voltage series 	

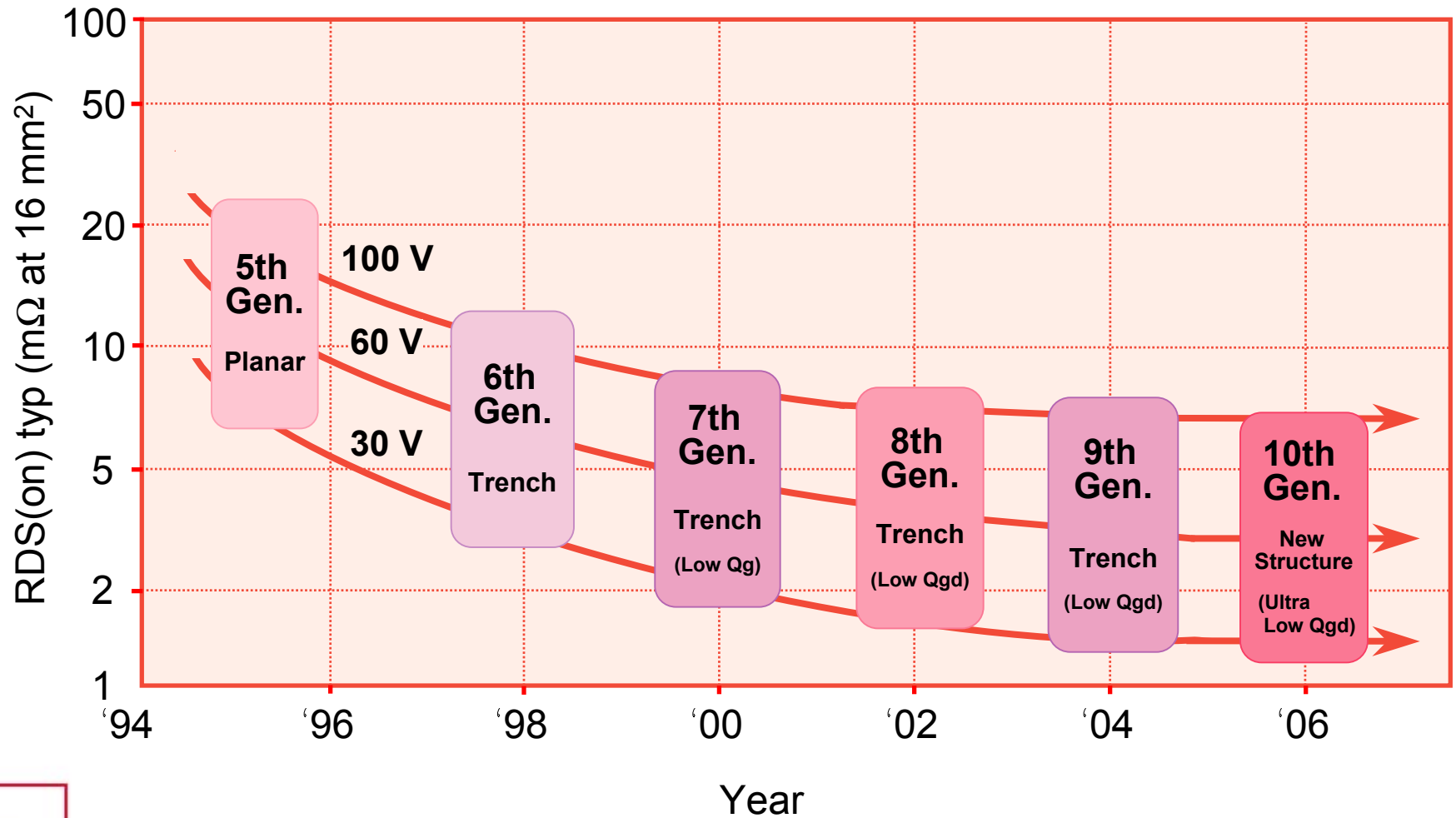
Power MOS FET Products

Category	Application	Product	Polarity	Appearance, etc.
Low voltage (20 V-100 V)	DC/DC power supplies	HAT series, FY series H7N, H8N, FS series	N-ch N-ch	SOP-8, LFPAK, WPAK, HSOP-11 LDPAK, TO-220
	Driving small motors	HAT series, FY series FS series, FX series	P-ch/N-ch P-ch/N-ch	SOP-8 MP-3A, TO-220
	Li battery protection (notebook, etc.) Portable devices	HAT series, FY series HAT series, FY series	P-ch/N-ch P-ch/N-ch	LFPAK, WPAK, SOP-8, TSSOP-8 TSSOP-8, TSOP-6, CMFPAK6
	Automotive electrical equipment	HAT, H7N, HAF series	P-ch/N-ch	LDPAK, SOP-8, thermal FET
Medium voltage (150 V-200 V)	Isolated type DC/DC power supply	HAT series, FY series H5N, FS, FX series	N-ch P-ch/N-ch	LFPAK, SOP-8, TSSOP-8 DPAK, MP-3A, LDPAK
	Automotive (direct injector)	HAT, H5N, 2SK series	N-ch	SOP-8, DPAK, TO-220FM
High voltage (250 V-600 V)	PDP AC/DC power supply	H5N series, FS series H5N series, FS series	N-ch N-ch	LDPAK, TO-3PFM, TO220, wafer LDPAK, TO-220, TO-3P/3PL
	Inverter UPS power supply	FS series H5N, FK series (FRD)	N-ch N-ch	TO-220, TO-3P TO-220, TO-3P, TO-3PL

Low-Voltage Power MOS FETs

$V_{DSS} = 12 \text{ V to } 150 \text{ V}$

R_{DS(on)} Performance Trends for Low-Voltage Power MOS FETs



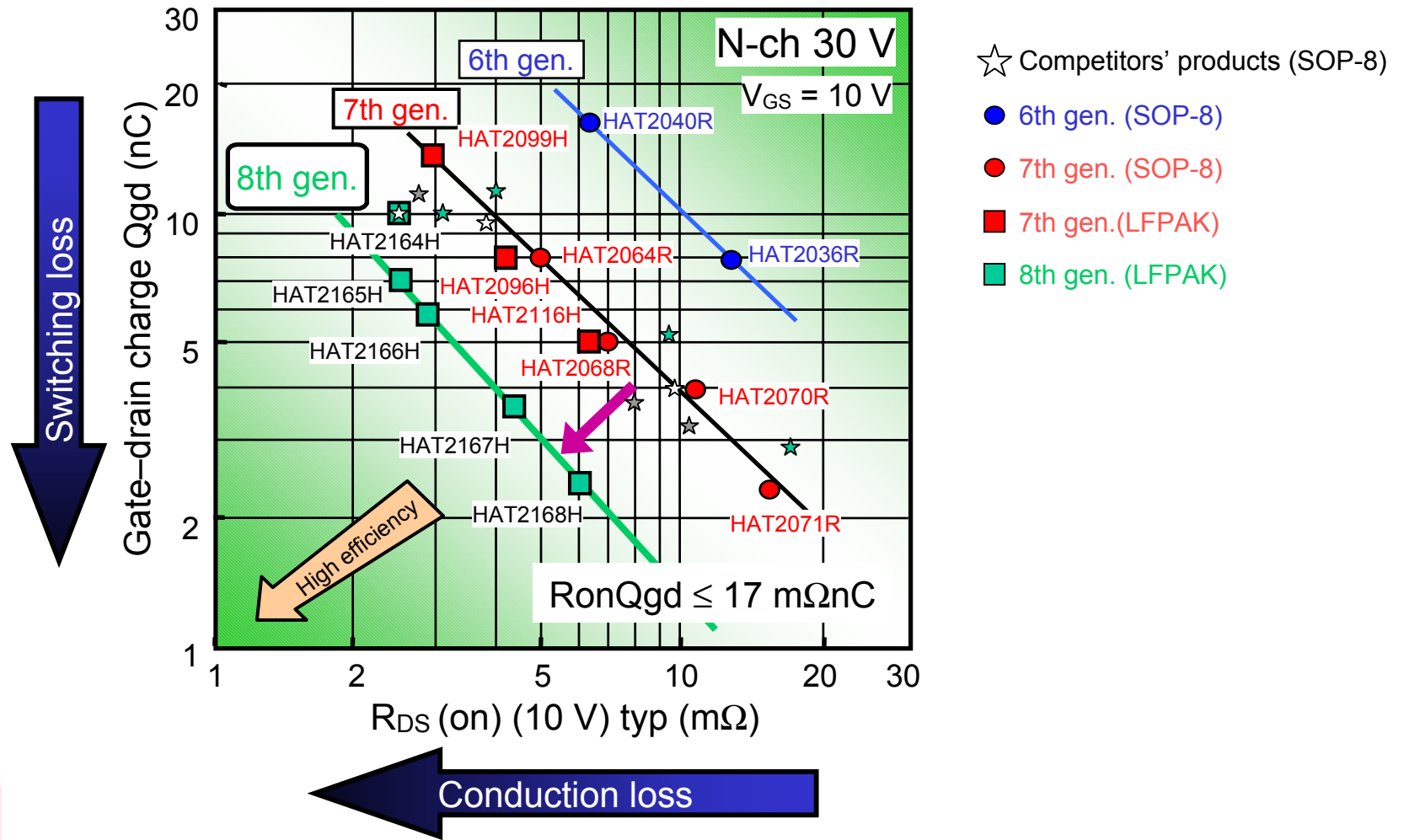
Features of Low-Voltage Power MOS FETs (8th Gen. 30 V Product)

Achieves the world's top level of performance

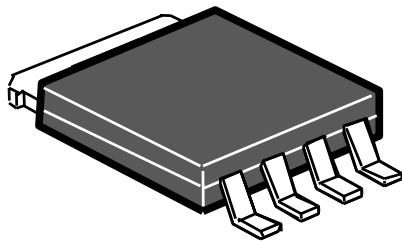
- Figure of merit: FOM ($R_{on} \cdot Q_{gd}$) at $V_{GS} = 4.5\text{ V}$
65 mΩnC → 24 mΩnC: 63% reduction

Category (product series)	Conduction loss performance $R_{DS(on)}$ at 4.5 V: typ (mΩ)					Performance and characteristics of switching loss						Drive-loss performance Q_g (nC) at $V_{GS} = 4.5\text{ V}$		
						Q_{gd} (nC)			R_g (Ω)					
	1	2	3	4	5	5	10	15	0.5	1.0	1.5	0	20	40
7th gen. (HAT2099H)	5.0					13			1.6			40		
8th gen. (HAT2165H)	3.4 (-32%)					7.1 (-45%)			0.5 (-69%)			33 (-17%)		
Competitors A	3.5					10			1.2			35		
B	3.9					11			2.0			43		

Correlation between On-Resistance and Gate - Drain Charge



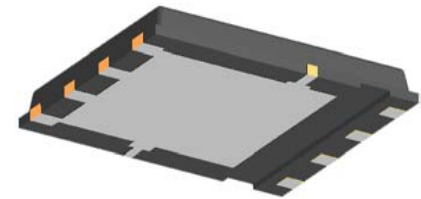
New Packages: LFPAK/WPAK



LFPAK

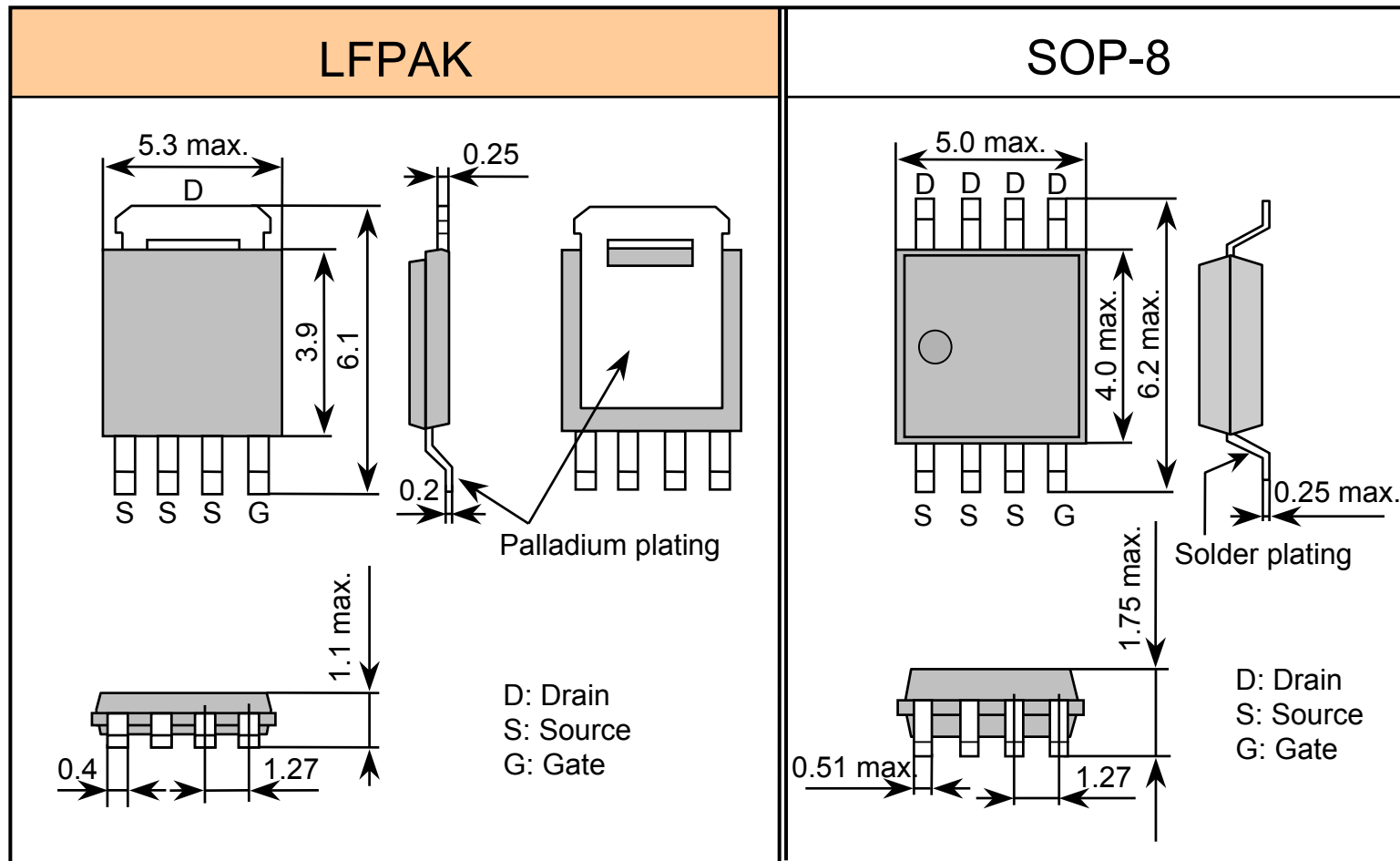
Features

- Low resistance (LFPAK)
- Low inductance (LFPAK)
- Low thermal resistance (WPAK)
- SOP-8 pin compatible
- Thin (t = 1.1 mm max./LFPAK)
(t = 0.8 mm max./WPAK)
- Lead-free

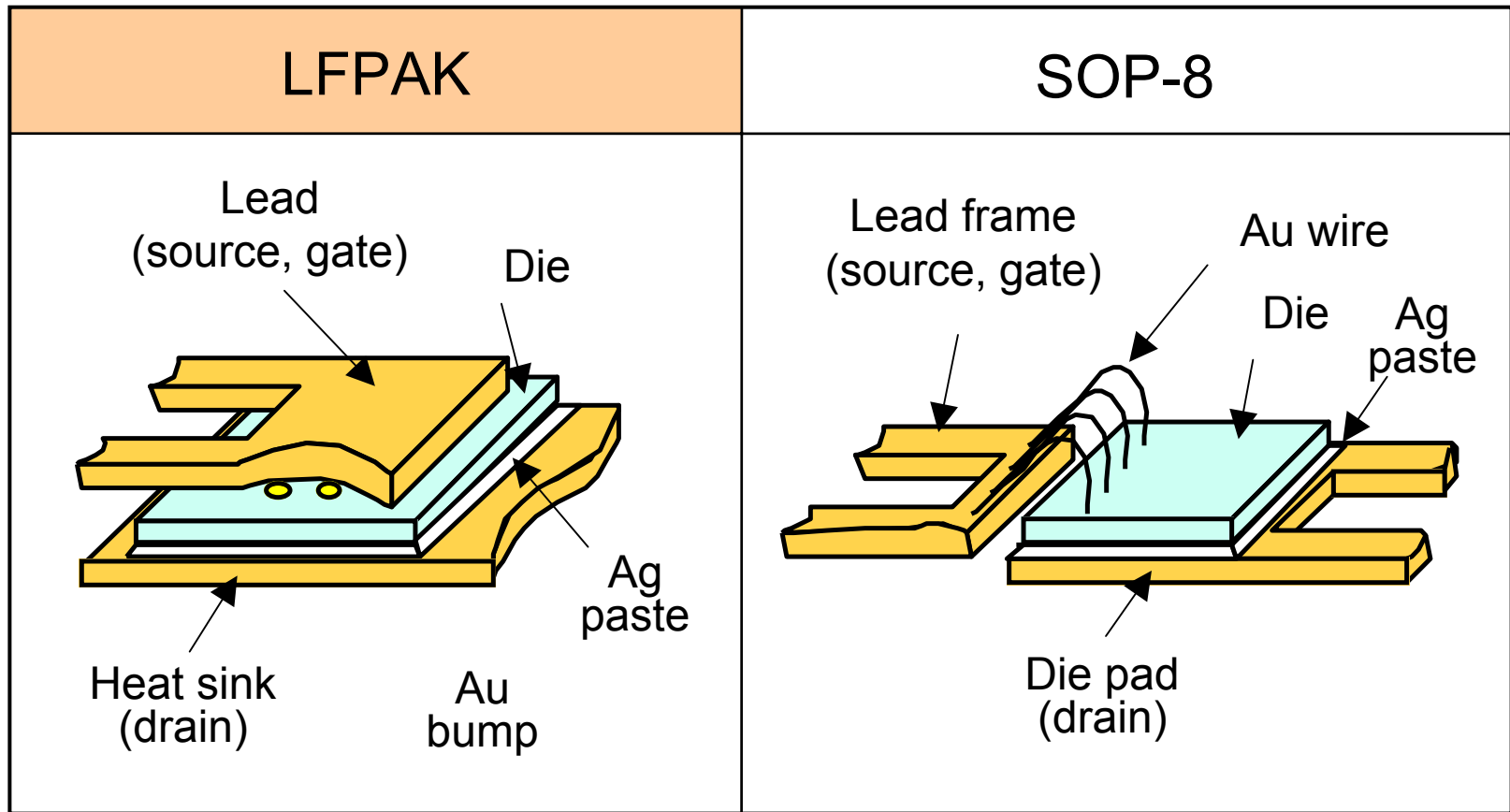


WPAK

LFPAK/SOP-8 Comparison of Package Dimensions



Comparison of LFPAK and SOP-8 Structures



Characteristics of LFPAK Package (SOP-8 Comparison)

Item	Unit	LFPAK	SOP-8	Superiority over SOP-8
Resistance R ^{*1}	mΩ	0.8	1.6	Low on-loss Cut-off Pd= -180 mW (at I _D = 15 A)
Thickness t (max)	mm	1.10	1.75	Thickness: (t = -0.65 mm)
Thermal resistance R _{th} ^{*2} (θ _{ch-c})	°C/W	3	50	
Inductance LS ^{*1,*3}	nH	1.1	2.0	Cut-off on-loss R= -1.2 mΩ/Pd= -270 mW at f= 1 MHz, I _D = 15 A

*1: Chip R_{DS(on)} is not included.

*2: Value of thermal resistance from channel to case (LFPAK: channel to heat sink, SOP-8: channel to bottom of the plastic case)

*3: Average for 0.5 GHz to 2.5 GHz



Plan for Development of the WPAK Series

• Features

- Ultra-thin package
t = 0.8 mm (max.), 54% thinner than SOP-8
- Low thermal resistance
 $\theta_{ch-c} = 5^{\circ}\text{C/W}$ ($T_c = 25^{\circ}\text{C}$)

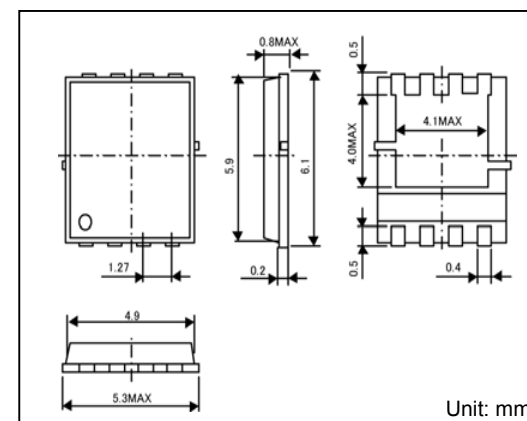
• External dimensions



• WPAK Lineup Plan

Type No.	Drive Voltage (V)	Max. Ratings				Characteristics			Schedule		Remarks
		V _{DSS} (V)	V _{GSS} (V)	I _D (A)	P _{ch} (W)	R _{DS(on)} typ(mΩ)	Q _g (nC) typ	Q _{gd} (nC) typ	WS	MP	
HAT2195WP	4.5	30	±20	40	25	5.6 (4.5 V)	23	5.5	OK	OK	Single device
HAT2197WP	4.5	30	±20	35	20	6.8 (4.5 V)	18	4.2	OK	OK	Single device
HAT2198WP	4.5	30	±20	25	15	9.4 (4.5 V)	11	2.5	OK	OK	Single device
HAT2199WP	4.5	30	±20	15	10	17 (4.5 V)	7.5	1.8	OK	OK	Single device
HAT2208WP	4.5	30	±20	12	5	24(4.5 V)	4.5	1.1	OK	OK	Single device
HAT2209WP	4.5	30	±20	10	5	38 (4.5 V)	2.8	0.7	OK	OK	Single device
HAT2200WP	8	100	±20	20	20	23 (8 V)	61	14.5	OK	OK	Single device
HAT2201WP	8	100	±20	15	15	35 (8 V)	34	8.4	OK	OK	Single device
HAT2183WP	10	150	±20	25	30	38 (10 V)	47	10	Apr/'04	Jul/'04	Single device
HAT2184WP	10	150	±20	18	25	65 (10 V)	28	6	Apr/'04	Jul/'04	Single device
HAT2187WP	10	200	±20	20	30	65 (10 V)	47	10	Apr/'04	Jul/'04	Single device
HAT2188WP	10	200	±20	14	25	106 (10 V)	28	6	Apr/'04	Jul/'04	Single device

These products are under development and the schedule is subject to change without notice.

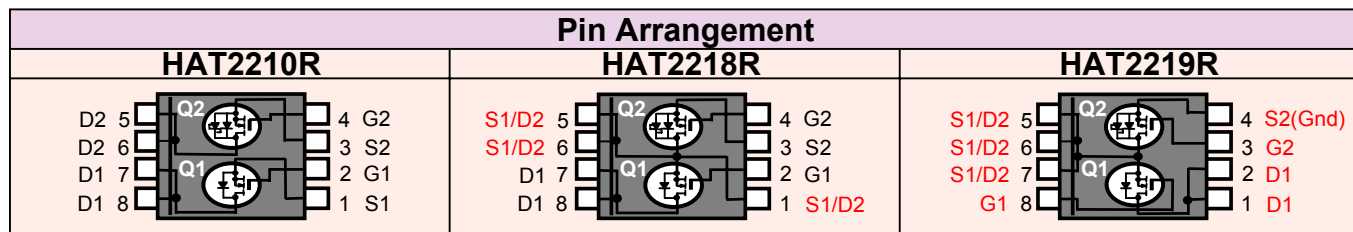


Unit: mm

Package	Thickness (mm)	Ratio (%)
SOP-8	1.75 max.	100
LFPACK	1.1 max.	63
WPAK	0.8 max.	46

8th Gen. High-Performance Low-Voltage Power MOS FET (SOP-8)

No	Type No	Max. Ratings				RDS(on) (mΩ)				Qgd (nC)	Qg *2 (nC)	Schedule		Note*1
		VDSS	VGss	ID	Pch	VGS=4.5 V(8 V)		VGS=10 V				WS	MP	
		(V)	(V)	(A)	(W)	typ	max	typ	max					
1	HAT2195R	30	±20	18	2.5	5.8	8.4	4.6	5.8	5.5	23	OK	OK	A
2	HAT2197R			16	2.5	6.8	9.9	5.3	6.7	4.2	18	OK	OK	A
3	HAT2198R			14	2.5	9.6	14	7.2	9	2.5	11	OK	OK	A
4	HAT2199R			11	2	17	25	13	16.5	1.8	7.5	OK	OK	A
5	HAT2208R			9	2	24	35	19	24	1.1	4.5	OK	OK	A
6	HAT2209R			7	2	38	55	29	36	0.7	2.8	OK	OK	A
7	HAT2200R	100	±20	8	2.5	(23)	(33)	22	28	7.2	33	OK	OK	A
8	HAT2201R			6	2.5	(35)	(49)	34	43	5.2	21	OK	OK	A
9	HAT2210R	30	±20	7.5	1.5	27	40	19	24	4.6	1.2	OK	May/'04	-
				±12	8	1.5	21	29	17	17	11			
10	HAT2218R	30	±20	7.5	1.5	27	40	19	24	4.6	1.2	OK	May/'04	-
				±12	8	1.5	21	29	17	17	11			
11	HAT2219R	30	±20	7.5	1.5	27	40	19	24	4.6	1.2	OK	May/'04	-
				±12	8	1.5	21	29	17	17	11			



*1 A: Maximum ratings are avalanche ratings.

*2 Qg test conditions: Nos. 1 to 6 V_{GS} = 4.5 V, Nos. 7 to 8 V_{GS} = 10 V

These products are under development and the values and schedule are subject to change without notice.

8th Gen. High-Performance Low-Voltage Power MOS FETs

No	Type No	PKG	Max Ratings				RDS(0n) (mΩ)				Qgd (nC)	Qg *2 (nC)	Schedule		Note*1
			VDSS	VGSS	ID	Pch	VGS=4.5(7V)[8V]		VGS=10V				WS	MP	
			(V)	(V)	(A)	(W)	typ	max	typ	max					
1	HAT2160H	LFPAK	20	±20	60	30	28	4.1	2.1	2.6	14	54	OK	OK	A
2	HAT2164H		30		60	30	3.0	4.4	2.5	3.1	10	50	OK	OK	A
3	HAT2165H				55	30	3.4	5.3	2.5	3.3	7.1	33	OK	OK	A
4	HAT2166H				45	25	4.0	6.1	2.9	3.8	5.9	27	OK	OK	A
5	HAT2167H				40	20	6.1	9.3	4.2	5.5	3.7	17	OK	OK	A
6	HAT2168H				30	15	8.8	13.5	6.0	7.9	2.4	11	OK	OK	A
7	HAT2169H				40	50	30	4.0	6	2.8	3.5	10	45	OK	OK
8	HAT2170H		45			30	(3.7)	(5.0)	3.3	4.2	7.0	62	OK	OK	A
9	HAT2171H		40			25	(4.4)	(6.0)	3.8	4.8	6.0	52	OK	OK	A
10	HAT2172H		30			20	(6.6)	(9.2)	5.8	7.5	4.0	32	OK	OK	A
11	HAT2173H		100		25	30	[13]	[17.5]	12	15	14.5	61	OK	OK	A
12	HAT2174H				20	20	[22]	[30]	21	27	8.4	33.5	OK	OK	A
13	HAT2175H				15	15	[34]	[46]	33	42	4.5	21	OK	OK	A
14	HAT1072H		-30	-20/10	40	30	5.3	5.3	3.6	4.5	155	26	OK	OK	
15	H8N0801AB	TO-220AB	80	±20	60	90	9.5	13.8	8.4	10.5	12	74	OK	OK	A

*1 A: Maximum ratings are avalanche ratings.

*2 Qg test conditions: Nos. 1 to 7 $V_{GS} = 4.5$ V, Nos. 8 to 14 $V_{GS} = 10$ V,

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7th Gen. High-Performance Low-Voltage Power MOS FETs (LFPAK)

No.	Type No.	Maximum Ratings				R _{DS(on)} (mΩ)				Qgd (pF)	Qg* ² (nC)	Schedule		Remarks* ¹
		V _{DSS} (V)	V _{GSS} (V)	I _D (A)	P _{ch} (W)	V _{GS} =4.5 V (7 V) [8 V]		V _{GS} =10 V				WS	MP	
						typ	max	typ	max					
1	HAT2134H	20	±20	60	30	4.0	5.8	2.3	2.9	11	40	OK	OK	A
2	HAT2096H	30	±20	40	20	7.0	10	4.2	5.3	8	20	OK	OK	
3	HAT2099H	30	±20	50	30	5	7.3	2.9	3.7	14	40	OK	OK	A
4	HAT2143H	30	±20	40	20	7.7	11.0	4.9	6.1	7	20	OK	OK	A
5	HAT2116H	30	±20	30	15	10.5	15.3	6.3	8.2	5	14	OK	OK	
6	HAT2137H	40	±20	45	30	(4.4)	(6.0)	3.8	4.8	22	95	OK	OK	A
7	HAT2129H	40	±20	30	20	(7.0)	(9.5)	6.0	7.5	7.5	46	OK	OK	A
8	HAT2139H	40	±20	20	15	(11.0)	(15.0)	9.0	11.5	5	30	OK	OK	A
9	HAT2140H	100	±20	25	30	(13.5)	(18.5)	12.5	16.0	22	100	OK	OK	A
10	HAT2141H	100	±20	15	20	(23.5)	(32.0)	22.0	27.5	10	46	OK	OK	A
11	HAT2142H	100	±20	10	15	(38.0)	(51.0)	35.0	44.0	7.5	31	OK	OK	A

*1 A: Maximum ratings are avalanche ratings.

*2 Qg test conditions: Nos. 1 to 8 V_{GS} = 4.5 V, Nos. 9 to 11 V_{GS} = 10 V,

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Lineup of 7th Gen. Low-Voltage Products (1)

Application	Package	Type No.	Maximum Ratings				R _{DS(on)} (mΩ)						C _{iss} (pF)	Q _g (nC)	T _f (ns)	Schedule		Remarks
			V _{DSS} (V)	V _{GSS} (V)	I _D (A)	P _{ch} (W)	V _{GS} = 2.5 V		V _{GS} = 4.5 V (4 V)		V _{GS} = 10 V					WS	MP	
							typ	max	typ	max	typ	max						
DC/DC converters and synchronous rectifiers	SOP-8	HAT2064R	30	±20	16	2.5	-	-	7	10	5	6.3	2200	40	16	OK	OK	↑ VRM (notebook PCs) synchronous rectifiers ↓ Single ↑ VRM (PCs) synchronous rectifiers (servers) ↓
	SOP-8	HAT2118R*	30	±20	16	2.5	-	-	8.5	12.5	5.5	6.9	2450	40	17	OK	OK	
	SOP-8	HAT2068R	30	±20	14	2.5	-	-	11	16	7	9	1650	26	10	OK	OK	
	SOP-8	HAT2070R	30	±20	12	2.5	-	-	15	22	11	14	1400	22	9	OK	OK	
	SOP-8	HAT2071R	30	±20	10	2.5	-	-	30	40	19	24	740	12	7	OK	OK	
	TO-220AB	H7N0203AB	20	±20	90	100	-	-	3.5	5.1	2.4	3.0	6800	110	35	OK	OK	
	LPAK	H7N0310LM/LD	30	±20	30	50	-	-	13	19	8	10	1400	24	16	OK	OK	
	LPAK	H7N0311LM/LD	30	±20	45	60	-	-	11	16	7	8.8	1650	28	16	OK	OK	
	LPAK	H7N0307LM/LD	30	±20	60	90	-	-	8	11.5	4.6	5.8	2500	40	20	OK	OK	
	TO-220AB	H7N0307AB	30	±20	60	90	-	-	8	11.5	4.6	5.8	2500	40	20	OK	OK	
	LPAK	H7N0308LM/LD	30	±20	70	100	-	-	6	8.5	3.8	4.8	3350	52	27	OK	OK	
	TO-220AB	H7N0308AB	30	±20	70	100	-	-	6	8.5	3.8	4.8	3350	52	27	OK	OK	
	TO-220CFM	H7N0308CF	30	±20	60	30	-	-	6	8.5	3.8	4.8	3350	52	27	OK	OK	
	LPAK	H7N0312LM/LD	30	±20	85	125	-	-	4.0	5.8	2.6	3.3	6900	115	50	OK	OK	
	TO-220AB	H7N0312AB	30	±20	85	125	-	-	4.0	5.8	2.6	3.3	6900	115	50	OK	OK	

These products are under development and the values and schedule are subject to change without notice.

*: Avalanche tolerance guaranteed

Lineup of 7th Gen. Low-Voltage Products (2)

Application	Package	Type No.	Maximum Ratings				R _{DS(on)} (mΩ)						C _{iss} (pF)	Q _g (nC)	T _f (ns)	Schedule		Remarks
			V _{DSS} (V)	V _{GSS} (V)	I _D (A)	P _{ch} (W)	V _{GS} =2.5 V		V _{GS} =4.5 V (4 V)		V _{GS} =10 V					WS	MP	
							typ	max	typ	max	typ	max						
DC/DC converters and synchronous rectifiers	LFAK	HAT2096H	30	±20	40	20	-	-	6.2	8.8	4.2	5.3	2200	40	18	OK	OK	Single
	LFAK	HAT2099H*	30	±20	50	25	-	-	5.0	7.3	2.9	3.7	4750	70	30	OK	OK	
	LDBAK	H7N0602LM/LD*	60	±20	85	100	-	-	6.2	9.0	4.1	5.2	9000	140	50	OK	OK	
48-V DC/DC and primary switches	LDBAK	H7N1002LM/LD*	100	±20	75	100	-	-	10	15	8	10	9700	155	25	OK	OK	
	LDBAK TO-220AB	H7N1004LM/LD* H7N1004AB*	100	±20	30	50	-	-	30	45	25	35	2800	50	9.5	OK	OK	
	LDBAK	H7N1005LM/LD*	100	±20	15	40	-	-	105	155	85	110	830	15	7	OK	OK	

These products are under development and the values and schedule are subject to change without notice.

*: Avalanche tolerance guaranteed

Lineup of 7th Gen. Low-Voltage Products (3)

Application	Package	Type No.	Maximum Ratings				R _{DS(on)} (mΩ)						C _{iss} (pF)	Q _g (nC)	T _f (ns)	Schedule		Remarks	
			V _{DSS} (V)	V _{GSS} (V)	I _D (A)	P _{ch} (W)	V _{GS} = 2.5 V		V _{GS} = 4.5 V (4 V)		V _{GS} = 10 V					WS	MP		
							typ	max	typ	max	typ	max							
Power-management switches	SOP-8	HAT1048R	-30	±20	-16	2.5	-	-	9.5	13.5	5.5	7	5700	105	320	OK	OK	Single	
	SOP-8	HAT1047R	-30	±20	-14	2.5	-	-	19	25	10	12	3500	64	25	OK	OK		
	SOP-8	HAT1054R	-20	±12	-6	2	35	50	24	30	-	-	1550	19	150	OK	OK		
Driving small motors LCDs inverters PDPs DC/DC converters	SOP-8	HAT3010R	N-ch	60	±20	6	2	-	-	40	60	30	38	1050	18	10	OK	OK	Dual
			P-ch	-60	±20	5	2	-	-	90	130	60	76	1350	22	10			
	SOP-8	HAT3017R	N-ch	30	±20	3.8	1.3	-	-	125	185	65	85	150	2.8	15	OK	OK	
			P-ch	-30	±20	-2.6	1.3	-	-	300	450	140	180	210	4.2	7.5			
	SOP-8	HAT3019R	N-ch	100	±20	3.5	2	-	-	120	160	90	115	815	15	6.5	OK	OK	
			P-ch	-100	±20	-2.3	2	-	-	300	500	240	300	930	16	5.0			
	SOP-8	HAT2092R	30	±20	11	2	-	-	17	25	13	16	1400	22	9	OK	OK		
	SOP-8	HAT2093R	30	±20	9	2	-	-	27	39	18	23	750	12	7	OK	OK		
	SOP-8	HAT2103R	30	±20	4.5	1.5	-	-	90	130	50	65	220	3.6	7	OK	OK		

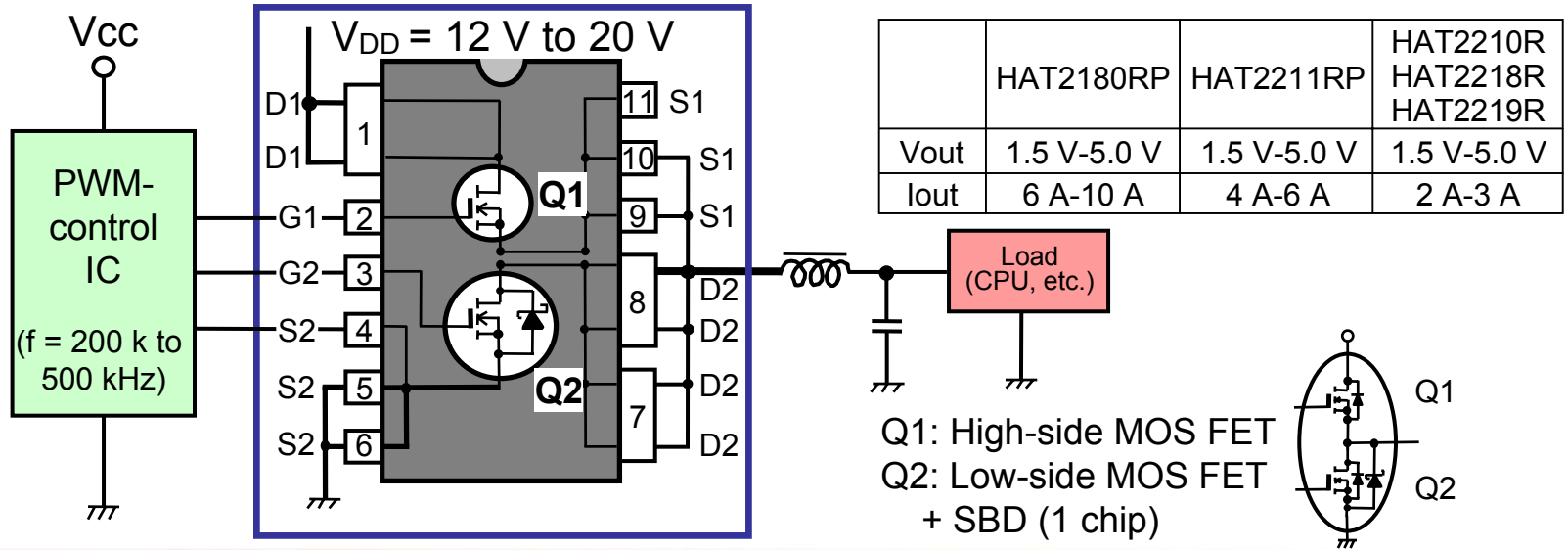
These products are under development and the values and schedule are subject to change without notice.

Composite Power MOS FET for DC/DC Converters

TYPE No	PKG	Max Rating				RDS(on) (mΩ)				Qg (nc)	Qgd (nc)	SBD		Schedule			
		VDSS (V)	VGSS (V)	ID (A)	Pch (W)	VGS=4.5 V		VGS=10 V				VF 3.5 A(V)	trr (ns)	WS	MP		
						typ	max	typ	max								
HAT2180RP	Q1	HSOP-11	30	±20	10	2	15	22	12	15	8.6	2.2	-	-	OK	OK	
	Q2		30	±12	16	3.5	8.5	11.5	7	8.8	26	6.8	0.5	26			
HAT2211RP	Q1		30	±20	7.5	1.5	27	40	19	24	4.6	1.2	-	-	OK	OK	
	Q2		30	±12	11	2.5	15	23	14	18	17	4.5	0.5	26			
HAT2210R	Q1		SOP-8	30	±20	8	1.5	26	38	18	23	4.8	1.2	-	-	OK	May/'04
	Q2			30	±12	11	2.5	20	28	16	20	10.4	2.7	0.5	26		
HAT2218R	Q1			30	±20	8	1.5	26	38	18	23	4.8	1.2	-	-	OK	May/'04
	Q2			30	±12	11	2.5	20	28	16	20	10.4	2.7	0.5	26		
HAT2219R	Q1	30		±20	8	1.5	26	38	18	23	4.8	1.2	-	-	OK	May/'04	
	Q2	30		±12	11	2.5	20	28	16	20	10.4	2.7	0.5	26			

These products are under development and the values and schedule are subject to change without notice.

* Pin arrangement is show in 1-14



Lineup of 6th Gen. Low-Voltage Products (1)

Application	Package	Type No.	Maximum Ratings				R _{DS(on)} (mΩ)						C _{iss} (pF)	Q _g (nC)	t _f (ns)	Schedule		Remarks
			V _{DSS} (V)	V _{GSS} (V)	I _D (A)	P _{ch} (W)	V _{GS} =2.5 V		V _{GS} =4.5 V (4 V)		V _{GS} =10 V					WS	MP	
							typ	max	typ	max	typ	max						
DC/DC converters Synchronous rectifiers Motor control	MP-3A	FS50ASJ-03F	30	±20	50	50	-	-	(13)	(19)	9.2	12.2	2100	41	85	OK	OK	↑ Single ↓
	TO-220FN	FS50KMJ-03F	30	±20	50	25	-	-	(13)	(19)	9.2	12.2	2100	41	85	OK	OK	
	TO-220FN	FS70KMJ-03F	30	±20	70	25	-	-	(8.5)	(12)	6	8	3250	70	130	OK	OK	
	TO-220	FS100UMJ-03F	30	±20	100	100	-	-	(4.2)	(5.7)	3.1	4.0	7600	150	290	OK	OK	
	TO-220S	FS100VSJ-03F	30	±20	100	100	-	-	(4.2)	(5.7)	3.1	4.0	7600	150	290	OK	OK	
	TO-220FN	FS100KMJ-03F	30	±20	100	30	-	-	(4.2)	(5.7)	3.1	4.0	7600	150	290	OK	OK	
	MP-3A	FS5ASJ-06F	60	±20	5	15	-	-	(140)	(190)	110	140	340	8	17	OK	OK	
	MP-3A	FS10ASJ-06F	60	±20	10	20	-	-	(66)	(86)	53	70	750	17	35	OK	OK	
	MP-3A	FS30ASJ-06F	60	±20	30	50	-	-	(22)	(28)	18	22	2600	45	100	OK	OK	
	TO-220FN	FS30KMJ-06F	60	±20	30	25	-	-	(22)	(28)	18	22	2600	45	100	OK	OK	
	TO-220FN	FS50KMJ-06F	60	±20	50	25	-	-	(14)	(18)	12	14	3850	80	160	OK	OK	
	TO-220	FS70UMJ-06F	60	±20	70	100	-	-	(6.6)	(8.3)	5.5	7.0	8500	180	330	OK	OK	
	TO-220S	FS70VSJ-06F	60	±20	70	100	-	-	(6.6)	(8.3)	5.5	7.0	8500	180	330	OK	OK	
	TO-220FN	FS70KMJ-06F	60	±20	70	30	-	-	(6.6)	(8.3)	5.5	7.0	8500	180	330	OK	OK	

Lineup of 6th Gen. Low-Voltage Products (2)

Application	Package	Type No.	Maximum Ratings				R _{DS(on)} (mΩ)						C _{iss} (pF)	Q _g (nC)	t _f (ns)	Schedule		Remarks
			V _{DSS} (V)	V _{GSS} (V)	I _D (A)	P _{ch} (W)	V _{GS} = 2.5 V		V _{GS} = 4.5 V (4 V)		V _{GS} = 10 V					WS	MP	
							typ	max	typ	max	typ	max						
DC/DC converters	SOP-8	FY8AAJ-03F	30	±20	8	1.7	-	-	31	43	22	28	600	13	6.5	OK	OK	Single
	SOP-8	FY10AAJ-03F	30	±20	10	1.9	-	-	19	26	14	18	1200	22	9	OK	OK	
Synchronous rectifiers	SOP-8	FY12AAJ-03F	30	±20	12	2.0	-	-	12.5	17.5	9	11.5	1800	35	12	OK	OK	
	SOP-8	FY14AAJ-03F	30	±20	14	2.3	-	-	8.8	12.0	6.5	8.1	2600	50	15	OK	OK	
Motor control	SOP-8	FY5ACJ-03F	30	±20	5	1.7	-	-	(34)	(48)	21	27	600	13	20	OK	OK	Dual
Li-ion battery protection	TSSOP-8	FY7BCH-02C	20	±10	7	1.6	21	30	(17)	(21)	-	-	1350	-	-	OK	OK	

MOS FET

(100 V-150 V and N-ch/P-ch P-ch MOS FET)

P/N	Maximum Ratings			Electrical Characteristics		Package	Status	
	VDSS (V)	ID (A)	VGS (V)	VGS(off) (V) min - max	RDS(on) (mΩ) typ/max		WS	MP
H5N1503P	150	70	±30	3.0 - 4.0	22/27	TO-3P	OK	OK
H5N1502LS	150	35	±30	3.0 - 4.5	45/55	LDBAK	OK	OK
H8N15xxAB	150	-	(±20)	(1.0) - (2.5)	-(/25)	TO220AB	Planning	Planning
H7N1002LS	100	75	±20	1.5 - 2.5	8/10	LDBAK	OK	OK
H7N1004FM	100	25	±20	1.5 - 2.5	25/35	TO220FM	OK	OK
H7N1005FM	100	15	±20	1.5 - 2.5	85/110	TO220FM	OK	OK

P/N	Maximum Ratings			Electrical Characteristics		Package	Status	
	VDSS (V)	ID (A)	VGS (V)	VGS(off) (V) min - max	RDS(on) (mΩ) typ/max		WS	MP
HAT3019R	100 -100	3.5 -2.3	±20 ±20	1.0 - 2.5 1.0 - 2.5	90/115 240/300	SOP-8	OK	OK
HAT1081R	-100	-2.3	±20	1.0 - 2.5	240/300	SOP-8(S)	OK	OK
HAT3021R	80V -80V	3.4 -2.6	±20 ±20	1.0 - 2.5 1.0 - 2.5	90/115 165/210	SOP-8	OK	OK

P/N	Maximum Ratings			Electrical Characteristics		Package	Status	
	VDSS (V)	ID (A)	VGS (V)	VGS(off) (V) min - max	RDS(on) (mΩ) typ/max		WS	MP
H5P2502CF	-250	(-10)	±30	(-3.0) - (-4.5)	(260)/(320)	TO220CFM	OK	May/'04
H5P1502CF	-150	(-12)	±30	(-3.0) - (-4.5)	(130)/(180)	TO220CFM	OK	May/'04



Next Generation Compact Low-Loss Power MOS FET CMFPAK-6 Series

- Power MOS FETs in compact packages realizes more compact and lighter portable devices

Power MOS FET incorporated in CMFPAK-6

- Supported gate-drive voltage: 1.8 V to 2.5 V
- P-ch/N-ch products using D8 process are planned
- Suitable for the step-up/down DC/DC converters and power-management switches of portable devices

Main Applications:

- Digital still cameras
- Cellular phones
- Portable information terminals, etc.

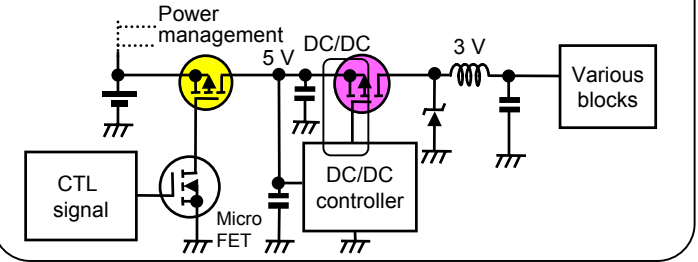
• Product Lineup

* Under development

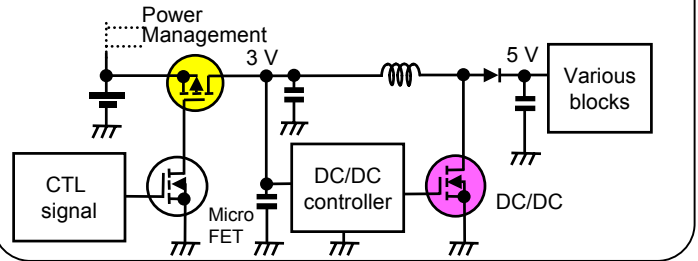
Application	Config.	Type No.	Gate drive voltage (V)	V _{DSS} (V)	I _D (A)	V _{GSS} (V)	R _{DS(on)} (mΩ) max.				C _{iss} (PF)	Schedule	
							V _{GS}					WS	MP
							10 V	4.5 V	2.5 V	1.8 V			
Power management of large-current DC/DC converters	P-ch	HAT1093C	-12	(-3)	(±8)	-	54	76	119	900	OK	OK	
		HAT1094C	-12	(-2.5)	(±8)	-	88	126	192	500	OK	OK	
		HAT1095C	-12	(-2)	(±8)	-	140	205	327	300	OK	OK	
		HAT1069C	-12	(-3)	(±8)	-	52	70	93	1310	OK	OK	
		HAT1096C	-20	(-1)	(±12)	-	293	530	-	155	OK	OK	
		HAT1090C	-20	(-2.5)	(±12)	-	65	104	-	640	OK	OK	
		HAT1089C	-20	(-2)	(±12)	-	103	168	-	360	OK	OK	
	HAT1091C	-20	(-1.5)	(±12)	-	175	287	-	205	OK	OK		
	* HAT1108C	-30	-1.5	(-20/10)	209	356	-	-	165	OK	Jun/'04		
	* HAT1111C	-60	-2	(-20/10)	306	450	-	-	(T.B.D)	OK	2Q/'04		
	N-ch	HAT2204C	12	(3.5)	(±8)	-	34	44	81	770	OK	OK	
		HAT2205C	12	(3)	(±8)	-	50	69	114	445	OK	OK	
		HAT2206C	12	(2)	(±8)	-	85	114	180	250	OK	OK	
		HAT2207C	20	(1.5)	(±12)	-	186	295	-	135	OK	OK	
HAT2202C		20	(3)	(±12)	-	40	55	-	520	OK	OK		
HAT2198C		20	(2.5)	(±12)	-	58	93	-	285	OK	OK		
HAT2203C		20	(2)	(±12)	-	90	150	-	170	OK	OK		
* HAT2221C	30	1.5	(-20/10)	206	305	-	-	(T.B.D)	OK	2Q/'04			
* HAT2217C	60	3	(-20/10)	133	183	-	-	(T.B.D)	OK	2Q/'04			

R_{DS(on)} is given as typ./max.
The above specifications are target values and are subject to change or products discontinued without notice.

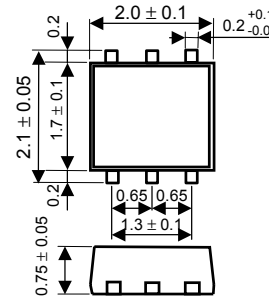
Portable device: DC/DC (step-down)



Portable device: DC/DC (step-up)



CMFPAK-6 Package Dimensions



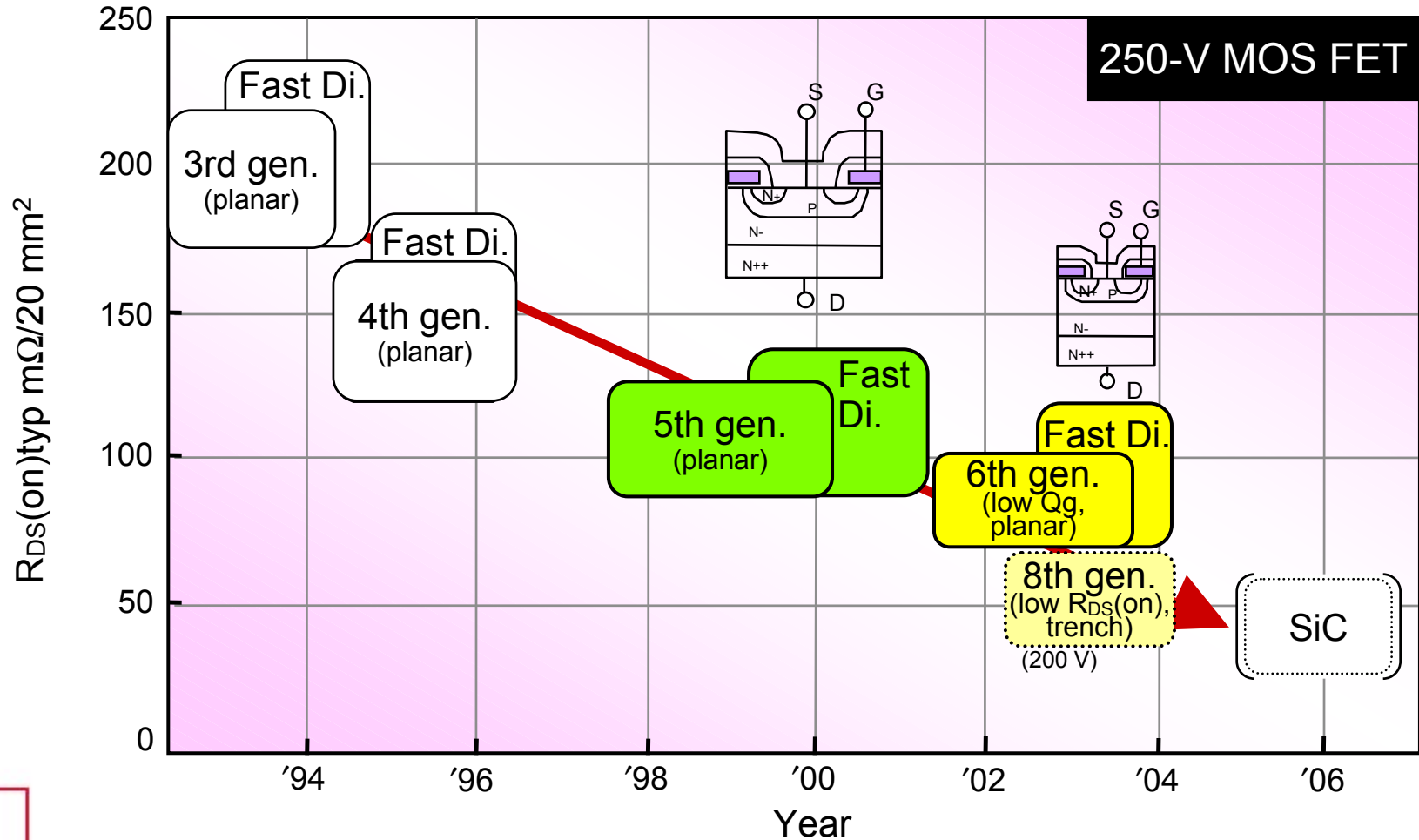
Package	Area		Weight	
	Mount area (mm ²)	Area ratio	Height (mm)	Height ratio
TSOP-6	9.3	1.00	1.10	1.00
MPAK (SC-59)	8.7	0.94	1.35	1.23
SOT-23	7.6	0.82	1.12	1.02
CMFPAK-6	4.5	0.49	0.80	0.73



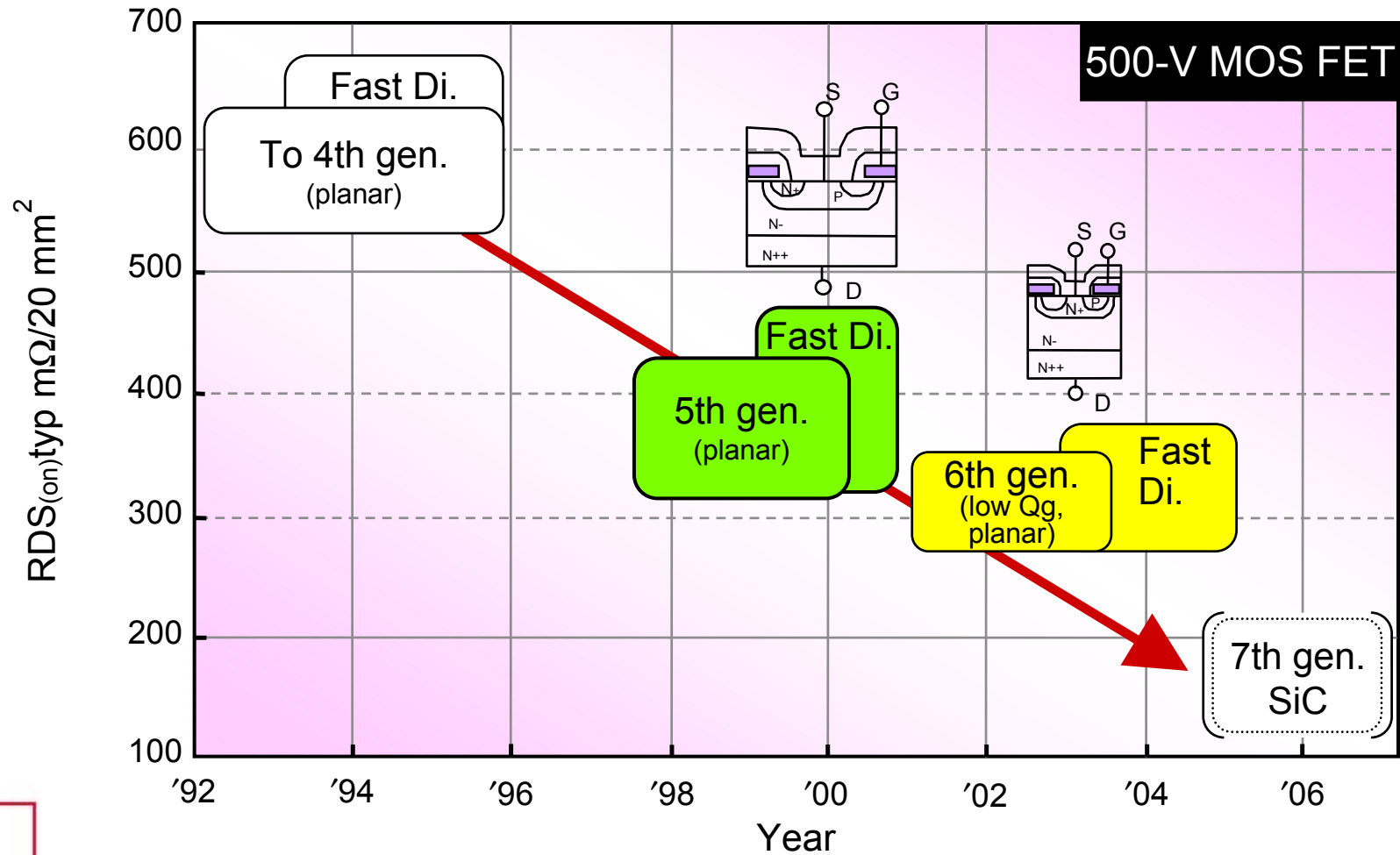
Medium-, High-Voltage Power MOS FETs

$V_{DSS} = 200 \text{ V to } 600 \text{ V}$

R_{DS(on)} Performance Trends for Medium-Voltage Power MOS FETs



R_{DS(on)} Performance Trends for High-Voltage Power MOS FETs



Features of Medium-, High-Voltage Power MOS FETs

- Lineup of ultra-low on-resistance, large-current products
 - H5N5005PL: 500 V/70 mΩ, TO-3PL
 - H5N2513PL: 250 V/20 mΩ, TO-3PL
- Low gate charge (low Qg)
- Avalanche tolerance guaranteed
- Built-in diode with high breakdown-tolerance
- Lineup of high-speed products with built-in diodes
 - FK series (250 V to 600 V)
 - HF, H5N series (250 V to 500 V)

Medium-, High-Voltage MOS FETs (500 V to 600 V) (1)

P/N	Maximum Ratings			Electrical Characteristics		Package	Status	
	VDSS (V)	ID (A)	VGS (V)	VGS(off) (V) min - max	RDS(on) (m Ω) typ/max		WS	MP
H5N6002PL	600	40	± 30	2.0 - 4.0	120/160	TO-3PL	OK	Jun/'04
H5N6004PL	600	35	± 30	3.0 - 4.0	170/210	TO-3PL	OK	May/'04
FS22SM-12A	600	22	± 30	2.5 - 3.5	230/300	TO-3P	OK	OK
H5N6001P	600	20	± 30	3.0 - 4.0	300/380	TO-3P	OK	OK
FS10KM-12A	600	10	± 30	2.5 - 3.5	720/940	TO-220FN	OK	OK
FS10VS-12A	600	10	± 30	2.5 - 3.5	720/940	TO-220S	OK	OK
FS7VS-12A	600	7	± 30	2.5 - 3.5	1000/1300	TO-220FN	OK	OK
FS7KM-12A	600	7	± 30	2.5 - 3.5	1000/1300	TO-220S	OK	OK
FS4VS-12A	600	4	± 30	2.5 - 3.5	1900/2400	TO-220FN	OK	OK
FS4KM-12A	600	4	± 30	2.5 - 3.5	1900/2400	TO-220S	OK	OK
H5N5005PL	500	60	± 30	2.0 - 4.0	70/85	TO-3PL	Apr/'04	May/'04
H5N5011PL	500	50	± 30	3.0 - 5.0	95/115	TO-3PL	OK	OK
H5N5004PL	500	50	± 30	2.0 - 4.0	90/110	TO-3PL	OK	OK
H5N5015P	500	32	± 30	1.5 - 4.0	140/170	TO-3P	OK	OK
H5N5007P	500	25	± 30	3.0 - 4.0	180/225	TO-3P	OK	OK
H5N5012P	500	25	± 30	2.0 - 4.0	180/225	TO-3P	OK	OK
FS25SM-10A	500	25	± 30	2.5 - 3.5	150/200	TO-3P	OK	OK
2SK3235	500	15	± 30	3.0 - 4.0	300/400	TO-3P	OK	OK
FS18KM-10A	500	18	± 30	2.5 - 3.5	300/400	TO-220FN	OK	OK

Medium-, High-Voltage MOS FETs (450 V to 500 V) (2)

P/N	Maximum Ratings			Electrical Characteristics		Package	Status	
	VDSS (V)	ID (A)	VGS (V)	VGS(off) (V) min - max	RDS(on) (mΩ) typ/max		WS	MP
H5N5013CF	500	12	±30	(2.0) - (4.0)	(500)/(620)	TO220CFM	Apr/'04	Jun/'04
FS14KM-10A	500	14	±30	2.5 - 3.5	500/640	TO-220FN	OK	OK
2SK3234	500	8	±30	3.0 - 4.0	650/850	TO220CFM	OK	OK
FS10KM-10A	500	10	±30	2.5 - 3.5	700/900	TO-220FN	OK	OK
FS5AS-10A	500	5	±30	2.5 - 3.5	1200/1500	MP-3A	OK	Jun/'04
FS5KM-10A	500	5	±30	2.5 - 3.5	1200/1500	TO-220FN	OK	OK
2SK3233	500	5	±30	3.0 - 4.0	1100/1500	TO220CFM	OK	OK
H5N5006DL	500	3	±30	3.0 - 4.5	2500/3000	DPAK	OK	OK
H5N5006FM	500	3	±30	3.0 - 4.5	2500/3000	TO220FM	OK	OK
FS25SM-9A	450	25	±30	2.5 - 3.5	130/160	TO-3P	OK	OK
FS18KM-9A	450	18	±30	2.5 - 3.5	260/350	TO-220FN	OK	OK
FS14KM-9A	450	14	±30	2.5 - 3.5	410/520	TO-220FN	OK	OK
FS14VS-9A	450	14	±30	2.5 - 3.5	410/520	LDPAK(S)	OK	OK
FS10KM-9A	450	10	±30	2.5 - 3.5	560/730	TO-220FN	OK	OK
FS5KM-9A	450	5	±30	2.5 - 3.5	1000/1200	TO-220FN	OK	OK

Medium-, High-Voltage MOS FETs (280 V to 350 V)

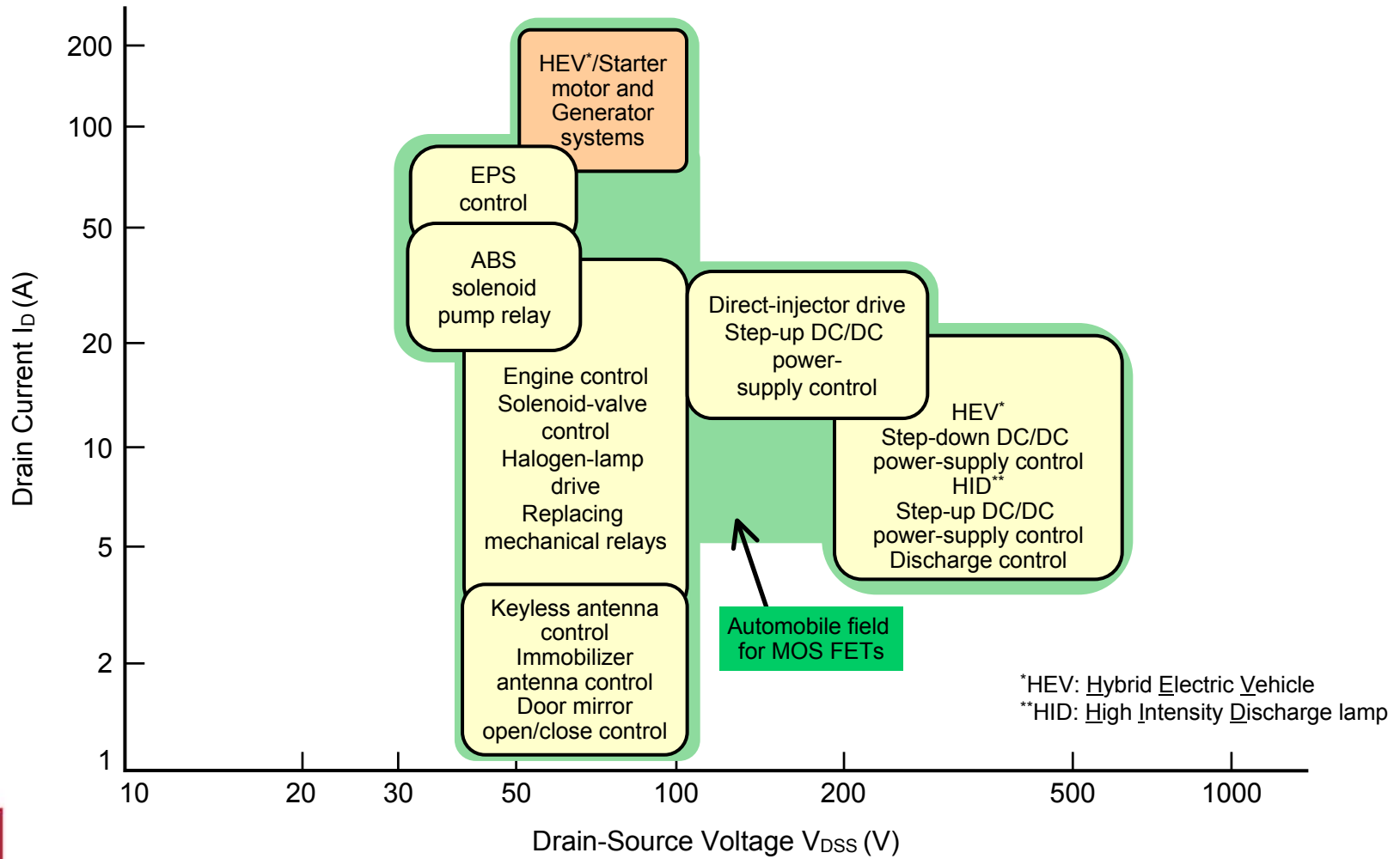
P/N	Maximum Ratings			Electrical Characteristics		Package	Status	
	VDSS (V)	ID (A)	VGS (V)	VGS(off) min ^(V) - max	RDS(on) (mΩ) typ/max		WS	MP
H5N3503P	350	30	±30	3.0 - 4.0	75/ 95	TO-3P	OK	May/'04
H5N3504P	350	20	±30	3.0 - 4.0	100/130	TO-3P	OK	May/'04
(HC8677)	350	(20)	(±30)	(3.0) - (4.0)	-(210)	Chip/Wafer	OK	May/'04
H5N3003P	300	40	±30	3.0 - 4.0	58/69	TO-3P	OK	OK
H5N3007LS	300	25	±30	1.5 - 4.0	120/160	LDPAK	OK	OK
H5N3004P	300	25	±30	3.0 - 4.0	76/93	TO-3P	OK	OK
(HC8676)	300	(25)	(±30)	(3.0) - (4.0)	-(140)	Chip/Wafer	OK	Jun/'04
FS40SM-6A	300	40	±30	3.0 - 4.0	74/105	TO-3P	OK	OK
H5N3007AB	300	25	±30	1.5 - 4.0	120/160	TO220AB	OK	OK
H5N3008P	300	40	±30	2.0 - 4.0	58/69	TO-3P	OK	OK
FS20KM-6A	300	20	±30	2.5 - 3.5	200/260	TO-220FN	OK	OK
FS20VS-6A	300	20	±30	2.5 - 3.5	200/260	TO-220S	OK	OK
H5N3005LS	300	(15)	±30	(3.0) - (4.5)	(210)/(280)	LDPAK	OK	May/'04
H5N2801P	280	60	±30	3.0 - 4.5	34/43	TO-3P	OK	May/'04
H5N2801PL	280	70	±30	3.0 - 4.5	34/43	TO-3PL	OK	OK
H5N2803PF	280	(30)	±30	(3.0) - (4.0)	(40)/(52)	TO-3PFM	OK	May/'04
H5N2802PF	280	(25)	±30	(3.0) - (4.0)	(57)/(74)	TO-3PFM	OK	May/'04
(HC8682)	280	(30)	(±30)	(3.0) - (4.0)	-(110)	Chip/Wafer	OK	May/'04

Medium-, High-Voltage MOS FETs (200 V to 250 V)

P/N	Maximum Ratings			Electrical Characteristics		Package	Status	
	VDSS (V)	ID (A)	VGS (V)	VGS(off) (V) min - max	RDS(on) (mΩ) typ/max		WS	MP
H5N2513PL	250	100	±30	2.0 - 4.0	20/26	TO-3PL	OK	OK
H5N2514P	250	(65)	±30	(3.0) - (4.5)	(29)/(35)	TO-3P	OK	May/'04
H5N2515P	250	(60)	±30	(3.0) - (4.5)	(33)/(40)	TO-3P	OK	May/'04
H5N2503P	250	50	±30	3.0 - 4.0	40/55	TO-3P	OK	OK
H5N2509P	250	30	±30	3.0 - 4.0	53/69	TO-3P	OK	OK
FS50SM-5A	250	50	±30	3.0 - 4.0	52/68	TO-3P	OK	OK
H5N2502LS	250	30	±30	3.0 - 4.0	82/105	LDBAK	OK	OK
H5N2512LS	250	30	±30	1.5 - 4.0	82/105	LDBAK	OK	OK
H5N2501LS	250	18	±30	3.0 - 4.5	140/180	LDBAK	OK	OK
H5N2501P	250	20	±30	3.0 - 4.5	140/180	TO-3P	OK	OK
FS20KM-5A	250	20	±30	2.5 - 3.5	150/190	TO-220FN	OK	OK
FS20VS-5A	250	20	±30	2.5 - 3.5	150/190	TO-220S	OK	OK
H5N2508DL	250	7	±30	3.0 - 4.5	480/630	DPAK	OK	OK
H5N2505DL	250	5	±30	3.0 - 4.5	680/890	DPAK	OK	OK
H5N2305P	230	60	±30	2.5 - 4.0	30/38	TO-3P	OK	OK
H5N2305PF	230	35	±30	2.5 - 4.0	30/38	TO-3PFM	OK	OK
H5N2306PF	230	30	±30	2.5 - 4.0	41/52	TO-3PFM	OK	OK
H5N2301PF	230	25	±30	3.0 - 4.0	65/85	TO-3PFM	OK	OK
H5N2301LS	230	30	±30	3.0 - 4.0	65/85	LDBAK	OK	OK
H5N2003P	200	60	±30	3.0 - 4.0	32/42	TO-3P	OK	OK
H5N2006LS	200	30	±30	3.0 - 4.0	65/85	LDBAK	OK	OK
H5N2001LS	200	20	±30	3.0 - 4.5	110/150	LDBAK	OK	OK
H5N2004DL	200	8	±30	3.0 - 4.5	380/480	DPAK	OK	OK
H5N2005DL	200	6	±30	3.0 - 4.5	520/650	DPAK	OK	OK

Power MOS FETs for In-Vehicle Applications: Technical Trends

Map of Automobile Applications for Power MOS FETs



Trends for In-Vehicle Devices and Corresponding Power MOS FET or IGBT

Field	Use	Trends for Machinery	Corresponding Power MOS FET or IGBT
Engine control	Fuel injectors Drivers for small solenoids	Direct-injection engines (environmental measure) → mounting of bare chips High-functionality control to reduce exhaust gases	<ul style="list-style-type: none"> • Development of 100-V 7th-generation MOS FETs (including p-ch devices) • Support in bare-chip form • Thermal FETs (development of high-functionality products under examination)
Safety control	ABS, VSC airbags	Multifunctional, compact → multi-channel control → inclusion of protective functions	<ul style="list-style-type: none"> • Development of 40- to 60-V 7th-generation MOS FETs in small packages for surface mounting • Large-current thermal FETs
Car body control, etc.	HEVs Starter motors Generators Junction boxes Relay boxes Controllers for small motors	<p>Reducing wiring-harness weight Responding to increased demand for in-vehicle power Environmental measures → high-voltage, high-current control</p> <p>High reliability, long life → inclusion of protective functions</p> <p>High reliability, long life Elimination of the need for surge protection</p>	<ul style="list-style-type: none"> • 7th generation: 60/80/100 V, 200 to 400 A MOS FETs with built-in detection functions → current + temperature • Support in bare-chip form • Thermal FETs (development of high-functionality products under examination) • Development of 7th gen. MOS FETs • Development of 40- to 60-V 7th-generation MOS FETs in small packages for surface mounting • Development of 100-V 7th-generation MOS FETs (including p-ch devices)

Lineup and Development of 7th Generation N-ch Power MOS FETs

Channel Impurity Type	Package	Type No.	Maximum Ratings			VGS (off) (V)	RDS (on) (mΩ)				Schedule		Remarks
			VDSS (V)	VGSS (V)	ID (A)		VGS = 10 V (12 V)		VGS = 4.5 V		WS	MP	
							typ	max	typ	max			
Nch	LDBPAK (L) / (S)	H7N0401LD/LS	40	±20	95	1.5 to 2.5	3.1	4.2	4.8	7.0	OK	OK	
	SOP-8	HAT2153RJ	60	±20	6	1.5 to 2.5	28	35	40	50	3Q '04	3Q '05	1 device
		HAT2114RJ			6		28	32	40	50	OK	OK	2 devices
	DPAK (L) / (S)	H7N0607DL/DS			(20)		(26)	(34)	(40)	(56)	OK	3Q '04	
		H7N0603DL/DS			30		11	15	16	23	OK	3Q '04	
	LDBPAK (L) / (S)	H7N0607LD/LS			(25)		(26)	(34)	(40)	(56)	OK	3Q '04	
		H7N0608LD/LS			70		6	8	8	12	OK	OK	
		H7N0602LD/LS			85		4.3	5.2	6.0	7.8	OK	OK	
		H7N0603AB			(60)		11	15	16	23	OK	3Q '04	
	TO-220AB	H7N0608AB			70		6	8	8	12	OK	OK	
		H7N0602AB			85		4.3	5.2	6.0	7.8	OK	OK	
	TO-220FM	H7N0608FM	50	6.5	8.5	8.5	13	OK	3Q '04				
	TO-3P	H7N0801P	80	±20	(90)	3.0 to 4.5	(3.0)	(3.7)	-	-	3Q '04	3Q '05	
	TO-92MOD	H7N1009MD	100	±20	2	1.5 to 2.5	160	160	150	230	OK	OK	
	SOP-8	HAT2152RJ			4		65	85	80	110	OK	1Q '05	2 devices
	DPAK (L) / (S)	H7N1005DL/DS			10		95	120	115	165	OK	OK	
		H7N1004DL/DS			25		25	35	30	45	OK	OK	
	LDBPAK (L) / (S)	H7N1005LD/LS			15		85	110	105	155	OK	OK	
		H7N1004LD/LS			30		25	35	30	45	OK	OK	
		H7N1002LD/LS			75		8	11	10	15	OK	OK	
	TO-220AB	H7N1004AB			30		25	35	30	45	OK	OK	
		H7N1002AB			75		8	11	10	15	OK	OK	
	TO-220FM	H7N1005FM			12		85	110	105	155	OK	OK	
H7N1004FM		20			25		35	30	45	OK	OK		
TO-3P	H7N1001P	-90			3.0 to 4.5		(3.5)	(4.3)	-	-	3Q '04	3Q '05	

These products are under development and the values and schedule are subject to change without notice.

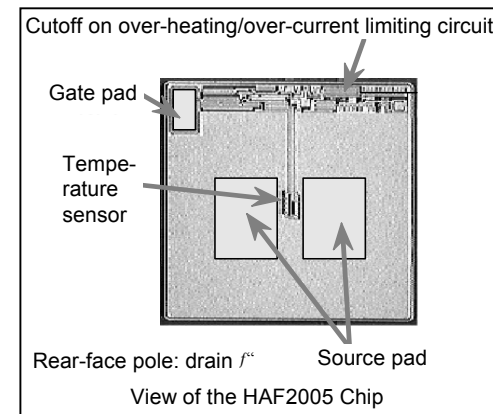
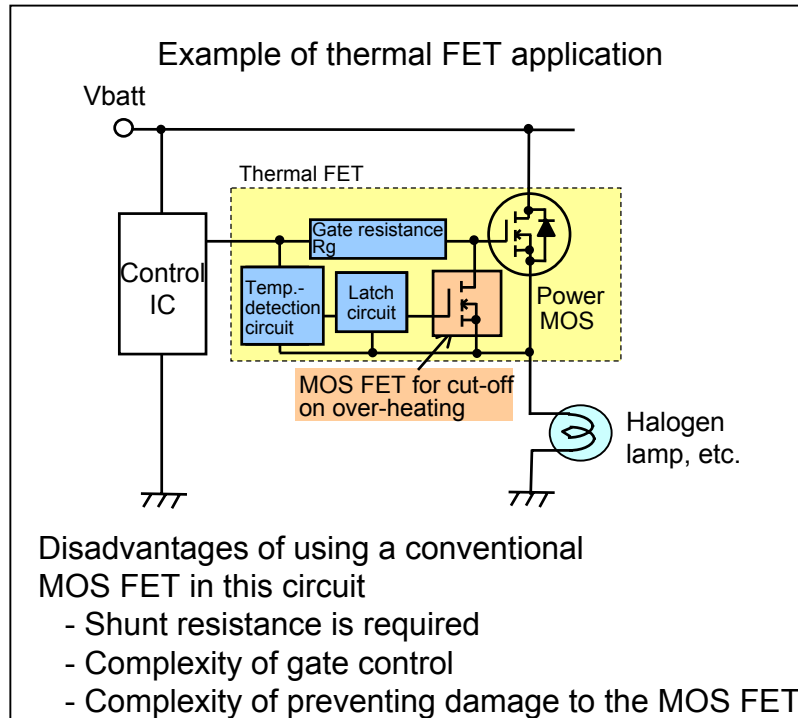
Lineup and Development of 7th Generation P-ch Power MOS FETs

Channel Impurity Type	Package	Type No.	Maximum Ratings			VGS (off) (V)	RDS (on) (mΩ)				Suchedule		Remarks
			VDSS (V)	VGSS (V)	ID (A)		VGS = 10 V (12 V)		VGS = 4.5 V		WS	MP	
							typ	max	typ	max			
Pch	SOP-8	HAT1097RJ	-60	±20	-5	-1.0 to -2.5	60	76	90	130	OK	OK	1 device
		HAT1055RJ			-5		60	76	90	130	OK	OK	2 devices
	DPAK (L) / (S) H7P0601DL/DS	20			40		50	60	85	OK	OK		
	TO-92MOD	H7P1001MD	-100	±20	-1.1	-1.0 to -2.5	600	800	720	1100	OK	OK	
		H7P1006MD			-1.8		130	180	160	240	OK	OK	
	DPAK (L) / (S) H7P1002DL/DS	-15			85		105	105	150	OK	OK		
N/P	SOP-8	HAT3018RJ	60/-60	±20	6/-5	1.5 to 2.5	28/60	35/76	40/90	50/130	OK	OK	2 devices

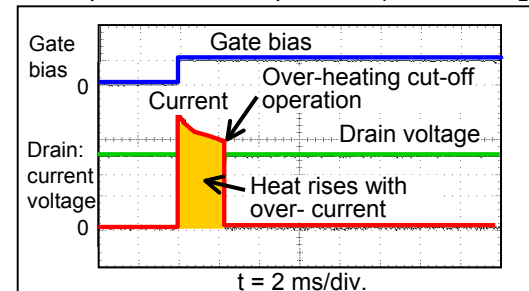
Development of Thermal FETs with Over-Heating Cut-Off Function

- Features

- Built-in over-heating cut-off function (when $T_{ch} \geq 150^{\circ}\text{C}$ or more, the current is cut off)
- The transistor retains its own cut-off state (latch type) and controls its own resumption (hysteresis of response with temperature)
- 3-pin package configuration, same as power MOS FETs



Example of Cut-Off Operation (Overheating)

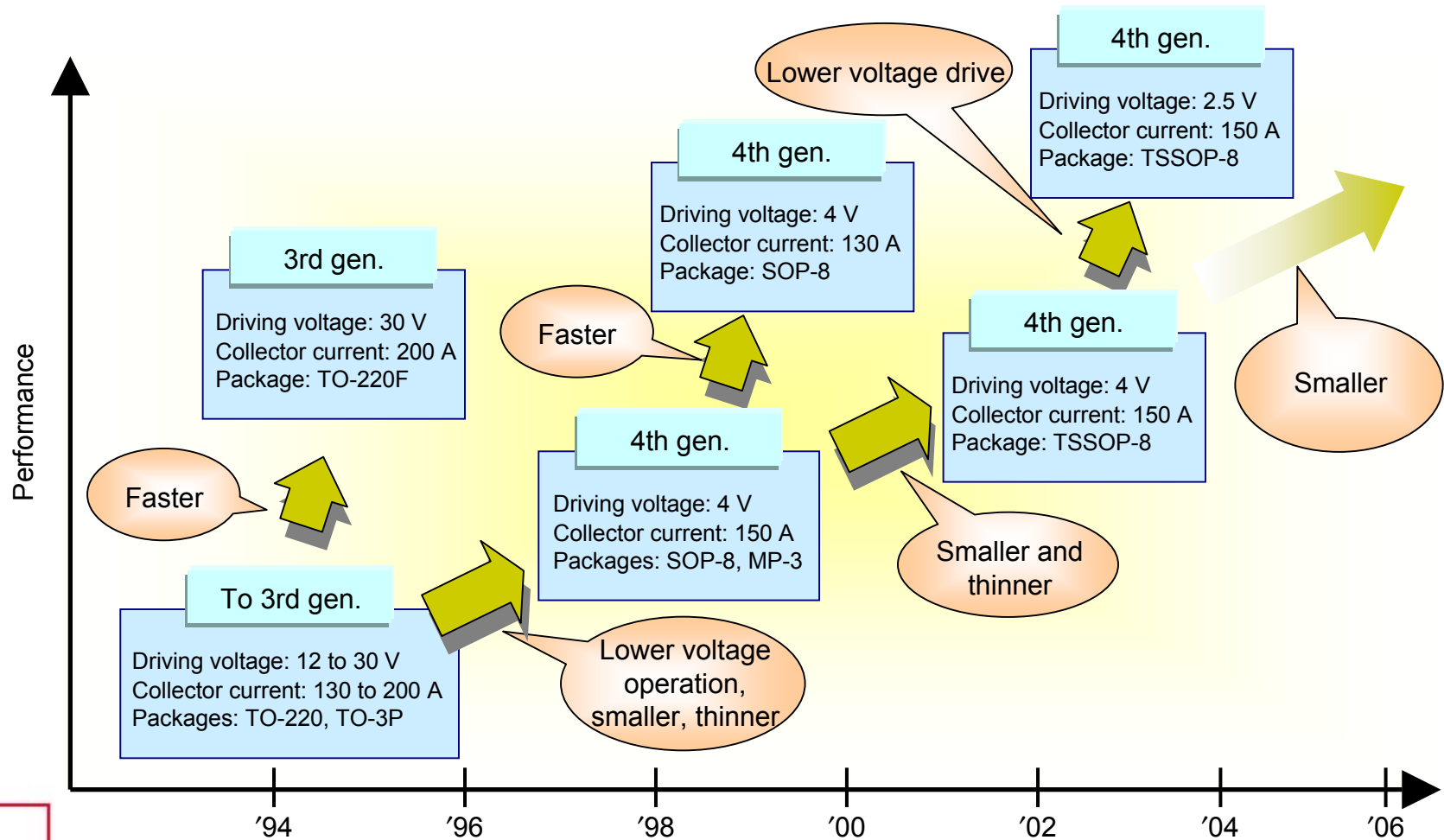


Lineup and Development of Thermal FETs

Channel Impurity Type	FET process	Package	Type No.	Maximum Ratings				RDS (on) (mΩ)				Shutdown temperature typ	★:Latch type ○:Hysteresis type	Schedule	
				VDSS (V)	VGSS (V)	ID (A)	Pch (W)	VGS = 4 V (6 V) [4.5 V]		VGS = 10 V [5 V]					
								typ	max	typ	max				
Nch	4th Gen	TO-220AB	HAF2001	60	+16/-2.8	20	50	50	65	30	43	175 °C	★	OK	OK
		TO-220FM	HAF2002	60	+16/-2.8	20	30	50	65	30	43	175 °C	★	OK	OK
		LDBAK	HAF2012	60	+16/-2.8	20	50	50	65	30	43	175 °C	★	OK	OK
	5th Gen	LDBAK	HAF2017	60	+16/-2.5	20	50	[35]	[53]	27	43	175 °C	★	OK	OK
		TO-220FM	HAF2005	60	+16/-2.5	40	30	25	33	15	20	175 °C	★	OK	OK
		DPAK	HAF2011	60	+16/-2.5	40	50	25	33	15	20	175 °C	★	OK	OK
		TO-220AB	HAF2014	60	+16/-2.5	40	50	25	33	15	20	175 °C	★	OK	OK
		DPAK	HAF2007	60	+16/-2.5	5	20	73	120	55	75	175 °C	★	OK	OK
		DPAK	HAF2025	60	+16/-2.5	15	40	T.B.D	{60}	T.B.D	45	175 °C	★	OK	2Q '04
		LDBAK	HAF2021	60	+16/-2.5	50	100	(9.5)	(15)	8	12	175 °C	★	OK	OK
SOP-8	HAF2015RJ	60	+16/-2.5	2	1.5	130	200	110	160	175 °C	○	OK	OK		
Pch	4th Gen	TO-220FM	HAF1001	60	-16/+3.0	-15	50	100	130	70	90	175 °C	★	OK	OK
		LDBAK	HAF1002	60	-16/+3.0	-15	50	100	130	70	90	175 °C	★	OK	OK
	5th Gen	DPAK	HAF1004	60	-16/+2.5	-5	20	200	340	140	200	175 °C	★	OK	OK
		LDBAK	HAF1008	60	-16/+2.5	-20	50	60	80	42	54	175 °C	★	OK	OK
		LDBAK	HAF1009	60	-16/+2.5	-40	50	33	50	22	27	175 °C	★	OK	OK

IGBTs for Driving Strobe-Flash Usage

Development Roadmap of IGBTs for Strobe-Flash Usage



2.5-V/4-V IGBTs in TSSOP-8 Packages for Strobe-Flash Usage

- Outline

IGBTs control strobe-flash units in digital still cameras, digital video cameras, compact cameras, etc. IGBTs from Renesas have high voltage, handle large currents, and are easy to drive. Models are now available in the TSSOP-8, currently the smallest possible package. In an industry first, we've reduced the minimum drive voltage from 4 V to 2.5 V. This contributes to the elimination of internal power supplies, reducing the sizes of cameras.

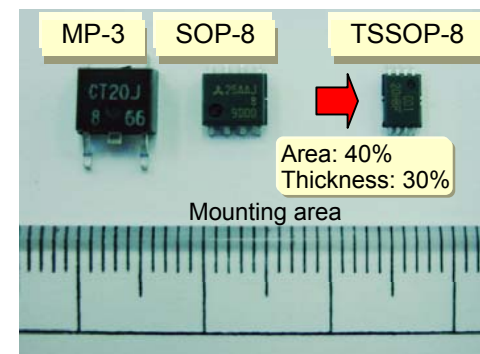
- Features

- Adoption of a small, thin package for surface mounting ⇒ TSSOP-8
- Large-current (150 A) control with low voltage ⇒ 2.5 V/4 V
- Zener diode between the gate and the emitter ⇒ high static-electricity tolerance

- Product Lineup

Type No.	V _{CES} (V)	ICP (A)	Drive (V)	Package
CY25BAJ-8F	400	150	4	TSSOP-8
CY25BAH-8F	400	150	2.5	TSSOP-8

- Appearance



A List of IGBT Products for Strobe-Flash Usage

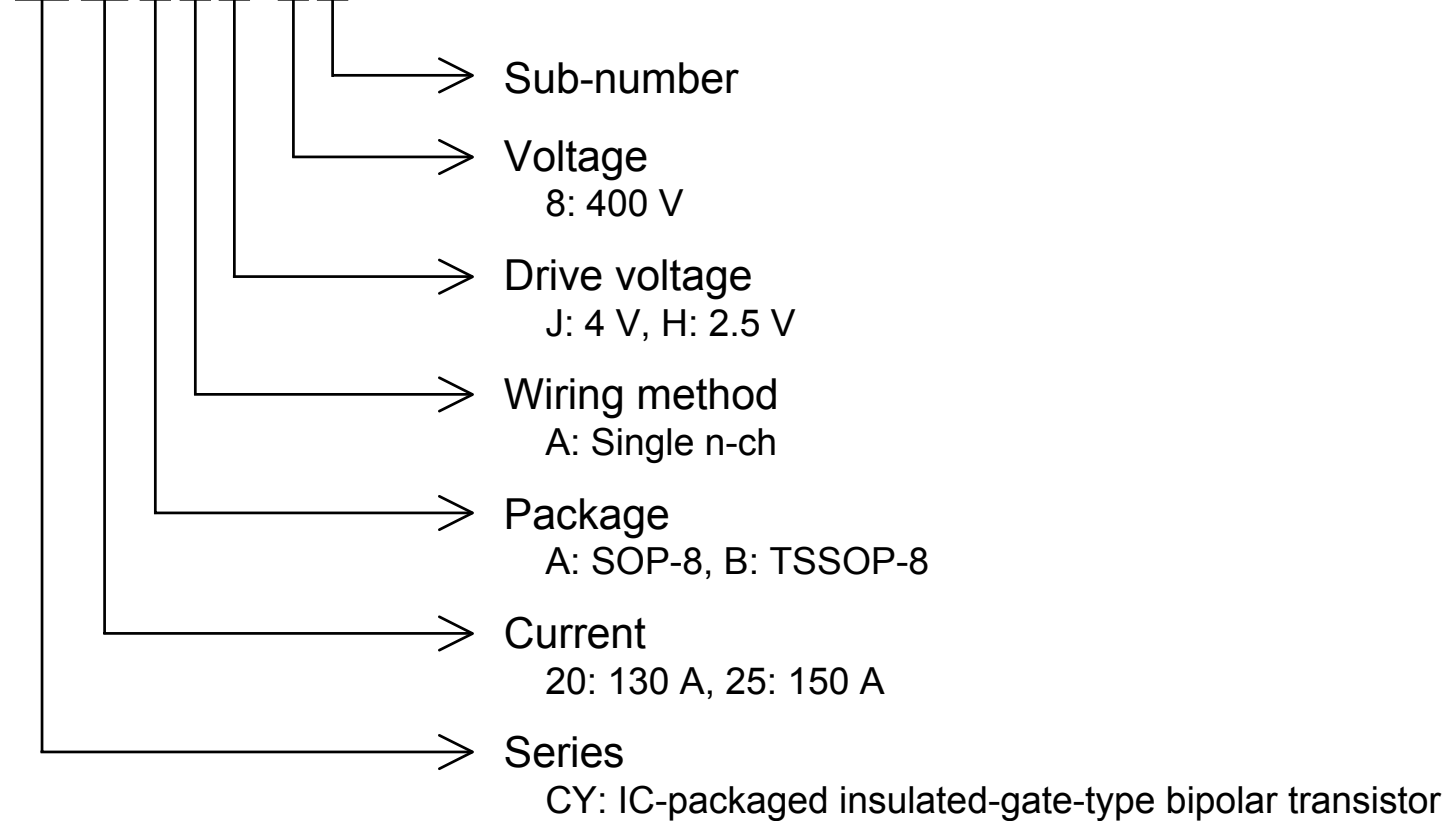
Type No.	Maximum Ratings			Package
	V_{CES} (V)	ICP (A)	Drive (V)	
CY20AAJ-8	400	130	4	SOP-8
CY20AAJ-8F	400	130	4	SOP-8
CY20AAJ-8H*	400	130	4	SOP-8
CY25AAJ-8	400	150	4	SOP-8
CY25AAJ-8F	400	150	4	SOP-8
CY25BAJ-8F	400	150	4	TSSOP-8
CY25BAH-8F	400	150	2.5	TSSOP-8
CT40KM-8H*	400	200	30	TO-220FN

* For high-frequency light emission

Description of Product Names of IGBTs for Strobe-Flash Usage

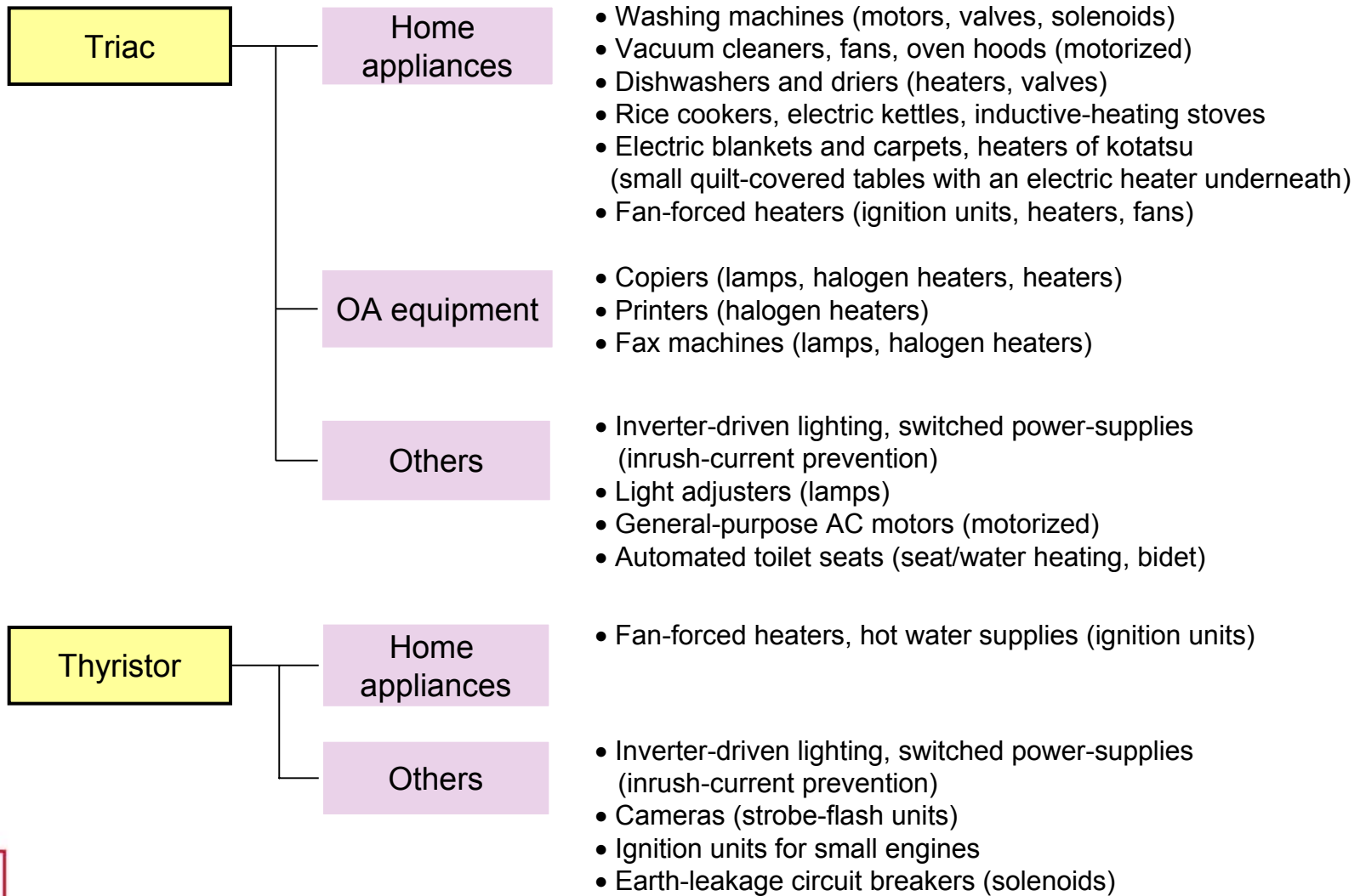
IGBT CY series for driving strobe-flash usage

CY 25 A A J - 8 F



Triacs and Thyristors

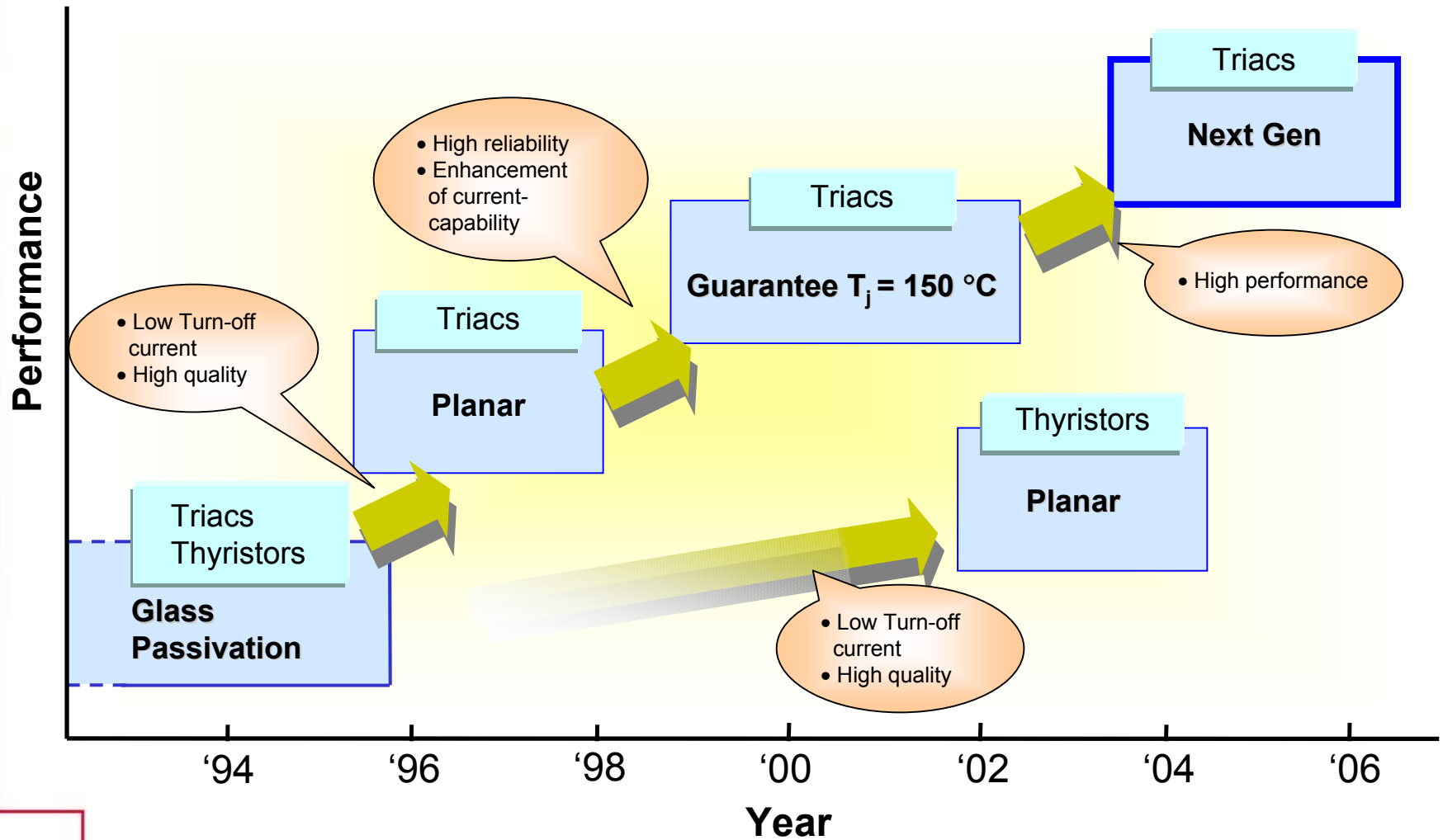
Applications of Triacs and Thyristors



Support for Application Devices by Triacs and Thyristors

Product	Application Device	Requirements	Support
Triac	Copier, printer, washing machine, vacuum cleaner, fan, toilet seat with heated water bidet, etc.	<ul style="list-style-type: none"> • High quality • High-temperature guarantee • Simplified circuit 	<ul style="list-style-type: none"> • 150°C guarantee (planar) • High voltage • Development of next-generation product
Thyristor	Ignition device, leakage breaker, strobe flasher, inverter light	<ul style="list-style-type: none"> • Large-current control • Small package • High quality 	<ul style="list-style-type: none"> • Development of products with SC-59 package for strobe flasher, trigger • Planar • Development of products in small surface mounting packages

Triac and Thyristor Roadmap



Features of Thyristors and Triacs from Renesas

- Guaranteed operation for triacs at a junction temperature of 150°C: an industry first
 - Triacs: 3 to 30 A: 28 types
 - Note: Unless the delivery specification indicates the 150°C-guaranteed product, we will deliver the general-purpose (125°C-guaranteed) product.
- Comprehensive range of product series
 - Triacs: 0.8 to 30 A, 40 types (general-purpose products)
 - Thyristors: 0.3 to 12 A, 16 types
- These products are suitable when you need:
 - High tolerance against surge currents
 - Small and thin packages
 - Guaranteed commutation
 - Support for IGT items
- Range enriched by the addition of high-voltage products

Features of Triacs for Guaranteed Operation at Junction Temperature = 150°C

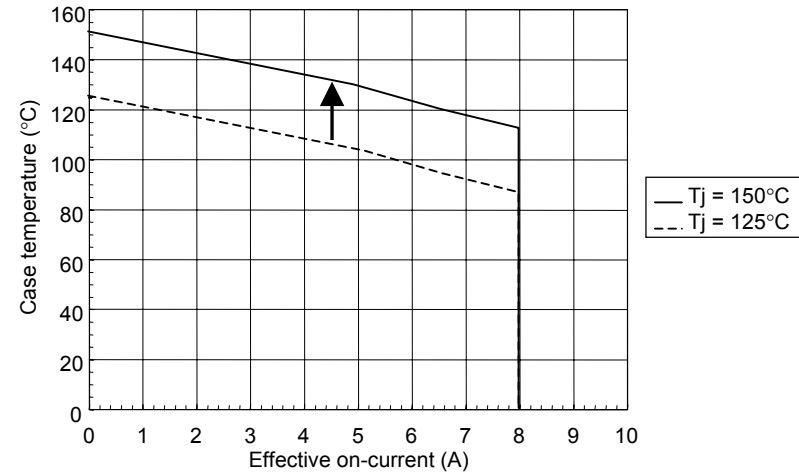
- Functional Outline
 - Rated for guaranteed operation with a junction temperature of 150°C (previously 125°C)
 - Increased current capacity through increased rated temperature
 - Adoption of a planar structure

- Product Types
3 to 30-A/400 to 600-V general-purpose triacs are listed below.

Package	Type No.
TO-220	BCR5/6/20AM-12LB BCR8/10/12/16CM-12LB
TO-220FN	BCR3/5/8/10/12/16/12KM-12LB
TO-220FN	BCR3/5KM-12RB
TO-220S	BCR8/10/12/16CS-12RB
TO-3P	BCR30AM-12LB

- Sales Points
 - Small off-current at high temperatures
Smaller off-current due to replacement of glass structure by planar structure
 - Larger thermal design margins ease design.
E.g. When design margin is 80%,
 $T_j = 150 \times 80\% = 120^\circ\text{C}$
Conventionally, $T_j = 125 \times 80\% = 100^\circ\text{C}$, that is, the limit is now 20°C higher.

- Increased Current Capacity (e.g., BCR8KM-12L*)



- Smaller radiating fin: Area is reduced to 1/4
E.g. For a BCR8KM when $T_a = 60^\circ\text{C}$, $I_{T(RMS)} = 8\text{ A}$,
 $R_{th}(f-a) = 4.8^\circ\text{C/W}$ (50 cm^2)
(conventionally $R_{th}(f-a) = 2.3^\circ\text{C/W}$ (200 cm^2);
the area has thus been quartered).
- A radiating fin is not necessarily required
E.g. BCR3KM $T_a = 80^\circ\text{C}$, 100-VAC/140-W heater control
 $\rightarrow T_j = 1.3\text{ W} \times 50^\circ\text{C/W} + 80 = 145^\circ\text{C}$
- High reliability
- Usable in high-temperature environments



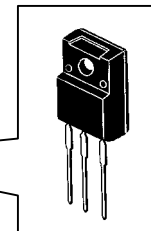
150°C-Guaranteed Triacs in a TO-220FN Package

- Outline

Raising the guaranteed junction temperature to 150°C makes this device suitable for controlling equipment that has relatively low inrush-current values, i.e. heaters such as ceramic heaters and small motors.

- Features

- Adoption of insulating-type package⇒TO-220FN (dielectric-breakdown tolerance of 2000 V is guaranteed)
- Maximum junction temperature⇒150°C guaranteed
- Highly tolerant of noise⇒IGT = 50 mA

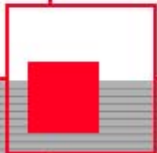


- Product Lineup

Type No.	I _{T(RMS)} (A)	V _{DRM} (V)	I _{TSM} (A)	IGT (mA)
BCR8KM-12LC	8	600	48	50
BCR10KM-12LC	10	600	60	50
BCR16KM-12LC	16	600	96	50
BCR5KM-14LC	5	700	30	50
BCR8KM-14LC	8	700	48	50

- Example of Usage in Ceramic Heater Control

Power-Supply Voltage	Load	Type No.
100 to 120 VAC	400 W	BCR5KM-14LC
	600 W	BCR8KM-12LC/BCR8KM-14LC
	800 W	BCR10KM-12LC
	1000 W	BCR16KM-12LC
	1200 W	BCR16KM-12LC
200 to 240 VAC	400 W	BCR5KM-14LC
	600 W	BCR5KM-14LC
	800 W	BCR5KM-14LC
	1000 W	BCR8KM-12LC/BCR8KM-14LC
	1200 W	BCR8KM-12LC



150°C Guaranteed Triac Lineup

TO-220 package

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR5AM-12LB	5	50	600	720	20
BCR6AM-12LB	6	60	600	720	30
BCR8CM-12LB	8	80	600	720	30
BCR10CM-12LB	10	100	600	720	30
BCR12CM-12LB	12	120	600	720	30
BCR16CM-12LB	16	170	600	720	30
BCR20AM-12LB	20	200	600	720	30

TO-220FN package (general use)

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR3KM-12LB	3	30	600	720	20
BCR5KM-12LB	5	50	600	720	20
BCR8KM-12LB	8	80	600	720	30
BCR8KM-12LC	8	48	600	720	50
BCR10KM-12LB	10	100	600	720	30
BCR10KM-12LC	10	60	600	720	50
BCR12KM-12LB	12	120	600	720	30
BCR16KM-12LB	16	160	600	720	30
BCR16KM-12LC	16	96	600	720	50
BCR20KM-12LB	20	200	600	720	30
BCR5KM-14LC	5	30	600	720	50
BCR8KM-14LC	8	48	600	720	50

TO-220FN package (resistance load)

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR3KM-12RB	3	30	600	720	15
BCR5KM-12RB	5	50	600	720	15

TO-220S package

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR8CS-12LB	8	80	600	720	30
BCR10CS-12LB	10	100	600	720	30
BCR12CS-12LB	12	120	600	720	30
BCR16CS-12LB	16	170	600	720	30

TO-3P package

Type No.	IT(RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR30AM-12LB	30	300	600	720	50

125°C Guaranteed Triac Lineup

TO-220 package

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR5AM-12LA	5	50	600	720	20
BCR6AM-12LA	6	60	600	720	30
BCR8CM-12LA	8	80	600	720	30
BCR10CM-12LA	10	100	600	720	30
BCR12CM-12LA	12	120	600	720	30
BCR16CM-12LA	16	170	600	720	30
BCR20AM-12LA	20	200	600	720	30

TO-220FN package

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR3KM-12LA	3	30	600	720	20
BCR5KM-12LA	5	50	600	720	20
BCR8KM-12LA	8	80	600	720	30
BCR10KM-12LA	10	100	600	720	30
BCR12KM-12LA	12	120	600	720	30
BCR16KM-12LA	16	160	600	720	30
BCR20KM-12LA	20	200	600	720	30
BCR3KM-14LA	3	30	700	840	30
BCR5KM-14LA	5	50	700	840	30
BCR8KM-14LA	8	80	700	840	30
BCR12KM-14LA	12	120	700	840	30
BCR8KM-16LA	8	80	800	960	30
BCR8KM-20LA	8	80	1000	1200	30

TO-220F package (resistance load)

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR2PM-12RA	2	10	600	720	10 (2, 3)

TO-220FN package (resistance load)

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR3KM-12RA	3	30	600	720	15
BCR5KM-12RA	5	50	600	720	15

MP-3A/DPAK (L) package

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR3AS-12LA	3	30	600	720	15
BCR5AS-12LA	5	50	600	720	30

TO-220S package

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR8CS-12LA	8	80	600	720	30
BCR10CS-12LA	10	100	600	720	30
BCR12CS-12LA	12	120	600	720	30
BCR16CS-12LA	16	170	600	720	30

TO-92 package

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR08AM-12A	0.8	8	600	720	5 (2, 3)
BCR1AM-12	1	10	600	720	5 (4 = 10)
BCR1AM-12A	1	10	600	720	7 (1, 2, 3)
BCR08AM-14	0.8	8	700	840	5 (2, 3)

SOT-89 package

Type No.	IT (RMS) (A)	ITSM (A)	VDRM (V)	VDSM (V)	IGT (mA)
BCR08AS-12A	0.8	8	600	720	5 (4 = 10)

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MP-3A/DPAK (L) package

Type No.	IT(AV) (A)	ITSM (A)	VDRM (V)	IGT (mA)	VGT (V)
CR3AS-12	3	90	600	0.1	0.8
CR5AS-12	5	90	600	0.1	0.8

SC-59 package

Type No.	IT(AV) (A)	ITSM (A)	VDRM (V)	IGT (mA)	VGT (V)
CR05BS-8	0.1	10	400	0.1	0.8

SOT-89 package

Type No.	IT(AV) (A)	ITSM (A)	VDRM (V)	IGT (mA)	VGT (V)
CR05AS-8	0.5	10	400	0.1	0.8
CR08AS-12	0.8	10	600	0.1	0.8

TO-220 package

Type No.	IT(AV) (A)	ITSM (A)	VDRM (V)	IGT (mA)	VGT (V)
CR12CM-12	12	360	600	30	1.5

TO-92 package

Type No.	IT(AV) (A)	ITSM (A)	VDRM (V)	IGT (mA)	VGT (V)
CR02AM-8	0.3	10	400	0.1	0.8
CR03AM-12	0.3	20	600	0.1	0.8
CR05AM-12	0.3	10	600	0.1	0.8
CR04AM-12	0.4	10	600	0.1	0.8
CR03AM-16	0.3	20	800	0.1	0.8
CR05AM-16	0.3	10	800	0.1	0.8

TO-220FN package

Type No.	IT(AV) (A)	ITSM (A)	VDRM (V)	IGT (mA)	VGT (V)
CR3KM-12	3	70	600	0.1	0.8
CR6KM-12	6	90	600	10	1.0
CR8KM-12	8	120	600	15	1.0

Renesas Power MOS FETs, IGBTs, Triacs, and Thyristors Products

Publication Date: Rev.4.00, April 23, 2004

Published by: Sales Strategic Planning Div.

Renesas Technology Corp.

Edited by: Technical Documentation & Information Department

Renesas Kodaira Semiconductor Co., Ltd.

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REJ13G0003-0400Z

