



DIODES GROUP

TURIN BARE DIE OVERVIEW

JANUARY 2016

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A **WORLD OF**
SOLUTIONS





VISHAY ITALY INTRODUCTION



BORGARO Torinese s- ITALY

- ❖ In this location since 1969 (International Rectifier)
- ❖ Vishay site (Vishay Semiconductor Italiana) since 2007
- ❖ Borgaro Torinese (TORINO)
- ❖ 124,000 sq ft (11,500 m²)
- ❖ 240 employees
- ❖ 2 Class 1000 Fabs for planar platforms:
 - ✓ Fred Pt 200V – 600V
 - ✓ Hexfred 400V – 1200V
 - ✓ Schottky Gen2 15V – 150V:
- ❖ 1 Class 100 Fab for sub- μ m platforms:
 - ✓ Schottky Gen5 45V – 100V
 - ✓ New development
- ❖ Die Products (customized)

Vishay Company Confidential



BARE DIE ULTRAFAST DIODES PRODUCTS

1.0 Ultrafast diodes technology overview

1.1 Bare die Pt[®] Portfolio

1.2 Fred Pt[®] 200V features

1.3 Fred Pt[®] Gen4 600V-650V features

1.4 Fred Pt[®] 1200V features

1.5 Shipping package options

1.6 Nomenclature Guide

2.0 Planar Schottky

3.0 Standard Diode and Thyristors



Fred Pt[®] Hexfred[®] Bare Die Technology Overview

| Family Name | Voltage availability | | Tj Max | Life time control technology | Typical Trr @ If rated, 25°C | Passivation technology | Front Metal | Status |
|---------------|----------------------|----------------------------|--------|------------------------------|---|------------------------|-------------------|-------------|
| | min | Max | | | | | | |
| FRED Pt Gen 4 | | 600V 650V | 175°C | Platinum doping | from 12 ns to 100ns | Planar multiring | Bondable | New release |
| FRED Pt Gen 2 | | 650V | 175°C | Platinum doping | from 12 ns to 100ns | Planar multiring | Bondable | New release |
| FRED Pt Gen 2 | | 600V | 175°C | Platinum doping | from 12 ns to 100ns | Planar multiring | Solderable | |
| FRED Pt Gen 2 | 200V | 600V | 175°C | Platinum doping | from 12 ns to 100ns | Planar multiring | Bondable | |
| FRED Pt Gen 1 | 200V | 600V | 175°C | Platinum doping | from 12 ns to 100ns | Planar multiring | Bondable | |
| Tandem | 2x300V | | 175°C | Platinum doping | 11ns | Planar multiring | Bondable | |
| Fred Pt 1200V | | 1200V | 175°C | Platinum doping | from 30 ns to 150ns soft recovery feature | Planar multiring | Bondable | New release |
| Hexfred Gen2 | 400V | 1200V | 150°C | e- irradiation | from 30 ns to 150ns | Planar multiring | Bondable | |
| Hexfred Gen3 | 600V | 1200V | 150°C | e- irradiation + He Implant | from 50 ns to 150ns soft | Planar multiring | Bondable | |

In development

new release

Released



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Fred Pt[®] die Portfolio

Fred Pt[®] Die sales Product Portfolio - Tjmax=175°C

| | 1A | 1-3A | 4-5A | 6A-7A | 8A | 8-10A | 15A | 15-20A | 25-30A | 30-40A | 40-50A | 60A | 60-75A | 100A | 150A | 200A | 250A |
|------|--------|--------|--------|--------|--------|---------|--------|---------|---------|--------|---------|--------|---------|---------|---------|--------|--------|
| 200V | FD040H | FD046H | | FD080H | FD087H | | | FD122H | | FD160H | FD170H | | FD200H | | | | |
| 300V | | | | | | FD110H | | FD120H | | FD160H | FD170H | | | | | | |
| | | | | | | FD100H | | | | | | | | | | | |
| 400V | | | | | | FD090U | | FD120U | | FD160S | | | FD200S | | | | |
| | FD051H | FD056H | FD068H | FD072H | FD083H | FD097H | FD111H | FD117H | FD145H | | | | FD197H | 4FD282U | 4FD335U | FD378U | FD447U |
| | | FD056U | FD068U | FD072T | FD083W | FD097W | FD111W | FD117W | FD145U | | | | | 4FD282H | 4FD335H | FD378H | |
| 600V | | | | FD072U | FD083T | FD097T | FD111T | FD117T | 4FD156U | | 4FD198U | | 4FD236U | | | | |
| | | | | | | 4FD081U | FD111U | 4FD121U | 4FD156H | | 4FD198H | FD184U | 4FD236H | | | | |
| | | | | | | 4FD081H | | 4FD121H | | | | | | | | | |
| | | FD056H | | FD072H | FD083H | FD107 | | FD117H | FD145H | FD157H | | FD184H | FD197H | FD310H | FD394H | FD378U | FD447U |
| 650V | | | | | | | | 4FD121U | FD145W | | | FD184W | | FD310W | | FD378H | |
| | | | | | | | | 4FD121H | 4FD156U | | 4FD198U | | 4FD236U | 4FD282U | 4FD335U | | |
| | | | | | | | | | 4FD156H | | 4FD198H | | 4FD236H | 4FD282H | 4FD335H | | |

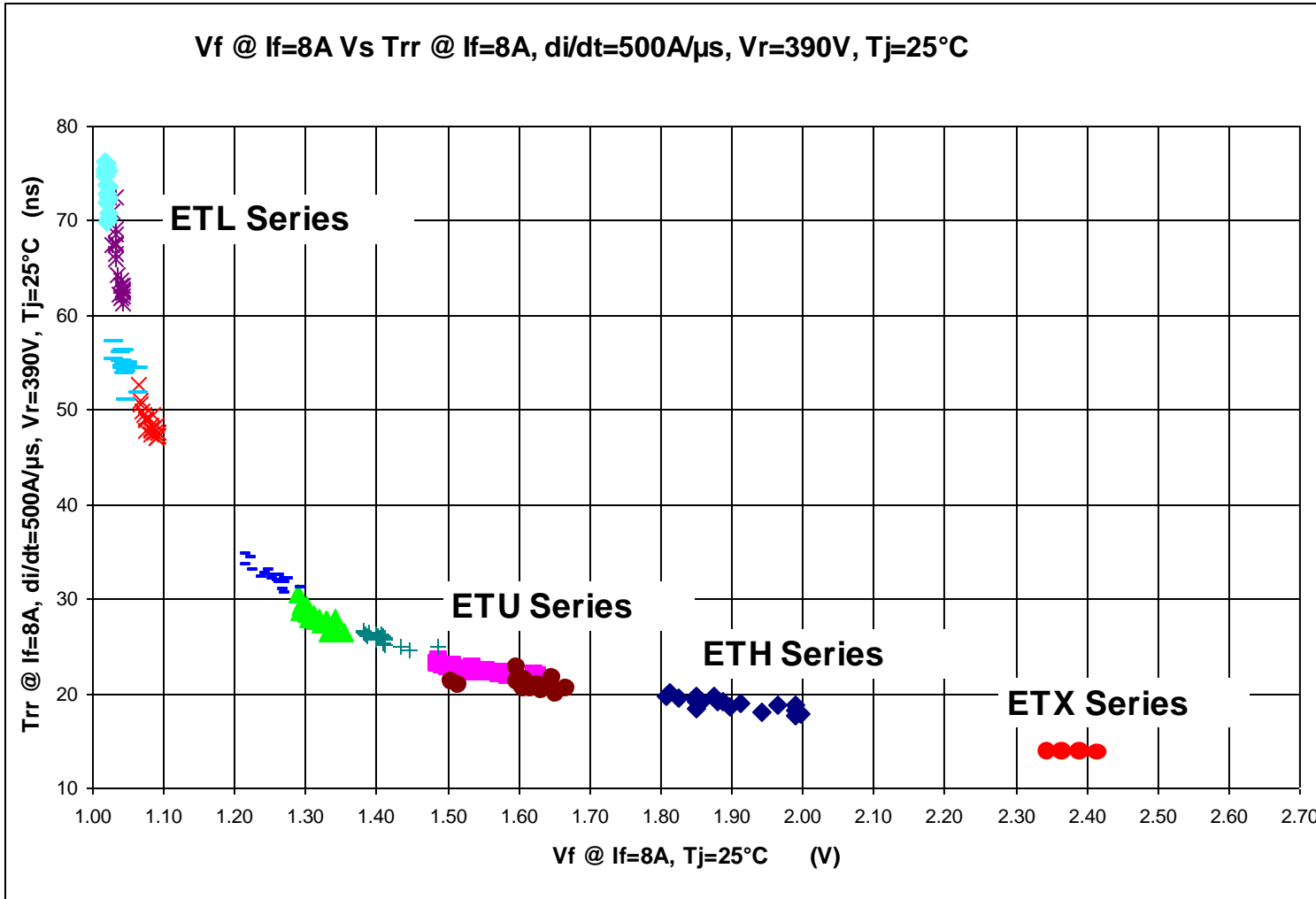
| W | H | U | S | L |
|-------|-------|-------|-------|--------|
| <18ns | <35ns | <50ns | <90ns | <120ns |

| |
|------------------------------|
| Fred Pt [®] Gen 1 |
| Fred Pt [®] Gen 2 |
| Fred Pt [®] Gen 4 - |





Fred Pt[®] 600V – Trade-off



Fred Pt adopting Vishay proprietary process offers a high level of flexibility for almost all high frequency application, with excellent trade off with Vf.

COMPANY CONFIDENTIAL



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1.2 Fred Pt[®] 200V features

1.3 Fred Pt[®] Gen4 600V-650V features

1.4 Fred Pt[®] 1200V features

1.5 Shipping package options

1.6 Nomenclature Guide

2.0 Planar Schottky

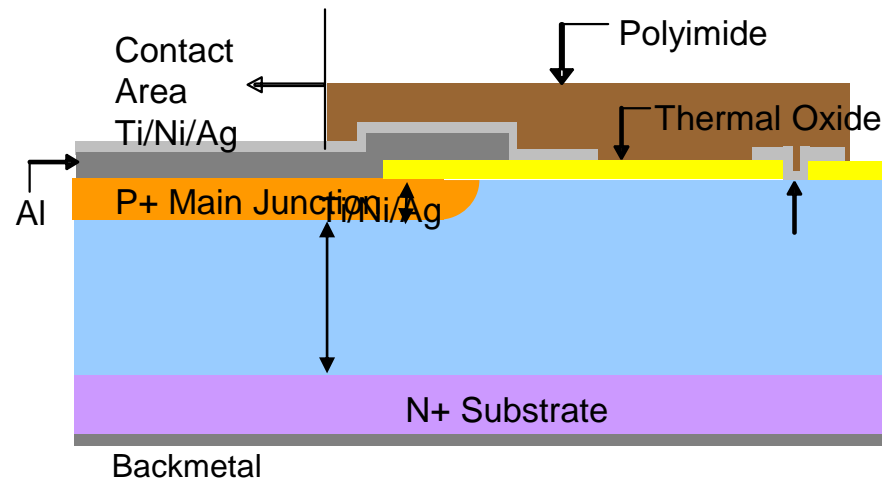
3.0 Standard Diode and Thyristors



Vishay Fred Pt[®] technology advantages

Main features for the Fred Pt technology die are:

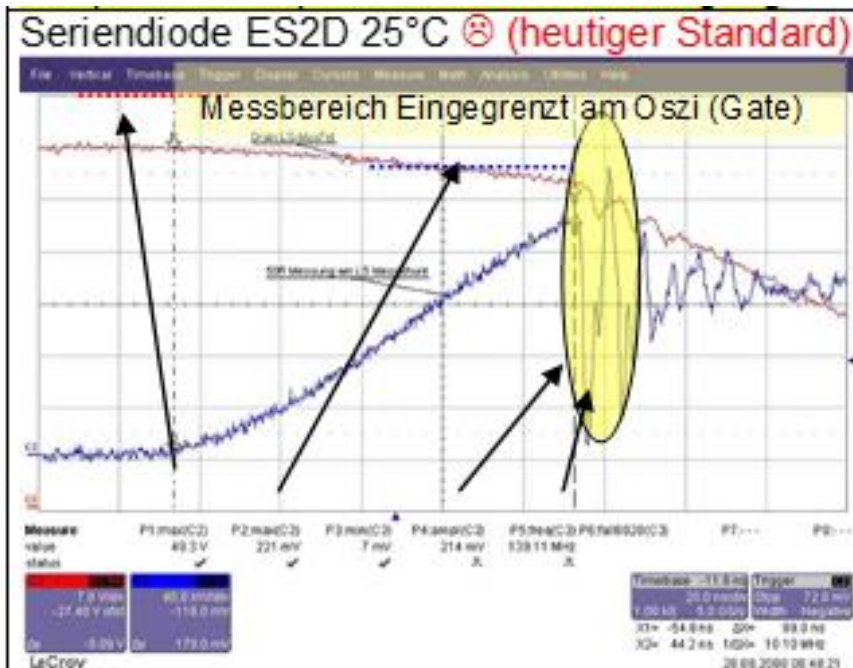
- ✓ $T_{jmax}=175^{\circ}C$
- ✓ Can offer flexible V_f/Q_{rr} trade off (from DCM to CCM)
- ✓ Current range: 1Amp to 200Amp chip
- ✓ Voltage range: dedicated silicon for 200V, 300V, 400V, 600V, 650V
- ✓ Use Polimide passivation (std & AEC Q101) for 200V,600V,650V,1200V
- ✓ All parts qualified based on 1000h HTRB
- ✓ **Soft recovery behavior at any temperature**





Fred Pt[®] 200V Ultrafast diode: 25°C behaviour

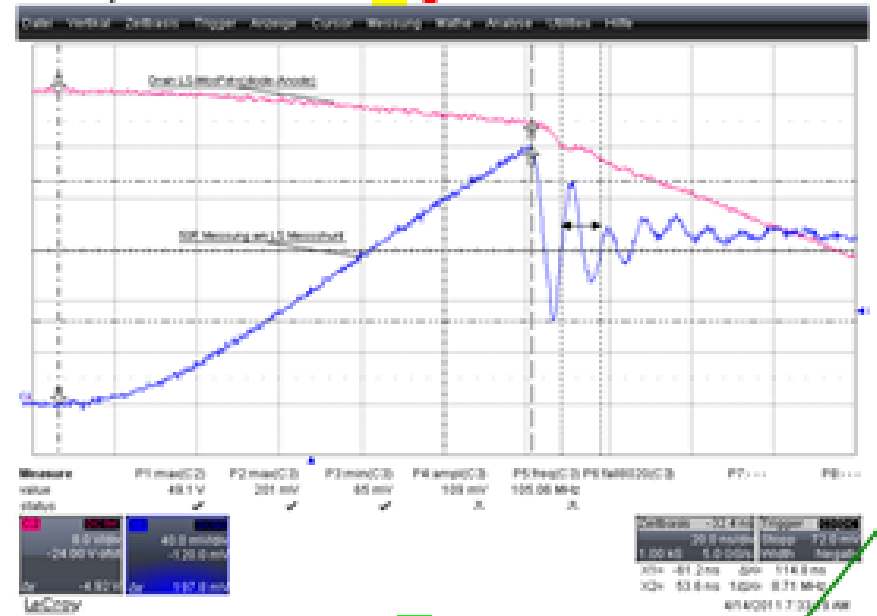
Industry Std 2A,200V



Fred Pt[®] 2A,200V

VS-2EGH02HM3

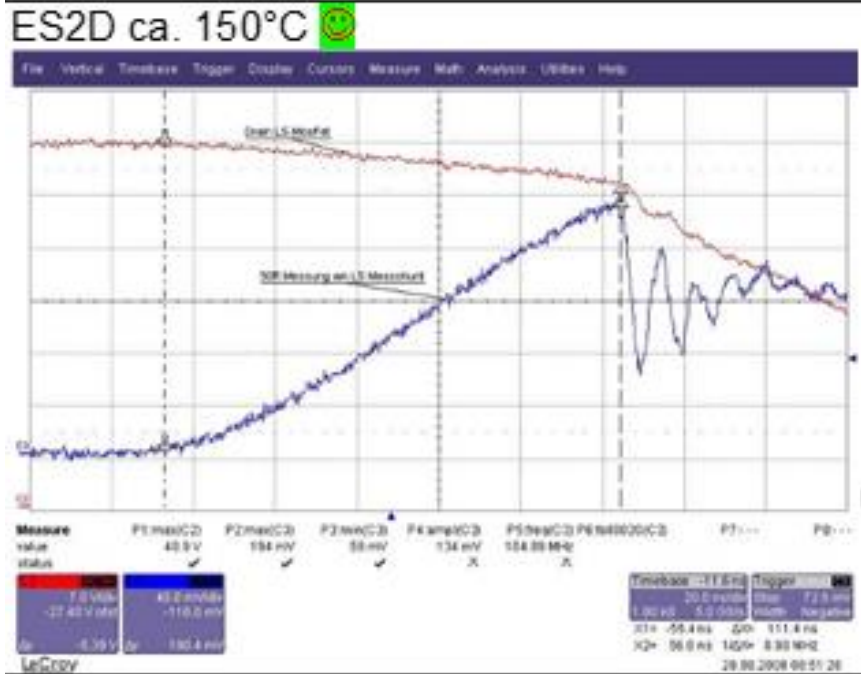
Group B3 ca. 25°C ☺️ gut





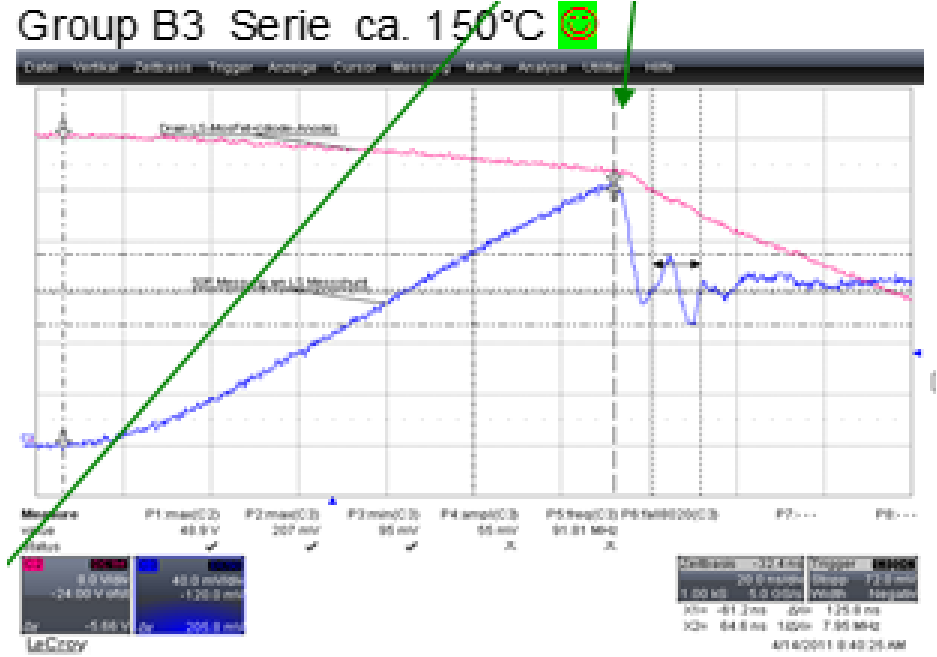
Fred Pt® 200V Ultrafast diode: 150°C behaviour

Industry Std 2A,200V



Fred Pt® 2A,200V

VS-2EGH02HM3





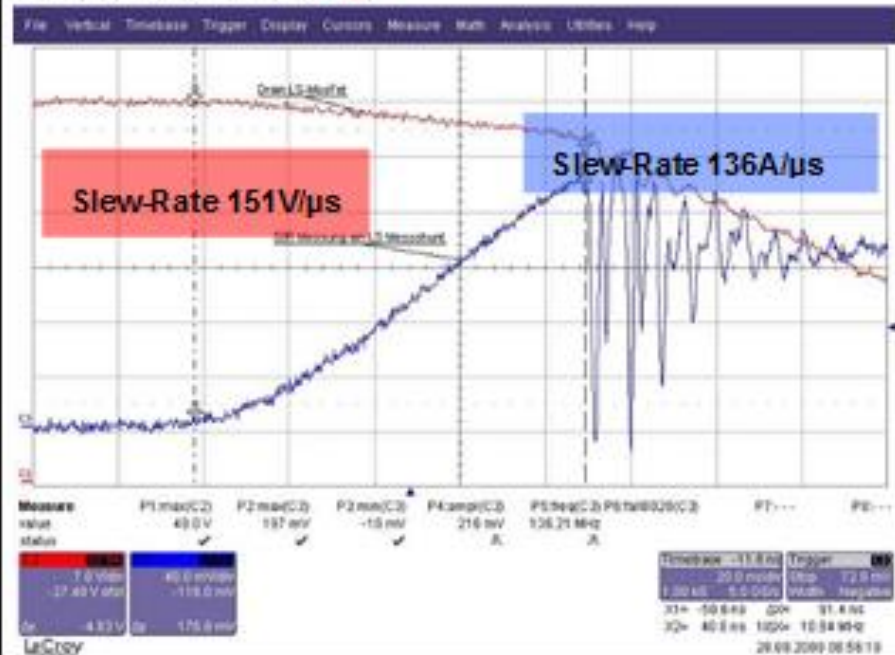
Fred Pt[®] 200V Ultrafast diode: -40°C behaviour

Industry Std 2A,200V

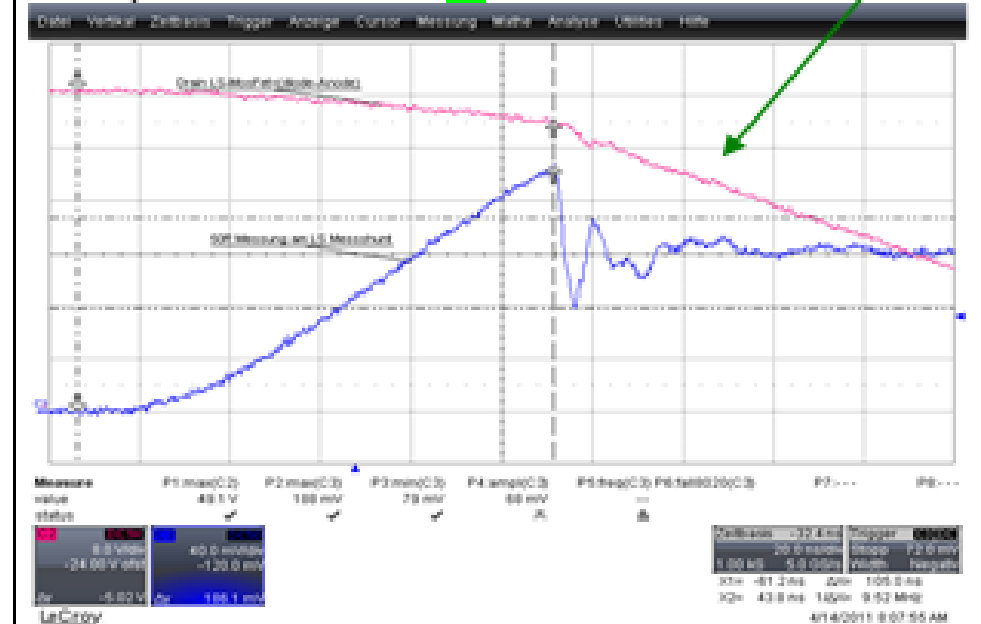
Fred Pt[®] 2A,200V

VS-2EGH02HM3

ES2D ca. -40°C ☹️



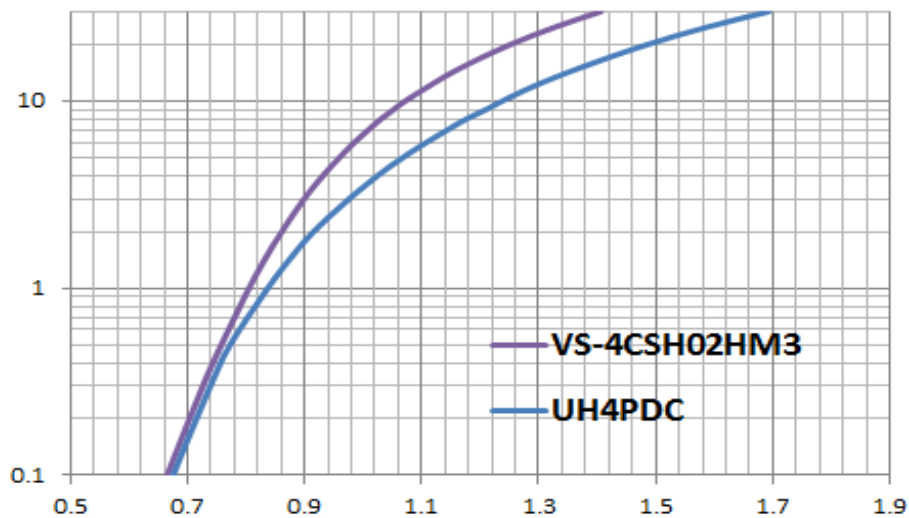
Group B3 ca. -40°C 😊



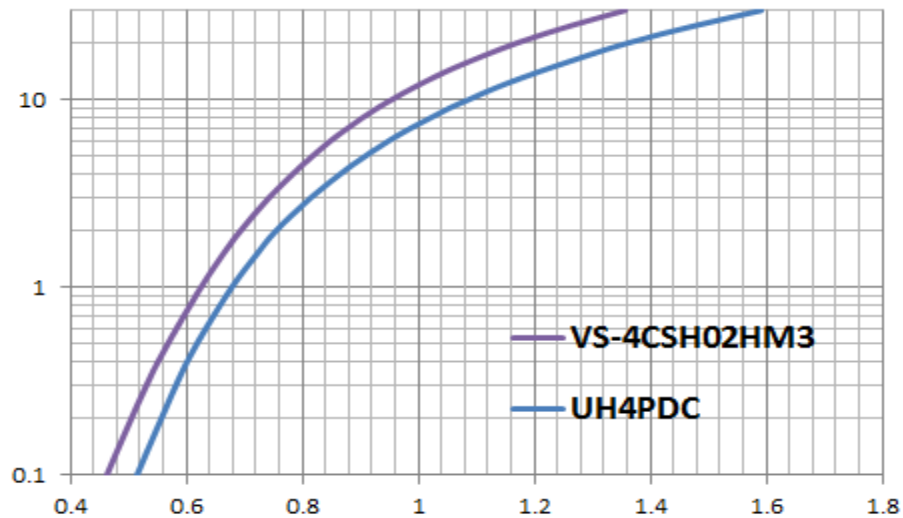


Fred Pt[®] 200V – low Vf, soft recovery

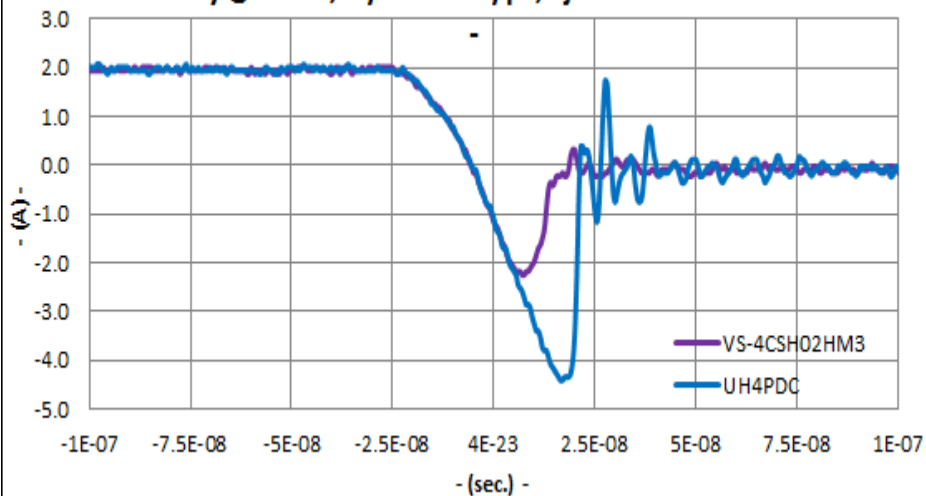
Vf @25°C



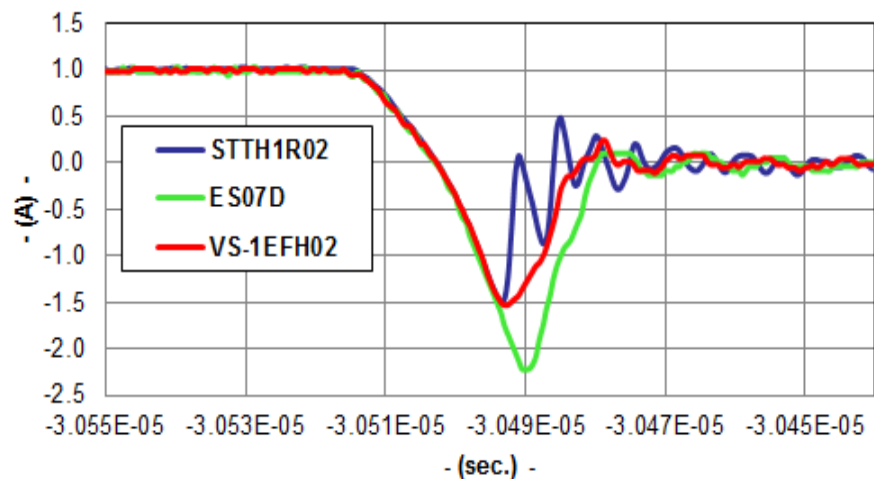
Vf @150°C



Recovery @ If=2A, di/dt=200A/μs, Tj=25°C - Hard Mode



Recovery characteristics @ If=1A - di/dt=200A/μs - Tj=25°C





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1.2 Fred Pt[®] 200V features

1.3 Fred Pt[®] Gen4 600V-650V features

1.4 Fred Pt[®] 1200V features

1.5 Shipping package options

1.6 Nomenclature Guide

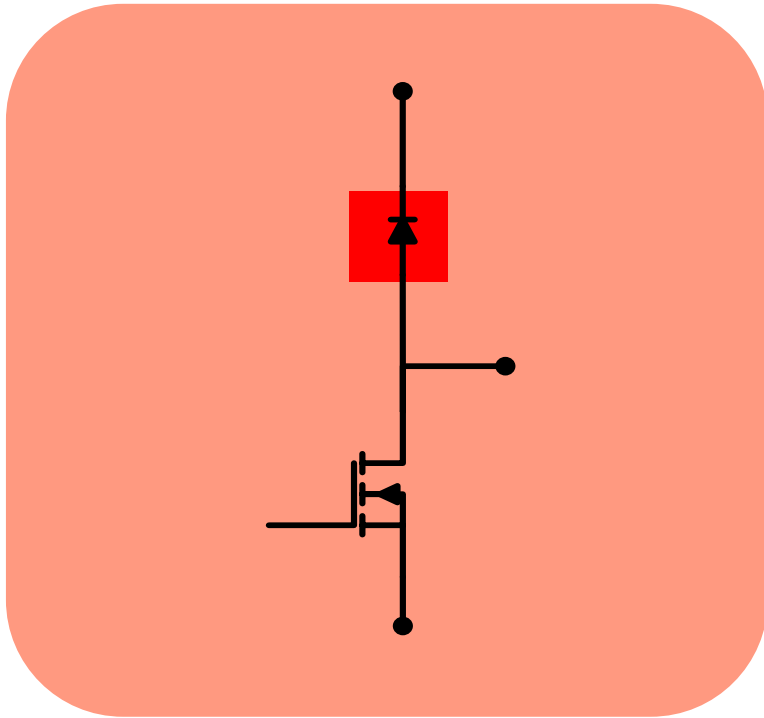
2.0 Planar Schottky

3.0 Standard Diode and Thyristors

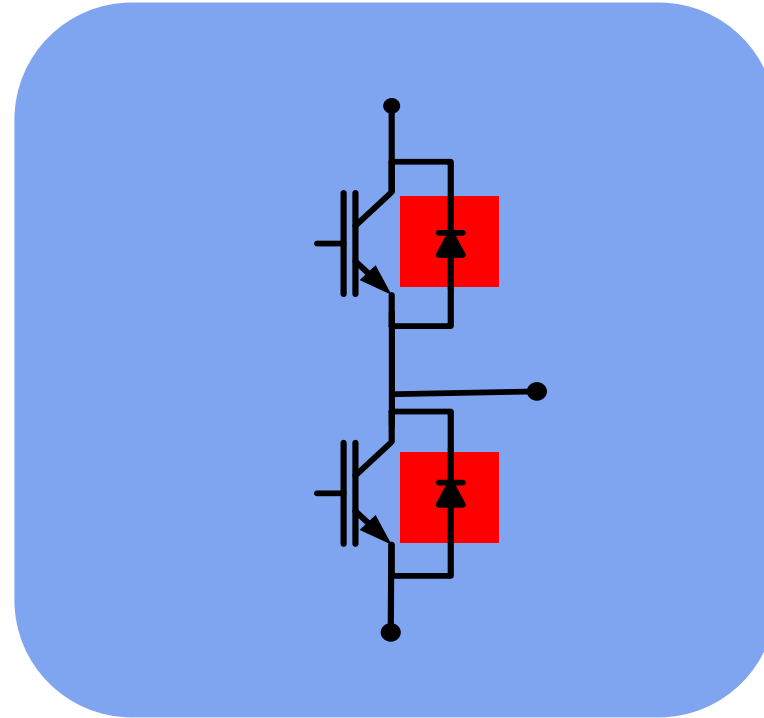


FRED PT 600V & 650V

- MAIN ULTRAFAST DIODEs APPLICATION



BOOST

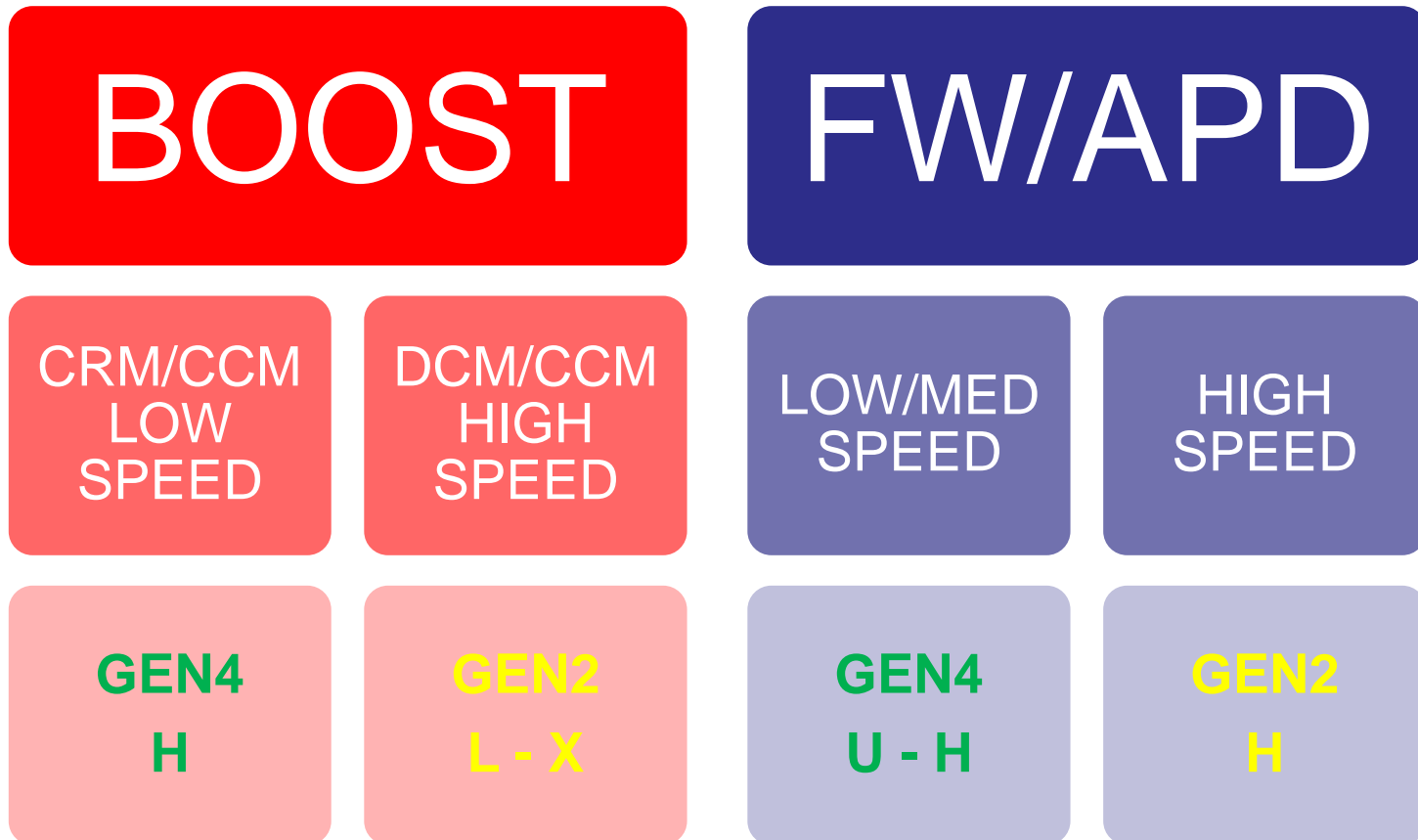


FW/APD



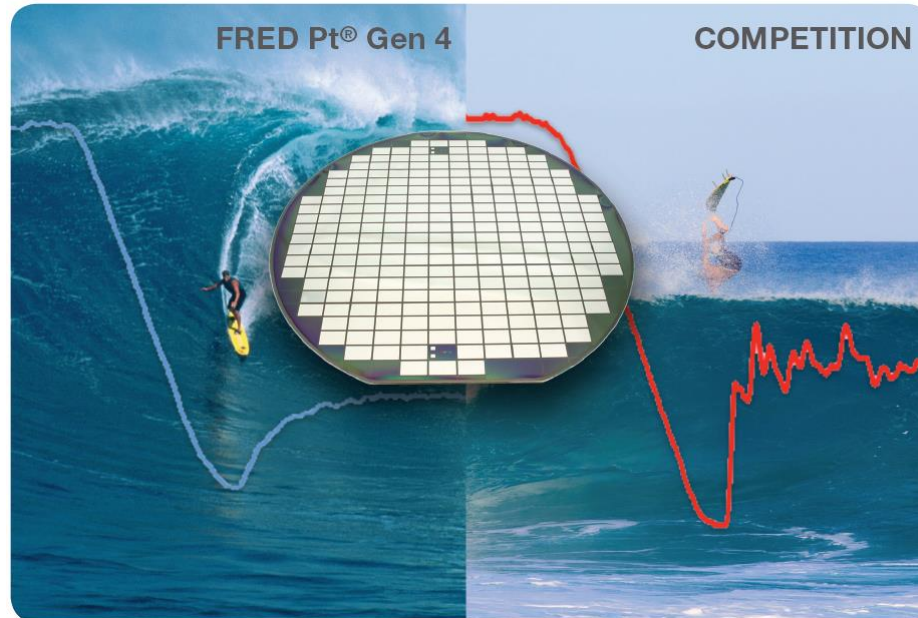
FRED GEN 4 PT 600-650V

- Right companion for Low/High Speed IGBTs in their Typical Application
- Gen4 has been developed to the Best combination with IGBT and to reduce its losses





FRED PT GEN4 ® 600/650V - FEATURES



| TECHNOLOGY FEATURES | | APPLICATION BENEFIT |
|---------------------|---------------|------------------------|
| 1 | SOFTNESS | EMI, NO VOLTAGE SPIKES |
| 2 | LOW I_{RRM} | EMI, EFFICIENCY |
| 3 | LOW V_F | EFFICIENCY, THERMALS |
| 4 | LOW Q_{RR} | EFFICIENCY, THERMALS |

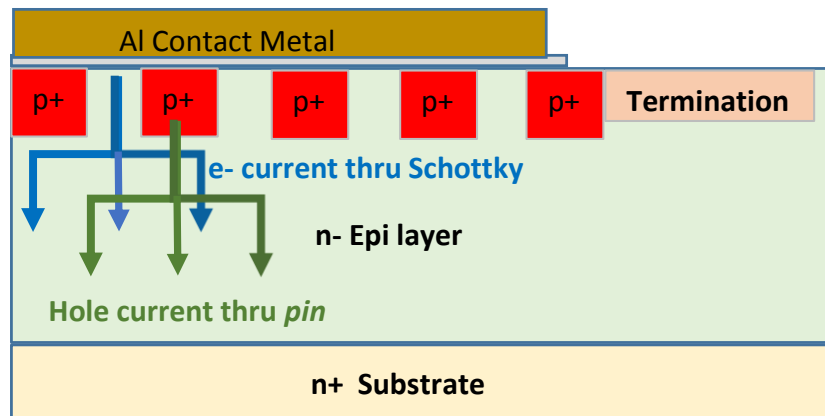


WHY

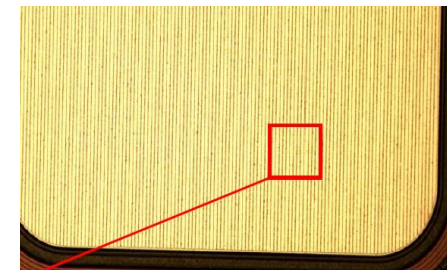
FRED PT GEN4 MERGED-PIN-SCHOTTKY STRUCTURE

- Submicron **MPS** structure means:
 - excellent VF, very high current density, soft reverse recovery performance at any di/dt
- Termination: High efficiency design blocks BV using less silicon
- Passivation: Highly reliable and moisture proof Polyimide **coating**

MPS Structure sketch



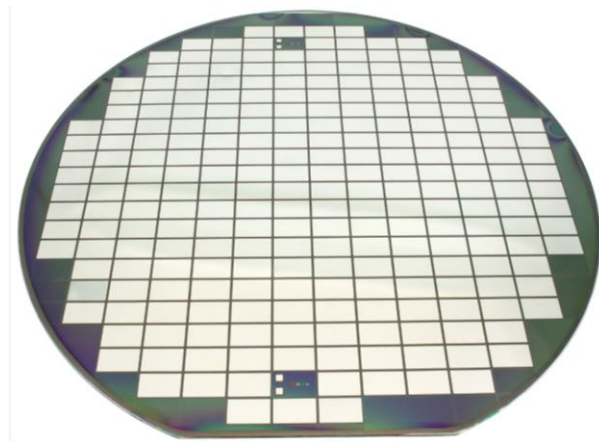
Schottky / pin alternation





FRED PT® GEN 4 DIODES CHIPS- ROADMAP

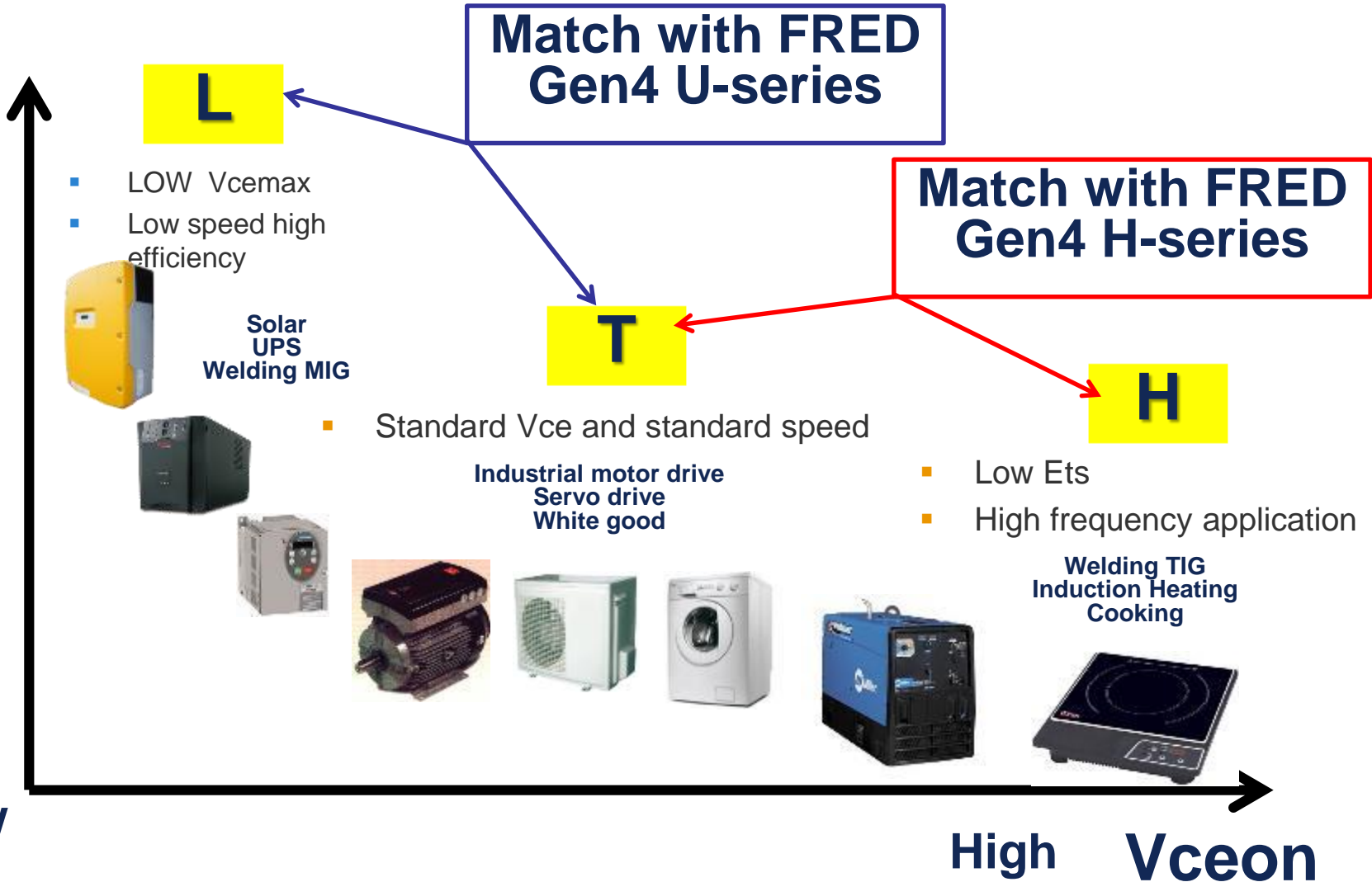
| <i>Rated VBR (V)</i> | 600 | 600 V & 650 V | | | | | | | 600 |
|--------------------------|--------------|--------------------------|-----------|-----------|-----------|------------|------------|------------|------------|
| <i>Rated ICE (A)</i> | 12 | 20 | 30 | 50 | 75 | 100 | 150 | 200 | 250 |
| Speed | U / H | | | | | | | | |
| Release | √ | √ | √ | √ | √ | √ | √ | √ | √ |





VISHAY IGBT AND FRED PT GEN 4

Ets
High





Design /Technology Benchmark

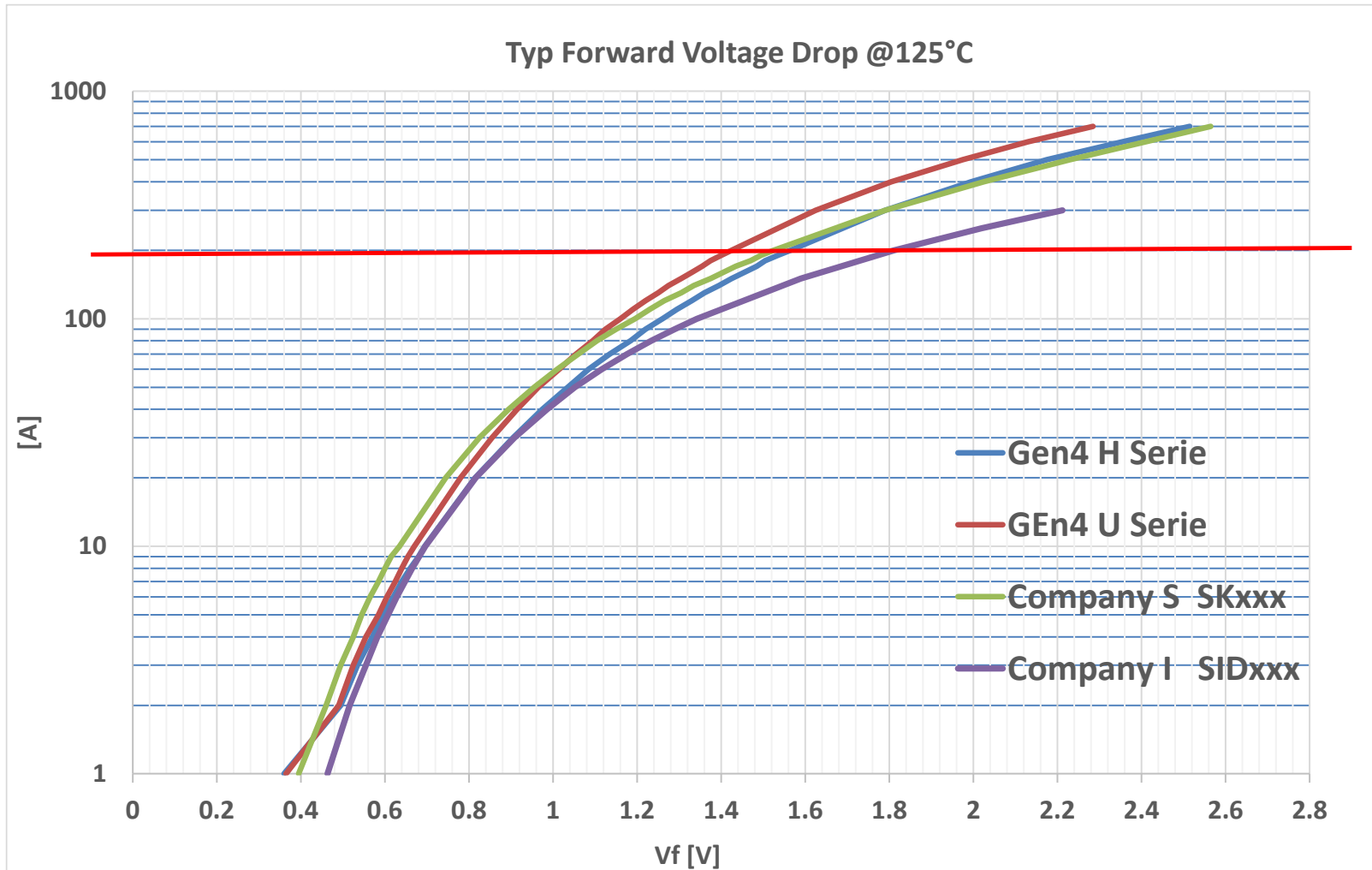
■ General Chip Size information:

| Series | Supplier | PN | Family | Rated current | Rated Voltage | Active Area Composition | Chip Thickness (μm) | Die size (mm x mm) | Area (mm ²) | Active Area (mm ²) |
|--------|-----------|-----------------|--------------|---------------|---------------|---------------------------------|---------------------|--------------------|-------------------------|--------------------------------|
| H | Vishay | VS-4FD378H7A6BC | Fred Gen 4 H | 200A | 650V | MPS Merged <i>pin</i> -Schottky | 250 | 9.601x6.045 | 58.04 | 50.76 |
| U | Vishay | VS-4FD378U7A6BC | Fred Gen 4 U | 200A | 650V | MPS Merged <i>pin</i> -Schottky | 250 | 9.601x6.045 | 58.04 | 50.76 |
| - | Company S | SK XXX | CAL-DIODE | 200A | 650V | <i>pin</i> | 238 | 9x9 | 81.00 | 70.12 |
| - | Company I | SID XXX | EMCON | 200 A | 650V | <i>pin</i> | 65 | 9.2x5.44 | 50.05 | 44.10 |



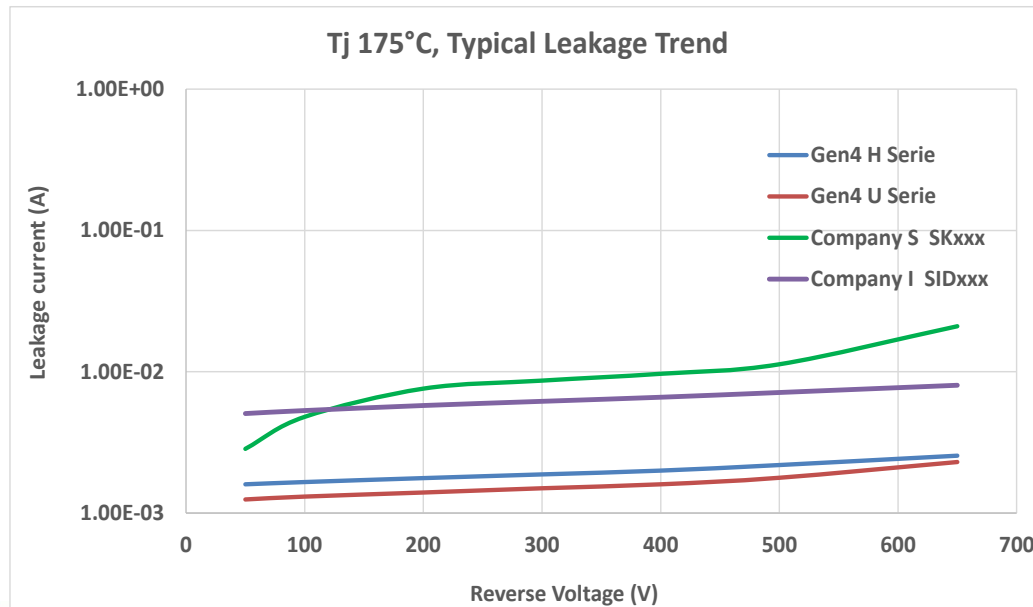
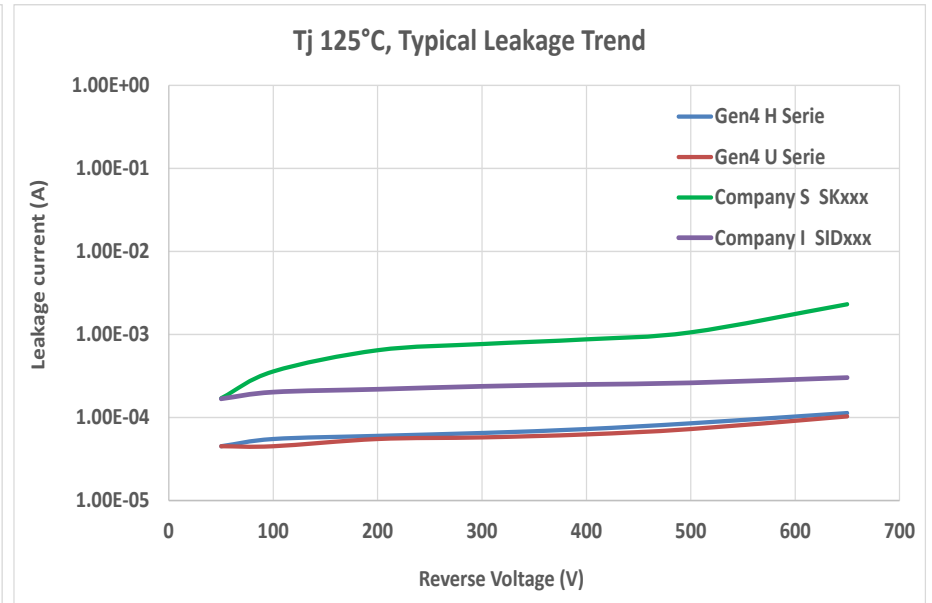
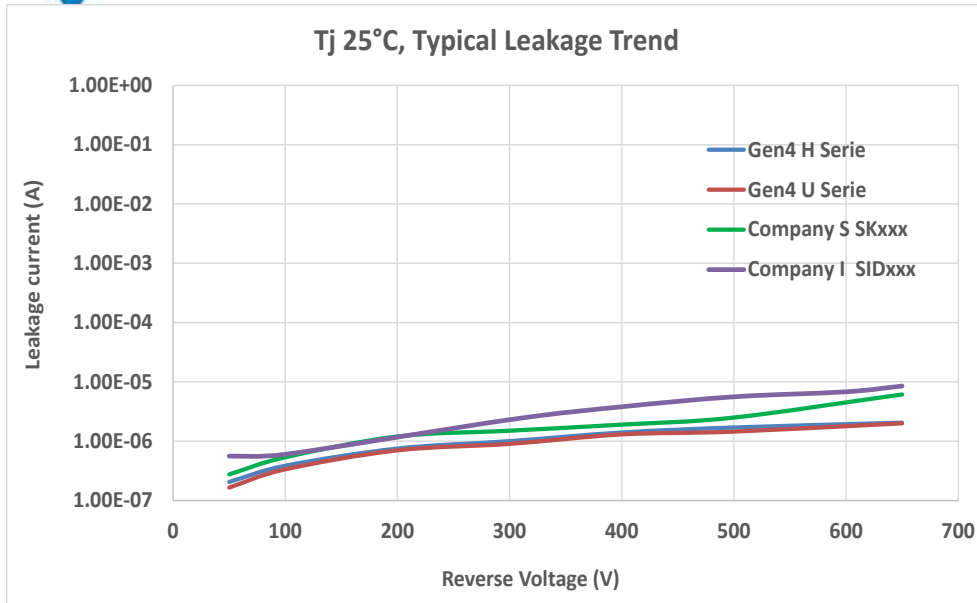
Static Characterization for 200Amp Gen4

- Vf curves are showed, measured on Real Devices at Vishay Eval. Lab
- Also showed Vf trend vs current Density, to evaluate Si usage and technology effect





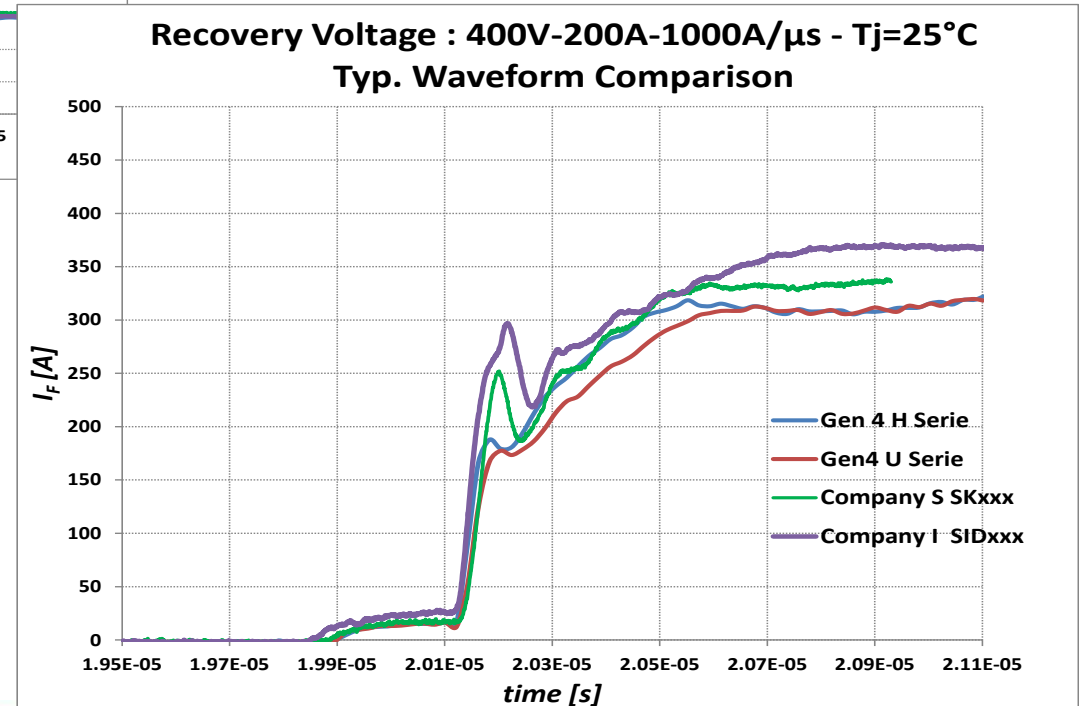
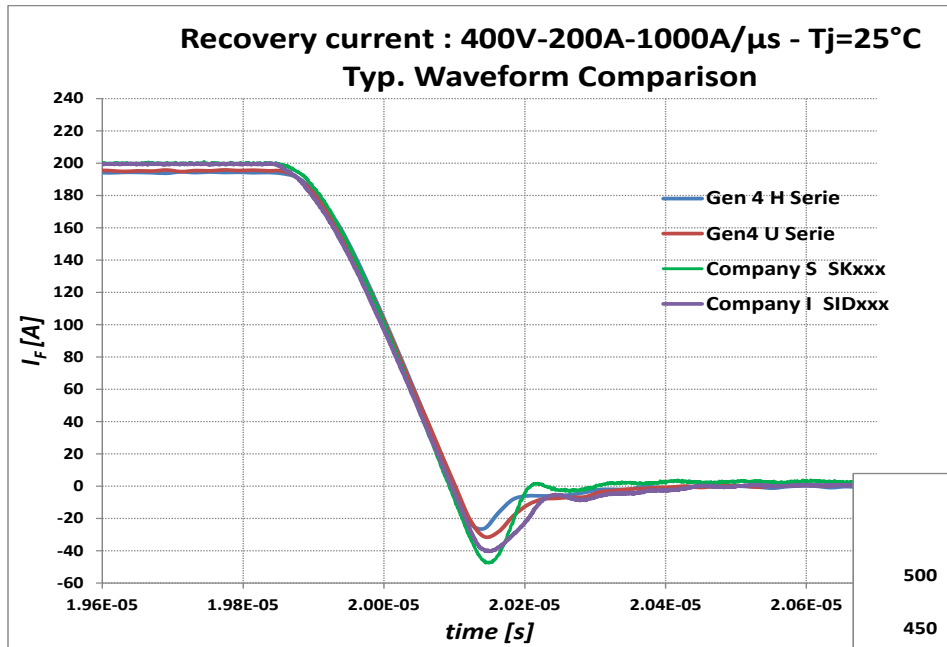
Static Characterization: Typical Leakage Trend





Dynamic Characterization: Reverse Recovery T_j 25° C

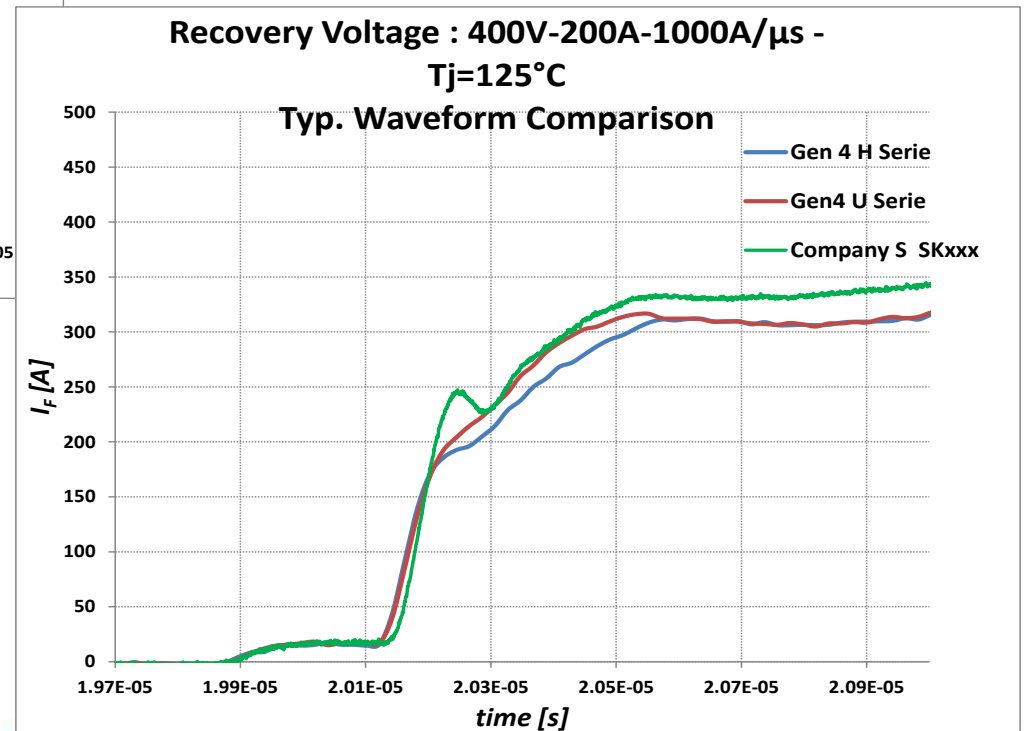
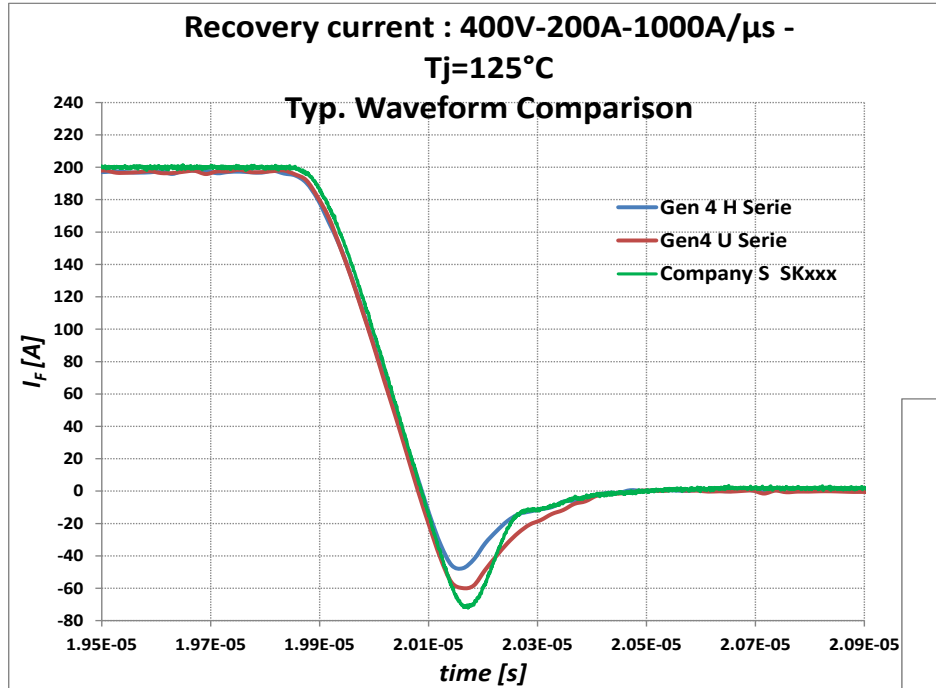
- Recovery Conditions: 25° C, 400V, 200A I_f , 1000A/usec





Dynamic Characterization: Reverse Recovery T_j 125° C

- Recovery Conditions: 125 C, 400V, 200A I_f , 1000A/usec
- Not showed IFX waveform: socket for high temp Test not available for its module





Build **Vishay**
into your **Design**



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1.3 Fred Pt[®] Gen4 600V-650V features

1.4 Fred Pt[®] 1200V features

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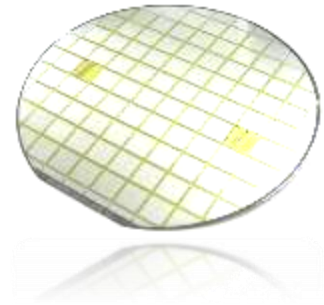
2.0 Planar Schottky

3.0 Standard Diode and Thyristors



Vishay Semiconductor Italiana S.P.A.

FRED PT **1200 V** PROJECT UPDATE





FRED Pt 1200V – Target Features Summary

| | TECHNOLOGY FEATURES | APPLICATION BENEFIT |
|---|---|--|
| 1 | IMPROVE PERFORMANCE/COST RATIO (BASELINE HF G3) | LOWER SYSTEM COST |
| 2 | $T_{J\text{MAX}} = 175^{\circ}\text{C}$ | RUGGEDNESS, MATCHING IGBTs EXTENDED RATINGS |
| 3 | LOW I_R | HIGH REL, LOW NO-LOAD LOSSES |
| 4 | SMALL CHIP SIZE | EASE OF USE IN MODULES AND DISCRETE COPACK |





FRED PT 1200V

Performances/Technology

- ✓ TJMax = 175°C (instead of current Tjmax=150°C)
- ✓ Dynamic Recovery, VF, BV baseline of Hexfred G3

Target Application:

- ✓ UPS, Motor drives and Inverter Apps
- ✓ All application targeted on Actual Hexfred 1200V platform

| Current Rating | Generic die sales PN | Fred Pt 1200V | | Hexfred Gen3 1200V | | Generic die sales PN |
|----------------|----------------------|---------------|----------|--------------------|----------|----------------------|
| | | X(mils) | Y (mils) | X(mils) | Y (mils) | |
| 8A 1200V | VS-FD128H12A6BC | 128 | 104 | 130 | 107 | VS-H3107D12A6B |
| 15A 1200V | VS-FD151H12A6BC | 151 | 112 | 155 | 115 | VS-H3115D12A6B |
| 25A 1200V | VS-FD215H12A6BC | 215 | 165 | 220 | 169 | VS-H3169D12A6B |
| 50A 1200V | VS-FD334H12A6BC | 334 | 188 | 340 | 195 | VS-H3195D12A6B |
| 75A 1200V | VS-FD432H12A6BC | 432 | 228 | 443 | 234 | VS-H3234D12A6B |
| 100A 1200V | VS-FD348H12A6BC | 348 | 348 | 357 | 357 | VS-H3357D12A6B |

Fred Pt allow a 5% die shrink vs current Hexfred G3

Selling points

- Cost effective
- Performance in line with Hex G3
- Tjmax=175°C (Tj=Top)



1200V FRED PT

25Amp 1200V evaluation

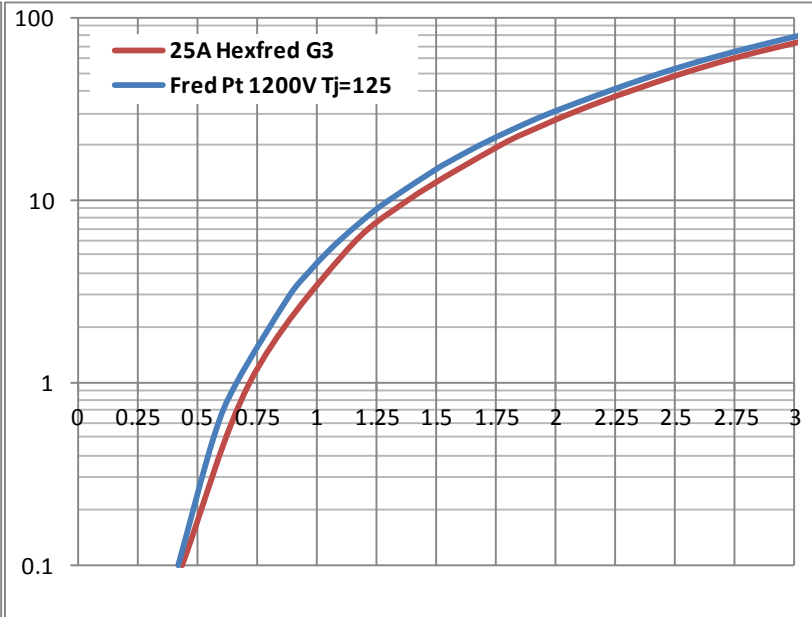
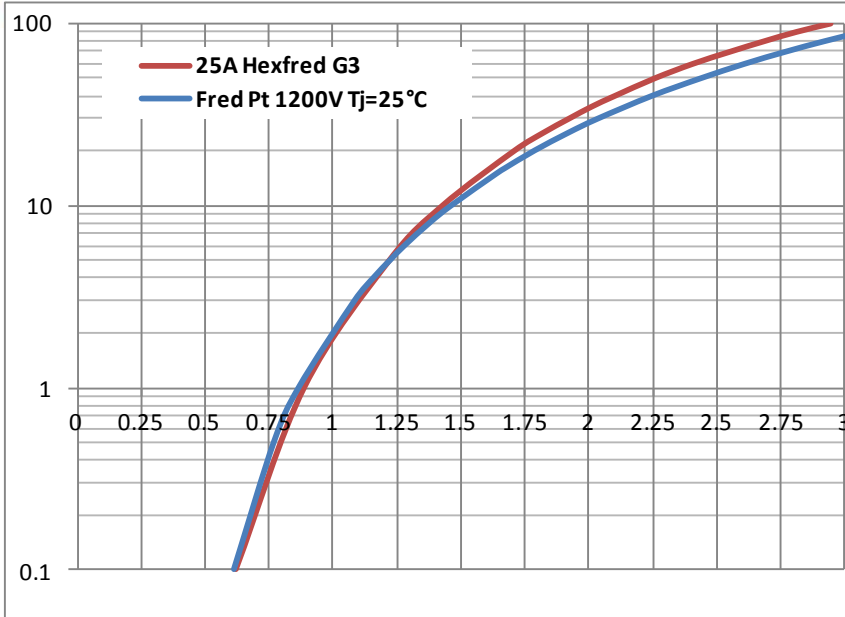
- ✓ 1200V/25A Diode Static test and comparison
- ✓ 1200V/25A Diode Dynamic test and comparison
- ✓ 1200V/25A Diode Conclusion

50Amp 1200V evaluation

- ✓ 1200V/50A Diode Static test and comparison
- ✓ 1200V/50A Diode Dynamic test and comparison
- ✓ 1200V/50A Diode Conclusion



Forward characteristics in TO247 25A



| Fred Pt 1200V Tj=25°C | |
|-----------------------|-----------|
| Vf [V] | If [A] |
| 0.613 | 0.1 |
| 0.769 | 0.5 |
| 0.8665 | 1 |
| 1.0845 | 3 |
| 1.158 | 4 |
| 1.223 | 5 |
| 1.2785 | 6 |
| 1.3765 | 8 |
| 1.4625 | 10 |
| 1.64 | 15 |
| 1.671 | 16 |
| 1.787 | 20 |
| 1.9175 | 25 |
| 2.035 | 30 |
| 2.246 | 40 |
| 2.4375 | 50 |
| 2.608 | 60 |
| 2.769 | 70 |
| 2.9215 | 80 |
| 3.069 | 90 |
| 3.209 | 100 |

| Fred Pt 1200V Tj=125 | |
|----------------------|-----------|
| Vf [V] | If [A] |
| 0.4215 | 0.1 |
| 0.569 | 0.5 |
| 0.665 | 1 |
| 0.8855 | 3 |
| 0.9635 | 4 |
| 1.032 | 5 |
| 1.094 | 6 |
| 1.2035 | 8 |
| 1.3005 | 10 |
| 1.5055 | 15 |
| 1.5425 | 16 |
| 1.679 | 20 |
| 1.834 | 25 |
| 1.973 | 30 |
| 2.2265 | 40 |
| 2.442 | 50 |
| 2.6425 | 60 |
| 2.836 | 70 |
| 3.0175 | 80 |
| 3.1895 | 90 |
| 3.3555 | 100 |

| 25A Hexfred G3 | | | |
|-------------------------------|----------------|--------------|--------------|
| BV @ 100µA [V] | 1276 | | |
| BV @ 250µA [V] | 1272 | | |
| Die Size | 169x220 | | |
| Lifetime | ≥ 36 kGray +He | | |
| Active Area[cm ²] | 0.145 | | |
| I [A] | Vf @ 25C | Vf @ 125C | Vf @ 150C |
| 0.1 | 0.624 | 0.433 | 0.384 |
| 1 | 0.891 | 0.716 | 0.667 |
| 5 | 1.224 | 1.105 | 1.056 |
| 10 | 1.432 | 1.379 | 1.334 |
| 20 | 1.712 | 1.766 | 1.732 |
| 25 | 1.823 | 1.923 | 1.893 |
| 30 | 1.925 | 2.064 | 2.04 |
| 35 | 2.015 | 2.196 | 2.177 |
| 40 | 2.104 | 2.319 | 2.307 |
| 50 | 2.26 | 2.539 | 2.53 |
| 60 | 2.408 | 2.744 | 2.747 |
| 70 | 2.554 | 2.947 | 2.968 |
| 80 | 2.688 | 3.139 | 3.16 |
| 90 | 2.814 | 3.312 | 3.339 |
| 100 | 2.947 | 3.482 | 3.525 |

Fred Pt show a lower Vf with increasing temperature



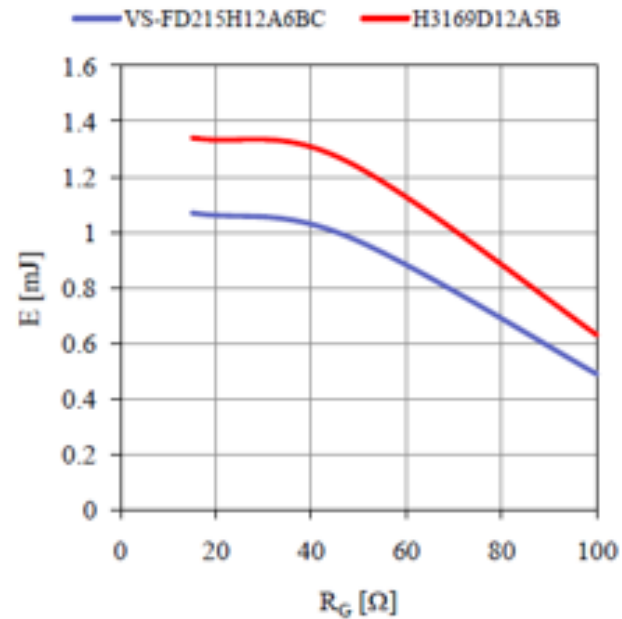
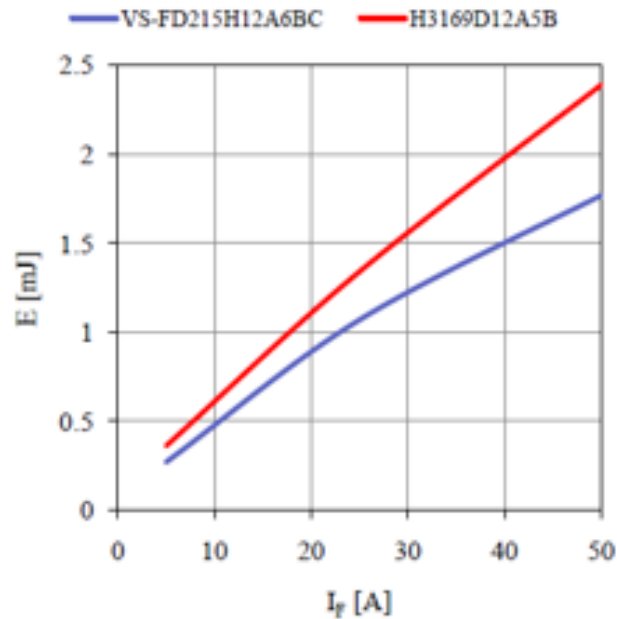
1200V / 25A Diode Dynamic test and comparison

- VS-FD215H12A6BC switching characteristics:
If=25A, RG=15Ω >>
Irr=34.7A, trr=119ns, Qrr=2.47μC, Erec=1.07mJ
 - VS-H3169D12A5B switching characteristics
If=25A, RG=15Ω >>
Irr=32.2A, trr=130ns, Qrr=2.78μC, Erec=1.34mJ
- VS-FD215H12A6BC have lower Erec Value



1200V / 25A Diode Dynamic test and comparison

Switching characteristics

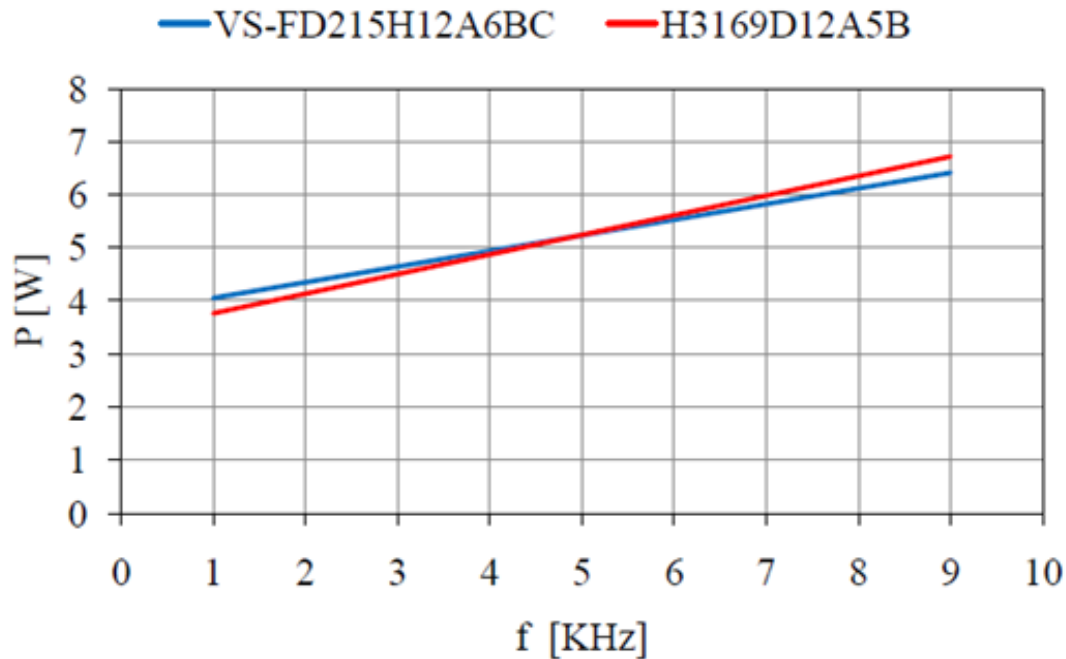


Changing I_f and R_g , VS-FD215H12A6BC have lower E_{rec} Value



1200V / 25A Diode conclusions

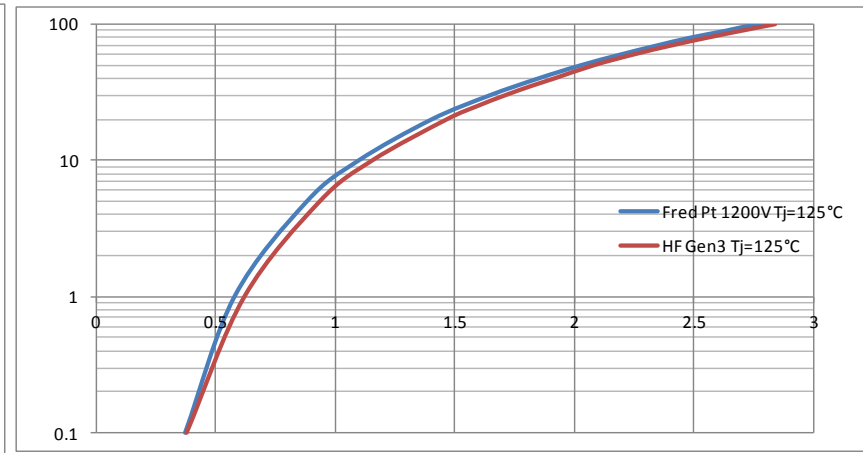
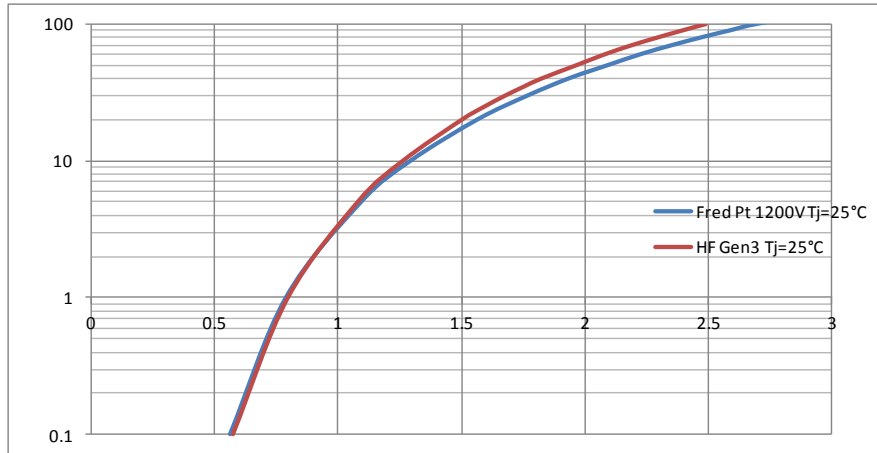
- VS-FD215H12A6BC have higher V_F Value and lower E_{rec} Value Compared to H3169D12A5B.
- VS-FD215H12A6BC will have lower power losses above 5Khz.



• with the decrease of V_f at higher T_j – Fred Pt has a negative coefficient temperature the 2 curves at 125°C overlap at lower fsw.



Forward characteristics in TO247 50A



Fred Pt 1200V Tj=25°C

| Vf[V] | If[A] |
|---------------|-----------|
| 0.5625 | 0.1 |
| 0.789 | 1 |
| 1.0935 | 5 |
| 1.2945 | 10 |
| 1.565 | 20 |
| 1.7695 | 30 |
| 1.9365 | 40 |
| 2.0945 | 50 |
| 2.226 | 60 |
| 2.355 | 70 |
| 2.4765 | 80 |
| 2.593 | 90 |
| 2.6985 | 100 |
| 3.639 | 200 |
| 4.4515 | 300 |
| 5.2105 | 400 |

Fred Pt 1200V Tj=125°C

| Vf[V] | If[A] |
|-------------|-----------|
| 0.37 | 0.1 |
| 0.576 | 1 |
| 0.878 | 5 |
| 1.094 | 10 |
| 1.398 | 20 |
| 1.639 | 30 |
| 1.843 | 40 |
| 2.02 | 50 |
| 2.186 | 60 |
| 2.339 | 70 |
| 2.48 | 80 |
| 2.629 | 90 |
| 2.758 | 100 |
| 3.908 | 200 |
| 4.734 | 300 |
| 4.722 | 400 |

HF Gen3 Tj=25°C

| Vf[V] | If[A] |
|--------------|-----------|
| 0.573 | 0.1 |
| 0.796 | 1 |
| 1.079 | 5 |
| 1.262 | 10 |
| 1.501 | 20 |
| 1.594 | 25 |
| 1.677 | 30 |
| 1.754 | 35 |
| 1.824 | 40 |
| 1.965 | 50 |
| 2.079 | 60 |
| 2.189 | 70 |
| 2.296 | 80 |
| 2.396 | 90 |
| 2.489 | 100 |

HF Gen3 Tj=125°C

| Vf[V] | If[A] |
|--------------|-----------|
| 0.379 | 0.1 |
| 0.621 | 1 |
| 0.936 | 5 |
| 1.156 | 10 |
| 1.467 | 20 |
| 1.594 | 25 |
| 1.71 | 30 |
| 1.817 | 35 |
| 1.918 | 40 |
| 2.083 | 50 |
| 2.25 | 60 |
| 2.41 | 70 |
| 2.563 | 80 |
| 2.707 | 90 |
| 2.84 | 100 |



1200V / 50A Diode Dynamic test and comparison

- VS-FD334H12A6BC switching characteristics:

$I_f=50A$, $R_G=15\Omega$ >>

$I_{rr}=34.4A$, $t_{rr}=243ns$, $Q_{rr}=3.45\mu C$, $E_{rec}=1.12mJ$

- VS- H3195D12A5B switching characteristics

$I_f=32A$, $R_G=15\Omega$ >>

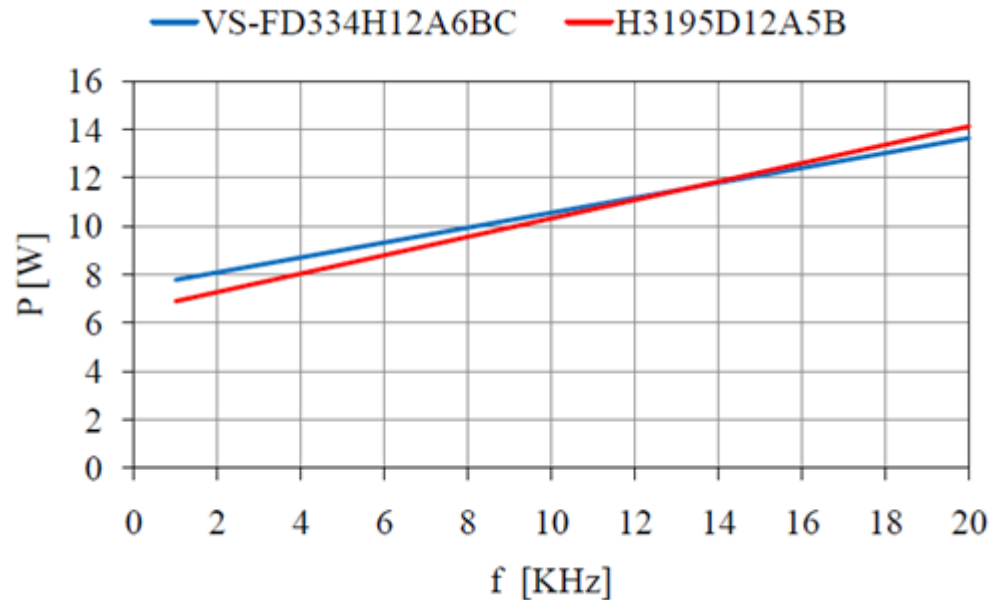
$I_{rr}=28.8A$, $t_{rr}=315ns$, $Q_{rr}=3.75\mu C$, $E_{rec}=1.38mJ$

→ VS-FD334H12A6BC have lower Erec Value



1200V / 50A Diode conclusions

- VS-FD334H12A6BC have higher V_F Value and lower E_{rec} Value Compared to H3195D12A5B.
- VS-FD334H12A6BC will have lower power losses above 14Khz.



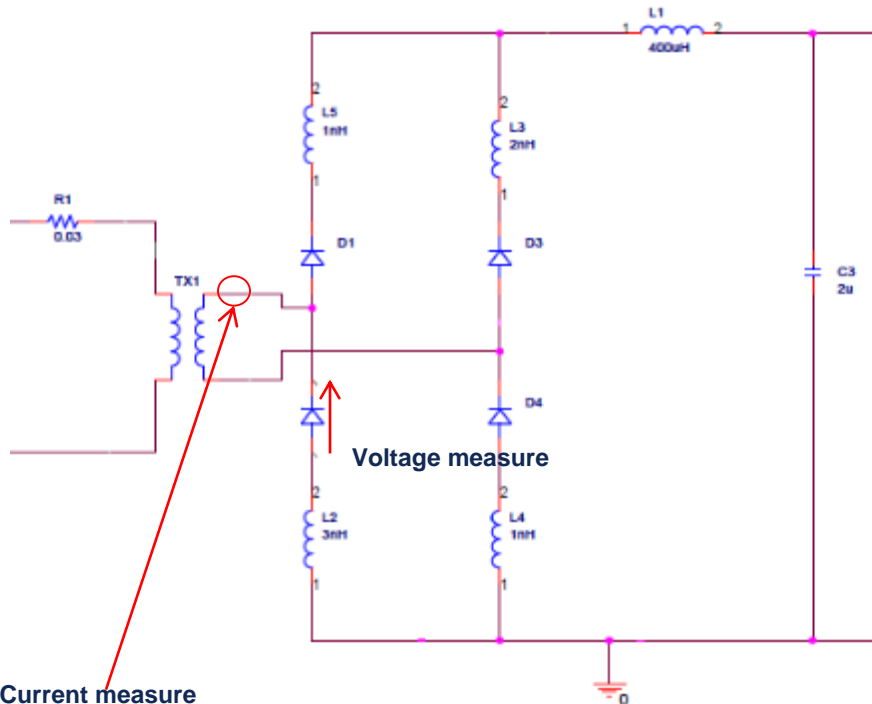
• with the decrease of V_f at higher T_j – Fred Pt has a negative coefficient temperature the 2 curves at 125° C overlap at lower fsw.

TEST CIRCUIT

Test circuit is board battery charger used in automotive application

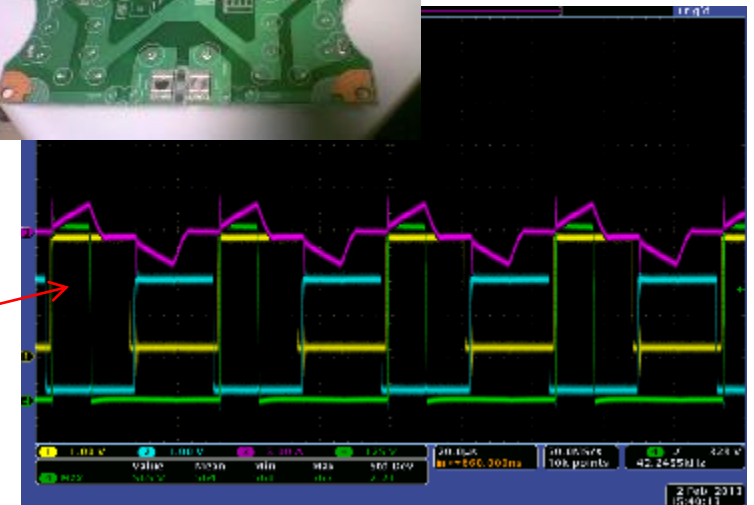
In the board are mounted 8A 1200V diode

- Hexfred GEN2 or
- Hefred GEN3 or
- FredPT



Current measure
For technical reason isn't possible measure only the current trough the diode but is possible measure only the current from output transformer.
Screenshots in next pages has channel:

- C1 yellow driver 1
- C2 blue driver 2
- C3 purple transformer current
- C4 voltage on diode

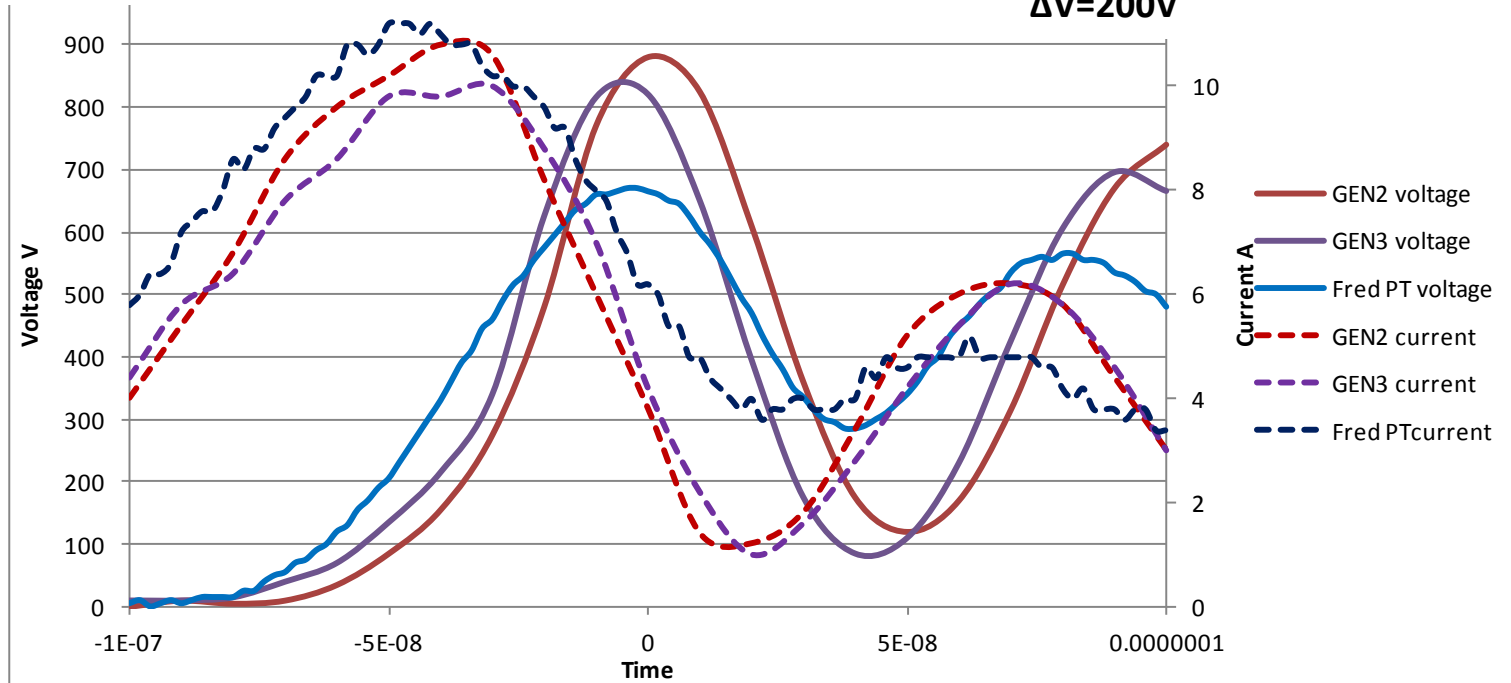




FRED PT 1200V: RECOVERY VOLTAGE AND CURRENT

Reverse recovery current
 I_{rrm}
Similar for all device $\Delta I=1A$

Voltage overshoot
Overshoot is very different
 $\Delta V=200V$



GEN2 diode has good recovery time and 7A I_{rrm} . Very short t_b induce 880V overshoot in switching

GEN3 diode has higher recovery time compared to GEN2 but similar $I_{rrm} \approx 7A$. Short t_b still induce 820V overshoot

Fred Pt diode has a longer recovery time, I_{rrm} is similar to GEN2 diode $\approx 7A$ but t_b slope behaviour induce only 620V in switching.

Vishay Company Confidential



BARE DIE ULTRAFAST DIODES PRODUCTS

1.0 Ultrafast diodes technology overview

1.1 Bare die Pt[®] Portfolio

1.2 Fred Pt[®] 200V features

1.3 Fred Pt[®] Gen4 600V-650V features

1.4 Fred Pt[®] 1200V features

1.5 Shipping package options

1.6 Nomenclature Guide

2.0 Planar Schottky

3.0 Standard Diode and Thyristors



DIE SALES PRODUCTS AVAILABLE OPTIONS

Wafer sales(Die on Wafer)



Die on film



Chip pack



Tape & Reel





Die on Wafer



Inner label



2D label



ESD bag

- **Inner Label:** Paste on Jelly Jar. Indicate Part No., Lot No., Die qty/wafer qty, date code.
- **2D label:** Paste on ESD bag. Indicate die qty, Part No., Lot No., MFG date etc...
- **ESD bag:** Seal the product (Can rip it by small knife or any sharp tool)



Die on film



Fragile label



ESD bag

2D label

2D label



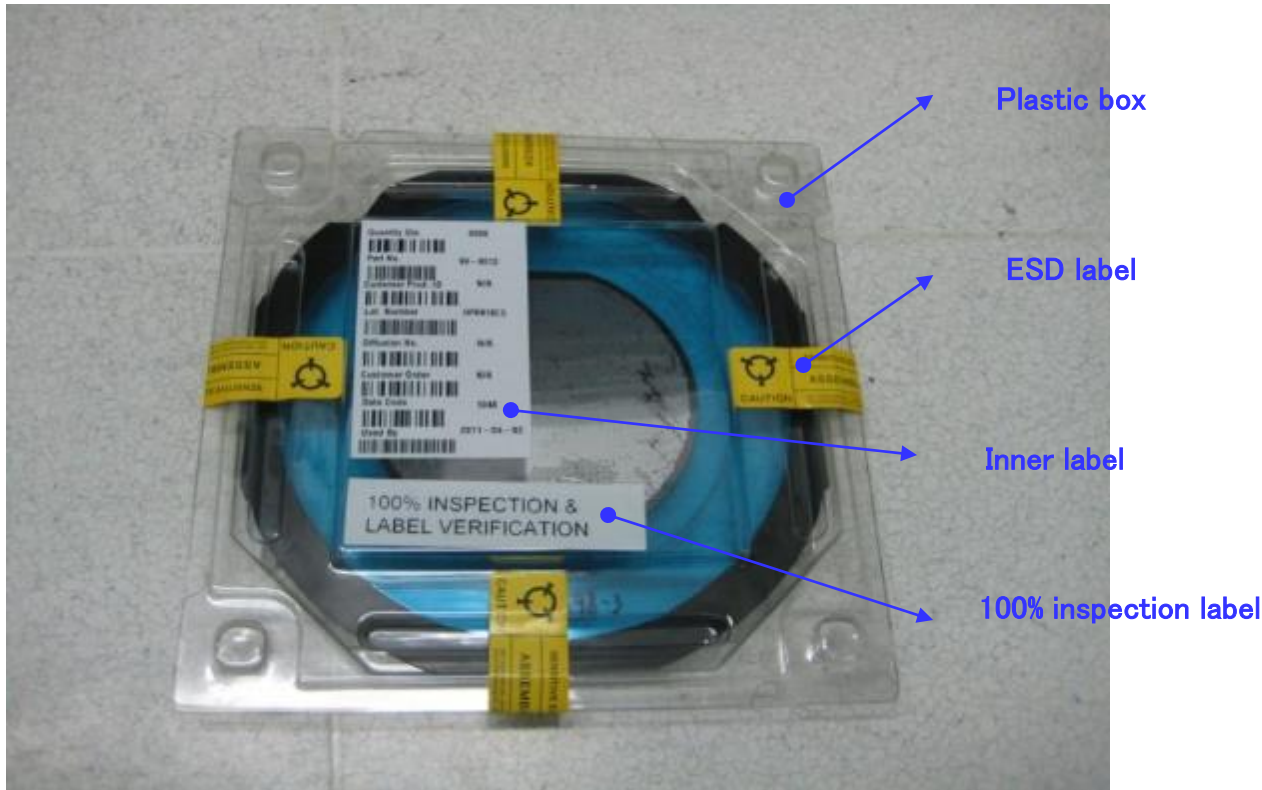
Backside



- **ESD bag:** Seal the product (Can rip it by small knife or any sharp tool)
- **2D label:** Indicate die qty, Part No., Lot No., MFG date etc...



Die on film



- **Plastic box:** protect wafer (Can open it after ripping ESD labels)
- **ESD label:** total 4 pieces, seal the plastic box (Can rip it by small knife or any sharp tool)
- **Inner label:** Indicate die qty, part no., lot no., date code and expire date.
- **Interleaf under wafer backside:** To avoid blue tap sticking to the plastic box, Please do not put it on wafer surface



Build **Vishay**
into your **Design**



BARE DIE ULTRAFAST DIODES PRODUCTS

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Die Sales Nomenclature Guide

| 4FD | 156 | H | 600 | A | 5 | R | N |
|---|--------------------------|--|---|--|----------------------------|---|---|
| <u>Product Type</u> | <u>Chip size in mils</u> | <u>Process</u> | <u>Voltage</u> | <u>Surface Metal</u> | <u>Wafer Diameter</u> | <u>Packaging</u> | <u>Passivation (valid for FRED Pt• only)</u> |
| SC = Planar Schottky Fab2 FD = FredPt® 4FD = Fred Pt® Gen 4 H2 = Hexfred Gen2 H3 = Hexfred Gen3 | | For Schottky R = Tj max. 125 °C S = Tj max. 150 °C H = Tj max. 175 °C For FRED Pt This is SPEED code W = 14 ns to 17 ns H = 18 ns to 35 ns U = 36 ns to 50 ns C = 51 ns to 70 ns S = 71 ns to 90 ns L = 91 ns to 120 ns T = 121 ns to 200 ns N > 200 ns For HEXFRED H = Gen2 D = Gen3 E = Gen3 | 02=200V 03=300V 04=400V 06=600V 07=650V 12=1200V | A = Wirebondable Al(1%Si) S = Solderable CrNiAg | 4 = 4" 5 = 5" 6 = 6" | B = Inked probed unsawn wafer (wafer in box) P = Probed die in wafer pack D = Probed die in wafer pack (HEXFRED only) F = Inked probed sawn wafer on film R = Probed die in tape and 13" reel | none = SiO2 N = Silicon Nitride C = polyimide Thickness (valid for Planar Schottky Fab2 only) none = standard 14 mils T = 10 mils - |

Example for: Fred Pt® 600V : VS-FD083U06A6BN
Fred Pt® Gen4 600V : VS-4FD156U06A6BC
Fred Pt® 1200V: VS-FD215H12A6BC

Schottky: VS-SC180H100A6B



BARE DIE ULTRAFAST DIODES PRODUCTS

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Schottky Diodes –Die Matrix

Planar Technology Schottky Die Sales Product Portfolio

| | 1A | 2A-3A | 3A | 5A-7A | 8A-12A | 12A-15A | 20A-30A | 35A-45A | 50A-60A | 100A | 200A |
|-------------|--------|--------|--------|--------|--------|---------|---------|---------|---------|--------|--------|
| 15V | SC036R | | | | | SC125R | | | SC200R | | |
| 20V | SC036S | | | | | SC125S | | | SC200S | | |
| 30V | SC036S | | | SC070S | SC105S | | SC170S | | SC200S | SC275S | SC400S |
| 45V low Vf | SC036S | | SC060S | | SC105S | | | SC180S | SC200S | | SC400S |
| 45V Low Ir | | SC050H | | SC070H | SC105H | SC125H | SC170H | SC180H | SC200H | | SC400H |
| 60V low Vf | SC036S | | SC060S | | | SC125S | | SC180S | | | SC400S |
| 100V Low Ir | SC036H | SC050H | SC060H | SC070H | SC105H | SC125H | | | SC200H | SC275H | SC430H |
| 150V low Ir | | | | SC070H | SC105H | | | | SC200H | | |

R=OR'ing diode

S=Low Vf Barrier

H=Low Leakage Barrier



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RECTIFIERS OVERVIEW

✓ HIGH VOLTAGE DIODES

✓ THYRISTORS



HIGH VOLTAGE DIODES AND THYRISTORS IN BARE DIE FORM

Diodes

| | MOAT Standard | | MOAT Fast | | | | | |
|--------|---------------|------------------------|------------------------|-----------|----------------------|-------------------------------------|------------------------|-----------|
| | 2 - 4 A | 8 A | 20 A | 30 A | 40 A | 60 A | 80 A | 100-160 A |
| 600 V | VS060L... | VS135L... | VS180L... VS207L... | VS210L... | VS230L... | VS340L... VS340D... VS350L... | VS390L... | VS480D... |
| 800 V | | VS135D... | | VS210L... | | | | |
| 1000 V | | | VS180L... | VS210L... | | | | |
| 1200 V | VS080D... | VS135L... VS135D... | VS180D... VS207D... | VS210D... | VS230... VS230... | VS340L... VS340D... | VS390L... VS390D... | VS480D... |
| 1600 V | | VS135D... | VS180D... | VS210D... | VS230... | VS350D... | | VS480D... |

Current Rated in Discrete/Module Package or based on technology
 Probed Die-on-Wafer and Die-On-Waffle Pack Available



Key Features

- Glass passivated moat diodes up to 160 A, 1600V (Vishay probed)
- Thyristors up to 160 A, 1600V (Vishay probed)
- High current - high voltage: up to 3000 A, 4500 V
- Center and corned gate thyristors
- Solderable and wirebondable top metal available

| | 8 - 12 A | 25 A | 35 A | 40 A | 50 A | 56-60 A | 90 A | 160 A |
|--------|----------|----------------------------------|----------|----------------------|----------------------|----------|----------|----------|
| 600 V | VS110... | VS180... VS210... | VS230... | VS250... VS255... | VS350... | VS370... | VS480... | VS590... |
| 1200 V | VS110... | VS180... VS185... VS210... | VS230... | VS250... VS255... | VS343... VS350... | VS370... | VS480... | VS590... |
| 1600 V | | VS185... | | VS250... VS255... | | VS370... | | |

Thyristors

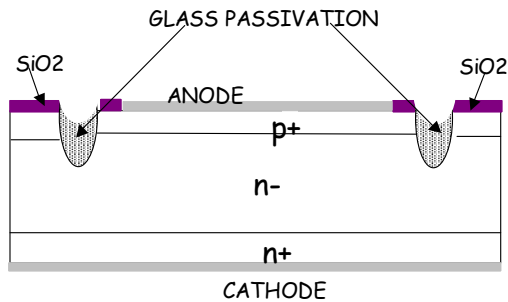
Current Rated in Discrete/Module Package or based on technology
 Probed Die-on-Wafer and Die-On-Waffle Pack Available
 Both Solderable and Bondable Surface Metal Available



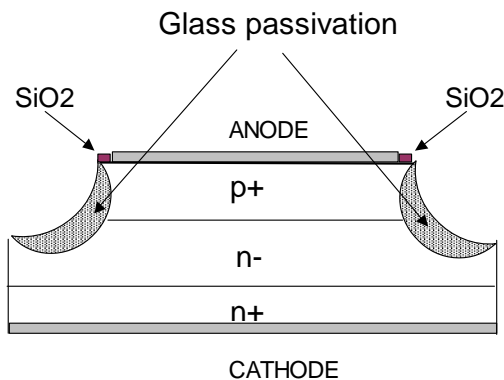
SOFT RECOVERY RECTIFIER

Standard recovery rectifier are glass passivated junctions available with two different Mesa termination, Mesa and Moat.

MOAT TERMINATION



MESA TERMINATION



Not to scale

Main features:

- Vrrm 600V and 1200V
- If (av) from 8A to 100A
- Die size from 60mils to 480mils
- Mesa and Moat termination (P+ up)
- Bondable (Al) and Solderable (Ag) top metal



SOFT FAST RECOVERY PRODUCT LIST

| Die PN | Die size (mils) | Trr (nsec) max at If | Vf max (V) @ If, 25°C | Tjmax (°C) | If (A) | Vrrm(V) |
|-----------------|-----------------|-------------------------|-----------------------|------------|--------|---------|
| VS060LM06CS02CB | 60X60 | 200 | 1.3 | 150 | 2 | 600 |
| VS135LM06CS02CB | 100x135 | 200 | 1.2 | 150 | 8 | 600 |
| VS180LG10HS05 | 180X180 | 500 | 1.4 | 150 | 16 | 1200 |
| VS180LM06CS02CB | 180X180 | 200 | 1.3 | 150 | 20 | 600 |
| VS180LM12CS05CB | 180X180 | 500 | 1.35 | 150 | 20 | 1200 |
| VS207LM06CS02CB | 207X157 | 200 | 1.3 | 150 | 20 | 600 |
| VS230LM06CS02CB | 230X230 | 200 | 1.08 at 20A | 150 | 30 | 600 |
| VS340LM06CS02CB | 350X230 | 200 | 1.3 | 150 | 60 | 600 |
| VS340LM12S05CB | 350X230 | 500 | 1.3 | 150 | 60 | 1200 |
| VS390LM06CS02CB | 390x270 | 200 | 1.25 | 150 | 80 | 600 |
| VS390LM12CS05CB | 390x270 | 500 | 1.3 | 150 | 80 | 1200 |

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HP SOFT RECOVERY DIODE



| | | | | | | | |
|-------|---------|----------------------|--------------------|------------------------|--|--------------------|---------|
| 600V | 8EWF06S | 10ETF06S 20ETF06S | 10ETF06 20ETF06 | 10ETF06FP 20ETF06FP | 30EPF06 40EPF06 60EPF06 80EPF06 | 30CPF06 60CPF12 | |
| 1200V | 8EWF12S | 10ETF12S 20ETF12S | 10ETF12 20ETF12 | 10ETF12FP 20ETF12FP | 30EPF06 40EPF06 60EPF06 80EPF06 | 30CPF12 60CPF12 | 85EPF12 |

| | | | | | |
|-----------------|----------------|----------------------------------|---|----------------------------------|----------------|
| Current | 8A | 10/20A | 10/20A | 30/80A | 85A |
| Die size | 100x135 | 100x135 180x180 | 100x135 180x180 (207x15) | 180x180 270x390 | 270x390 |

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HIGH VOLTAGE DIODES

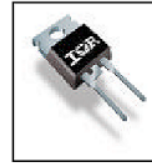
D-Pak



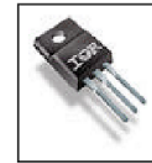
D² Pak



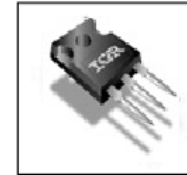
TO-220AC



TO-220FP



TO-247



| | | | | | |
|-------|--------------------|----------------------|--------------------|------------------------|--|
| 800V | 8EWS08S | 10ETS08S 20ETS08S | 10ETS08 20ETS08 | 10ETS08FP 20ETS08FP | 30EPS08 40EPS08 60EPS08 80EPS08 |
| 1200V | 8EWS12S 8EWS12S | 10ETS12S 20ETS12S | 10ETS12 20ETS12 | 10ETS12FP 20ETS12FP | 30EPS08 40EPS12 60EPS12 80EPS12 |
| 1600V | 8EWS16S | | | | 40EPS16 |

Current

8A

10/20A

10/20A

10/20A

30/80A

Die size

100x135

100x135

100x135

100x135

230x230

180x180

180x180

180x180

270x390

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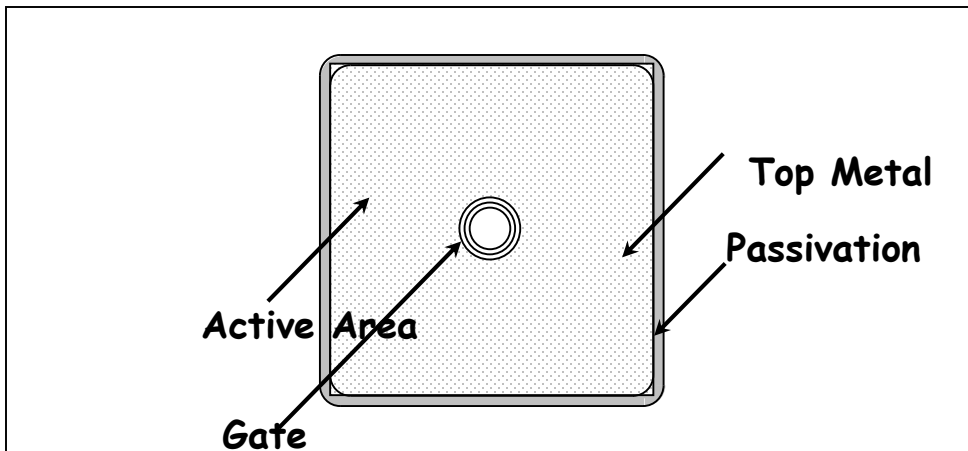
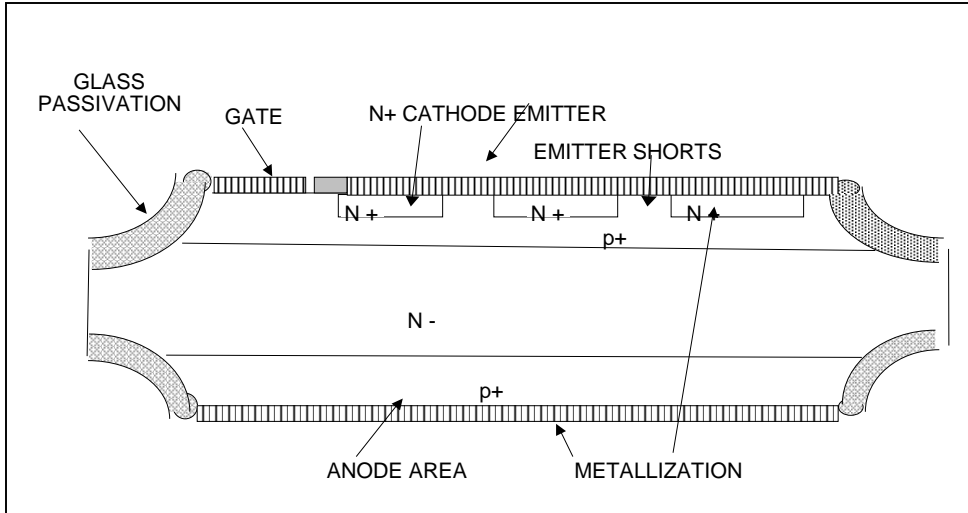
THYRISTORS

Tyristors are Glass passivated and Mesa termination. Two platforms available :1200V and 1600V

Main features:

- **V_{drm}/V_{rrm} from 400V to 1600V**
- **I_t (av) from 8A to 280A**
- **Die size from 110 mils to 620 mils**
- **Center gate and Corner gate**
- **Bondable (Al) and Solderable (Ag) top metal**

THYRISTORS



Main Features

- Mesa termination
- V_{drm}/V_{rrm} from 400V to 1600V
- Glass passivated
- $I_t (av)$ from 10A to 280A
- Die size: 110 mils to 620 mils
- Center gate and Corner gate
- Bondable (Al) and Solderable (Ag)

Die dimensions

- | | |
|------------|---------|
| • 110mils | 350mils |
| • 155 mils | 370mils |
| • 180mils | 480mils |
| • 210mils | 590mils |
| • 230mils | 625mils |
| • 250mils | 825mils |



THYRISTORS & DIODES DIE NOMENCLATURE GUIDE

| THYRISTOR AND DIODE | | | | | | | |
|---------------------|------------------------|------------------------------|-----------------------------------|---|--|----------------------------------|-------------------------|
| VS | 135 | L | M | 06 | C | S02 | CB |
| Vishay product | Die size (see table 1) | Type of device (see table 2) | Passivation process (see table 3) | Voltage code (x 100 = V_{RRM}/V_{DRM}) | Chip surface metallization (see table 4) | Fast Recovery type (see table 5) | Customers (see table 6) |

| TABLE 1 - CHIP SIZE | | |
|---------------------|------------------|-------------|
| CODE | DIMENSION (MILS) | GEOMETRY |
| 60 | 60 x 60 | Square |
| 110 | 110 x 110 | Square |
| 135 | 135 x 100 | Rectangular |
| 155 | 155 x 155 | Square |
| 180 | 180 x 180 | Square |
| 185 | 185 x 185 | Square |
| 207 | 207 x 157 | Rectangular |
| 210 | 210 x 210 | Square |
| 230 | 230 x 230 | Square |
| 250 | 250 x 250 | Square |
| 340 | 350 x 230 | Rectangular |
| 350 | 350 x 350 | Square |
| 370 | 370 x 370 | Square |
| 390 | 390 x 270 | Rectangular |
| 480 | 480 x 480 | Square |
| 590 | 590 x 590 | Square |
| 080 | 80 x 80 | Square |
| 343 | 340 x 340 | Square |

| TABLE 2 - TYPE OF DEVICE | |
|--------------------------|---------------------------------------|
| CODE | DESCRIPTION |
| D | Wire bondable standard recovery diode |
| B | Wire bondable SCR |
| S | Solderable SCR |
| L | Fast recovery diode |

| TABLE 3 - PASSIVATION PROCESS | |
|-------------------------------|------------|
| CODE | PROCESS |
| G | Glass MESA |
| M | Glass MOAT |

| TABLE 4 - CHIP SURFACE METALLIZATION | | |
|--------------------------------------|----------|----------|
| CODE | ANODE | CATHODE |
| H | Silver | Silver |
| C | Aluminum | Silver |
| D | Silver | Aluminum |

| TABLE 5 - FAST RECOVERY TYPE | |
|------------------------------|-----------------------|
| CODE | Reverse recovery time |
| S01 | 100 ns |
| S02 | 200 ns |
| S05 | 500 ns |

| TABLE 6 - CUSTOMERS | |
|---------------------|---------------------------------|
| CODE | DESCRIPTION |
| CB | Probed uncut die (water in box) |
| No code | Probed die in chip carrier |



THIRISTORS DIE PRODUCTS

| Die PN | Die size (mils) | V_{TM} (V) @ $I_{T(AV)}$, 25° C | I_{GT} max (mA) | T_{jmax} (° C) | Rated current $I_{T(AV)}$ (A) | V_{DRM} / V_{RRM} (V) |
|--------------|-----------------|------------------------------------|-------------------|------------------|-------------------------------|-------------------------|
| VS110BG12DCB | 110x110 | 1.2 | 20 | 125 | 8 | 1200 |
| VS110SG12HCB | 110x110 | 1.2 | 20 | 125 | 8 | 1200 |
| VS180SG12HCB | 180x180 | 1.3 | 45 | 125 | 25 | 600/1200 |
| VS185BG12DCB | 185x185 | 1.25 | 60 | 125 | 16 | 1200 |
| VS210SG12HCB | 210x210 | 1.5 | 60 | 125 | 25 | 1200 |
| VS230SG12HCB | 230x230 | 1.3 | 60 | 125 | 25 | 1200 |
| VS250BG12DCB | 250x250 | 1.3 at 25A | 150 | 125 | 35 | 600/1200 |
| VS250SG12HCB | 250x250 | 1.3 at 25A | 100 | 125 | 35 | 1200 |
| VS255SG12HCB | 250x250 | 1.25 at 25A | 80 | 125 | 35 | 600/ 1200 |
| VS343SG12HCB | 340x340 | 1.2 at 25A | 100 | 125 | | 1200 |
| VS350SG12HCB | 350x350 | 1.2 at 25A | 100 | 125 | 50 | 1200 |
| VS370BG12DCB | 370X370 | 1.2 at 25A | 150 | 125 | 60 | 1200 |
| VS370SG12HCB | 370x370 | 1.2 at 25A | 150 | 125 | 50 | 600/ 1200 |
| VS480SG12HCB | 480x480 | 1.2 at 25A | 110 | 125 | 90 | 600/ 1200 |
| VS590SG12HCB | 590x590 | 1.2 at 25A | 140 | 125 | 180 | 600 - 1200 |

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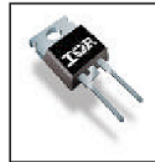


THYRISTORS DISCRETE DEVICE

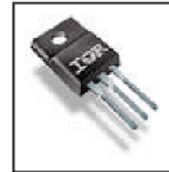
D² Pak



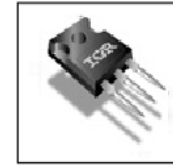
TO-220AC



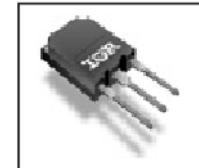
TO-220FP



TO-247



*Super
TO-247*



| | | | | | |
|-------|--|--|------------------------|--------------------|---------|
| 800V | 10TTS08S 12TTS08S 16TTS08S 25TTS08S | 10TTS08 12TTS08 16TTS08 25TTS08 | 16TTS08FP 25TTS08FP | 30TPS08 40TPS08 | |
| 1200V | 16TTS12S 25TTS12S | 16TTS12 25TTS12 40TTS12 | 16TTS12FP 25TTS12FP | 30TPS12 40TPS12 | 70TPS12 |
| 1600V | | | | 30TPS16 40TPS16 | 70TPS16 |

**Current
Die size**

8-25A

25A

30A

70A

110x110

155x155

155x155

185x185

370x370

185x185

185x185

250x250

VISHAY CONFIDENTIAL



Build **Vishay**
into your **Design**