

# KA5x03xx-SERIES

**KA5H0365R, KA5M0365R, KA5L0365R**

**KA5H0380R, KA5M0380R, KA5L0380R**

## Fairchild Power Switch(FPS)

### Features

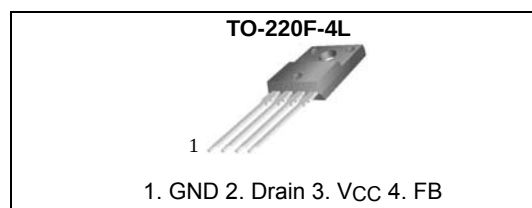
- Precision Fixed Operating Frequency (100/67/50kHz)
- Low Start-up Current(Typ. 100uA)
- Pulse by Pulse Current Limiting
- Over Current Protection
- Over Voltage Protection (Min. 25V)
- Internal Thermal Shutdown Function
- Under Voltage Lockout
- Internal High Voltage Sense FET
- Auto-Restart Mode

### Applications

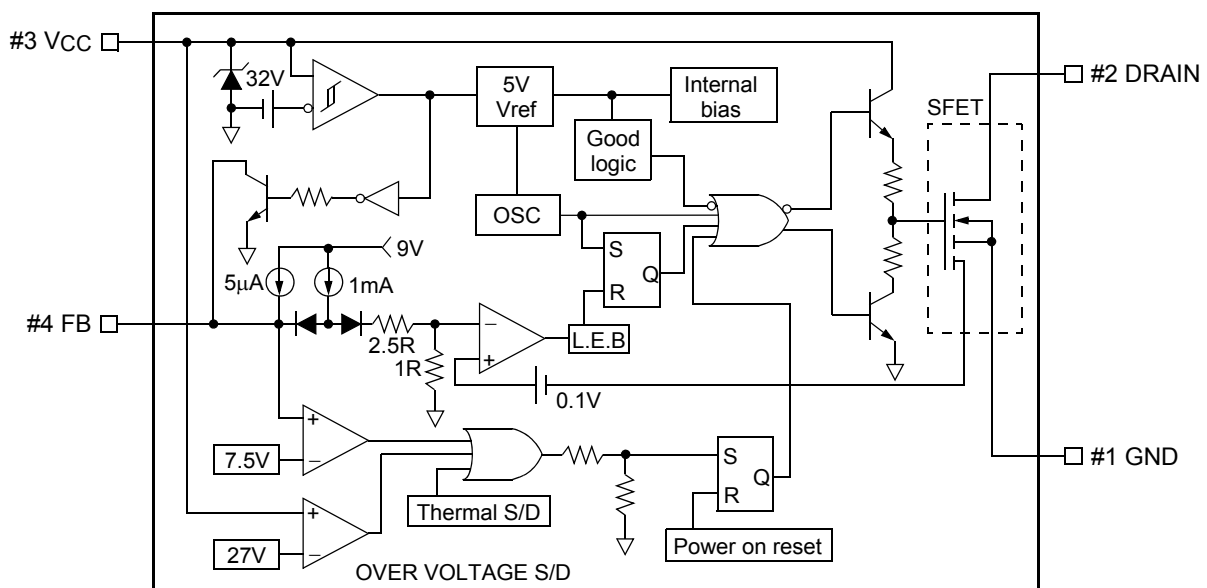
- SMPS for VCR, SVR, STB, DVD & DVCD
- SMPS for Printer, Facsimile & Scanner
- Adaptor for Camcorder

### Description

The Fairchild Power Switch(FPS) product family is specially designed for an off-line SMPS with minimal external components. The Fairchild Power Switch(FPS) consists of a high voltage power SenseFET and a current mode PWM IC. Included PWM controller integrates the fixed frequency oscillator, the under voltage lock-out, the leading edge blanking, the optimized gate turn-on/turn-off driver, the thermal shutdown protection, the over voltage protection, and the temperature compensated precision current sources for the loop compensation and the fault protection circuitry. Compared to a discrete MOSFET and a PWM controller or an RCC solution, a Fairchild Power Switch(FPS) can reduce the total component count, design size and weight and at the same time increase efficiency, productivity, and system reliability. It has a basic platform well suited for the cost effective design in either a flyback converter or a forward converter



### Internal Block Diagram



Rev.1.0.7

## Absolute Maximum Ratings

(Ta=25°C, unless otherwise specified)

| Characteristic                                   | Symbol              | Value                   | Unit |
|--------------------------------------------------|---------------------|-------------------------|------|
| <b>KA5H0365R, KA5M0365R, KA5L0365R</b>           |                     |                         |      |
| Drain-Gate Voltage (R <sub>GS</sub> =1MΩ)        | V <sub>DGR</sub>    | 650                     | V    |
| Gate-Source (GND) Voltage                        | V <sub>GS</sub>     | ±30                     | V    |
| Drain Current Pulsed <sup>(1)</sup>              | I <sub>DM</sub>     | 12.0                    | ADC  |
| Continuous Drain Current (T <sub>C</sub> =25°C)  | I <sub>D</sub>      | 3.0                     | ADC  |
| Continuous Drain Current (T <sub>C</sub> =100°C) | I <sub>D</sub>      | 2.4                     | ADC  |
| Single Pulsed Avalanche Energy <sup>(2)</sup>    | E <sub>AS</sub>     | 358                     | mJ   |
| Maximum Supply Voltage                           | V <sub>CC,MAX</sub> | 30                      | V    |
| Analog Input Voltage Range                       | V <sub>FB</sub>     | -0.3 to V <sub>SD</sub> | V    |
| Total Power Dissipation                          | P <sub>D</sub>      | 75                      | W    |
|                                                  | Derating            | 0.6                     | W/°C |
| Operating Junction Temperature.                  | T <sub>J</sub>      | +150                    | °C   |
| Operating Ambient Temperature.                   | T <sub>A</sub>      | -40 to +85              | °C   |
| Storage Temperature Range.                       | T <sub>STG</sub>    | -55 to +150             | °C   |
| <b>KA5H0380R, KA5M0380R, KA5L0380R</b>           |                     |                         |      |
| Drain-Gate Voltage (R <sub>GS</sub> =1MΩ)        | V <sub>DGR</sub>    | 800                     | V    |
| Gate-Source (GND) Voltage                        | V <sub>GS</sub>     | ±30                     | V    |
| Drain Current Pulsed <sup>(1)</sup>              | I <sub>DM</sub>     | 12.0                    | ADC  |
| Continuous Drain Current (T <sub>C</sub> =25°C)  | I <sub>D</sub>      | 3.0                     | ADC  |
| Continuous Drain Current (T <sub>C</sub> =100°C) | I <sub>D</sub>      | 2.1                     | ADC  |
| Single Pulsed Avalanche Energy <sup>(2)</sup>    | E <sub>AS</sub>     | 95                      | mJ   |
| Maximum Supply Voltage                           | V <sub>CC,MAX</sub> | 30                      | V    |
| Analog Input Voltage Range                       | V <sub>FB</sub>     | -0.3 to V <sub>SD</sub> | V    |
| Total Power Dissipation                          | P <sub>D</sub>      | 75                      | W    |
|                                                  | Derating            | 0.6                     | W/°C |
| Operating Junction Temperature.                  | T <sub>J</sub>      | +150                    | °C   |
| Operating Ambient Temperature.                   | T <sub>A</sub>      | -40 to +85              | °C   |
| Storage Temperature Range.                       | T <sub>STG</sub>    | -55 to +150             | °C   |

### Note:

1. Repetitive rating: Pulse width limited by maximum junction temperature
2. L = 51mH, starting T<sub>J</sub> = 25°C
3. L = 13μH, starting T<sub>J</sub> = 25°C

## Electrical Characteristics (SenseFET Part)

(Ta = 25°C unless otherwise specified)

| Parameter                                           | Symbol  | Condition                                                                                                  | Min. | Typ. | Max. | Unit |
|-----------------------------------------------------|---------|------------------------------------------------------------------------------------------------------------|------|------|------|------|
| KA5H0365R, KA5M0365R, KA5L0365R                     |         |                                                                                                            |      |      |      |      |
| Drain-Source Breakdown Voltage                      | BVDSS   | VGS=0V, ID=50μA                                                                                            | 650  | -    | -    | V    |
| Zero Gate Voltage Drain Current                     | IDSS    | VDS=Max. Rating, VGS=0V                                                                                    | -    | -    | 50   | μA   |
|                                                     |         | VDS=0.8Max. Rating, VGS=0V, TC=125°C                                                                       | -    | -    | 200  | μA   |
| Static Drain-Source on Resistance <sup>(Note)</sup> | RDS(ON) | VGS=10V, ID=0.5A                                                                                           | -    | 3.6  | 4.5  | Ω    |
| Forward Transconductance <sup>(Note)</sup>          | gfs     | VDS=50V, ID=0.5A                                                                                           | 2.0  | -    | -    | S    |
| Input Capacitance                                   | Ciss    | VGS=0V, VDS=25V, f=1MHz                                                                                    | -    | 720  | -    | pF   |
| Output Capacitance                                  | Coss    |                                                                                                            | -    | 40   | -    |      |
| Reverse Transfer Capacitance                        | Crss    |                                                                                                            | -    | 40   | -    |      |
| Turn On Delay Time                                  | td(on)  | VDD=0.5BVDSS, ID=1.0A (MOSFET switching time is essentially independent of operating temperature)          | -    | 150  | -    | nS   |
| Rise Time                                           | tr      |                                                                                                            | -    | 100  | -    |      |
| Turn Off Delay Time                                 | td(off) |                                                                                                            | -    | 150  | -    |      |
| Fall Time                                           | tf      |                                                                                                            | -    | 42   | -    |      |
| Total Gate Charge (Gate-Source+Gate-Drain)          | Qg      | VGS=10V, ID=1.0A, VDS=0.5BVDSS (MOSFET switching time is essentially independent of operating temperature) | -    | -    | 34   | nC   |
| Gate-Source Charge                                  | Qgs     |                                                                                                            | -    | 7.3  | -    |      |
| Gate-Drain (Miller) Charge                          | Qgd     |                                                                                                            | -    | 13.3 | -    |      |
| KA5H0380R, KA5M0380R, KA5L0380R                     |         |                                                                                                            |      |      |      |      |
| Drain-Source Breakdown Voltage                      | BVDSS   | VGS=0V, ID=50μA                                                                                            | 800  | -    | -    | V    |
| Zero Gate Voltage Drain Current                     | IDSS    | VDS=Max. Rating, VGS=0V                                                                                    | -    | -    | 250  | μA   |
|                                                     |         | VDS=0.8Max. Rating, VGS=0V, TC=125°C                                                                       | -    | -    | 1000 | μA   |
| Static Drain-Source on Resistance <sup>(Note)</sup> | RDS(ON) | VGS=10V, ID=0.5A                                                                                           | -    | 4.0  | 5.0  | Ω    |
| Forward Transconductance <sup>(Note)</sup>          | gfs     | VDS=50V, ID=0.5A                                                                                           | 1.5  | 2.5  | -    | S    |
| Input Capacitance                                   | Ciss    | VGS=0V, VDS=25V, f=1MHz                                                                                    | -    | 779  | -    | pF   |
| Output Capacitance                                  | Coss    |                                                                                                            | -    | 75.6 | -    |      |
| Reverse Transfer Capacitance                        | Crss    |                                                                                                            | -    | 24.9 | -    |      |
| Turn On Delay Time                                  | td(on)  | VDD=0.5BVDSS, ID=1.0A (MOSFET switching time is essentially independent of operating temperature)          | -    | 40   | -    | nS   |
| Rise Time                                           | tr      |                                                                                                            | -    | 95   | -    |      |
| Turn Off Delay Time                                 | td(off) |                                                                                                            | -    | 150  | -    |      |
| Fall Time                                           | tf      |                                                                                                            | -    | 60   | -    |      |
| Total Gate Charge (Gate-Source+Gate-Drain)          | Qg      | VGS=10V, ID=1.0A, VDS=0.5BVDSS (MOSFET switching time is essentially independent of operating temperature) | -    | -    | 34   | nC   |
| Gate-Source Charge                                  | Qgs     |                                                                                                            | -    | 7.2  | -    |      |
| Gate-Drain (Miller) Charge                          | Qgd     |                                                                                                            | -    | 12.1 | -    |      |

### Note:

1. Pulse test: Pulse width ≤ 300μs, duty ≤ 2%

2.  $S = \frac{1}{R}$

**Electrical Characteristics (Control Part)** (Continued)

(Ta = 25°C unless otherwise specified)

| Characteristic                                   | Symbol             | Test condition                                   | Min. | Typ. | Max. | Unit  |
|--------------------------------------------------|--------------------|--------------------------------------------------|------|------|------|-------|
| <b>UVLO SECTION</b>                              |                    |                                                  |      |      |      |       |
| Start Threshold Voltage                          | VSTART             | VFB=GND                                          | 14   | 15   | 16   | V     |
| Stop Threshold Voltage                           | VSTOP              | VFB=GND                                          | 8.4  | 9    | 9.6  | V     |
| <b>OSCILLATOR SECTION</b>                        |                    |                                                  |      |      |      |       |
| Initial Accuracy                                 | FOSC               | KA5H0365R<br>KA5H0380R                           | 90   | 100  | 110  | kHz   |
| Initial Accuracy                                 | FOSC               | KA5M0365R<br>KA5M0380R                           | 61   | 67   | 73   | kHz   |
| Initial Accuracy                                 | FOSC               | KA5L0365R<br>KA5L0380R                           | 45   | 50   | 55   | kHz   |
| Frequency Change With Temperature <sup>(2)</sup> | -                  | -25°C≤Ta≤+85°C                                   | -    | ±5   | ±10  | %     |
| Maximum Duty Cycle                               | Dmax               | KA5H0365R<br>KA5H0380R                           | 62   | 67   | 72   | %     |
| Maximum Duty Cycle                               | Dmax               | KA5M0365R<br>KA5M0380R<br>KA5L0365R<br>KA5L0380R | 72   | 77   | 82   | %     |
| <b>FEEDBACK SECTION</b>                          |                    |                                                  |      |      |      |       |
| Feedback Source Current                          | IFB                | Ta=25°C, 0V≤Vfb≤3V                               | 0.7  | 0.9  | 1.1  | mA    |
| Shutdown Feedback Voltage                        | VSD                | Vfb≥6.5V                                         | 6.9  | 7.5  | 8.1  | V     |
| Shutdown Delay Current                           | Idelay             | Ta=25°C, 5V≤Vfb≤VSD                              | 4    | 5    | 6    | μA    |
| <b>REFERENCE SECTION</b>                         |                    |                                                  |      |      |      |       |
| Output Voltage <sup>(1)</sup>                    | Vref               | Ta=25°C                                          | 4.80 | 5.00 | 5.20 | V     |
| Temperature Stability <sup>(1)(2)</sup>          | Vref/ΔT            | -25°C≤Ta≤+85°C                                   | -    | 0.3  | 0.6  | mV/°C |
| <b>CURRENT LIMIT(SELF-PROTECTION)SECTION</b>     |                    |                                                  |      |      |      |       |
| Peak Current Limit                               | I <sub>OVER</sub>  | Max. inductor current                            | 1.89 | 2.15 | 2.41 | A     |
| <b>PROTECTION SECTION</b>                        |                    |                                                  |      |      |      |       |
| Over Voltage Protection                          | VOVP               | VCC≥24V                                          | 25   | 27   | 29   | V     |
| Thermal Shutdown Temperature (Tj) <sup>(1)</sup> | TSD                | -                                                | 140  | 160  | -    | °C    |
| <b>TOTAL STANDBY CURRENT SECTION</b>             |                    |                                                  |      |      |      |       |
| Start-up Current                                 | I <sub>START</sub> | VCC=14V                                          | -    | 100  | 170  | μA    |
| Operating Supply Current<br>(Control Part Only)  | I <sub>OP</sub>    | VCC≤28                                           | -    | 7    | 12   | mA    |

**Note:**

1. These parameters, although guaranteed, are not 100% tested in production
2. These parameters, although guaranteed, are tested in EDS(water test) process

## Typical Performance Characteristics(SenseFET part)

(KA5H0365R, KA5M0365R, KA5L0365R)

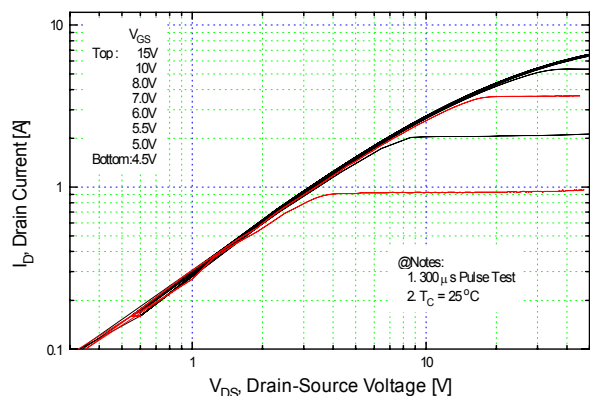


Figure 1. Output Characteristics

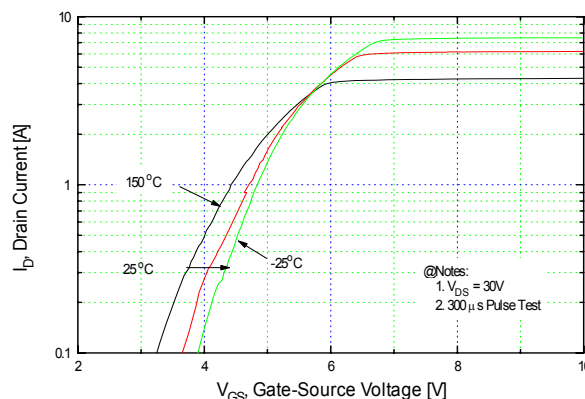


Figure 2. Transfer Characteristics

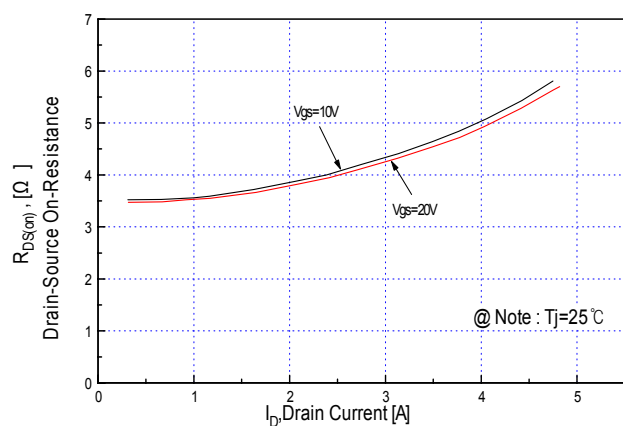


Figure 3. On-Resistance vs. Drain Current

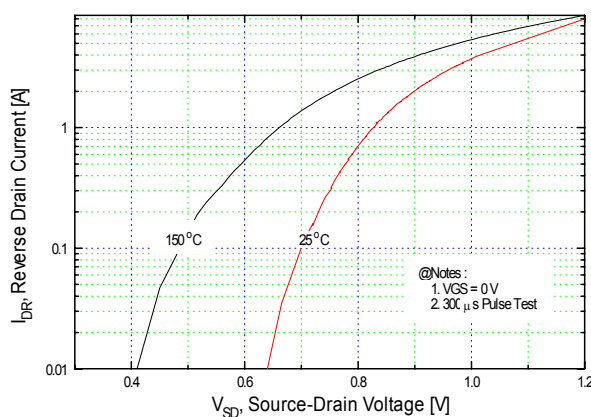


Figure 4. Source-Drain Diode Forward Voltage

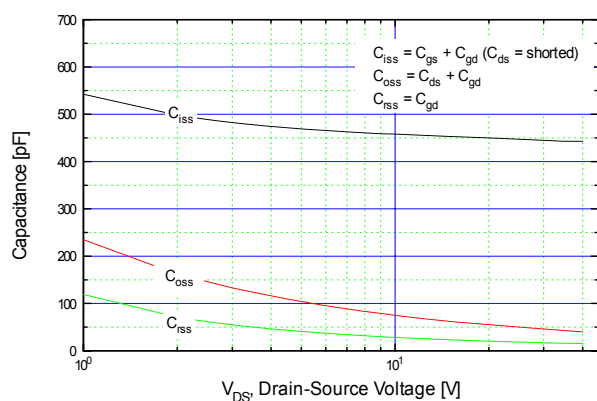


Figure 5. Capacitance vs. Drain-Source Voltage

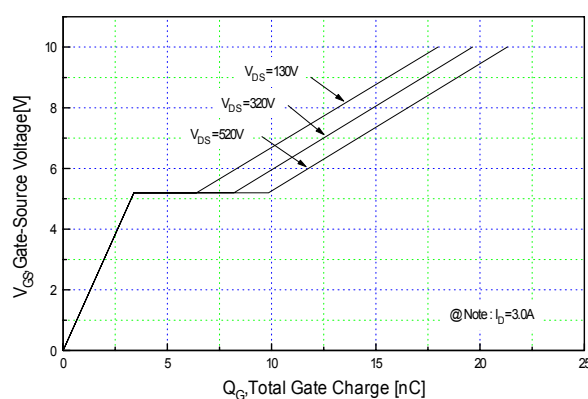


Figure 6. Gate Charge vs. Gate-Source Voltage

## Typical Performance Characteristics (Continued)

(KA5H0365R, KA5M0365R, KA5L0365R)

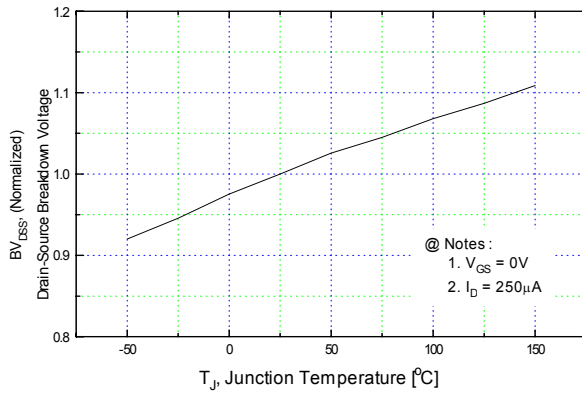


Figure 7. Breakdown Voltage vs. Temperature

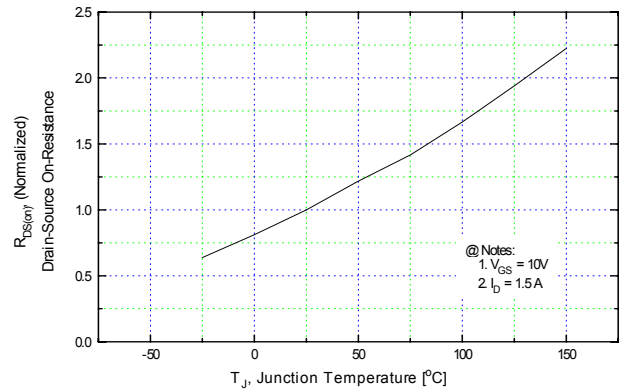


Figure 8. On-Resistance vs. Temperature

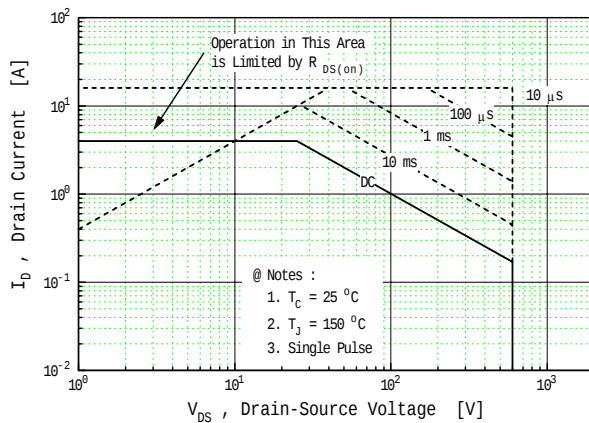


Figure 9. Max. Safe Operating Area

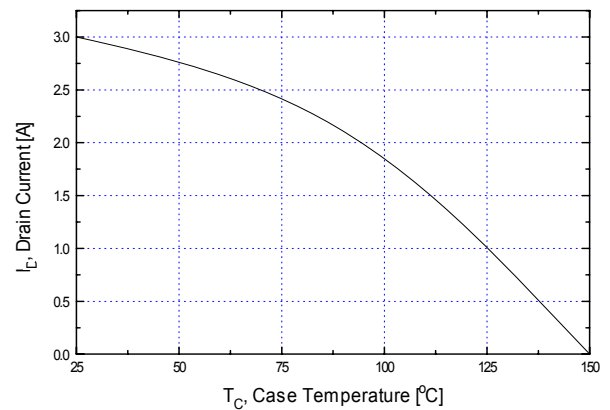


Figure 10. Max. Drain Current vs. Case Temperature

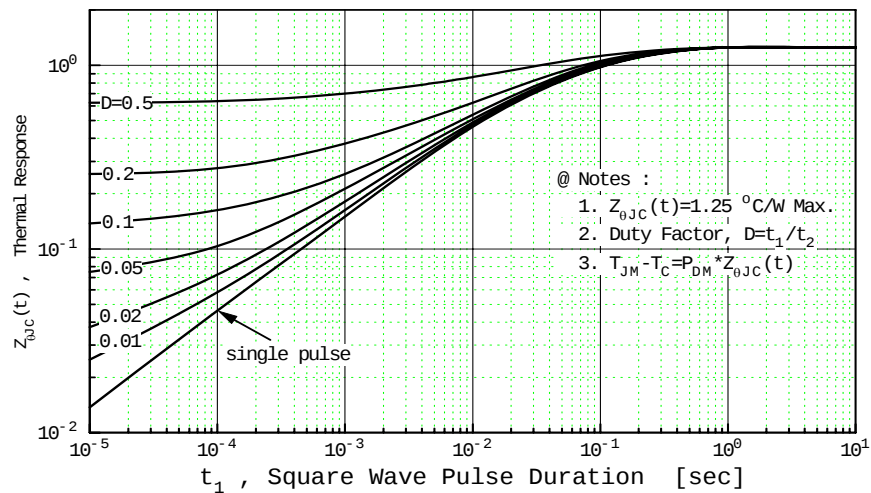


Figure 11. Thermal Response

## Typical Performance Characteristics (Continued)

(KA5H0380R, KA5M0380R, KA5L0380R)

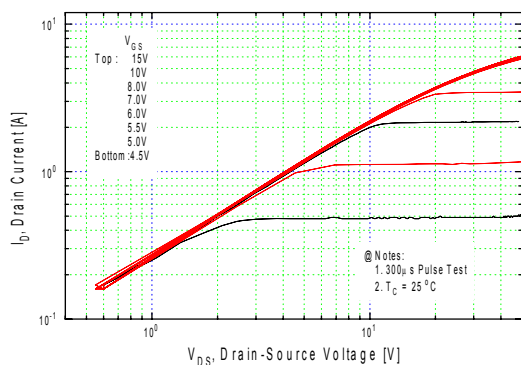


Figure 1. Output Characteristics

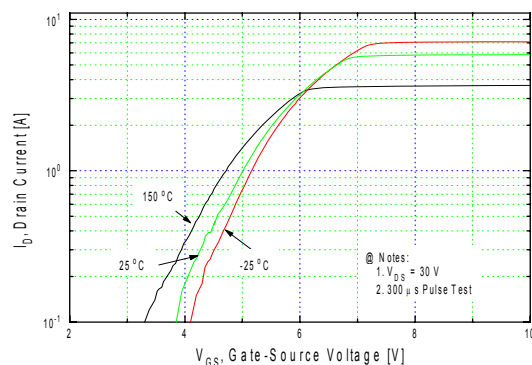


Figure 2. Transfer Characteristics

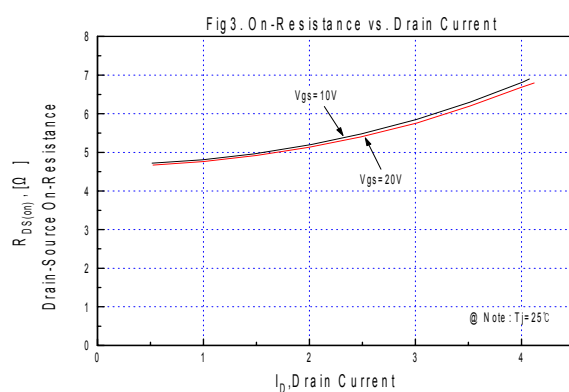


Figure 3. On-Resistance vs. Drain Current

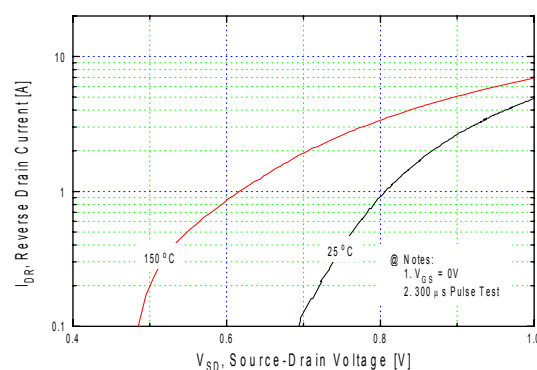


Figure 4. Source-Drain Diode Forward Voltage

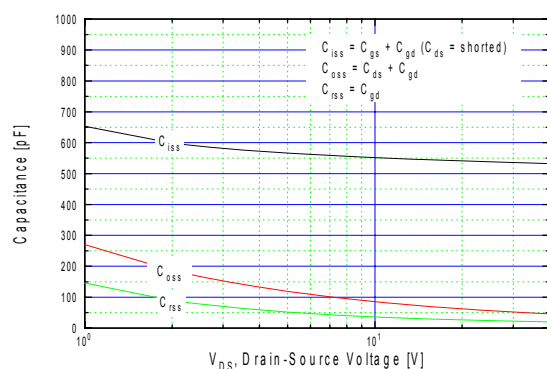


Figure 5. Capacitance vs. Drain-Source Voltage

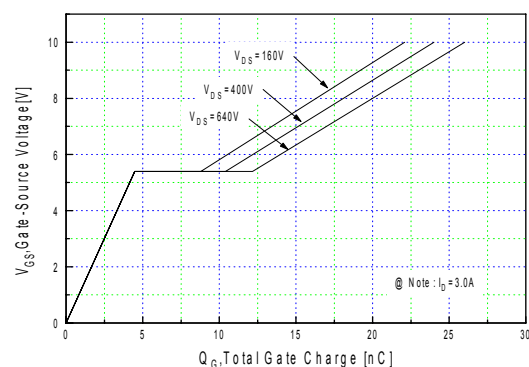


Figure 6. Gate Charge vs. Gate-Source Voltage

## Typical Performance Characteristics (Continued)

(KA5H0380R, KA5M0380R, KA5L0380R)

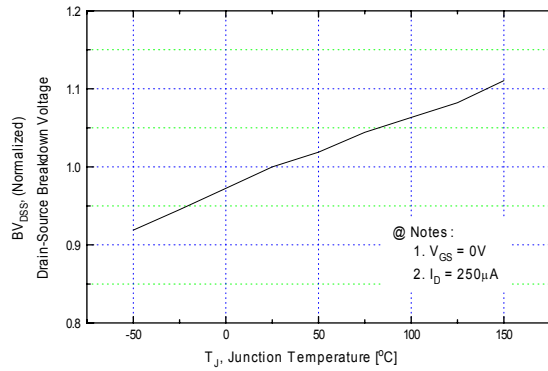


Figure 7. Breakdown Voltage vs. Temperature

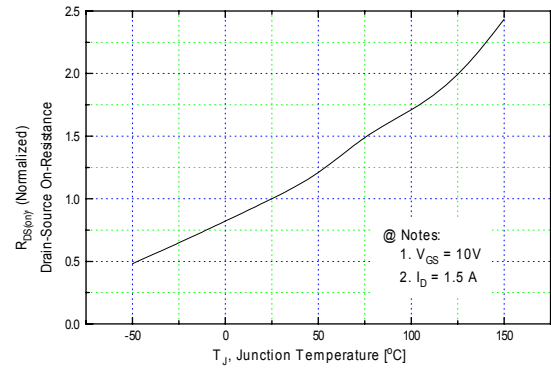


Figure 8. On-Resistance vs. Temperature

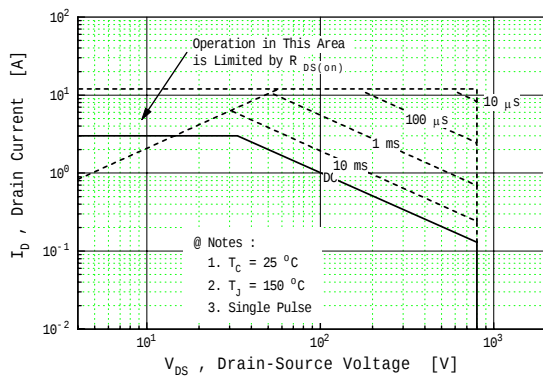


Figure 9. Max. Safe Operating Area

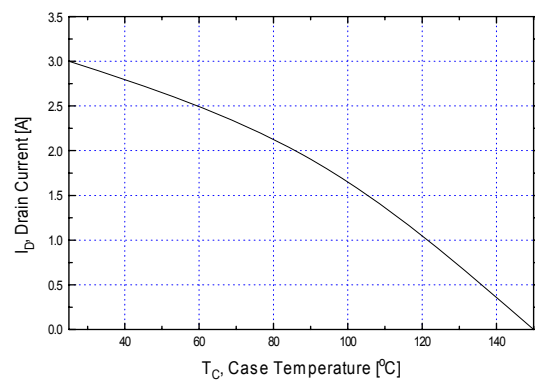


Figure 10. Max. Drain Current vs. Case Temperature

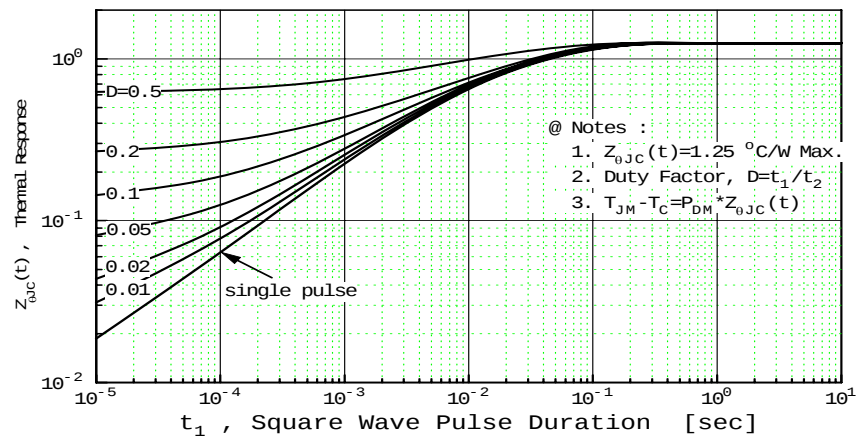


Figure 11. Thermal Response

## Typical Performance Characteristics (Control Part) (Continued)

(These characteristic graphs are normalized at  $T_a = 25^\circ\text{C}$ )

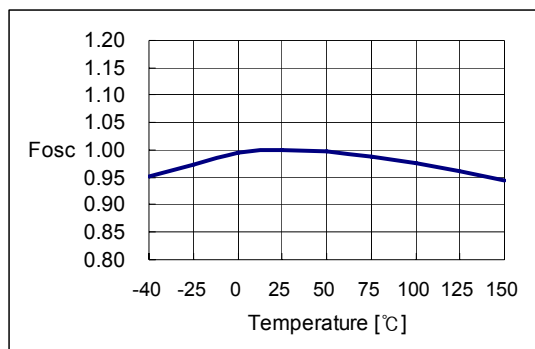


Figure 1. Operating Frequency

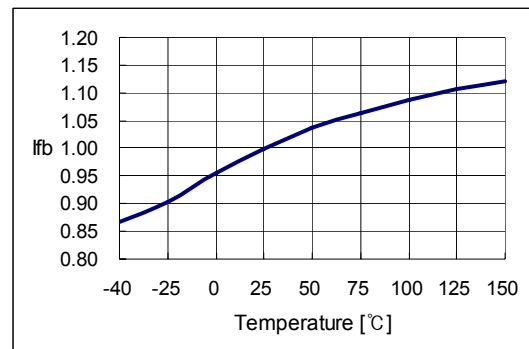


Figure 2. Feedback Source Current

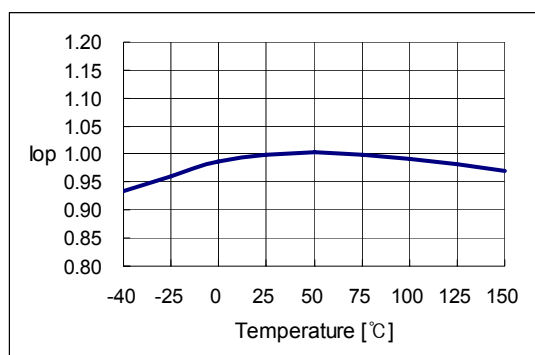


Figure 3. Operating Supply Current

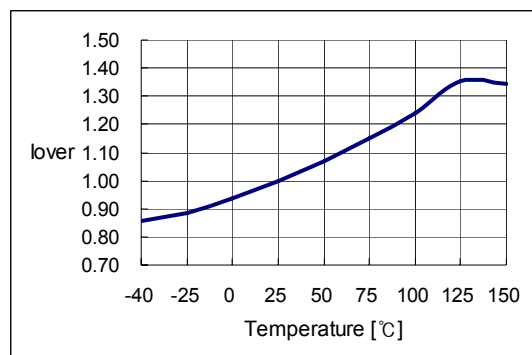


Figure 4. Peak Current Limit

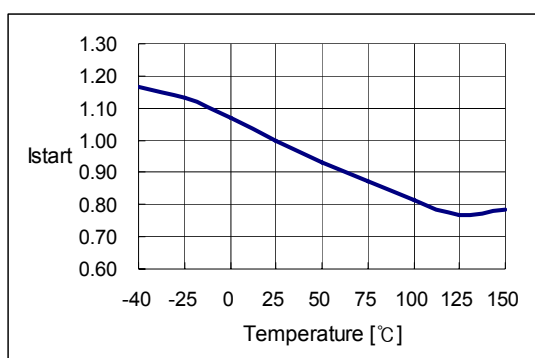


Figure 5. Start up Current

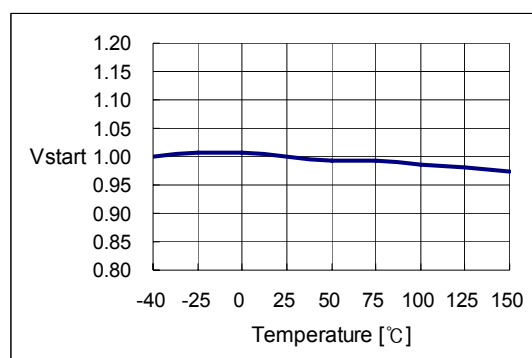
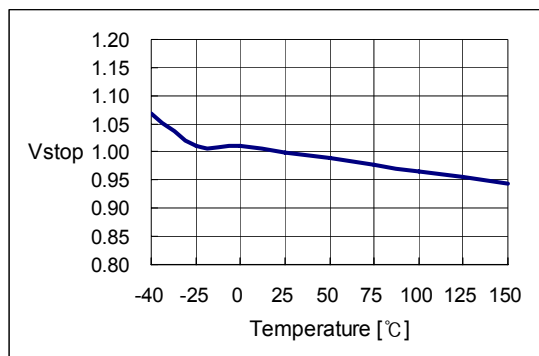
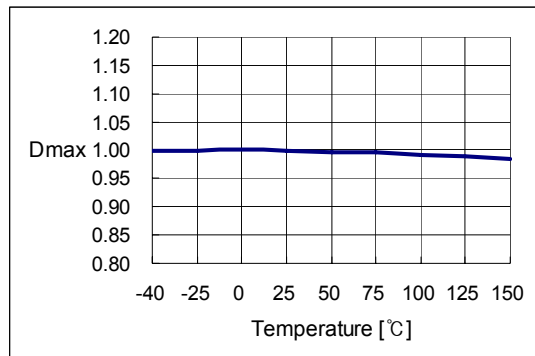
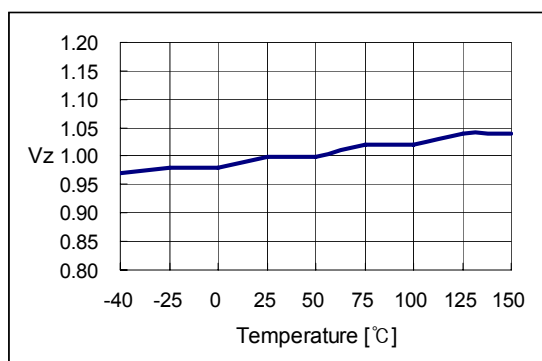
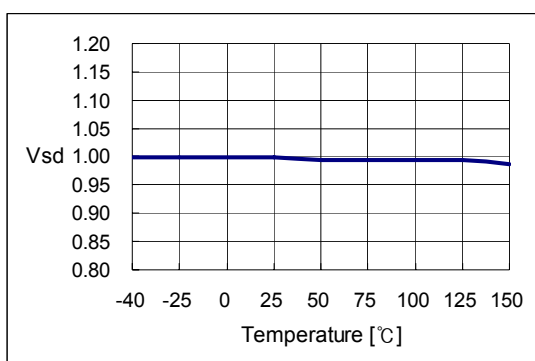
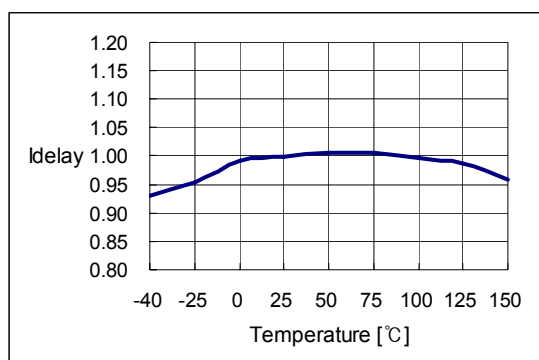
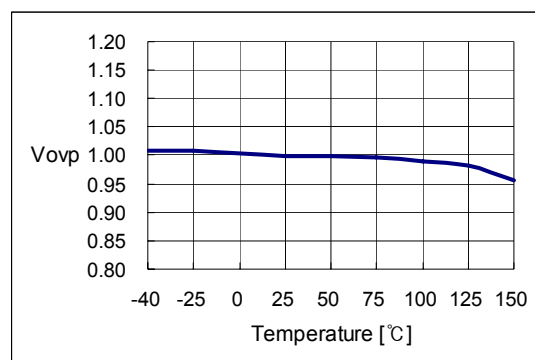
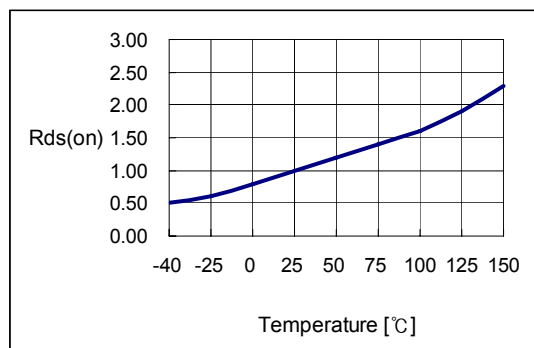


Figure 6. Start Threshold Voltage

**Typical Performance Characteristics** (Continued)(These characteristic graphs are normalized at  $T_a = 25^\circ\text{C}$ )**Figure 7. Stop Threshold Voltage****Figure 8. Maximum Duty Cycle****Figure 9. VCC Zener Voltage****Figure 10. Shutdown Feedback Voltage****Figure 11. Shutdown Delay Current****Figure 12. Over Voltage Protection**

## Typical Performance Characteristics (Continued)

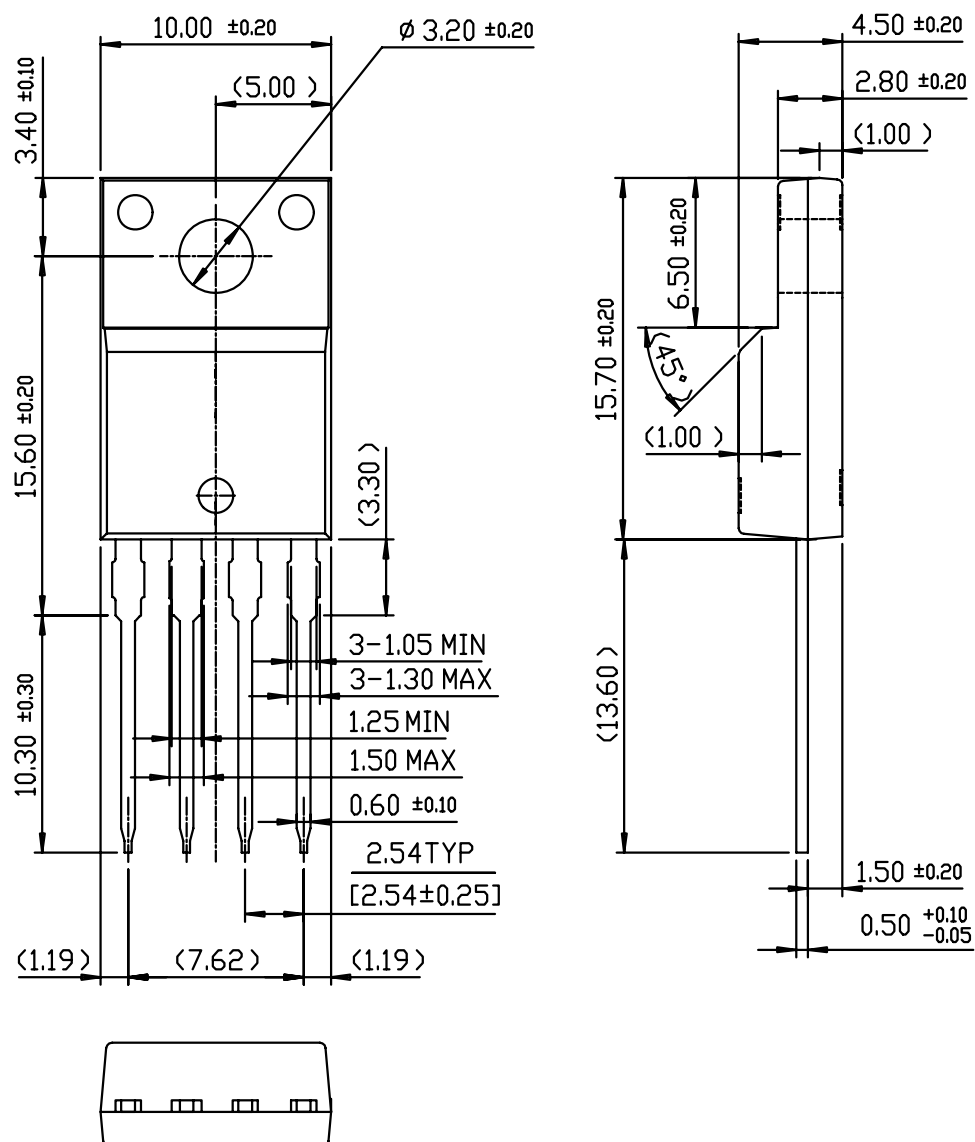
(These characteristic graphs are normalized at  $T_a = 25^\circ\text{C}$ )



**Figure13. Static Drain-Source on Resistance**

## Package Dimensions

## TO-220F-4L



Technical drawing of a 4-pin connector showing front, side, and top views with dimensions in mm.

**Front View Dimensions:**

- Overall width:  $10.00 \pm 0.20$
- Pin pitch:  $2.54 \text{ TYP}$  ( $[2.54 \pm 0.25]$ )
- Pin diameter:  $\phi 3.20 \pm 0.20$
- Pin height:  $3.40 \pm 0.10$
- Pin #1 to #4 width:  $(1.19)$
- Pin #2 to #3 width:  $(7.62)$
- Pin #1 to #4 height:  $15.60 \pm 0.20$
- Pin #2 to #3 height:  $(3.30)$
- Pin #1 to #4 height:  $5.00 \pm 0.30$
- Pin #2 to #3 height:  $3-1.05 \text{ MIN}$  /  $3-1.30 \text{ MAX}$
- Pin #1 to #4 height:  $1.25 \text{ MIN}$  /  $1.50 \text{ MAX}$
- Pin #2 to #3 height:  $0.60 \pm 0.10$

**Side View Dimensions:**

- Overall height:  $26.00 \pm 0.80$
- Pin #1 to #4 height:  $15.70 \pm 0.20$
- Pin #2 to #3 height:  $6.50 \pm 0.20$
- Pin #1 to #4 height:  $5.00 \pm 0.30$
- Pin #2 to #3 height:  $5.30 \pm 0.30$
- Pin #1 to #4 height:  $3.18 \pm 0.30$
- Pin #2 to #3 height:  $1.50 \pm 0.10$
- Pin #1 to #4 height:  $0.50^{+0.10}_{-0.05}$
- Pin #2 to #3 height:  $(3.50)$
- Pin #1 to #4 height:  $(1.00)$
- Pin #2 to #3 height:  $(1.00)$
- Pin #1 to #4 height:  $(4.5)$

**Top View Dimensions:**

- Overall width:  $4.50 \pm 0.20$
- Pin #1 to #4 width:  $2.80 \pm 0.20$
- Pin #2 to #3 width:  $(1.00)$

## Ordering Information

| Product Number | Package             | Marking Code | BVDSS | FOSC   | RDS(on) |
|----------------|---------------------|--------------|-------|--------|---------|
| KA5H0365RTU    | TO-220F-4L          | 5H0365R      | 650V  | 100kHz | 3.6Ω    |
| KA5H0365RYDTU  | TO-220F-4L(Forming) |              |       |        |         |
| KA5M0365RTU    | TO-220F-4L          | 5M0365R      | 650V  | 67kHz  | 3.6Ω    |
| KA5M0365RYDTU  | TO-220F-4L(Forming) |              |       |        |         |
| KA5L0365RTU    | TO-220F-4L          | 5L0365R      | 650V  | 50kHz  | 3.6Ω    |
| KA5L0365RYDTU  | TO-220F-4L(Forming) |              |       |        |         |
| Product Number | Package             | Marking Code | BVDSS | FOSC   | RDS(on) |
| KA5H0380RTU    | TO-220F-4L          | 5H0380R      | 800V  | 100kHz | 4.6Ω    |
| KA5H0380RYDTU  | TO-220F-4L(Forming) |              |       |        |         |
| KA5M0380RTU    | TO-220F-4L          | 5M0380R      | 800V  | 67kHz  | 4.6Ω    |
| KA5M0380RYDTU  | TO-220F-4L(Forming) |              |       |        |         |
| KA5L0380RTU    | TO-220F-4L          | 5L0380R      | 800V  | 50kHz  | 4.6Ω    |
| KA5L0380RYDTU  | TO-220F-4L(Forming) |              |       |        |         |

TU :Non Forming Type

YDTU : Forming type



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|                                                                                              |                                                |                                                                                                    |                                                                                             |
|----------------------------------------------------------------------------------------------|------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 2Cool™                                                                                       | FPS™                                           | PDP SPM™                                                                                           | The Power Franchise®                                                                        |
| AccuPower™                                                                                   | F-PFS™                                         | Power-SPM™                                                                                         | the power™                                                                                  |
| Auto-SPM™                                                                                    | FRFET®                                         | PowerTrench®                                                                                       | franchise                                                                                   |
| AX-CAP™**                                                                                    | Global Power Resource™                         | PowerXS™                                                                                           | TinyBoost™                                                                                  |
| BitSiC®                                                                                      | Green FPS™                                     | Programmable Active Droop™                                                                         | TinyBuck™                                                                                   |
| Build it Now™                                                                                | Green FPS™ e-Series™                           | QFET®                                                                                              | TinyCalc™                                                                                   |
| CorePLUS™                                                                                    | Gmax™                                          | QS™                                                                                                | TinyLogic®                                                                                  |
| CorePOWER™                                                                                   | GTO™                                           | Quiet Series™                                                                                      | TINYOPTO™                                                                                   |
| CROSSVOLT™                                                                                   | IntelliMAX™                                    | RapidConfigure™                                                                                    | TinyPower™                                                                                  |
| CTL™                                                                                         | ISOPLANAR™                                     |  ™                | TinyPWM™                                                                                    |
| Current Transfer Logic™                                                                      | Making Small Speakers Sound Louder and Better™ | Saving our world, 1mW/W/kW at a time™                                                              | TinyWire™                                                                                   |
| DEUXPEED®                                                                                    | MegaBuck™                                      | SignalWise™                                                                                        | TranSiC®                                                                                    |
| Dual Cool™                                                                                   | MICROCOUPLER™                                  | SmartMax™                                                                                          | TriFault Detect™                                                                            |
| EcoSPARK®                                                                                    | MicroFET™                                      | SMART START™                                                                                       | TRUECURRENT®*                                                                               |
| EfficientMax™                                                                                | MicroPak™                                      | SPM®                                                                                               | µSerDes™                                                                                    |
| ESBC™                                                                                        | MicroPak2™                                     | STEALTH™                                                                                           |  SerDes™ |
|  Fairchild® | MillerDrive™                                   | SuperFET®                                                                                          | UHC®                                                                                        |
| Fairchild Semiconductor®                                                                     | MotionMax™                                     | SuperSOT™-3                                                                                        | Ultra FRFET™                                                                                |
| FACT Quiet Series™                                                                           | Motion-SPM™                                    | SuperSOT™-6                                                                                        | UniFET™                                                                                     |
| FACT®                                                                                        | mWSaver™                                       | SuperSOT™-8                                                                                        | VCX™                                                                                        |
| FAST®                                                                                        | OptoHit™                                       | SupreMOS®                                                                                          | VisualMax™                                                                                  |
| FastvCore™                                                                                   | OPTOLOGIC®                                     | SyncFET™                                                                                           | VoltagePlus™                                                                                |
| FETBench™                                                                                    | OPTOPLANAR®                                    | Sync-Lock™                                                                                         | XS™                                                                                         |
| FlashWriter®*                                                                                |                                                |  SYSTEM GENERAL®* |                                                                                             |

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## PRODUCT STATUS DEFINITIONS

### Definition of Terms

| Datasheet Identification | Product Status        | Definition                                                                                                                                                                                          |
|--------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance Information      | Formative / In Design | Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.                                                                       |
| Preliminary              | First Production      | Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |
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