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Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China









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FAN7085_GF085 High Side Gate Driver with Recharge FET

R

Features

- · Qualified to AEC Q100
- Floating channel designed for bootstrap operation fully operational up to 300V.
- · Tolerance to negative transient voltage on VS pin
- dv/dt immune.
- · Gate drive supply range from 4.5V to 20V
- · Under-voltage lockout
- · CMOS Schmitt-triggered inputs with pull-down and pull-up
- · High side output out of phase with input (Inverted input)
- · Reset input
- Internal recharge FET for bootstrap refresh

Typical Applications

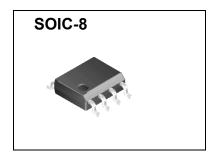
- · Diesel and gasoline injectors/valves
- · MOSFET-and IGBT high side driver applications



For Fairchild's definition of "green" Eco Status, please visit: http://www.fairchildsemi.com/company/green/rohs_green.html

Description

The FAN7085_GF085 is a high-side gate drive IC with reset input and built-in recharge FET. It is designed for high voltage and high speed driving of MOSFET or IGBT, which operates up to 300V. Fairchild's high-voltage process and common-mode noise cancellation technique provide stable operation in the high side driver under high-dV/dt noise circumstances. Logic input is compatible with standard CMOS outputs. The UVLO circuits prevent from malfunction when VCC and VBS are lower than the specified threshold voltage. It is available with space saving SOIC-8 Package. Minimum source and sink current capability of output driver is 250mA and 250mA. Built-in recharge FET to refresh bootstrap circuit is very useful for circuit topology requiring switches on low and high side of load.

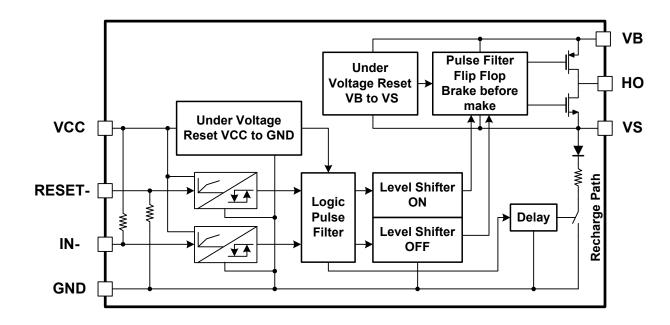


Ordering Information

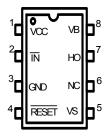
| Device | Package | Operating Temp. | | |
|-----------------|---------|--------------------|--|--|
| FAN7085M_GF085 | SOIC-8 | -40 °C ~ 125 °C | | |
| FAN7085MX_GF085 | SOIC-8 | -40 °C ~ 125 °C | | |

X : Tape & Reel type

Block Diagrams



Pin Assignments



Pin Definitions

| Pin Number | Pin Name | I/O | Pin Function Description |
|------------|----------|-----|--|
| 1 | VCC | Р | Driver supply voltage, typically 5V |
| 2 | IN- | I | Driver control signal input (Negative Logic) |
| 3 | GND | Р | Ground |
| 4 | RESET- | I | Driver enable input signal (Negative Logic) |
| 5 | VS | Р | High side floating offset for MOSFET Source connection |
| 6 | NC | - | No connection (No Bond wire) |
| 7 | НО | Α | High side drive output for MOSFET Gate connection |
| 8 | VB | Р | Driver output stage supply |

Absolute Maximum Ratings

Absolute Maximum Ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to GND.

| Parameter | Symbol | Min. | Max. | Unit |
|---|------------------|--------|---------|------|
| High side floating supply voltage | VBS | -0.3 | 25 | V |
| High side driver output stage voltage Neg. transient: 0.5 ms, external MOSFET off | VB | -5 | 325 | V |
| High side floating supply offset voltage Neg. transient 0.2 us | Vs | -25 | 300 | V |
| High side floating output voltage | VHO | VS-0.3 | VB+0.3 | V |
| Supply voltage | Vcc | -0.3 | 25 | V |
| Input voltage for IN- | VIN | -0.3 | Vcc+0.3 | V |
| Input voltage for RESET- | VRES | -0.3 | Vcc+0.3 | V |
| Power Dissipation 1) | Pd | | 0.625 | W |
| Thermal resistance, junction to ambient 1) | Rthja | | 200 | °C/W |
| Electrostatic discharge voltage (Human Body Model) | V _{ESD} | 1.5K | | V |
| Charge device model | V_{CDM} | 500 | | V |
| Junction Temperature | Tj | | 150 | °C |
| Storage Temperature | T _S | -55 | 150 | °C |

Note: 1) The thermal resistance and power dissipation rating are measured bellow conditions;

Recommended Operating Conditions

For proper operation the device should be used within the recommended conditions.-40°C <= Ta <= 125°C

| Parameter | Symbol | Min. | Max. | Unit |
|--|-----------------------|--------|-------|------|
| High side floating supply voltage(DC) Transient:-10V@ 0.2 us | VB | VS+4.5 | VS+20 | V |
| High side floating supply offset voltage(DC) @VBS=7V | Vs | -3 | 300 | V |
| High side floating supply offset voltage(Transient) 0.2us @VBS<25V | Vs | -25 | 300 | V |
| High side floating output voltage | VHO | Vs | VB | V |
| Allowable offset voltage Slew Rate 1) | dv/dt | - | 50 | V/ns |
| Supply voltage for logic part | Vcc | 4.5 | 20 | V |
| Input voltage for IN- | VIN | 0 | Vcc | V |
| Input voltage for RESET- | VRESET | 0 | Vcc | V |
| Switching frequency ²⁾ | Fs | | 200K | Hz |
| Minimum low input width 3) | tIN(low,min) | 560 | - | ns |
| Minimum high input width 3) | tIN(high,min) | 60 | - | ns |
| Minimum operating voltage of VB related to GND | VB(MIN) ⁴⁾ | 4 | - | V |
| Ambient temperature | Та | -40 | 125 | °C |

Note: 1) Guaranteed by design.

JESD51-2: Integrated Circuit Thermal Test Method Environmental Conditions - Natural condition(StillAir)

JESD51-3: Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Package

²⁾ Duty = 0.5, VBS >=7V

³⁾ Guaranteed by design. Pulse widths below the specified values, may be ignored. Output will either follow the input signal or will ignore it. No false output state is guaranteed when minimum input width is smaller than tin 4) Guaranteed by design

Statics Electrical Characteristics

Unless otherwise specified, -40°C <= Ta <= 125°C, VCC = 5V, VBS = 7V, VS = 0V, VRESET = 5V, RL = 50Ω , CL = 2.5nF.

| VCC and VBS supply under voltage positive going threshold VCCUV+ VBSUV+ VBSUV+ VBSUV+ VBSUV+ VCC and VBS upply under voltage regative going threshold VCCUV+ VBSUV+ VCC and VBS dropping from SV VCC and VBS under voltage physteresis VCCUV+ VBSUV+ VCC and VBS dropping from SV VCC and VBS under voltage hysteresis VCCUVH VBSUVH VCC and VBS under voltage hysteresis V Under voltage lockout response time indivorse with vBSUVH VBS under voltage lockout response time indivorse with vBSUVH VBS under value and vBSUVH VBS under vBSUVH VBS under vBSUPHy vBSUVH VBS under vBSUPHy vBSUP | Parameter | Symbol | Conditions | Min. | Тур. | Max. | Unit |
|--|---|---------------|------------------------------|--------|------|---------|------|
| VBSUV+ | VCC and VBS Supply Characteristics | l | 1 | | | | |
| Negative going threshold Negative Nega | VCC and VBS supply under voltage positive going threshold | | Vcc and VBS rising from 0V | - | 3.7 | 4.3 | V |
| VBSUVH | VCC and VBS supply under voltage negative going threshold | | Vcc and VBS dropping from 5V | 2.8 | 3.4 | - | V |
| Iduvbs VBS: 6.5V->2.4V or 2.4V->6.5V 0.5 20 us | VCC and VBS under voltage hysteresis | | - | 0.02 | 0.3 | - | V |
| Quiescent Vos supply current IQCC Voc=20V - - 500 UA | Under voltage lockout response time | | | | | _ | |
| Company Com | Offset supply leakage current | ILK | VB=VS=300V | - | - | 200 | uA |
| VBS=7V, VIN=0 or 5V VBS | Quiescent Vcc supply current | IQCC | Vcc=20V | - | - | 500 | uA |
| VBS drop due to output turn-on (Design guaranty) ΔVBS VBS=7V, Cbs=1uF, tdic-IN=3uS, trEST=100uS 210 mV VBS drop due to output turn-on (Design guaranty) ΔVBS VBS=7V, Cbs=1uF, tdic-IN=3uS, trEST=100uS 210 mV Imput Characteristics WEST-V, Cbs=1uF, tdic-IN=3uS, trEST=100uS 210 mV High logic level input voltage for IN- Low logic level input voltage for IN- VIL VIH 0.6VCC - - V 2.028VCC V Low logic level input bias current for IN- High logic level input bias current for IN- High logic level input bias current for IN- IIN+ VIN=5V - - 5 0.6 VCC - - 5 0.0 uA High logic level input bias current for IN- High logic level input voltage for RESET- VRH 0.6VCc - - - 5 0.0 uA VID-000 VCC - - V V V - - 5 0.0 uA V V Impulse Input bias current for IN- VRH VIN-5V - - 5 0.0 uA V V V V V V V V V V V V V V V V | Quiescent VBS supply current | IQBS1 | , | | | 100 | uA |
| Input Characteristics ViH O.6VCC - O.28VCC V | Quiescent VBS supply current | IQBS2 | | | | 200 | uA |
| High logic level input voltage for IN- | VBS drop due to output turn-on (Design guaranty) | ΔVBS | | | | 210 | mV |
| Low logic level input voltage for IN- VIL | Input Characteristics | l . | 1 | | | | |
| Low logic level input bias current for IN- IIN- VIN=0 5 25 60 UA High logic level input bias current for IN- IIN+ VIN=5V 5 UA Full up resistance at IN RIN 83 200 1000 KΩ High logic level input voltage for RESET- VRH 0.6Vcc V UA US IN US | High logic level input voltage for IN- | VIH | | 0.6VCC | - | - | V |
| High logic level input bias current for IN- IIN+ VIN=5V - - 5 UA | Low logic level input voltage for IN- | VIL | | - | - | 0.28VCC | V |
| Full up resistance at IN RIN 0.6Vcc V High logic level input voltage for RESET- VRH 0.6Vcc V Low logic level input voltage for RESET- VRL 0.28Vcc V High logic level input current for RESET- IRES+ VRESET=5V 5 25 60 uA Low logic level input bias current for RESET- IRES- VRESET=0 5 uA Full down resistance at RESET- RRES 83 200 1000 ΚΩ Output characteristics High level output voltage, VB - VHO VOH IO=0 0.1 V Low level output voltage, VHO-GND VOL IO=0 0.1 V Peak output source current IO+ VIN=5V 250 450 - mA Equivalent output resistance ROP 15.5 28 Ω ROP 15.5 28 Ω Recharge Characteristics Recharge TR turn-on propagation delay Ton_rech 4 7.9 9.8 us Recharge TR turn-off propagation delay Tof_rech Is=1mA, VIN=5V @125°C 1.2 V Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF VCC=5V, VS=7V 4 7.8 9.8 us | Low logic level input bias current for IN- | IIN- | VIN=0 | 5 | 25 | 60 | uA |
| High logic level input voltage for RESET- | High logic level input bias current for IN- | lin+ | VIN=5V | - | - | 5 | uA |
| Low logic level input voltage for RESET- VRL | Full up resistance at IN | RIN | | 83 | 200 | 1000 | ΚΩ |
| High logic level input current for RESET- | High logic level input voltage for RESET- | VRH | | 0.6Vcc | - | - | V |
| Low logic level input bias current for RESET- RRES | Low logic level input voltage for RESET- | VRL | | | | 0.28Vcc | V |
| Full down resistance at RESET- RRES 83 200 1000 ΚΩ Output characteristics High level output voltage, VB - VHO VOH IO=0 - - 0.1 V Low level output voltage, VHO-GND VOL IO=0 - - 0.1 V Peak output source current IO+ VIN=5V 250 450 - mA Peak output sink current IO- VIN=0 250 450 - mA Equivalent output resistance ROP 15.5 28 Ω Recharge Characteristics Recharge TR turn-on propagation delay Ton_rech 4 7.9 9.8 us Recharge TR turn-off propagation delay Toff_rech 0.2 0.4 us Recharge TR on-state voltage drop VRECH Is=1mA, VIN=5V @125°C 1.2 V Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF VCC=5V, VS=7V 4 7.8 9.8 us | High logic level input current for RESET- | IRES+ | VRESET=5V | 5 | 25 | 60 | uA |
| Output characteristics High level output voltage, VB - VHO VOH IO=0 - - 0.1 V Low level output voltage, VHO-GND VOL IO=0 - - 0.1 V Peak output source current IO+ VIN=5V 250 450 - mA Peak output sink current IO- VIN=0 250 450 - mA Equivalent output resistance ROP 15.5 28 Ω Recharge Characteristics Recharge TR turn-on propagation delay Ton_rech 4 7.9 9.8 us Recharge TR turn-off propagation delay Toff_rech 0.2 0.4 us Recharge TR on-state voltage drop VRECH Is=1mA, VIN=5V @125°C 1.2 V Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF VCC=5V, VS=7V 4 7.8 9.8 us | Low logic level input bias current for RESET- | IRES- | VRESET=0 | | | 5 | uA |
| High level output voltage, VB - VHO | Full down resistance at RESET- | RRES | | 83 | 200 | 1000 | ΚΩ |
| Low level output voltage, VHO-GND VOL IO=0 - - 0.1 V Peak output source current IO+ VIN=5V 250 450 - mA Peak output sink current IO- VIN=0 250 450 - mA Equivalent output resistance ROP 15.5 28 Ω RoN 15.5 28 Ω Recharge Characteristics Recharge TR turn-on propagation delay Ton_rech 4 7.9 9.8 us Recharge TR turn-off propagation delay Toff_rech 0.2 0.4 us Recharge TR on-state voltage drop VRECH Is=1mA, VIN=5V @125°C 1.2 V Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF VCC=5V, VS=7V 4 7.8 9.8 us | Output characteristics | | | | | | |
| Peak output source current IO+ | High level output voltage, VB - VHO | Voн | IO=0 | - | - | 0.1 | V |
| Peak output sink current IO- | Low level output voltage, VHO-GND | VOL | IO=0 | - | - | 0.1 | V |
| ROP | Peak output source current | IO+ | VIN=5V | 250 | 450 | - | mA |
| Recharge Characteristics Recharge TR turn-on propagation delay Ton_rech 4 7.9 9.8 us Recharge TR turn-off propagation delay Toff_rech 0.2 0.4 us Recharge TR on-state voltage drop VRECH Is=1mA, VIN=5V @125°C 1.2 V Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF VCC=5V, VS=7V 4 7.8 9.8 us | Peak output sink current | Ю- | VIN=0 | 250 | 450 | - | mA |
| Recharge Characteristics Recharge TR turn-on propagation delay Recharge TR turn-off propagation delay Ton_rech Toff_rech Recharge TR on-state voltage drop VRECH Toff_rech Toff_rech VRECH Toff_rech Tof | Equivalent output resistance | Rop | | | 15.5 | 28 | Ω |
| Recharge TR turn-on propagation delay Ton_rech Recharge TR turn-off propagation delay Toff_rech Recharge TR on-state voltage drop VRECH Toff_rech VRECH Is=1mA, VIN=5V @125°C 1.2 V Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF VCC=5V, VS=7V 4 7.8 9.8 us | | Ron | | | 15.5 | 28 | Ω |
| Recharge TR turn-off propagation delay Toff_rech Recharge TR on-state voltage drop VRECH Is=1mA, VIN=5V @125°C 1.2 V Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF VCC=5V, VS=7V 4 7.8 9.8 us | Recharge Characteristics | | | | | | |
| Recharge TR on-state voltage drop VRECH Is=1mA, VIN=5V @125°C 1.2 V Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF Vcc=5V, VS=7V 4 7.8 9.8 us | Recharge TR turn-on propagation delay | Ton_rech | | 4 | 7.9 | 9.8 | us |
| Dead Time Characteristics High side turn-off to recharge gate turn-on DTHOFF VCC=5V, VS=7V 4 7.8 9.8 us | Recharge TR turn-off propagation delay | Toff_rech | | | 0.2 | 0.4 | us |
| High side turn-off to recharge gate turn-on DTHOFF Vcc=5V, VS=7V 4 7.8 9.8 us | Recharge TR on-state voltage drop | VRECH | Is=1mA, VIN=5V @125°C | | | 1.2 | V |
| | Dead Time Characteristics | • | | - | | • | |
| Recharge gate turn-off to high side turn-on DTHON VCC=5V, VS=7V 0.1 0.4 0.7 us | High side turn-off to recharge gate turn-on | DTHOFF | Vcc=5V, Vs=7V | 4 | 7.8 | 9.8 | us |
| | Recharge gate turn-off to high side turn-on | D THON | Vcc=5V, Vs=7V | 0.1 | 0.4 | 0.7 | us |

Note: The input parameter are referenced to GND. The VO and IO parameters are referenced to GND.

Dynamic Electrical Characteristics

Unless otherwise specified, -40°C <= Ta <= 125°C, VCC = 5V, VBS = 7V, VS = 0V, VRESET = 5V, RL = 50Ω , CL = 2.5nF.

| Parameter | Symbol | Conditions | Min. | Тур. | Max. | Unit |
|--|----------|---|------|------|------|------|
| Input-to-output turn-on propagation delay | tplh | 50% input level to 10% output level, VS = 0V | | 0.56 | 1 | us |
| Input-to-output turn-off propagation delay | tphI | 50% input level to 90% output level VS = 0V | - | 0.15 | 0.5 | us |
| RESET-to-output turn-off propagation delay | tphl_res | 50% input level to 90% output level | - | 0.17 | 0.5 | us |
| RESET-to-output turn-on propagation delay | tplh_res | 50% input level to 10% output level | - | 0.56 | 1 | us |
| Output rising time | tr1 | Tj=25°C | - | 65 | 200 | ns |
| | tr2 | | | - | 400 | ns |
| | tr3 | Tj=25°C,V _{BS} =16V | | 65 | 200 | ns |
| | tr4 | V _B S=16V | | - | 400 | ns |
| Output falling time | tf1 | Tj=25°C | - | 25 | 200 | ns |
| | tf2 | | | - | 300 | ns |
| | tf3 | Tj=25°C,V _{BS} =16V | | 25 | 200 | ns |
| | tf4 | V _B S=16V | | - | 300 | ns |

Application Information

1. Logic Tables

| VCC | VBS | RESET- | IN- | Но | RechFET |
|------------|------------|--------|------|-----|---------|
| < VCCUVLO- | Х | Х | X | OFF | ON |
| Х | Х | LOW | Х | OFF | ON |
| Х | X | X | HIGH | OFF | ON |
| > VCCUVLO+ | > VBSUVLO+ | HIGH | LOW | ON | OFF |
| > VCCUVLO+ | < VBSUVLO- | HIGH | LOW | OFF | OFF |

Notes:

X means independent from signal

IN-=LOW indicates that the high side NMOS is ON

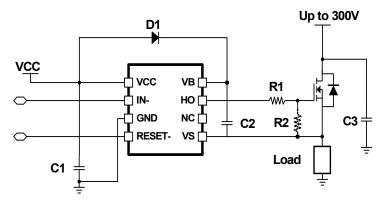
IN-=HIGH indicates that the high side NMOS is OFF

RechFET =ON indicates that the recharge MOSFET is ON

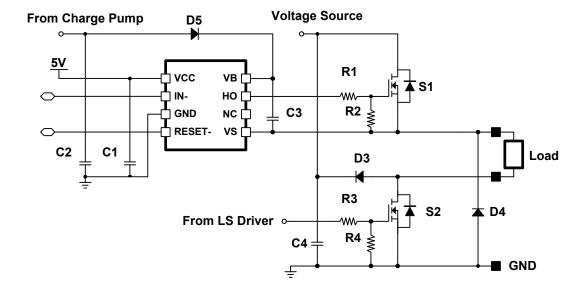
RechFET =OFF indicates that the recharge MOSFET is OFF

Typical Application Circuit

1. Typical Application Circuit



2. Application Example



Input-Output Waveforms

1. Input/Output Timing Diagrams

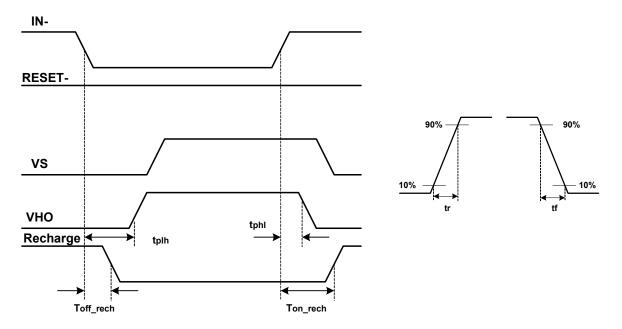


Figure.1 Input and Output Timing Diagram and Switching Time Waveform Definition

2. Reset Timing Diagrams

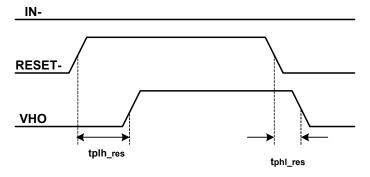
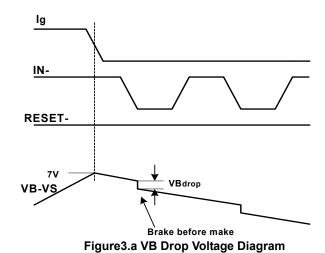


Figure.2 Reset and Output Timing Diagram

3.VB Drop Voltage Diagram



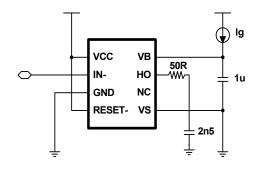


Figure 3.b VB Drop Voltage Test Circuit

4.Recommendation Min. Short Pulse Width

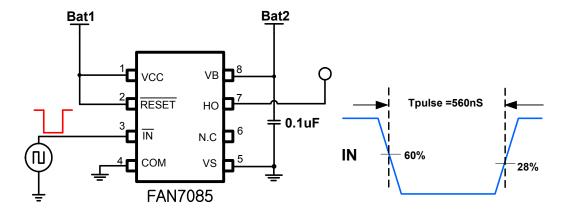


Figure 4a. Short Pulse Width Test Circuit and Pulse Width Waveform

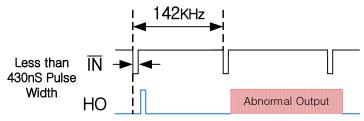


Figure 4b. Abnormal Output Waveform with short pulse width

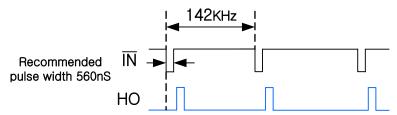


Figure 4c. Recommendation of pulse width Output Waveform

Performance Graphs

This performance graphs based on ambient temperature -40°C ~125°C

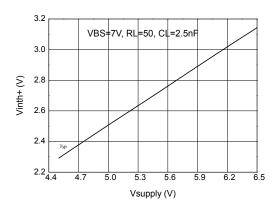


Figure 5a. Positive IN and RESET Threshold vs VCC Supply

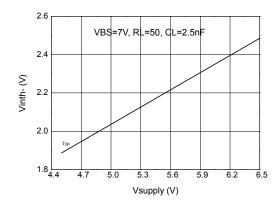


Figure 5b. Negative IN and RESET Threshold vs VCC Supply

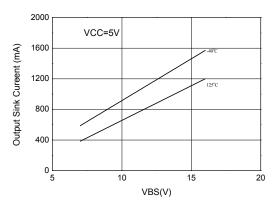


Figure6a. Output Sink Current vs VBS Supply

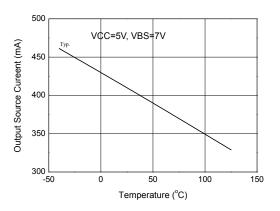


Figure6b. Output Source Current vs Temperature

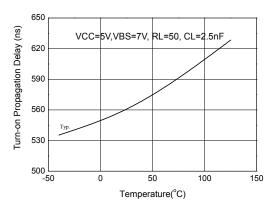


Figure 7a. Turn-On Propagation Delay Time vs Temperature

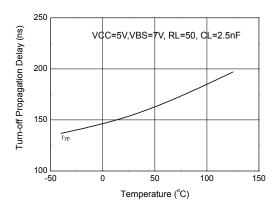
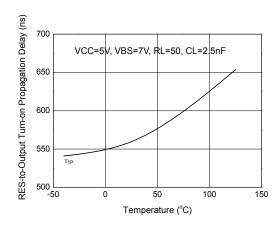


Figure 7b. Turn-Off Propagation Delay Time vs Temperature

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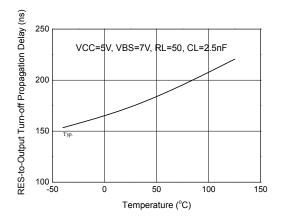
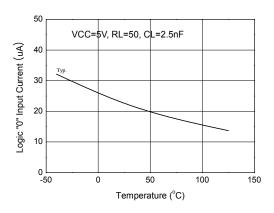


Figure 8a. RES to Output Turn-On Propagation Delay vs Temperature Figure 8b. RES to Output Turn-Off Propagation Delay vs Temperatur



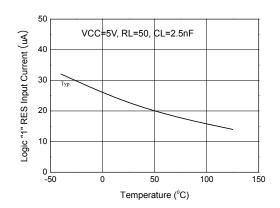
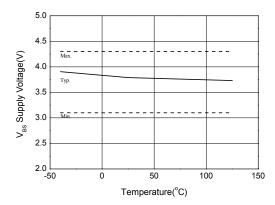


Figure 9. Logic "0" IN Input Current vs Temperature

Figure 10. Logic "1" RESET Input Current vs Temperature



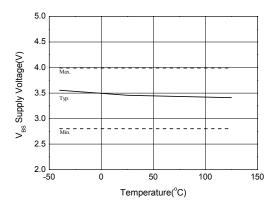
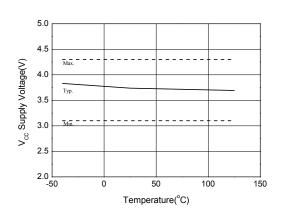


Figure 11a. VBS Under Voltage Threshold(+) vs Temperature

Figure 11b. VBS Under Voltage Threshold(-) vs Temperature



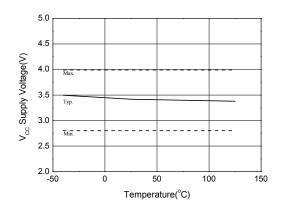
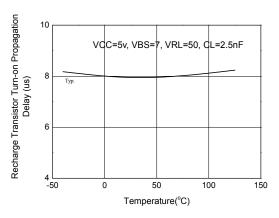


Figure 12a. VCC Under Voltage Threshold(+) vs Temperature

Figure 12b. VCC Under Voltage Threshold(-) vs Temperature



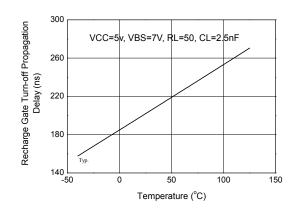
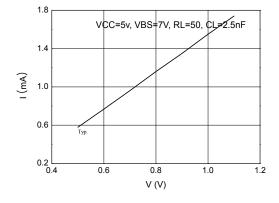


Figure 13. Recharge FET Turn-on Delay time

Figure 14. Recharge FET Turn-off Delay time



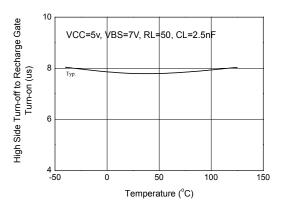
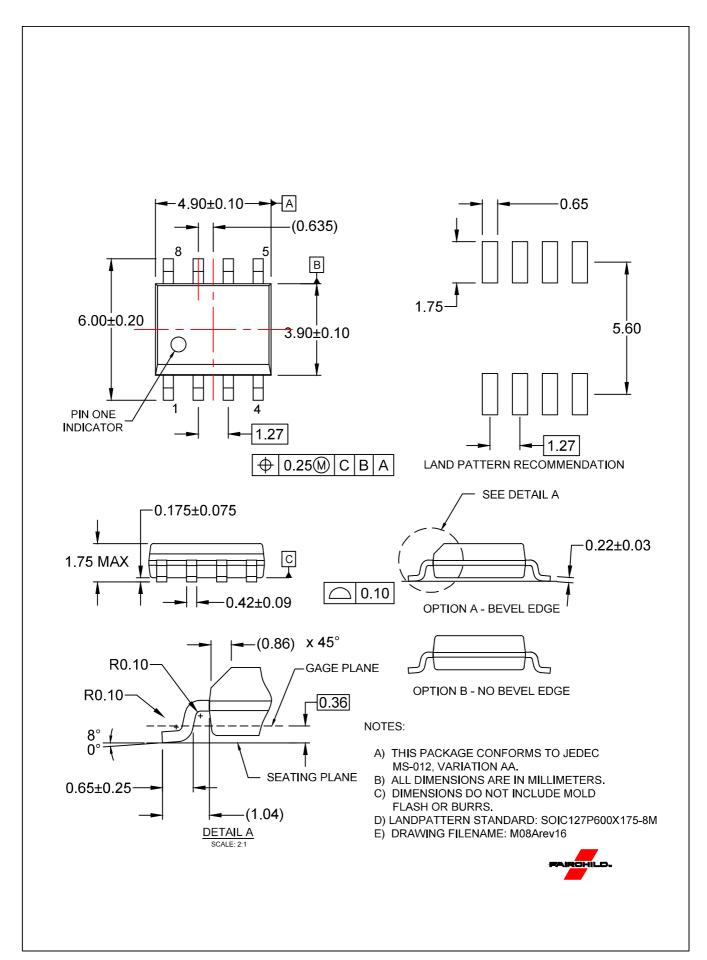


Figure 15. Recharge FET I-V curve

Figure 16. High Side Turn-off to Recharge FET turn-on VS Temperature



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