

# FAN6250M6X

## Secondary Side Synchronous Rectifier Controller for Flyback Converters

### Description

The FAN6250M6X is a secondary-side synchronous rectifier (SR) controller for an isolated flyback converter operating in Discontinuous Conduction Mode (DCM). The adaptive dead time control algorithm minimizes the body diode conduction of SR MOSFET while guaranteeing stable and robust SR operation against noise and disturbance caused by the circuit parasitic.

Programmable thermal Shut-Down (SD) function that is informing primary side controller to shut-down the power system when pairing with PSR controller – FAN1080. The Dynamic Response Enhancement (DRE) function that minimizes system response time when pairing with PSR controller – FAN1080.

### Features

- Works in Discontinuous Conduction Modes (DCM) and Boundary Conduction Modes (BCM)
- Adaptive Turn-off Trigger Blanking Time for Wide SR MOSFET Application
- Gate Turn-on Blanking Time (minimum Gate OFF Time)
- Dynamic Response Enhancement (DRE) Function that minimizes System Response Time
- Programmable Shut-Down (SD) Protection
- Minimum Turn-on Delay (20 ns)
- Input Voltage (VIN) Range for LDO Input: 3.25 V to 20 V
- Fewest External Components Allowed
- Accurate Turn Off Dead Time Regulation when working with PSR Power System
- Small Footprint: SOT-23 6 Pin
- This is a Pb-Free Device

### Typical Applications

- Travel Adapter for Smart Phones, Feature Phones, and Tablet PCs
- AC-DC Adapters for Portable Devices that Require CV/CC Control

### ORDERING INFORMATION

| Part Number | Operating Temperature | Package                 | Packing Method <sup>†</sup> |
|-------------|-----------------------|-------------------------|-----------------------------|
| FAN6250M6X  | -40°C to 125°C        | 6 Lead, SOT23 (Pb-Free) | 3000 / Tape & Reel          |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D



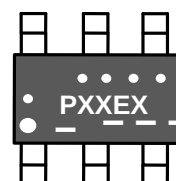
ON Semiconductor®

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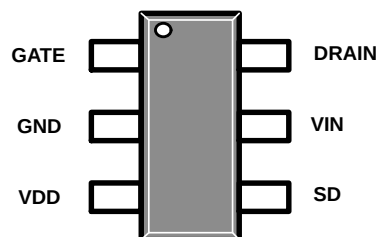
SOT-23, 6 Lead  
CASE 527AJ

### MARKING DIAGRAM



... = Year Code  
PXX = 250 : FAN6250  
E X = Die Run Code  
--- = Date Code

### PIN CONNECTIONS



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# FAN6250M6X

**Table 1. PIN FUNCTION DESCRIPTION**

| Pin # | Name  | Description                                                                                                                                                                                                    |
|-------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | GATE  | Gate drive output                                                                                                                                                                                              |
| 2     | GND   | Ground                                                                                                                                                                                                         |
| 3     | VDD   | Internal regulator 5 V output and gate drive power supply. Bypass with a 1uF capacitor to GND.                                                                                                                 |
| 4     | SD    | Shut-Down pin. This pin is implemented for external over-temperature-protect by connecting the NTC thermistor.                                                                                                 |
| 5     | VIN   | Input Voltage Pin. This pin is connected to the output of the adaptor to monitor its output voltage and supply internal bias. IC operating current and MOSFET gate drive current is supplied through this pin. |
| 6     | DRAIN | Synchronous rectifier drain sense input.                                                                                                                                                                       |

**Table 2. ABSOLUTE MAXIMUM RATINGS** (Notes 1, 2, 3)

| Parameter                                      | Symbol                     | Value       | Unit             |
|------------------------------------------------|----------------------------|-------------|------------------|
| Power Supply Input Pin Voltage                 | $V_{IN}$                   | -0.3 to 20  | V                |
| Internal Regulator Output Pin Voltage          | $V_{DD}$                   | -0.3 to 6.5 | V                |
| Drain Sense Input Pin Voltage                  | $V_{DRAIN}$                | -1 to 65    | V                |
| Gate Drive Output Pin Voltage                  | $V_{GATE}$                 | -0.3 to 6.5 | V                |
| Shut-Down Pin Voltage                          | $V_{SD}$                   | -0.3 to 6.5 | V                |
| Sense Pin Voltage                              | $V_{SNS}$                  | -0.3 to 6.5 | V                |
| Power Dissipation ( $T_A = 25^\circ\text{C}$ ) | $P_D$                      | 0.446       | W                |
| Operating Junction Temperature                 | $T_J$                      | -40 to 125  | $^\circ\text{C}$ |
| Storage Temperature Range                      | $T_{STG}$                  | -60 to 150  | $^\circ\text{C}$ |
| Lead Temperature (Soldering) 10 Seconds        | $T_L$                      | 260         | $^\circ\text{C}$ |
| Electrostatic Discharge Capability             | Charged Device Model (CDM) | ESD         | > 0.5            |
|                                                | Human Body Model (HBM)     |             | > 2              |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. All voltage values, except differential voltages, are given with respect to the GND pin.
2. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device.
3. Meets JEDEC standards JS-001-2012 and JESD 22-C101.

**Table 3. THERMAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$  unless otherwise specified)

| Parameter                             | Symbol        | Min   | Unit               |
|---------------------------------------|---------------|-------|--------------------|
| Junction-to-Ambient Thermal Impedance | $\theta_{JA}$ | 218.2 | $^\circ\text{C/W}$ |
| Junction-to-Top Thermal Impedance     | $\theta_{JT}$ | 31.3  | $^\circ\text{C/W}$ |

**Table 4. RECOMMENDED OPERATING RANGES**

| Parameter         | Symbol      | Min  | Max | Unit |
|-------------------|-------------|------|-----|------|
| Drain Pin Voltage | $V_{DRAIN}$ |      | 60  | V    |
| VDD Pin Voltage   | $V_{DD}$    | 3.1  | 5.5 | V    |
| VIN Pin Voltage   | $V_{IN}$    | 3.25 | 20  | V    |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

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**Table 5. ELECTRICAL CHARACTERISTICS**

$V_{IN} = 5.5\text{ V}$  and  $T_A = -40$  to  $125^\circ\text{C}$  unless noted otherwise

| Parameter                                                 | Test Conditions                                                                   | Symbol                | Min   | Typ   | Max   | Unit          |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------|-------|-------|-------|---------------|
| <b>VDD Section</b>                                        |                                                                                   |                       |       |       |       |               |
| Turn-On Threshold                                         | $V_{IN}$ rising                                                                   | $V_{IN-ON}$           | 3.06  | 3.15  | 3.25  | V             |
| Turn-Off Threshold                                        | $V_{IN}$ falling                                                                  | $V_{IN-OFF}$          | 2.78  | 2.9   | 3.05  | V             |
| Operating Current                                         | $f_{SW} = 100\text{ kHz}$ , $C_{GATE} = 3.3\text{ nF}$ ,<br>$V_{IN} = 5\text{ V}$ | $I_{IN-OP}$           |       | 2.0   | 2.8   | mA            |
| <b>Power Supply Section</b>                               |                                                                                   |                       |       |       |       |               |
| Internal LDO Output Voltage                               | $V_{IN} = 20\text{ V}$                                                            | $V_{DD}$              | 5.0   | 5.25  | 5.5   | V             |
| Dropout Voltage of LDO                                    | $I_{OUT} = 10\text{ mA}$ , $V_{IN} = 3.3\text{ V}$                                | $V_{DO}$              |       |       | 0.3   | V             |
| <b>Drain Voltage Sensing Section</b>                      |                                                                                   |                       |       |       |       |               |
| Comparator Input Offset Voltage                           | Internal design suggestion                                                        | $V_{OSI}^{(4)}$       | -1    | 0     | 1     | mV            |
| Turn-On Threshold Voltage                                 | $R_{DRAIN} = 0\ \Omega$ (includes comparator input offset voltage)                | $V_{TH-ON}$           | -250  | -200  | -150  | mV            |
| Slope detection disable criteria                          |                                                                                   | $t_{SLO-DIS}^{(6)}$   | 53    | 58    | 63    | $\mu\text{s}$ |
| Slope detection disable criteria Hysteresis               |                                                                                   | $t_{SLO-HYS}^{(4)}$   |       | 8     |       | $\mu\text{s}$ |
| Turn on delay                                             | With 50 mV overdrive<br>From $V_{TH-ON}$ to Gate $> 1\text{ V}$                   | $t_{ON-DLY}^{(4)}$    |       | 20    |       | ns            |
| Turn-Off Threshold Tuning Range 1                         |                                                                                   | $V_{TH-OFF}$          | -5    |       | 5     | mV            |
| Comparator delay for $V_{TH-OFF1}$                        | With 0mV overdrive<br>From $V_{TH-OFF}$ to Gate $= 1\text{ V}$                    | $t_{OFF-DLY}^{(4)}$   |       | 20    |       | ns            |
| Gate Re-arming threshold                                  | $V_{IN} = 5\text{ V}$ (Typically $0.7V_{DD}$ )                                    | $V_{TH-ARM}$          | 3.3   | 3.5   | 3.7   | V             |
| Gate Re-arming time for slope detection                   |                                                                                   | $t_{ARM}^{(4)}$       | 70    | 85    | 100   | ns            |
| Slope detection high threshold                            |                                                                                   | $V_{TH-HGH}^{(4)}$    | 0.4   | 0.5   | 0.6   | V             |
| <b>Minimum On-Time and Minimum OFF-time Section</b>       |                                                                                   |                       |       |       |       |               |
| Minimum On-Time                                           |                                                                                   | $t_{ON-MIN}$          | 2.16  | 2.4   | 2.64  | $\mu\text{s}$ |
| Minimum On-Time Upper at light load                       |                                                                                   | $t_{ON-MIN-L}$        | 1.50  | 1.65  | 1.80  | $\mu\text{s}$ |
| Minimum $t_{ON}$ cycles during start-up                   |                                                                                   | $N_{ON-MIN-ST}$       |       | 3     |       | cycles        |
| Minimum Off-Time                                          |                                                                                   | $t_{OFF-MIN-L}^{(5)}$ | 1.53  | 1.70  | 1.87  | $\mu\text{s}$ |
| Minimum Off-Time at light load<br>( $t_s > t_{SLO-DIS}$ ) |                                                                                   | $t_{OFF-MIN-H}^{(5)}$ | 3.6   | 4     | 4.4   | $\mu\text{s}$ |
| <b>Dead Time Control Section</b>                          |                                                                                   |                       |       |       |       |               |
| Dead time self-tuning target                              | From GATE OFF to $V_{DRAIN}$ rising above 0.5 V                                   | $t_{DEAD}^{(4)}$      | 170   | 200   | 230   | ns            |
| <b>DRE Section</b>                                        |                                                                                   |                       |       |       |       |               |
| VIN pin DRE function trigger level                        |                                                                                   | $V_{DRE}^{(5)}$       | 4.68  | 4.78  | 4.85  | V             |
| Threshold voltage for DRE function                        |                                                                                   | $V_{DREI}$            | 1.188 | 1.200 | 1.212 | V             |
| Drain Pin sinking current period when DRE triggered       |                                                                                   | $t_{DREI}^{(4)}$      | 1.2   | 1.5   | 1.8   | $\mu\text{s}$ |
| DRE function enable period                                |                                                                                   | $t_{DRE-EN}$          | 64    | 72    | 80    | $\mu\text{s}$ |
| IDRE re-arm period                                        |                                                                                   | $t_{RE-ARM}$          |       | 4     |       | $\mu\text{s}$ |
| Drain Pin sinking current when DRE triggered              |                                                                                   | $I_{DRE}$             | 50    |       |       | mA            |

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**Table 5. ELECTRICAL CHARACTERISTICS** (continued)

$V_{IN} = 5.5\text{ V}$  and  $T_A = -40$  to  $125^\circ\text{C}$  unless noted otherwise

| Parameter                                          | Test Conditions                                                      | Symbol            | Min   | Typ   | Max   | Unit             |
|----------------------------------------------------|----------------------------------------------------------------------|-------------------|-------|-------|-------|------------------|
| <b>Shut-Down Section</b>                           |                                                                      |                   |       |       |       |                  |
| Threshold voltage for Shut-Down function triggered |                                                                      | $V_{SD-TH}$       | 0.97  | 1.00  | 1.03  | V                |
| Shut-Down current source                           |                                                                      | $I_{SD-TH}$       | 44    | 50    | 56    | $\mu\text{A}$    |
| Impedance for Shut-Down trigger                    |                                                                      | $Z_{SD-TH}$       | 18.48 | 20.00 | 21.68 | $\text{k}\Omega$ |
| Denounce Cycles for Shut-Down                      |                                                                      | $N_{SD-Debounce}$ |       | 7     |       | Cycles           |
| <b>Output Driver Section</b>                       |                                                                      |                   |       |       |       |                  |
| Output Voltage Low                                 | $V_{IN} = 6\text{ V}$                                                | $V_{OL}$          |       |       | 0.25  | V                |
| Output Voltage High                                | $V_{IN} = 6\text{ V}$                                                | $V_{OH}$          | 4.9   |       |       | V                |
| Rise Time                                          | $V_{IN} = 6\text{ V}$ , $C_L = 3300\text{ pF}$ ,<br>GATE = 1 V ~ 4 V | $t_R$             |       |       | 90    | ns               |
| Fall Time                                          | $V_{IN} = 6\text{ V}$ , $C_L = 3300\text{ pF}$ ,<br>GATE = 4 V ~ 1 V | $t_F$             |       |       | 30    | ns               |

4. Guaranteed by Design.
5. Specification operation temperature range  $-5^\circ\text{C} \sim 85^\circ\text{C}$
6. Specification operation temperature range  $-5^\circ\text{C} \sim 50^\circ\text{C}$

TYPICAL PERFORMANCE CHARACTERISTICS

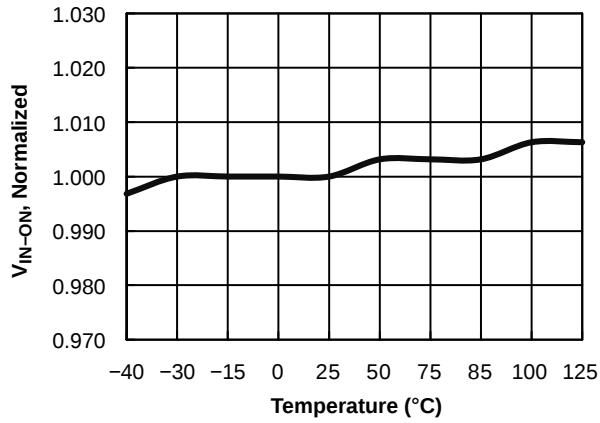


Figure 3. Turn-On Threshold Voltage ( $V_{IN-ON}$ ) vs. Temperature

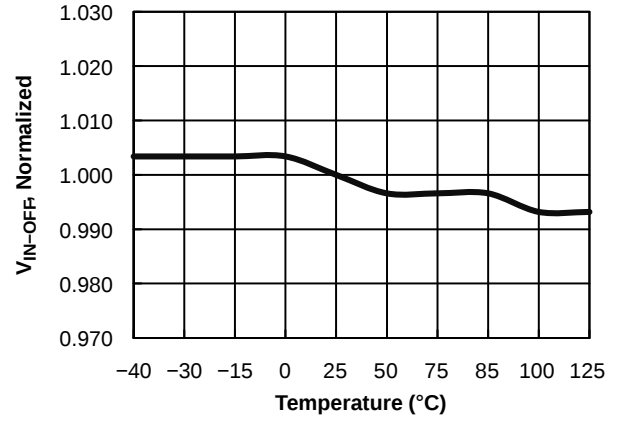


Figure 4. Turn-Off Threshold Voltage ( $V_{IN-OFF}$ ) vs. Temperature

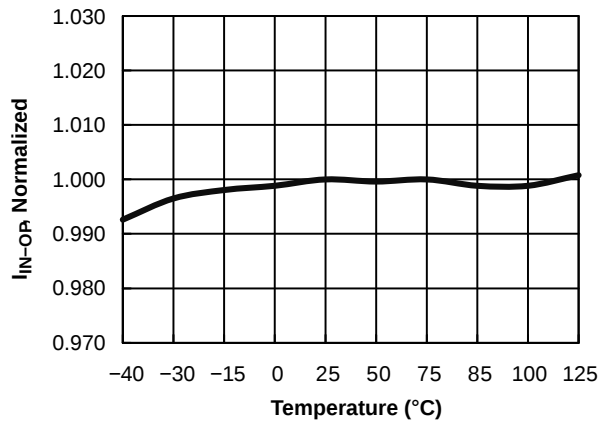


Figure 5. Operating Supply Current ( $I_{IN-OP}$ ) vs. Temperature

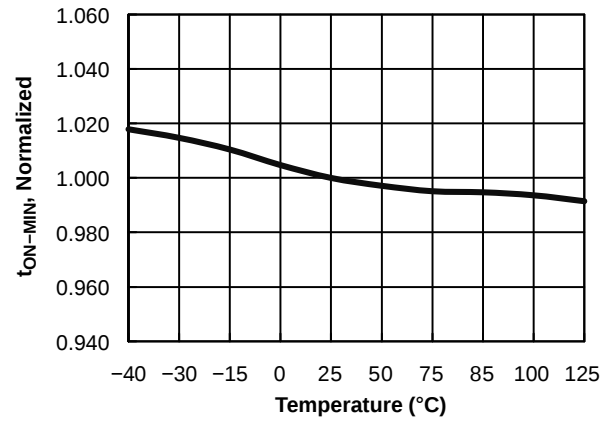


Figure 6. Minimum On Time ( $t_{ON-MIN}$ ) vs. Temperature

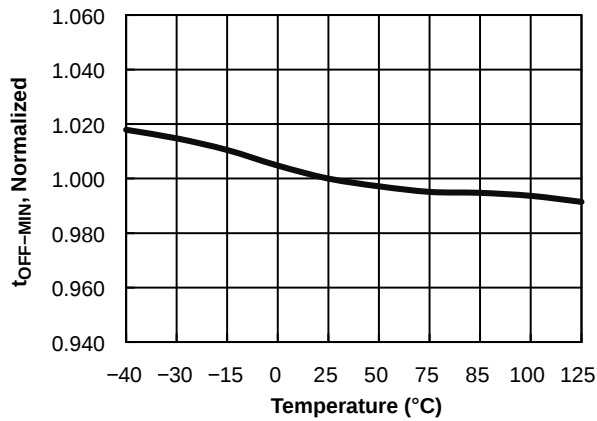


Figure 7. Minimum Gate Turn Off Time ( $t_{OFF-MIN}$ ) vs. Temperature

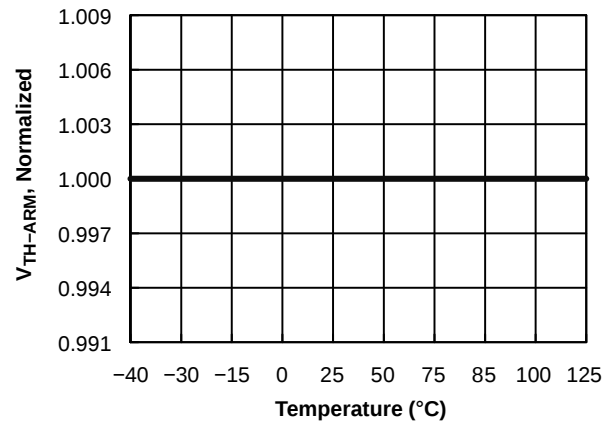


Figure 8. Gate Turn On Threshold Voltage ( $V_{TH-ARM}$ ) vs. Temperature

# FAN6250M6X

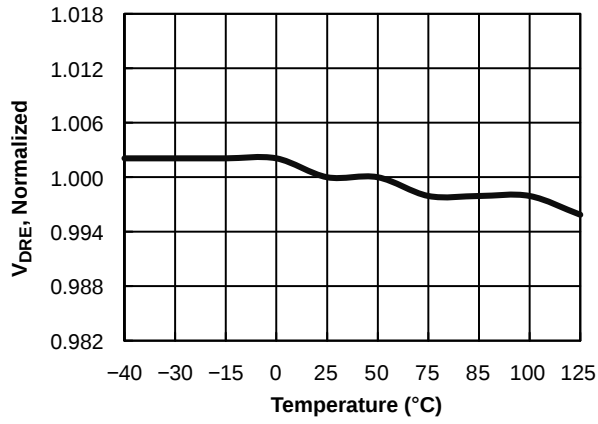


Figure 9. VIN Pin DRE Function Trigger Level ( $V_{DRE}$ ) vs. Temperature

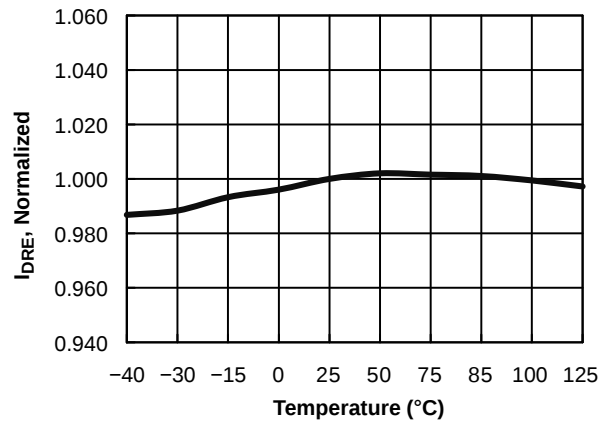


Figure 10. Drain Pin Sinking Current for DRE Triggered ( $I_{DRE}$ ) vs. Temperature

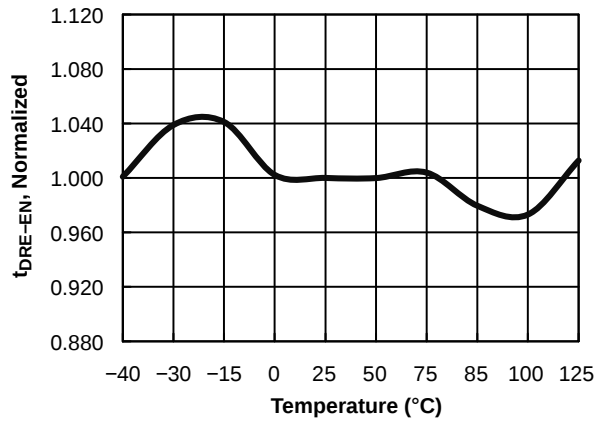


Figure 11. DRE Function Enable Period ( $t_{DRE-EN}$ ) vs. Temperature

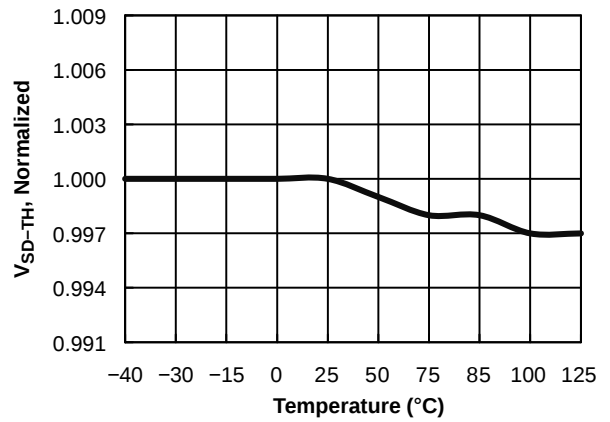


Figure 12. Shut-Down Threshold Voltage ( $V_{SD-TH}$ ) vs. Temperature

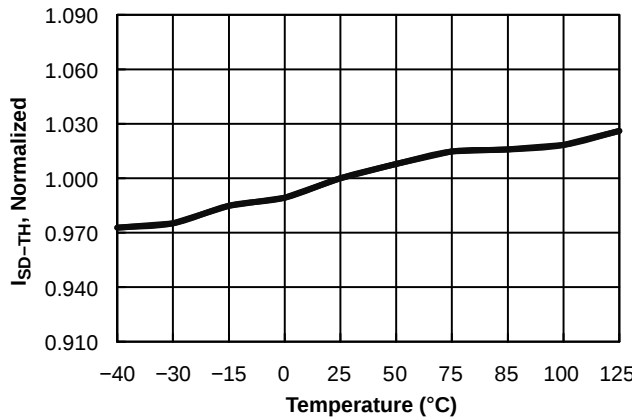


Figure 13. Shut-Down Current Source ( $I_{SD-TH}$ ) vs. Temperature

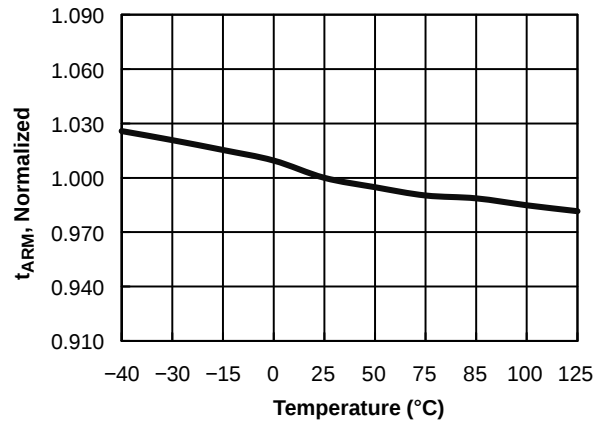
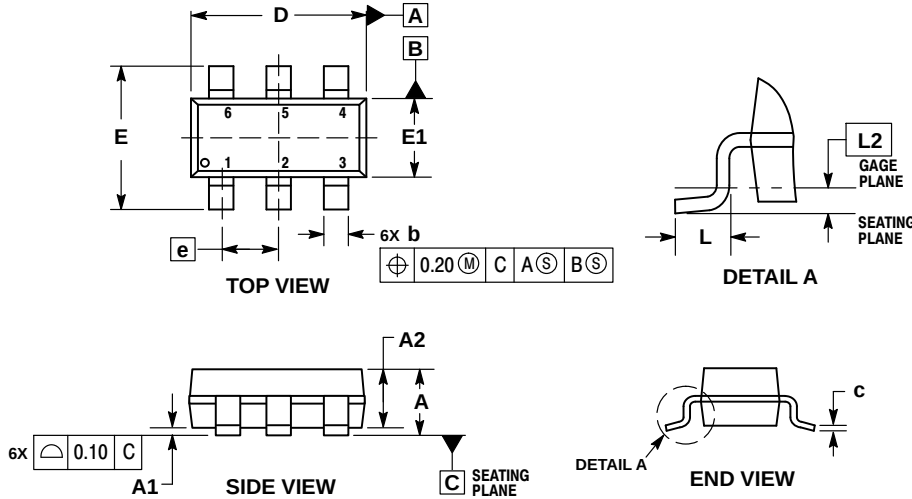


Figure 14. Gate Re-arming Time for Slope Detection ( $t_{ARM}$ ) vs. Temperature

# FAN6250M6X

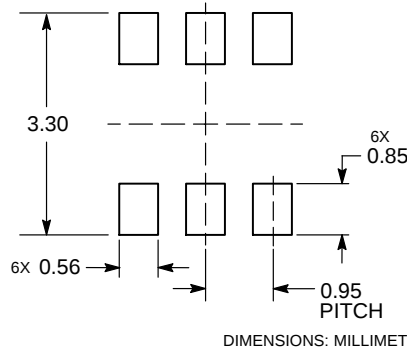
## PACKAGE DIMENSIONS

SOT-23, 6 Lead  
CASE 527AJ  
ISSUE B



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: MILLIMETERS.
  3. DATUM C IS THE SEATING PLANE.

### RECOMMENDED SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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