# TMUX582F-SEP Radiation-Tolerant +60V Protected, Latch-Up Immune 8:1 Multiplexer with Adjustable Fault Threshold

## 1 Features

- VID V62/23607-01XE
- Radiation hardened
  - Single event latch-up (SEL) immune to 43 MeV-cm2/mg at 125°C
  - ELDRS free to 30krad(Si)
  - Total ionizing dose (TID) RLAT for every wafer lot up to 30krad(Si)
  - TID characterized up to 30krad(Si)
  - Single event transient (SET) characterized to 43 MeV-cm2 /mg
- Supply range: +8V to +22V
- Integrated powered-off and overvoltage protection
  - Overvoltage and power-off-protected up to +60V
  - Cold sparing capable up to +60V
  - Adjustable fault threshold threshold ($V_{FP}$) from 3V to supply
  - Interrupt flag feedback indicating faulted channel
  - Non-fault channels continue to operate with low leakage currents
- Latch-up immune construction
- Precision performance with ±4.5nA source off leakage current (max) and 4pF off-cap
- Space enhanced plastic
  - Operating temperature from –55°C to +125°C
  - Controlled baseline
  - Gold wire and NiPdAu lead finish
  - One assembly and test site
  - One fabrication site
  - Extended product life cycle
  - Product traceability
  - Enhanced mold compound for low outgassing
- Small, industry standard TSSOP-20 packaging

## 2 Applications

- Low earth orbit (LEO) space applications
- Remote interface unit (RIU)
- Remote telemetry unit (RTU)
- System monitoring for space
- Latch-up and overvoltage detection
- Power-up sequencing protection
- Satellite telemetry and telecommand for on board data handling
- Sensor data acquisition

## 3 Description

The TMUX582F-SEP is a modern 8:1 multiplexer suitable for single ended operation. This latch-up immune device offers robust overvoltage protection up to +60V making it optimal for harsh space environments. Additionally, this protection operates in powered-on, powered-off, and floating supply conditions.

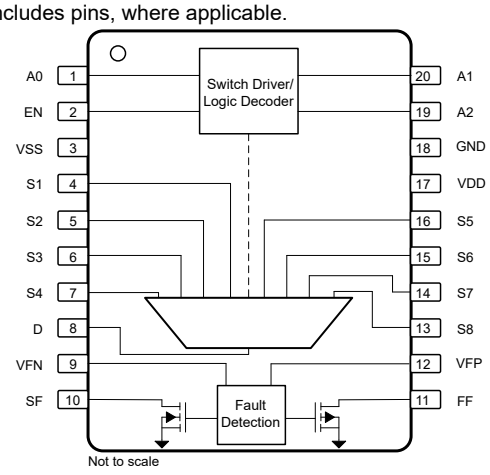
During a fault such as an overvoltage or undervoltage event, the offending channel turns OFF and the Sx pin becomes high impedance. If this fault channel is selected, the drain (D) is pulled to the fault rail that is exceeded (Vfp or Vfn). All other Sx pins which are not under fault continue to operate normally. During normal operation, when the source (Sx) does not exceed Vfp or Vfn, the switch operates with low leakage, low capacitance and an ultra-flat on-resistance. This provides high performance signal integrity with minimal distortion.

The TMUX582F-SEP is a fault protected CMOS multiplexer flexible enough to handle almost any application, from system monitoring, to power-up sequencing protection, to high precision front end data acquisition.

**Package Information**

| PART NUMBER | PACKAGE(1) | PACKAGE SIZE(2) |
|---|---|---|
| TMUX582F-SEP | PW (TSSOP, 20) | 6.5mm × 6.4mm |

(1) For more information, see Section 12.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.




**Simplified Schematic**

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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# 4 Pin Configuration and Functions

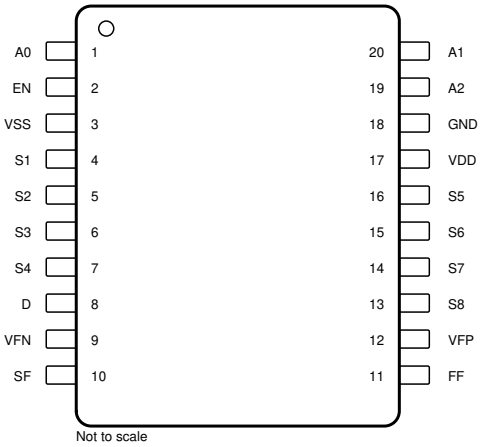



**Figure 4-1. PW Package, 20-Pin TSSOP (Top View)**

**Table 4-1. Pin Functions: TMUX582F-SEP**

| PIN | | TYPE[1] | DESCRIPTION |
|---|---|---|---|
| NAME | NO. | | |
| A0 | 1 | I | Logic control input address 0 (A0). The pin has a weak internal pull-down. This pin can also be used together with the specific fault pin (SF) to indicate which input is under fault. |
| EN | 2 | I | Active high digital enable (EN) pin. The pin has a weak internal pull-down. The device is disabled and all switches become high impedance when the pin is low. When the pin is high, the Ax logic inputs determine individual switch states. |
| $V_{SS}$ | 3 | P | Negative power supply. This pin must be tied to GND. |
| S1 | 4 | I/O | Overvoltage protected source pin 1. Can be an input or output. |
| S2 | 5 | I/O | Overvoltage protected source pin 2. Can be an input or output. |
| S3 | 6 | I/O | Overvoltage protected source pin 3. Can be an input or output. |
| S4 | 7 | I/O | Overvoltage protected source pin 4. Can be an input or output. |
| D | 8 | I/O | Drain pin. Can be an input or output. The drain pin is not overvoltage protected and shall remain within the recommended operating range. |
| $V_{FN}$ | 9 | P | Negative fault voltage supply that determines the overvoltage protection triggering threshold on the negative side. This pin must be tied to GND. |
| SF | 10 | O | Specific fault flag. This pin is an open drain output and is asserted low when overvoltage condition is detected on a specific pin, depending on the state of A0, A1, and A2 , as shown in Table 7-1. Connect this pin to an external supply (1.8V to 5.5V) through a 1kΩ pull-up resistor. |
| FF | 11 | O | General fault flag. This pin is an open drain output and is asserted low when overvoltage condition is detected on any of the source (Sx) input pins. Connect this pin to an external supply (1.8V to 5.5V) through a 1kΩ pull-up resistor. |
| $V_{FP}$ | 12 | P | Positive fault voltage supply that determines the overvoltage protection triggering threshold on the positive side. Connect to $V_{DD}$ if the triggering threshold is to be the same as the device's positive supply. For reliable operation, connect a decoupling capacitor ranging from 0.1µF to 10µF between $V_{FP}$ and GND. |
| S8 | 13 | I/O | Overvoltage protected source pin 8. Can be an input or output. |
| S7 | 14 | I/O | Overvoltage protected source pin 7. Can be an input or output. |
| S6 | 15 | I/O | Overvoltage protected source pin 6. Can be an input or output. |
| S5 | 16 | I/O | Overvoltage protected source pin 5. Can be an input or output. |
| $V_{DD}$ | 17 | P | Positive power supply. This pin is the most positive power-supply potential. For reliable operation, connect a decoupling capacitor ranging from 0.1µF to 10µF between $V_{DD}$ and GND. |
| GND | 18 | P | Ground (0V) reference |
| A2 | 19 | I | Logic control input address 2 (A2). The pin has a weak internal pull-down. This pin can also be used together with the specific fault pin (SF) to indicate which input is under fault. |
| A1 | 20 | I | Logic control input address 1 (A1). The pin has a weak internal pull-down. This pin can also be used together with the specific fault pin (SF) to indicate which input is under fault. |

(1) I = input, O = output, I/O = input and output, P = power

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# 5 Specifications

## 5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{DD}$ to $V_{SS}$ | Supply voltage | | 28 | V |
| $V_{DD}$ to GND | | –0.3 | 28 | V |
| $V_{SS}$ to GND | | 0 | 0 | V |
| $V_{FP}$ to GND | Positive fault clamping voltage | –0.3 | $V_{DD}$ + 0.3 | V |
| $V_{FN}$ to GND | Negative fault clamping voltage | 0 | 0 | V |
| $V_S$ to GND | Source input pin (Sx) voltage to GND | 0 | 65 | V |
| $V_D$ | Drain pin (D or Dx) voltage | 0 | $V_{FP}$+0.7 | V |
| $V_{SEL}$ or $V_{EN}$ | Logic control input pin voltage (EN, A0, A1, A2) (2) | GND –0.7 | 28 | V |
| $V_{DIG_OUT}$ | Digital output pin (SF, FF) voltage(2) | GND –0.7 | 6 | V |
| $I_{SEL}$ or $I_{EN}$ | Logic control input pin current (EN, A0, A1, A2)(2) | –30 | 30 | mA |
| $I_{DIG_OUT}$ | Digital output pin (SF, FF) current(2) | –10 | 10 | mA |
| $I_S$ or $I_{D\ (CONT)}$ | Source or drain continuous current (Sx or D) | $I_{DC}$ ± 10 %(3) | $I_{DC}$ ± 10 %(3) | mA |
| $T_{stg}$ | Storage temperature | –65 | 150 | °C |
| $T_A$ | Ambient temperature | –55 | 150 | °C |
| $T_J$ | Junction temperature | | 150 | °C |
| $P_{tot}$ (4) | Total power dissipation | | 800 | mW |

(1) Stresses beyond those listed under *Absolute Maximum Rating* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) Stresses have to be kept at or below both voltage and current ratings at all time.
(3) Refer to Recommended Operating Conditions for $I_{DC}$ ratings.
(4) $P_{tot}$ derates linearly above $T_A$ = 70°C by 12.0 mW/°C

## 5.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | ±3500 | V |
| | | Charged device model (CDM), per JEDEC specification JESD22-C101 or ANSI/ESDA/JEDEC JS-002(2) | ±750 | |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

## 5.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{DD}$ | Positive power supply voltage | 8 | | 22 | V |
| Vss(1) | Negative power supply voltage | 0 | | 0 | V |
| $V_{FP}$ | Positive fault clamping voltage | 3 | | $V_{DD}$ | V |
| $V_{FN}$ (1) | Negative fault clamping voltage | 0 | | 0 | V |
| $V_S$ | Source pin (Sx) voltage (non-fault condition) | 0 | | $V_{FP}$ | V |
| $V_{S_FAULT}$ (2) | Source pin (Sx) voltage (fault condition) | 0 | | 60 | V |
| $V_D$ | Drain pin (D, Dx) voltage | 0 | | $V_{FP}$ | V |
| $V_{SEL}$ of $V_{EN}$ | Logic control input pin voltage (EN, A0, A1, A2) | 0 | | 22 | V |
| $V_{DIG_OUT}$ | Digital output pin (SF, FF) voltage | 0 | | 5.5 | V |
| $T_A$ | Ambient temperature | –55 | | 125 | °C |


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## 5.3 Recommended Operating Conditions (continued)

over operating free-air temperature range (unless otherwise noted)

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| IDC(2) | Continuous current through switch, TSSOP package | $T_A$ = 25°C | | | 9 | mA |
| | | $T_A$ = 85°C | | | 6.5 | mA |
| | | $T_A$ = 150°C | | | 5 | mA |

(1) $V_{SS}$ and $V_{FN}$ must be tied to GND as this device is strictly single supply capable.
(2) Fault supplies are tied to the primary supplies (VFP= VDD, VFN = GND)

## 5.4 Thermal Information

| THERMAL METRIC(1) | | TMUX582F-SEP PW (TSSOP) 20 PINS | UNIT |
|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 84.3 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 22.7 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 37.3 | °C/W |
| $\Psi_{JT}$ | Junction-to-top characterization parameter | 1.0 | °C/W |
| $\Psi_{JB}$ | Junction-to-board characterization parameter | 36.7 | °C/W |

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

## 5.5 Electrical Characteristics (Global)

Typical at $T_A$ = 25°C (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | $T_A$ | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **ANALOG SWITCH** | | | | | | | |
| $V_T$ | Threshold voltage for fault detector | | –55°C to +125°C | | 0.7 | | V |
| **DIGITAL INPUT/ OUTPUT** | | | | | | | |
| $V_{IH}$ | High-level input voltage | EN, Ax pins | –55°C to +125°C | 1.3 | | 22 | V |
| $V_{IL}$ | Low-level input voltage | EN, Ax pins | –55°C to +125°C | 0 | | 0.8 | V |
| $V_{OL(FLAG)}$ | Low-level output voltage | FF and SF pins, $I_O$ = 5 mA | –55°C to +125°C | | 0.1 | | V |
| **POWER SUPPLY** | | | | | | | |
| $V_{UVLO}$ | Undervoltage lockout (UVLO) threshold voltage ($V_{DD}$) | single supply configuration only | –55°C to +125°C | | 6 | | V |
| $R_{D(OVP)}$ | Drain resistance to fault rail during overvoltage event on selected source pin | | 25°C | | 40 | | kΩ |

## 5.6 Single Supply: Electrical Characteristics

Typical at $V_{DD}$ = +12 V, $V_{SS}$ = 0 V, GND = 0V, $T_A$ = +25°C (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | $T_A$ | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **ANALOG SWITCH** | | | | | | | |
| $R_{ON}$ | On-resistance | $V_S$ = 0 V to 7.8 V, $I_S$ = –1 mA | –55°C to +125°C | | 180 | 400 | Ω |
| $\Delta R_{ON}$ | On-resistance mismatch between channels | $V_S$ = 0 V to 7.8 V, $I_S$ = –1 mA | –55°C to +125°C | | 5 | 13 | Ω |
| $R_{FLAT}$ | On-resistance flatness | $V_S$ = 0 V to 7.8 V, $I_S$ = –1 mA | –55°C to +125°C | | 7 | 80 | Ω |
| $R_{ON_DRIFT}$ | On-resistance drift | $V_S$ = 6 V, $I_S$ = –1 mA | –55°C to +125°C | | 1.2 | | Ω/°C |
| $I_{S(OFF)}$ | Source off leakage current | Switch state is off, $V_S$ = 1 V/ 10 V, $V_D$ = 10 V/ 1 V, $V_{DD}$ = 13.2 V | –55°C to +125°C | –4.5 | | 4.5 | nA |
| $I_{D(OFF)}$ | Drain off leakage current | Switch state is off, $V_S$ = 1 V/ 10 V, $V_D$ = 10 V/ 1 V, $V_{DD}$ = 13.2 V | –55°C to +125°C | –15 | | 15 | nA |
| $I_{S(ON)}$, $I_{D(ON)}$ | Channel on leakage current | Switch state is on, $V_S$ = floating, $V_D$ = 1 V/ 10 V, $V_{DD}$ = 13.2 | –55°C to +125°C | -23 | | 23 | nA |
| **FAULT CONDITION** | | | | | | | |

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## 5.6 Single Supply: Electrical Characteristics (continued)

Typical at $V_{DD}$ = +12 V, $V_{SS}$ = 0 V, GND = 0V, $T_A$ = +25°C (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | $T_A$ | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{S(FA)}$ | Input leakage current durring overvoltage | $V_S$ = + 60 V, GND = 0V, $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V | 25°C | | ±145 | | µA |
| $I_{S(FA)}$ | Input leakage current during overvoltage with grounded supplies | $V_S$ = + 60 V, GND = 0V, $V_{DD}$ = $V_{SS}$ = $V_{FP}$ = $V_{FN}$= 0 V, $V_{EN}$ = $V_{Ax}$ = 0 V or floating | 25°C | | ±135 | | µA |
| $I_{S(FA)}$ | Input leakage current during overvoltage with floating suppllies | $V_S$ = + 60 V, GND = 0V, $V_{DD}$ = $V_{SS}$ = $V_{FP}$ = $V_{FN}$= floating, $V_{EN}$ = $V_{Ax}$ = 0 V or floating | 25°C | | ±135 | | µA |
| $I_{D(FA)}$ | Output leakage current durring overvoltage | $V_S$ = + 60 V, GND = 0V, $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V | –55°C to +125°C | –100 | | 100 | nA |
| $I_{D(FA)}$ | Output leakage current during overvoltage with grounded supplies | $V_S$ = + 60 V, GND = 0V, $V_{DD}$ = $V_{SS}$ = $V_{FP}$ = $V_{FN}$= 0 V, $V_{EN}$ = $V_{Ax}$ = 0 V or floating | –55°C to +125°C | –550 | | 550 | nA |
| $I_{D(FA)}$ | Output leakage current during overvoltage with floating suppllies | $V_S$ = + 60 V, GND = 0V, $V_{DD}$ = $V_{SS}$ = $V_{FP}$ = $V_{FN}$= floating, $V_{EN}$ = $V_{Ax}$ = 0 V or floating | 25°C | | ±8 | | µA |
| **DIGITAL INPUT/ OUTPUT** | | | | | | | |
| $I_{IH}$ | High-level input current | $V_{EN}$ = $V_{Ax}$ = $V_{DD}$ | –55°C to +125°C | –2.5 | | 2.5 | µA |
| $I_{IL}$ | Low-level input current | $V_{EN}$ = $V_{Ax}$ = 0 V | –55°C to +125°C | –1.5 | | 1.5 | µA |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| $t_{ON\ (EN)}$ | Enable turn-on time | $V_S$ = 8 V, $R_L$ = 4 kΩ, $C_L$= 12 pF | 25°C | | 160 | | ns |
| $t_{OFF\ (EN)}$ | Enable turn-off time | $V_S$ = 8 V, $R_L$ = 4 kΩ, $C_L$= 12 pF | 25°C | | 420 | | ns |
| $t_{TRAN}$ | Transition time | $V_S$ = 8 V, $R_L$ = 4 kΩ, $C_L$= 12 pF | 25°C | | 160 | | ns |
| $t_{BBM}$ | Break-before-make time delay | $V_S$ = 8 V, $R_L$ = 4 kΩ, $C_L$= 12 pF | 25°C | | 90 | | ns |
| $t_{RESPONSE}$ | Fault response time | $V_{FP}$ = 8 V, $V_{FN}$ = 0 V, $R_L$ = 4 kΩ, $C_L$= 12 pF | 25°C | | 225 | | ns |
| $t_{RECOVERY}$ | Fault recovery time | $V_{FP}$ = 8 V, $V_{FN}$ = 0 V, $R_L$ = 4 kΩ, $C_L$= 12 pF | 25°C | | 0.75 | | µs |
| $t_{RESPONSE(FLAG)}$ | Fault flag response time | $V_{FP}$ = 8 V, $V_{FN}$ = 0 V, $V_{PU}$ = 5 V, $R_{PU}$ = 1 kΩ, $C_L$= 12 pF | 25°C | | 120 | | ns |
| $t_{RECOVERY(FLAG)}$ | Fault flag recovery time | $V_{FP}$ = 8 V, $V_{FN}$ = 0 V, $V_{PU}$ = 5 V, $R_{PU}$ = 1 kΩ, $C_L$= 12 pF | 25°C | | 0.75 | | µs |
| $Q_{INJ}$ | Charge injection | $V_S$ = 6 V, $C_L$ = 1 nF, $R_S$ = 0 Ω | 25°C | | -11 | | pC |
| $O_{ISO}$ | Off-isolation | $R_S$ = 50 Ω, $R_L$ = 50 Ω, $C_L$ = 5 pF, $V_S$ = 200 $mV_{RMS}$, $V_{BIAS}$ = 2 V, f = 1 MHz | 25°C | | –75 | | dB |
| $X_{TALK}$ | Intra-channel crosstalk | $R_S$ = 50 Ω, $R_L$ = 50 Ω, $C_L$ = 5 pF, $V_S$ = 200 $mV_{RMS}$, $V_{BIAS}$ = 2 V, f = 1 MHz | 25°C | | –90 | | dB |
| BW | –3 dB bandwidth | $R_S$ = 50 Ω, $R_L$ = 50 Ω, $C_L$ = 5 pF, $V_S$ = 200 $mV_{RMS}$, $V_{BIAS}$ = 2 V, f = 1 MHz | 25°C | | 130 | | MHz |
| $I_{LOSS}$ | Insertion loss | $R_S$ = 50 Ω, $R_L$ = 50 Ω, $C_L$ = 5 pF, $V_S$ = 200 $mV_{RMS}$, $V_{BIAS}$ = 2 V, f = 1 MHz | 25°C | | –9 | | dB |
| THD+N | Total harmonic distortion plus noise | $R_S$ = 40 Ω, $R_L$ = 10k Ω, $V_S$ = 6 $V_{PP}$, $V_{BIAS}$ = 6 V, f = 20 Hz to 20k Hz | 25°C | | 0.0025 | | % |
| $C_{S(OFF)}$ | Input off-capacitance | f = 1 MHz, $V_S$ = 6 V | 25°C | | 4 | | pF |
| $C_{D(OFF)}$ | Output off-capacitance | f = 1 MHz, $V_S$ = 6 V | 25°C | | 31 | | pF |
| $C_{S(ON)}$, $C_{D(ON)}$ | Input/Output on-capacitance | f = 1 MHz, $V_S$ = 6 V | 25°C | | 34 | | pF |
| **POWER SUPPLY** | | | | | | | |
| $I_{DD}$ | $V_{DD}$ supply current | $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$, $V_S$ = 6 V | –55°C to +125°C | | | 0.6 | mA |
| $I_{SS}$ | $V_{SS}$ supply current | $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$, $V_S$ = 6 V | –55°C to +125°C | | | 0.5 | mA |
| $I_{GND}$ | GND current | $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$, $V_S$ = 6 V | 25°C | | 0.075 | | mA |


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## 5.6 Single Supply: Electrical Characteristics (continued)

Typical at $V_{DD}$ = +12 V, $V_{SS}$ = 0 V, GND = 0V, $T_A$ = +25°C (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | $T_A$ | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{FP}$ | $V_{FP}$ supply current | $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$, $V_S$ = 6 V | 25°C | | 10 | | µA |
| $I_{FN}$ | $V_{FN}$ supply current | $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$, $V_S$ = 6 V | 25°C | | 10 | | µA |
| $I_{DD(FA)}$ | $V_{DD}$ supply current under fault | $V_S$ = + 60 V, $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$ | –55°C to +125°C | | | 1.25 | mA |
| $I_{SS(FA)}$ | $V_{SS}$ supply current under fault | $V_S$ = + 60 V, $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$ | –55°C to +125°C | | | 0.75 | mA |
| $I_{GND(FA)}$ | GND current under fault | $V_S$ = + 60 V, $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$ | –55°C to +125°C | | 0.2 | | mA |
| $I_{FP(FA)}$ | $V_{FP}$ supply current under fault | $V_S$ = + 60 V, $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$ | 25°C | | 20 | | µA |
| $I_{FN(FA)}$ | $V_{FN}$ supply current under fault | $V_S$ = + 60 V, $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{EN}$/ $V_{Ax}$ = 0V, 5V, or $V_{DD}$ | 25°C | | 20 | | µA |
| $I_{DD(DISABLE)}$ | $V_{DD}$ supply current (disable mode) | $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{Ax}$ = 0 V, 5 V, or $V_{DD}$, $V_{EN}$ = 0 V, $V_S$ = 0 V | –55°C to +125°C | | | 0.6 | mA |
| $I_{SS(DISABLE)}$ | $V_{SS}$ supply current (disable mode) | $V_{DD}$ = $V_{FP}$ = 13.2 V, $V_{SS}$ = $V_{FN}$ = 0 V, $V_{Ax}$ = 0 V, 5 V, or $V_{DD}$, $V_{EN}$ = 0 V, $V_S$ = 0 V | –55°C to +125°C | | | 0.5 | mA |

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## 5.7 Typical Characteristics

at $T_A$ = 25°C (unless otherwise noted)

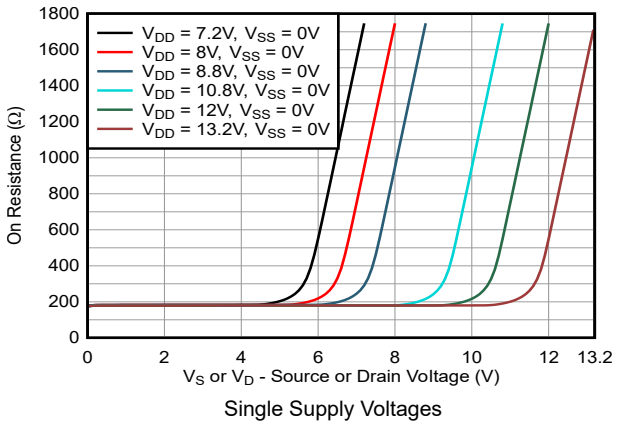



**Figure 5-1. On-Resistance vs Source or Drain Voltage**

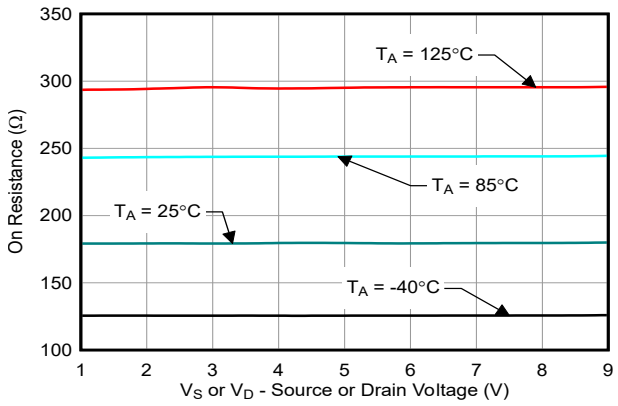



**Figure 5-2. On-Resistance vs Source or Drain Voltage**

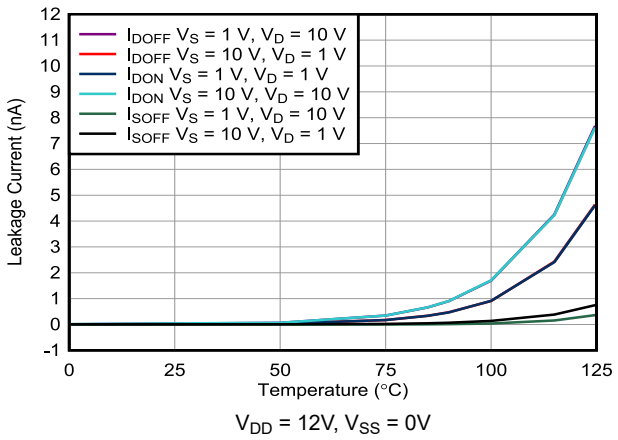



**Figure 5-3. Leakage Current vs Temperature**

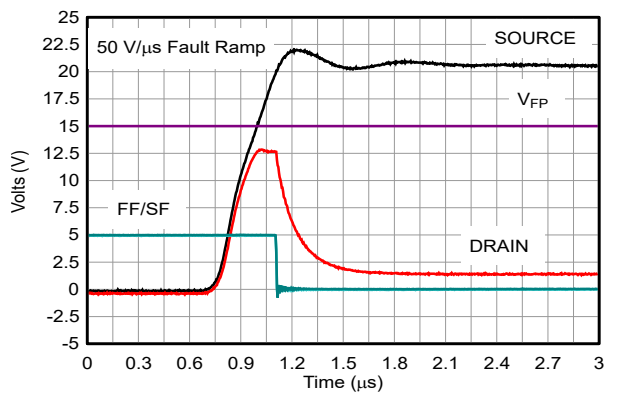



**Figure 5-4. Drain Output Response – Positive Overvoltage**

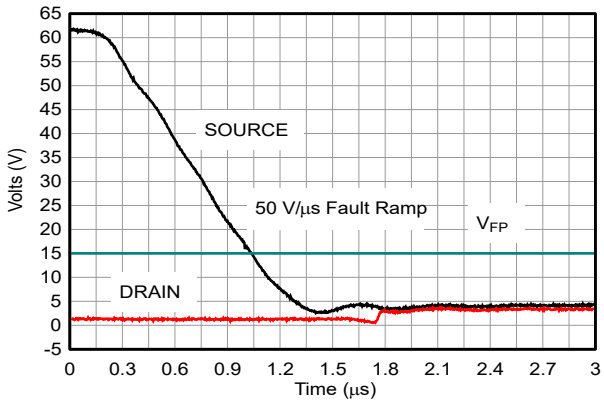



**Figure 5-5. Drain Output Recovery – Positive Overvoltage**


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# 6 Parameter Measurement Information

## 6.1 On-Resistance

The on-resistance of the TMUX582F-SEP is the ohmic resistance across the source (Sx) and drain (Dx) pins of the device. The on-resistance varies with input voltage and supply voltage. The symbol $R_{ON}$ is used to denote on-resistance. The measurement setup used to measure $R_{ON}$ is shown in Figure 6-1. $\Delta R_{ON}$ represents the difference between the $R_{ON}$ of any two channels, while $R_{ON_FLAT}$ denotes the flatness that is defined as the difference between the maximum and minimum value of on-resistance measured over the specified analog signal range.

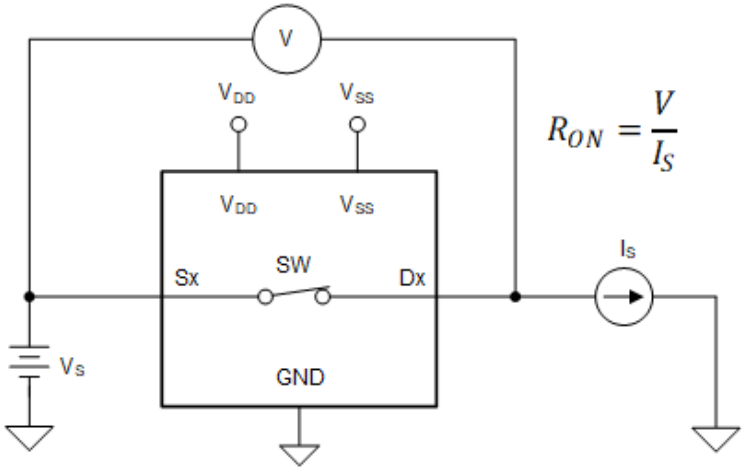



**Figure 6-1. On-Resistance Measurement Setup**

## 6.2 Off-Leakage Current

There are two types of leakage currents associated with a switch during the off state:

1. Source off-leakage current $I_{S(OFF)}$: the leakage current flowing into or out of the source pin when the switch is off.
2. Drain off-leakage current $I_{D(OFF)}$: the leakage current flowing into or out of the drain pin when the switch is off.

Figure 6-2 shows the setup used to measure both off-leakage currents.

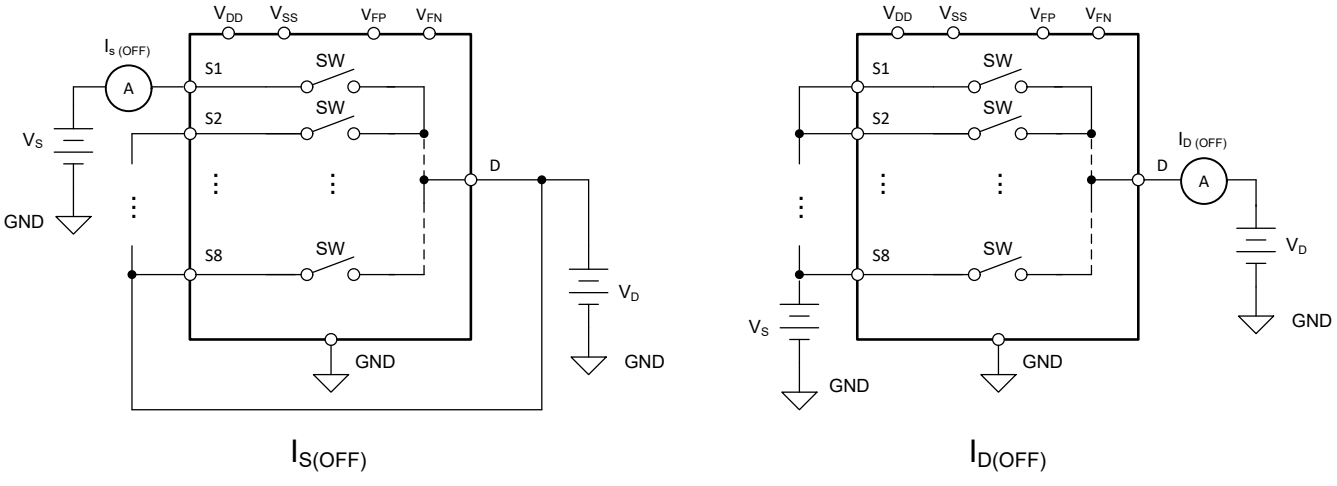



**Figure 6-2. Off-Leakage Measurement Setup**

## 6.3 On-Leakage Current

Source on-leakage current ($I_{S(ON)}$) and drain on-leakage current ($I_{D(ON)}$) denote the channel leakage currents when the switch is in the on state. $I_{S(ON)}$ is measured with the drain floating, while $I_{D(ON)}$ is measured with the source floating. Figure 6-3 shows the circuit used for measuring the on-leakage currents.

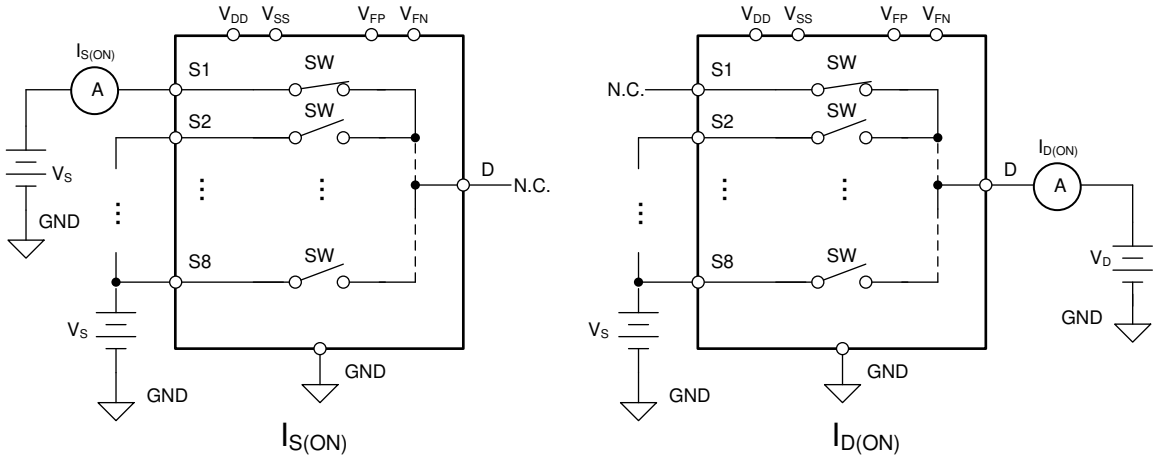



**Figure 6-3. On-Leakage Measurement Setup**

## 6.4 Input and Output Leakage Current Under Overvoltage Fault

If any of the source pin voltage goes above the fault supplies ($V_{FP}$ or $V_{FN}$), the overvoltage protection feature of the TMUX582F-SEP is triggered to turn off the switch under fault, keeping the fault channel in high-impedance state. $I_{S(FA)}$ and $I_{D(FA)}$ denotes the input and output leakage current under overvoltage fault conditions, respectively. For $I_{D(FA)}$ the device is disabled to measure leakage current on the drain pin without being impacted by the 40kΩ impedance to the fault supply. When the overvoltage fault occurs, the supply (or supplies) can either be in normal operating condition (Figure 6-5) or abnormal operating condition (Figure 6-5). During abnormal operating condition, the supply (or supplies) can either be unpowered ($V_{DD}$= VSS = $V_{FN}$ = $V_{FP}$ = 0V) or floating ($V_{DD}$= VSS = $V_{FN}$ = $V_{FP}$ = No Connection), and remains within the leakage performance specifications.

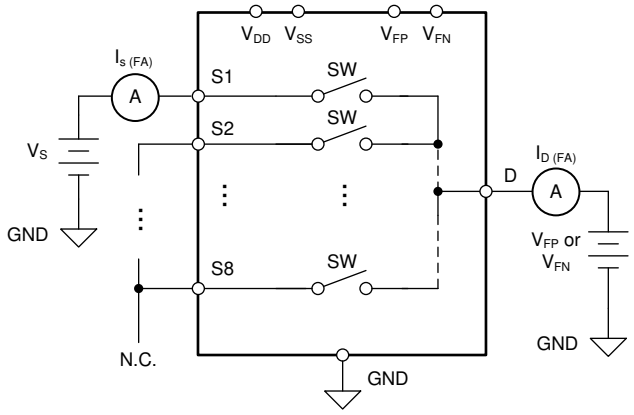



**Figure 6-4. Measurement Setup for Input and Output Leakage Current under Overvoltage Fault with Normal Supplies**


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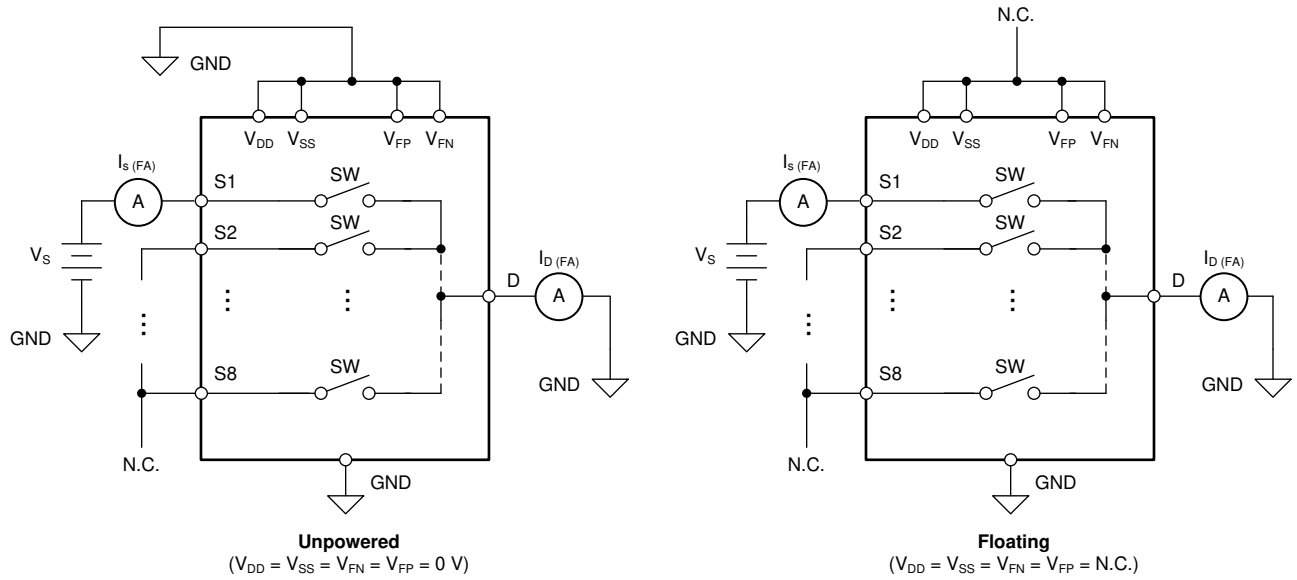



**Figure 6-5. Measurement Setup for Input and Output Leakage Current Under Overvoltage Fault with Unpowered or Floating Supplies**

## 6.5 Break-Before-Make Delay

The break-before-make delay is a safety feature of the TMUX582F-SEP. The ON switches first break the connection before the OFF switches make connection. The time delay between the *break* and the *make* is known as break-before-make delay. Figure 6-6 shows the setup used to measure break-before-make delay, denoted by the symbol $t_{BBM}$.

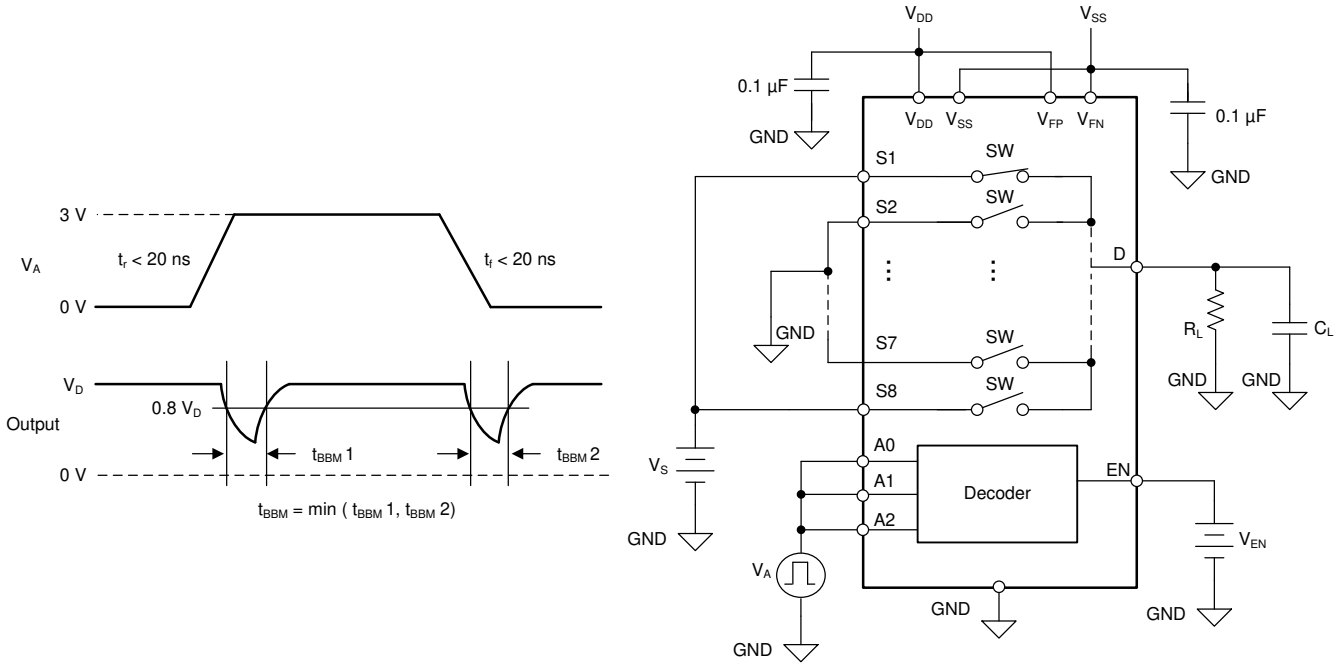



**Figure 6-6. Break-Before-Make Delay Measurement Setup**

## 6.6 Enable Delay Time

$t_{ON(EN)}$ time is defined as the time taken by the output of the TMUX582F-SEP to rise to a 90% final value after the EN signal has risen to a 50% final value. $t_{OFF(EN)}$ is defined as the time taken by the output of the TMUX582F-SEP to fall to a 10% initial value after the EN signal has fallen to a 50% initial value. Figure 6-7 shows the setup used to measure the enable delay time.

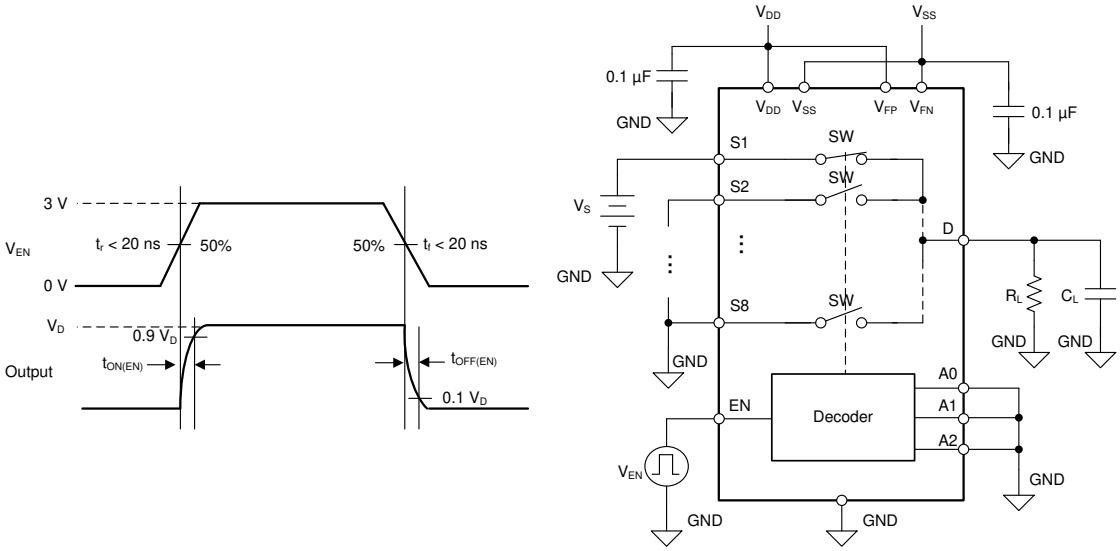



**Figure 6-7. Enable Delay Measurement Setup**

## 6.7 Transition Time

Transition time is defined as the time taken by the output of the device to rise (to 90% of the transition) or fall (to 10% of the transition) after the address signal (Ax) has fallen or risen to 50% of the transition. Figure 6-8 shows the setup used to measure transition time, denoted by the symbol $t_{TRAN}$.

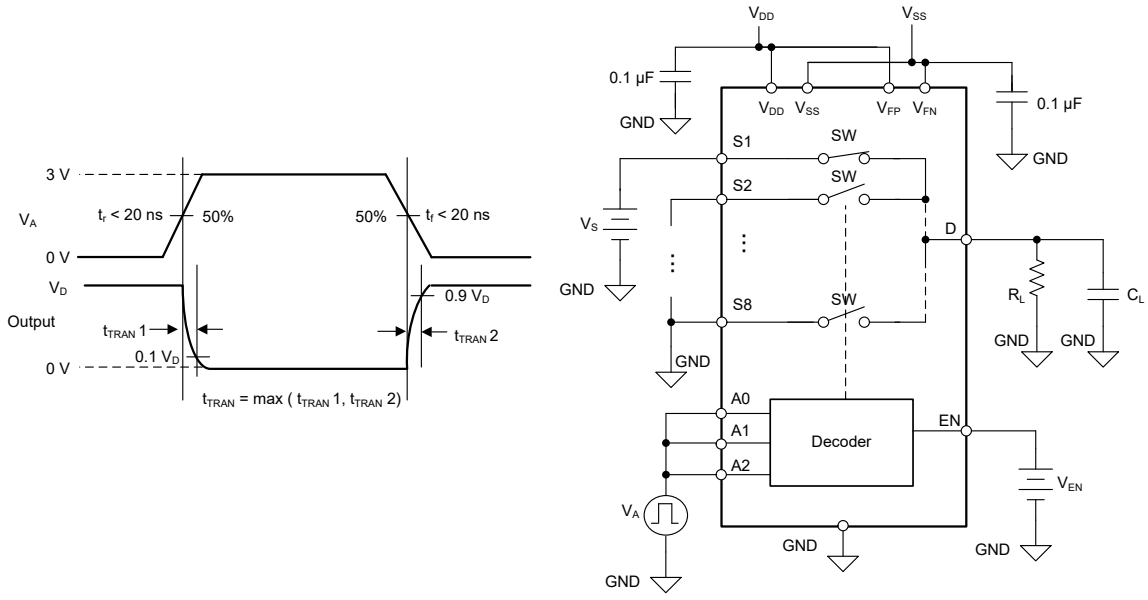



**Figure 6-8. Transition Time Measurement Setup**


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## 6.8 Fault Response Time

Fault response time ($t_{RESPONSE}$) measures the delay between the source voltage exceeding the fault supply voltage ($V_{FP}$ or $V_{FN}$) by 0.5V and the drain voltage failing to 50% of the maximum output voltage. Figure 6-9 shows the setup used to measure $t_{RESPONSE}$.

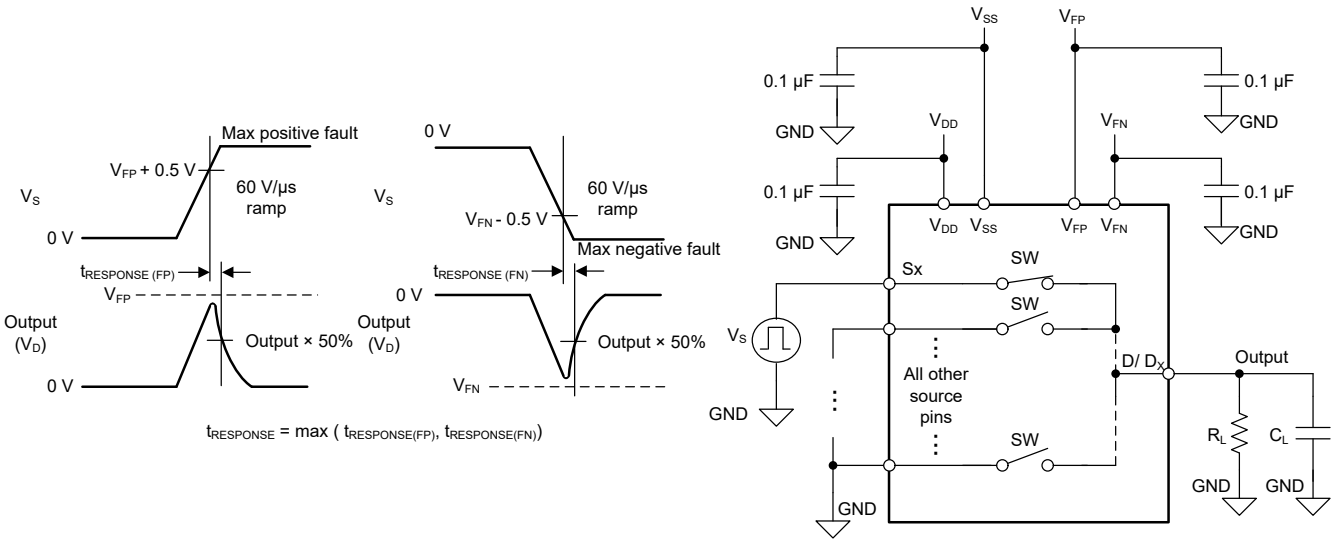



**Figure 6-9. Fault Response Time Measurement Setup**

## 6.9 Fault Recovery Time

Fault recovery time ($t_{RECOVERY}$) measures the delay between the source voltage falling from overvoltage condition to below fault supply voltage ($V_{FP}$ or $V_{FN}$) plus 0.5V and the drain voltage rising from 0V to 50% of the final output voltage. Figure 6-10 shows the setup used to measure $t_{RECOVERY}$.

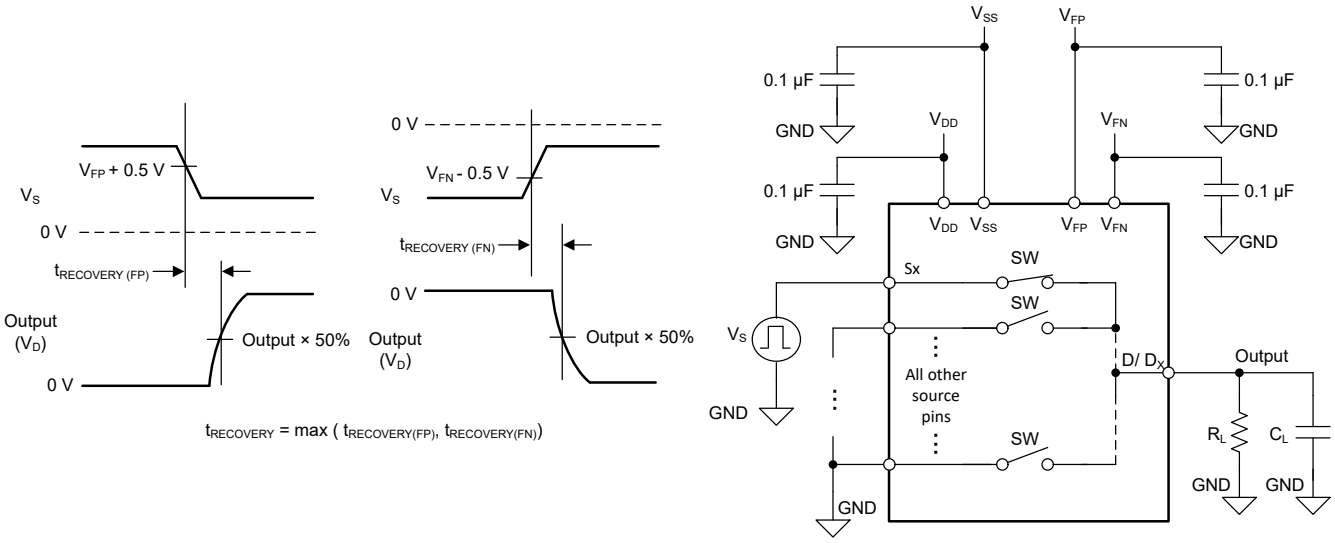



**Figure 6-10. Fault Recovery Time Measurement Setup**

## 6.10 Fault Flag Response Time

Fault flag response time ($t_{RESPONSE(FLAG)}$) measures the delay between the source voltage exceeding the fault supply voltage ($V_{FP}$ or $V_{FN}$) by 0.5V and the general fault flag (FF) pin or specific fault flag (SF) pin to go below 10% of its original value. Figure 6-11 shows the setup used to measure $t_{RESPONSE(FLAG)}$.

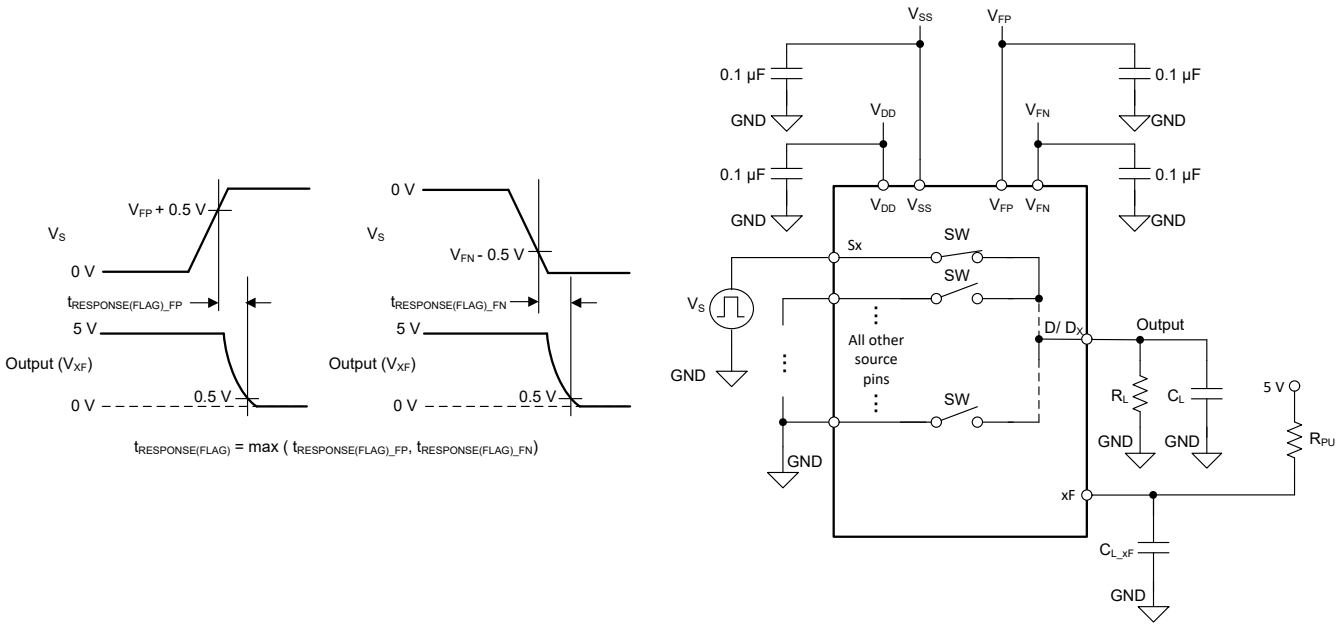



**Figure 6-11. Fault Flag Response Time Measurement Setup**

## 6.11 Fault Flag Recovery Time

Fault flag recovery time ($t_{RECOVERY(FLAG)}$) measures the delay between the source voltage falling from overvoltage condition to below fault supply voltage ($V_{FP}$ or $V_{FN}$) plus 0.5V and the general fault flag (FF) pin or the specific fault flag (SF) pin to rise above 3V with 5V external pull-up. Figure 6-12 shows the setup used to measure $t_{RECOVERY(FLAG)}$.

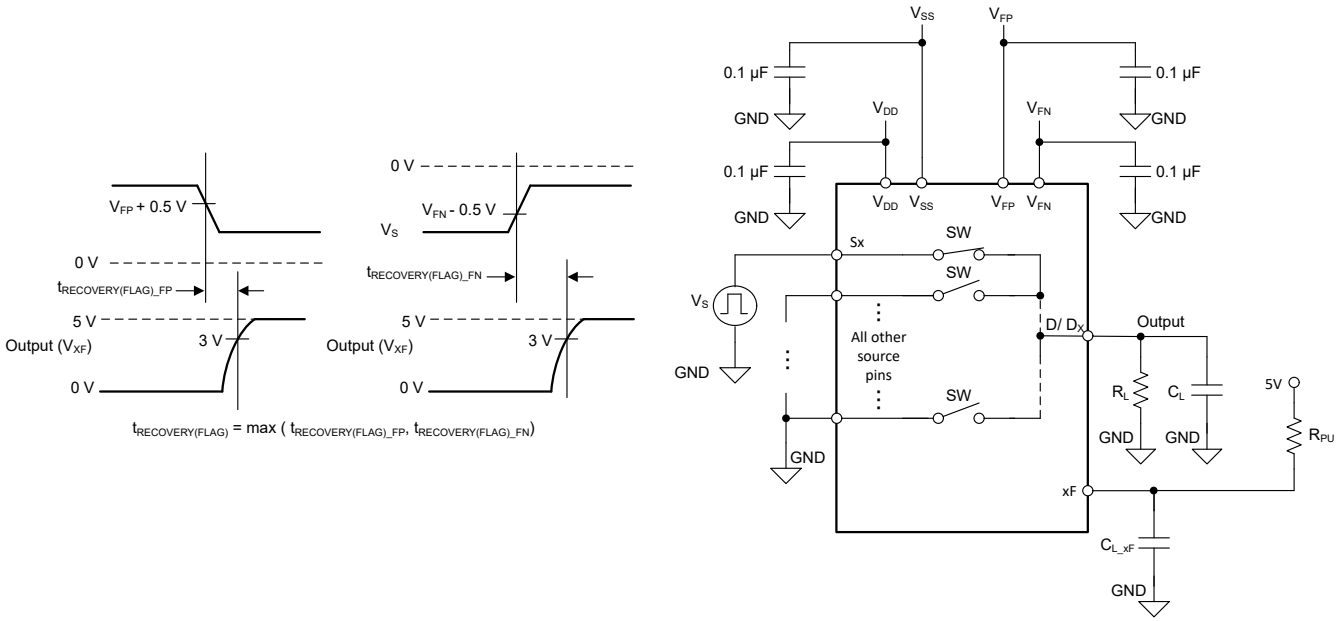



**Figure 6-12. Fault Flag Recovery Time Measurement Setup**


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## 6.12 Charge Injection

Charge injection is a measure of the glitch impulse transferred from the logic input to the analog output during switching, and is denoted by the symbol $Q_{INJ}$. Figure 6-13 shows the setup used to measure charge injection from the source to drain.

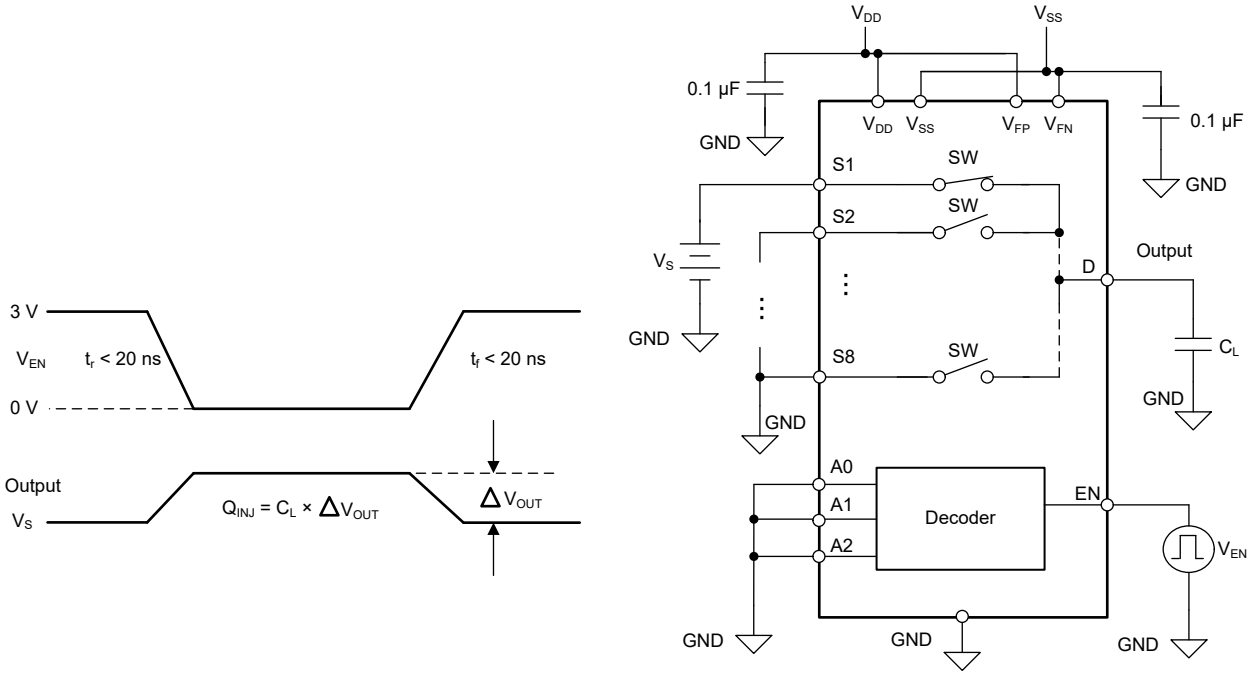



**Figure 6-13. Charge-Injection Measurement Setup**

## 6.13 Off Isolation

Off isolation is defined as the ratio of the signal at the drain pin (Dx) of the device when a signal is applied to the source pin (Sx) of an off-channel. Figure 6-14 and Equation 1 shows the setup used to measure, and the equation used to calculate off isolation.

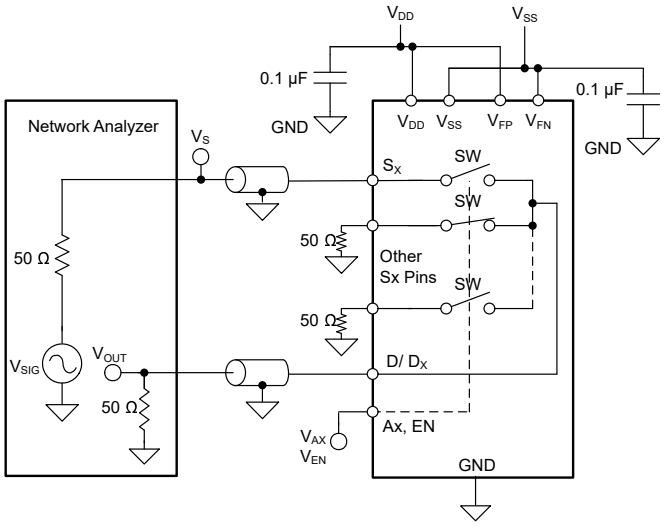



**Figure 6-14. Off Isolation Measurement Setup**

$$Off\ Isolation\ =\ 20\ \times\ Log\ \frac{V_{OUT}}{V_S} \tag{1}$$

## 6.14 Crosstalk

Crosstalk ($X_{TALK}$) is defined as the voltage at the source pin (Sx) of an off-switch input, when a signal is applied at the source pin of an on-switch input in the same channel, as shown in Figure 6-15 and Equation 2.

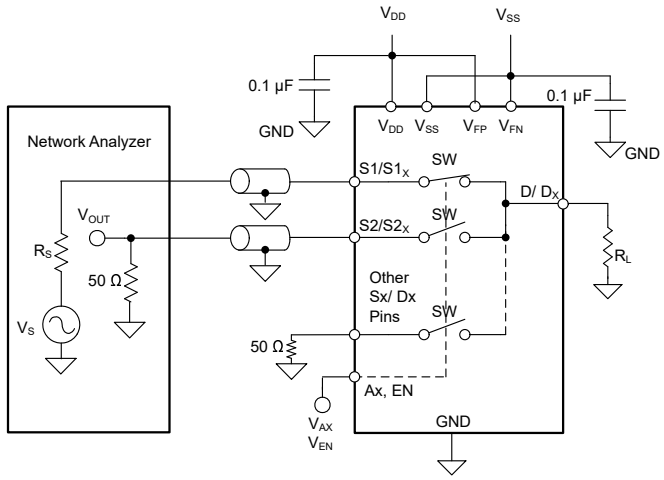



**Figure 6-15. Intra-Channel Crosstalk Measurement Setup**

$$Intra-channel\ Crosstalk\ =\ 20\ \times\ Log\ \frac{V_{OUT}}{V_S} \tag{2}$$


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## 6.15 Bandwidth

Bandwidth (BW) is defined as the range of frequencies that are attenuated by < 3 dB when the input is applied to the source pin (Sx) of an on-channel, and the output is measured at the drain pin (D) of the TMUX582F-SEP. Figure 6-16 and Equation 3 shows the setup used to measure bandwidth of the switch.

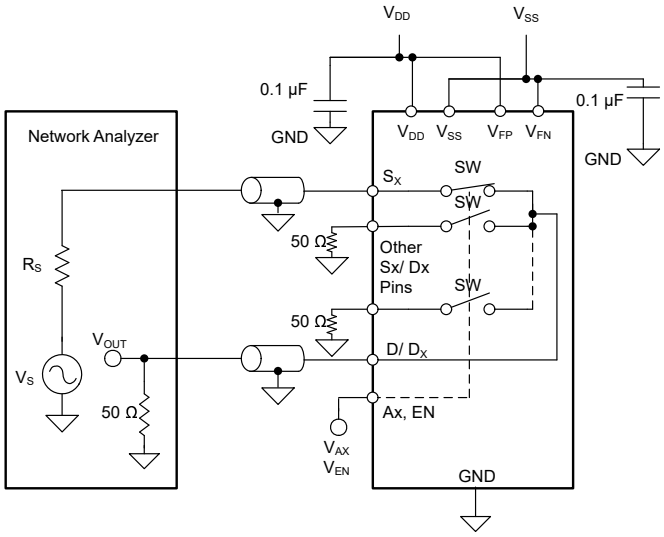



**Figure 6-16. Bandwidth Measurement Setup**

$$Bandwidth = 20 \times Log \frac{V_{OUT}}{V_S} \quad (3)$$

## 6.16 THD + Noise

The total harmonic distortion (THD) of a signal is a measurement of the harmonic distortion, and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency at the multiplexer output. The on-resistance of the TMUX582F-SEP varies with the amplitude of the input signal and results in distortion when the drain pin is connected to a low-impedance load. Total harmonic distortion plus noise is denoted as THD+N. Figure 6-17 shows the setup used to measure THD+N of the devices.

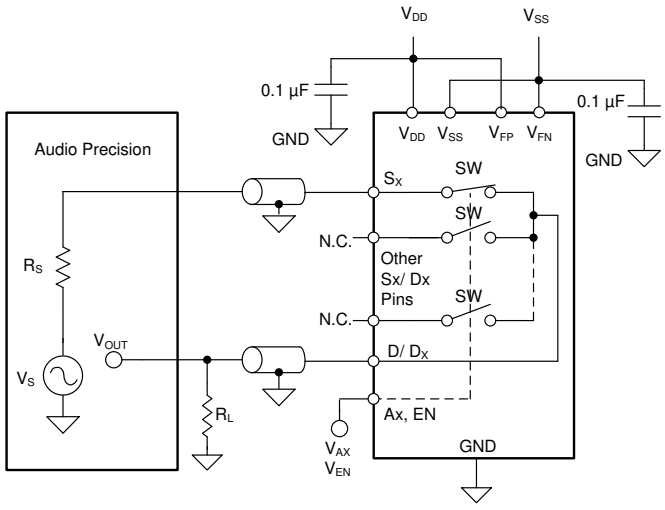



**Figure 6-17. THD+N Measurement Setup**

# 7 Truth Table

Table 7-1 provides the truth tables for the TMUX582F-SEP under normal and fault conditions.

**Table 7-1. TMUX582F-SEP Truth Table**

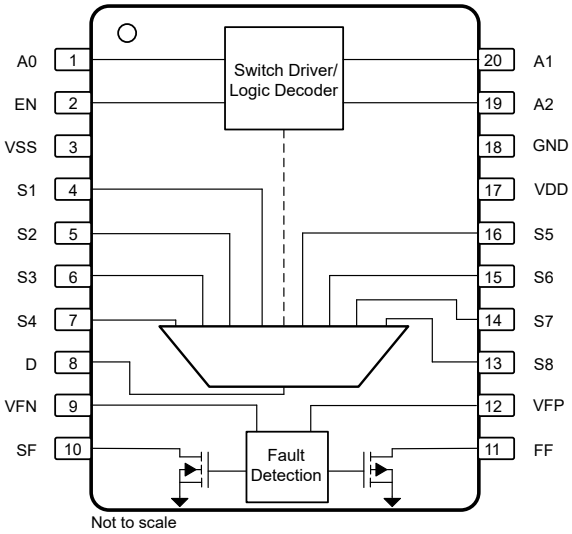
| EN | A2 | A1 | A0 | Normal Condition | Fault Condition | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | State of Specific Flag (SF) when fault occurs on | | | | | | | |
| | | | | On Switch | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 |
| 0 | 0 | 0 | 0 | None | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | None | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 | None | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | None | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | None | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | None | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | None | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | None | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | S1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | S2 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 | S3 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | S4 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | S5 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | S6 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | S7 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | S8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |


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# 8 Detailed Description

The TMUX582F-SEP is a modern complementary metal-oxide semiconductor (CMOS) analog multiplexers in a 8:1 configuration. The device is single supply capable from +8V to +22V. The device features a number of protection features, allowing it to be used in harsh industrial environments.

## 8.1 Functional Block Diagram



Not to scale

## 8.2 Feature Description

### *8.2.1 Flat ON- Resistance*

The TMUX582F-SEP is designed with a special switch architecture to produce ultra-flat on-resistance ($R_{ON}$) across most of the switch input operation region. The flat $R_{ON}$ response allows the device to be used in precision sensor applications since the $R_{ON}$ is controlled regardless of the signals sampled. The architecture is implemented without a charge pump, so no unwanted noise is produced from the device to affect sampling accuracy.

### *8.2.2 Protection Features*

The TMUX582F-SEP offer a number of protection features to enable robust system implementations.

#### 8.2.2.1 Powered-Off Protection

When the supplies of TMUX582F-SEP are removed ($V_{DD}$/ $V_{SS}$ = 0V or floating), the source (Sx) pins of the device remain in the high impedance (Hi-Z) state, and the source (Sx) and drain (Dx) pins of the device remain within the leakage performance mentioned in the Electrical Specifications. Powered-off protection minimizes system complexity by removing the need to control the power supply sequencing of the system. The feature prevents errant voltages on the input source pins from reaching the rest of the system and maintains isolation when the system is powering up. Without powered-off protection, the signal on the input source pins can back-power the supply rails through the internal ESD diodes and potentially cause damage to the system. For more information on powered-off protection refer to *Eliminate Power Sequencing With Powered-Off Protection Signal Switches*.

The switch remains OFF regardless of whether the $V_{DD}$ and $V_{SS}$ supplies are 0V or floating. A GND reference must always be present to allow for proper operation. Source voltage levels of up to +60V are blocked in the powered-off condition.

#### 8.2.2.2 Fail-Safe Logic

Fail-safe logic circuitry allows voltages on the logic control pins to be applied before the supply pins, protecting the device from potential damage. The switch is specified to be in the OFF state, regardless of the state of the logic signals. The logic inputs are protected against positive faults of up to +22V in the powered-off condition, but do not offer protection against the negative overvoltage condition.

Fail-safe logic also allows the TMUX582F-SEP devices to interface with a voltage greater than $V_{DD}$ during normal operation to add maximum flexibility in system design. For example, with a $V_{DD}$ of 15V, the logic control pins could be connected to +22V for a logic high signal which allows different types of signals, such as analog feedback voltages, to be used when controlling the logic inputs. Regardless of the supply voltage, the logic inputs can be interfaced as high as 22V.

#### 8.2.2.3 Overvoltage Protection and Detection

The TMUX582F-SEP detects overvoltage inputs by comparing the voltage on a source pin (Sx) with the fault supplies ($V_{FP}$ and $V_{FN}$). $V_{FN}$ must be set to GND. A signal is considered overvoltage if it exceeds the fault supply voltages by the threshold voltage ($V_T$).

When an overvoltage is detected, the switch automatically turns OFF regardless of the logic controls. The source pin becomes high impedance and allows only a small leakage current through the switch and the overvoltage does not appear on the drain. When the overvoltage channel is selected by the logic control, the drain pin (D) is pulled to the supply that was exceeded. For example, if the source voltage exceeds $V_{FP}$, the drain output is pulled to $V_{FP}$. The pull-up impedance is approximately 40kΩ, and as a result, the drain current is limited to roughly 1mA during a shorted load (to GND) condition.

Figure 8-1 shows a detailed view of how the pullup/down controls the output state of the drain pin under a fault scenario.


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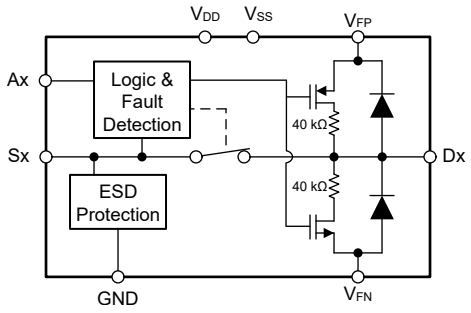



**Figure 8-1. Detailed Functional Diagram**

$V_{FP}$ and $V_{FN}$ are required fault supplies that set the level at which the overvoltage protection is engaged. $V_{FP}$ can be supplied from 3V to $V_{DD}$, while the $V_{FN}$ must be set to GND. If the fault supplies are unavailable in the system, the $V_{FP}$ pin must be connected to $V_{DD}$, while the $V_{FN}$ pin must be set to GND. In this case, overvoltage protection then engages at the primary supply voltage $V_{DD}$.

#### 8.2.2.4 Adjacent Channel Operation During Fault

When the logic pins are set to a channel under a fault, the overvoltage detection will trigger, the switch will open, and the drain pin will be pulled up or down as described in Section 8.2.2.3. During such an event, all other channels not under a fault can continue to operate as normal. For example, if S1 voltage exceeds $V_{FP}$, and the logic pins are set to S1, the drain output is pulled to $V_{FP}$. Then if the logic pins are changed to set S4, which is not in overvoltage, the drain will disconnect from the pullup to $V_{FP}$ and the S4 switch will be enabled and connected to the drain, operating as normal. If the logic pins are switched back to S1, the S4 switch will be disabled, the drain pin will be pulled up to $V_{FP}$ again, and the switch from S1 to drain will not be enabled until the overvoltage fault is removed.

#### 8.2.2.5 ESD Protection

All pins on the TMUX582F-SEP support HBM ESD protection level up to ±3.5kV, which helps the device from getting ESD damages during the manufacturing process.

The drain pins (D) have internal ESD protection diodes to the fault supplies $V_{FP}$ and $V_{FN}$. Therefore, the voltage at the drain pins must not exceed the fault supply voltages to prevent excessive diode current. The source pins have specialized ESD protection that allows the signal voltage to reach +60V regardless of the supply voltage level. Exceeding +60V on any source input may damage the ESD protection circuitry on the device and cause the device to malfunction if the damage is excessive.

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#### 8.2.2.6 Latch-Up Immunity

Latch-up is a condition where a low impedance path is created between a supply pin and ground. This condition is caused by a trigger (current injection or overvoltage), but once activated, the low impedance path remains even after the trigger is no longer present. This low impedance path may cause system upset or catastrophic damage due to excessive current levels. The latch-up condition typically requires a power cycle to eliminate the low impedance path.

The TMUX582F-SEP devices are constructed on silicon on insulator (SOI) based process where an oxide layer is added between the PMOS and NMOS transistor of each CMOS switch to prevent parasitic structures from forming. The oxide layer is also known as an insulating trench and prevents triggering of latch up events due to overvoltage or current injections. The latch-up immunity feature allows the TMUX582F-SEP to be used in harsh environments. For more information on latch-up immunity, refer to *Using Latch Up Immune Multiplexers to Help Improve System Reliability*.

#### 8.2.2.7 EMC Protection

The TMUX582F-SEP are not intended for standalone electromagnetic compatibility (EMC) protection in industrial applications. There are three common high voltage transient specifications that govern industrial high voltage transient specification: IEC61000-4-2 (ESD), IEC61000-4-4 (EFT), and IEC61000-4-5 (surge immunity). A transient voltage suppressor (TVS), along with some low-value series current limiting resistors, are required to prevent source input voltages from going above the rated +60V limits.

When selecting a TVS protection device, it is critical to confirm that the maximum working voltage is greater than both the normal operating range of the input source pins to be protected and any known system common-mode overvoltage that may be present due to incorrect wiring, loss of power, or short circuit. Figure 8-2 shows an example of the proper design window when selecting a TVS device.

Region 1 denotes normal operation region of TMUX582F-SEP where the input source voltages stay below the fault supplies $V_{FP}$ and $V_{FN}$. Region 2 represents the range of possible persistent DC (or long duration AC overvoltage fault) presented on the source input pins. Region 3 represents the margin between any known DC overvoltage level and the absolute maximum rating of the TMUX582F-SEP. The TVS breakdown voltage must be selected to be less than the absolute maximum rating of the TMUX582F-SEP, but greater than any known possible persistent DC or long duration AC overvoltage fault to avoid triggering the TVS inadvertently. Region 4 represents the margin system designers must impose when selecting the TVS protection device to prevent accidental triggering of ESD cells of the TMUX582F-SEP devices.

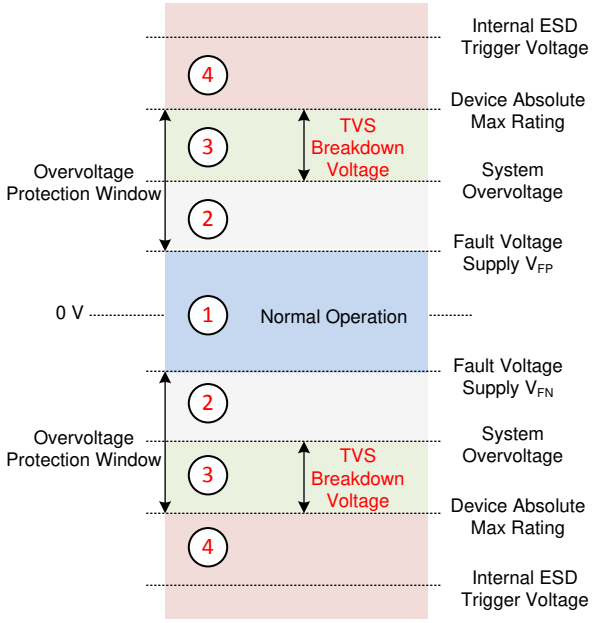



**Figure 8-2. System Operation Regions and Proper Region of Selecting a TVS Protection Device**


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### 8.2.3 Overvoltage Fault Flags

The voltages on the source input pins of the TMUX582F-SEP is continuously monitored, and the status of whether an overvoltage condition occurs is indicated by an active low general fault flag (FF). The voltage on the FF pin indicates if any of the source input pins are experiencing an overvoltage condition. If any source pin voltage exceeds the fault supply voltages by $V_T$, then the FF output is pulled-down to below $V_{OL}$.

The specific fault (SF) output pins, on the other hand, can be used to decode which inputs are experiencing an overvoltage condition. The SF pin is pulled-down to below $V_{OL}$ when an overvoltage condition is detected on a specific source input pin, depending on the state of the A0, A1, A2, and EN logic pins (Table 7-1 provides more details).

Both the FF pin and SF pin are open-drain output and external pull-up resistors of 1 kΩ are recommended. The pull-up voltage can be in the range of 1.8V to 5.5V, depending on the controller voltage the device interfaces with.

### 8.2.4 Bidirectional and Rail-to-Rail Operation

The TMUX582F-SEP conducts equally well from source (Sx) to drain (D or Dx) or from drain (D or Dx) to source (Sx). Each signal path has very similar characteristics in both directions. It is important to note, however, that the overvoltage protection is implemented only on the source (Sx) side. The voltage on the drain is only allowed to swing between $V_{FP}$ and $V_{FN}$ and no overvoltage protection is available on the drain side.

The primary supplies ($V_{DD}$ and $V_{SS}$) define the on-resistance profile of the switch channel, whereas the fault voltage supplies ($V_{FP}$ and $V_{FN}$) define the signal range that can be passed through from source to drain of the device. It is good practice to use voltages on $V_{FP}$ and $V_{FN}$ that are lower than $V_{DD}$ and $V_{SS}$ to take advantage of the flat on-resistance region of the device for better input-to-output linearity. The flattest on-resistance region is roughly 3V below $V_{DD}$. Once the signal is within 3V of $V_{DD}$ the on-resistance will exponentially increase and may impact desired signal transmission.

### 8.2.5 1.8V Logic Compatible Inputs

The TMUX582F-SEP devices have 1.8V logic compatible control for all logic control inputs. 1.8V logic level inputs allows the TMUX582F-SEP to interface with processors that have lower logic I/O rails and eliminates the need for an external translator, which saves both space and BOM cost. For more information on 1.8V logic implementations, refer to *Simplifying Design with 1.8V logic Muxes and Switches*.

### 8.2.6 Integrated Pull-Down Resistor on Logic Pins

The TMUX582F-SEP have internal weak pull-down resistors to GND to confirm the logic pins are not left floating. The value of this pull-down resistor is approximately 4MΩ, but is clamped to about 1µA at higher voltages. This feature integrates up to four external components and reduces system size and cost.

## 8.3 Device Functional Modes

The TMUX582F-SEP offer two modes, Normal mode and Fault mode, of operation depending on whether any of the input pins experience overvoltage condition.

### 8.3.1 Normal Mode

In Normal mode operation, signals of up to $V_{FP}$ and $V_{FN}$(GND) can be passed through the switch from source (Sx) to drain (D or Dx) or from drain (D or Dx) to source (Sx). As provided in Table 7-1, the address (Ax) pins and the enable (EN) pin determine which switch path to turn on, The following conditions must be satisfied for the switch to stay in the ON condition:

- The primary supply, $V_{DD}$, must be higher or equal to 8V. Vss must be set to GND.
- $V_{FP}$ must between 3V and $V_{DD}$.
- The input signals on the source (Sx) or the drain (D or Dx) must be between $V_{FP}$+ $V_T$ and GND.
- The logic control (Ax and EN) must have selected the switch.

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### 8.3.2 Fault Mode

The TMUX582F-SEP enters into Fault mode when any of the input signals on the source (Sx) pins exceed $V_{FP}$ by a threshold voltage $V_T$. Under the overvoltage condition, the switch input experiencing the fault automatically turns OFF regardless of the digital logic status, and the source pin becomes high impedance with a negligible amount of leakage current flowing through the switch. When the fault channel is selected by the digital logic control, the drain pin (D or Dx) is pulled to the supply that was exceeded through a 40kΩ internal resistor.

In the Fault Mode, the general fault flag (FF) is asserted low. The specific flag (SF) is asserted low when a specific input path is selected, as provided in Table 7-1.

The overvoltage protection is provided only for the source (Sx) input pins. The drain (D or Dx) pin, if used as signal input, must stay in between $V_{FP}$ and GND at all times since no overvoltage protection is implemented on the drain pin.


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# 9 Application and Implementation

**Note**

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

## 9.1 Application Information

The TMUX582F-SEP is part of the fault protected switches and multiplexers family of devices. The ability to protect downstream components from overvoltage events up to +60V makes these switches and multiplexers an excellent choice for harsh aerospace environments.

## 9.2 Typical Application

### *9.2.1 System Diagnostics – Telemetry*

In large remote systems, on-board diagnostics is essential to correct fault scenarios. Through measuring subsystem voltage, current consumption, or a fault pin directly, the system MCU can easily detect where a potential issue surfaces and automatically correct it; however, this requires many ADC channels to accomplish. TMUX582F-SEP allows a significant reduction in ADC channels. Low distortion, charge injection and off-isolation increases measurement accuracy and helps reduce the likelihood of false positives or negatives. In addition, overvoltage and power-off or cold sparing protection helps prevent faults from the subsystems propagating throughout the system.

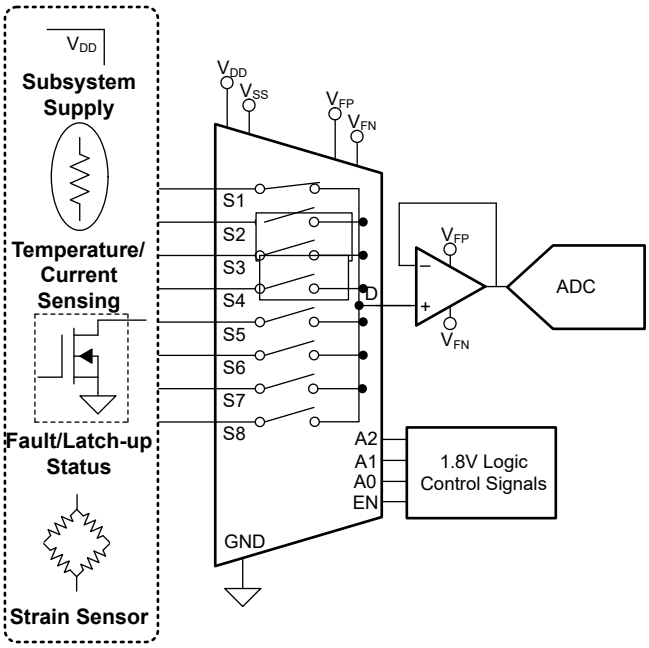



**Figure 9-1. System Diagnostics - Telemetry**

### 9.2.2 Design Requirements

**Table 9-1. Design Parameters**

| PARAMETER | VALUE |
|---|---|
| Positive supply ($V_{DD}$) mux | +12V |
| Negative supply ($V_{SS}$) mux | 0V |
| Positive fault voltage supply ($V_{FP}$) mux and ADC | +5V |
| Negative fault voltage supply ($V_{FN}$) mux and ADC | 0V |
| Max power supply voltage on board | +24V |
| Input / output signal range non-faulted | +5V to 0V |
| Overvoltage protection levels | up to +60V |
| Control logic thresholds | 1.8V compatible |
| Temperature range | -55°C to +125°C |

### 9.2.3 Detailed Design Procedure

The TMUX582F-SEP is built on a latch-up immune process that can support telemetry applications by decreasing the number of ADC channels used while also reducing distortions in sampled inputs by maintaining an ultra low Ron flatness response that helps prevent false positives and negatives. TMUX582F-SEP also utilizes overvoltage and power-off protection (cold sparing capable up to +60V), which can help prevent downstream devices from experiencing these events.

### 9.2.4 Application Curves

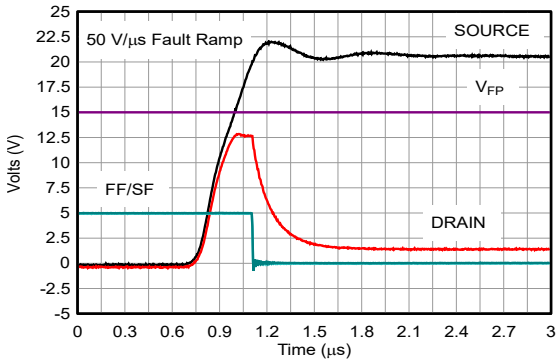



**Figure 9-2. Positive Overvoltage Response**

## 9.3 Power Supply Recommendations

The TMUX582F-SEP operates across a wide supply range of 8V to 22V in single-supply mode. T. For improved supply noise immunity, use a supply decoupling capacitor ranging from 0.1µF to 10µF from $V_{DD}$ pin to ground. Always ensure the ground (GND) connection is established before supplies are ramped.

The fault supply ($V_{FP}$ ) provide the current required to operate the fault protection, and thus, must be a low impedance supply. They can be derived from the primary supplies by using a resistor divider and buffer. The fault supply must not exceed the primary supply as it might cause unexpected behavior of the switch.

## 9.4 Layout

### 9.4.1 Layout Guidelines

The following figure illustrates an example of a PCB layout with the TMUX582F-SEP. Some key considerations are as follows:


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- Decouple the $V_{DD}$ pin with a 0.1µF capacitor, placed as close to the pin as possible.$V_{ss}$ pin must be set to GND. Ensure that the capacitor voltage rating is sufficient for the $V_{DD}$ supply.
- Keep the input lines as short as possible.
- Use a solid ground plane to help distribute heat and reduce electromagnetic interference (EMI) noise pickup.
- Do not run sensitive analog traces in parallel with digital traces. Avoid crossing digital and analog traces if possible, and only make perpendicular crossings when necessary.

### *9.4.2 Layout Example*

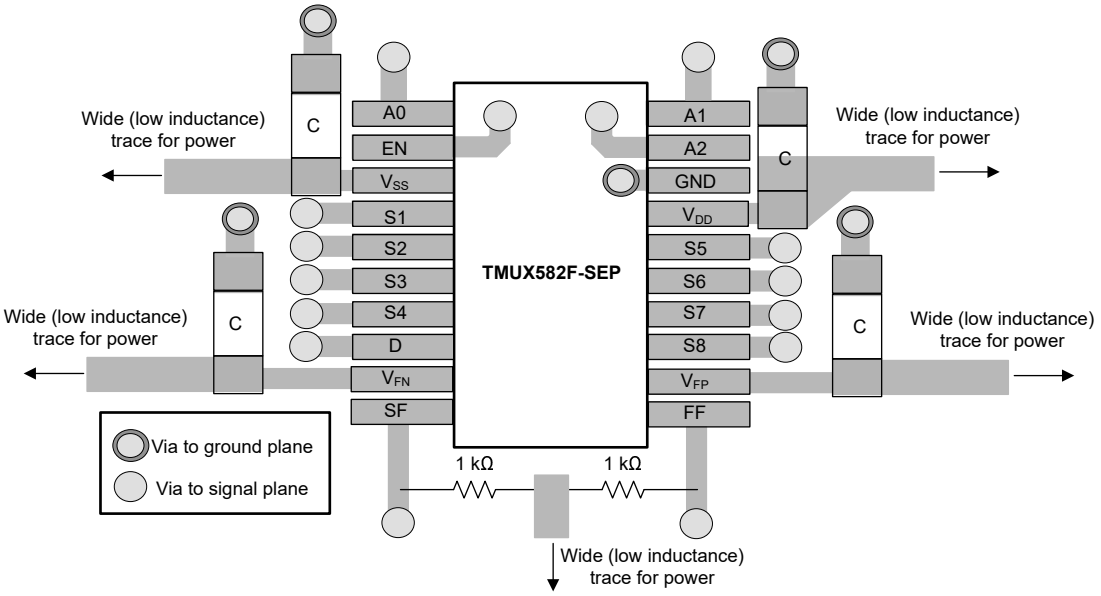



**Figure 9-3. TMUX582F-SEP PW Layout Example**

# 10 Device and Documentation Support

## 10.1 Documentation Support

### *10.1.1 Related Documentation*

For related documentation, see the following:

- Texas Instruments, *ADS866x 12-Bit, 500-kSPS, 4- and 8-Channel, Single-Supply, SAR ADCs with Bipolar Input Ranges*
- Texas Instruments, *OPAx140 High-Precision, Low-Noise, Rail-to-Rail Output, 11-MHz, JFET Op Amp*
- Texas Instruments, *OPAx192 36-V, Precision, Rail-to-Rail Input/Output, Low Offset Voltage, Low Input Bias Current Op Amp with e-trim™*

## 10.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

## 10.3 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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## 10.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## 10.6 Glossary

| | |
|---|---|
| TI Glossary | This glossary lists and explains terms, acronyms, and definitions. |

# 11 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision * (June 2022) to Revision A (September 2024) | Page |
|---|---|
| • Changed status from Advanced Information to Production Data | 1 |

# 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.


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## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| TMUX582FPWTSEP | Active | Production | TSSOP (PW) \| 20 | 250 \| SMALL T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -55 to 125 | TM582FSEP |
| V62/23607-01XE | Active | Production | TSSOP (PW) \| 20 | 250 \| SMALL T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -55 to 125 | TM582FSEP |

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

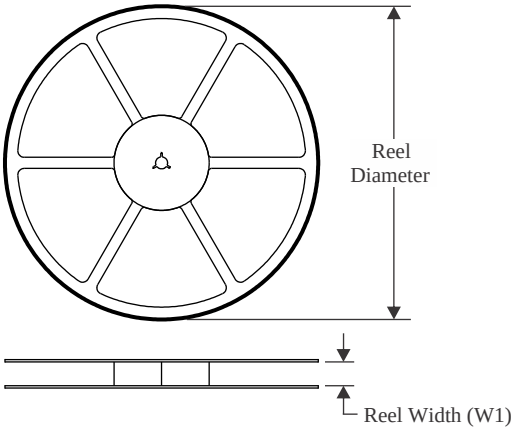
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

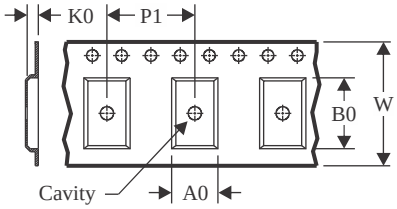
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

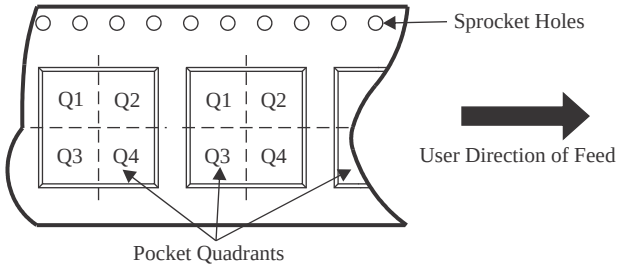



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

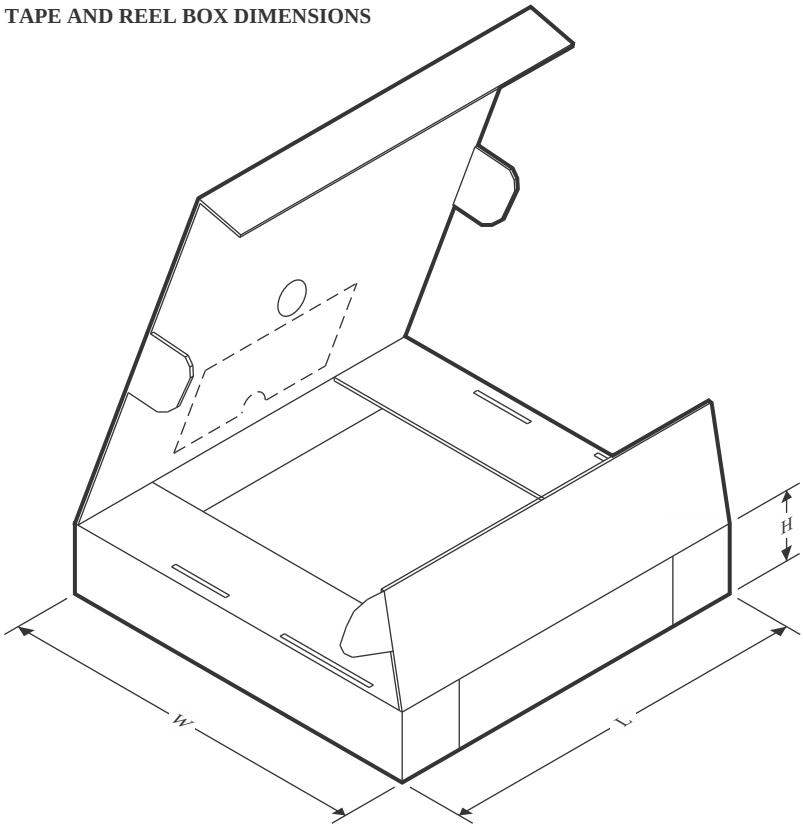
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TMUX582FPWTSEP | TSSOP | PW | 20 | 250 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TMUX582FPWTSEP | TSSOP | PW | 20 | 250 | 356.0 | 356.0 | 35.0 |

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