

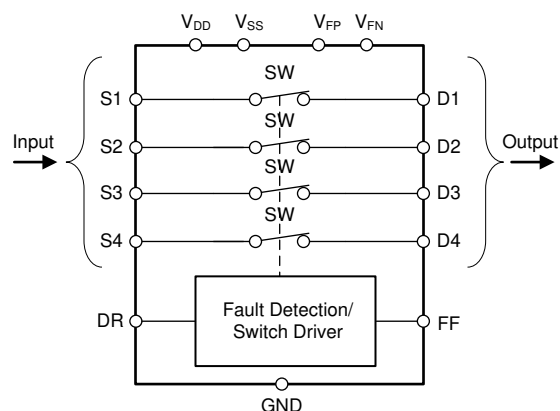
TMUX7462F ± 60 V Fault-Protected, Latch-Up Immune, Quad Channel Protector with Adjustable Fault Threshold and 1.8-V Logic

1 Features

- Wide supply range: 8 V to 44 V single supply ± 5 V to ± 22 V dual supply
- Channel protector without need for dedicated select pin per channel
 - Reduces number of control logic signals to route across PCB
- Integrated fault protection:
 - Overvoltage protection, source to supplies or source to drain: ± 85 V
 - Overvoltage protection: ± 60 V
 - Powered-off protection: ± 60 V
 - Interrupt flags to indicate fault status
 - Adjustable overvoltage triggering thresholds
 - V_{FP} : 3 V to V_{DD} , V_{FN} : 0 V to V_{SS}
 - Adjustable output behavior (clamped or open) during fault
- Latch-up immunity by device construction
- 6 kV human body model (HBM) ESD rating
- Low On-Resistance: 8.3 Ω typical
- Flat On-Resistance: 5 m Ω typical
- Industry-standard TSSOP and smaller WQFN package

2 Applications

- [Factory automation and control](#)
- [Programmable logic controllers \(PLC\)](#)
- [Analog input modules](#)
- [Semiconductor test equipment](#)
- [Battery test equipment](#)
- [Servo drive control module](#)
- [Data acquisition systems \(DAQ\)](#)



Block Diagram

3 Description

The TMUX7462F is a four-channel protector that can be placed on the front end of a signal path to protect sensitive components downstream from damage caused by overvoltage faults. Each of the 4 channels has an internal switch that is turned-off automatically upon occurrence of an overvoltage fault without the need of external controls. This simplifies robust system level protection designs by removing the need for control signals for each channel of the device. The overvoltage protection is available in powered and powered-off conditions, making the TMUX7462F suitable for applications where power supply sequencing cannot be precisely controlled.

The switch channels remain in the high impedance state (regardless of switch input conditions) when the devices power supplies are floating, grounded, or at a level that is below the undervoltage (UV) threshold. If the signal level on any S_x pin exceeds the fault supply (V_{FP} or V_{FN}) by a threshold voltage (V_T), then the S_x pin becomes high impedance and an output fault flag is asserted low to indicate a fault condition under normal operation. The drain pin (D_x) is either pulled to the fault supply voltage that was exceeded or left floating depending on the DR control logic.

The device operates with dual supplies (± 5 V to ± 22 V), a single supply (8 V to 44 V), or asymmetric supplies. The low and flat on-resistance of the device makes the TMUX7462F an excellent solution for data acquisition applications where excellent linearity and low distortion is critical.

Package Information

PART NUMBER	PACKAGE ⁽¹⁾	PACKAGE SIZE ⁽²⁾
TMUX7462F	PW (TSSOP, 16)	5 mm \times 6.4 mm
	RRP (WQFN, 16)	4 mm \times 4 mm

- (1) See the orderable addendum at the end of the data sheet for all available packages.
- (2) The package size (length \times width) is a nominal value and includes pins, where applicable.



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4 Revision History

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

Changes from Revision A (October 2021) to Revision B (November 2022)	Page
• Changed the status of the PW package from: <i>preview</i> to: <i>active</i>	1
• Updated the format of the <i>Package Information</i> table to include package leads.....	1

Changes from Revision * (March 2021) to Revision A (October 2021)	Page
• Changed the status of the data sheet from: <i>Advanced Information</i> to: <i>Production Data</i>	1

5 Pin Configuration and Functions

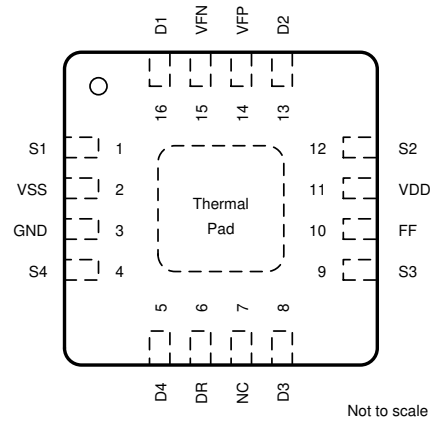
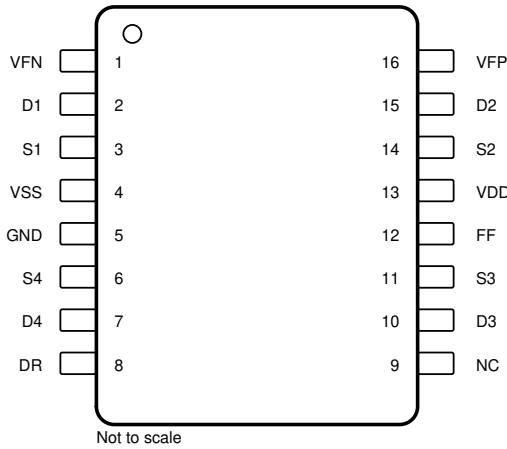


Figure 5-1. PW Package, 16-Pin TSSOP (Top View) Figure 5-2. RRP Package, 16-Pin WQFN (Top View)

Table 5-1. Pin Functions

PIN			TYPE ⁽¹⁾	DESCRIPTION
NAME	TSSOP	WQFN		
D1	2	16	I/O	Drain pin 1 can be an input or output. The drain pin is not overvoltage protected and shall remain within the recommended operating range.
D2	15	13	I/O	Drain pin 2 can be an input or output. The drain pin is not overvoltage protected and shall remain within the recommended operating range.
D3	10	8	I/O	Drain pin 3 can be an input or output. The drain pin is not overvoltage protected and shall remain within the recommended operating range.
D4	7	5	I/O	Drain pin 4 can be an input or output. The drain pin is not overvoltage protected and shall remain within the recommended operating range.
DR	8	6	I	Drain Response (DR) input. Tying the DR pin to GND enables the drain to be pulled to V _{FP} or V _{FN} through a 40 kΩ resistor during an overvoltage fault event. The drain pin becomes open circuit when the DR pin is a logic high or left floating.
FF	12	10	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) pins. Connect this pin to an external supply (1.8 V to 5.5 V) through a 1 kΩ pull-up resistor.
GND	5	3	P	Ground (0 V) reference.
N.C.	9	7	—	No internal connection
S1	3	1	I/O	Overvoltage protected source pin 1 can be an input or output.
S2	14	12	I/O	Overvoltage protected source pin 2 can be an input or output.
S3	11	9	I/O	Overvoltage protected source pin 3 can be an input or output.
S4	6	4	I/O	Overvoltage protected source pin 4 can be an input or output.
V _{DD}	13	11	P	Positive power supply. This pin is the most positive power-supply potential. Connect a decoupling capacitor ranging from 0.1 μF to 10 μF between V _{DD} and GND for reliable operation.
V _{FP}	16	14	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 the same as the device's positive supply. Connect a decoupling capacitor ranging from 0.1 μF to 10 μF between V _{FP} and GND for reliable operation.
V _{FN}	1	15	P	Negative fault voltage supply that determines the overvoltage protection triggering threshold on the negative side. Connect to V _{SS} if the triggering threshold is the same as the device's negative supply. Connect a decoupling capacitor ranging from 0.1 μF to 10 μF between V _{FN} and GND for reliable operation.
V _{SS}	4	2	P	Negative power supply. This pin is the most negative power-supply potential. This pin can be connected to ground in single-supply applications. Connect a decoupling capacitor ranging from 0.1 μF to 10 μF between V _{SS} and GND for reliable operation.
Thermal Pad			—	The thermal pad is not connected internally. No requirement to solder this pad. For best performance it is recommended that the pad be tied to GND or VSS.

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

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V _{DD} to V _{SS}	Supply voltage		48	V
V _{DD} to GND		-0.3	48	V
V _{SS} to GND		-48	0.3	V
V _{FP} to GND	Fault clamping voltage	-0.3	V _{DD} + 0.3	V
V _{FN} to GND		V _{SS} - 0.3	0.3	V
V _S to GND	Source input pin (Sx) voltage to GND	-65	65	V
V _S to V _{DD}	Source input pin (Sx) voltage to V _{DD} or V _D	-90		V
V _S to V _{SS}	Source input pin (Sx) voltage to V _{SS} or V _D		90	V
V _D	Drain pin (Dx) voltage	V _{FN} -0.7	V _{FP} +0.7	V
V _{DR}	Logic input pin (DR) voltage ⁽²⁾	GND -0.7	48	V
V _{FF}	Logic output pin (FF) voltage ⁽²⁾	GND -0.7	6	V
I _{DR}	Logic input pin (DR) current ⁽²⁾	-30	30	mA
I _{FF}	Logic output pin (FF) current ⁽²⁾	-10	10	mA
I _S or I _D (CONT)	Source or drain continuous current (Sx or Dx)	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 (QFN)		1600	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) For QFN package: P_{tot} derates linearly above T_A = 70°C by 23.5 mW/°C

6.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	±6000 V
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002, all pins ⁽²⁾	±750 V

- (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.

6.3 Thermal Information

THERMAL METRIC ⁽¹⁾		TMUX7462F		UNIT
		PW (TSSOP)	RRP (WQFN)	
		16 PINS	16 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	100.4	42.8	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	31.3	28.5	°C/W
R _{θJB}	Junction-to-board thermal resistance	46.4	17.9	°C/W
Ψ _{JT}	Junction-to-top characterization parameter	1.7	0.3	°C/W
Ψ _{JB}	Junction-to-board characterization parameter	45.8	17.9	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	N/A	4.0	°C/W

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

6.4 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V _{DD} – V _{SS} ⁽¹⁾	Power supply voltage differential	8		44	V
V _{DD}	Positive power supply voltage	5		44	
V _{FP}	Positive fault clamping voltage	3		V _{DD}	
V _{FN}	Negative fault clamping voltage	V _{SS}		0	
V _S	Source pin (Sx) voltage (non-fault condition)			V _{FP}	V
V _S to GND	Source pin (Sx) voltage to GND (fault condition)	–60		60	
V _S to V _{DD} ⁽²⁾	Source pin (Sx) voltage to V _{DD} or V _D (fault condition)	–85			
V _S to V _{SS} ⁽²⁾	Source pin (Sx) voltage to V _{SS} or V _D (fault condition)			85	
V _D	Drain pin (Dx) voltage	V _{FN}		V _{FP}	V
V _{DR}	Logic input pin (DR) voltage	GND		44	
V _{FF} ⁽³⁾	Logic output pin (FF) voltage	GND		5.5	
T _A	Ambient temperature	–40		125	°C
I _{DC}	Continuous current through switch, WQFN package	T _A = 25°C		150	mA
		T _A = 85°C		100	
		T _A = 125°C		60	

(1) V_{DD} and V_{SS} can be any value as long as 8 V ≤ (V_{DD} – V_{SS}) ≤ 44 V, and the minimum V_{DD} is met.

(2) Source pin voltage (Sx) under a fault condition may not exceed 85 V from supply pins (V_{DD} and V_{SS}.) or drain pins (D, Dx).

(3) Logic output pin (FF) is an open drain output and should be pulled up to a voltage within the max ratings

6.5 Electrical Characteristics (Global)

at T_A = 25°C (unless otherwise noted)

Typical at V_{DD} = 15 V, V_{SS} = –15 V, GND = 0 V (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T _A	MIN	TYP	MAX	UNIT
ANALOG SWITCH						
V _T	Threshold voltage for fault detector	25°C		0.7		V
LOGIC INPUT/ OUTPUT						
V _{IH}	High-level input voltage	DR pin	–40°C to +125°C	1.3		V
V _{IL}	Low-level input voltage	DR pin	–40°C to +125°C		0.8	V
I _{IH}	High-level input current	V _{DR} = logic high	–40°C to +125°C		0.4	3 μA
I _{IL}	Low-level input current	V _{DR} = logic low	–40°C to +125°C	–1	–0.65	μA
V _{OL(FLAG)}	Low-level output voltage	FF pin, I _O = 5 mA	–40°C to +125°C		0.35	V

6.5 Electrical Characteristics (Global) (continued)

at $T_A = 25^\circ\text{C}$ (unless otherwise noted)

Typical at $V_{DD} = 15\text{ V}$, $V_{SS} = -15\text{ V}$, $\text{GND} = 0\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
POWER SUPPLY							
V_{UVLO}	Undervoltage lockout (UVLO) threshold voltage ($V_{DD} - V_{SS}$)	Rising edge, single supply	-40°C to $+125^\circ\text{C}$	5.1	5.8	6.4	V
		Falling edge, single supply	-40°C to $+125^\circ\text{C}$	5	5.7	6.3	V
V_{HYS}	V_{DD} Undervoltage lockout (UVLO) hysteresis	Single supply	-40°C to $+125^\circ\text{C}$		0.2		V
$R_{D(OVP)}$	Drain resistance to fault supply during overvoltage protection when enabled by DR pin		25°C		40		k Ω

6.6 $\pm 15\text{ V}$ Dual Supply: Electrical Characteristics

$V_{DD} = +15\text{ V} \pm 10\%$, $V_{SS} = -15\text{ V} \pm 10\%$, $\text{GND} = 0\text{ V}$ (unless otherwise noted)

Typical at $V_{DD} = +15\text{ V}$, $V_{SS} = -15\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
ANALOG SWITCH							
R_{ON}	On-resistance	$V_S = -10\text{ V}$ to $+10\text{ V}$ $I_D = -10\text{ mA}$	25°C		8.3	10.7	Ω
			-40°C to $+85^\circ\text{C}$			13.5	
			-40°C to $+125^\circ\text{C}$			16	
ΔR_{ON}	On-resistance mismatch between channels	$V_S = -10\text{ V}$ to $+10\text{ V}$ $I_D = -10\text{ mA}$	25°C		0.05	0.45	Ω
			-40°C to $+85^\circ\text{C}$			0.5	
			-40°C to $+125^\circ\text{C}$			0.6	
R_{FLAT}	On-resistance flatness	$V_S = -10\text{ V}$ to $+10\text{ V}$ $I_D = -10\text{ mA}$	25°C		0.005	0.4	Ω
			-40°C to $+85^\circ\text{C}$			0.4	
			-40°C to $+125^\circ\text{C}$			0.4	
R_{ON_DRIFT}	On-resistance drift	$V_S = 0\text{ V}$, $I_S = -10\text{ mA}$	-40°C to $+125^\circ\text{C}$		0.04		$\Omega/^\circ\text{C}$
$I_{S(ON)}$, $I_{D(ON)}$	Channel on leakage current ⁽¹⁾	Switch state is on, $V_{DD} = 16.5\text{ V}$, $V_{SS} = -16.5\text{ V}$, $V_S = V_D = \pm 10\text{ V}$	25°C	-0.7	0.1	0.7	nA
			-40°C to $+85^\circ\text{C}$		-2	2	
			-40°C to $+125^\circ\text{C}$		-15	15	
FAULT CONDITION							
$I_{S(FA)}$	Input leakage current during overvoltage	$V_S = \pm 60\text{ V}$, $\text{GND} = 0\text{ V}$, $V_{DD} = V_{FP} = 16.5\text{ V}$, $V_{SS} = V_{FN} = -16.5\text{ V}$	-40°C to $+125^\circ\text{C}$		± 110		μA
$I_{S(FA)}$ Grounded	Input leakage current during overvoltage with grounded supply voltages	$V_S = \pm 60\text{ V}$, $\text{GND} = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = 0\text{ V}$	-40°C to $+125^\circ\text{C}$		± 135		μA
$I_{S(FA)}$ Floating	Input leakage current during overvoltage with floating supply voltages	$V_S = \pm 60\text{ V}$, $\text{GND} = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = \text{floating}$,	-40°C to $+125^\circ\text{C}$		± 140		μA
$I_{D(FA)}$	Output leakage current during overvoltage	$V_S = \pm 60\text{ V}$, $\text{GND} = 0\text{ V}$, $V_{DD} = V_{FP} = 16.5\text{ V}$, $V_{SS} = V_{FN} = -16.5\text{ V}$, $V_{DR} = 5\text{ V}$ or floating	25°C	-20	± 0.1	20	nA
			-40°C to $+85^\circ\text{C}$		-30	30	
			-40°C to $+125^\circ\text{C}$		-60	60	
$I_{D(FA)}$ Grounded	Output leakage current during overvoltage with grounded supply voltages	$V_S = \pm 60\text{ V}$, $\text{GND} = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = 0\text{ V}$	25°C	-30	± 0.01	30	nA
			-40°C to $+85^\circ\text{C}$		-50	50	
			-40°C to $+125^\circ\text{C}$		-90	90	
$I_{D(FA)}$ Floating	Output leakage current during overvoltage with floating supply voltages	$V_S = \pm 60\text{ V}$, $\text{GND} = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = \text{floating}$	25°C		± 0.6		μA
			-40°C to $+85^\circ\text{C}$		± 1.2		
			-40°C to $+125^\circ\text{C}$		± 2.2		

6.6 ±15 V Dual Supply: Electrical Characteristics (continued)

$V_{DD} = +15\text{ V} \pm 10\%$, $V_{SS} = -15\text{ V} \pm 10\%$, $GND = 0\text{ V}$ (unless otherwise noted)

Typical at $V_{DD} = +15\text{ V}$, $V_{SS} = -15\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
SWITCHING CHARACTERISTICS							
t_{RESPONSE}	Fault response time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $R_L = 300\ \Omega$, $C_L = 12\text{ pF}$	25°C	100	350		ns
			-40°C to +85°C			380	
			-40°C to +125°C			400	
t_{RECOVERY}	Fault recovery time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $R_L = 300\ \Omega$, $C_L = 12\text{ pF}$	25°C	1600	4500		ns
			-40°C to +85°C			4800	
			-40°C to +125°C			4800	
$t_{\text{RESPONSE(FLAG)}}$	Fault flag response time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $V_{PU} = 5\text{ V}$, $R_{PU} = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	25°C		250		ns
$t_{\text{RECOVERY(FLAG)}}$	Fault flag recovery time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $V_{PU} = 5\text{ V}$, $R_{PU} = 1\text{ k}\Omega$, $C_L = 15\text{ pF}$	25°C		1.2		μs
$t_{\text{RESPONSE(DR)}}$	Fault output response time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $V_{PU} = 5\text{ V}$, $C_L = 12\text{ pF}$	25°C		2.7		μs
X_{TALK}	Intra-channel crosstalk	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 0\text{ V}$, $f = 1\text{ MHz}$	25°C		-100		dB
BW	-3 dB bandwidth (WQFN Package)	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 0\text{ V}$	25°C		650		MHz
BW	-3 dB bandwidth (TSSOP Package)	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 0\text{ V}$	25°C		580		MHz
I_{LOSS}	Insertion loss	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 0\text{ V}$, $f = 1\text{ MHz}$	25°C		-0.7		dB
THD+N	Total harmonic distortion plus noise	$R_S = 50\ \Omega$, $R_L = 10\text{ k}\Omega$, $V_S = 15\text{ V}_{\text{PP}}$, $V_{\text{BIAS}} = 0\text{ V}$, $f = 20\text{ Hz to } 20\text{ kHz}$	25°C		0.0006		%
$C_{\text{S(ON)}}$, $C_{\text{D(ON)}}$	Input/Output on-capacitance	$f = 1\text{ MHz}$, $V_S = 0\text{ V}$	25°C		14		pF
POWER SUPPLY							
I_{DD}	V_{DD} supply current	$V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.32	0.5		mA
			-40°C to +85°C			0.5	
			-40°C to +125°C			0.6	
I_{SS}	V_{SS} supply current	$V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.26	0.4		mA
			-40°C to +85°C			0.4	
			-40°C to +125°C			0.5	
I_{GND}	GND current	$V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		0.06		mA
I_{FP}	V_{FP} supply current	$V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA
I_{FN}	V_{FN} supply current	$V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA
$I_{\text{DD(FA)}}$	V_{DD} supply current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.27	0.5		mA
			-40°C to +85°C			0.5	
			-40°C to +125°C			0.6	
$I_{\text{SS(FA)}}$	V_{SS} supply current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.2	0.3		mA
			-40°C to +85°C			0.3	
			-40°C to +125°C			0.4	
$I_{\text{GND(FA)}}$	GND current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		0.15		mA
$I_{\text{FP(FA)}}$	V_{FP} supply current under fault	$V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA
$I_{\text{FN(FA)}}$	V_{FN} supply current under fault	$V_{\text{DD}} = V_{\text{FP}} = 16.5\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -16.5\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA

(1) When V_S is at a voltage potential, V_D is floating, or when V_D is at a voltage potential, V_S is floating.

6.7 ±20 V Dual Supply: Electrical Characteristics

$V_{DD} = +20\text{ V} \pm 10\%$, $V_{SS} = -20\text{ V} \pm 10\%$, GND = 0 V (unless otherwise noted)

Typical at $V_{DD} = +20\text{ V}$, $V_{SS} = -20\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
ANALOG SWITCH							
R_{ON}	On-resistance	$V_S = -15\text{ V to } +15\text{ V}$ $I_D = -10\text{ mA}$	25°C	8.3	10.5		Ω
			-40°C to +85°C			14	
			-40°C to +125°C			17	
ΔR_{ON}	On-resistance mismatch between channels	$V_S = -15\text{ V to } +15\text{ V}$ $I_D = -10\text{ mA}$	25°C	0.05	0.35		Ω
			-40°C to +85°C			0.5	
			-40°C to +125°C			0.5	
R_{FLAT}	On-resistance flatness	$V_S = -15\text{ V to } +15\text{ V}$ $I_D = -10\text{ mA}$	25°C	0.006	0.4		Ω
			-40°C to +85°C			0.5	
			-40°C to +125°C			0.5	
R_{ON_DRIFT}	On-resistance drift	$V_S = 0\text{ V}$, $I_S = -10\text{ mA}$	-40°C to +125°C	0.04			$\Omega/^\circ\text{C}$
$I_{S(ON)}$, $I_{D(ON)}$	Channel on leakage current ⁽¹⁾	Switch state is on, $V_{DD} = 22\text{ V}$, $V_{SS} = -22\text{ V}$ $V_S = V_D = \pm 15\text{ V}$	25°C	-0.7	0.1	0.7	nA
			-40°C to +85°C	-2		2	
			-40°C to +125°C	-15		15	
FAULT CONDITION							
$I_{S(FA)}$	Input leakage current during overvoltage	$V_S = \pm 60\text{ V}$, GND = 0 V, $V_{DD} = V_{FP} = 22\text{ V}$, $V_{SS} = V_{FN} = -22\text{ V}$	-40°C to +125°C		±95		μA
$I_{S(FA)\text{ Grounded}}$	Input leakage current during overvoltage with grounded supply voltages	$V_S = \pm 60\text{ V}$, GND = 0V, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = 0\text{ V}$	-40°C to +125°C		±135		μA
$I_{S(FA)\text{ Floating}}$	Input leakage current during overvoltage with floating supply voltages	$V_S = \pm 60\text{ V}$, GND = 0V, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = \text{floating}$	-40°C to +125°C		±140		μA
$I_{D(FA)}$	Output leakage current during overvoltage	$V_S = \pm 60\text{ V}$, GND = 0 V, $V_{DD} = V_{FP} = 22\text{ V}$, $V_{SS} = V_{FN} = -22\text{ V}$, $V_{DR} = 5\text{ V}$ or floating	25°C	-50	±10	50	nA
			-40°C to +85°C	-70		70	nA
			-40°C to +125°C	-90		90	nA
$I_{D(FA)\text{ Grounded}}$	Output leakage current during overvoltage with grounded supply voltages	$V_S = \pm 60\text{ V}$, GND = 0 V, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = 0\text{ V}$	25°C	-700	±500	700	nA
			-40°C to +85°C	-700		700	nA
			-40°C to +125°C	-700		700	nA
$I_{D(FA)\text{ Floating}}$	Output leakage current during overvoltage with floating supply voltages	$V_S = \pm 60\text{ V}$, GND = 0 V, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = \text{floating}$	25°C		±0.6		μA
			-40°C to +85°C		±1.3		μA
			-40°C to +125°C		±2.3		μA

6.7 ±20 V Dual Supply: Electrical Characteristics (continued)

$V_{DD} = +20\text{ V} \pm 10\%$, $V_{SS} = -20\text{ V} \pm 10\%$, $GND = 0\text{ V}$ (unless otherwise noted)
Typical at $V_{DD} = +20\text{ V}$, $V_{SS} = -20\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
SWITCHING CHARACTERISTICS							
t_{RESPONSE}	Fault response time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $R_L = 300\ \Omega$, $C_L = 12\text{ pF}$	25°C	150	400		ns
			-40°C to +85°C		430		
			-40°C to +125°C		450		
t_{RECOVERY}	Fault recovery time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $R_L = 300\ \Omega$, $C_L = 12\text{ pF}$	25°C	1100	4500		ns
			-40°C to +85°C		4900		
			-40°C to +125°C		4900		
$t_{\text{RESPONSE(FLAG)}}$	Fault flag response time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $V_{PU} = 5\text{ V}$, $R_{PU} = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	-40°C to +125°C		220		ns
$t_{\text{RECOVERY(FLAG)}}$	Fault flag recovery time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $V_{PU} = 5\text{ V}$, $R_{PU} = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	-40°C to +125°C		1.1		μs
$t_{\text{RESPONSE(DR)}}$	Fault output response time	$V_{FP} = 10\text{ V}$, $V_{FN} = -10\text{ V}$, $V_{PU} = 5\text{ V}$, $C_L = 12\text{ pF}$	-40°C to +125°C		2.7		μs
X_{TALK}	Intra-channel crosstalk	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 0\text{ V}$, $f = 1\text{ MHz}$	25°C		-100		dB
BW	-3 dB bandwidth (WQFN Package)	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 0\text{ V}$	25°C		650		MHz
BW	-3 dB bandwidth (TSSOP Package)	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 0\text{ V}$	25°C		590		MHz
I_{LOSS}	Insertion loss	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 0\text{ V}$, $f = 1\text{ MHz}$	25°C		-0.7		dB
THD+N	Total harmonic distortion plus noise	$R_S = 50\ \Omega$, $R_L = 10\text{ k}\Omega$, $V_S = 20\text{ V}_{\text{PP}}$, $V_{\text{BIAS}} = 0\text{ V}$, $f = 20\text{ Hz to } 20\text{ kHz}$	25°C		0.0006		%
$C_{\text{S(ON)}}$, $C_{\text{D(ON)}}$	Input/Output on-capacitance	$f = 1\text{ MHz}$, $V_S = 0\text{ V}$	25°C		14		pF
POWER SUPPLY							
I_{DD}	V_{DD} supply current	$V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.32	0.5		mA
			-40°C to +85°C		0.5		
			-40°C to +125°C		0.6		
I_{SS}	V_{SS} supply current	$V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.26	0.4		mA
			-40°C to +85°C		0.4		
			-40°C to +125°C		0.5		
I_{GND}	GND current	$V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		0.07		mA
I_{FP}	V_{FP} supply current	$V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA
I_{FN}	V_{FN} supply current	$V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA
$I_{\text{DD(FA)}}$	V_{DD} supply current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.27	0.5		mA
			-40°C to +85°C		0.5		
			-40°C to +125°C		0.6		
$I_{\text{SS(FA)}}$	V_{SS} supply current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.2	0.3		mA
			-40°C to +85°C		0.3		
			-40°C to +125°C		0.4		
$I_{\text{GND(FA)}}$	GND current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		0.15		mA
$I_{\text{FP(FA)}}$	V_{FP} supply current under fault	$V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA
$I_{\text{FN(FA)}}$	V_{FN} supply current under fault	$V_{\text{DD}} = V_{\text{FP}} = 22\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = -22\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA

(1) When V_S is at a voltage potential, V_D is floating, or when V_D is at a voltage potential, V_S is floating.

6.8 12 V Single Supply: Electrical Characteristics

$V_{DD} = +12\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $GND = 0\text{ V}$ (unless otherwise noted)

Typical at $V_{DD} = +12\text{ V}$, $V_{SS} = 0\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
ANALOG SWITCH							
R_{ON}	On-resistance	$V_S = 0\text{ V to } 7.8\text{ V}$, $I_S = -10\text{ mA}$	25°C		8.3	11	Ω
		$V_S = 0\text{ V to } 7.8\text{ V}$, $I_S = -10\text{ mA}$	-40°C to +85°C			15	Ω
		$V_S = 0\text{ V to } 7.8\text{ V}$, $I_S = -10\text{ mA}$	-40°C to +125°C			18	Ω
ΔR_{ON}	On-resistance mismatch between channels	$V_S = 0\text{ V to } 7.8\text{ V}$, $I_S = -10\text{ mA}$	25°C		0.05	0.5	Ω
			-40°C to +85°C			0.6	
			-40°C to +125°C			0.7	
R_{FLAT}	On-resistance flatness	$V_S = 0\text{ V to } 7.8\text{ V}$, $I_S = -10\text{ mA}$	25°C		0.05	0.4	Ω
			-40°C to +85°C			0.5	
			-40°C to +125°C			0.5	
R_{ON_DRIFT}	On-resistance drift	$V_S = 6\text{ V}$, $I_S = -10\text{ mA}$	-40°C to +125°C		0.04		$\Omega/^\circ\text{C}$
$I_{S(ON)}$, $I_{D(ON)}$	Output on leakage current ⁽¹⁾	Switch state is on, $V_{DD} = 13.2\text{ V}$, $V_{SS} = 0\text{ V}$, $V_S = V_D = 1\text{ V/ } 10\text{ V}$,	25°C	-0.7	0.1	0.7	nA
			-40°C to +85°C	-2		2	
			-40°C to +125°C	-14		14	
FAULT CONDITION							
$I_{S(FA)}$	Input leakage current during overvoltage	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{FP} = 13.2\text{ V}$, $V_{SS} = V_{FN} = 0\text{ V}$,	-40°C to +125°C		± 145		μA
$I_{S(FA)} \text{ Grounded}$	Input leakage current during overvoltage with grounded supply voltages	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = 0\text{ V}$	-40°C to +125°C		± 135		μA
$I_{S(FA)} \text{ Floating}$	Input leakage current during overvoltage with floating supply voltages	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = \text{floating}$	-40°C to +125°C		± 140		μA
$I_{D(FA)}$	Output leakage current during overvoltage	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{FP} = 13.2\text{ V}$, $V_{SS} = V_{FN} = 0\text{ V}$, $V_{DR} = 5\text{ V or floating}$	25°C	-20	± 2	20	nA
			-40°C to +85°C	-30		30	
			-40°C to +125°C	-50		50	
$I_{D(FA)} \text{ Grounded}$	Output leakage current during overvoltage with grounded supply voltages	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = 0\text{ V}$	25°C	-30	± 10	30	nA
			-40°C to +85°C	-50		50	
			-40°C to +125°C	-90		90	
$I_{D(FA)} \text{ Floating}$	Output leakage current during overvoltage with floating supply voltages	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = \text{floating}$	25°C		± 0.6		μA
			-40°C to +85°C		± 1.3		
			-40°C to +125°C		± 2.3		

6.8 12 V Single Supply: Electrical Characteristics (continued)

 $V_{DD} = +12\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $GND = 0\text{ V}$ (unless otherwise noted)

 Typical at $V_{DD} = +12\text{ V}$, $V_{SS} = 0\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
SWITCHING CHARACTERISTICS							
t_{RESPONSE}	Fault response time	$V_{FP} = 8\text{ V}$, $V_{FN} = 0\text{ V}$, $R_L = 300\ \Omega$, $C_L = 12\text{ pF}$	25°C	500	600		ns
			–40°C to +85°C		650		
			–40°C to +125°C		700		
t_{RECOVERY}	Fault recovery time	$V_{FP} = 8\text{ V}$, $V_{FN} = 0\text{ V}$, $R_L = 300\ \Omega$, $C_L = 12\text{ pF}$	25°C	850	2400		ns
			–40°C to +85°C		2900		
			–40°C to +125°C		2900		
$t_{\text{RESPONSE(FLAG)}}$	Fault flag response time	$V_{FP} = 8\text{ V}$, $V_{FN} = 0\text{ V}$, $V_{PU} = 5\text{ V}$, $R_{PU} = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	–40°C to +125°C		110		ns
$t_{\text{RECOVERY(FLAG)}}$	Fault flag recovery time	$V_{FP} = 8\text{ V}$, $V_{FN} = 0\text{ V}$, $V_{PU} = 5\text{ V}$, $R_{PU} = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	–40°C to +125°C		0.8		μs
$t_{\text{RESPONSE(DR)}}$	Fault output response time	$V_{FP} = 8\text{ V}$, $V_{FN} = 0\text{ V}$, $R_L = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	–40°C to +125°C		3		μs
X_{TALK}	Inter-channel crosstalk	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 2\text{ V}$, $f = 1\text{ MHz}$	25°C		–100		dB
BW	–3 dB bandwidth (WQFN Package)	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 2\text{ V}$	25°C		620		MHz
BW	–3 dB bandwidth (TSSOP Package)	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 2\text{ V}$	25°C		560		MHz
I_{LOSS}	Insertion loss	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 2\text{ V}$, $f = 1\text{ MHz}$	25°C		–0.7		dB
THD+N	Total harmonic distortion plus noise	$R_S = 50\ \Omega$, $R_L = 10\text{ k}\Omega$, $V_S = 6\text{ V}_{\text{PP}}$, $V_{\text{BIAS}} = 6\text{ V}$, $f = 20\text{ Hz to } 20\text{ kHz}$	25°C		0.0007		%
$C_{\text{S(ON)}}$, $C_{\text{D(ON)}}$	Input/Output on-capacitance	$f = 1\text{ MHz}$, $V_S = 6\text{ V}$	25°C		16		pF
POWER SUPPLY							
I_{DD}	V_{DD} supply current	$V_{\text{DD}} = V_{\text{FP}} = 13.2\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}, 5\text{ V}, \text{ or } V_{\text{DD}}$	25°C	0.3	0.5		mA
			–40°C to +85°C		0.5		mA
			–40°C to +125°C		0.6		mA
I_{GND}	GND current	$V_{\text{DD}} = V_{\text{FP}} = 13.2\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}, 5\text{ V}, \text{ or } V_{\text{DD}}$	25°C		0.06		mA
I_{FP}	V_{FP} supply current	$V_{\text{DD}} = V_{\text{FP}} = 13.2\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}, 5\text{ V}, \text{ or } V_{\text{DD}}$	25°C		10		μA
I_{FN}	V_{FN} supply current	$V_{\text{DD}} = V_{\text{FP}} = 13.2\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}, 5\text{ V}, \text{ or } V_{\text{DD}}$	25°C		10		μA
$I_{\text{DD(FA)}}$	V_{DD} supply current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 13.2\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}, 5\text{ V}, \text{ or } V_{\text{DD}}$	25°C	0.32	0.5		mA
			–40°C to +85°C		0.5		mA
			–40°C to +125°C		0.6		mA
$I_{\text{GND(FA)}}$	GND current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 13.2\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}, 5\text{ V}, \text{ or } V_{\text{DD}}$	25°C		0.16		mA
$I_{\text{FP(FA)}}$	V_{FP} supply current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 13.2\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}, 5\text{ V}, \text{ or } V_{\text{DD}}$	25°C		10		μA
$I_{\text{FN(FA)}}$	V_{FN} supply current under fault	$V_S = \pm 60\text{ V}$, $V_{\text{DD}} = V_{\text{FP}} = 13.2\text{ V}$, $V_{\text{SS}} = V_{\text{FN}} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}, 5\text{ V}, \text{ or } V_{\text{DD}}$	25°C		10		μA

 (1) When V_S is at a voltage potential, V_D is floating, or when V_D is at a voltage potential, V_S is floating.

6.9 36 V Single Supply: Electrical Characteristics

$V_{DD} = +36\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $GND = 0\text{ V}$ (unless otherwise noted)

Typical at $V_{DD} = +36\text{ V}$, $V_{SS} = 0\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
ANALOG SWITCH							
R_{ON}	On-resistance	$V_S = 0\text{ V to }30\text{ V}$, $I_S = -10\text{ mA}$	25°C	8.3	11		Ω
			-40°C to +85°C			14	
			-40°C to +125°C			17	
ΔR_{ON}	On-resistance mismatch between channels	$V_S = 0\text{ V to }30\text{ V}$, $I_S = -10\text{ mA}$	25°C	0.05	0.5		Ω
			-40°C to +85°C			0.6	
			-40°C to +125°C			0.7	
R_{FLAT}	On-resistance flatness	$V_S = 0\text{ V to }30\text{ V}$, $I_S = -10\text{ mA}$	25°C	0.06	0.9		Ω
			-40°C to +85°C			1.1	
			-40°C to +125°C			1.3	
R_{ON_DRIFT}	On-resistance drift	$V_S = 18\text{ V}$, $I_S = -10\text{ mA}$	-40°C to +125°C	0.04			$\Omega/^\circ\text{C}$
$I_{S(ON)}$, $I_{D(ON)}$	Output on leakage current ⁽¹⁾	Switch state is on, $V_{DD} = 39.6\text{ V}$, $V_{SS} = 0\text{ V}$, $V_S = V_D = 1\text{ V}/30\text{ V}$	25°C	-0.7	0.2	0.7	nA
			-40°C to +85°C	-2		2	
			-40°C to +125°C	-15		15	
FAULT CONDITION							
$I_{S(FA)}$	Input leakage current during overvoltage	$V_S = 60 / -40\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{FP} = 39.6\text{ V}$, $V_{SS} = V_{FN} = 0\text{ V}$	-40°C to +125°C		±98		μA
$I_{S(FA)\text{ Grounded}}$	Input leakage current during overvoltage with grounded supply voltages	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = 0\text{ V}$	-40°C to +125°C		±135		μA
$I_{S(FA)\text{ Floating}}$	Input leakage current during overvoltage with floating supply voltages	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = \text{floating}$	-40°C to +125°C		±140		μA
$I_{D(FA)}$	Output leakage current during overvoltage	$V_S = 60 / -40\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{FP} = 39.2\text{ V}$, $V_{SS} = V_{FN} = 0\text{ V}$, $V_{DR} = 5\text{ V}$ or floating	25°C	-20	±2	20	nA
			-40°C to +85°C	-30		30	
			-40°C to +125°C	-50		50	
$I_{D(FA)\text{ Grounded}}$	Output leakage current during overvoltage with grounded supply voltages	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = 0\text{ V}$	25°C	-30	±10	30	nA
			-40°C to +85°C	-50		50	
			-40°C to +125°C	-90		90	
$I_{D(FA)\text{ Floating}}$	Output leakage current during overvoltage with floating supply voltages	$V_S = \pm 60\text{ V}$, $GND = 0\text{ V}$, $V_{DD} = V_{SS} = V_{FP} = V_{FN} = \text{floating}$	25°C		±0.6		μA
			-40°C to +85°C		±1.3		
			-40°C to +125°C		±2.3		

6.9 36 V Single Supply: Electrical Characteristics (continued)

$V_{DD} = +36\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $GND = 0\text{ V}$ (unless otherwise noted)

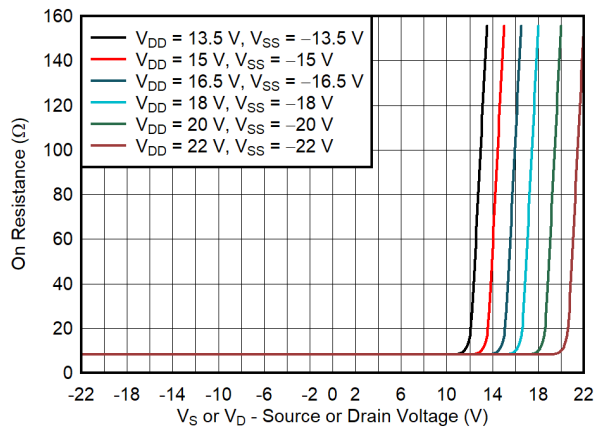
Typical at $V_{DD} = +36\text{ V}$, $V_{SS} = 0\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
SWITCHING CHARACTERISTICS							
t_{RESPONSE}	Fault response time	$V_{FP} = 18\text{ V}$, $V_{FN} = 0\text{ V}$, $R_L = 300\ \Omega$, $C_L = 12\text{ pF}$	25°C	150	310		ns
			-40°C to +85°C		330		
			-40°C to +125°C		350		
t_{RECOVERY}	Fault recovery time	$V_{FP} = 18\text{ V}$, $V_{FN} = 0\text{ V}$, $R_L = 300\ \Omega$, $C_L = 12\text{ pF}$	25°C	1100	2200		ns
			-40°C to +85°C		2700		
			-40°C to +125°C		2700		
$t_{\text{RESPONSE(FLAG)}}$	Fault flag response time	$V_{FP} = 18\text{ V}$, $V_{FN} = 0\text{ V}$, $V_{PU} = 5\text{ V}$, $R_{PU} = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	-40°C to +125°C		110		ns
$t_{\text{RECOVERY(FLAG)}}$	Fault flag recovery time	$V_{FP} = 18\text{ V}$, $V_{FN} = 0\text{ V}$, $V_{PU} = 5\text{ V}$, $R_{PU} = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	-40°C to +125°C		0.8		μs
$t_{\text{RESPONSE(DR)}}$	Fault output response time	$V_{FP} = 8\text{ V}$, $V_{FN} = 0\text{ V}$, $R_L = 1\text{ k}\Omega$, $C_L = 12\text{ pF}$	-40°C to +125°C		2.7		μs
X_{TALK}	Inter-channel crosstalk	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 2\text{ V}$, $f = 1\text{ MHz}$	25°C		-100		dB
BW	-3 dB bandwidth (WQFN Package)	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 2\text{ V}$	25°C		600		MHz
BW	-3 dB bandwidth (TSSOP Package)	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 2\text{ V}$	25°C		580		MHz
I_{LOSS}	Insertion loss	$R_S = 50\ \Omega$, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $V_S = 200\text{ mV}_{\text{RMS}}$, $V_{\text{BIAS}} = 2\text{ V}$, $f = 1\text{ MHz}$	25°C		-0.7		dB
THD+N	Total harmonic distortion plus noise	$R_S = 50\ \Omega$, $R_L = 10\text{ k}\Omega$, $V_S = 18\text{ V}_{\text{PP}}$, $V_{\text{BIAS}} = 18\text{ V}$, $f = 20\text{ Hz}$ to 20 kHz	25°C		0.0006		%
$C_{\text{S(ON)}}$, $C_{\text{D(ON)}}$	Input/Output on-capacitance	$f = 1\text{ MHz}$, $V_S = 18\text{ V}$	25°C		17		pF
POWER SUPPLY							
I_{DD}	V_{DD} supply current	$V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.3	0.5		mA
			-40°C to +85°C		0.5		
			-40°C to +125°C		0.6		
I_{SS}	V_{SS} supply current	$V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		0.25		mA
I_{GND}	GND current	$V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 5\text{ V}$, or V_{DD}	25°C		0.07		mA
I_{FP}	V_{FP} supply current	$V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 5\text{ V}$, or V_{DD}	25°C		10		μA
I_{FN}	V_{FN} supply current	$V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 5\text{ V}$, or V_{DD}	25°C		10		μA
$I_{\text{DD(FA)}}$	V_{DD} supply current under fault	$V_S = 60 / -40\text{ V}$, $V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C	0.32	0.5		mA
			-40°C to +85°C		0.5		
			-40°C to +125°C		0.6		
$I_{\text{SS(FA)}}$	V_{SS} supply current under fault	$V_S = 60 / -40\text{ V}$, $V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		0.18		mA
$I_{\text{GND(FA)}}$	GND current under fault	$V_S = 60 / -40\text{ V}$, $V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		0.12		mA
$I_{\text{FP(FA)}}$	V_{FP} supply current under fault	$V_S = 60 / -40\text{ V}$, $V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA
$I_{\text{FN(FA)}}$	V_{FN} supply current under fault	$V_S = 60 / -40\text{ V}$, $V_{\text{DD}} = V_{FP} = 39.6\text{ V}$, $V_{\text{SS}} = V_{FN} = 0\text{ V}$, $V_{\text{DR}} = 0\text{ V}$, 5 V , or V_{DD}	25°C		10		μA

(1) When V_S is at a voltage potential, V_D is floating, or when V_D is at a voltage potential, V_S is floating.

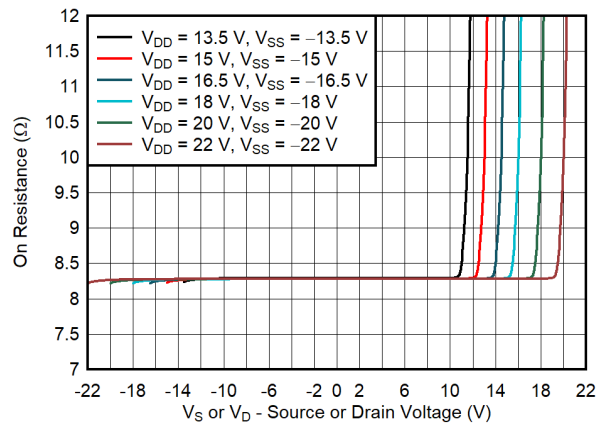
6.10 Typical Characteristics

at $T_A = 25^\circ\text{C}$, $V_{DD} = 15\text{ V}$, and $V_{SS} = -15\text{ V}$ (unless otherwise noted)



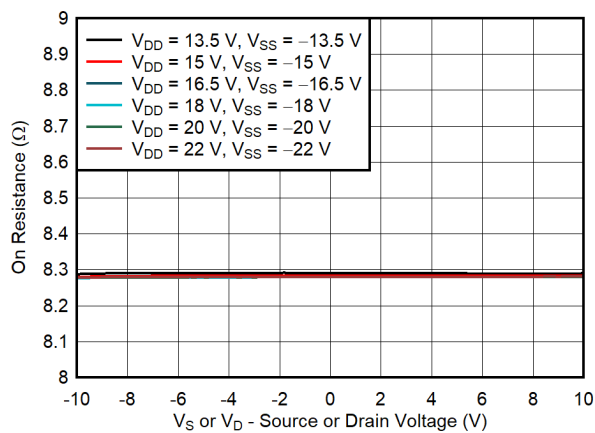
Dual Supply Voltages

Figure 6-1. On-Resistance vs Source or Drain Voltage



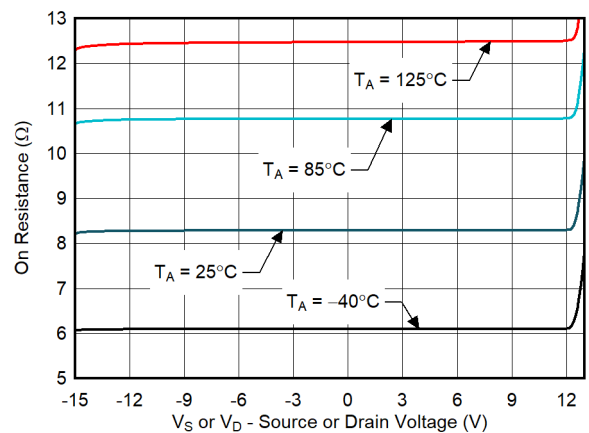
Dual Supply Flat Ron Region

Figure 6-2. On-Resistance vs Source or Drain Voltage



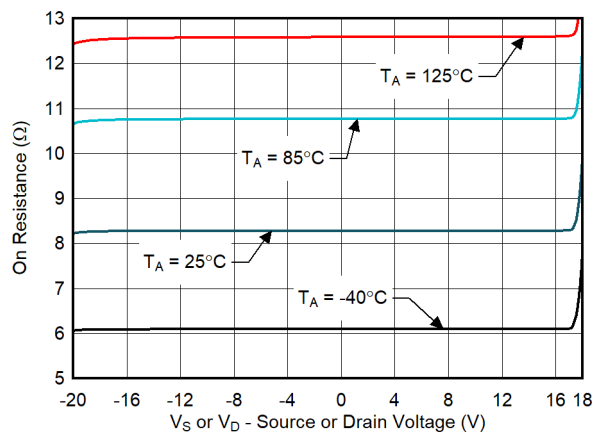
Flattest R_{ON} region for all supply voltages shown

Figure 6-3. On-Resistance vs Source or Drain Voltage



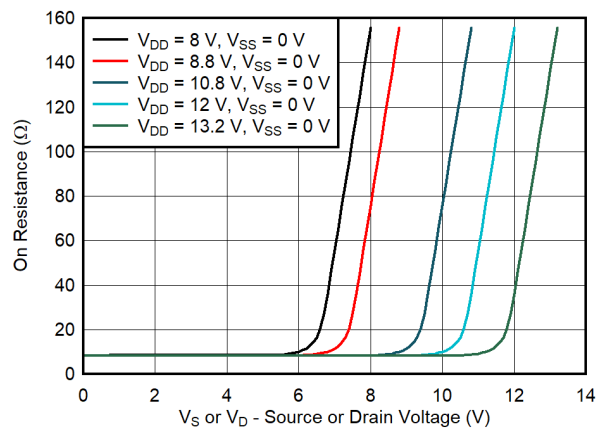
$\pm 15\text{ V}$ Supply Flattest Ron Region

Figure 6-4. On-Resistance vs Source or Drain Voltage



$\pm 20\text{ V}$ Supply Flattest Ron Region

Figure 6-5. On-Resistance vs Source or Drain Voltage

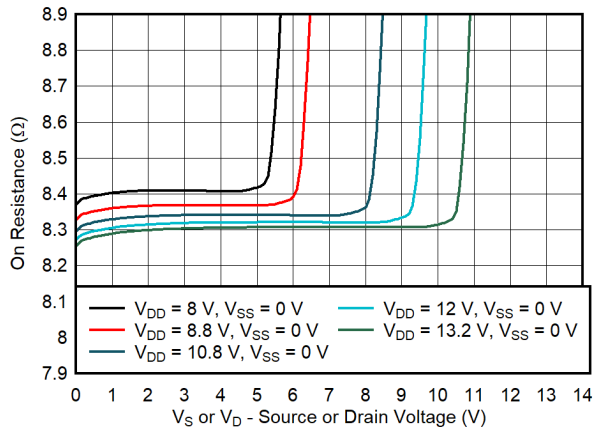


Single Supply Voltages

Figure 6-6. On-Resistance vs Source or Drain Voltage

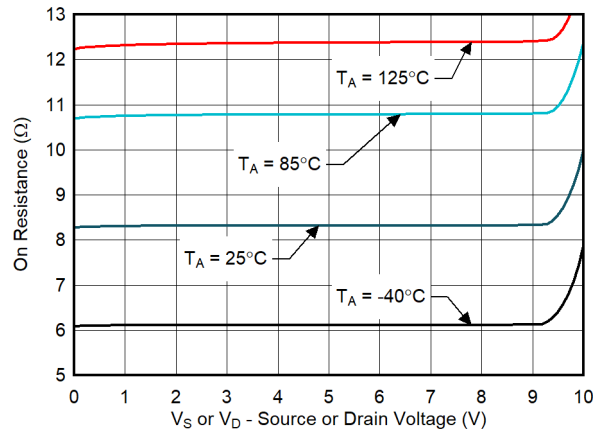
6.10 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 15\text{ V}$, and $V_{SS} = -15\text{ V}$ (unless otherwise noted)



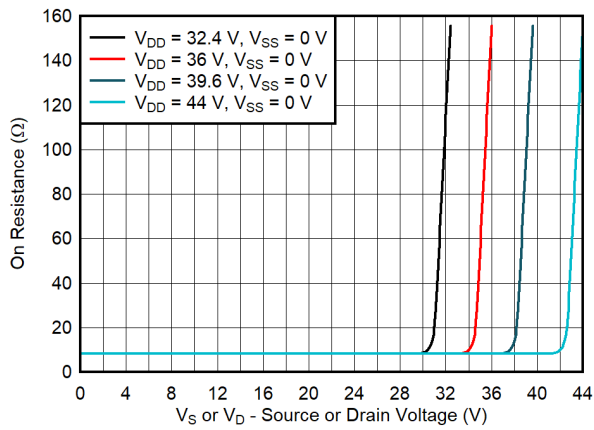
Single Supply Flat Ron Region

Figure 6-7. On-Resistance vs Source or Drain Voltage



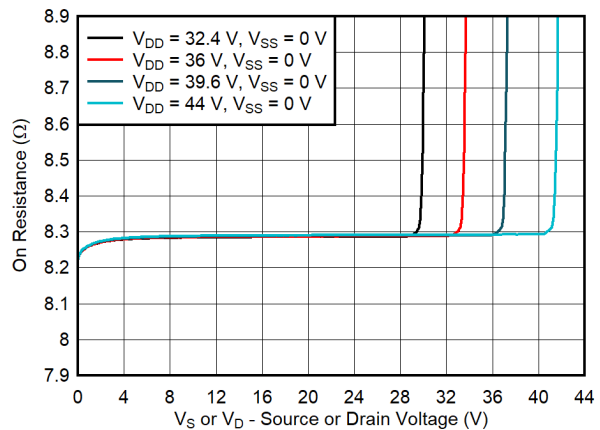
12 V V_{DD} Flattest Ron Region

Figure 6-8. On-Resistance vs Source or Drain Voltage



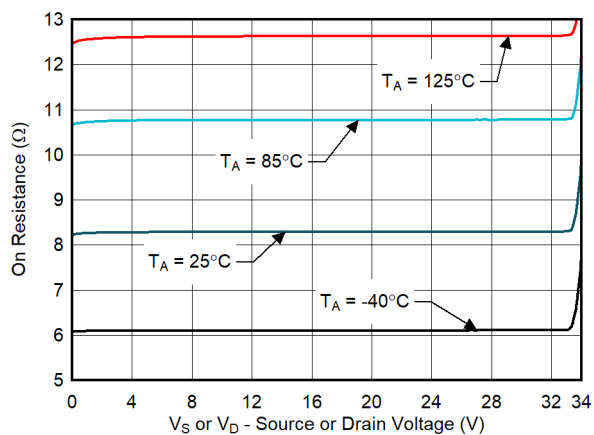
Single Supply Voltages

Figure 6-9. On-Resistance vs Source or Drain Voltage



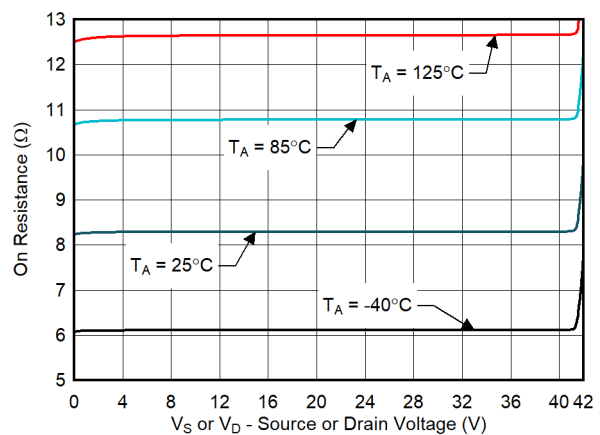
Single Supply Flat Ron Region

Figure 6-10. On-Resistance vs Source or Drain Voltage



36 V V_{DD} Flattest Ron Region

Figure 6-11. On-Resistance vs Source or Drain Voltage

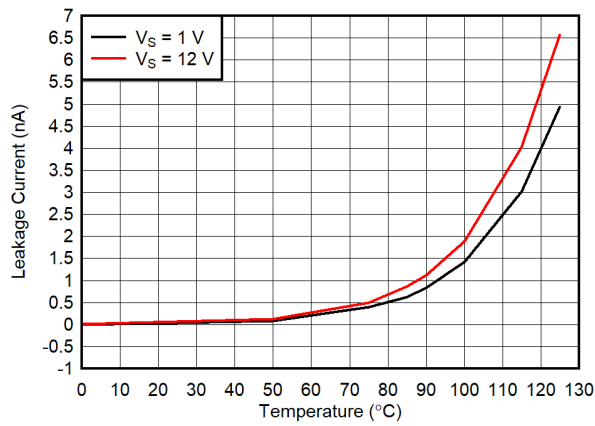


44 V V_{DD} Flattest Ron Region

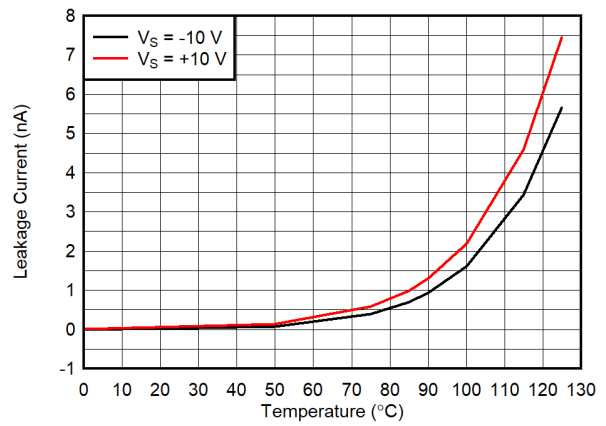
Figure 6-12. On-Resistance vs Source or Drain Voltage

6.10 Typical Characteristics (continued)

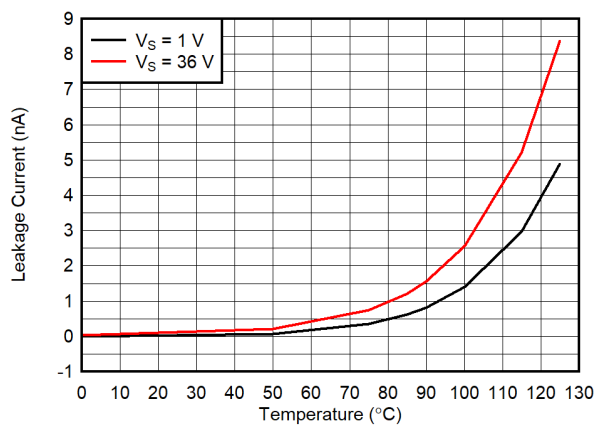
at $T_A = 25^\circ\text{C}$, $V_{DD} = 15\text{ V}$, and $V_{SS} = -15\text{ V}$ (unless otherwise noted)



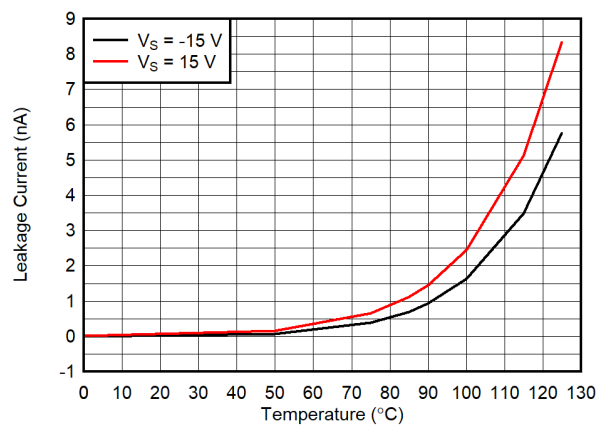
$V_{DD} = 12\text{ V}$, $V_{SS} = 0\text{ V}$
Figure 6-13. I_{ON} Leakage Current vs Temperature



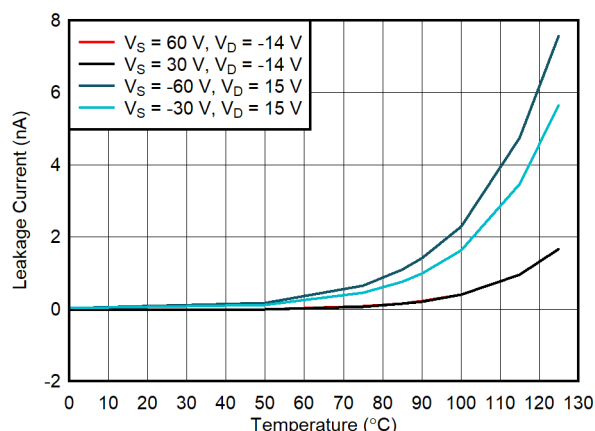
$V_{DD} = 15\text{ V}$, $V_{SS} = -15\text{ V}$
Figure 6-14. I_{ON} Leakage Current vs Temperature



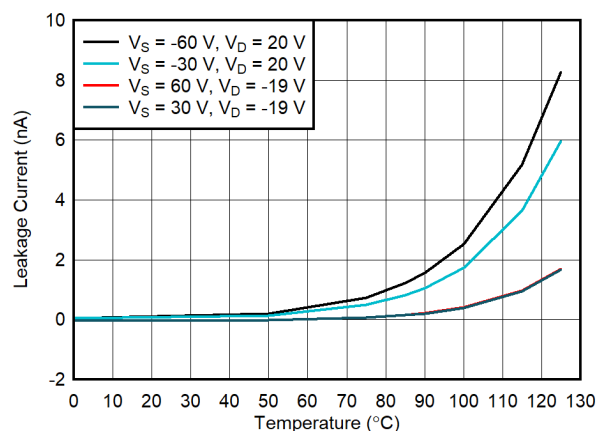
$V_{DD} = 36\text{ V}$, $V_{SS} = 0\text{ V}$
Figure 6-15. I_{ON} Leakage Current vs Temperature



$V_{DD} = +20\text{ V}$, $V_{SS} = -20\text{ V}$
Figure 6-16. I_{ON} Leakage Current vs Temperature



$\pm 15\text{ V}$ Dual Supply
Figure 6-17. $I_{D(FA)}$ Overvoltage Leakage Current vs Temperature



$\pm 20\text{ V}$ Dual Supply
Figure 6-18. $I_{D(FA)}$ Overvoltage Leakage Current vs Temperature

6.10 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 15\text{ V}$, and $V_{SS} = -15\text{ V}$ (unless otherwise noted)

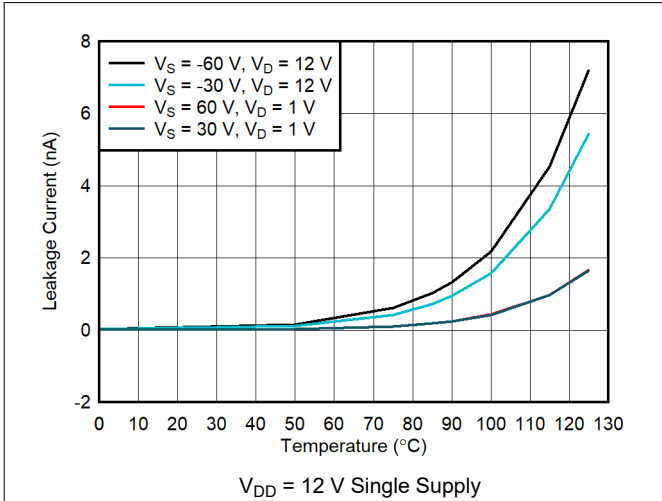


Figure 6-19. $I_{D(FA)}$ Overvoltage Leakage Current vs Temperature

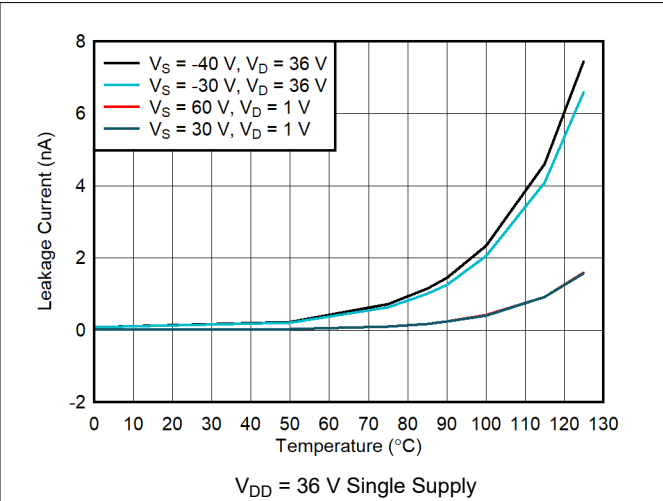


Figure 6-20. $I_{D(FA)}$ Overvoltage Leakage Current vs Temperature

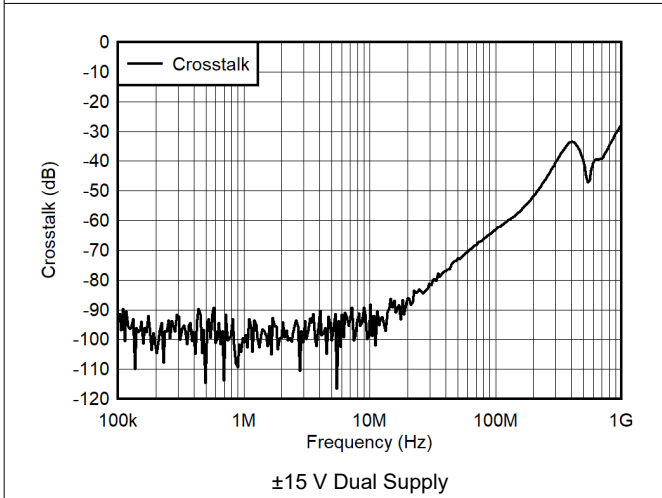


Figure 6-21. Crosstalk vs Frequency

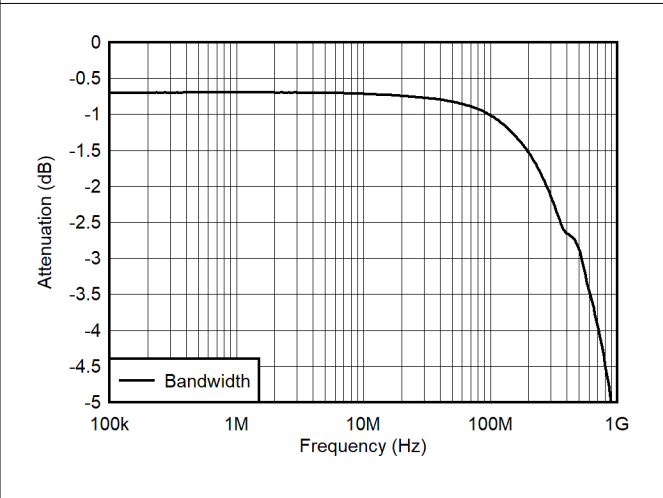
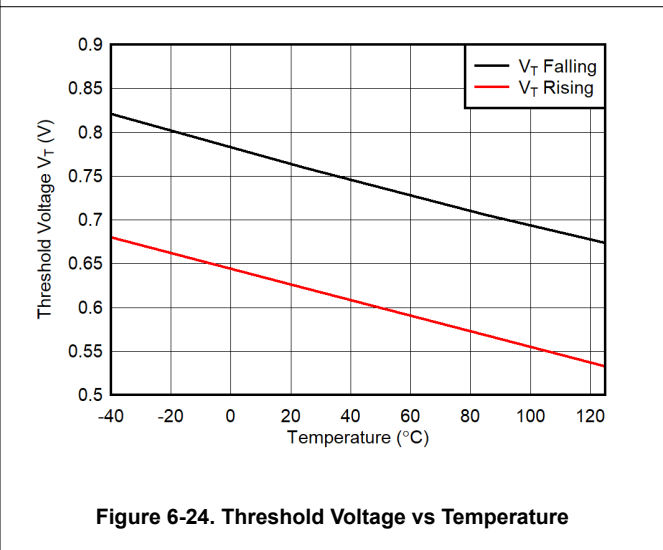
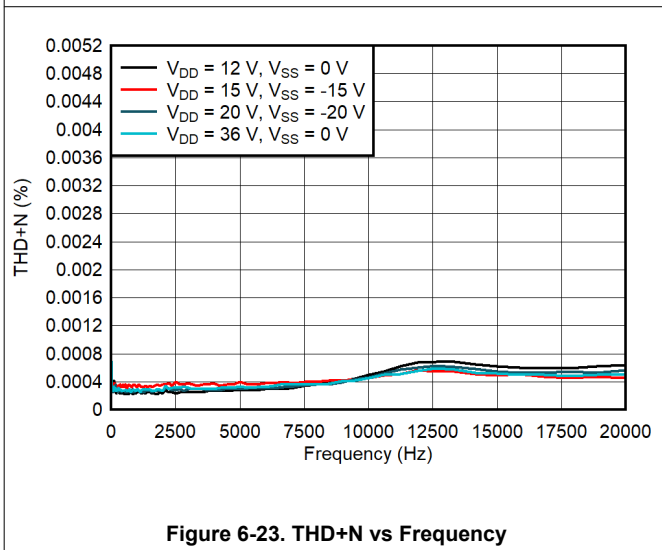
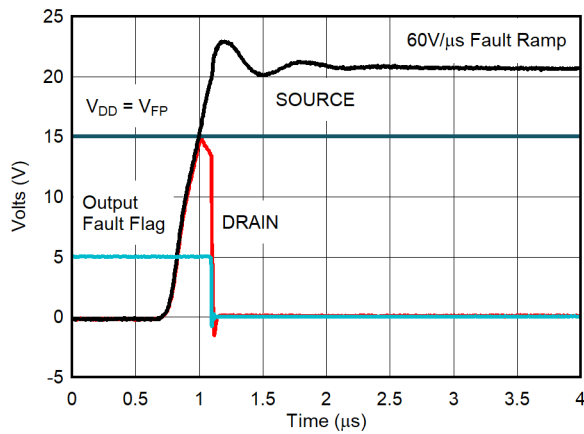


Figure 6-22. Insertion Loss vs Frequency



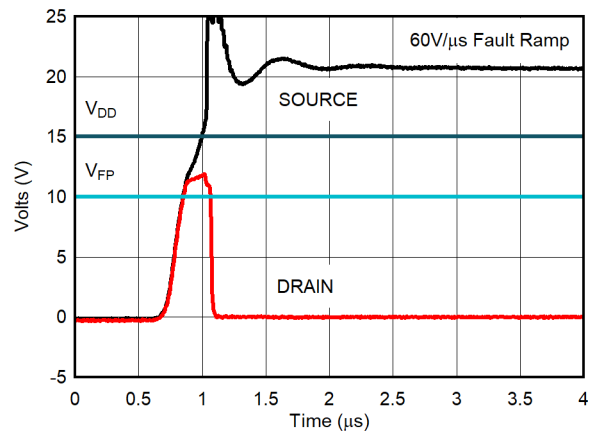
6.10 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 15\text{ V}$, and $V_{SS} = -15\text{ V}$ (unless otherwise noted)



$V_{DD} = V_{FP} = 15\text{ V}$

Figure 6-25. Drain Output Response - Positive Overvoltage



$V_{DD} = 15\text{ V}, V_{FP} = 10\text{ V}$

Figure 6-26. Drain Output Response - Positive Overvoltage

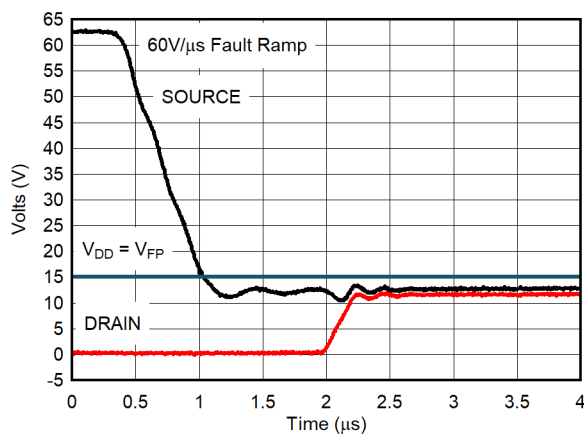


Figure 6-27. Drain Output Recovery - Positive Overvoltage

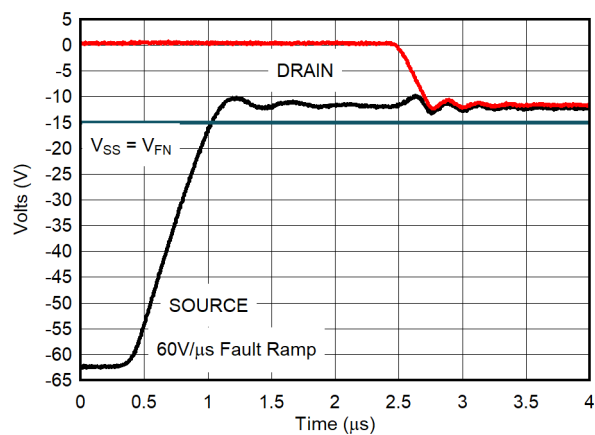


Figure 6-28. Drain Output Recovery - Negative Overvoltage

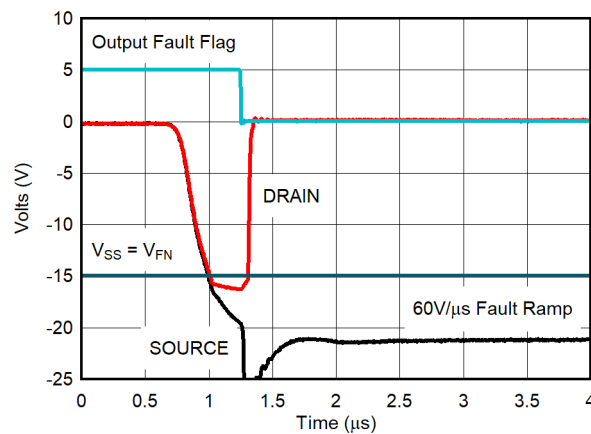


Figure 6-29. Drain Output Response - Negative Overvoltage

7 Parameter Measurement Information

7.1 On-Resistance

The TMUX7462F's on-resistance 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 7-1. ΔR_{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.

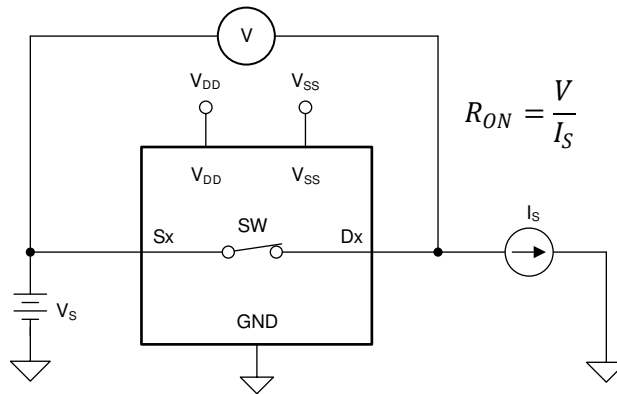


Figure 7-1. On-Resistance Measurement Setup

7.2 On-Leakage Current

Source on-leakage current ($I_{S(ON)}$) and drain on-leakage current ($I_{D(ON)}$) denotes 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 7-2 shows the circuit used for measuring the on-leakage currents.

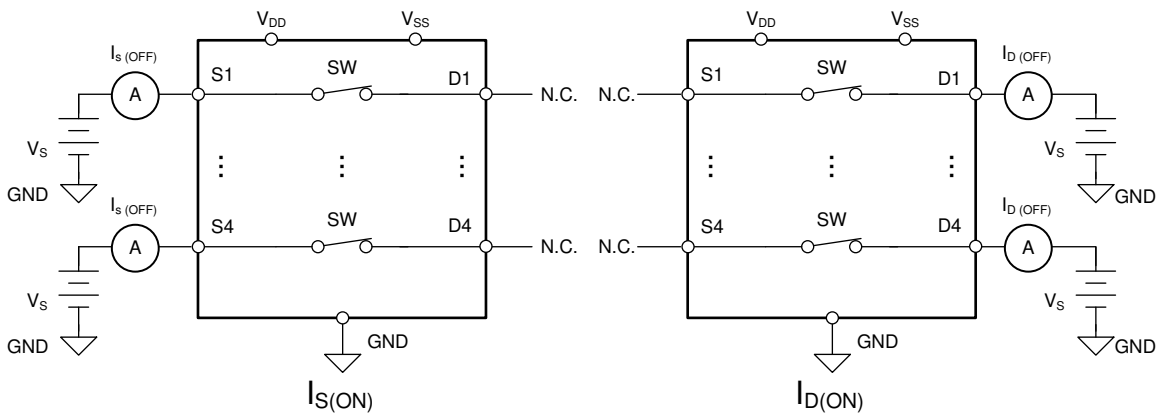


Figure 7-2. On-Leakage Measurement Setup

7.3 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}) by one threshold voltage (V_T), the TMUX7462F's overvoltage protection feature is triggered to turn off the switch under fault, keeping the fault channel in the high-impedance state. $I_{S(FA)}$ and $I_{D(FA)}$ denotes the input and output leakage current under overvoltage fault conditions, respectively. The supply (or supplies) can either be in normal operating condition (Figure 7-3) or abnormal operating condition (Figure 7-4) when the overvoltage fault occurs. The supply (or supplies) can either be unpowered ($V_{DD} = V_{SS} = V_{FN} = V_{FP} = 0$ V), floating ($V_{DD} = V_{SS} = V_{FN} = V_{FP} =$ No Connection), or at any level that is below the undervoltage (UV) threshold during abnormal operating conditions.

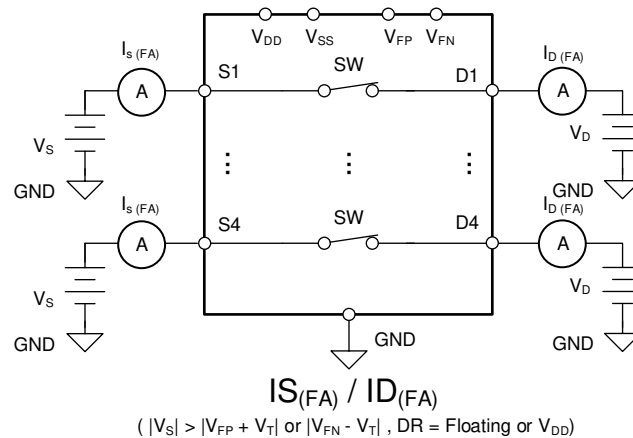


Figure 7-3. Measurement Setup for Input and Output Leakage Current Under Overvoltage Fault with Normal Supplies

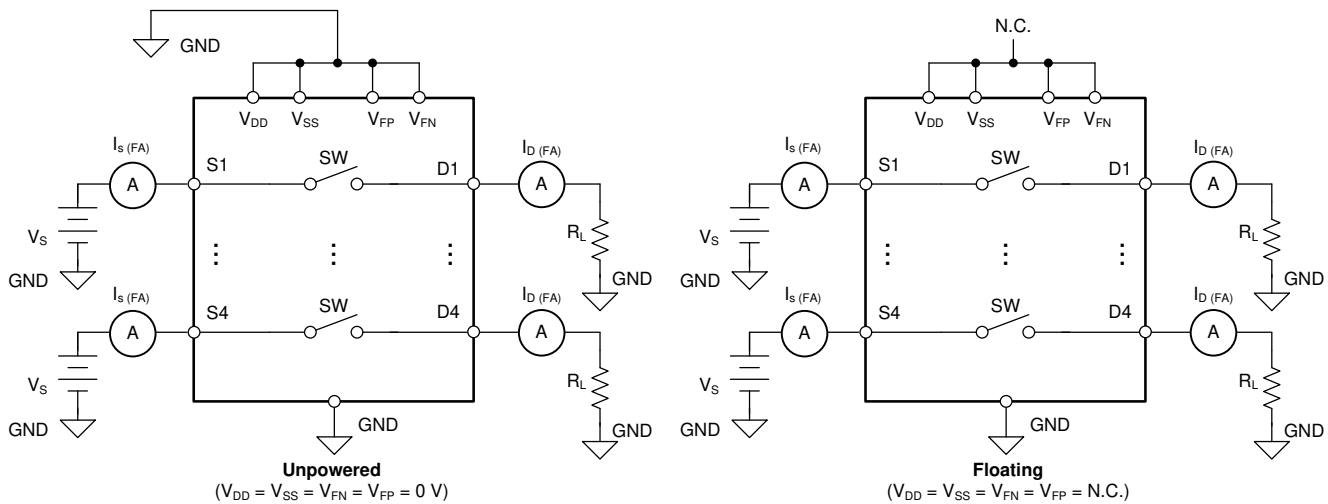


Figure 7-4. Measurement Setup for Input and Output Leakage Current Under Overvoltage Fault with Unpowered or Floating Supplies

7.4 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 90% of the fault supply voltage exceeded. Figure 7-5 shows the setup used to measure t_{RESPONSE} .

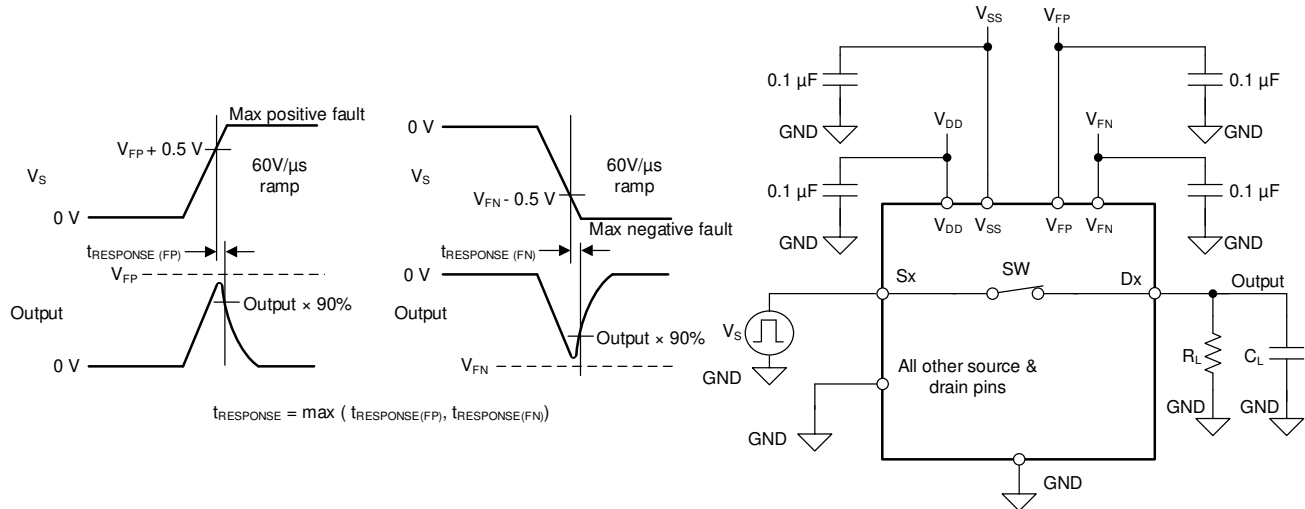


Figure 7-5. Fault Response Time Measurement Setup

7.5 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 0.5 V and the drain voltage rising from 0V to 50% of the fault supply voltage exceeded. Figure 7-6 shows the setup used to measure t_{RECOVERY} .

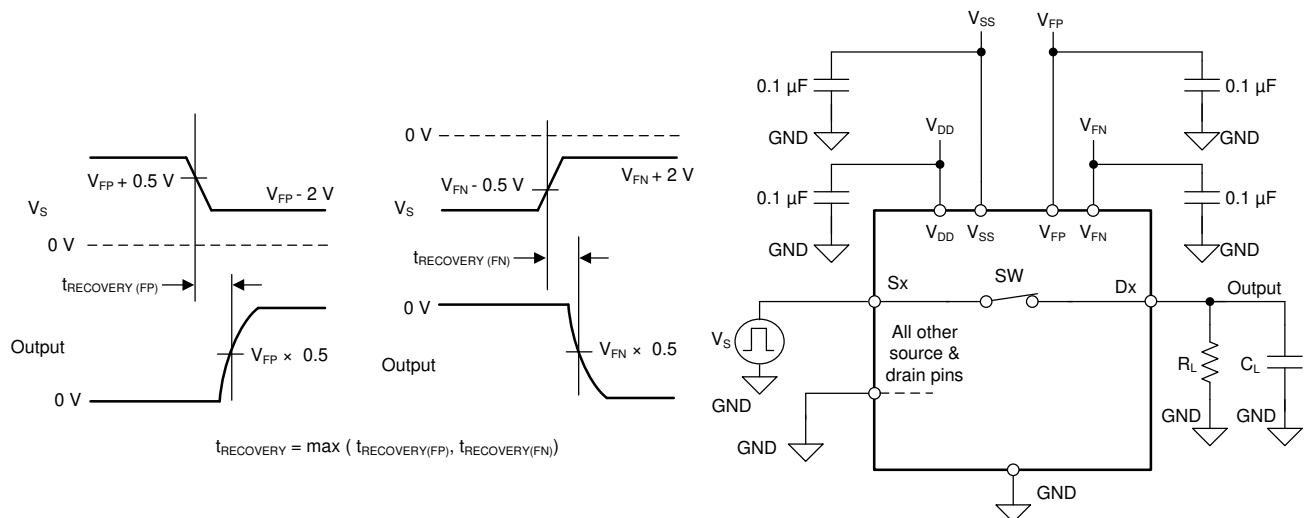


Figure 7-6. Fault Recovery Time Measurement Setup

7.6 Fault Flag Response Time

Fault flag response time ($t_{\text{RESPONSE(FLAG)}}$) measures the delay between the source voltage exceeding the fault supply voltage (V_{FP} or V_{FN}) by 0.5 V and the general fault flag (FF) pin to go below 10% of its original value. Figure 7-7 shows the setup used to measure $t_{\text{RESPONSE(FLAG)}}$.

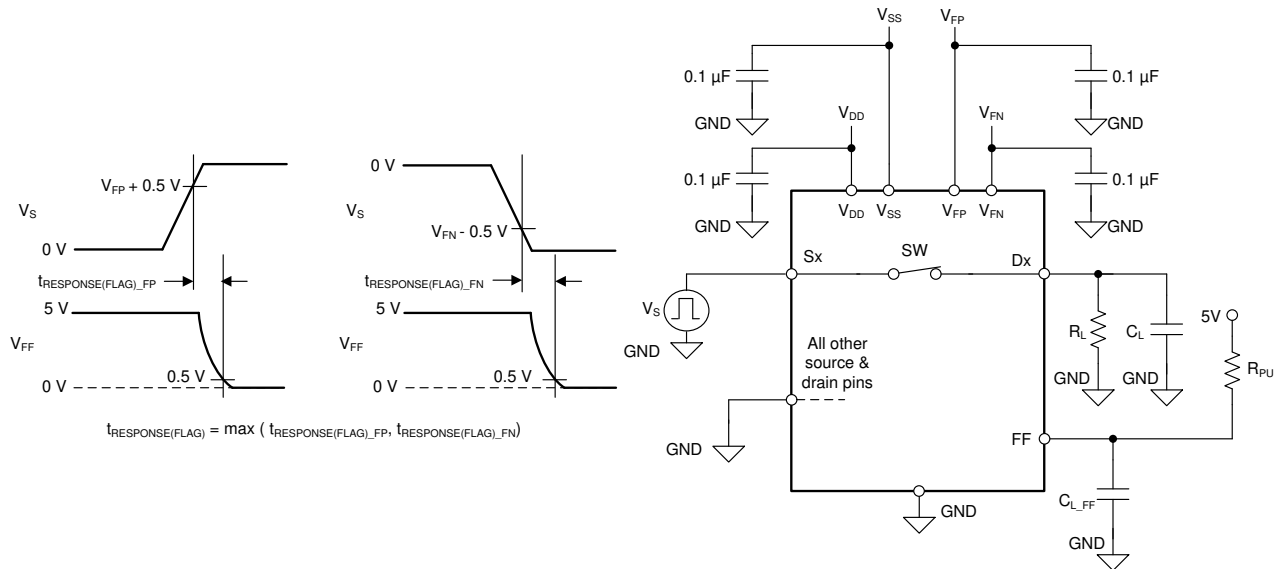


Figure 7-7. Fault Flag Response Time Measurement Setup

7.7 Fault Flag Recovery Time

Fault flag recovery time ($t_{\text{RECOVERY(FLAG)}}$) measures the delay between the source voltage falling from the overvoltage condition to below the fault supply voltage (V_{FP} or V_{FN}) plus 0.5 V and the general fault flag (FF) pin to rise above 3 V with 5 V external pull-up. Figure 7-8 shows the setup used to measure $t_{\text{RECOVERY(FLAG)}}$.

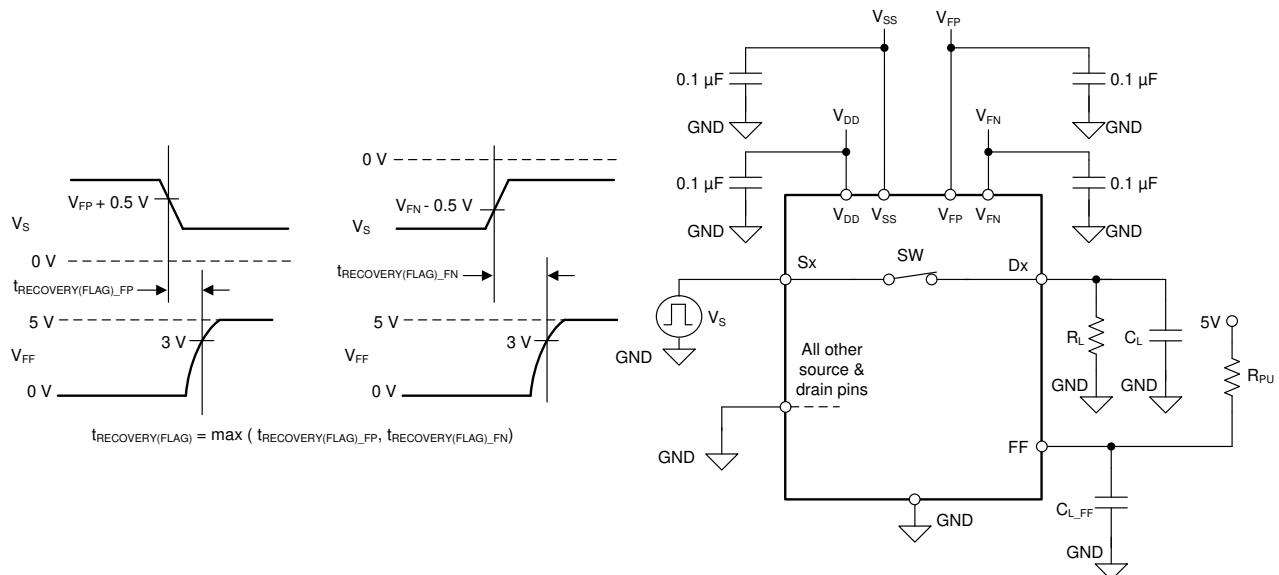


Figure 7-8. Fault Flag Recovery Time Measurement Setup

7.8 Fault Drain Enable Time

$t_{RESPONSE(DR)}$ represents the delay between the voltage at the DR pin falling from a high to low signal and the output of the drain pin reaching 90% of the fault supplies (V_{FP} or V_{FN}). $t_{RESPONSE(DR)}$ is a measure of how quickly the internal pull-up engages in response to the DR pin. Figure 7-9 shows the setup used to measure $t_{RESPONSE(DR)}$.

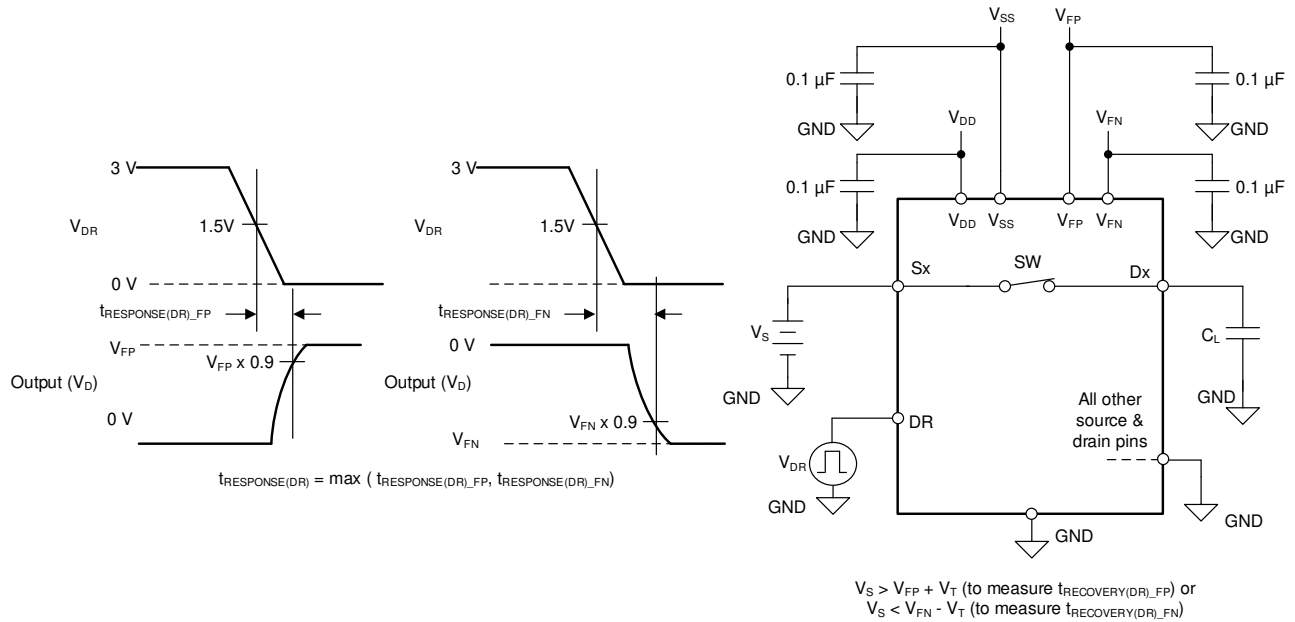


Figure 7-9. Fault Drain Enable Time Measurement Setup

7.9 Inter-Channel Crosstalk

Figure 7-10 and Equation 1 shows how the inter-channel crosstalk ($X_{TALK(INTER)}$) is measured as the voltage at the source pin (S_x) of an on-switch input, when a $1-V_{RMS}$ signal is applied at the source pin of an on-switch input in a different channel.

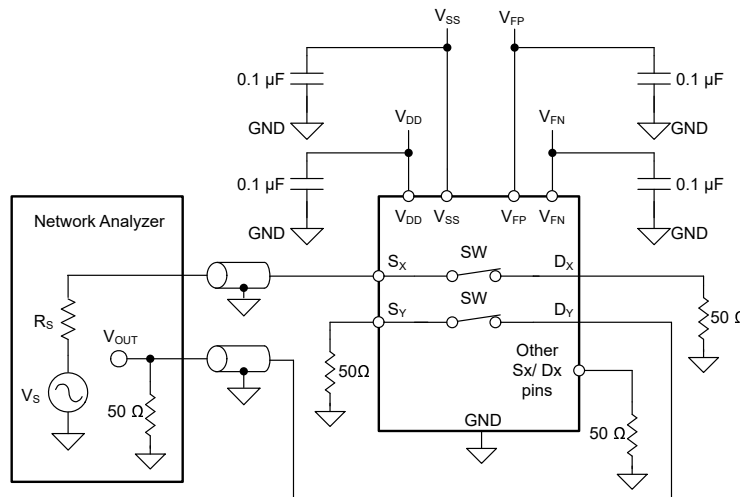


Figure 7-10. Inter-Channel Crosstalk Measurement Setup

$$Inter - channel \text{ Crosstalk} = 20 \times \text{Log} \frac{V_{OUT}}{V_S} \quad (1)$$

7.10 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 TMUX7462F's drain pin (D or Dx). Figure 7-11 and Equation 2 shows the setup used to measure bandwidth of the switch.

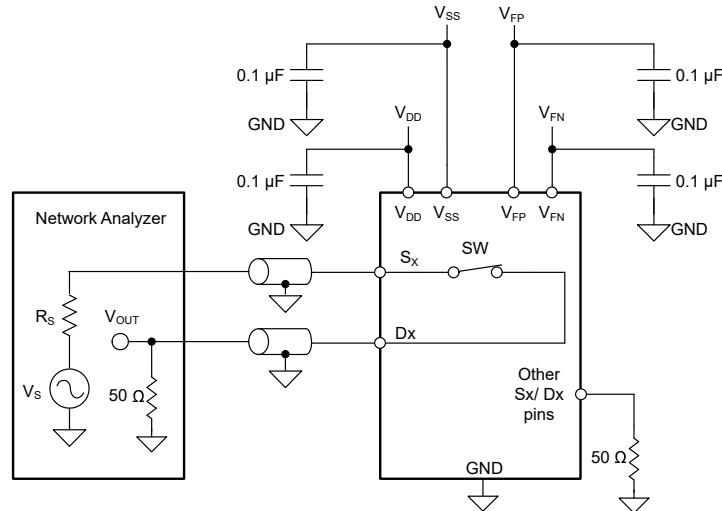


Figure 7-11. Bandwidth Measurement Setup

$$\text{Bandwidth} = 20 \times \text{Log} \frac{V_{OUT}}{V_S} \tag{2}$$

7.11 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 TMUX7462F 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 7-12 shows the setup used to measure THD+N of the devices.

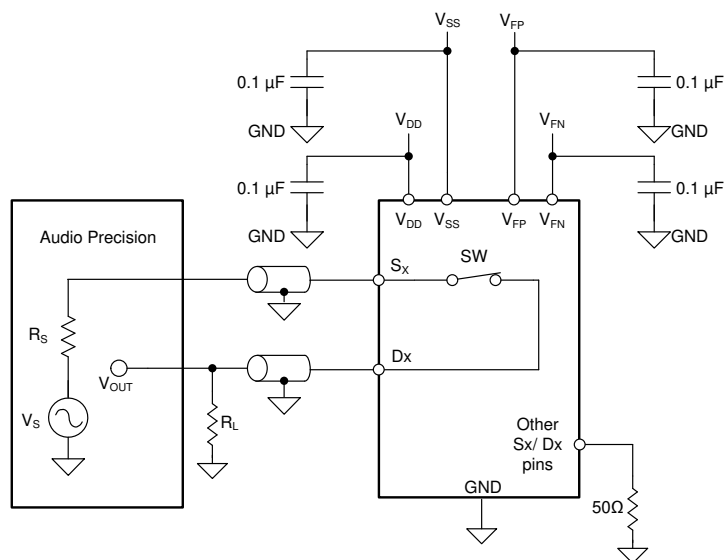


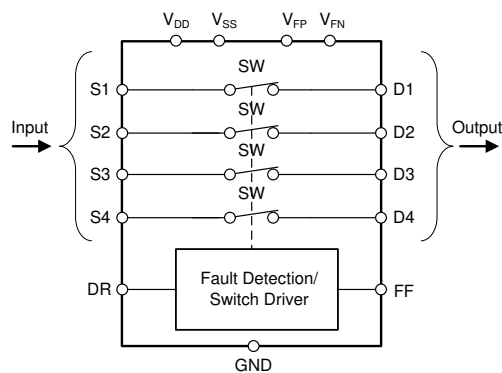
Figure 7-12. THD+N Measurement Setup

8 Detailed Description

8.1 Overview

The TMUX7462F is a four-channel protector that can be placed in series with the signal path to protect sensitive components downstream from overvoltage faults. The channel protector prevents overvoltages in both powered and powered-off conditions, making it suitable for applications where correct power supply sequencing cannot be precisely controlled. The powered-off condition includes floating power supplies, grounded power supplies, or power supplies at any level that are below the undervoltage (UV) threshold. The internal switch is turned-on and turned-off autonomously based on the fault situation without the need of external controls, making the device extremely easy to implement in the system. The primary supply voltages define the on-resistance profile, while the secondary supply voltages define the voltage level at which the overvoltage protection engages. The device works well with dual supplies ($\pm 5\text{ V}$ to $\pm 22\text{ V}$), a single supply (8 V to 44 V), or asymmetric supplies (such as $V_{DD} = 12\text{ V}$, $V_{SS} = -5\text{ V}$).

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Flat ON-Resistance

The TMUX7462F are 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.

8.3.2 Protection Features

The TMUX7462F offers a number of protection features to enable robust system implementations.

8.3.2.1 Input Voltage Tolerance

The maximum voltage that can be applied to any source input pin is +60 V or -60 V, allowing the device to handle typical voltage fault conditions in industrial applications. Take caution: the device has different maximum stress ratings across different pin combinations and are defined as the following:

1. Between source pins and supply rails: 85 V

For example, if the device is powered by V_{DD} supply of 25 V, then the maximum negative signal level on any source pin is -60 V. If the device is powered by V_{DD} supply of 40 V, then the maximum negative signal level on any source pin is reduced to -45 V to maintain the 85 V maximum rating across the source pin and the supply.

2. Between source pins and drain pin of the same channel: 85 V

For example, if the DR pin is left floating and an overvoltage voltage fault of -60 V occurs on the source pin S1, then the maximum positive voltage signal level driven on the drain pin channel D1 is 25 V to maintain the 85 V maximum rating across the source pin and the drain pin.

8.3.2.2 Powered-Off Protection

The source (Sx) pins of the device remain in the high impedance (Hi-Z) state, and the device performance remains within the leakage performance specifications when the supplies of TMUX7462F are removed ($V_{DD}/V_{SS} = 0\text{ V}$ or floating) or at a level that is below the undervoltage (UV) threshold. Powered-off protection minimizes system design complexity by removing the need to control the system's power supply sequencing. 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, signal on the input source pins can back-power the supply rails through internal ESD diodes and cause potential damage to the system.

A GND reference must always be present to for proper operation. Source and drain voltage levels of up to $\pm 60\text{ V}$ are blocked in the powered-off condition.

8.3.2.3 Fail-Safe Logic

Fail-Safe logic circuitry allows voltages on the control input pin (DR) to be applied before the supply pins. This eliminates the need for power sequencing of the logic signals and protects the device from potential damage. The control inputs are protected against positive faults of up to $+44\text{ V}$ in the powered-off condition, but do not offer protection against a negative overvoltage condition.

8.3.2.4 Overvoltage Protection and Detection

The TMUX7462F detects overvoltage inputs by comparing the voltage on a source pin (Sx) with the fault supplies (V_{FP} and V_{FN}). A signal is considered overvoltage if it exceeds the fault supply voltages by the threshold voltage (V_T).

The switch automatically turns OFF and the source pin becomes high impedance so that only small leakage currents flow through the switch when an overvoltage is detected. The drain pin (Dx) behavior can be adjusted by controlling the drain response (DR) pin in the following ways:

1. **DR pin floating or driven above V_{IH} :**

If the DR pin is driven about V_{IH} level of the pin, then the drain pin becomes high impedance (Hi-Z) upon overvoltage fault.

2. **DR driven below V_{IL} :**

If the DR pin is driven below V_{IL} level of the pin, then the drain pin (Dx) is pulled to the supply that was exceeded. For example, if the source voltage exceeds V_{FP} , then the drain output is pulled to V_{FP} . If the source voltage exceeds V_{FN} , then the drain output is pulled to V_{FN} . The pull-up impedance is approximately $40\text{ k}\Omega$, and as a result, the drain current is limited to roughly 1 mA during a shorted load (to GND) condition.

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

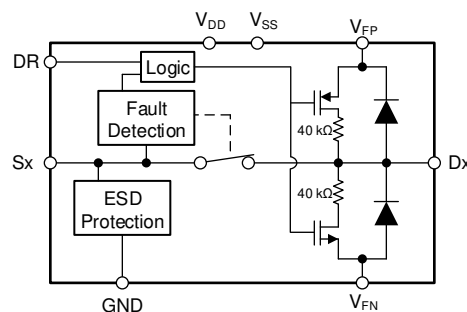


Figure 8-1. Detailed Functional Diagram

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 3 V to V_{DD} , while the V_{FN} can be supplied from V_{SS} to 0 V . If the fault supplies are not available in the system, then the V_{FP} pin must be connected to V_{DD} , while the V_{FN} pin must be connected to V_{SS} . In this case, the overvoltage protection then engages at the primary supply voltages V_{DD} and V_{SS} .

8.3.2.5 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.

An insulating oxide layer is placed on top of the silicon substrate to prevent any parasitic junctions from forming in the TMUX7462F devices. As a result, the devices are latch-up immune under all circumstances by device construction.

8.3.2.6 EMC Protection

The TMUX7462F is 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 specifications: 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 resistor, are required to prevent source input voltages from going above the rated ± 60 V limits.

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

Region 1 denotes the normal operation region of TMUX7462F, 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 TMUX7462F. The TVS breakdown voltage must be selected to be less than the absolute maximum rating of the TMUX7462F, 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 the system designers must impose when selecting the TVS protection device to prevent accidental triggering the ESD cells of the TMUX7462F.

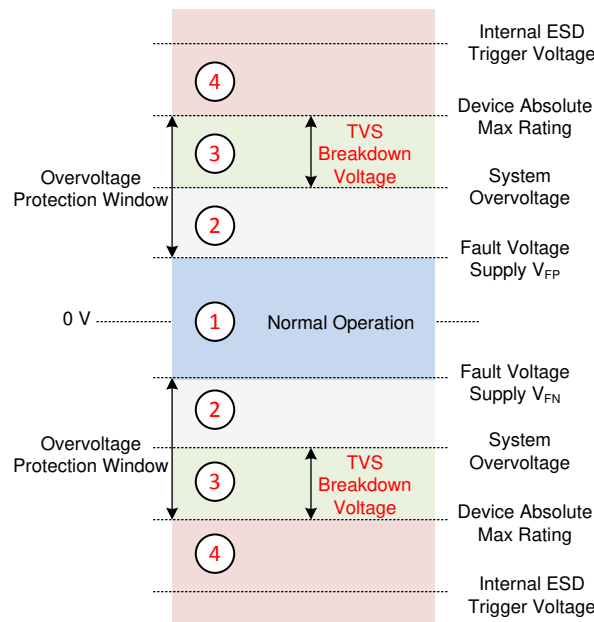


Figure 8-2. System Operation Regions and Proper Region of Selecting a TVS Protection Device

8.3.3 Overvoltage Fault Flags

The voltages on TMUX7462F's source input pins are 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 a V_T , the FF output is pulled-down to below V_{OL} . The FF pin is an open-drain output, and external pull-up resistors of 1 k Ω are recommended. The pull-up voltage can be in the range of 1.8 V to 5.5 V, depending on the controller voltage the device interfaces with.

8.3.4 Bidirectional Operation

The TMUX7462F conducts equally well from source (Sx) to drain (Dx) or from drain (Dx) to source (Sx). Each signal path has very similar characteristics in both directions; however, it is noted 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 extends from V_{SS} to roughly 3 V below V_{DD} . Once the signal is within 3 V of V_{DD} the on-resistance will exponentially increase and may impact desired signal transmission.

8.4 Device Functional Modes

The TMUX7462F offers two modes of operation (Normal mode and Fault mode) depending on whether any of the input pins experience an overvoltage condition.

8.4.1 Normal Mode

In Normal mode operation, signals of up to V_{FP} and V_{FN} can be passed through the switch from source (Sx) to drain (Dx) or from drain (Dx) to source (Sx). The following conditions must be satisfied for the switch to stay in the ON condition:

- The difference between the primary supplies ($V_{DD} - V_{SS}$) must be higher or equal to 8 V.
- V_{FP} must be between 3 V and V_{DD} , and V_{FN} must be between V_{SS} and 0 V.
- The input signals on the source (Sx) or the drain (Dx) must be between $V_{FP} + V_T$ and $V_{FN} - V_T$.

8.4.2 Fault Mode

The TMUX7462F enters into the Fault mode when any of the input signals on the source (Sx) pins exceed V_{FP} or V_{FN} by a threshold voltage V_T . The switch input experiencing the fault automatically turns off, and the source pin becomes high impedance with negligible amount of leakage current flowing through the switch under the overvoltage condition. For how the drain pin (Dx) behavior under the Fault mode can be programmed, refer to [Section 8.3.2.4](#). The general fault flag (FF) is asserted low in the Fault mode.

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

8.4.3 Truth Table

[Table 8-1](#) provides the truth tables for the TMUX7462F. Each switch is independently controlled by its own select pin.

Table 8-1. TMUX7462F Truth Table

DR PIN STATE	Dx State During Fault Condition
0	Pulled up to V_{FP} or V_{FN}
1	Open (HI-Z)

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 TMUX7462F is part of the fault protected switches and multiplexers family of devices. The ability to protect downstream components from overvoltage events up to ± 60 V and latch-up immunity features makes these switches and multiplexers suitable for harsh environments.

9.2 Typical Application

The need to monitor remote sensors is common among factory automation control systems. For example, an analog input module or mixed module (AI, AO, DI, and DO) of a programmable logic controller (PLC) will interface to a field transmitter to monitor various process sensors at remote locations around the factory. A switch or multiplexer is often used to connect multiple inputs from the system and reduce the number of downstream channels.

There are a number of fault cases that may occur that can be damaging to many of the integrated circuits. Such fault conditions may include, but are not limited to, human error due to miswiring, component failure, wire shorts, electromagnetic interference (EMI), transient disturbances, and more.

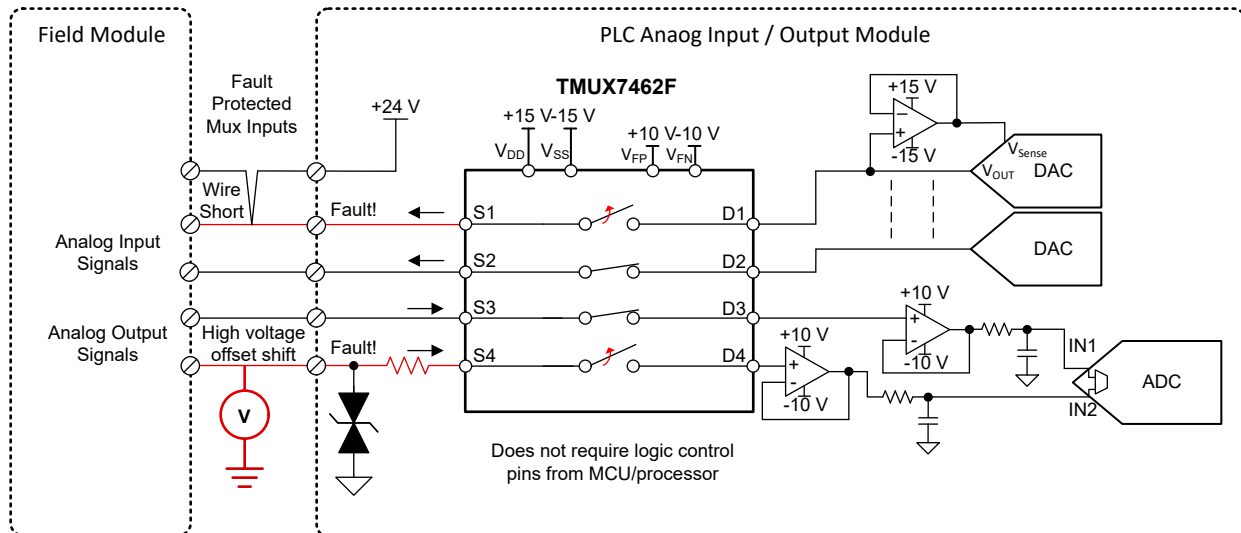


Figure 9-1. Typical Application

9.2.1 Design Requirements

Table 9-1. Design Parameters

PARAMETER	VALUE
Positive supply (V_{DD}) mux	+15 V
Negative supply (V_{SS}) mux	-15 V
Power board supply voltage	24 V
Input or output signal range non-faulted	-10 V to 10 V
Overtoltage protection levels	-60 V to 60 V
Control logic thresholds	1.8 V compatible, up to 44 V
Temperature range	-40°C to +125°C

9.2.2 Detailed Design Procedure

The TMUX7462F device's normal operation is to provide fault protection for the system while minimizing the control logic signals required to route across the PCB. The device works as a channel protector by allowing the signals to pass when in the valid voltage range, and opening the switch if there is a fault case. A fault protected switch can add extra robustness to the system against fault conditions while also reducing the number of components required to interface with the physical input channels.

The application shows two channels of the TMUX7462F connected as analog outputs and two channels connected as analog inputs to the PLC system. The analog input channels utilize the TMUX7462F to protect down stream operational amplifiers that are operating at a lower supply voltage than the multiplexer. The TMUX7462F only has overvoltage protection on the source pins, therefore these pins are connected to the external system connector on the analog output channels. If there is a miswiring or wire short issue on the connectors, the channel protector will open the switch channel to help prevent long term fault conditions from damaging the DAC.

If there is a fault condition, the drain pin of the channels can either be pulled up to the fault supply voltage (V_{FP} and V_{FN}) through a 40 kΩ resistor or be left floating depending on the state of the DR pin. This can be configured to match the system requirements on how to handle a fault condition.

9.2.3 Application Curves

The example application utilizes adjustable fault threshold voltages of the TMUX7462F to allow for protection of downstream components operating on lower supply voltages. Figure 9-2 shows an example of positive overvoltage fault response with a fast fault ramp rate of 60 V/μs. Figure 9-3 shows the extremely flat on-resistance across source voltage while operating within the fault threshold voltage levels for many supply voltage scenarios. These features make the TMUX7462F an excellent solution for data acquisition applications that may face various fault conditions but also require excellent linearity and low distortion.

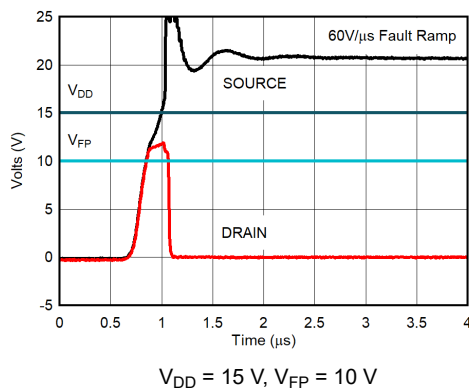


Figure 9-2. Positive Overtoltage Response

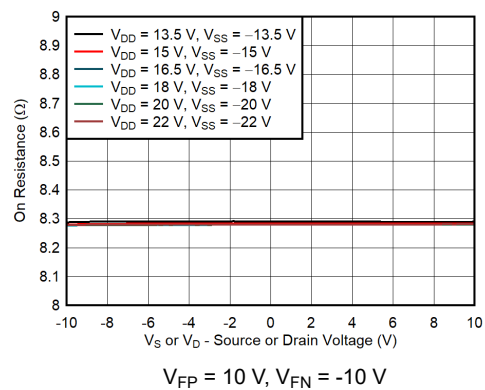


Figure 9-3. R_{ON} Flatness in Non-Fault Region

9.3 Power Supply Recommendations

The TMUX7462F operates across a wide supply range of ± 5 V to ± 22 V (8 V to 44 V in single-supply mode). The device also performs well with asymmetrical supplies such as $V_{DD} = 12$ V and $V_{SS} = -5$ V. For improved supply noise immunity, use a supply decoupling capacitor ranging from 1 μ F to 10 μ F at the V_{DD} and V_{SS} pins to ground. Always ensure the ground (GND) connection is established before supplies are ramped.

The fault supplies (V_{FP} and V_{FN}) provide the current required to operate the fault protection, and thus, must be low impedance supplies. They can be derived from the primary supplies by using a resistor divider and buffer or be an independent supply rail. The fault supplies must not exceed the primary supplies as it might cause unexpected behavior of the switch. Use a supply decoupling capacitor ranging from 1 μ F to 10 μ F at the V_{FP} and V_{FN} pins to ground for improved supply noise immunity.

The positive supply, V_{DD} , must be ramped before the positive fault rail, V_{FP} , for proper power sequencing of the TMUX7462F. Similarly, the negative supply, V_{SS} , must be ramped before the negative fault voltage rail, V_{FN} .

9.4 Layout

9.4.1 Layout Guidelines

The following images shows an example of a PCB layout with the TMUX7462F. Some key considerations are as follows:

- Decouple the V_{DD} and V_{SS} pins with a 1- μ F capacitor, placed as close to the pin as possible. Make sure that the capacitor voltage rating is sufficient for the supplies.
- Multiple decoupling capacitors can be used if there is a lot of noise in the system. For example, a 0.1- μ F and 1- μ F can be placed on the supply pins. If multiple capacitors are used, then it is recommended to place the lowest value capacitor closest to the supply pin.
- 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

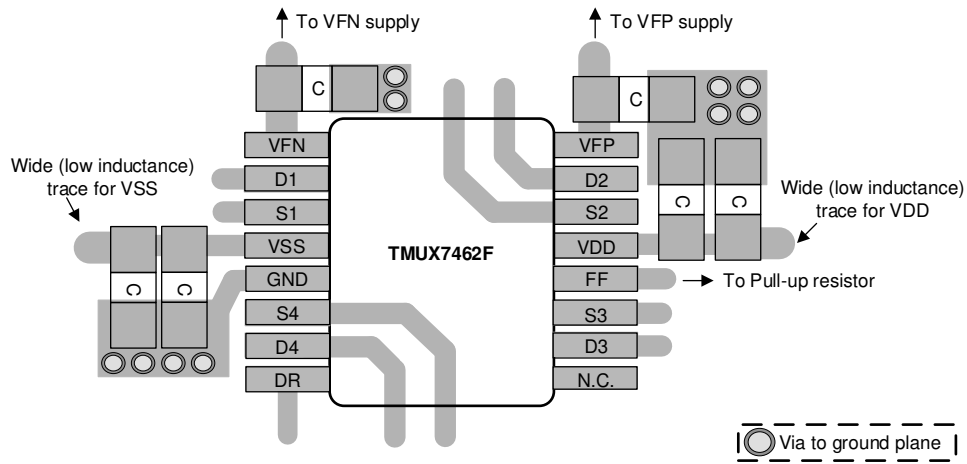


Figure 9-4. TSSOP Layout Example

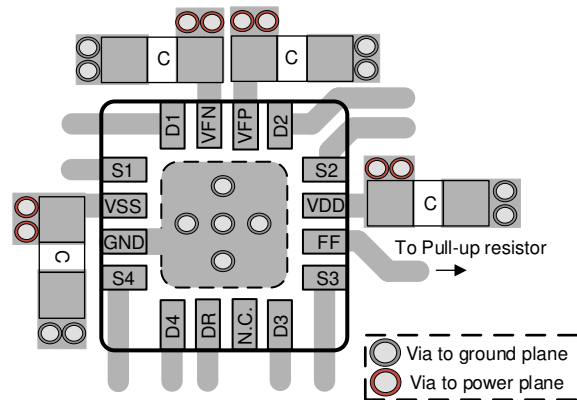


Figure 9-5. WQFN Layout Example

10 Device and Documentation Support

10.1 Documentation Support

10.1.1 Related Documentation

- Texas Instruments, [Multiplexers and Signal Switches Glossary](#)
- Texas Instruments, [Protection Against Overvoltage Events, Miswiring, and Common Mode Voltages](#)
- Texas Instruments, [Improving Analog Input Modules Reliability Using Fault Protected Multiplexers](#)
- Texas Instruments, [Using Latch-Up Immune Multiplexers to Help Improve System Reliability](#)

10.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](#). Click on *Subscribe to updates* 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 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.

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)
TMUX7462FPWR	Active	Production	TSSOP (PW) 16	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TM7462F
TMUX7462FPWR.B	Active	Production	TSSOP (PW) 16	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TM7462F
TMUX7462FRRPR	Active	Production	WQFN (RRP) 16	3000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	TMUX 7462F
TMUX7462FRRPR.B	Active	Production	WQFN (RRP) 16	3000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	TMUX 7462F

(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.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

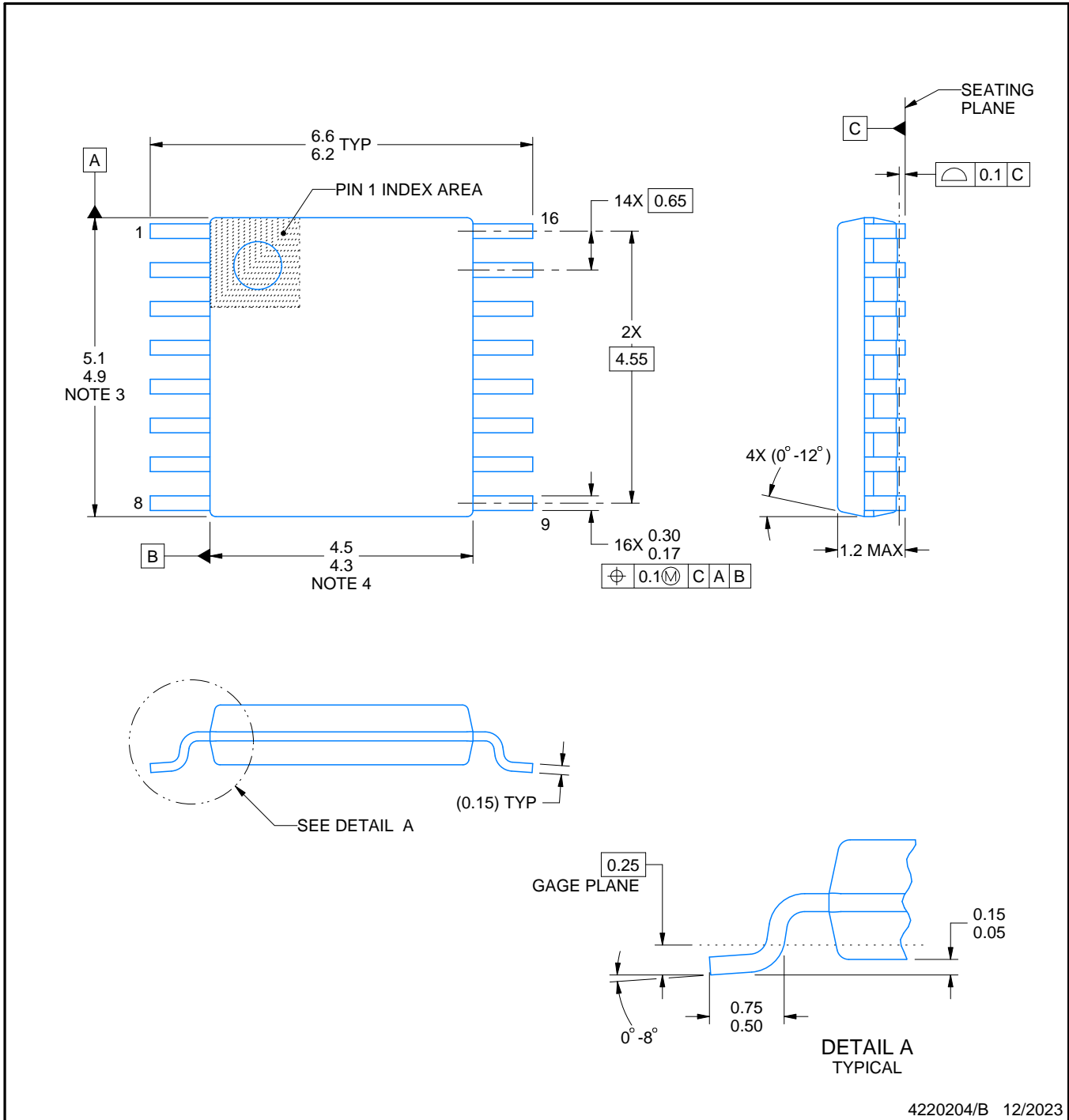

*All dimensions are nominal

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
TMUX7462FPWR	TSSOP	PW	16	3000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TMUX7462FRRPR	WQFN	RRP	16	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMUX7462FPWR	TSSOP	PW	16	3000	353.0	353.0	32.0
TMUX7462FRRPR	WQFN	RRP	16	3000	367.0	367.0	35.0



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NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

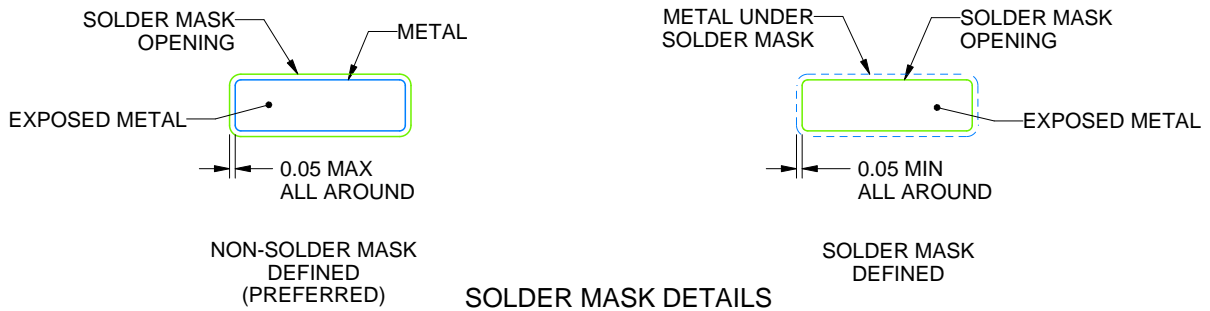
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



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NOTES: (continued)

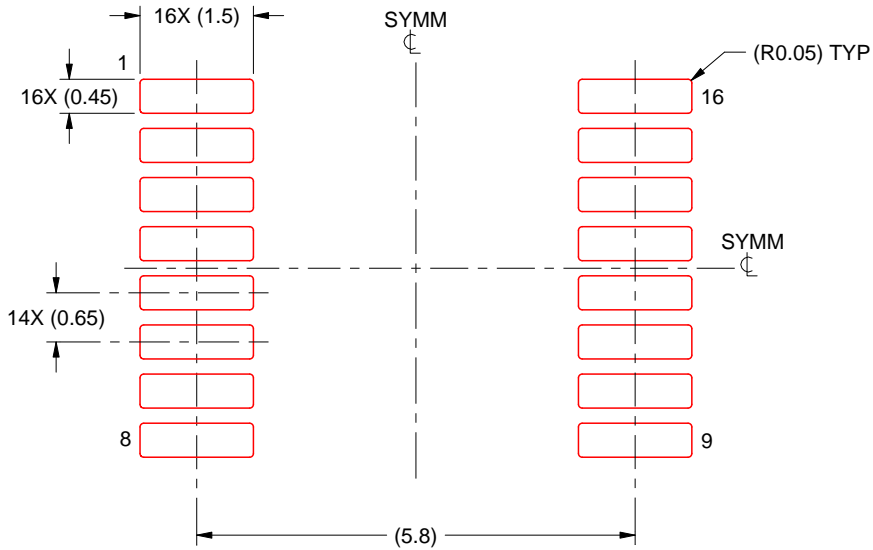
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

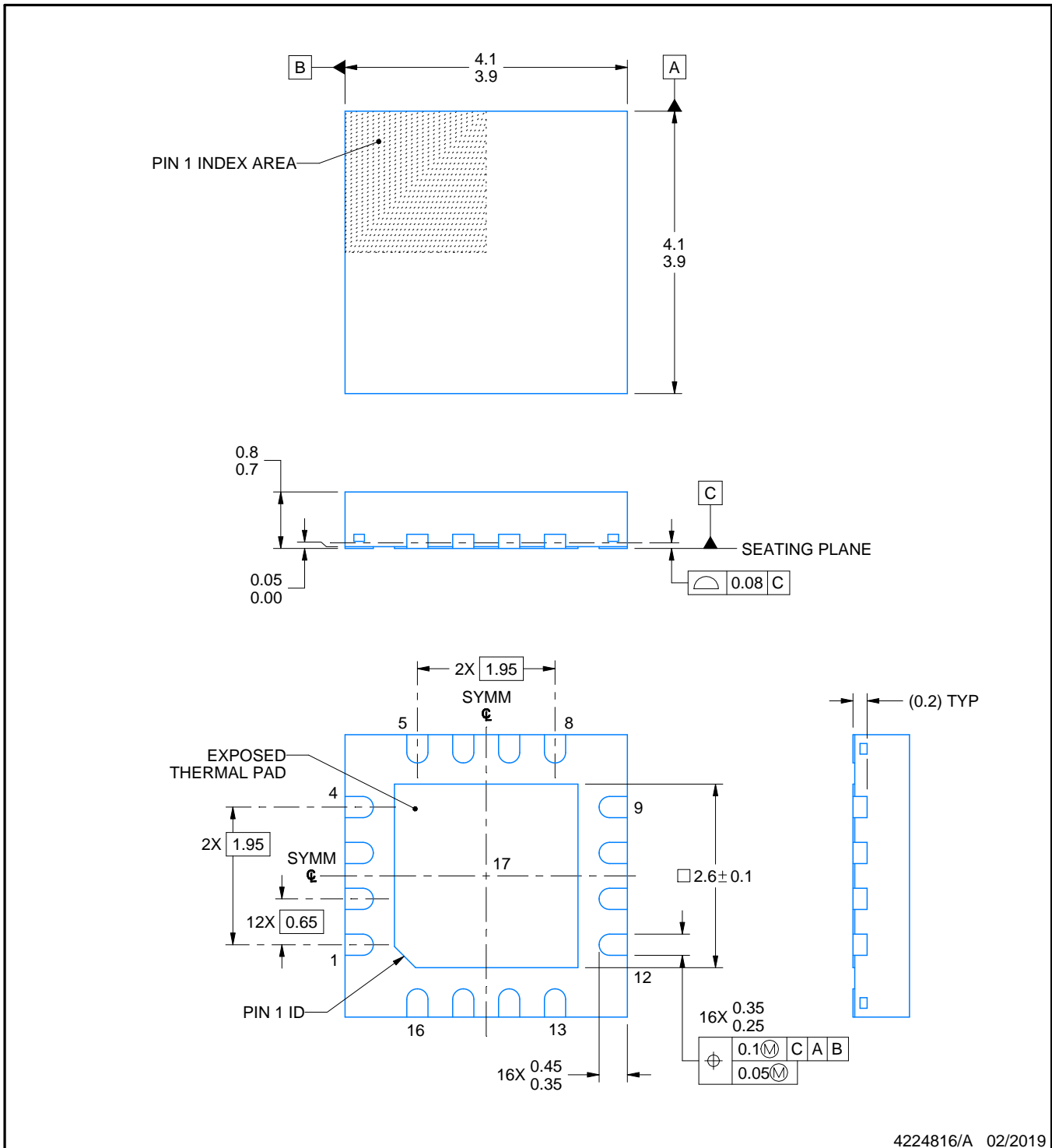
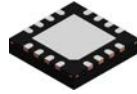


SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.



4224816/A 02/2019

NOTES:

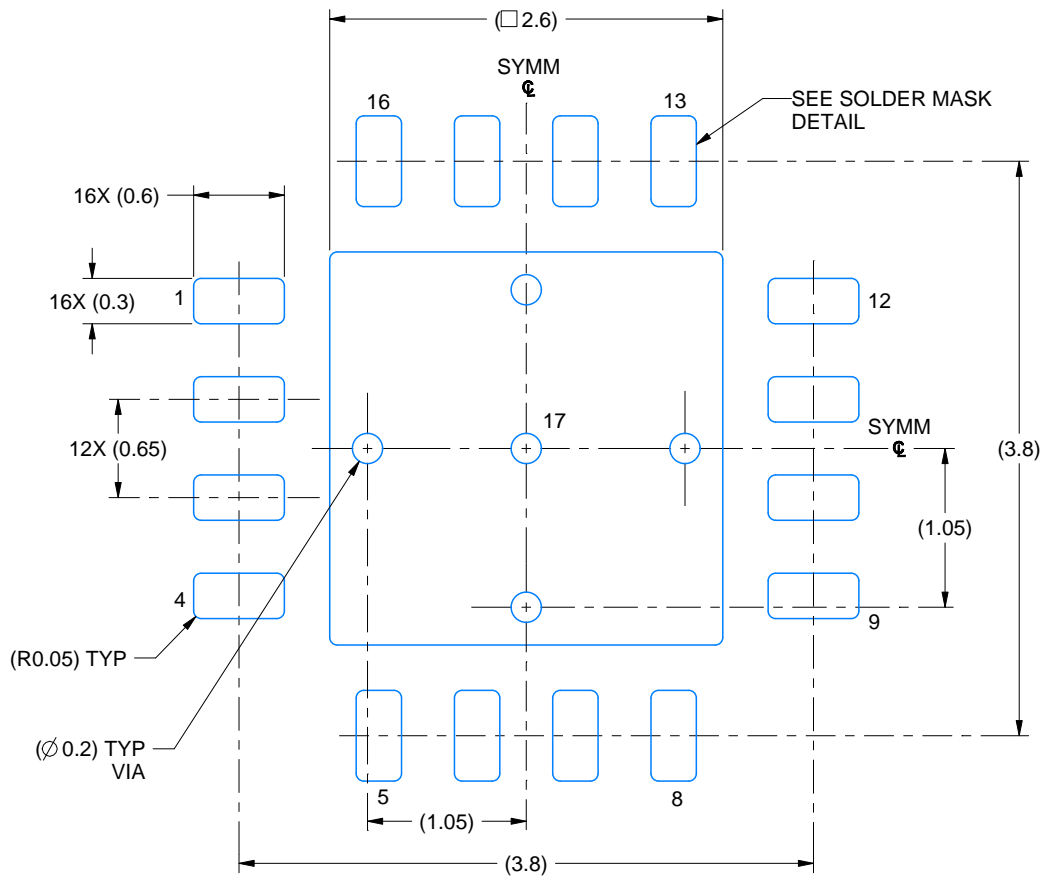
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

RRP0016A

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 20X



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NOTES: (continued)

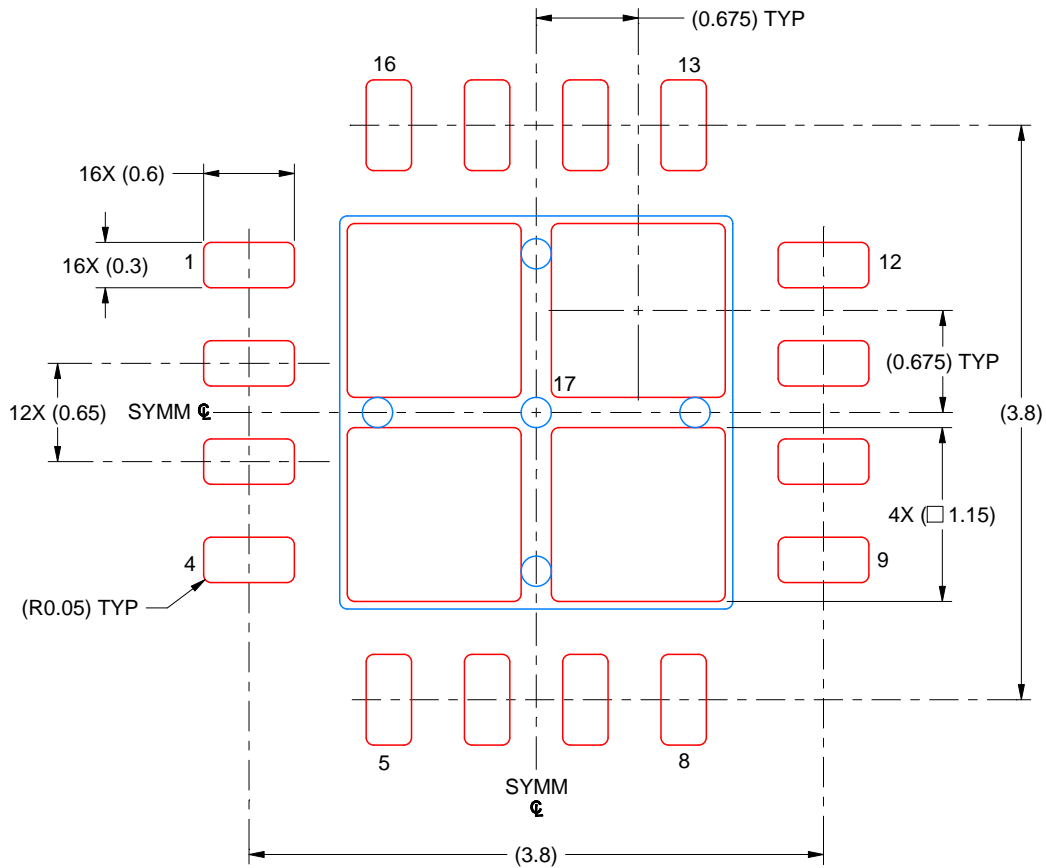
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

RRP0016A

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 MM THICK STENCIL
SCALE: 20X

EXPOSED PAD 17
78% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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