



# High-Bandwidth, T1/E1, SPST Analog Switches

## General Description

The MAX4815/MAX4816/MAX4817 high-bandwidth, low-on-resistance, quad-SPST analog switches are designed to serve as integrated T1/E1 protection switches for 1+1 and N+1 line-card redundancy applications. Each MAX4815/MAX4816/MAX4817 replaces four electromechanical relays, significantly reducing board space, simplifying PC board routing, and reducing power consumption. These devices operate with  $\pm 3.3\text{V}$  or  $\pm 5\text{V}$  dual supplies for applications requiring T1/E1 signal switching in the line side of the interface transformer. Internal voltage multipliers drive the analog switches, yielding excellent linearity and low  $3.7\Omega$  typical on-resistance within the T1/E1 analog signal range. This high-bandwidth (550MHz typical) family of products is optimized for low return loss and matched pulse template performance in T1/E1 long-haul and short-haul applications.

The MAX4815/MAX4816/MAX4817 are available in a tiny 16-pin, 5mm x 5mm, thin QFN package and are specified over the extended  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range.

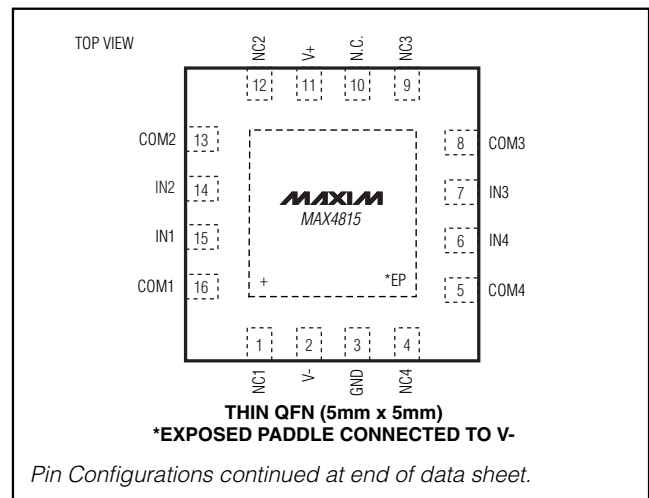
## Applications

T1/E1 Redundancy Switching  
Base Stations and Base-Station Controllers  
Add and Drop Multiplexers  
Multiservice Provisioning Platforms  
Edge Routers  
Multiservice Switches (MSSs)  
Digital Loop Carriers  
Industrial Applications  
Data Acquisition  
Telecom Signal Switching  
Test Equipment  
Avionics

## Features

- ◆ Quad-SPST NO, NC, and NC/NO Configurations
- ◆ Dual-Supply Operation from  $\pm 3.3\text{V}$  to  $\pm 5\text{V}$
- ◆ Single-Supply Operation from  $+6\text{V}$  to  $+11\text{V}$
- ◆ Hot Insertion Tolerant with No DC Path to the Supplies
- ◆ Low On-Resistance,  $R_{ON} = 3.7\Omega$  (typ) and  $6\Omega$  (max)
- ◆ Over 550MHz, -3dB Signal Bandwidth
- ◆ Excellent Crosstalk and Off-Isolation Performance Over the T1/E1 Signal Spectrum: 110dB Crosstalk Attenuation at 1MHz
- ◆ Low Current Consumption of 2mA (max)
- ◆  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  Extended Temperature Range
- ◆ Space-Saving, 16-Pin, 5mm x 5mm Thin QFN

## Pin Configurations



## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	CONFIGURATION	PKG CODE
MAX4815ETE+	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	16 TQFN-EP*	4 x SPST NC	T1655-3
MAX4816ETE+	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	16 TQFN-EP*	4 x SPST NO	T1655-3
MAX4817ETE+	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	16 TQFN-EP*	4 x SPST NC/NO	T1655-3

\*EP = Exposed paddle.

Devices are available in lead-free packaging.



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**For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at [www.maxim-ic.com](http://www.maxim-ic.com).**

MAX4815/MAX4816/MAX4817

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## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND unless otherwise noted.)

V+	.....-0.3V to +6V
V-	.....-6V to +0.3V
V+ to V-	.....-0.3V to +12V
IN	.....-0.3V to (V+ + 0.3V)
NO <sub>-</sub> , NC <sub>-</sub> , COM <sub>-</sub>	.....-12V to +12V
NO <sub>-</sub> to COM <sub>-</sub> , NC <sub>-</sub> to COM <sub>-</sub>	.....-18V to +18V
Continuous Current (NO <sub>-</sub> , NC <sub>-</sub> , COM <sub>-</sub> )	..... ±100mA
Continuous Current (any other terminal)	..... ±30mA

Peak Current (NO<sub>-</sub>, NC<sub>-</sub>, COM<sub>-</sub>)

(pulsed at 1ms, 10% duty cycle)..... ±300mA

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

16-Pin Thin QFN 5mm x 5mm (derate 33.3mW/°C

above +70°C) .....2667mW

Operating Temperature Range ..... -40°C to +85°C

Storage Temperature Range ..... -65°C to +150°C

Junction Temperature ..... +150°C

Lead Temperature (soldering, 10s) ..... +300°C

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS—Dual ±3.3V Supplies

(V+ = +3.3V ±10%, V- = -3.3V ±10%, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Fault-Free Analog Signal Range	V <sub>COM_</sub> V <sub>NO_</sub> V <sub>NC_</sub>			V-		V+	V
On-Resistance (Note 2)	R <sub>ON</sub>	V+ = +3V, V- = -3V, I <sub>COM_</sub> = 30mA, V <sub>NO_</sub> or V <sub>NC_</sub> = +3V	T <sub>A</sub> = +25°C	3.7	5	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	6			
On-Resistance Match Between Channels (Notes 2, 3)	ΔR <sub>ON</sub>	V+ = +3V, V- = -3V, I <sub>COM_</sub> = 30mA, V <sub>NO_</sub> or V <sub>NC_</sub> = +3V	T <sub>A</sub> = +25°C	0.1	0.6	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	0.8			
On-Resistance Flatness (Notes 2, 4)	R <sub>FLAT(ON)</sub>	V+ = +3V, V- = -3V, I <sub>COM_</sub> = 30mA; V <sub>NO_</sub> or V <sub>NC_</sub> = -3V, 0V, +3V	T <sub>A</sub> = +25°C	0.4	1.2	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	1.5			
NO or NC Off-Leakage Current	I <sub>NO_(OFF)</sub> I <sub>NC_(OFF)</sub>	V+ = +3.6V, V- = -3.6V; V <sub>COM_</sub> = -3V, +3V; V <sub>NO_</sub> or V <sub>NC_</sub> = +3V, -3V		-10		+10	nA
COM Off-Leakage Current	I <sub>COM_(OFF)</sub>	V+ = +3.6V, V- = -3.6V; V <sub>COM_</sub> = -3V, +3V; V <sub>NO_</sub> or V <sub>NC_</sub> = +3V, -3V		-10		+10	nA
COM On-Leakage Current	I <sub>COM_(ON)</sub>	V+ = +3.6V, V- = -3.6V; V <sub>COM_</sub> = -3V, +3V; NO_ or NC_ unconnected		-15		+15	nA
FAULT							
Fault Analog Signal Range	V <sub>COM_</sub>	V+ = +3.3V, V- = -3.3V		-11		+11	V

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## ELECTRICAL CHARACTERISTICS—Dual $\pm 3.3\text{V}$ Supplies (continued)

( $V_+ = +3.3\text{V} \pm 10\%$ ,  $V_- = -3.3\text{V} \pm 10\%$ ,  $T_A = T_{\text{MIN}}$  to  $T_{\text{MAX}}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
NO or NC Off-Leakage Current	$I_{\text{NO\_}}$ $I_{\text{NC\_}}$	$V_+ = +3.3\text{V}$ , $V_- = -3.3\text{V}$ ; $V_{\text{NO\_}}$ or $V_{\text{NC\_}} = +11\text{V}$ , $-11\text{V}$ ; $V_{\text{COM\_}} = -5.5\text{V}$ , $+5.5\text{V}$	-1		+1	$\mu\text{A}$
COM Off-Leakage Current	$I_{\text{COM\_}}$	$V_+ = +3.3\text{V}$ , $V_- = -3.3\text{V}$ ; $V_{\text{COM\_}} = +11\text{V}$ , $-11\text{V}$ ; $V_{\text{NO\_}}$ or $V_{\text{NC\_}} = -5.5\text{V}$ , $+5.5\text{V}$	-1		+1	$\mu\text{A}$
<b>SWITCH DYNAMIC CHARACTERISTICS</b>						
Crosstalk (Note 5)	$V_{\text{CT1}}$	$R_L = 50\Omega$ , $f = 1.024\text{MHz}$ , Figure 4		110		dB
	$V_{\text{CT2}}$	$R_L = 50\Omega$ , $f = 30\text{MHz}$ , Figure 4		77		
Off-Isolation (Note 6)	$V_{\text{ISO1}}$	$V_{\text{COM\_}}$ to $V_{\text{NO\_}}$ or $V_{\text{NC\_}}$ , $R_L = 50\Omega$ , $f = 1.024\text{MHz}$ , Figure 4		60		dB
	$V_{\text{ISO2}}$	$V_{\text{COM\_}}$ to $V_{\text{NO\_}}$ or $V_{\text{NC\_}}$ , $R_L = 50\Omega$ , $f = 30\text{MHz}$ , Figure 4		30		
On-Channel -3dB Bandwidth	BW	$R_S = R_L = 50\Omega$ , Figure 4		550		MHz
COM On-Capacitance	$C_{\text{ON}}(\text{COM\_})$	$f = 1\text{MHz}$ , Figure 5		10		pF
COM Off-Capacitance	$C_{\text{OFF}}(\text{COM\_})$	$f = 1\text{MHz}$ , Figure 5		7		pF
NC/NO Off-Capacitance	$C_{\text{OFF}}$	$f = 1\text{MHz}$ , Figure 5		7		pF
Charge Injection	Q	$C_L = 1.0\text{nF}$ , $V_{\text{GEN}} = 0$ , $R_{\text{GEN}} = 0$ , Figure 3		55		pC
Fault Recovery Time	$t_{\text{REC}}$	$V_{\text{NO\_}}$ , $V_{\text{NC\_}}$ , $V_{\text{COM\_}} = -11\text{V}$		128		$\mu\text{s}$
Turn-On Time	$t_{\text{ON}}$	$V_{\text{NO\_}}$ or $V_{\text{NC\_}} = +3\text{V}$ , $R_L = 300\Omega$ , $C_L = 35\text{pF}$ , Figure 2	$T_A = +25^\circ\text{C}$	20	40	$\mu\text{s}$
			$T_A = T_{\text{MIN}}$ to $T_{\text{MAX}}$		40	
Turn-Off Time	$t_{\text{OFF}}$	$V_{\text{NO\_}}$ or $V_{\text{NC\_}} = +3\text{V}$ , $R_L = 300\Omega$ , $C_L = 35\text{pF}$ , Figure 2	$T_A = +25^\circ\text{C}$	0.5	1	$\mu\text{s}$
			$T_A = T_{\text{MIN}}$ to $T_{\text{MAX}}$		1	
Power-Up Delay	$t_{\text{DEL}}$			128		$\mu\text{s}$
<b>LOGIC INPUT (<math>I_{\text{N\_}}</math>)</b>						
Input-Voltage Low	$V_{\text{IL}}$				0.8	V
Input-Voltage High	$V_{\text{IH}}$		2.4			V
Input Leakage Current	$I_{\text{IN}}$	$V_{\text{IN}} = 0$ or $V_+$	-1		+1	$\mu\text{A}$
<b>POWER SUPPLY</b>						
Quiescent Positive Supply Current	$I_+$	$V_+ = +3.6\text{V}$ , $V_- = -3.6\text{V}$ , $V_{\text{IN\_}} = 0$ or $V_+$		0.8	2	mA
Quiescent Negative Supply Current	$I_-$	$V_+ = +3.6\text{V}$ , $V_- = -3.6\text{V}$ , $V_{\text{IN\_}} = 0$ or $V_+$		0.8	2	mA
Negative Supply Voltage	$V_-$		-3.6		-3.0	V
Positive Supply Voltage	$V_+$		3.0		3.6	V

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## ELECTRICAL CHARACTERISTICS—Dual $\pm 5V$ Supplies

( $V_+ = +5V \pm 10\%$ ,  $V_- = -5V \pm 10\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Fault-Free Analog Signal Range	V <sub>COM_</sub> V <sub>NO_</sub> V <sub>NC_</sub>			V-		V+	V
On-Resistance (Note 2)	R <sub>ON</sub>	V+ = +4.5V, V- = -4.5V, I <sub>COM_</sub> = 30mA, V <sub>NO_</sub> or V <sub>NC_</sub> = +3V	T <sub>A</sub> = +25°C T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	3.7		5	Ω
						6	
On-Resistance Match Between Channels (Notes 2, 3)	ΔR <sub>ON</sub>	V+ = +4.5V, V- = -4.5V, I <sub>COM_</sub> = 30mA, V <sub>NO_</sub> or V <sub>NC_</sub> = +3V	T <sub>A</sub> = +25°C T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	0.1		0.6	Ω
						0.8	
On-Resistance Flatness (Notes 2, 4)	R <sub>FLAT(ON)</sub>	V+ = +4.5V, V- = -4.5V, I <sub>COM_</sub> = 30mA; V <sub>NO_</sub> or V <sub>NC_</sub> = -3V, 0V, +3V	T <sub>A</sub> = +25°C T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	0.4		1.2	Ω
						1.5	
NO or NC Off-Leakage Current	I <sub>NO_(OFF)</sub> I <sub>NC_(OFF)</sub>	V+ = +5.5V, V- = -5.5V; V <sub>COM_</sub> = -5V, +5V; V <sub>NO_</sub> or V <sub>NC_</sub> = +5V, -5V		-10		+10	nA
COM Off-Leakage Current	I <sub>COM_(OFF)</sub>	V+ = +5.5V, V- = -5.5V; V <sub>COM_</sub> = -5V, +5V; V <sub>NO_</sub> or V <sub>NC_</sub> = +5V, -5V		-10		+10	nA
COM On-Leakage Current	I <sub>COM_(ON)</sub>	V+ = +5.5V, V- = -5.5V; V <sub>COM_</sub> = -5V, +5V; NO_ or NO_ unconnected		-15		+15	nA
FAULT							
Fault Analog Signal Range	V <sub>COM_</sub> V <sub>NO_</sub> V <sub>NC_</sub>	V+ = +5V, V- = -5V		-11		+11	V
NO or NC Off-Leakage Current	I <sub>NO_</sub> I <sub>NC_</sub>	V+ = +5V, V- = -5V; V <sub>NO_</sub> or V <sub>NC_</sub> = +11V, -11V; V <sub>COM_</sub> = -5.5V, +5.5V		-1		+1	μA
COM Off-Leakage Current	I <sub>COM_</sub>	V+ = +5V, V- = -5V; V <sub>COM_</sub> = +11V, -11V; V <sub>NO_</sub> or V <sub>NC_</sub> = -5.5V, +5.5V		-1		+1	μA
SWITCH DYNAMIC CHARACTERISTICS							
Crosstalk (Note 5)	V <sub>CT1</sub>	R <sub>L</sub> = 50Ω, f = 1.024MHz, Figure 4		110			dB
	V <sub>CT2</sub>	R <sub>L</sub> = 50Ω, f = 30MHz, Figure 4		77			

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## ELECTRICAL CHARACTERISTICS—Dual $\pm 5\text{V}$ Supplies (continued)

( $V_+ = +5\text{V} \pm 10\%$ ,  $V_- = -5\text{V} \pm 10\%$ ,  $T_A = T_{\text{MIN}}$  to  $T_{\text{MAX}}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Off-Isolation (Note 6)	$V_{\text{ISO1}}$	$V_{\text{COM}_-}$ to $V_{\text{NO}_-}$ or $V_{\text{NC}_-}$ , $R_L = 50\Omega$ , $f = 1.024\text{MHz}$ , Figure 4		60		dB
	$V_{\text{ISO2}}$	$V_{\text{COM}_-}$ to $V_{\text{NO}_-}$ or $V_{\text{NC}_-}$ , $R_L = 50\Omega$ , $f = 30\text{MHz}$ , Figure 4		30		
On-Channel -3dB Bandwidth	BW	$R_S = R_L = 50\Omega$ , Figure 4		550		MHz
COM On-Capacitance	$C_{\text{ON}}(\text{COM}_-)$	$f = 1\text{MHz}$ , Figure 5		10		pF
COM Off-Capacitance	$C_{\text{OFF}}(\text{COM}_-)$	$f = 1\text{MHz}$ , Figure 5		7		pF
NC/NO Off-Capacitance	$C_{\text{OFF}}$	$f = 1\text{MHz}$ , Figure 5		7		pF
Charge Injection	Q	$C_L = 1.0\text{nF}$ , $V_{\text{GEN}} = 0$ , $R_{\text{GEN}} = 0$ , Figure 3		55		pC
Fault Recovery Time	$t_{\text{REC}}$	$V_{\text{NO}_-}$ , $V_{\text{NC}_-}$ , $V_{\text{COM}_-} = -11\text{V}$		128		$\mu\text{s}$
Turn-On Time	$t_{\text{ON}}$	$V_{\text{NO}_-}$ or $V_{\text{NC}_-} = +3\text{V}$ , $R_L = 300\Omega$ , $C_L = 35\text{pF}$ , Figure 2	$T_A = +25^\circ\text{C}$	20	40	$\mu\text{s}$
			$T_A = T_{\text{MIN}}$ to $T_{\text{MAX}}$		40	
Turn-Off Time	$t_{\text{OFF}}$	$V_{\text{NO}_-}$ or $V_{\text{NC}_-} = +3\text{V}$ , $R_L = 300\Omega$ , $C_L = 35\text{pF}$ , Figure 2	$T_A = +25^\circ\text{C}$	0.5	1	$\mu\text{s}$
			$T_A = T_{\text{MIN}}$ to $T_{\text{MAX}}$		1	
Power-Up Delay	$t_{\text{DEL}}$			128		$\mu\text{s}$
<b>LOGIC INPUT (IN<sub>-</sub>)</b>						
Input-Voltage Low	$V_{\text{IL}}$				0.8	V
Input-Voltage High	$V_{\text{IH}}$		2.4			V
Input Leakage Current	$I_{\text{IN}}$	$V_{\text{IN}} = 0$ or $V_+$	-1		+1	$\mu\text{A}$
<b>POWER SUPPLY</b>						
Quiescent Positive Supply Current	$I_+$	$V_+ = +5.5\text{V}$ , $V_- = -5.5\text{V}$ , $V_{\text{IN}_-} = 0$ or $V_+$		0.9	2	mA
Quiescent Negative Supply Current	$I_-$	$V_+ = +5.5\text{V}$ , $V_- = -5.5\text{V}$ , $V_{\text{IN}_-} = 0$ or $V_+$		0.9	2	mA
Negative Supply Voltage	$V_-$		-5.5		-4.5	V
Positive Supply Voltage	$V_+$		4.5		5.5	V

**Note 1:** All parameters are production tested at  $T_A = +85^\circ\text{C}$  and guaranteed by design over specified temperature range.

**Note 2:** Guaranteed by design, not production tested.

**Note 3:**  $\Delta R_{\text{ON}} = R_{\text{ON}}(\text{MAX}) - R_{\text{ON}}(\text{MIN})$ .

**Note 4:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

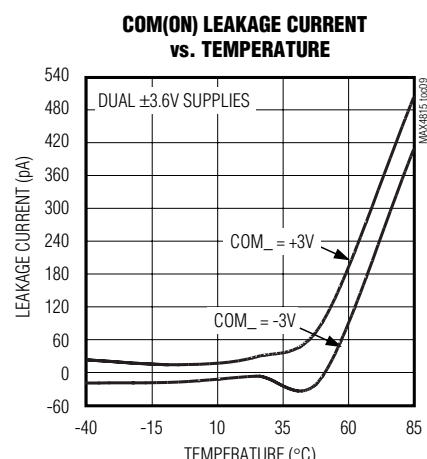
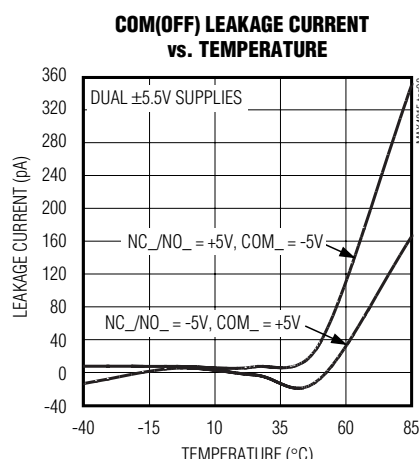
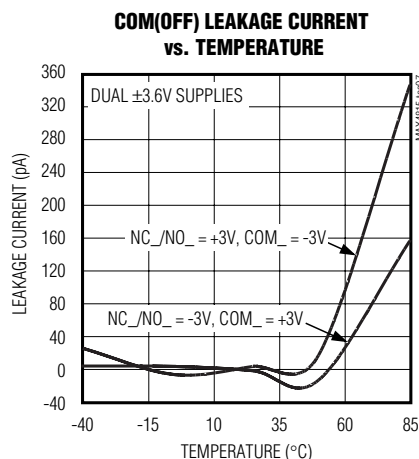
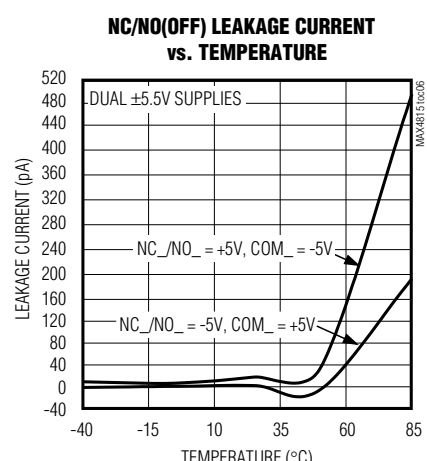
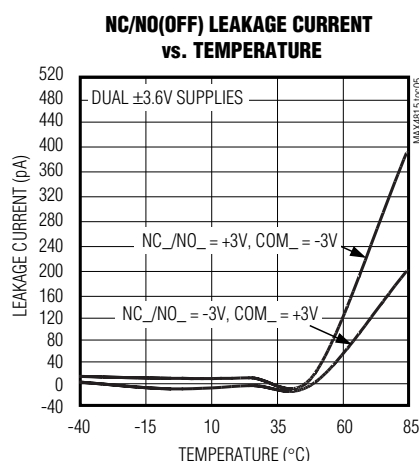
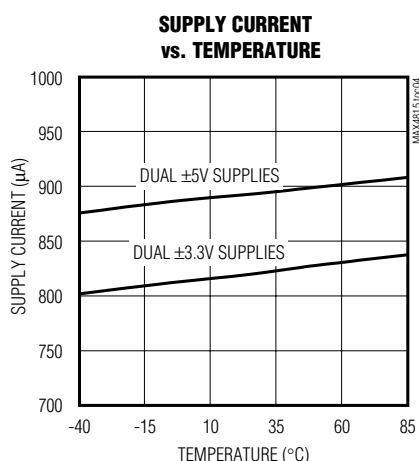
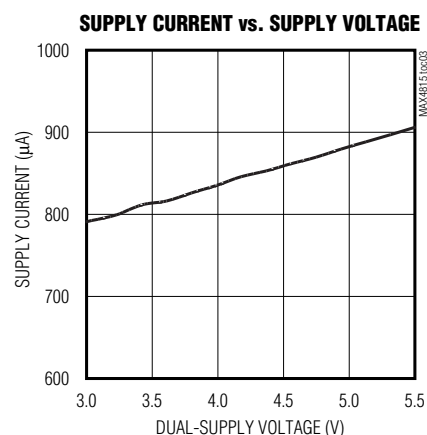
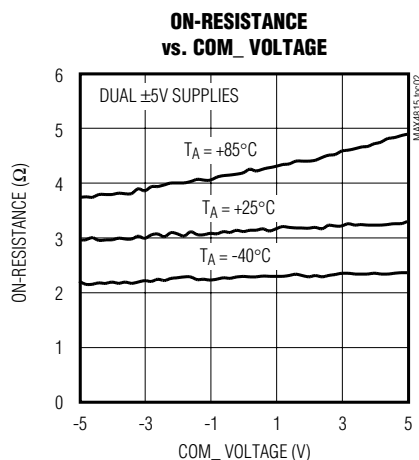
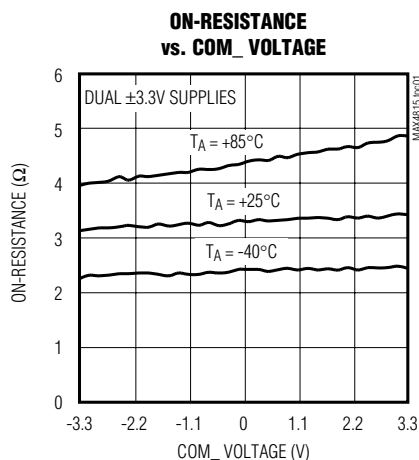
**Note 5:** Between any two switches.

**Note 6:** Off-isolation =  $20 \times \log_{10} [V_{\text{COM}_-}/(V_{\text{NC}_-} \text{ or } V_{\text{NO}_-})]$ ,  $V_{\text{COM}_-}$  = output,  $V_{\text{NC}_-}$  or  $V_{\text{NO}_-}$  = input to OFF switch.

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## Typical Operating Characteristics

( $V_+ = +3.3V$ ,  $V_- = -3.3V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



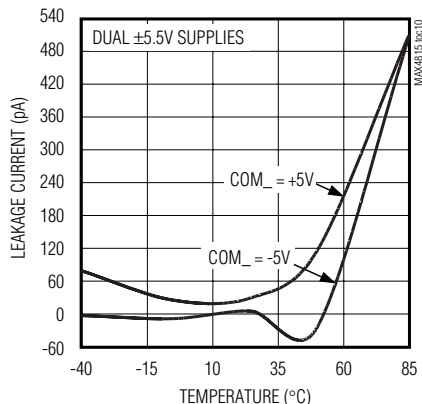
# High-Bandwidth, T1/E1, SPST Analog Switches

## Typical Operating Characteristics (continued)

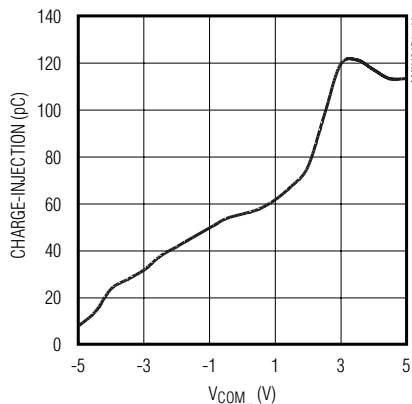
(V+ = +3.3V, V- = -3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)

MAX4815/MAX4816/MAX4817

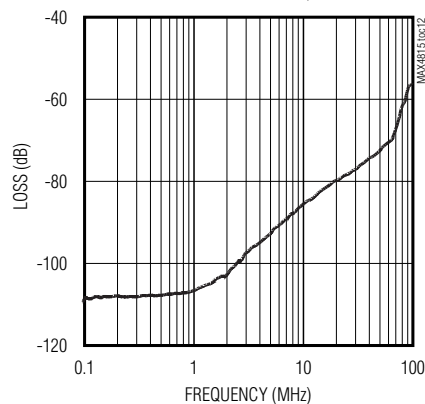
**COM(ON) LEAKAGE CURRENT vs. TEMPERATURE**



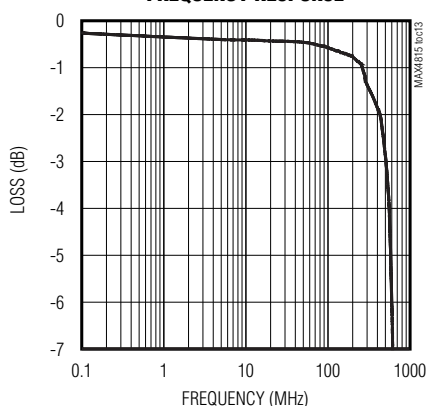
**CHARGE INJECTION vs. COMMON VOLTAGE**



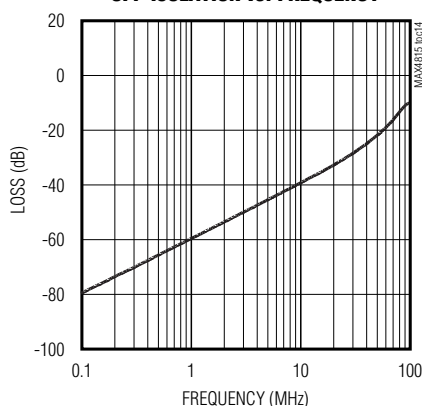
**CROSSTALK vs. FREQUENCY**



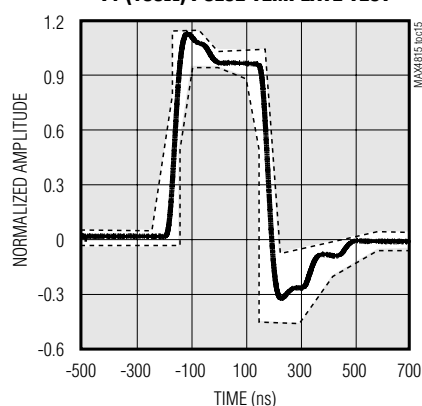
**FREQUENCY RESPONSE**



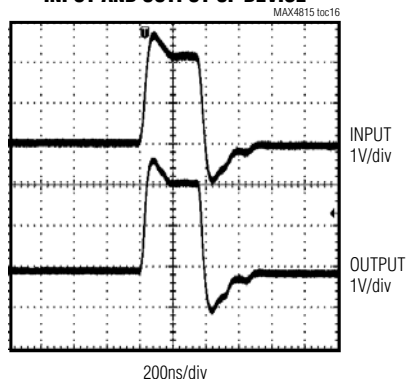
**OFF-ISOLATION vs. FREQUENCY**



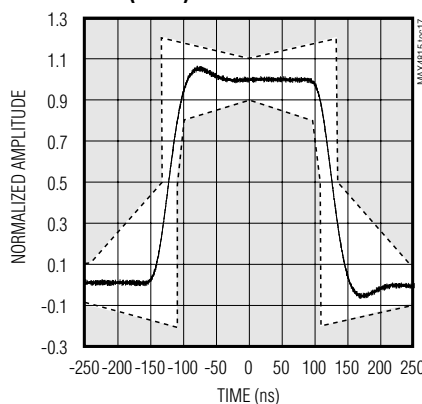
**T1 (100Ω) PULSE TEMPLATE TEST**



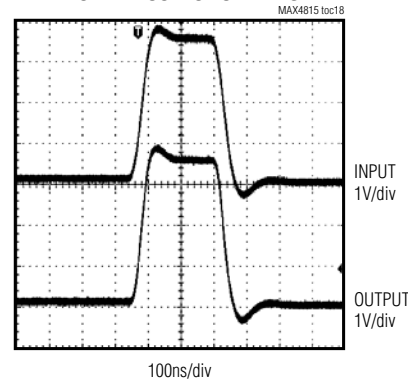
**T1 (100Ω) SCOPE SHOT OF THE INPUT AND OUTPUT OF DEVICE**



**E1 (120Ω) PULSE TEMPLATE TEST**



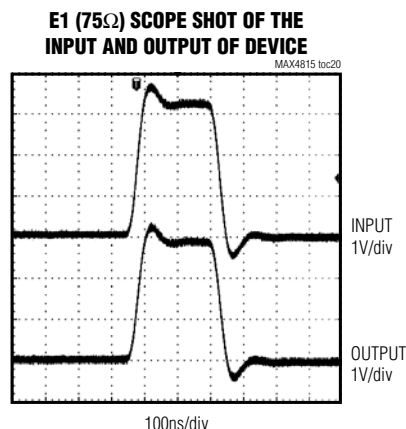
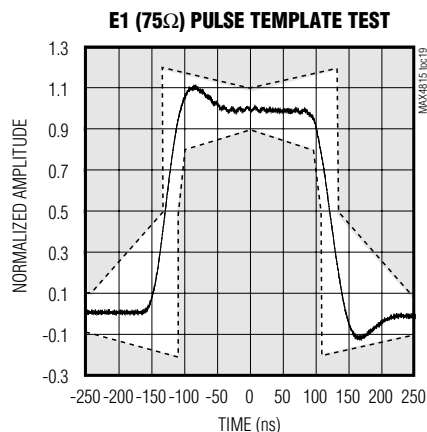
**E1 (120Ω) SCOPE SHOT OF THE INPUT AND OUTPUT OF DEVICE**



# High-Bandwidth, T1/E1, SPST Analog Switches

## Typical Operating Characteristics (continued)

(V<sub>+</sub> = +3.3V, V<sub>-</sub> = -3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)



## Pin Description

PIN			NAME	FUNCTION
MAX4815	MAX4816	MAX4817		
1	—	—	NC1	Analog Switch Normally Closed Terminal 1
2	2	2	V-	Negative Supply Voltage. Bypass V- to ground with a 0.1μF ceramic capacitor.
3	3	3	GND	Ground
4	—	—	NC4	Analog Switch Normally Closed Terminal 4
5	5	5	COM4	Analog Switch Common Terminal 4
6	6	6	IN4	Switch 4 Logic-Control Input
7	7	7	IN3	Switch 3 Logic-Control Input
8	8	8	COM3	Analog Switch Common Terminal 3
9	—	9	NC3	Analog Switch Normally Closed Terminal 3
10	10	10	N.C.	No Connection. Not internally connected.
11	11	11	V+	Positive Supply Voltage. Bypass V+ to ground with a 0.1μF ceramic capacitor.
12	—	12	NC2	Analog Switch Normally Closed Terminal 2
13	13	13	COM2	Analog Switch Common Terminal 2
14	14	14	IN2	Switch 2 Logic-Control Input
15	15	15	IN1	Switch 1 Logic-Control Input
16	16	16	COM1	Analog Switch Common Terminal 1
—	1	1	NO1	Analog Switch Normally Open Terminal 1
—	4	4	NO4	Analog Switch Normally Open Terminal 4
—	9	—	NO3	Analog Switch Normally Open Terminal 3
—	12	—	NO2	Analog Switch Normally Open Terminal 2
EP	EP	EP	EP	Exposed Paddle. Connect exposed paddle to V- or leave unconnected.



# High-Bandwidth, T1/E1, SPST Analog Switches

## Detailed Description

The MAX4815/MAX4816/MAX4817 are high-bandwidth, low-on-resistance, quad-SPST analog switches targeted to serve as integrated T1/E1 analog protection switches for 1+1 and N+1 line-card redundancy applications. These devices are designed to replace electromechanical relays to save board space, reduce power consumption, and simplify PC board routing. The devices allow the user to live insert the boards with no adverse effects.

The MAX4815/MAX4816/MAX4817 support  $\pm 3.3\text{V}$  or  $\pm 5\text{V}$  dual-supply operation, which is required for E1/T1 signal switching in the line-side of the interface transformer. Internal voltage multipliers supply the switches yielding excellent linearity and low on-resistance, typically  $3.7\Omega$ , within the E1/T1 analog signal range. This high-bandwidth, typically 550MHz, family of devices is optimized for low return loss and matched pulse template performance in E1/T1 short-haul and long-haul applications.

### Analog Signal Levels

The on-resistance of the MAX4815/MAX4816/MAX4817 is very low and stable as the analog signals are swept from V- to V+ (see the *Typical Operating Characteristics*).

### Fault Protection

The fault protection of the MAX4815/MAX4816/MAX4817 allows the devices to handle input signals of more than twice the supply voltage without clamping the signal, latching up, or disturbing other cards in the system. The device detects when the input voltage drops below the negative supply. As soon as a fault condition is detected, the switch is immediately turned off for 128 clock cycles (typically 128 $\mu\text{s}$ ). At the end of the 128 $\mu\text{s}$  timeout, the switch is turned back on for one clock cycle. At the end of the one clock cycle, if the signal is within the operating range, the switch will remain on. Otherwise, the device will turn the switch off again for 128 clock cycles. This will repeat until the signal is within the operating range. In T1/E1 redundancy applications, this can happen when the load resistor ( $R_L$ ) is removed or disconnected for any reason, as shown in Figure 1. Without a load resistor, the output voltage when using a 1:2 transformer can be as high as  $\pm 11\text{V}$ .

### Hot Insertion

The MAX4815/MAX4816/MAX4817 tolerate hot insertions, thus are not damaged when inserted into a live backplane. Competing devices can exhibit low impedance when plugged into a live backplane that can cause high power dissipation leading to damage of the device itself. The MAX4815/MAX4816/MAX4817 have relatively high input impedance when V+ and V- are

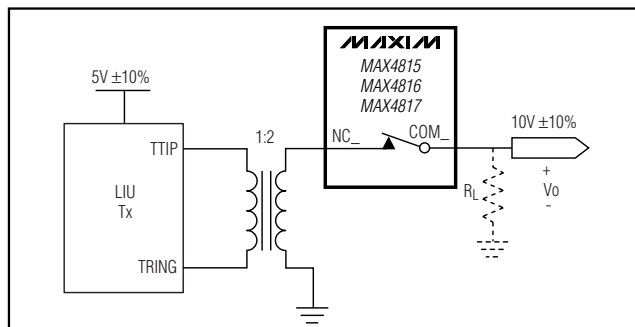


Figure 1. Fault Protection

unconnected or connected to GND. Therefore, the devices are not destroyed by a hot insertion. In order to guarantee data integrity, the V+ and V- supplies must be properly biased.

## Applications Information

### T1/E1 N+1 Redundancy

The MAX4815/MAX4816/MAX4817 are designed for adjacent line-card protection applications. Figures 6 and 7 show a basic architecture for twisted-pair interface (120 $\Omega$  E1, or 100 $\Omega$  T1). Coaxial cable interface (75 $\Omega$  E1) can be illustrated with the same figures but without the single-ended-to-differential conversion stage. A single protection card can replace up to N line cards in a N+1 redundancy scheme. Figure 6 shows the MAX4815/MAX4816/MAX4817 sitting in the line cards where they can reroute any of the input/output signals to a protection line card. Figure 7 shows the MAX4815/MAX4816/MAX4817 sitting in a protection-switching card where the switches are always powered. These figures do not show the surge protection elements and resistors for line termination/impedance matching.

The low on-resistance and high bandwidth of the MAX4815/MAX4816/MAX4817 yield good pulse template and return-loss performance (see the *Typical Operating Characteristics*). The pulse template tests for E1 (twisted pair interface 120 $\Omega$  and coaxial interface 75 $\Omega$ ) and T1 (twisted pair interface 100 $\Omega$ ) were tested using the Dallas DS2155 single-chip transceiver evaluation board, and twelve switches in parallel with one switch closed and the other eleven open. The internal transmit termination feature must be disabled when using this circuit. To use the same transmit resistors for E1 twisted pair and coaxial cables, the transmit line build out control register (TLBC) is set to the value 6Ah. This sets the driver voltage so the output pulse has the right amplitude for both 120 $\Omega$  (twisted pair) and 75 $\Omega$  (coaxial) loads. The analog switches were powered with dual power supplies at  $\pm 5\text{V}$ .

# High-Bandwidth, T1/E1, SPST Analog Switches

## Test Circuits/Timing Diagrams

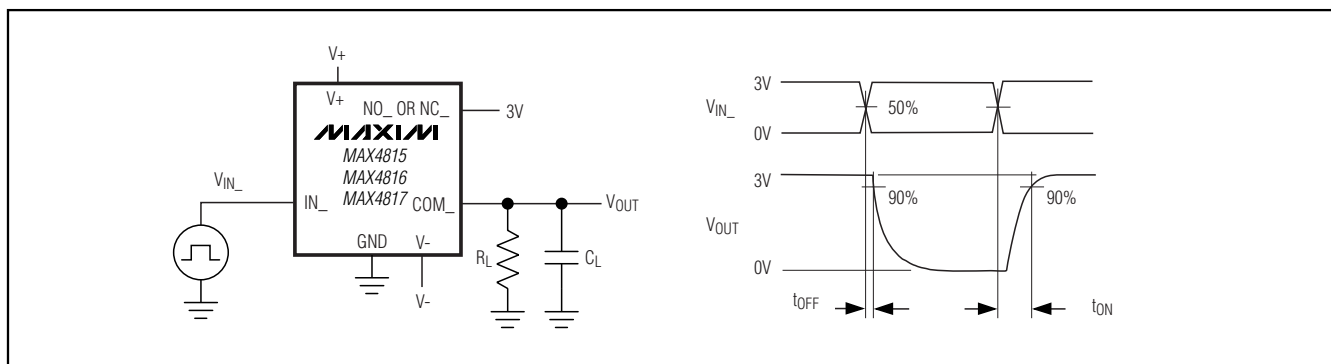


Figure 2. Switch Turn-On/Turn-Off Times

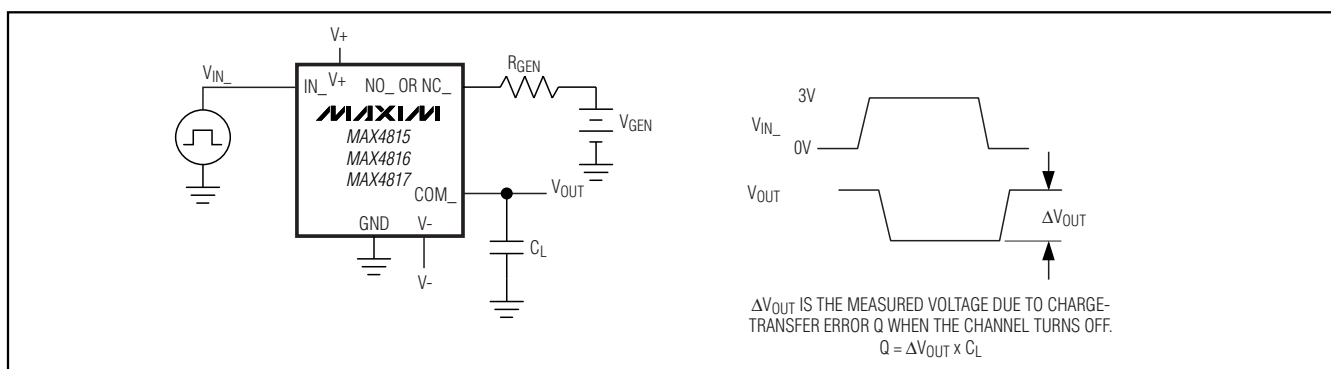


Figure 3. Charge Injection

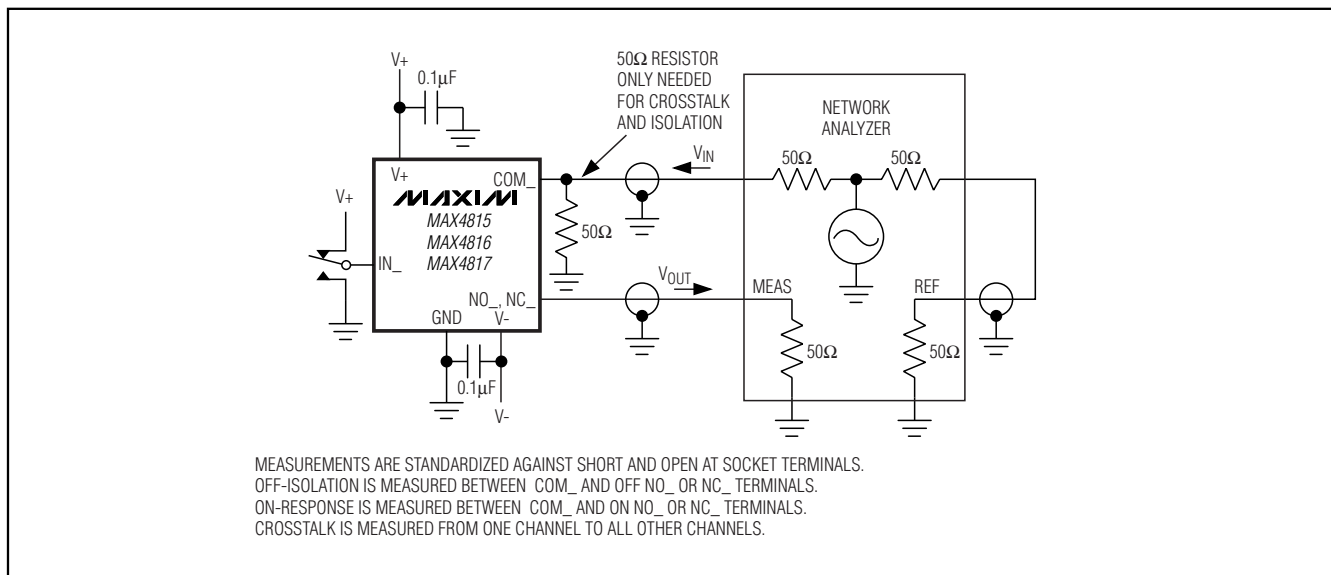


Figure 4. On-Loss, Off-Isolation, and Crosstalk

**MAX4815/MAX4816/MAX4817**

MAXIM

# High-Bandwidth, T1/E1, SPST Analog Switches

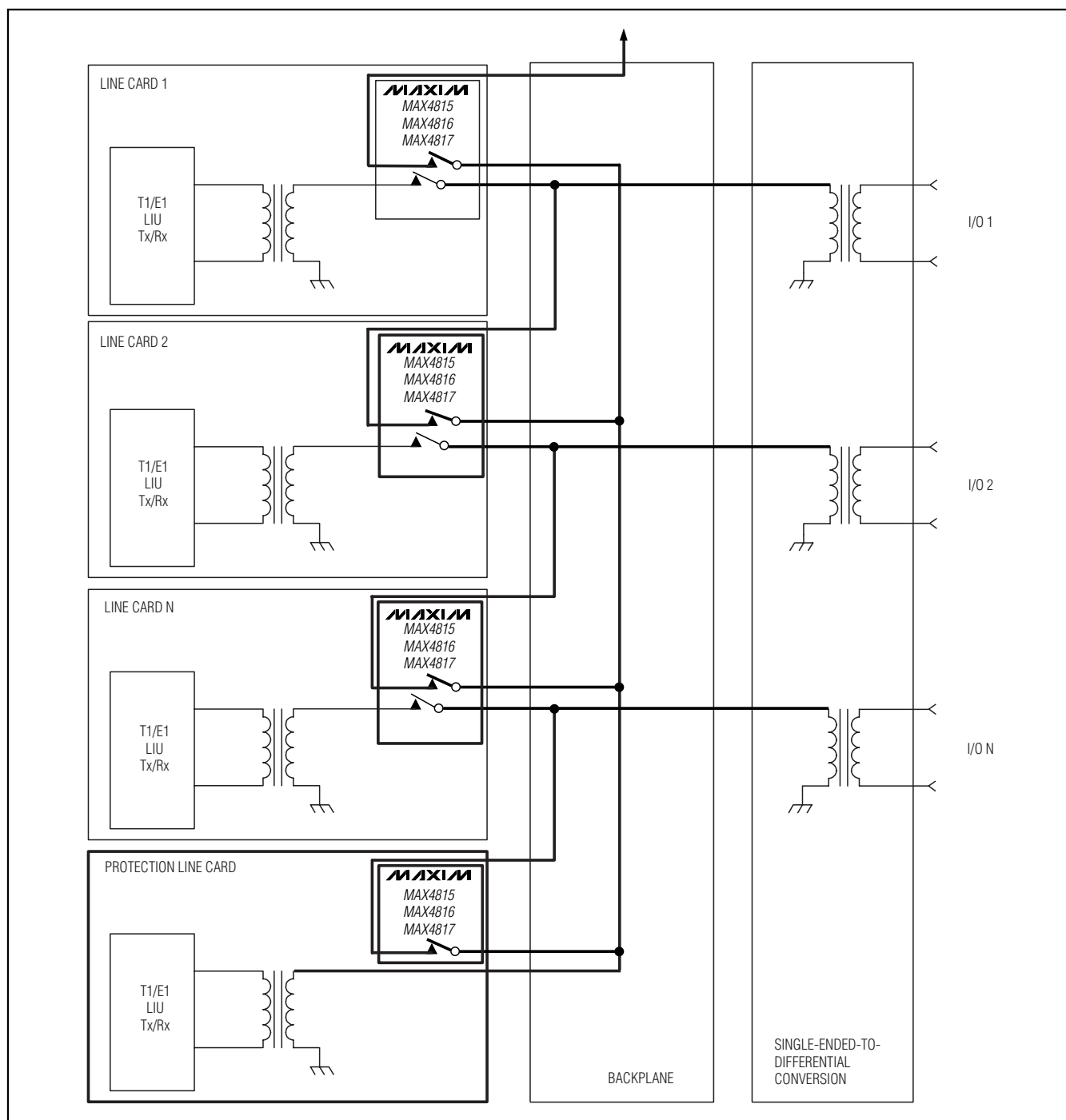


Figure 6. Adjacent Line-Card Protection Architecture with Switches in the Line Cards for Twisted Pair Cable ( $120\Omega$  E1, or  $100\Omega$  T1). Figure for coaxial cable ( $75\Omega$  E1) is the same without the single-ended-to-differential conversion.

# High-Bandwidth, T1/E1, SPST Analog Switches

MAX4815/MAX4816/MAX4817

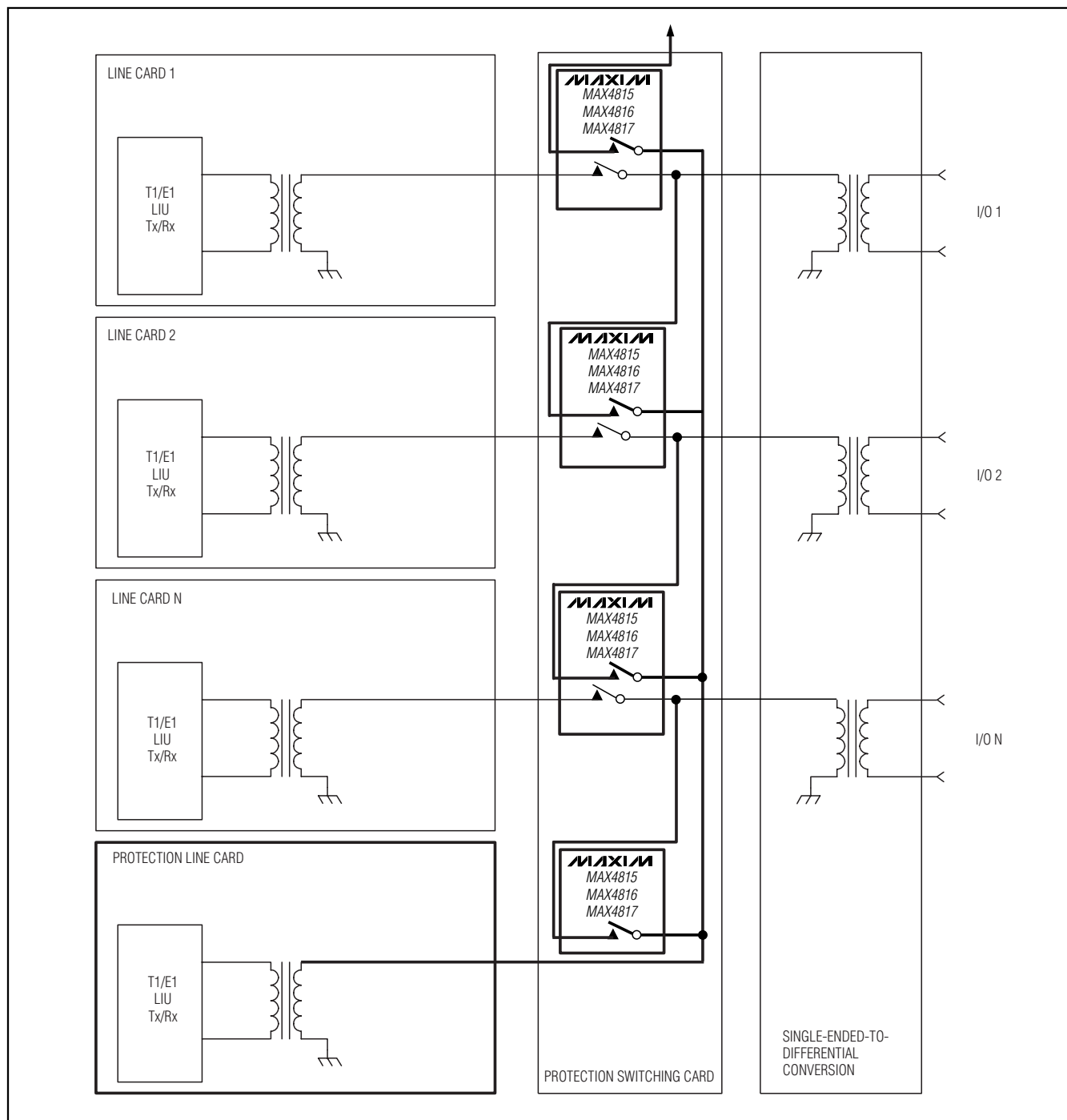
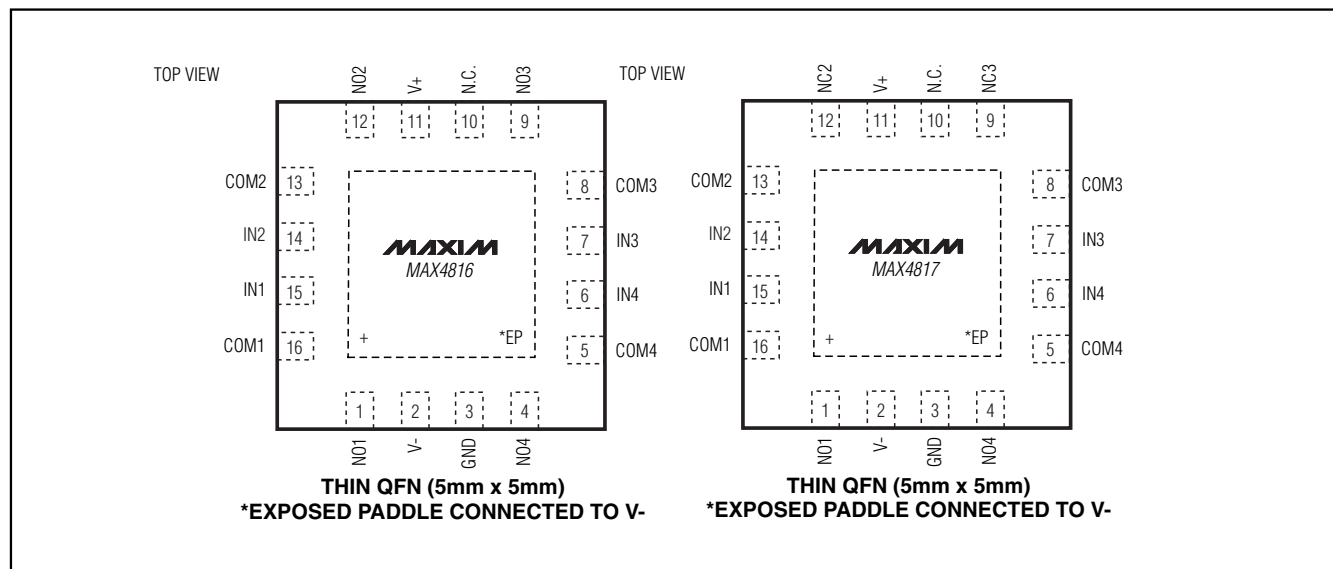


Figure 7. Adjacent Line-Card Protection Architecture with Switches out of the Line Cards for Twisted Pair Cable ( $120\Omega$  E1, or  $100\Omega$  T1). Figure for coaxial cable ( $75\Omega$  E1) is the same without the single-ended-to-differential conversion.

# High-Bandwidth, T1/E1, SPST Analog Switches

## Pin Configurations (continued)



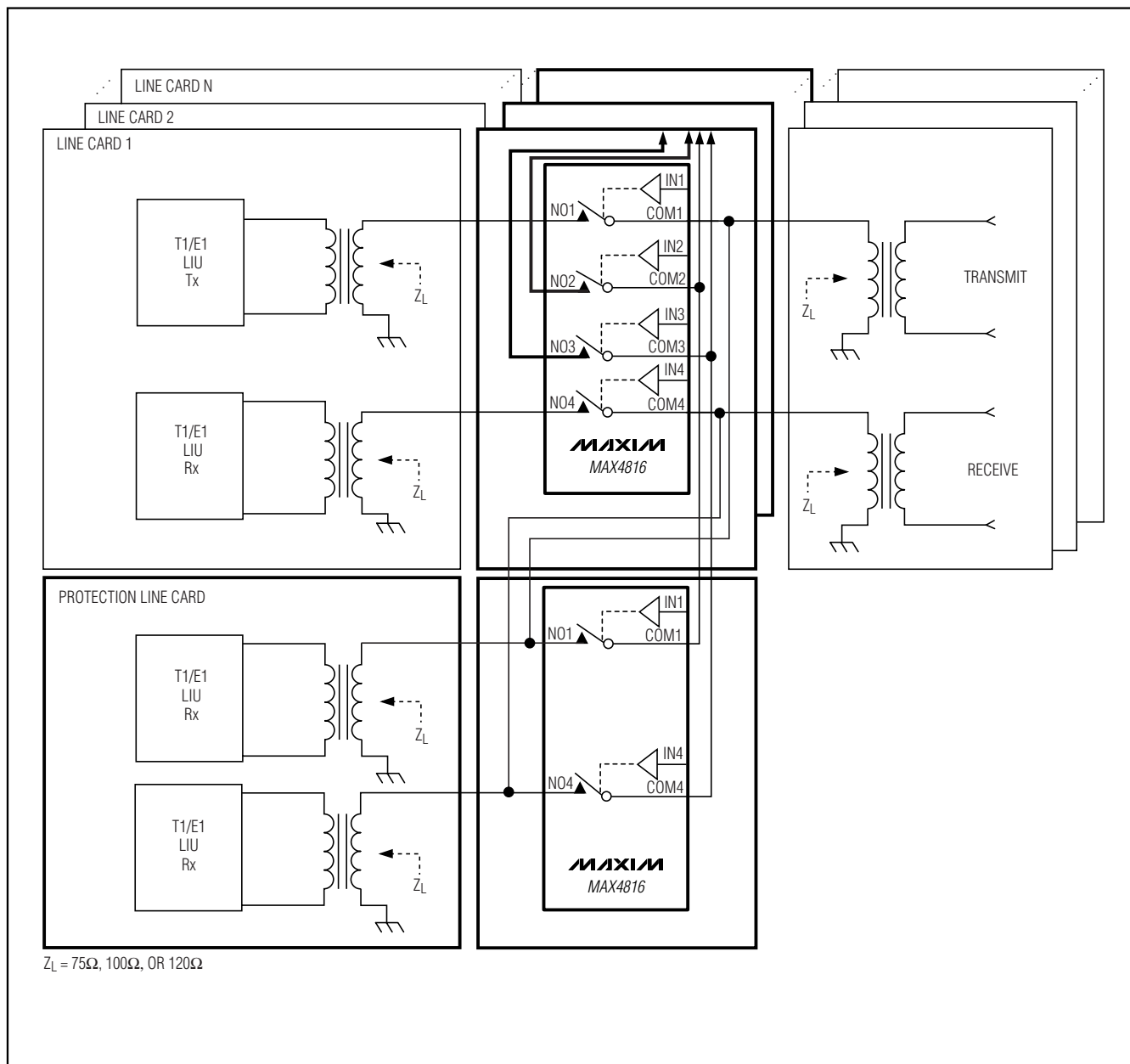
## Chip Information

PROCESS: BiCMOS

CONNECT EXPOSED PADDLE TO V-.

# High-Bandwidth, T1/E1, SPST Analog Switches

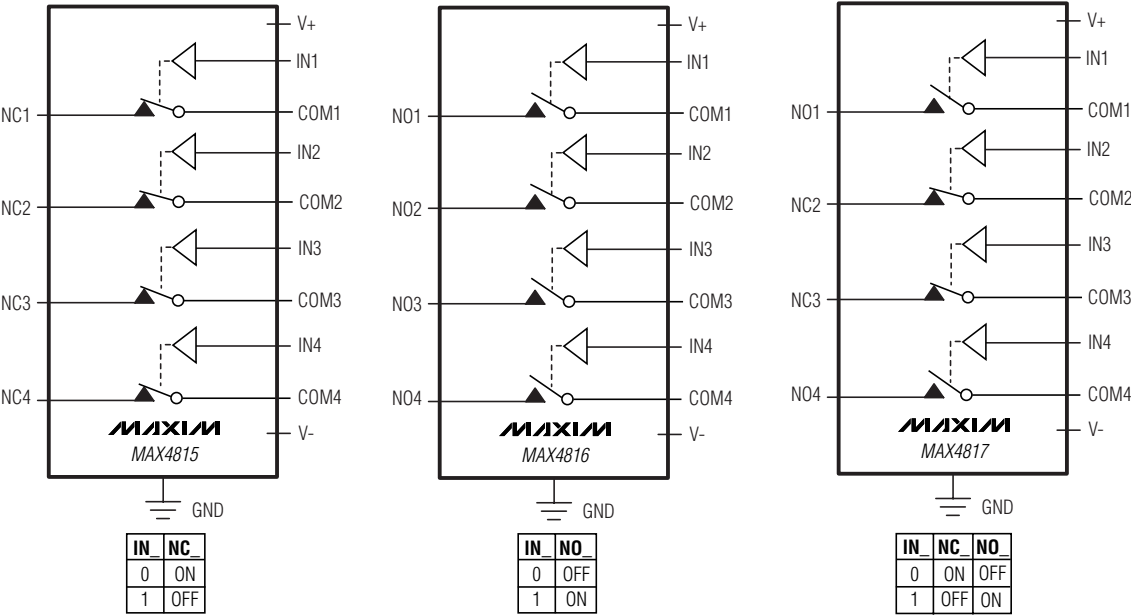
## Typical Operating Circuit



MAX4815/MAX4816/MAX4817

# High-Bandwidth, T1/E1, SPST Analog Switches

Functional Diagram





**MAX4815/MAX4816/MAX4817**

The drawing illustrates the mechanical specifications of a 16-pin Quad Flat Pack (QFN) package. It includes three main views: Top View, Bottom View, and Side View.

- Top View:** Shows a square package with side length  $D$ . The pin pitch is  $D/2$ . A shaded square in the bottom-left corner represents the exposed pad, with a width of  $E/2$  and a total width of  $E$ . Marking 'AAAAA' is located in the center. A detail callout 'PIN #1 I.D.' points to a corner.
- Bottom View:** Shows the underside of the package. It features 16 pins arranged in a 4x4 grid. The pin pitch is  $D/2$ . The distance from the package edge to the center of the pins is  $D/2$ . The pin diameter is  $\phi 0.35 \times 45^\circ$ . A detail callout 'DETAIL A' points to a pin. A marking 'PIN #1 I.D. 0.35x45°' is shown near a pin.
- Side View:** Shows the profile of the package. The total height is  $A$ . The distance from the seating plane to the top of the package is  $A_1$ . The distance from the seating plane to the bottom of the package is  $A_2$ . The package is shown with a leaded wire bond connection.

Additional details include a 'MARKING' callout pointing to the 'AAAAA' text, a 'SEATING PLANE' callout pointing to the bottom of the package, and a 'DETAIL A' callout pointing to a pin. The drawing is labeled 'TOP VIEW', 'BOTTOM VIEW', and 'SIDE VIEW'.

[illegible]

PKG. CODES	D2				E2			
	MIN.	MAX	MIN	MAX	MIN	MAX	MIN	MAX
T16552	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T16553	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T16554-H	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T20553	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T20554	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T20555	3.15	3.25	3.35	3.45	3.25	3.35	3.45	3.55
T28553	3.15	3.25	3.35	3.45	3.25	3.35	3.45	3.55
T28554	2.80	2.70	2.80	2.70	2.80	2.70	2.80	2.70
T28555	3.15	3.25	3.35	3.45	3.25	3.35	3.45	3.55
T28556	3.15	3.25	3.35	3.45	3.25	3.35	3.45	3.55
T28557	2.60	2.70	2.80	2.60	2.70	2.80	2.60	2.70
T28558	3.15	3.25	3.35	3.45	3.25	3.35	3.45	3.55
T28559-H	3.15	3.25	3.35	3.45	3.25	3.35	3.45	3.55
T32553-H	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T32554	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T32555-H	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T32555-H1	3.00	3.10	3.20	3.30	3.10	3.20	3.30	3.40
T40551	3.40	3.50	3.60	3.40	3.50	3.60	3.40	3.50
T40552	3.40	3.50	3.60	3.40	3.50	3.60	3.40	3.50

-DRAWING NOT TO SCALE-

		
TITLE: PACKAGE OUTLINE. 16, 20, 28, 32, 40L THIN QFN, 5x5x0.8mm		
APPROVAL:	DOCUMENT CONTROL NO. 21-0140	REV. J 2

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