

#### **General Description**

The MAX4613 quad analog switch features on-resistance matching (4 $\Omega$  max) between switches and guarantees on-resistance flatness over the signal range (9 $\Omega$ max). This low on-resistance switch conducts equally well in either direction. It guarantees low charge injection (10pC max), low power consumption (35µW max), and an electrostatic discharge (ESD) tolerance of 2000V minimum per Method 3015.7. The new design offers lower off-leakage current over temperature (less than 5nA at +85°C).

The MAX4613 quad, single-pole/single-throw (SPST) analog switch has two normally closed switches and two normally open switches. Switching times are less than 250ns for ton and less than 70ns for toff. Operation is from a single +4.5V to +40V supply or bipolar ±4.5V to ±20V supplies.

#### **Applications**

Sample-and-Hold Circuits Test Equipment Heads-Up Displays Guidance and Control Systems

Military Radios

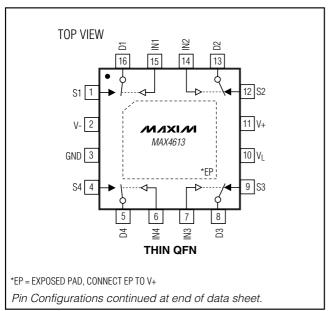
Communication Systems **Battery-Operated Systems** PBX, PABX

Audio Signal Routing Modems/Faxes

#### **Features**

- ♦ Pin Compatible with Industry-Standard DG213
- **♦ Guaranteed Ron Match Between Channels** (4 $\Omega$  max)
- ♦ Guaranteed RFLAT(ON) Over Signal Range (9 $\Omega$  max)
- ♦ Guaranteed Charge Injection (10pC max)
- **♦ Low Off-Leakage Current Over Temperature** (<5nA at +85°C)
- ♦ Withstands 2000V min ESD, per Method 3015.7
- ♦ Low RDS(ON) (85 $\Omega$  max)
- ♦ Single-Supply Operation +4.5V to +40V Bipolar-Supply Operation ±4.5V to ±20V
- ♦ Low Power Consumption (35µW max)
- ♦ Rail-to-Rail Signal Handling
- ◆ TTL/CMOS-Logic Compatible

### **Pin Configurations/** Functional Diagrams/TruthTable



#### **Ordering Information**

PART	TEMP RANGE	PIN-PACKAGE
MAX4613CPE	0°C to +70°C	16 Plastic DIP
MAX4613CSE	0°C to +70°C	16 Narrow SO
MAX4613CEE	0°C to +70°C	16 QSOP
MAX4613CUE	0°C to +70°C	16 TSSOP**
MAX4613CC/D	0°C to +70°C	Dice*
MAX4613ETE	-40°C to +85°C	16 TQFN-EP*** (5mm x 5mm)
MAX4613EPE	-40°C to +85°C	16 Plastic DIP
MAX4613ESE	-40°C to +85°C	16 Narrow SO
MAX4613EEE	-40°C to +85°C	16 QSOP
MAX4613EUE	-40°C to +85°C	16 TSSOP**

<sup>\*</sup>Contact factory for dice specifications.

<sup>\*\*</sup>Contact factory for availability.

<sup>\*\*\*</sup>EP = Exposed Pad

#### **ABSOLUTE MAXIMUM RATINGS**

Voltage Referenced to GND
V++44V
V44V
V+ to V+44V
V <sub>L</sub> (GND - 0.3V) to (V+ + 0.3V)
Digital Inputs Vs VD (Note 1)(V 2V) to (V+ + 2V)
or 30mA (whichever occurs first)
Continuous Current (any terminal)30mA
Peak Current, S_ or D_
(pulsed at 1ms, 10% duty cycle max)100mA

Continuous Power Dissipation ( $T_A = +70^{\circ}C$ )	
Plastic DIP (derate 10.53mW/°C above +70°C	C)842mW
Narrow SO (derate 8.70mW/°C above +70°C	C)696mW
QSOP (derate 8.3mW/°C above +70°C)	667mW
Thin QFN (derate 33.3mW/°C above +70°C)	2667mW
TSSOP (derate 6.7mW/°C above +70°C)	457mW
Operating Temperature Ranges	
MAX4613C	0°C to +70°C
MAX4613E	40°C to +85°C
Storage Temperature Range	
Lead Temperature (soldering, 10sec)	+300°C

Note 1: Signals on S\_, D\_, or IN\_ exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current rating.

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 Supplies**

 $(V+ = 15V, V- = -15V, V_L = 5V, GND = 0V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = T_{MIN}$ to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDIT	MIN	TYP (Note 2)	MAX	UNITS		
SWITCH								
Analog Signal Range	Vanalog	(Note 3)		-15		15	V	
Drain-Source On-Resistance	Process	$V_D = \pm 10V$ ,	T <sub>A</sub> = +25°C		55	70	Ω	
Dialii-Source Ori-nesistance	R <sub>DS</sub> (ON)	Is = 1mA	TA = TMIN to TMAX			85	22	
On-Resistance Match	ADDO(ON)	$V_D = \pm 10V$ ,	T <sub>A</sub> = +25°C			4	Ω	
Between Channels (Note 4)	$\Delta R_{DS(ON)}$	I <sub>S</sub> = 1mA	$T_A = T_{MIN}$ to $T_{MAX}$			5	22	
On Designation of Flatness (Note 4)	DEL ATIONS	$V_D = \pm 5V$ ,	T <sub>A</sub> = +25°C			9	Ω	
On-Resistance Flatness (Note 4)	RFLAT(ON)	I <sub>S</sub> = 1mA	$T_A = T_{MIN}$ to $T_{MAX}$			15	22	
Source Leakage Current	1	$V_D = \pm 14V$ ,	T <sub>A</sub> = +25°C	-0.50	0.01	0.50	nA	
(Note 5)	IS(OFF)	V <sub>S</sub> = ∓14V	TA = TMIN to TMAX	-5		5		
Drain-Off Leakage Current	1	$V_D = \pm 14V$ ,	T <sub>A</sub> = +25°C	-0.50	0.01	0.50	A	
(Note 5)	ID(OFF)	Vs = ∓14V	TA = TMIN to TMAX	-5		5	nA	
Drain-On Leakage Current	ID(ON)	V <sub>D</sub> = ±14V,	T <sub>A</sub> = +25°C	-0.50	0.08	0.50	A	
(Note 5)	or Is(ON)	$V_S = \pm 14V$	TA = TMIN to TMAX	-10		10	nA	
INPUT	l .		1					
Input Current with Input Voltage High	linh	V <sub>IN</sub> = 2.4V, all others = 0	V <sub>IN</sub> = 2.4V, all others = 0.8V		-0.00001	0.5	μΑ	
Input Current with Input Voltage Low	linl	V <sub>IN</sub> = 0.8V, all others = 2	-0.5	-0.00001	0.5	μΑ		
SUPPLY	ľ							
Power-Supply Range	V+, V-			±4.5		±20.0	V	
Positive Supply Current	l+	All channels on or off,	T <sub>A</sub> = +25°C	-1 0.00		1		
i ositive supply current	+	$V_{IN} = 0 \text{ or } 5V$	$T_A = T_{MIN}$ to $T_{MAX}$	-5		5	μΑ	
Negative Supply Current	I-	All channels on or off,	T <sub>A</sub> = +25°C	-1	0.001	1	^	
negative Supply Culterit	-	VIN = 0  or  5V	TA = TMIN to TMAX	-5		5	μΑ	

#### **ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)**

 $(V+ = 15V, V- = -15V, V_L = 5V, GND = 0V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDI	MIN	TYP (Note 2)	MAX	UNITS	
Logio Cupply Current	I.	All channels on or off,	T <sub>A</sub> = +25°C	-1	0.001	1	
Logic Supply Current	l_ 	VIN = 0 or 5V	TA = TMIN to TMAX	-5		5	μA  ns ns ns pC  dB  dB  pF pF
Ground Current	love	All channels on or off,	T <sub>A</sub> = +25°C	-1	-0.0001	1	
Ground Current	IGND	$V_{IN} = 0 \text{ or } 5V$	$T_A = T_{MIN}$ to $T_{MAX}$	-5		5	μΑ
DYNAMIC			<u>.</u>	•			
Turn-On Time (Note 3)	ton	$V_S = \pm 10V$ , Figure 2	T <sub>A</sub> = +25°C		150	250	ns
Turn-Off Time (Note 3)	toff	$V_S = \pm 10V$ , Figure 2	T <sub>A</sub> = +25°C		90	120	ns
Break-Before-Make Time Delay (Note 3)	t <sub>D</sub>	Figure 3	T <sub>A</sub> = +25°C	5	20		ns
Charge Injection (Note 3)	Q	C <sub>L</sub> = 1nF, V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0, Figure 4	T <sub>A</sub> = +25°C		5	10	рС
Off-Isolation Rejection Ratio (Note 6)	OIRR	$R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$ , Figure 5	T <sub>A</sub> = +25°C		60		dB
Crosstalk (Note 7)		$R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$ , Figure 6	T <sub>A</sub> = +25°C		100		dB
Source-Off Capacitance	Cs(off)	f = 1MHz, Figure 7	T <sub>A</sub> = +25°C		4		рF
Drain-Off Capacitance	C <sub>D</sub> (OFF)	f = 1MHz, Figure 7	T <sub>A</sub> = +25°C		4		рF
Source-On Capacitance	Cs(on)	f = 1MHz, Figure 8	T <sub>A</sub> = +25°C		16		рF
Drain-On Capacitance	C <sub>D(ON)</sub>	f = 1MHz, Figure 8	T <sub>A</sub> = +25°C		16		рF

 $\textbf{ELECTRICAL CHARACTERISTICS-Single Supply} \\ (V+=12V, V-=0V, V_L=5V, GND=0V, V_{INH}=2.4V, V_{INL}=0.8V, T_A=T_{MIN} \text{ to } T_{MAX}, \text{ unless otherwise noted.})$ 

PARAMETER	SYMBOL	CONDIT	IONS	MIN	TYP (Note 2)	MAX	UNITS			
SWITCH	•		$V_{D} = 3V, 8V; \qquad \begin{array}{c ccccc} & & & & & & & & & & & & & & & & &$							
Analog Signal Range	Vanalog			0		12	V			
Drain-Source	Proyent	$V_L = 5V; V_D = 3V, 8V;$	T <sub>A</sub> = +25°C		100	160	0			
On-Resistance	R <sub>DS(ON)</sub>	$I_S = 1mA$	$T_A = T_{MIN}$ to $T_{MAX}$			200	V Ω V μΑ μΑ			
SUPPLY										
Power-Supply Range	V+, V-			4.5		40	V			
Dawar Cumply Current	1.	All channels on or off,	T <sub>A</sub> = +25°C	-1	0.001	1				
Power-Supply Current	l+	VIN = 0  or  5V	TA = TMIN to TMAX	-5		5	- μA			
Negative Cumply Current		All channels on or off,	T <sub>A</sub> = +25°C	-1	-0.0001	1				
Negative Supply Current	I-	$V_{IN} = 0 \text{ or } 5V$	$T_A = T_{MIN}$ to $T_{MAX}$	-5		5	μΑ			
Lagia Cumply Current	1.	All channels on or off,	T <sub>A</sub> = +25°C	-1	0.001	1				
Logic Supply Current	l IL	$V_{IN} = 0 \text{ or } 5V$	$T_A = T_{MIN}$ to $T_{MAX}$	-5		5	- μΑ			
Ground Current	lavia	All channels on or off,	T <sub>A</sub> = +25°C	-1	-0.0001	1				
Ground Current	IGND	VIN = 0  or  5V	TA = TMIN to TMAX	-5		5	μΑ			

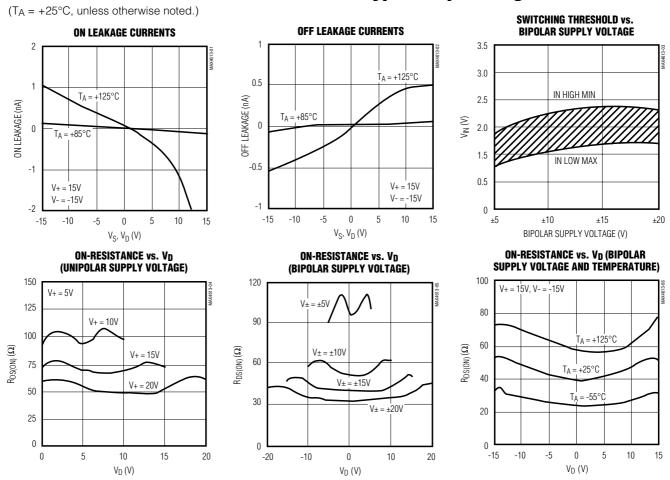
#### **ELECTRICAL CHARACTERISTICS—Single Supply (continued)**

(V+ = 12V, V- = 0, VL = 5V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITION	s	MIN	TYP (Note 2)	MAX	UNITS
DYNAMIC							
Turn-On Time (Note 3)	ton	V <sub>S</sub> = 8V, Figure 2	$T_A = +25^{\circ}C$		300	400	ns
Turn-Off Time (Note 3)	toff	V <sub>S</sub> = 8V, Figure 2	T <sub>A</sub> = +25°C		60	200	ns
Charge Injection (Note 3)	Q	C <sub>L</sub> = 1nF, V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0, Figure 4	T <sub>A</sub> = +25°C		5	10	рС

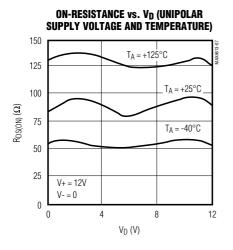
- Note 2: Typical values are for design aid only, are not guaranteed and are not subject to production testing. The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.
- Note 3: Guaranteed by design.
- Note 4: On-resistance match between channels and flatness are guaranteed only with bipolar-supply operation. Flatness is defined as the difference between the maximum and the minimum value of on-resistance as measured at the extremes of the specified analog signal range.
- Note 5: Leakage parameters Is(OFF), ID(OF), ID(ON), and Is(ON) are 100% tested at the maximum rated hot temperature and guaranteed at +25°C. Note 6: Off-Isolation Rejection Ratio = 20log (VD/Vs).
- Note 7: Between any two switches.

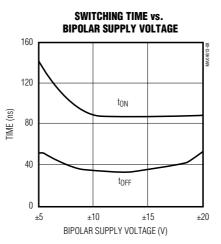
#### **Typical Operating Characteristics**

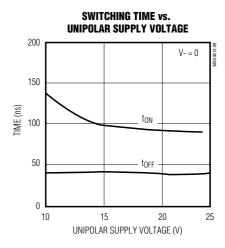


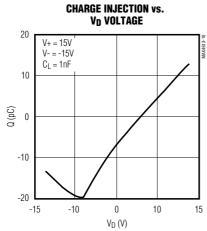
### Typical Operating Characteristics (continued)

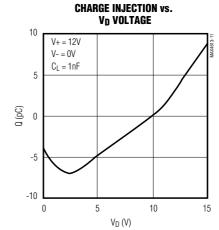
 $(T_A = +25^{\circ}C, \text{ unless otherwise noted.})$ 











### Pin Description

PI	PIN		FUNCTION					
DIP/SO/TSSOP	THIN QFN	NAME	FUNCTION					
1, 8, 9, 16	6, 7, 14, 15	IN1-IN4	Logic Control Input					
2, 7, 10, 15	5, 8, 13, 16	D1-D4	Analog-Switch Drain Output					
3, 6, 11, 14	1, 4, 9, 12	S1-S4	Analog-Switch Source Output					
4	2	V-	Negative-Supply Voltage Input					
5	3	GND	Ground					
12	10	VL	Logic-Supply Voltage Input					
13	11	V+	Positive-Supply Voltage Input—Connected to Substrate					
_	EP	PAD	Exposed Pad. Connect PAD to V+.					

### **Applications Information**

#### **General Operation**

- 1) Switches are open when power is off.
- 2) IN\_, D\_, and S\_ should not exceed V+ or V-, even with the power off.
- 3) Switch leakage is from each analog switch terminal to V+ or V-, not to other switch terminals.

#### Operation with Supply Voltages Other than ±15V

Using supply voltages less than  $\pm 15V$  will reduce the analog signal range. The MAX4613 operates with  $\pm 4.5V$  to  $\pm 20V$  bipolar supplies or with a +4.5V to +40V single supply; connect V- to GND when operating with a single supply. Also, all device types can operate with unbalanced supplies such as +24V and -5V.  $V_L$  must be connected to +5V to be TTL compatible, or to V+ for CMOS-logic level inputs. The *Typical Operating Characteristics* graphs show typical on-resistance with  $\pm 20V$ ,  $\pm 15V$ ,  $\pm 10V$ , and  $\pm 5V$  supplies. (Switching times increase by a factor of two or more for operation at  $\pm 5V$ .)

#### **Overvoltage Protection**

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the devices. Always sequence V+ on first, followed by V<sub>L</sub>, V<sub>-</sub>, and logic inputs. If power-supply sequencing is not possible, add two small, external signal diodes in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to 1V below V+ and 1V above V-, but low switch resistance and low leakage characteristics are unaffected. Device operation is unchanged, and the difference between V+ and V-should not exceed +44V.

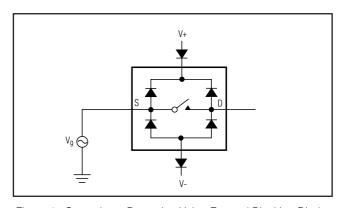


Figure 1. Overvoltage Protection Using External Blocking Diodes

### Timing Diagrams/Test Circuits

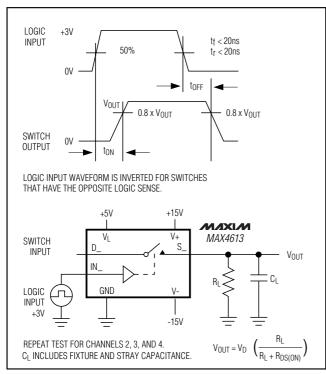


Figure 2. Switching Time

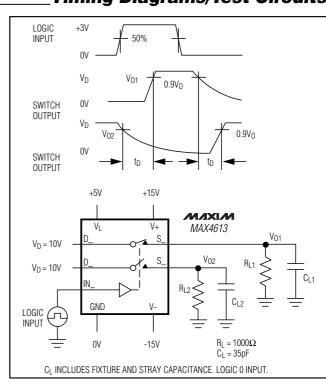


Figure 3. Break-Before-Make Test Circuit

**Revision History** 

Pages changed at Rev 3: 1, 9, 10

### Timing Diagrams/Test Circuits (continued)

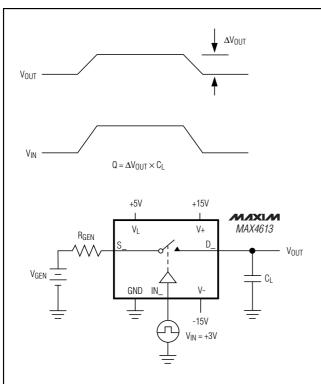


Figure 4. Charge Injection

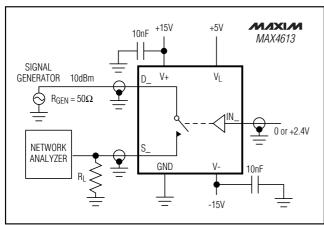


Figure 5. Off-Isolation Rejection Ratio

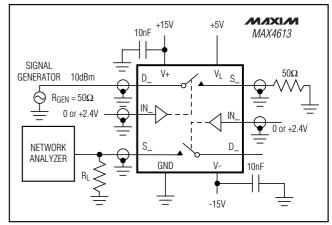


Figure 6. Crosstalk

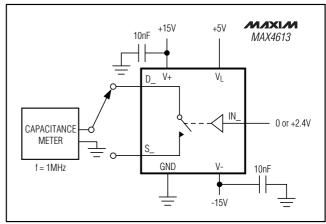


Figure 7. Source/Drain-Off Capacitance

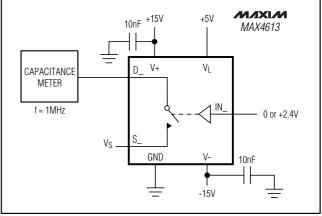
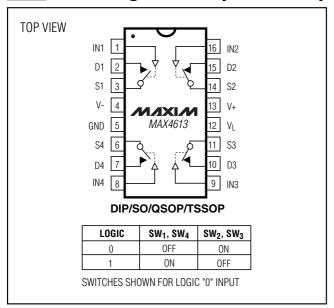


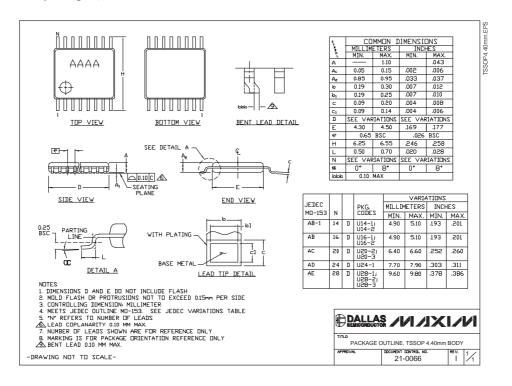
Figure 8. Source/Drain-On Capacitance

#### Pin Configurations (continued)



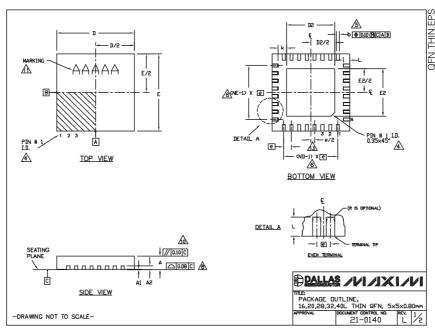
### **Package Information**

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to <a href="https://www.maxim-ic.com/packages">www.maxim-ic.com/packages</a>.)



### Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)



						COMP	AON D	IMEN:	SIONS									EX	POSED	PAD V	/ARIAT	ZMDI	
PKG. 16L 5x5 20L 5x5 28L 5x5 32L 5x5 40L 5						1	PKG.	DS ES															
MBOL	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN	NDM.	MAX.	MIN.	NOM.	MAX.	]	CODES	MIN.	NOM.	мах.	MIN.	NOM.	MAX.
Α	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	1	T1655-2	3.00	3.10	3.20	3.00	3.10	3.20
Al	0	9.02	0.05	0	0.02	0.05	0	9.02	0.05	0	0.02	0.05	0	0.02	0.05	]	T1655-3	3.00	3.10	3.20	3.00	310	3.20
<b>SA</b>		20 RE			0 RE			20 RE			20 RE			20 RE			T1655N-1	3.00	3.10	3.20	3.00	3.10	3.20
														0.20		1	T2055-3	3.00	3.10	3.20	3.00	3.10	3.20
D														5.00		1	T2055-4	3.00	3.10	3.20	3.00	3.10	3.20
E														5,00			T2055-5	3.15	3.25	3.35	3.15	3.25	3.35
e	_	BO B:			65 B			50 B			50 38			140 BS	C.	1	T2055MN-5		3.25	3.35		3.25	3.35
k L	0.25		-	0.25			0.25			0.25			0.25		-	-	T2855-3	3.15	3.25	3.35		3.25	3.35
N	0.30	16	u.50	U.45	20	U.65	0.45	28	0.65	u.30	32	v.50	u.30	0.40	0.50	1	T2855-4	2.60	2.70	2.80	2.60	2.70	2.80
ND ND	$\vdash$	4		_	5		-	7		$\vdash$	SE R			10		1	T2855-5	2.60	2.70	2.80	2.60	2.70	2.80
NE.	$\vdash$	4	_	_	5		-	7	_	$\vdash$	8			10		1	T2855-6	3.15	3.25	3.35	3.15	3.25	3.35
EDEC	_	/HHB		١	VHHC		١	/HHD-	-i	V	/HHD-	2				1	T2855-7	2.60	2.70	2.80	2.60	2.70	2.90
							_									•	T2855-8	3.15	3.25	3.35		3.25	3.35
																	T2855N-1	3.15	3.25	3.35	3.15	3.25	3.35
OTES:																	T3255-3	3.00	3.10	3.20	3.00	3.10	3.20
DIM																	T3255-4	3.00	3.10	3.20	3.00	3.10	3.20
				NUMBE					JLES	MKL	IN D	EURE	E3.				T3255M-4	3.00	3.10	3.20	3.00	3.10	3.20
THE									AL N	UMBE	RING	CON	√ENT	IDN S	HALL		T3255-5	3.00	3.10	3,20	3.00	310	3.20
														TIFIE			T3255N-1	3,00	3.10	3.20	3.00	3.10	3.20
OP"	TIONA	L, BI	JT MI	JST B	ELD	CATE	D VI	THIN	THE	ZON	E IND	ICAT	ED. 1	THE T	ermi	NAL #1	T4055-1	3.40	3.50	3.60	3.40	3.50	3.60
				E EI													T4055-2	3,40	3.50	3,60	3.40	3.50	3.60
Z DIM				LIES mm F					RMINA	L AN	D 12	MEA	SURE	D BET	WEE	N	T4055MN-1	3.40	3.50	3.60	3.40	3.50	3.60
DEF COF DR/ T26 WA 1. MAF 2. NUI	POPUL PLANA AVINO B55-3 RPAG RKING 4BER AD CE	ATIO RITY CON B, T2 E SH IS I OF L	n is App Iforn 855- All I For I Eads Rline	POSS LIES IS TO 6, T4 NOT E PACKA S SHO S TO	JEI JEI O55- XCEI VN / BE	THE EDEC NO. 1 AND DEC NO. 1 AND DEC NO. 1 AND DEC NO. 1 AND DEC NO. 1 AND TO ARE FOR AT TO	A SYP EXPOS 10220 D T40 10 mm ITATII FOR F	METI ED H , EXC 055-2 ON RI EEFER POSII	RICAL HEAT CEPT 2. EFERE RENCE	FAS SINK EXPO ENCE ONL	SHION. SLUC ISED INLY	G AS PAD	VEL DIME	L AS NSION	THE	RESPECTIVELY.  TERMINALS.  SION "e", ±0.05.			AS	<u>/</u>	/1/	<b>1</b> >	(1,

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