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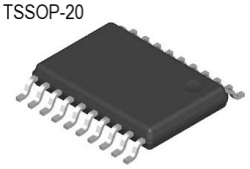
LEOAC74

Datasheet

Rad-hard plastic Dual D-type positive edge-triggered flip-flop

TSSOP-20



Maturity status link
LEOAC74

Features

- Dual D-type positive edge-triggered flip-flop
- 1.65 V to 6 V operating supply
- 7 V max. rating
- 8.5 ns propagation delay
- Nickel/Palladium/Gold-lead-finished (NiPdAu), whisker-free
- Gold-wires
- RML <1% and CVCM <0.1% guaranteed outgassing
- 50 krad (Si) Total Ionizing Dose
- SEL-free up to 62.5 MeV.cm²/mg
- Mass: 80 mg
- Compliant with ST-LEO-specification

Applications

- Low earth orbit (LEO) applications

Description

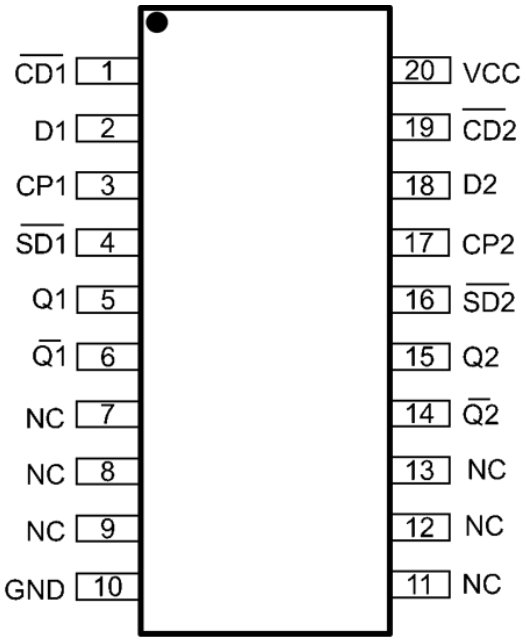
The LEOAC74 is a CMOS Dual D-type positive edge-triggered flip-flop for use in aerospace environments. It operates from 1.65 V to 6 V power supply (7 V absolute maximum rating).

The LEOAC74 can operate over a large temperature range of -40 °C to +125 °C and it is housed in plastic TSSOP-20, Thin-Shrink Small Outline Package, 20 leads, using golden bonding and Nickel/Palladium/Golden-lead-finishing to prevent whiskers.

The LEOAC74 is compliant with ST-LEO-specification, dedicated specification for space-ready rad-hard plastic products. This AEC-Q100-based specification offers a specific trade-off between footprint size savings, cost of ownership and quality assurance together with radiation hardness and large quantity capability.

1 Functional description

Figure 1. **Pin connections (top view)**



NC: not internally connected.

The pin can be externally connected to any potential.

Figure 2. **Equivalent schematic**

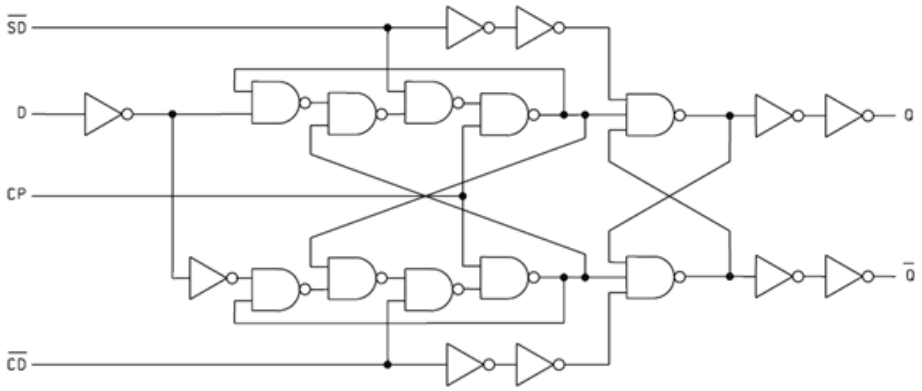


Table 1. Truth table for each flip-flop

INPUTS				OUTPUTS	
/SD	/CD	CP	D	Q	/Q
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H [1]	H [1]
H	H	Rise clock edge	H	H	L
H	H	Rise clock edge	L	L	H
H	H	L	X	Q0	/Q0

1. *This configuration is unstable; that is, it does not persist when either SD or CD returns to its inactive (high) level.*

H = High voltage level.

L = Low voltage level.

X = Don’t care.

Q0 (or /Q0) = Previous Q (or /Q) before low to high transition of clock.

* = This configuration is unstable; that is, it does not persist when either SD or CD returns to its inactive (high) level.

2 Maximum ratings and operating conditions

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC} (1)	Maximum power supply between V_{CC} and GND	-0.5 to 7	V
V_{IN}	DC input voltage range	-0.5 to V_{CC} +0.5 (and 7 V max.)	V
V_{OUT}	DC output voltage range	-0.5 to V_{CC} + 0.5 (and 7 V max.)	V
I_K	I/O clamp diode current	+/-20	mA
T_{stg}	Maximum temperature storage	-65 to +150	°C
T_j (2)	Maximum junction temperature	+150	°C
R_{th} (3)	Junction to ambient thermal resistance (Θja)	80	°C/W
	Junction to case thermal resistance (Θjc)	17	°C/W
ESD	HBM (human body model)	2k	V

1. *All voltages, except differential I/O bus voltage, are with respect to the network ground terminal.*
2. *Maximum junction temperature shall not be exceeded except for allowable short duration burn-in screening conditions as per the method 5004 of MIL-STD-883.*
3. *Short-circuits can cause excessive heating. Destructive dissipation can result from short-circuits on the amplifiers.*

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. All values are referred to GND.

Table 3. Operating conditions

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Analog supply voltage	1.65	6	V
V_{IN}	Input voltage range	0	V_{CC}	V
V_{OUT}	Output voltage range	0	V_{CC}	V
Ta	Ambient temperature range	-40	+125	°C

Note: All unused inputs must be held at VCC or GND to ensure proper device operation.

3 Electrical characteristics

V_{CC} = 3 V to 5.5 V, typical values are at ambient Ta = +25 °C, min. and max. values are at Ta = -40 °C and +125 °C, unless otherwise specified.

Table 4. Electrical characteristics.

Symbol	Parameter	Test condition	VCC (V)	Min.	Typ.	Max.	Unit
V_{OH} (1)	High level output voltage	For all inputs affecting output under test, V_{IN} = V_{IH} minimum or V_{IL} maximum. For all other inputs, V_{IN} = V_{CC} or GND, I_{OH} = -50 µA	3	2.9			V
			4.5	4.4			
			5.5	5.4			
		For all inputs affecting output under test, V_{IN} = V_{IH} minimum or V_{IL} maximum. For all other inputs, V_{IN} = V_{CC} or GND, I_{OH} = -12 mA	3	2.4			
		For all inputs affecting output under test, V_{IN} = V_{IH} minimum or V_{IL} maximum. For all other inputs, V_{IN} = V_{CC} or GND, I_{OH} = -24 mA	4.5	3.7			
			5.5	4.7			
		For all inputs affecting output under test, V_{IN} = V_{IH} minimum or V_{IL} maximum. For all other inputs, V_{IN} = V_{CC} or GND I_{OH} = -50 mA	5.5	3.85			
V_{OL} (1)	Low level output voltage	For all inputs affecting output under test, V_{IN} = V_{IH} minimum or V_{IL} maximum. For all other inputs, V_{IN} = V_{CC} or GND, I_{OL} = +50 µA	3			0.1	V
			4.5			0.1	
			5.5			0.1	
		For all inputs affecting output under test, V_{IN} = V_{IH} minimum or V_{IL} maximum. For all other inputs, V_{IN} = V_{CC} or GND, I_{OL} = +12 mA	3			0.5	
		For all inputs affecting output under test, V_{IN} = V_{IH} minimum or V_{IL} maximum. For all other inputs, V_{IN} = V_{CC} or GND, I_{OL} = +24 mA	4.5			0.5	
			5.5			0.5	
		For all inputs affecting output under test, V_{IN} = V_{IH} minimum or V_{IL} maximum. For all other inputs, V_{IN} = V_{CC} or GND, I_{OL} = +50 mA	5.5			1.65	
I_{OH}	High level output current		3	-12			mA
			4.5	-24			
			5.5	-24			
I_{OL}	Low level output current		3			12	
			4.5			24	
			5.5			24	
V_{IH} (2)	High level input voltage		3	2.1			mA
			4.5	3.15			
			5.5	3.85			
V_{IL} (2)	Low level input voltage		3			0.9	V
			4.5			1.35	
			5.5			1.65	

Symbol	Parameter	Test condition	VCC (V)	Min.	Typ.	Max.	Unit
V_{IC+}	Positive input clamp voltage	For input under test, I_{IN} = -1.0 mA	0	0.4		1.5	V
V_{IC-}	Negative input clamp voltage	For input under test, I_{IN} = -1.0 mA	Open	0.4		-1.5	V
I_{IH}	Input current high	For input under test, V_{IN} = V_{CC}. For all other inputs, V_{IN} = V_{CC} or GND	5.5			1	µA
I_{IL}	Input current low	For input under test, V_{IN} = GND. For all other inputs, V_{IN} = V_{CC} or GND	5.5			-1	µA
I_{CCH}	Quiescent supply current, output high	For all inputs, V_{IN} = V_{CC} or GND I_{OUT} = 0 A	5.5			40	µA
I_{CCL}	Quiescent supply current, output low	For all inputs, V_{IN} = V_{CC} or GND I_{OUT} = 0 A	5.5			40	µA
C_{IN} (3)	Input capacitance	Ta = +25 °C	5			10	pF
C_{PD} (3) (4)	Power dissipation capacitance	Ta = +25 °C, F = 1 MHz	5			88	pF
T_r, T_f	Output rise time and fall time	C_L = 2 pF, R_L = 500 ohm (see Figure 3)	3		3.7		ns
			4.5		2.0		
		C_L = 50 pF, R_L = 500 ohm (see Figure 3)	3		5.2		
			4.5		4.5		
T_{PHL} (5)	Propagation delay time An to Yn, high to low	C_L = 50 pF, R_L = 500 ohm (see Figure 3)	3	1		11.5	ns
			4.5	1		8.5	
T_{PLH} (5)	Propagation delay time An to Yn, low to high	C_L = 50 pF, R_L = 500 ohm (see Figure 3)	3	1		12.5	
			4.5	1		9	

1. *The V_{OH} and V_{OL} tests shall be tested at V_{CC} = 3.0 V and 4.5 V. The V_{OH} and V_{OL} tests are guaranteed, if not tested, for other values of V_{CC}. Limits shown apply to operation at V_{CC} = 3.3 V, ±0.3 V and V_{CC} = 5.0 V ±0.5 V. Tests with input current at +50 mA and –50 mA are performed on only one input at a time with duration not to exceed 10 ms. Transmission driving tests may be performed using V_{IN} = V_{CC} or GND. When V_{IN} = V_{CC} or GND is used, the test is guaranteed for V_{IN} = V_{IH} minimum and V_{IL} maximum.*
2. *The V_{IH} and V_{IL} tests are not required if applied as forcing functions for V_{OH} and V_{OL} tests.*
3. *C_{IN} and C_{PD} shall be measured only for initial qualification and after process or design changes which may affect capacitance. C_{IN} shall be measured between the designated terminal and GND at a frequency of 1 MHz. C_{PD} shall be tested in accordance with the latest revision of JEDEC Standard JESD20 and table IA herein. For C_{IN} and C_{PD}, test all applicable pins on five devices with zero failures.*
4. *Power dissipation capacitance (C_{PD}) determines both the power consumption (P_D) and dynamic current consumption (IS). Where: P_D = (C_{PD} + C_L) (V_{CC} x V_{CC}) f + (I_{CC} x V_{CC}) and IS = (C_{PD} + C_L) V_{CC} x f + I_{CC}, and f is the frequency of the input signal and C_L is the external output load capacitance.*
5. *For propagation delay tests, all paths are tested. The AC limits at V_{CC} = 5.5 V are equal to the limits at V_{CC} = 4.5 V and guaranteed by testing at V_{CC} = 4.5 V. The AC limits at V_{CC} = 3.6 V are equal to the limits at V_{CC} = 3.0 V and guaranteed by testing at V_{CC} = 3.0 V. Minimum AC limits for V_{CC} = 5.5 V and V_{CC} = 3.6 V are 1.0 ns and guaranteed by guard banding the V_{CC} = 4.5 V and V_{CC} = 3.0 V minimum limits, respectively, to 1.5 ns. For propagation delay tests, all paths must be tested.*

4 Waveform and test circuit

Figure 3. **Switching waveforms**

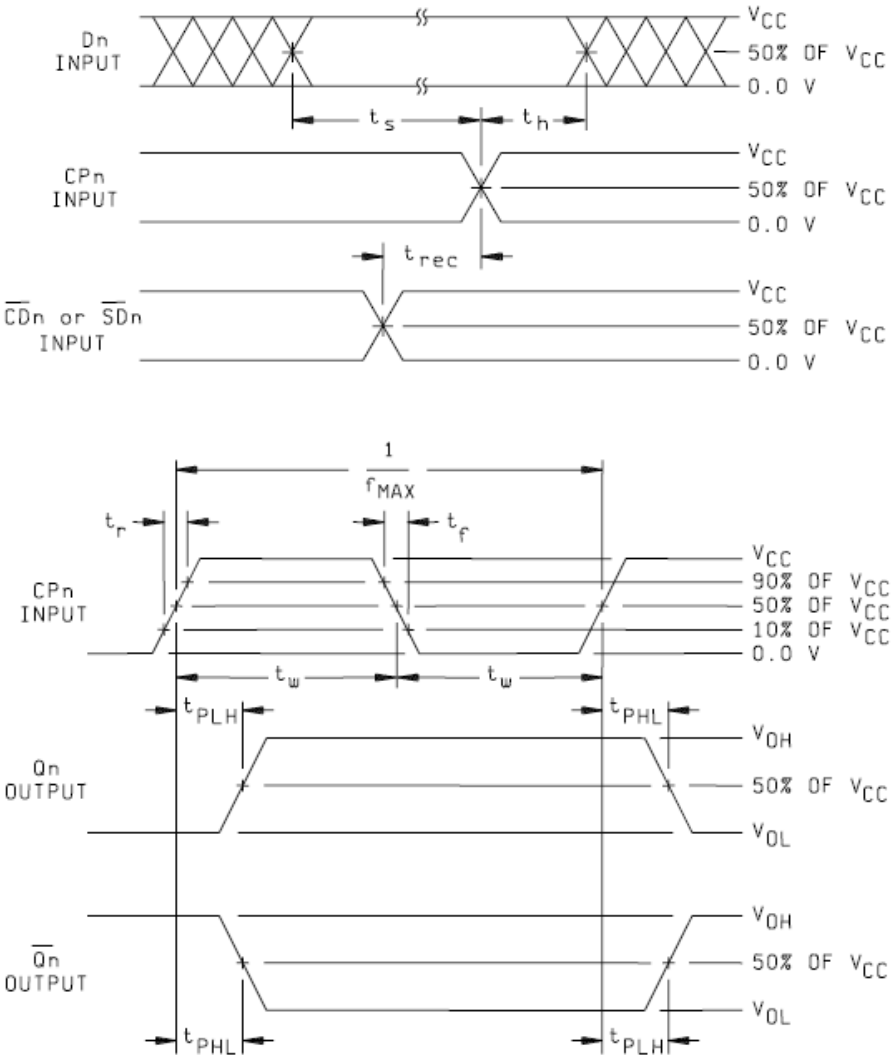


Figure 4. **Switching wave forms (continued)**

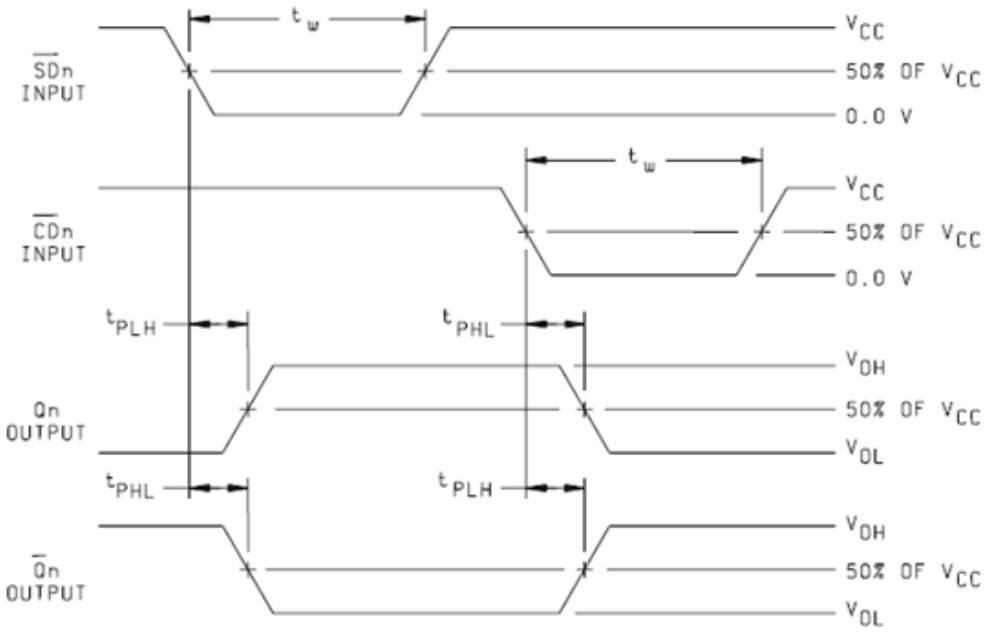
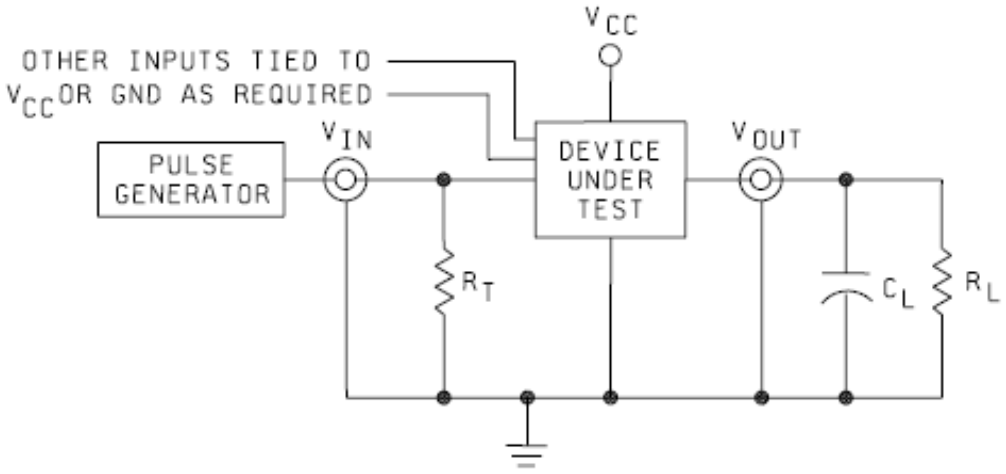


Figure 5. **Test circuit**



Note:

- *V_{TEST} = open for t_{PLH} and t_{PHL}.*
- *C_L = 50 p_F or equivalent (includes probe and jig capacitance).*
- *R_L = 500-ohm or equivalent.*
- *Input signal from pulse generator: V_{IN} = 0.0 V to V_{CC}; P_{RR} < 1 MHz; ZO = 50-ohm; tr < 3.0 ns; tf < 3.0 ns; tr and tf shall be measured from 10% of V_{CC} to 90% of V_{CC} and from 90% of V_{CC} to 10% of V_{CC}, respectively; duty cycle = 50 percent.*
- *Timing parameters shall be tested at a minimum input frequency of 1 MHz.*
- *The outputs are measured one at a time with one transition per measurement.*

5 Radiations

Total ionizing dose (TID):

For the qualification, the product is characterized in TID as per MIL-STD-883 TM 1019 up to 50 krad(Si) on 5 biased parts at high dose rate, such a rate being the worst condition for a pure CMOS technology.

All parameters provided in Table 1 apply to both pre- and post-irradiation.

Each new production lot is tested at high dose rate as per MIL-STD-883 TM 1019 on 5 parts.

Heavy-ions:

Single Event Latchup (SEL) is characterized at 125 °C at a LET of 62.5 MeV.cm2/mg. The test shows the product is immune to heavy ions at this LET. Heavy-ion trials are performed on qualification lots only.

The results in radiation are summarized in table 5 as follows.

Table 5. Radiations

Type	Conditions	Results
TID(1)	• High-dose rate (40 krad (Si) / h) • Temperature: 25 °C • Performed on 5 biased parts	Within Table 1 up to 50 krad(Si)
SEL(2)	• LET: 62.5 MeV.cm2/mg (Xenon ions) • Temperature: 125 °C • Fluence: 1 x 10^7 ions/cm^2 (10 Million of particles per cm^2) • Normal incidence	Immune to SEL up to 62.5 MeV.cm^2/mg

1. *A total ionizing dose (TID) of 50 krad(Si) is equivalent to 500 Gy(Si), (1 gray = 100 rad).*
2. *SEL: single event latch-up.*

6 Outgassing

Specification (tested per ASTM E 595)	Value	Unit
Recovered mass loss (RML) (1)	0.06	%
Collected volatile condensable material (CVCM) (2)	0.00	%

1. *RML < 1%*
2. *CVCM < 0.1%*

7 Package information

To meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions, and product status are available at: www.st.com. ECOPACK is an ST trademark.

7.1 TSSOP-20 package information

Figure 6. TSSOP-20 Mechanical drawing

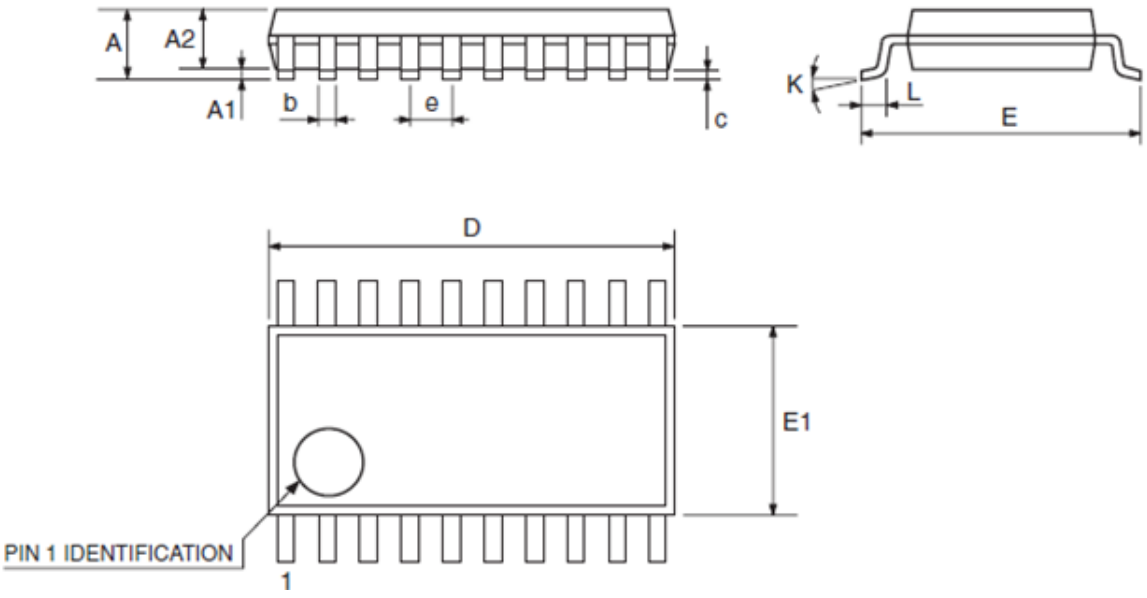


Table 6. TSSOP-20 package mechanical data

Symbol	Milimeters			Inches[1]		
	Min.	Typ.	Max.	Min	Typ	Max
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		
c	0.09		0.20	0.004		
D	6.4	6.5	6.6	0.252	0.256	0.260
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030

1. *Values in inches are converted from mm and rounded to 4 decimal digits.*

Note: TSSOP: Thin-Shrink Small Outline Package, using golden bonding and Nickel/Palladium/Golden-lead-finishing.

7.2 TSSOP-20 packing information

Figure 7. **TSSOP-20 Carrier tape (dimensions in mm)**

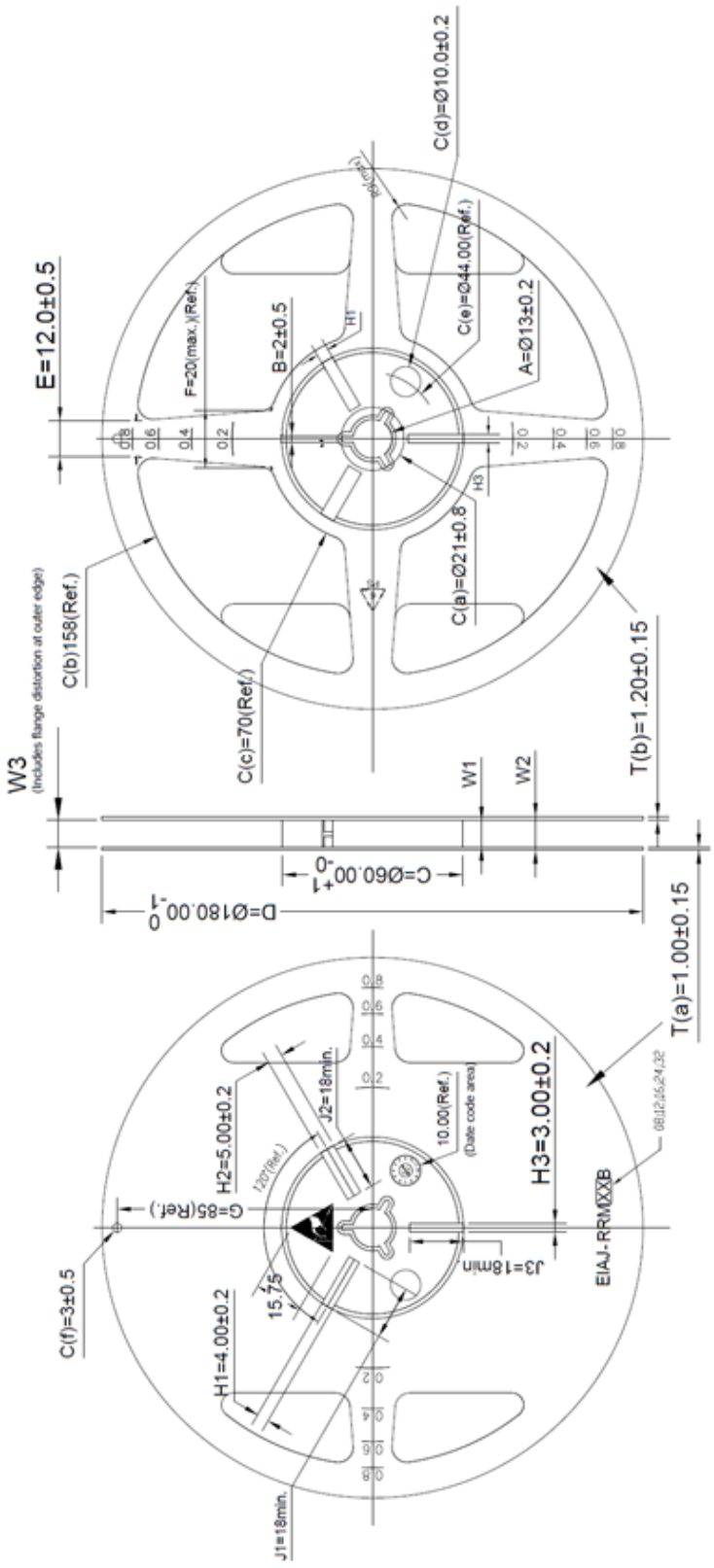
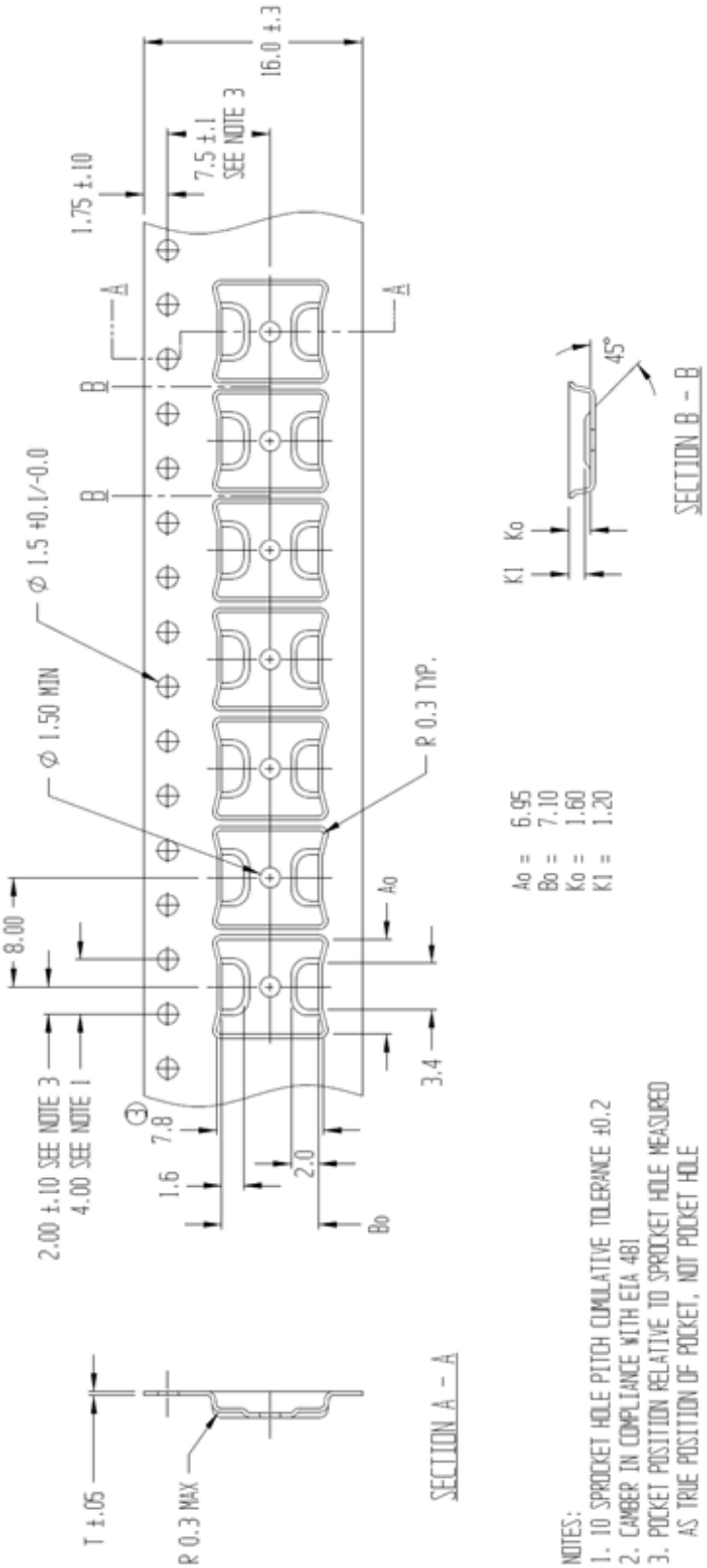


Figure 8. **Tape drawing for TSSOP-20 (dimensions in mm)**



8 Ordering information

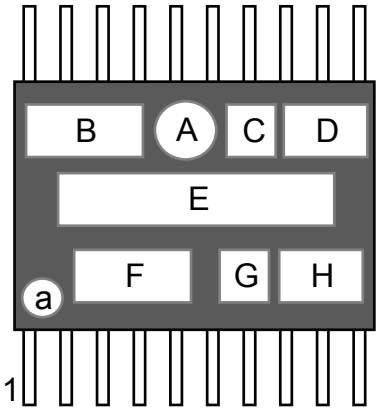
Table 7. **Ordering information**

Order code	Quality level	Package	Lead-finish	Marking	Packing
LEOAC74PT-D	Development sample	TSSOP-20	NiPdAu	DLEOAC74	Tape and reel
LEOAC74PT	Flight model	TSSOP-20	NiPdAu	LEOAC74	Tape and reel

Table 8. **Order code**

LEO	AC74	P	T
LEO qualification	Name	TSSOP-20 package	Tape and reel

Figure 9. **TSSOP20 Marking**



a: pin-1 reference
A : Second Level of interconnexion (type of lead-finishing)
B: ST logo
C: Assy plant
D: Lot code
E: Marking area
F: Country of origin
G: Assy year
H: Assy week

Revision history

Table 9. **Document revision history**

Date	Version	Changes
10-Jan-2022	1	First release.
31-Jan-2022	2	Removed footnote in Table 7. Ordering information.
27-Sep-2024	3	Updated minimum operating power supply from 2 V to 1.65 V.

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