

Description

Abracon's ultra-low power Real-Time Clock (RTC) module with embedded 32.768 kHz crystal oscillator, AB-RTC-XP-32.768kHz-2, uses I²C communication interface to configure numerous features while sustaining frequency accuracy ($\pm 20\text{ppm}$ @ 25°C) in a compact lead-free ceramic SMD 2.0 x 1.2 mm package. These features include a digital offset function, alarm and timer function capability, oscillator stop detection and internal power-on reset function. The RTC has a broad operating power supply range of 0.9V to 5.5V with low power consumption (190nA @ 3V).



Features

- Very low power consumption: 190nA @ 3V
- Time accuracy: ± 20 ppm @ 25°C
- Oscillator stop detection function
- Integrated CMOS Oscillator with 32.768kHz crystal resonator
- Wide operating voltage range: 0.9V to 5.5V
- Wide interface operating voltage: 1.8 to 5.5V
- Programmable offset register for frequency adjustment
- Internal Power-On Reset (POR)
- Alarm Interrupts for second, minutes, hour, date and weekday
- Automatic leap year calculation (2000 to 2099)
- Clock output: 32.768 kHz, 16.384kHz, 8.192 kHz, 4.096 kHz, 2.048 kHz, 1.024 kHz, and 1 Hz
- I²C-bus interface: 400 kHz
- REACH/RoHS II Compliant | MSL Level 1

Typical Applications

- IoT, Smart Metering
- Industrial, Factory Automation
- Health Care Monitoring Systems
- Wearables, Portables, and Sensors

Absolute Maximum Ratings according to IEC 60134:

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V _{DD}	Power Supply Voltage		-0.5		6.5	V
I _{DD}	Power supply Current		-50		50	mA
V _I	Input voltage	Input Pin	-0.5		6.5	V
V _O	Output voltage	Output Pin	-0.5		6.5	V
I _I	Input current		-10		10	mA
I _O	Output current		-10		10	mA
P _{TOT}	Total power dissipation				300	mW
V _{ESD}	ESD Voltage	HBM			± 5000	V
		CDM			± 2000	V
I _{LU}	Latch-up Current	JEDEC			± 200	mA
T _{OPR}	Operating Temperature		-40		85	°C
T _{STO}	Storage Temperature		-55		125	°C
T _{PEAK}	Maximum reflow condition	JEDEC J-STD-020C			265	°C

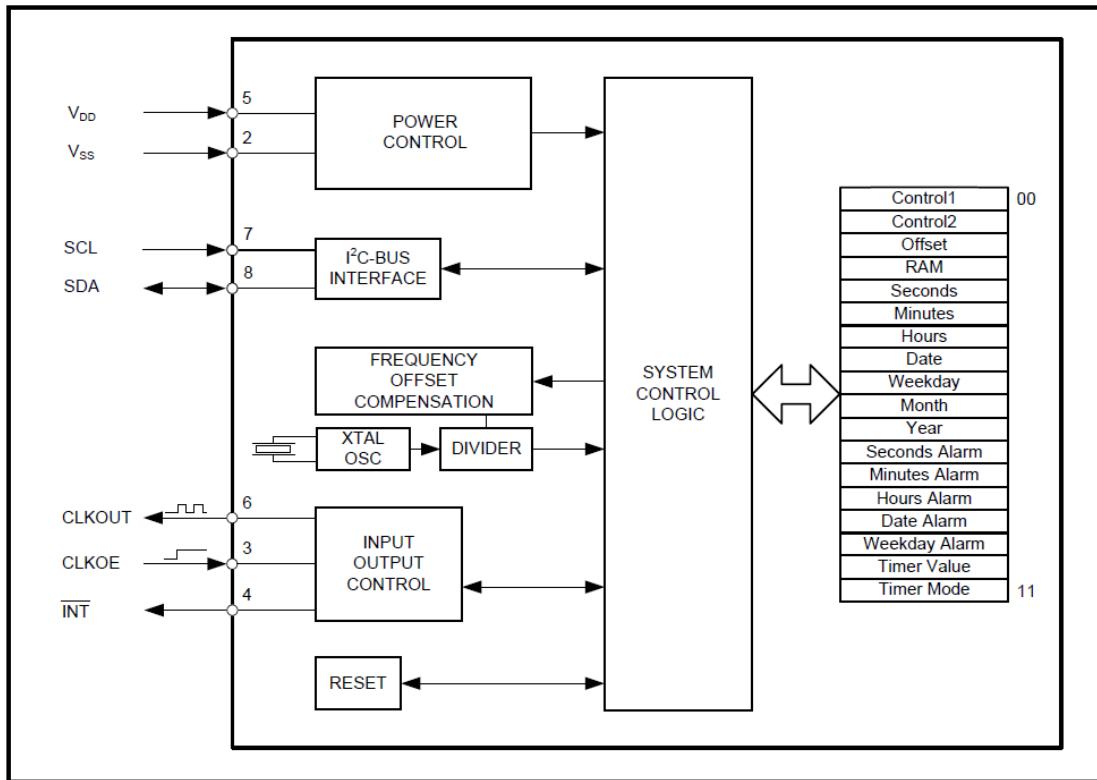
Conditions:

HBM: Human Body Model, according to JESD22-A114.

CDM: Charged-Device Model, according to JESD22-C101.

Latch-up testing: According to JESD78, at maximum ambient temperature (TA(max))

Block Diagram



Frequency Characteristics ($T_A = -40$ to $+85^\circ\text{C}$ unless otherwise indicated. $V_{DD} = 0.9$ to 5.5V , TYP values at 25°C and 3.0V)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
F	Crystal Frequency			32.768		kHz
t_{START}	Oscillator start-up time			0.2	2	s
$\Delta f/V$	Frequency vs. voltage characteristics			± 1		ppm/V
δ_{CLKOUT}	CLKOUT duty cycle	$F_{\text{CLKOUT}} = 32.768 \text{ kHz}$, $T_A = 25^\circ\text{C}$	40		60	%
$\Delta F/F$	Frequency accuracy	$F_{\text{CLKOUT}} = 32.768 \text{ kHz}$, $T_A = 25^\circ\text{C}$, $V_{DD} = 3.0 \text{ V}$		± 10	± 20	ppm
$\Delta F/F_{\text{TOPR}}$	Frequency vs. temperature characteristics	$T_{\text{OPR}} = -40$ to $+85^\circ\text{C}$ $V_{DD} = 3.0 \text{ V}$		$-0.035 \text{ ppm}/^\circ\text{C}^2 (T_{\text{OPR}} - T_0)^2 \pm 10\%$		ppm
T_0	Turnover temperature		20		30	$^\circ\text{C}$
$\Delta F/F$	Aging first year max.	$T_A = 25^\circ\text{C}$, $V_{DD} = 3.0 \text{ V}$			± 3	ppm

DC Characteristics ($T_A = -40$ to $+85^\circ\text{C}$ unless otherwise indicated. $V_{DD} = 0.9$ to 5.5V , TYP values at 25°C and 3.0V)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Supplies						
V_{DD}	Power Supply Voltage	Time-keeping mode ⁽¹⁾ ; interface; $f_{SCL} = 0\text{ Hz}$	0.9		5.5	V
		Interface active ⁽²⁾ ; $f_{SCL} = 400\text{ kHz}$	1.8		5.5	
I_{DD}	V_{DD} supply current timekeeping. CLKOUT disabled; Interface inactive, $f_{SCL} = 0\text{ Hz}$ ⁽³⁾	$V_{DD} = 3.0\text{ V}$, $T_A = 25^\circ\text{C}$		190		nA
		$V_{DD} = 3.0\text{ V}$, $T_A = 50^\circ\text{C}$ ⁽⁴⁾		230		
		$V_{DD} = 3.0\text{ V}$, $T_A = 85^\circ\text{C}$		450	600	
I_{DD}	V_{DD} supply current timekeeping. CLKOUT disabled; Interface active, $f_{SCL} = 400\text{ kHz}$	$V_{DD} = 3.0\text{ V}$		18	50	μA

Note 1: For reliable oscillator start-up at power-on, V_{DD} greater than 1.2 V has to be applied. If powered up at 0.9 V , t_{START} might be a little higher, especially at high temperature. Normally the power supply is not 0.9 V at start-up and only occurs at the end of a battery discharge.

V_{DD} min of 0.9 V is specified so that the customer can calculate the dimension of a battery or capacitor for a specific application. V_{DD} min of 1.2 V or greater is needed to ensure speedy oscillator start-up time.

Note 2: 400 kHz I²C operation is production tested at 1.8 V . Design methodology allows I²C operation at $1.8\text{ V} - 5\%$ (1.71 V) which has been verified during product characterization on a limited number of devices.

Note 3: Timer source clock = $1/60\text{ Hz}$; level of pins SCL and SDA is V_{DD} or V_{SS} .

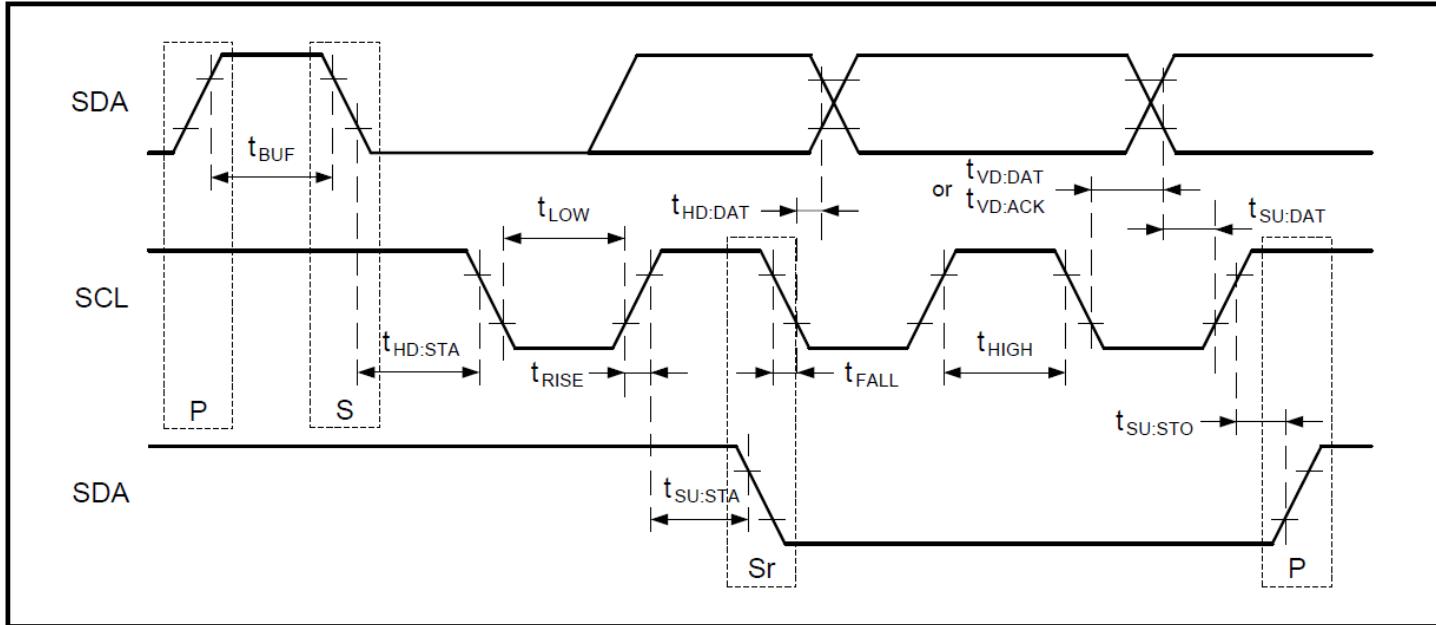
Note 4: Tested on sample basis.

DC Characteristics ($T_A = -40$ to $+85^\circ\text{C}$ unless otherwise indicated. $V_{DD} = 0.9$ to 5.5V , TYP values at 25°C and 3.0V)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Inputs						
V_I	Input Voltage		$V_{SS} - 0.5$		$V_{DD} + 0.5$	
V_{IH}	HIGH level input voltage		$0.7 * V_{DD}$		V_{DD}	V
V_{IL}	LOW level input voltage		V_{SS}		$0.3 * V_{DD}$	V
I_{LEAK}	Input leakage current	$V_I = V_{SS}$ or V_{DD}		0		μA
		$V_I = V_{SS}$ or V_{DD} , post ESD event	-0.15		+0.15	
C_I	Input capacitance ⁽⁵⁾	On pins SDA, SCL and CLKOE			7	pF
Outputs						
V_{OH}	HIGH level output voltage	On pin CLKOUT	$0.8 * V_{DD}$		V_{DD}	V
V_{OL}	LOW level output voltage	On pins SDA, INT, CLKOUT	V_{SS}		$0.2 * V_{DD}$	V
I_{OH}	HIGH level output current	Output source current				
		On pin CLKOUT, $V_{OH} = 2.6\text{V}$, $VDD = 3.0\text{V}$	1	3		V
I_{OL}	LOW level output current	Output sink current				
		On pins, SDA, $V_{OL} = 0.4 \text{ V}$, $VDD = 3.0 \text{ V}$	3	8.5		mA
		On pins, INT, $V_{OL} = 0.4 \text{ V}$, $VDD = 3.0 \text{ V}$	2	6		
		On pin, CLKOUT, $V_{OL} = 0.4 \text{ V}$, $VDD = 3.0 \text{ V}$	1	3		

Note 5: Implicit by design.

I²C BUS Timing Characteristics



I²C AC Characteristics ($V_{DD} = 1.8$ to 5.5V $T_A = -40$ to $+85^\circ C$)

SYMBOL	PARAMETER	MIN	MAX	UNIT
f_{SCL}	SCL input clock frequency	0	400	kHz
t_{LOW}	Low period of SCL clock	1.3		μs
t_{HIGH}	High period of SCL clock	0.6		μs
t_{RISE}	Rise time of SDA and SCL	20	300	ns
t_{FALL}	Fall time of SDA and SCL	$20 \times (V_{DD} / 5.5V)$	300	ns
$t_{HD:STA}$	START condition hold time	0.6		μs
$t_{SU:STA}$	START condition setup time	0.6		μs
$t_{SU:DAT}$	SDA setup time	100		ns
$t_{HD:DAT}$	SDA hold time	0		μs
$t_{SU:STO}$	STOP condition setup time	0.6		μs
t_{BUFS}	Bus free time before a new transmission	1.3		μs
$t_{VDD:DAT}$	Data valid time	0	0.9	μs
$t_{VDD:ACK}$	Data valid acknowledge time	0	0.9	μs
t_{SP}	Spike pulse width	0	50	ns
C_b	Capacitive load for each bus line		400	pF

S = Start condition, Sr = Repeated Start condition, P = Stop condition

Caution:

When communicating with the AB-RTC-XL-32.768kHz-2 module, the series of operations from transmitting the START (or repeated START) condition to transmitting the STOP (or repeated START) condition should occur within 1 second. If this series of operations requires 1 second or more, the I²C-bus interface will be automatically cleared and set to standby mode by the bus timeout function of the AB-RTC-XL-32.768kHz-2 module.

Part Identification

AB - RTC - XP - 32.768kHz - 2 -

Packaging	
Blank: Bulk	
T1: 1000pcs / reel	
T3: 3000pcs / reel	

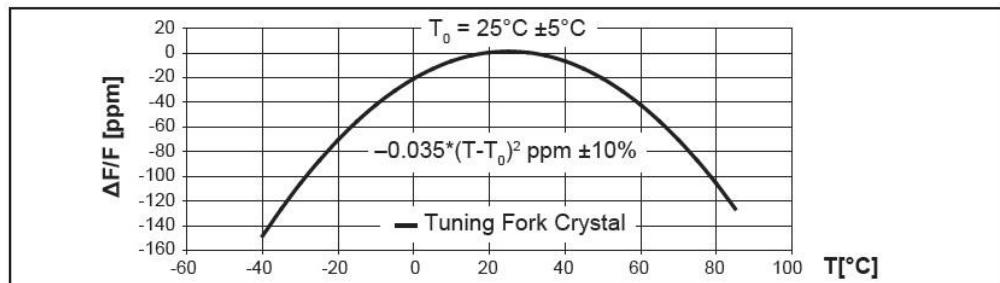
Environmental Characteristics

		Conditions	Max. Dev.
Shock resistance	$\Delta F/F$	5000 g, 0.3 ms, $\frac{1}{2}$ sine	± 5 ppm
Vibration resistance	$\Delta F/F$	20 g / 10–2000 Hz	± 5 ppm

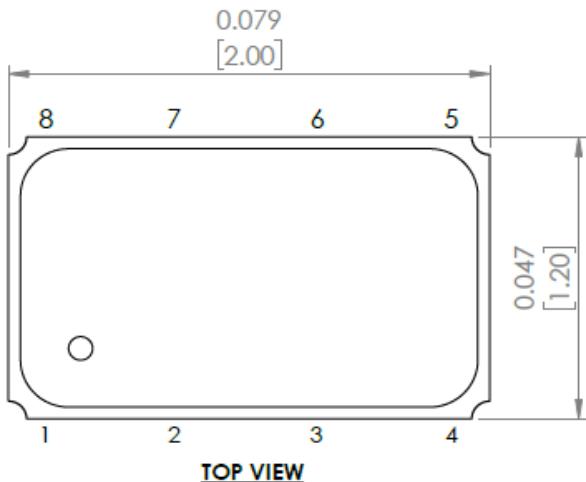
Terminating and Processing

Package	Termination	Processing
SON-8 (DFN-8)	Au flashed pads	IPC/JEDEC J-STD-020C 260°C / 20 - 40 s

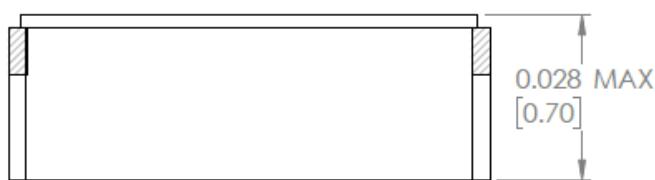
Frequency Temperature Characteristics



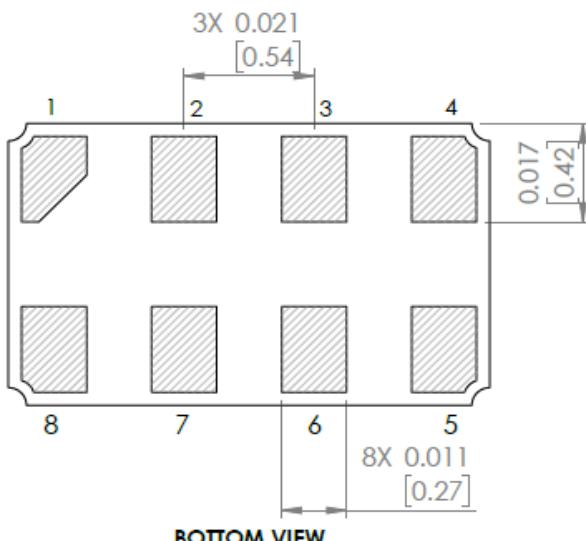
Mechanical Dimensions



TOP VIEW

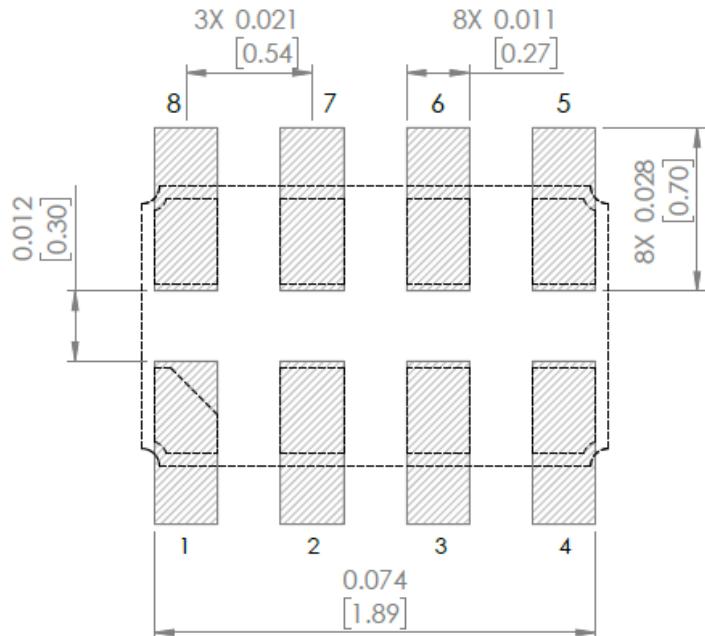


FRONT VIEW



BOTTOM VIEW

RECOMMENDED LAND PATTERN



Pin #	Function	Description
1	SDA	Serial Data
2	CLKOE	Clock Output Enable
3	IT	Interrupt Output
4	V _{ss}	Ground
5	V _{DD}	Power Supply Voltage
6	NC	No Connect
7	CLKOUT	Clock Output
8	SCL	I ² C Serial Clock Input

Pin 1 Note: I²C Serial Data Input-Output; open-drain; requires pull-up resistor.

Pin 2 Note: Input to enable the CLKOUT pin. If CLKOE is HIGH, the CLKOUT pin is in output mode. When CLKOE is tied to Ground, the CLKOUT pin is LOW.: Not connected. Is internally connected and should be left floating.

Pin 3 Note: Interrupt Output; open-drain; active LOW; requires pull-up resistor; Used to output alarm, minute, half minute, countdown timer and compensation Interrupt signals.

Pin 6 Note: Not Connected, Internally connected and should be left floating.

Pin 7 Note: Clock Output; push-pull; controlled by CLKOE. If CLKOE is HIGH (V_{DD}), the CLKOUT pin drives the square wave of 32.768 kHz, 16.384 kHz, 8.192 kHz, 4.096 kHz, 2.048 kHz, 1.024 kHz or 1 Hz (Default value is 32.768 kHz). When CLKOE is tied to Ground, the CLKOUT pin is LOW.

Pin 8 Note: I²C Serial Clock Input; requires pull-up resistor.

Metal Lid is Connected to V_{ss} (Pin #4).

Dimensions: Inches [mm]

Reflow Profile [JEDEC J-STD-020]

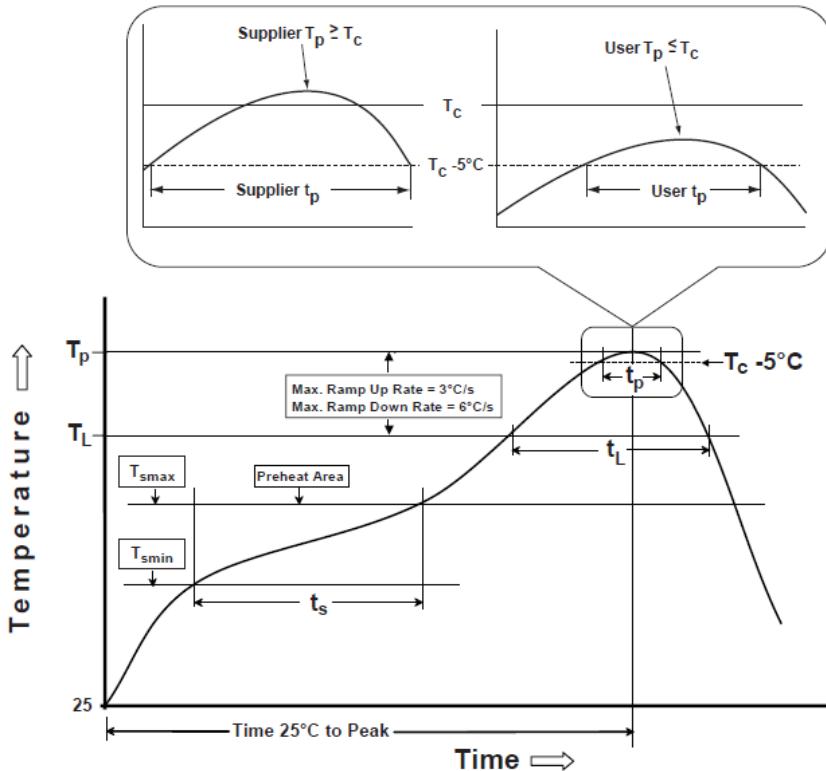


Table 1

**SnPb Eutectic Process
Classification Temperatures (T_c)**

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2

**Pb-Free Process
Classification Temperatures (T_c)**

Package Thickness	Volume mm ³ <350	Volume mm ³ 350-2000	Volume mm ³ >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm - 2.5 mm	260 °C	250 °C	245 °C
>2.5 mm	250 °C	245 °C	245 °C

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat / soak		
Temperature minimum (T_{smin})	100°C	150°C
Temperature maximum (T_{smax})	150°C	200°C
Time (T_{smin} to T_{smax}) (t_s)	60 - 120 sec.	60 - 120 sec.
Average ramp-up rate (T_{smax} to T_p)	$3^{\circ}\text{C/sec. max}$	$3^{\circ}\text{C/sec. max}$
Liquidous temperature (T_L)	183°C	217°C
Time at liquidous (t_L)	60 - 150 sec.	60 - 150 sec.
Peak package body temperature (T_p)*	see Table 1	see Table 2
Time (t_p)** within 5°C of the specified classification temperature (T_c)	20 sec.	30 sec.
Ramp-down rate (T_p to T_{smax})	$6^{\circ}\text{C/sec. max}$	$6^{\circ}\text{C/sec. max}$
Time 25°C to peak temperature	6 min. max	8 min. max
Reflow cycles	2 max	2 max

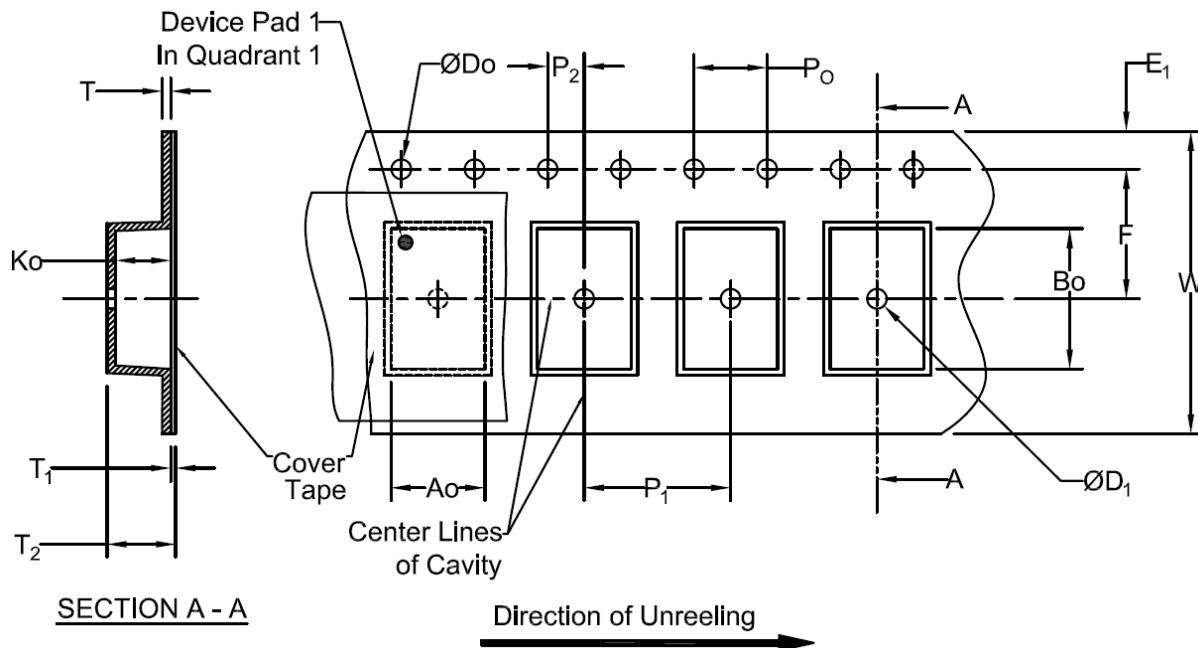
*Tolerance for peak profile temperature (T_p) is defined as a supplier minimum and a user maximum.

**Tolerance for time at peak profile temperature (t_p) is defined as supplier minimum and a user maximum.

Packaging

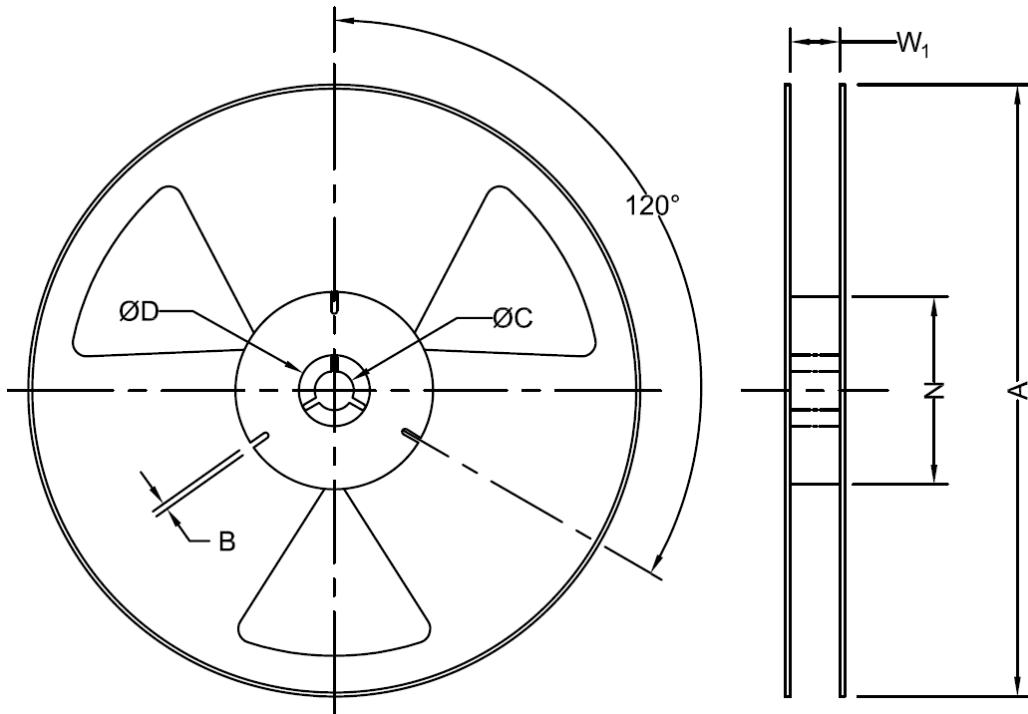
T1: 1,000pcs/reel

T3: 3,000pcs/reel



Tape Specifications (mm)							
Width	Ao	Bo	Do	D ₁ (Min)	E ₁	F	Ko
8mm	*	*	1.5+0.1/-0.0	1.0	1.25±0.1	3.5±0.05	*
Width	P ₁	P ₂	P ₀	T (Max)	T ₁ (Max)	T ₂ (Max)	W (Max)
8mm	4.0±0.1	2.0±0.05	4.0±0.1	0.6	0.1	2.5	8.3

*Note: Compliant to EIA-481



Reel Specifications (mm)							
Width	Qty/Reel	A (Nom)	B (Min)	C (Min)	D (Min)	N (Min)	*W ₁
8mm	1000	178	1.5	13.0+0.5/-0.2	20.2	50	8.4+1.5/-0.0
	3000	178	1.5	13.0+0.5/-0.2	20.2	50	8.4+1.5/-0.0

***Note: Measured at Hub**