AB-RTC-TN-32.768kHz-2

Ultra-Low Power RTC Module

Description

Abracon's ultra-low power Real-Time Clock (RTC) module with embedded 32.768 kHz crystal, AB-RTC-TN-32.768kHz-2, uses an I²C communication interface to configure numerous features while sustaining temperature compensated frequency accuracy (±3ppm over -40°C to 85°C) in a compact lead-free ceramic SMD 3.2 x 1.5 mm package. These features include a periodic time update interrupt function, low voltage detection, external event input with interrupt and internal power-on reset function. The RTC has a broad operating power supply voltage range of 1.5V to 5.5V with low power consumption (240nA @ 3V).

Features

- Very low power consumption: 240 nA @ 3V
- Time accuracy: ±3 ppm @ -40°C to 85°C
- External Event Input with Interrupt and Time Stamp function
- Wide operating voltage range: 1.5V to 5.5V
- Integrated CMOS Oscillator with 32.768kHz crystal resonator
- Factory calibrated temperature compensation
- 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, 1.024 Hz, and 1 Hz
- I²C-bus interface: 400 kHz
- REACH/RoHS II Compliant | MSL Level 1

Typical Applications

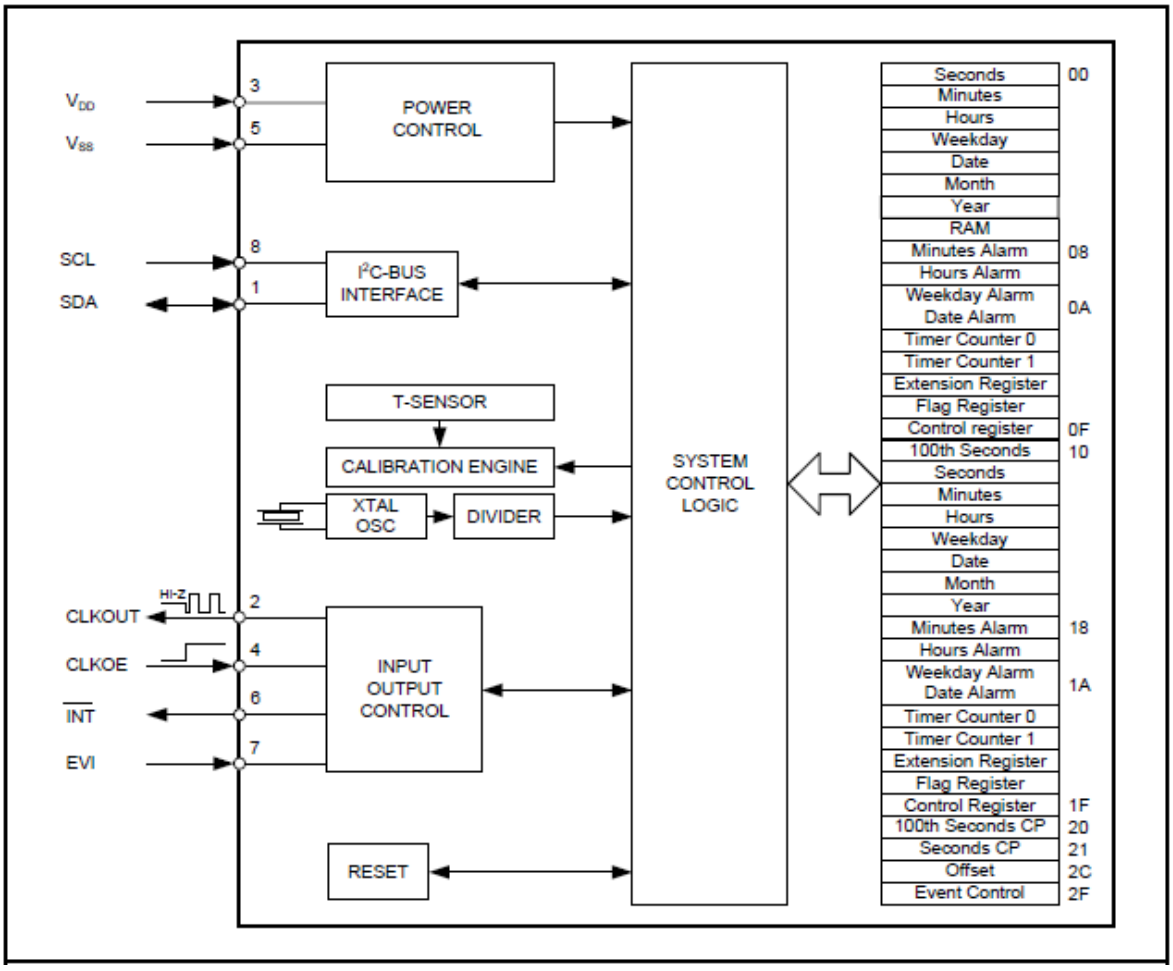
- IoT Metering
- Industrial
- Health Care
- Wearables/Portables

Absolute Maximum Ratings according to IEC 60134[4]:

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{DD}	Power Supply Voltage		-0.3		6.0	V
V_I	Input voltage	Input Pin	-0.3		V_{DD}+0.3	V
V_O	Output voltage	Output Pin	-0.3		V_{DD}+0.3	V
I_I	Input current		-10		10	mA
I_O	Output current		-10		10	mA
V_{ESD}	ESD Voltage	HBM [1]			±2000	V
		CDM [2]			±200	V
I_{LU}	Latch-up Current	JEDEC [3]			±100	mA
T_{OPR}	Operating Temperature		-40		85 [4]	°C
T_{STO}	Storage Temperature		-55		125	°C
T_{PEAK}	Maximum reflow condition	JEDEC J-STD-020C			265	°C

Note 1: HBM: Human Body Model, according to JESD22-A114.
Note 2: MM: Machine Model, according to JESD22-A115.
Note 3: Latch-up testing, according to JESD78., Class I (room temperature), level A (100 mA).
Note 4: Supports extended operating temperature range from +85°C to +105°C with limitations.

Block Diagram



Frequency Characteristics (T_A = -40 to +85°C unless otherwise indicated. V_{DD} = 1.5 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 $t_{START} = t_{POR1} + t_{POR2}$	CLKOE = V_{DD}		80	500	ms
$t_{START:EXT}$	Oscillator start-up time $t_{START:EXT} = t_{POR1:EXT} + t_{POR2:EXT}$ for extended temperature range	V_{DD} = 1.6 to 5.5 V CLKOE = VDD, T_A = +85°C to +105°C			500	ms
δ_{CLKOUT}	CLKOUT duty cycle	FCLKOUT = 32.768 kHz T_A = 25°C		50 ±10		%
ΔF/F	Frequency accuracy	T_A = 25°C, calibration disabled		±10	±20	ppm
$\Delta F/F_{TOPR}$	Frequency vs. temperature characteristics	T_{OPR} = -40 to +105°C V_{DD} = 3.0 V		$-0.035^{ppm/°C^2}$ $(T_{OPR}-T_0)^2$ ±10%		ppm
T_0	Turnover temperature			+25 ±5		°C
ΔF/F	Aging first year max.	T_A = 25°C, V_{DD} = 3.0 V			±3	ppm

Digital Temperature Compensated Xtal DTCXO (V_{DD} = 1.5 to 5.5V, TYP values at 25°C and 3.0V)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
ΔF/F	Time accuracy calibrated, CLKOUT measured on rising edge of One 1 Hz period	T_A = 0°C to +50°C		±1.5		ppm
				±0.13		s/day
		T_A = -40°C to +85°C		±3		ppm
				±0.26		s/day
		T_A = +85°C to +105°C		±7		ppm
				±0.6		s/day
ΔF/F	1 Hz OFFSET value Min. corr. step (LSB) and Max. corr. range	T_A = -40°C to +105°C	±0.2384		±7.4	ppm

DC Characteristics (T_A = -40 to +85°C unless otherwise indicated. V_{DD} = 1.5 to 5.5V, F_{OSC} = 32.768kHz, TYP values at 25°C and 3.0V)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Supplies						
V_{DD}	Power Supply Voltage	Time-keeping mode (2)	1.5		5.5	V
		I²C-bus (100 kHz)	1.5		5.5	
		I²C-bus (400 kHz)	1.5		5.5	
$V_{DD;EXT}$	Power Supply Voltage for extended temperature range	Time-keeping mode, T_A = +85 °C to +105°C (2)	1.6		5.5	V
		I²C-bus (100 kHz), T_A = +85 °C to +105°C	1.6		5.5	
		I²C-bus (400 kHz), T_A = +85 °C to +105°C	2.1		5.5	
V_{DDF}	V_{DD} failing slew rate(1)				0.5	V/µs
V_{DDR2}	V_{DD} rising slew rate(1)	Rising from V_{DD} = 1.5 V to VDD ≤ 3.5 V			0.2	V/µs
		Rising from V_{DD} = 1.5 V to VDD > 3.5 V			0.07	
V_{LOW1}	V_{DD} low and POR detection. Temperature compensation stops (flag V1F). (3)		1.1	1.2	1.3	V
V_{LOW1}	V_{DD} low and POR detection. Data no longer valid (flag V2F).(3)		1.1	1.2	1.3	V
I_{VDD}	V_{DD} supply current timekeeping I²C-bus inactive, CLKOUT disabled, average current	V_{DD} = 1.5 V (4)		240	600	nA
		V_{DD} = 3.0 V (4)		240	600	
		V_{DD} = 5.0 V (4)		250	700	
$I_{VDD:EXT}$	V_{DD} supply current timekeeping I²C-bus inactive, CLKOUT disabled, average current for extended temperature range	V_{DD} = 1.6 V, +85 to 105°C (4)			800	nA
		V_{DD} = 3.0 V, +85 to 105°C (4)			800	
		V_{DD} = 5.0 V, +85 to 105°C (4)			900	
$I_{VDD:12C}$	V_{DD} supply current during I²C burst read/write, CLKOUT disabled	V_{DD} = 1.5 V, SCL = 100kHz (5)		2	15	µA
		V_{DD} = 3.0 V, SCL = 400kHz (5)		5	40	
		V_{DD} = 5.0 V, SCL = 400kHz (5)		7	60	
$I_{DD:TSP}$	V_{DD} supply current temperature sensing peak	Typical duration = 1.3 ms		19		µA
$\Delta I_{VDD:CK32}$	Additional V_{DD} supply current (6)	V_{DD} = 3.0 V, FCLKOUT = 32.768 kHz, CL = 10 pF		1		µA
$\Delta I_{VDD:CK1024}$		V_{DD} = 3.0 V, FCLKOUT = 1024 Hz, C_L = 10 pF		30		nA
$\Delta I_{VDD:CK1}$		V_{DD} = 3.0 V, FCLKOUT = 1 Hz, C_L = 10 pF		0.03		nA

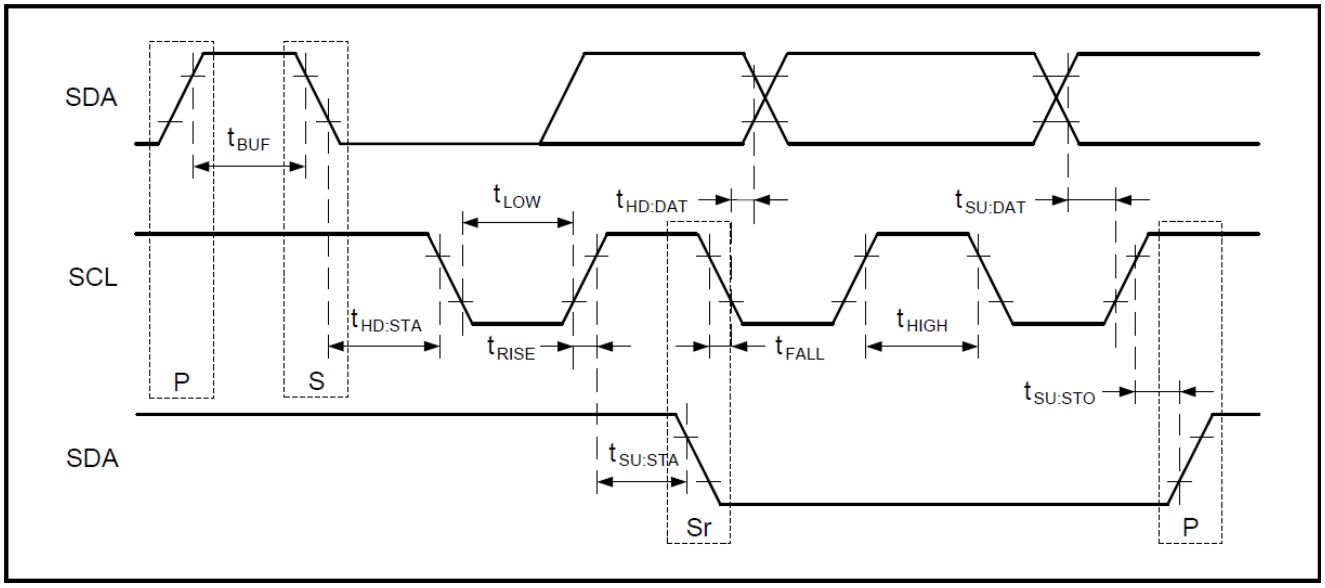
Note 1: See also VDD Backup and recovery AC Electrical Characteristics and Parameters in section BACKUP AND RECOVERY.
Note 2: Clocks operating and RAM and registers retained. Including temperature sensing and compensation.
Note 3: CLKOUT is held LOW during power on delay tPOR1 and is HIGH during the power on reset duration tPOR2.
Note that between VLOW1 (1.2 V) and VDD MIN (1.5 V), time accuracy specification limits are not guaranteed.
Note 4: All inputs and outputs are at 0 V or VDD.
Note 5: 2.2k pull-up resistors on SCL/SDA, excluding external peripherals and pull-up resistor current. All other inputs (besides SDA and SCL) are at 0 V or VDD. Test conditions: Continuous burst read/write, 55h data pattern, 25 µs between each data byte, 20 pF load on each bus pin.
Note 6: When CLKOUT is enabled (CLKOE is HIGH) the additional VDD supply current ΔIVDD can be calculated as follows: ΔIVDD = CL x VDD x fOUT, e.g. ΔIVDD = 10 pF x 3.0 V x 32'768 Hz = 980 nA ≈ 1 µA

DC Characteristics (T_A = -40 to +85°C unless otherwise indicated. V_{DD} = 1.5 to 5.5V, f_{OSC}=32.768kHz, TYP values at 25°C and 3.0V)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Inputs						
V_{IH}	HIGH level input voltage	VDD = 1.5 V to 5.5 V Pins: SCL, SDA, CLKOE, EVI	0.8 * V_{DD}			V
V_{IL}	LOW level input voltage				0.2 * V_{DD}	V
I_{LEAK}	Input leakage current	$V_{SS} \le V_I \le V_{DD}$ TA= -40°C to +105°C	-0.5		0.5	µA
C_I	Input capacitance	VDD = 3.0 V, TA = 25°C, f = 1 MHz			7	pF
Outputs						
$V_{OH:CLK}$	HIGH level output voltage CLKOUT	VDD = 1.5 V, IOH = 0.1 mA	1.2			V
		VDD = 3.0 V, IOH = 1.0 mA	2.5			
		VDD = 5.0 V, IOH = 1.0 mA	4.5			
$V_{OL:CLK}$	LOW level output voltage CLKOUT	VDD = 1.5 V, IOH = -0.1 mA			0.2	V
		VDD = 3.0 V, IOH = -1.0 mA			0.5	
		VDD = 5.0 V, IOH = -1.0 mA			0.5	
T_{CKH}	CLKOUT enable time(7)	FCLKOUT = 32.768kHz	0		30.5	µs
T_{CKL}	CLKOUT disable time(7)				0	µs
V_{OL}	LOW level output voltage Pins: SDA, INT	VDD = 1.5 V, IOH = -2.0 mA	-		0.4	V
		VDD = 3.0 V, IOH = -3.0 mA			0.4	
		VDD = 5.0 V, IOH = -3.0 mA			0.3	
I_{OLEAK}	Output leakage current	Vo = V_{DD} or V_{SS}, T_A=-40°C to +105°C	-0.5		0.5	µA
C_{OUT}	Output capacitance	V_{DD} = 3.0 V, T_A = 25°C, f = 1 MHz			7	pF

Note 7: Also refer to section 32.768 KHZ ENABLE/DISABLE TIMING.

I²C BUS Timing Characteristics



I²C AC Characteristics (T_A = -40 to +85°C, TYP values at 25°C)

SYMBOL	PARAMETER	Conditions	MIN	MAX	UNIT
f_{SCL}	SCL input clock frequency	$V_{DD} \geq 1.5$ V	0	100	kHz
		$V_{DD} \geq 2.0$ V	0	400	
t_{LOW}	Low period of SCL clock	$V_{DD} \geq 1.5$ V	4.7		µs
		$V_{DD} \geq 2.0$ V	1.3		
t_{HIGH}	High period of SCL clock	$V_{DD} \geq 1.5$ V	4.0		µs
		$V_{DD} \geq 2.0$ V	0.6		
t_{RISE}	Rise time of SDA and SCL	$V_{DD} \geq 1.5$ V		1000	ns
		$V_{DD} \geq 2.0$ V		300	
t_{FALL}	Fall time of SDA and SCL	$V_{DD} \geq 1.5$ V		300	ns
		$V_{DD} \geq 2.0$ V		300	
$t_{HD:STA}$	START condition hold time	$V_{DD} \geq 1.5$ V	4.0		µs
		$V_{DD} \geq 2.0$ V	0.6		
$t_{SU:STA}$	START condition setup time	$V_{DD} \geq 1.5$ V	4.7		µs
		$V_{DD} \geq 2.0$ V	0.6		
$t_{SU:DAT}$	SDA setup time	$V_{DD} \geq 1.5$ V	250		ns
		$V_{DD} \geq 2.0$ V	100		
$t_{HD:DAT}$	SDA hold time	$V_{DD} \geq 1.5$ V	0		µs
		$V_{DD} \geq 2.0$ V	0		
$t_{SU:STO}$	STOP condition setup time	$V_{DD} \geq 1.5$ V	4.0		µs
		$V_{DD} \geq 2.0$ V	0.6		
t_{BUF}	Bus free time before a new transmission	$V_{DD} \geq 1.5$ V	4.7		µs
		$V_{DD} \geq 2.0$ V	1.3		
S = Start condition, Sr = Repeated Start condition, P = Stop condition					

Part Identification

AB - RTC - TN - 32.768kHz - 2 - ☐

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

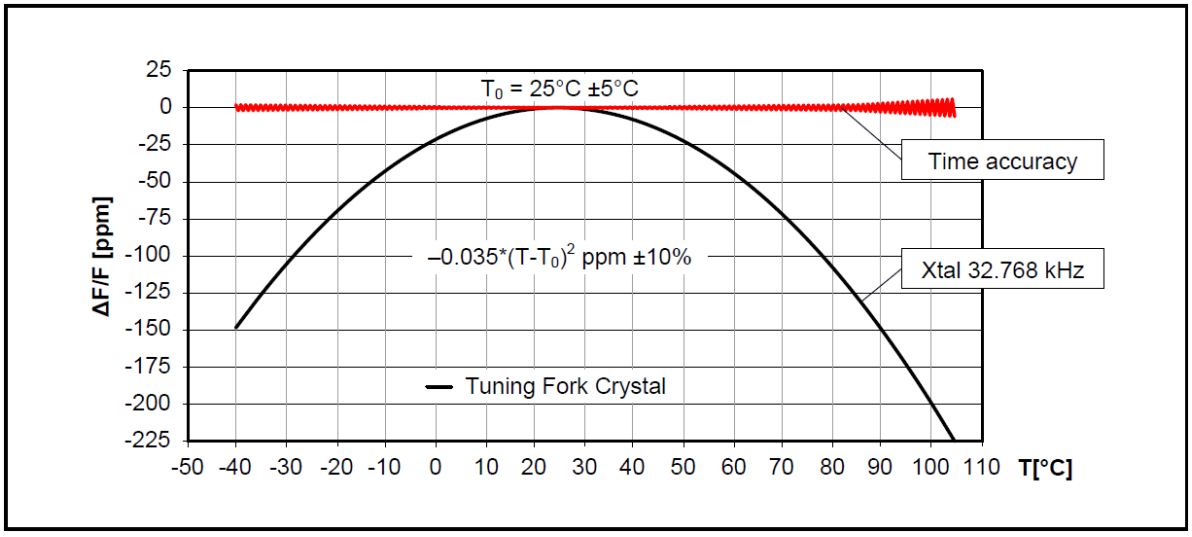
Environmental Characteristics

		Conditions	Max. Dev.
Shock resistance	ΔF/F	5000 g, 0.3 ms, ½ sine	±5 ppm
Vibration resistance	ΔF/F	20 g / 10–2000 Hz	±5 ppm

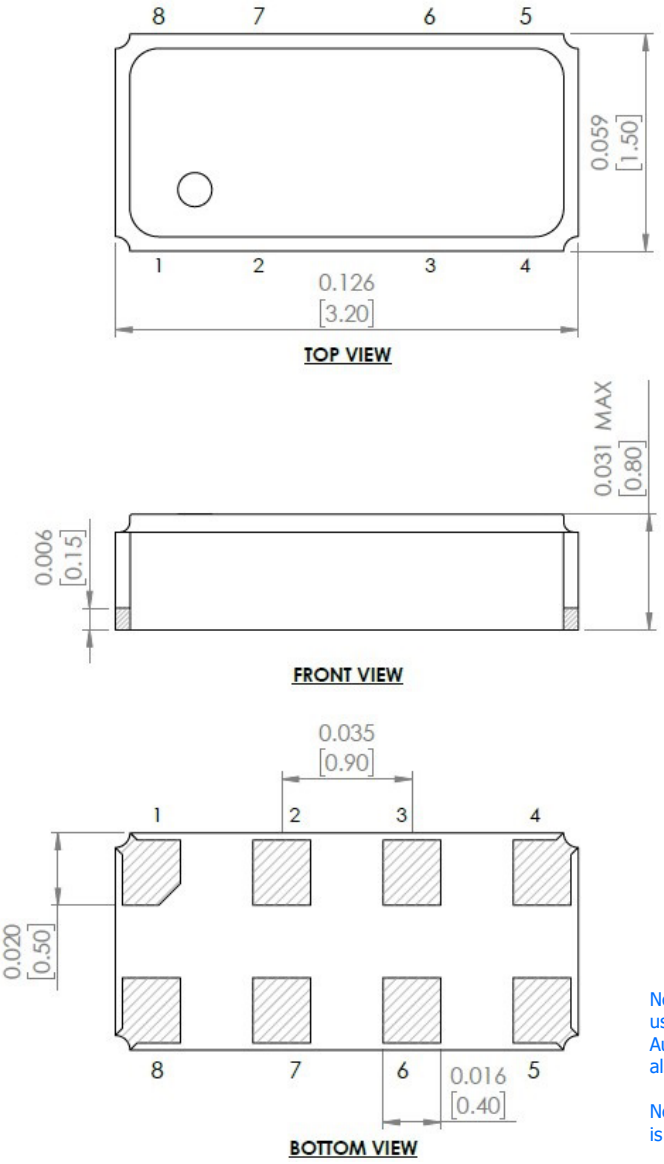
Terminating and Processing

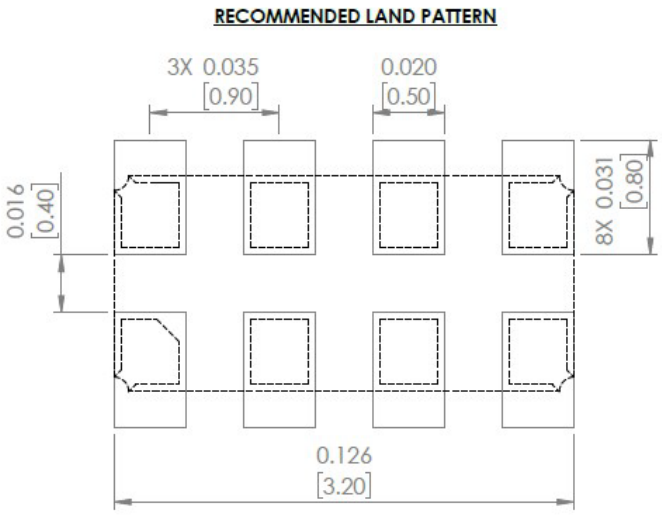
Package	Termination	Processing
SON-8 (DFN-8)	Au flashed pads	IPC/JEDEC J-STD-020C 260°C / 20 - 40 s

Frequency Temperature Characteristics



Mechanical Dimensions





Pin #	Function	Description
1	SDA	Serial Data
2	CLKOUT	Clock Output
3	V_{DD}	Power Supply Voltage
4	CLKOE	Clock Output Enable
5	V_{SS}	Ground
6	$\overline{INT}$	Interrupt
7	EVI	Event Input
8	SCL	Serial Clock Input

Note: Interrupt Output: open-drain; active LOW; requires pull-up resistor when used; used to output Periodic Countdown Timer, Periodic Time Update, Alarm, External Event, Automatic Backup Switchover and Power On Reset Interrupt signals. Interrupt output also in V_{BACKUP} Power state.

Note: I^2C Serial Clock Input: requires pull-up resistor. In V_{BACKUP} Power state, the SCL pin is disabled.

Note: I^2C Serial Data Input-Output: open-drain; requires pull-up resistor. In V_{BACKUP} Power state, the SDA pin is disabled (high impedance).

Note: Backup Supply Voltage: When the backup switchover function is not needed, V_{BACKUP} must be tied to V_{SS} with a 10 kΩ resistor.

Note: External Event Input: used for interrupt generation, interrupt driven clock output and time stamp function. Remains active also in V_{BACKUP} Power state. This pin should not be left floating.

Note: Metal Lid is Connected to V_{ss} (Pin #5)

Dimensions: Inches [mm]

Reflow Profile [JEDEC J-STD-020]

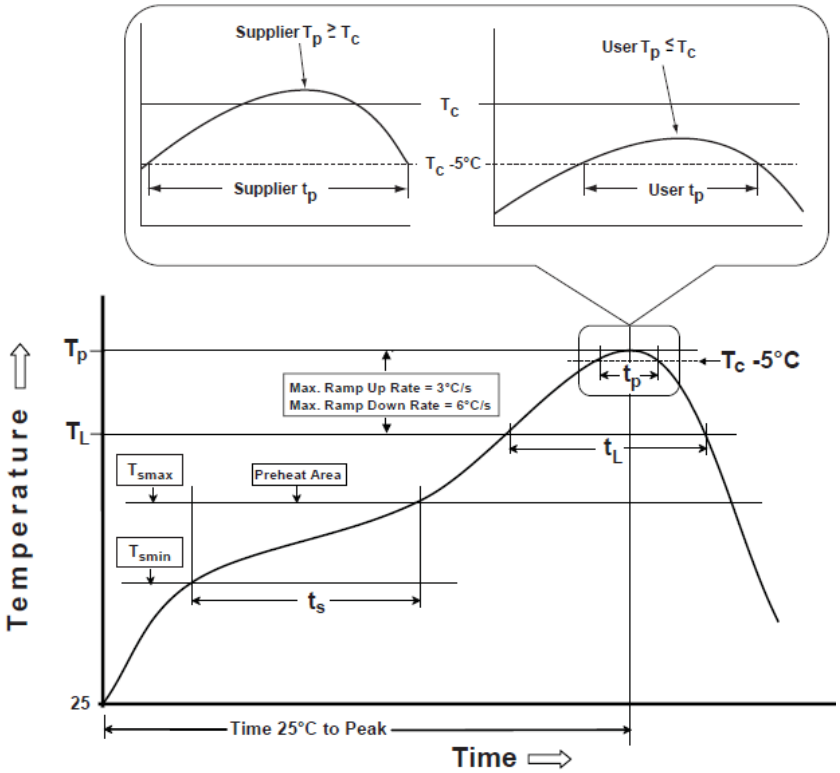


Table 1

SnPb Eutectic Process Classification Temperatures (T_c)		
Package Thickness	**Volume mm³ <350**	**Volume mm³ ≥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 mm³ <350**	**Volume mm³ 350-2000**	**Volume mm³ >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

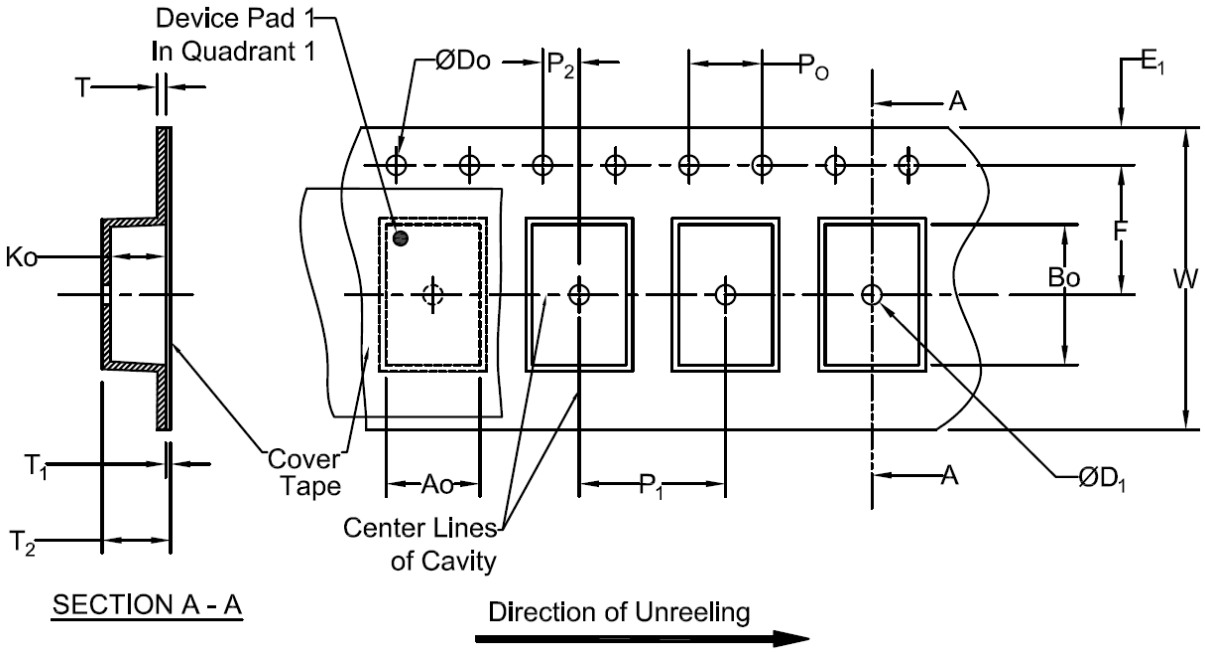
Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat / soak		
Temperature minimum (T_{smin})	100°C	150°C
Temperature maximum (T_{smax})	150°C	200°C
Time (T_{smin} to T_{smax}) (t_s)	60 - 120 sec.	60 - 120 sec.
Average ramp-up rate (T_{smax} to T_P)	3°C/sec. max	3°C/sec. max
Liquidous temperature (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°C/sec. max	6°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.

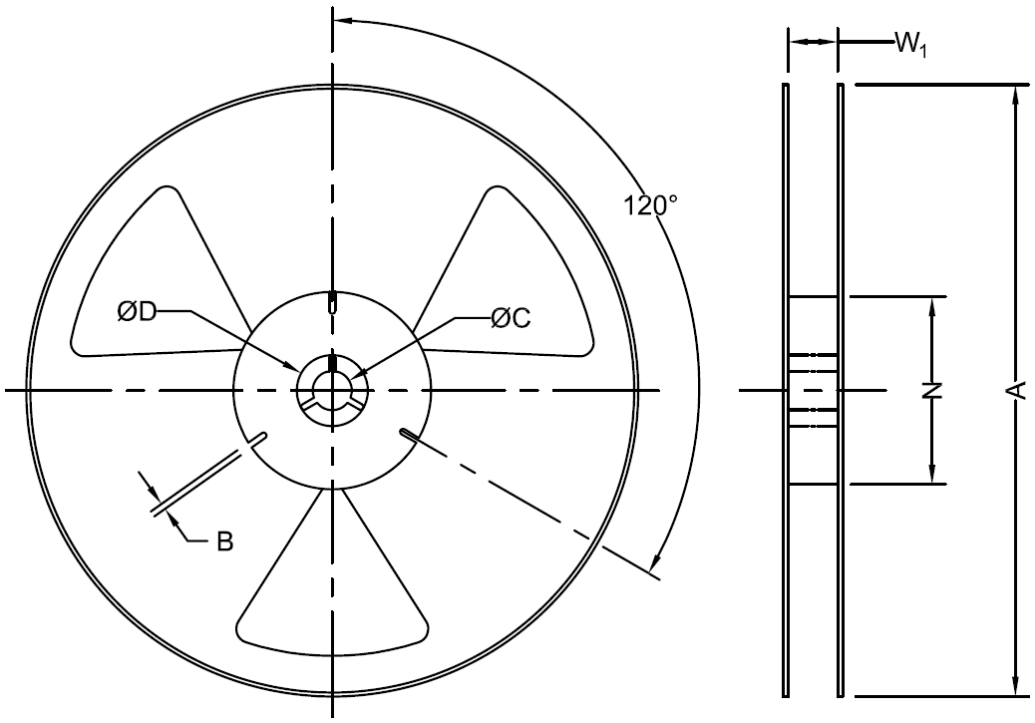
Packaging

T1: 1,000pcs/reel
T3: 3,000pcs/reel



Tape Specifications (mm)							
Width	Ao	Bo	Do	D_1 (Min)	E_1	F	Ko
12mm	*	*	1.5+0.1/-0.0	1.0	1.75±0.1	5.5±0.05	*
Width	P_1	P_2	P_0	T (Max)	T_1 (Max)	T_2 (Max)	W (Max)
12mm	4.0±0.1	2.0±0.05	4.0±0.1	0.6	0.1	6.5	12.3

***Note: Compliant to EIA-481**



Reel Specifications (mm)							
Width	Qty/Reel	A (Nom)	B (Min)	C (Min)	D (Min)	N (Min)	*W_1
12mm	1000	178	1.5	13.0+0.5/-0.2	20.2	50	12.4+2.0/-0.0
	3000	178	1.5	13.0+0.5/-0.2	20.2	50	12.4+2.0/-0.0

***Note: Measured at Hub**