AB-RTCMC-32.768kHz-EOZ9-S3

DTCXO TEMPERATURE COMPENSATED REAL-TIME-CLOCK MODULE WITH I2C BUS



Features

- RTC module with built-in “Tuning Fork” crystal oscillating at 32.768 kHz
- Factory calibrated, all built-in Temperature Compensation circuitry
- Time accuracy Option A & B. See Part Identification on Page 6 for details
- Ultra low power consumption: 800nA typ @ V_{DD} = 3.0V / T_{amb} = 25°C
- Wide clock operating voltage: 1.3 – 5.5V
- Wide interface operating voltage: 1.4 – 5.5V
- Extended operating temperature range: -40°C to +125°C
- I2C serial interface with fast mode SCL clock frequency of 400kHz
- Provides year, month, day, weekday, hours, minutes and seconds
- Highly versatile alarm and timer functions
- Integrated Low-Voltage Detector, Power-On Reset and Self-Recovery System
- Main Power Supply to Backup Battery switchover circuitry with Trickle Charger
- Programmable CLKOUT pins for peripheral devices (32.768 kHz / 1024 Hz / 32 Hz / 1 Hz)
- Small and compact package size: 3.7 x 2.5 x 0.9 mm
- REACH/RoHS II Compliant | MSL Level 1

Typical Applications

- Wide range in communication & measuring equipment
- Commercial & Industrial applications
- Automotive electronics applications
- Wireless communications
- Credit Cards with Security Technology

Absolute Maximum Ratings

Parameters	Min.	Typ.	Max.	Units	Notes
Supply Voltage (V_{DD})	GND-0.3		+6.0	V	>GND / <V_{DD}
Supply Current (I_{DD}; I_{SS})	-50		+50	mA	V_{DD} Pin
Input Voltage (V_I)	GND-0.3		V_{DD} +0.3	V	Input Pin
Output Voltage (V_O)	GND-0.5		V_{DD} +0.5	V	$\overline{INT}$/CLKOUT
DC Input Current (I_I)	-10		+10	mA	
DC Output Current (I_O)	-10		+10	mA	
Total Power Dissipation (P_{TOT})			300	mW	
Operating Temperature Range (T_{OPR})	-40		+125	ºC	
Storage Temperature (T_{STO})	-55		+125	ºC	Stored as bare product

Frequency and Time Characteristics

V_{DD}=3.0V; V_{SS}=0V; T_{AMB}=+25°C; f_{OSC}=32.768kHz

Parameters		Min.	Typ.	Max.	Units	Notes
32.768kHz Oscillator Characteristics						
Frequency Accuracy (ΔF/F)			±10	±20	ppm	F_{CLKOUT}=32.768kHz; T_{AMB}=+25°C; V_{DD}=3.0V
Frequency vs Voltage (ΔF/V)			±0.5	±1.0	ppm/V	T_{AMB}=+25°C; V_{DD}=1.4~5.5V
Frequency vs Temperature ($\Delta F/T_{OPR}$)		-0.035ppm/°C^2 (T_{OPR}-T_O)^2 ±10%			ppm	T_{OPR}=-40~+125°C; V_{DD}=3.0V
Turnover Temperature (T_O)		+20	+25	+30	°C	
Aging (first year)		-3		+3	ppm	T_{AMB}=+25°C
Start-up Time Voltage (V_{START})						
Start-up Time (T_{START})			0.5	3	s	T_{AMB}=-40 ~ +85°C
			1	3		T_{AMB}=-40 ~ +125°C
CLKOUT duty cycle		40	50	60	%	F_{CLKOUT}=32.768kHz; T_{AMB}=+25°C
Time accuracy, DTCXO Digitally Temperature Compensated						
Time Accuracy Option: A (Δt/t)	T_{AMB}=+25°C		±1	±3	ppm	
	T_{AMB}=0 ~ +50°C		±2	±4		
	T_{AMB}=-10 ~ +65°C		±3	±5		
	T_{AMB}=-40 ~ +85°C		±4	±6		
	T_{AMB}=-40 ~ +125°C		±5	±8		
Time Accuracy Option: B (Δt/t)	T_{AMB}=+25°C		±1	±3	ppm	
	T_{AMB}=0 ~ +50°C		±3	±5		
	T_{AMB}=-10 ~ +65°C		±5	±10		
	T_{AMB}=-40 ~ +85°C		±10	±25		
	T_{AMB}=-40 ~ +125°C		±15	±30		

Static Characteristics

V_{DD}=1.4~5.5V; V_{SS}=0V; T_{AMB}=-40°C ~+125°C; f_{OSC}=32.768kHz

Parameters		Min.	Typ.	Max.	Units	Notes
Supplies						
Supply Voltage (V_{DD})		1.4		5.5	V	Time-keeping mode I^{2}C bus reduced speed
		3.0		5.5		I^{2}C bus full speed
Minimum Supply Voltage Detection (V_{LOW1})		1.8		2.1	V	T_{AMB}=-40 ~ +125°C
Minimum Supply Voltage Detection (V_{LOW2})		1.0		1.4	V	T_{AMB}=-40 ~ +125°C
Main Supply to Backup Supply Switchover Hysteresis (V_{HYST})			20		mV	V_{DD} to V_{BACK} = 3.0V
Supply Current I_{DD} (V_{BACK}=0V) or I_{BACK} (V_{DD}=0V)	V_{DD}=1.4V T_{AMB}= -40°C ~ +85°C		0.6	1.5	μA	I^{2}C bus inactive CLKOUT disabled V_{BACK}= 0V Or V_{DD}= 0V
	V_{DD}=1.4V T_{AMB}= -40°C ~ +125°C			4.6		
	V_{DD}=3.3V T_{AMB}= -40°C ~ +85°C		0.8	2.0		
	V_{DD}=3.3V T_{AMB}= -40°C ~ +125°C			5.2		
	V_{DD}=5.0V T_{AMB}= -40°C ~ +85°C		0.9	2.2		
	V_{DD}=5.0V T_{AMB}= -40°C ~ +125°C			5.5		

Continued

Parameters		Min.	Typ.	Max.	Units	Notes
Supply Current (I_{DD})	SCL= 100kHz V_{DD} = 1.4V T_{AMB}= -40°C ~ +85°C			12	µA	I^2C bus active CLKOUT disabled
	SCL= 100kHz V_{DD} = 1.4V T_{AMB}= -40°C ~ +125°C			15		
	SCL= 400kHz V_{DD} = 3.3V T_{AMB}= -40°C ~ +85°C			35		
	SCL= 400kHz V_{DD} = 3.3V T_{AMB}= -40°C ~ +125°C			40		
	SCL= 400kHz V_{DD} = 5.0V T_{AMB}= -40°C ~ +85°C			50		
	SCL= 400kHz V_{DD} = 5.0V T_{AMB}= -40°C ~ +125°C			60		
Current Consumption (I_{DD32K})	V_{DD}=5.0V		2.5	3.4	µA	I^2C bus inactive CLKOUT=32.768kHz C_{LOAD} =7.5pF
	V_{DD}=3.3V		1.5	2.2		
	V_{DD}=1.4V		1.1	1.6		
Input						
LOW Level Input Voltage (V_{IL})				20%* V_{DD}	V	V_{DD} = 1.4 ~ 5.5V_{DD} Pins:SCL,SDA,CLKOE
HIGH Level Input Voltage (V_{IH})		80%* V_{DD}			V	
Input Leakage Current (I_L)	T_{amb}=-40 ~+85°C	-1		+1	µA	V_{SS}>V_I<V_{DD}
	T_{amb}=-40 ~+125°C	-1.5		+1.5		
Pull-down resistance (R_{PD}) on pin CE			240	550	kΩ	
Input Capacitance (C_I)				7	pF	
Output						
HIGH Level Output Voltage (V_{OH})	V_{DD} = 1.4V; I_{OH} = 0.1mA	1.0			V	
	V_{DD} = 3.3V; I_{OH} = 1.5mA	2.7				
	V_{DD} = 5.0V; I_{OH} = 2.0mA	4.5				
LOW Level Output Voltage (V_{OL})	V_{DD} = 1.4V; I_{OL} = 0.4mA			0.2	V	
	V_{DD} = 3.3V; I_{OL} = 1.5mA			0.25		
	V_{DD} = 5.0V; I_{OL} = 5.0mA			0.8		
HIGH Level Output Current (I_{OH})	V_{OH} = 4.5V/ V_{DD} = 5V			2.0	mA	
LOW Level Output Current (I_{OL})	V_{OL} = 0.8V/ V_{DD} = 5V			-5.0	mA	
Output Leakage Current (I_{LO})	V_O = V_{DD} or V_{SS} T_{AMB}= -40°C ~ +85°C	-1	0	+1	µA	
	V_O = V_{DD} or V_{SS} T_{AMB}= -40°C ~ +125°C	-1.5	0	+1.5		
Operating Temperature Range						
Operating Temperature Range (T_{OPR})		-40		+125	°C	
EEPROM Characteristics						
Read Voltage (V_{Read})	T_{AMB}= -40°C ~ +125°C	1.4			V	
Programming Voltage (V_{Prog})	T_{AMB}= -40°C ~ +125°C	2.2			V	
EEPROM Programming Time (T_{Prog})	T_{AMB}= -40°C ~ +125°C 1 Byte EEPROM User			35	ms	
	T_{AMB}= -40°C ~ +125°C 1 Byte EEPROM Control			100		
	T_{AMB}= -40°C ~ +125°C 2-4 Byte EEPROM Control			135		
EEPROM Write/Erase Cycles (V_{HYST})	V_{DD} to V_{BACK} = 3.0V	5000			Cycles	

Continued

Parameters		Min.	Typ.	Max.	Units	Notes
Trickle Charger						
Current Limiting Resistors	R80K		80		kΩ	V_{DD} = 5.0V V_{BACK} = 3.0V T_{AMB}= 25°C
	R20k		20			
	R5k		5			
	R1.5k		1.5			
Thermometer						
Thermometer Precision (T_E)	T_{AMB}= -40°C ~ +85°C		±4		°C	
	T_{AMB}= -40°C ~ +125°C		±6			

I²C Interface Dynamic Characteristics

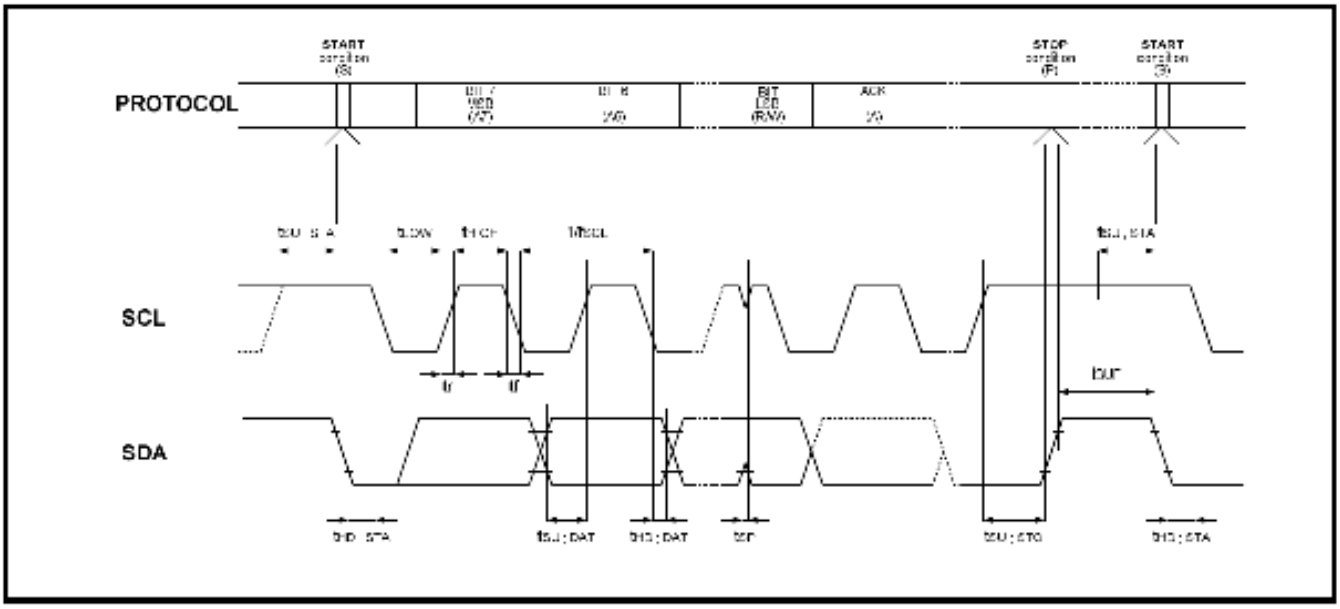
V_{SS}=0V; T_{AMB}=-40°C ~+125°C; All timing values are valid within the operating supply voltage range and references to V_{IL} and V_{IH} with an input voltage swing from V_{SS} and V_{DD}.

Parameters	Min.	Typ.	Max.	Units	Notes
SCL Clock Frequency (f_{SCL})			100	kHz	V_{DD} ≥ 1.4V
			300		V_{DD} ≥ 1.8V
			400		V_{DD} ≥ 3.0V
Start Condition Set-up Time ($t_{SU;\ STA}$)	50			µs	V_{DD} ≥ 1.4V
	30				V_{DD} ≥ 1.8V
	20				V_{DD} ≥ 3.0V
Start Condition Hold Time ($t_{HD;\ STA}$)	0.2			µs	V_{DD} ≥ 1.4V
					V_{DD} ≥ 1.8V
					V_{DD} ≥ 3.0V
Data Set-up Time ($t_{SU;\ DAT}$)	100			ns	V_{DD} ≥ 1.4V
	80				V_{DD} ≥ 1.8V
	50				V_{DD} ≥ 3.0V
Data Hold Time (t_{HD}; D_{AT})	50			ns	V_{DD} ≥ 1.4V
	30				V_{DD} ≥ 1.8V
	20				V_{DD} ≥ 3.0V
Data Valid Time (t_{VD}; D_{AT})	4.0			µs	V_{DD} ≥ 1.4V
	1.5				V_{DD} ≥ 1.8V
	1.2				V_{DD} ≥ 3.0V
Data Valid Acknowledge Time ($t_{VD;\ ACK}$)	3.5			µs	V_{DD} ≥ 1.4V
	1.1				V_{DD} ≥ 1.8V
	0.9				V_{DD} ≥ 3.0V
Stop Condition Set-up Time ($t_{SU;\ STO}$)	50			ns	V_{DD} ≥ 1.4V
	30				V_{DD} ≥ 1.8V
	20				V_{DD} ≥ 3.0V
Bus Free Time between STOP and START Condition (t_{BUF})	1.0			µs	V_{DD} ≥ 1.4V
	0.5				V_{DD} ≥ 1.8V
	0.4				V_{DD} ≥ 3.0V
SCL “LOW time” (t_{LOW})	4.5			µs	V_{DD} ≥ 1.4V
	1.7				V_{DD} ≥ 1.8V
	1.3				V_{DD} ≥ 3.0V
SCL “High time” (t_{HIGH})	0.6			µs	V_{DD} ≥ 1.4V
	0.5				V_{DD} ≥ 1.8V
	0.4				V_{DD} ≥ 3.0V

Continued

Parameters	Min.	Typ.	Max.	Units	Notes
SCL and SDA Rise Time (t_r)			1.0	µs	$V_{DD} \geq 1.4V$
			0.3		$V_{DD} \geq 1.8V$
			0.2		$V_{DD} \geq 3.0V$
SCL and SDA Fall Time(t_f)			0.4	µs	$V_{DD} \geq 1.4V$
			0.3		$V_{DD} \geq 1.8V$
			0.2		$V_{DD} \geq 3.0V$
Tolerance Spike Time on Bus (t_{SP})			50	ns	
SCL and SDA I/O Capacitance ($C_{I/O}$)			10	pF	
Capacitive Load Bus Lines (C_B)			200	pF	

I²C Interface Timing Characteristics



Options and Part Identification

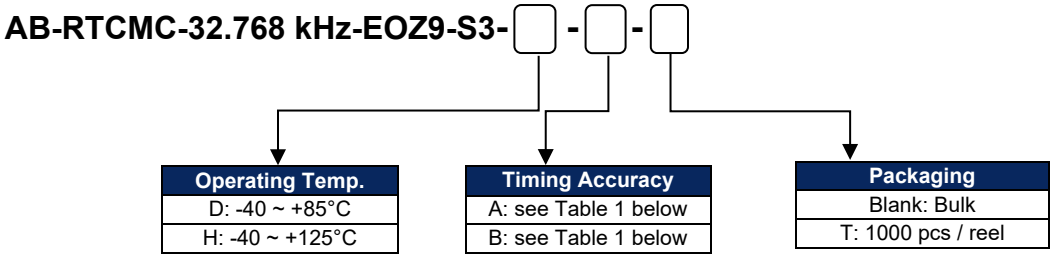
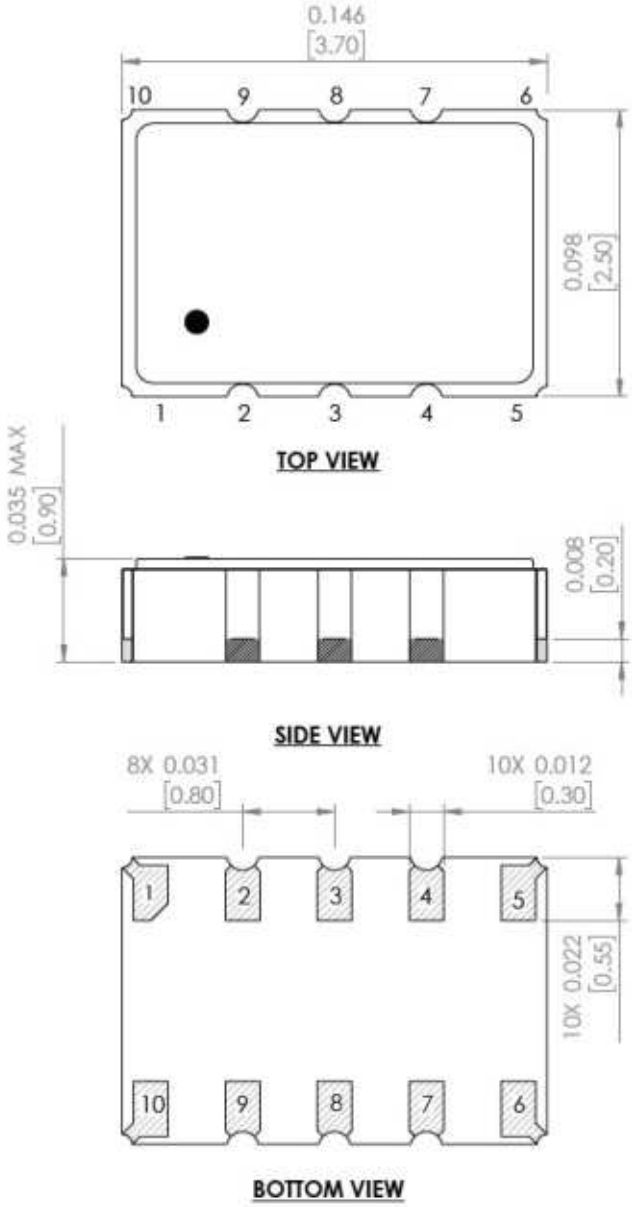
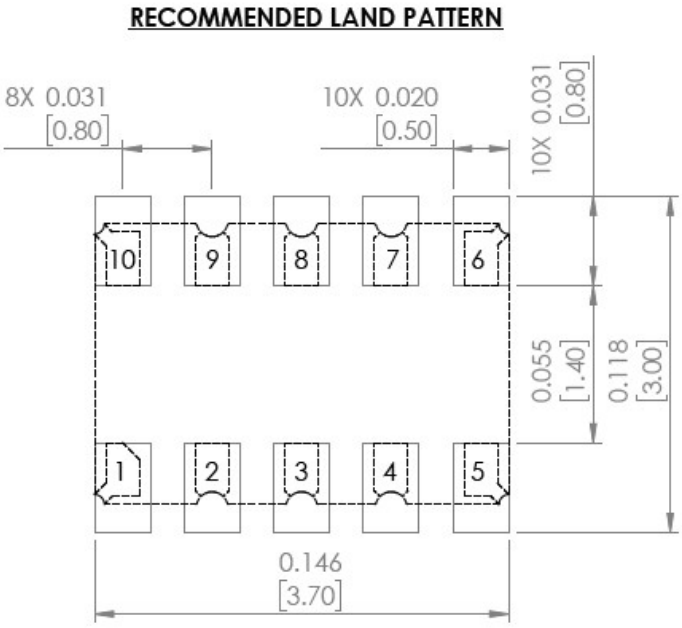


Table 1. Time accuracy, DTCXO Digitally Temperature Compensated

Parameters		Min.	Typ.	Max.	Units
Time Accuracy Option: A	T_{AMB}=+25°C		±1	±3	ppm
	T_{AMB}=0 ~ +50°C		±2	±4	
	T_{AMB}=-10 ~ +65°C		±3	±5	
	T_{AMB}=-40 ~ +85°C		±4	±6	
	T_{AMB}=-40 ~ +125°C		±5	±8	
Time Accuracy Option: B	T_{AMB}=+25°C		±1	±3	ppm
	T_{AMB}=0 ~ +50°C		±3	±5	
	T_{AMB}=-10 ~ +65°C		±5	±10	
	T_{AMB}=-40 ~ +85°C		±10	±25	
	T_{AMB}=-40 ~ +125°C		±15	±30	

Mechanical Dimensions





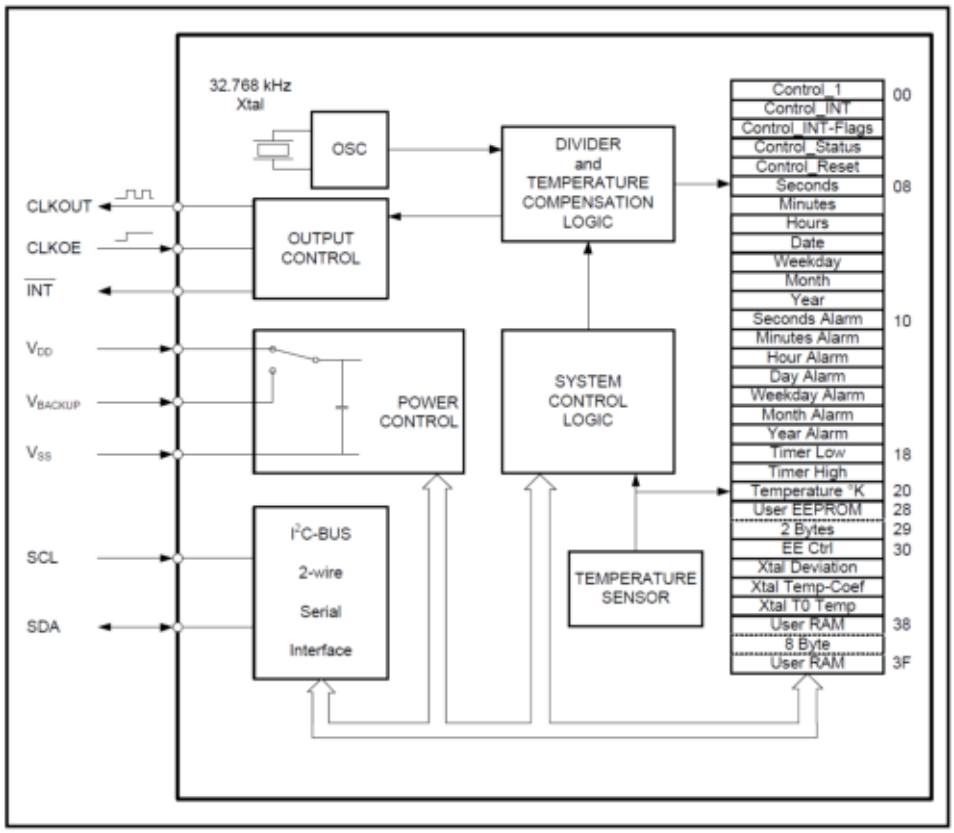
Note: Metal Lid is Connected to Vss (Pin #6)

Dimensions: inches [mm]

Pin Description

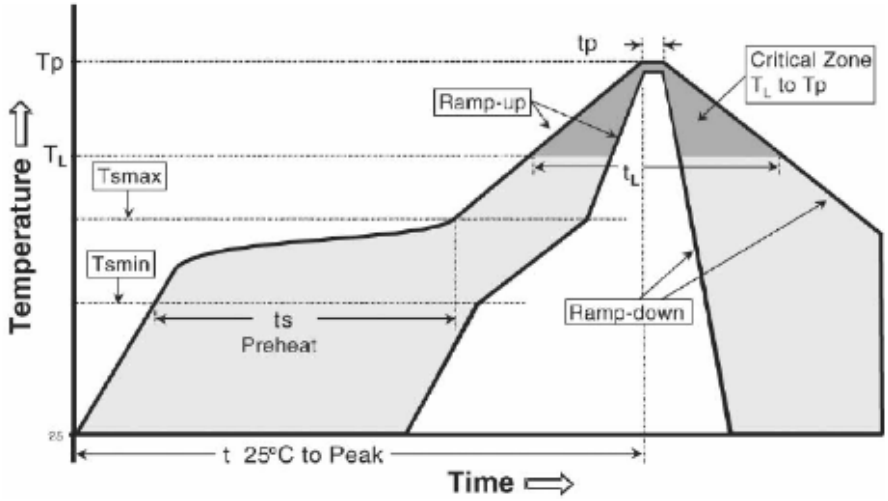
Pin No.	Pin Name	Function
1	CLKOE	CLKOUT enable/disable pin; enable is active HIGH; tie to GND when not using CLKOUT
2	V_{DD}	Positive supply voltage; positive or negative steps in supply voltage may affect oscillator performance, recommend 10 nF decoupling capacitor close to device
3	CLKOUT	Clock Output pin; CLKOUT or $\overline{INT}$ function can be selected.(Control_1; bit7; Clk/Int) CLKOUT output push-pull / $\overline{INT}$ function open-drain requiring pull-up resistor
4	SCL	Serial Clock Input pin; requires pull-up resistor
5	SDA	Serial Data Input-Output pin; open-drain; requires pull-up resistor
6	V_{SS}	Ground
7	$\overline{INT}$	Interrupt output pin; open-drain; active LOW
8	N.C.	Not connected; internally used for test. do not connect other signals than ground
9	V_{BACKUP}	Backup Supply Voltage; tie to GND when not using backup supply voltage
10	N.C.	Not connected; internally used for test. do not connect other signals than ground

Block Diagram



Recommended Reflow Profile

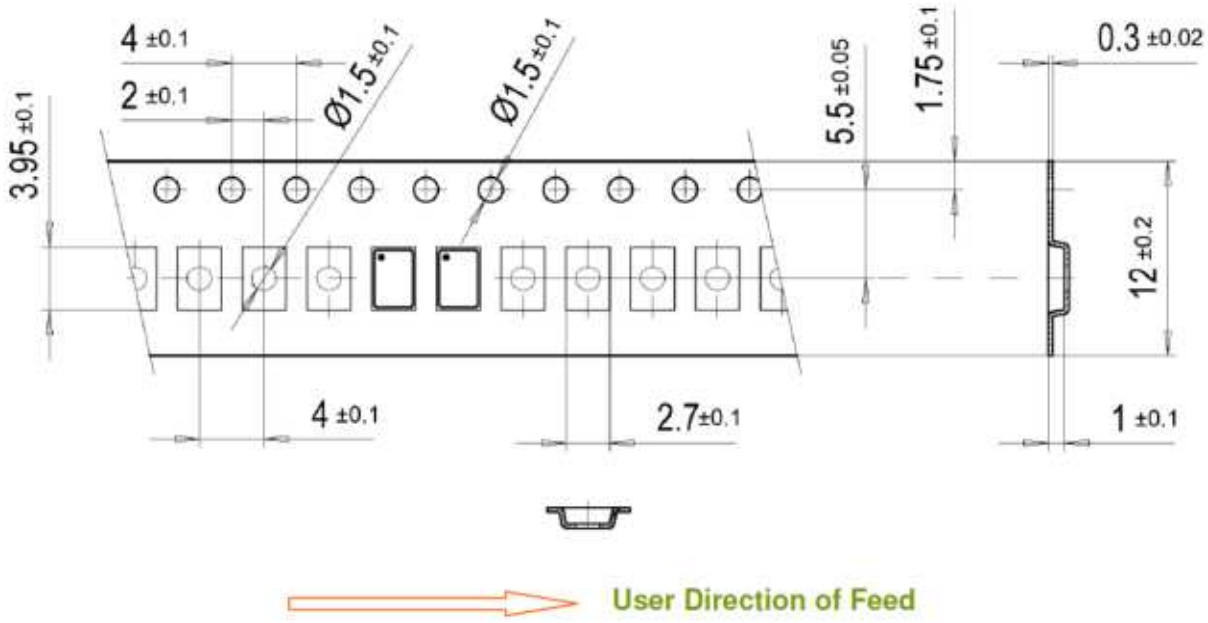
Maximum Reflow Conditions in accordance with IPC/JEDEC J-STD-020C "Pb-free"

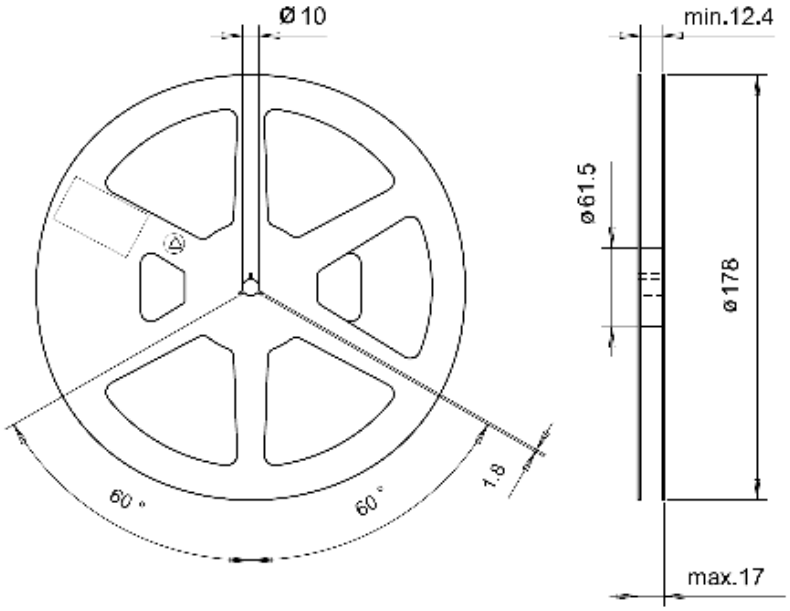


Temperature	Conditions	Units
Average Ramp-up Rate (T_{Smax} to T_P)	3°C/second max	°C/s
Ramp Down Rate (T_{cool})	6°C/second max	°C/s
Time 25°C to Peak Temperature ($T_{to\text{-}peak}$)	8 minutes max	m
Preheat		
Temperature Min (T_{Smin})	150	°C
Temperature Max (T_{Smax})	200	°C
Time T_{smin} to T_{smax} (ts)	60 ~ 180	sec
Time Above Liquidus		
Temperature Liquidus (T_L)	217	°C
Time above Liquidus (t_L)	60 ~150	sec
Peak Temperature		
Peak Temperature (T_P)	260	°C
Time within 5°C of Peak Temperature (t_P)	20 ~ 40	sec

Packaging

T=1000pcs/reel





Dimensions: mm