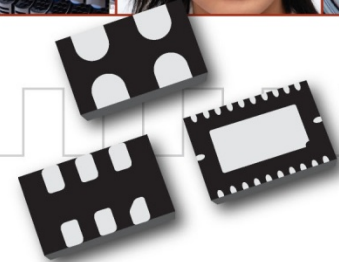




## SiT1552 – 32 kHz TCXO for Wearables

June 4, 2014



The Smart Timing Choice™

# SiTime – Clear Leader in MEMS Timing



**\$5 Billion  
Timing Market**

Market CAGR – 5%  
MEMS CAGR – 65%



**MEMS, Analog,  
Systems Leader**

100 Patents  
2 Year Lead



**Market Leader**

200MU Shipped, 100 Major OEMs  
80% Share of MEMS Timing



**Product Leader**

Programmable – 200K Part Numbers

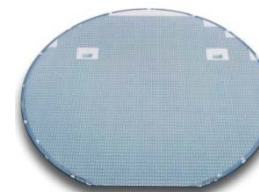
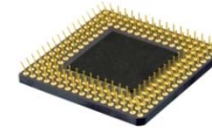
# Silicon Always Wins



Highest Performance, Best Reliability, Smallest, Lowest Cost

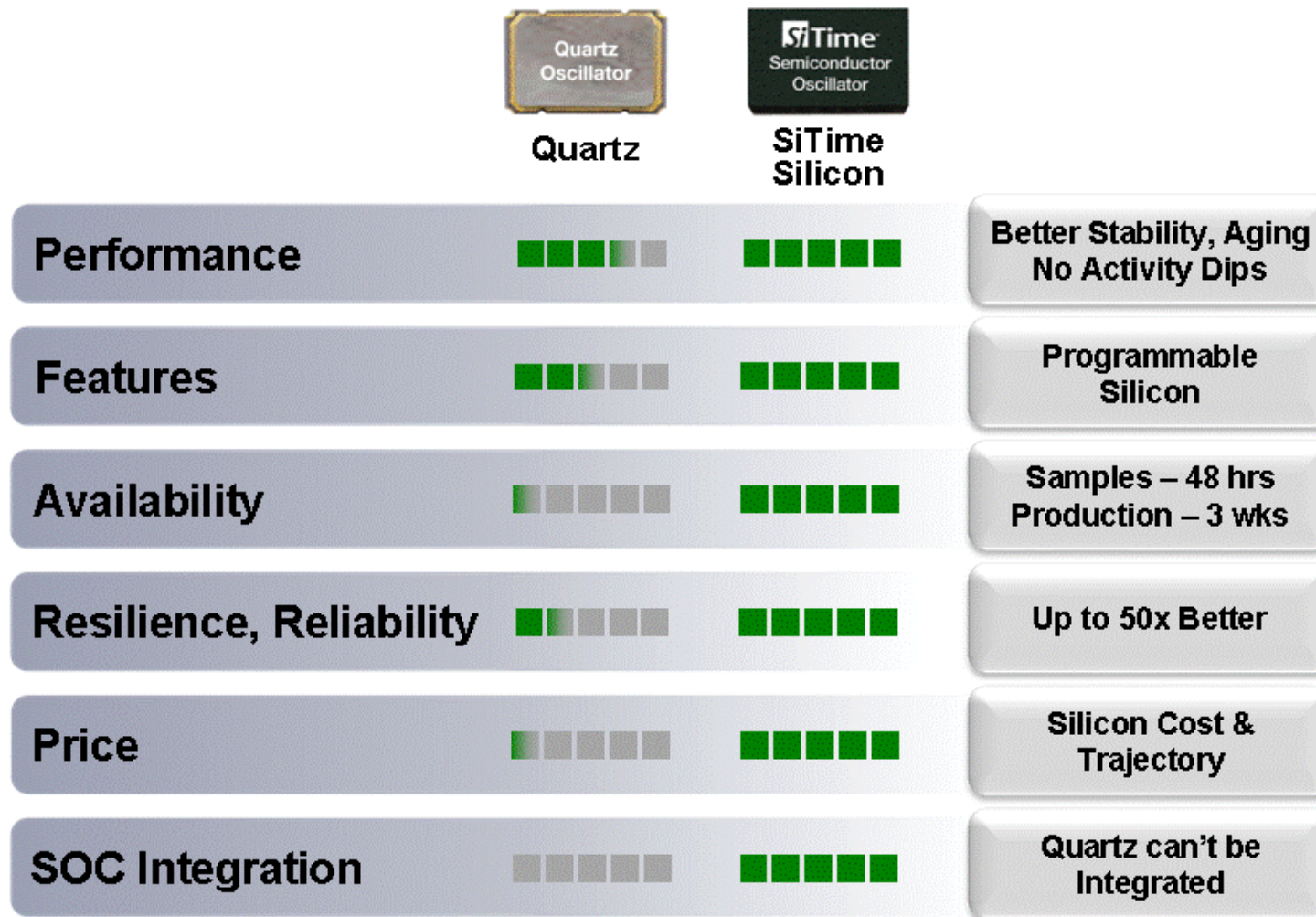


**EPSON®**  
Quartz



**SiTime™**  
MEMS

# Benefits of MEMS over Quartz





# Broadest Product Portfolio



32 kHz XO and XTAL Replacement	32 kHz TCXO	Ultra-Performance XO	Low Power XO	+125°C High Temp XO	AEC-Q100 Automotive Clocks	VCXO	(VC) TCXO	Spread Spectrum XO	DCXO	Clock Generator
<b>SiT1532</b> 32.768 kHz 1508 CSP 1.2 to 3.63V	<b>SiT1552</b> 32.768 kHz 1.5 to 3.63V	<b>SiT8208/9</b> 1-220 MHz	<b>SiT1602</b> 3.75-75 MHz	<b>SiT1618</b> 7.3728-48 MHz -40 to +125°C	<b>SiT8924</b> 1-110 MHz -40 to +125°C	<b>SiT3807</b> 1.5-45 MHz	<b>SiT5000</b> 10-45 MHz ±1.5 to 5 PPM	<b>SiT9001</b> 1-200 MHz	<b>SiT3907</b> 1-220 MHz	<b>SiT9201</b> 1-110 MHz
<b>SiT1533</b> 32.768 kHz 2012 SMD 1.2 to 3.63V	<b>SiT1553</b> 32.768 kHz 2.7 to 4.5V	<b>SiT8225</b> 25 MHz 1/10 GbE	<b>SiT8008/9</b> 1-137 MHz 3.5-7 mA	<b>SiT8918/9</b> 1-137 MHz -40 to +125°C	<b>SiT8925</b> 115.20-137 MHz -40 to +125°C	<b>SiT3808/9</b> 1-220 MHz	<b>SiT5001/2</b> 1-220 MHz ±1.5 to 5 PPM	<b>SiT9003</b> Low Power 1-110 MHz	<b>SiT3921/2</b> 1-625 MHz	<b>SiT2002</b> 115-137 MHz
<b>SiT1534</b> 1 Hz-32.768 kHz 1.2 to 3.63V		<b>SiT8256</b> 156.25 MHz 1/10 GbE	<b>SiT8003XT</b> 0.25mm thin 1-110 MHz	<b>SiT8920/1</b> 1-137 MHz -55 to +125°C	<b>SiT2024/5</b> 1-137 MHz -40 to +125°C SOT23	<b>SiT3821/2</b> 1-625 MHz	<b>SiT5021/2</b> 1-625 MHz ±1.5 to 5 PPM	<b>SiT9002</b> 1-220 MHz	<b>Serially Configured XO</b>	<b>High Temp Clock Generator</b>
<b>SiT1542</b> 32.768 kHz 1508 CSP 2.7 to 4.5V		<b>SiT9120</b> 25-212.5 MHz							<b>SiT3509</b> 1-220 MHz 9 selectable frequencies	<b>SiT2018/9</b> 1-137 MHz -40 to +125°C
<b>SiT1543</b> 32.768 kHz 2012 SMD 2.7 to 4.5V		<b>SiT9121/2</b> 1-625 MHz								<b>SiT2020/1</b> 1-137 MHz -55 to +125°C
<b>SiT1544</b> 1 Hz-32.768 kHz 2.7 to 4.5V		<b>SiT9156</b> 156.25 MHz 10/40 GbE							<b>Serially Configured DCXO</b>	
<b>SiT1630</b> 32.768 kHz Oscillator								<b>SiT3519</b> 1-220 MHz 9 selectable frequencies		

NanoDrive™ output for lowest power  
 LVCMOS output  
 LVDS/LVPECL output  
 Available as field programmable for use with Time Machine II Programmer  
 Pin-to-pin compatible with quartz devices

# SiTime Products Used in Many High-Volume Segments



**Consumer**



**Mobility +  
Wearables + IoT**



**Computing-Storage**



**Industrial**



**Wireless Telecom**



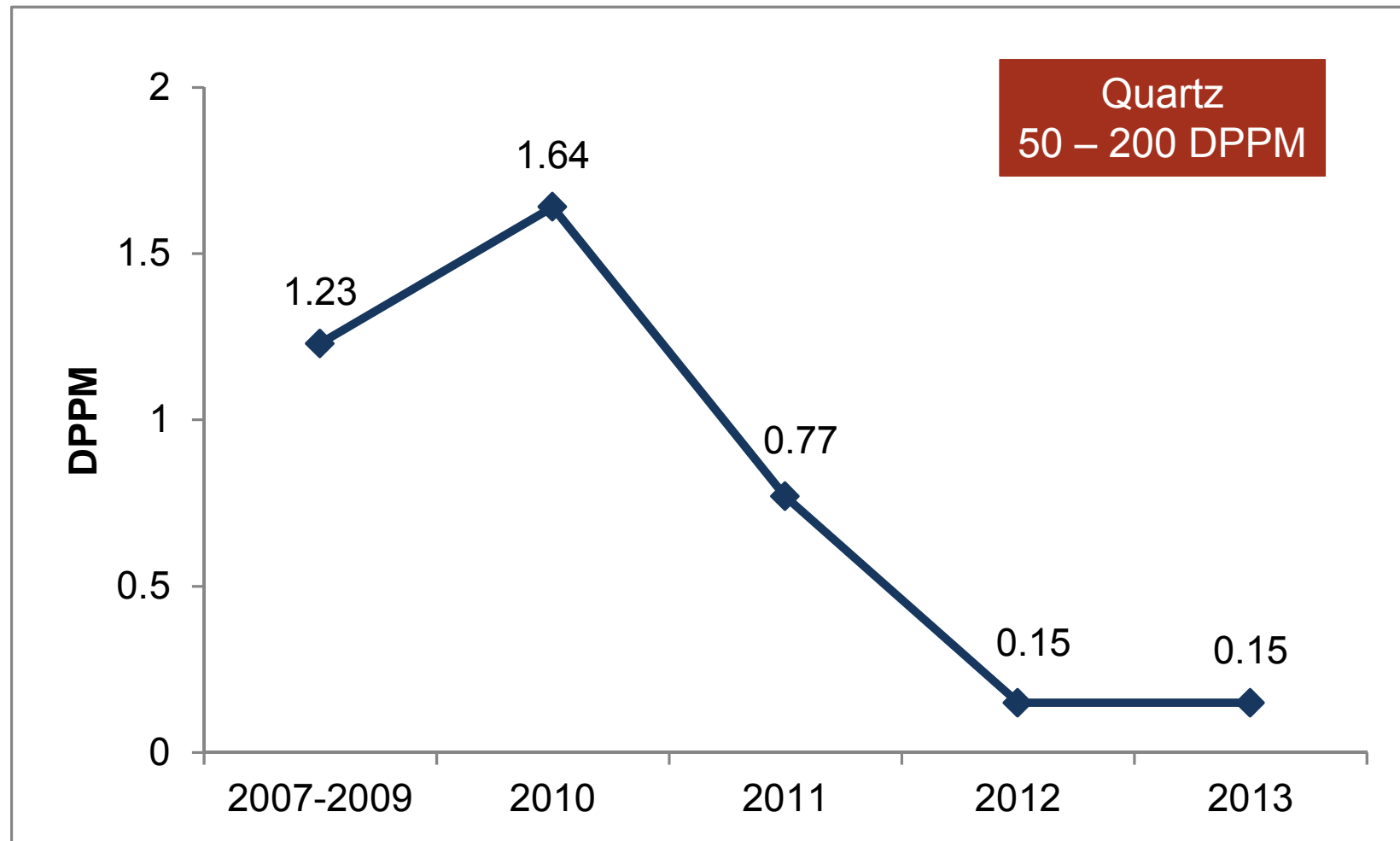
**Networking**

# World Class Quality – 2007 thru 2013



LIFETIME  
WARRANTY

**Zero MEMS Failures and Zero Long Term Failures**



Uniquely Available from SiTime



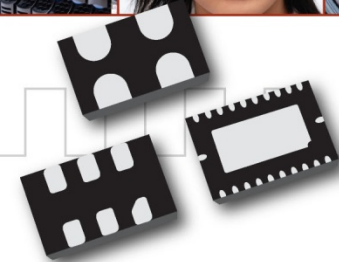
**LIFETIME  
WARRANTY**





## SiTime's 32 kHz MEMS TCXO

SiT1552



The Smart Timing Choice™

# 32 kHz MEMS TCXO for Wearables, IoT

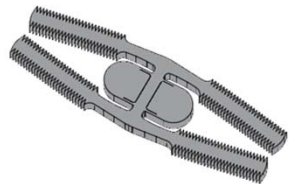


- 32 kHz MEMS Temperature Compensated Oscillator (TCXO)
  - Reference for Real Time Clock (RTC) function
  - Sleep clock for connectivity (BT / BLE, WiFi)
  - Heartbeat clock for battery supervisory function
- Replaces 32 kHz quartz resonators (X), oscillators (XO) and TCXOs
- Best-in-class 5 PPM frequency stability over -40 to +85°C
- 85% smaller than quartz TCXOs, available in tiny 1.5 x 0.8 mm CSP
- Best power savings
  - Half the power of quartz TCXO
  - 10X faster startup time for duty-cycling
  - 1.5X to 3X longer battery life
- Applications: Wearable electronics, Internet of Things (IoT)

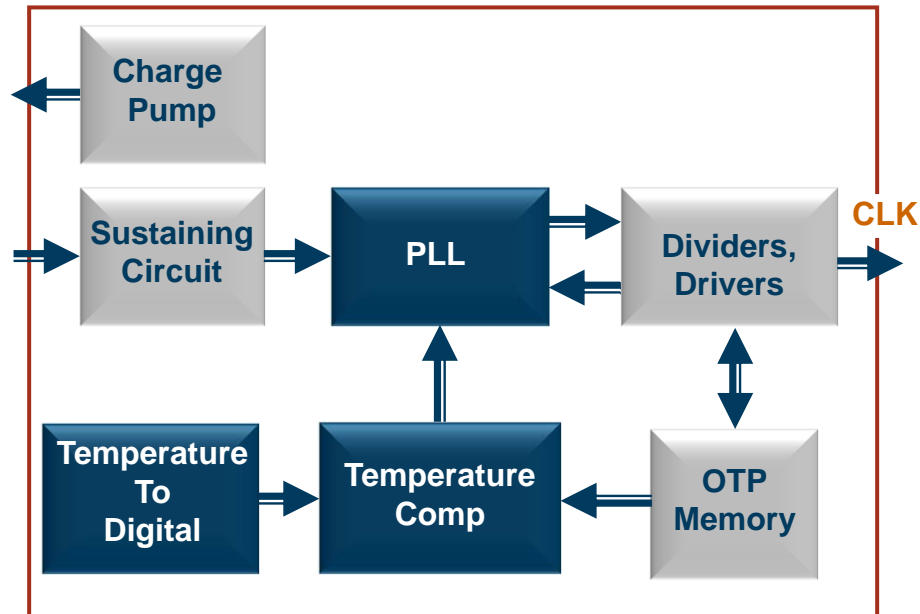
# SiT1552 MEMS TCXO Architecture



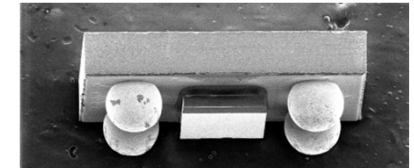
## MEMS Resonator



## High Performance Mixed Signal



## MEMS TCXO

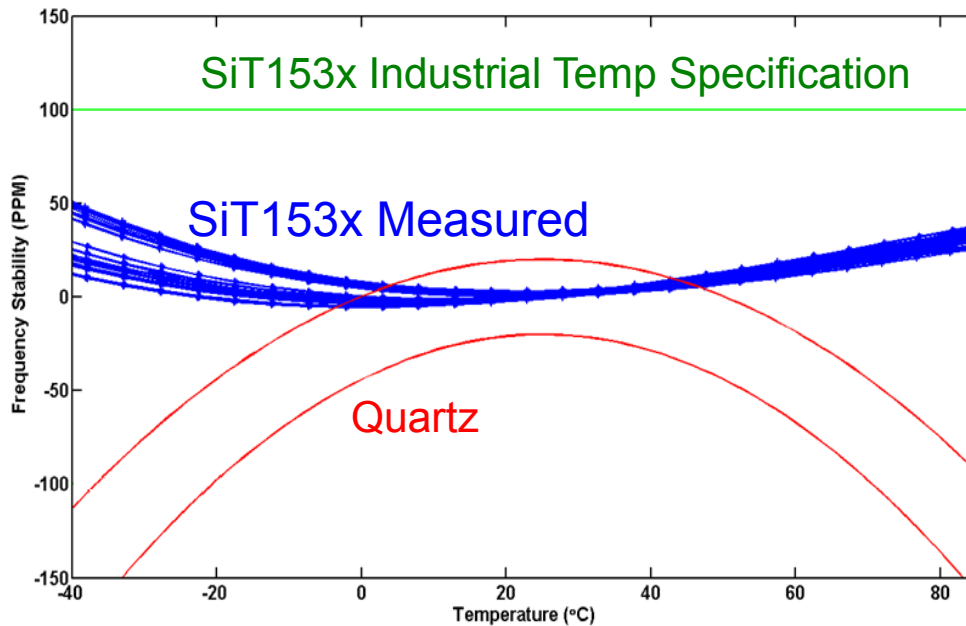


- Initial Tolerance (25°C) <  $\pm 5$  PPM
- Frequency Stability <  $\pm 5$  PPM
- Low Power < 1  $\mu$ A
- Mass Production: Now

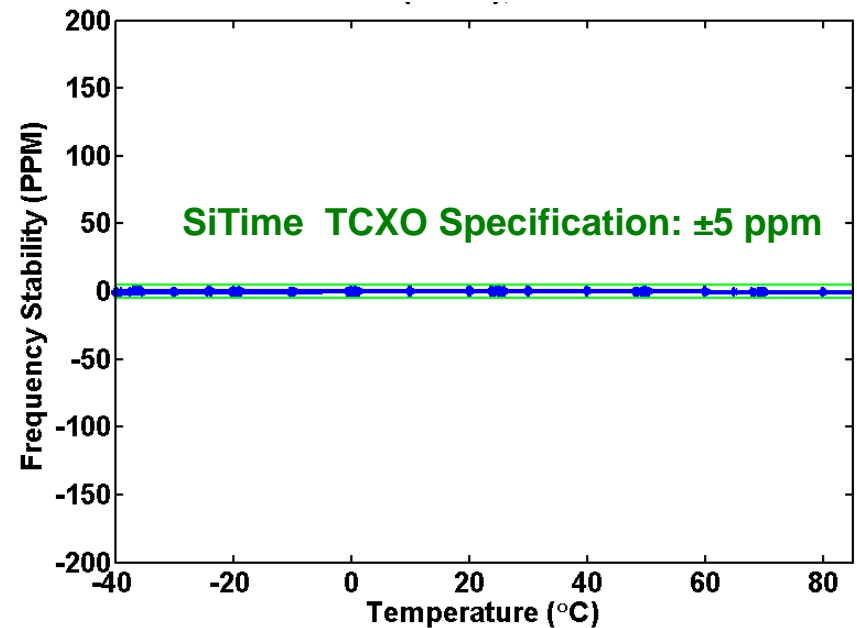
# SiT1552 Delivers $\pm 5$ PPM Stability



## SiT153x 32kHz XO (100 ppm)



## SiT1552 32kHz TCXO ( $\pm 5$ ppm)

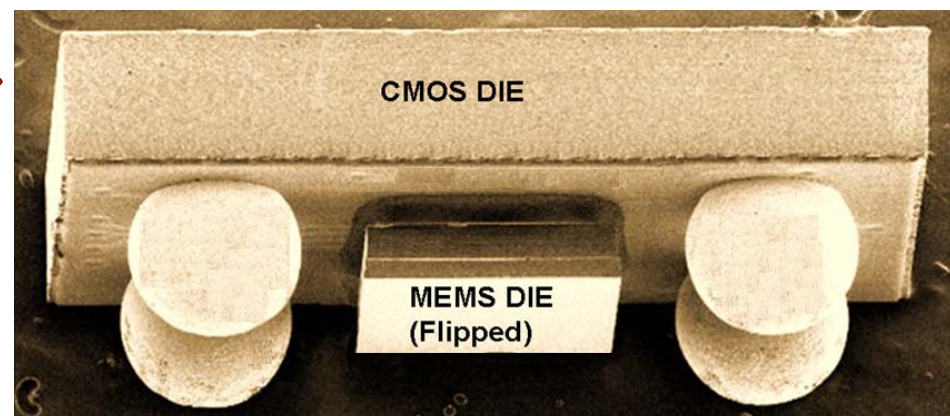


# Unique Packaging for Smallest Size



**Smallest, Lowest Power 32 kHz MEMSTCXO**

5 PPM, 1.2 mm<sup>2</sup>, 1  $\mu$ A



1.55 x 0.85 x 0.55 mm  
L x W x H

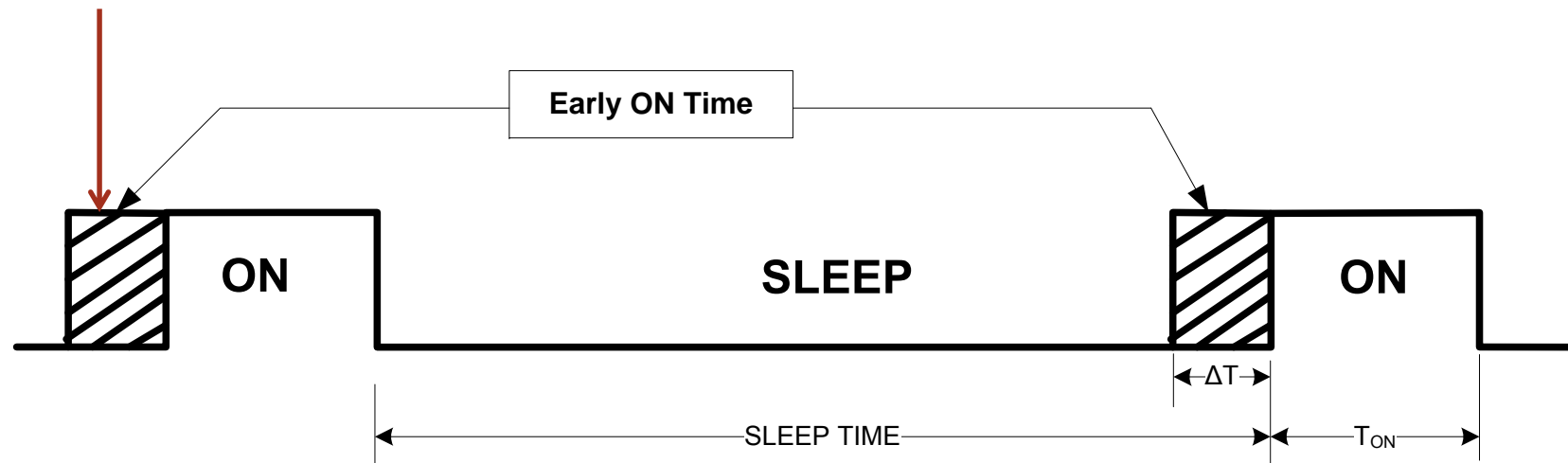


# 5ppm TCXO Extends Battery Life

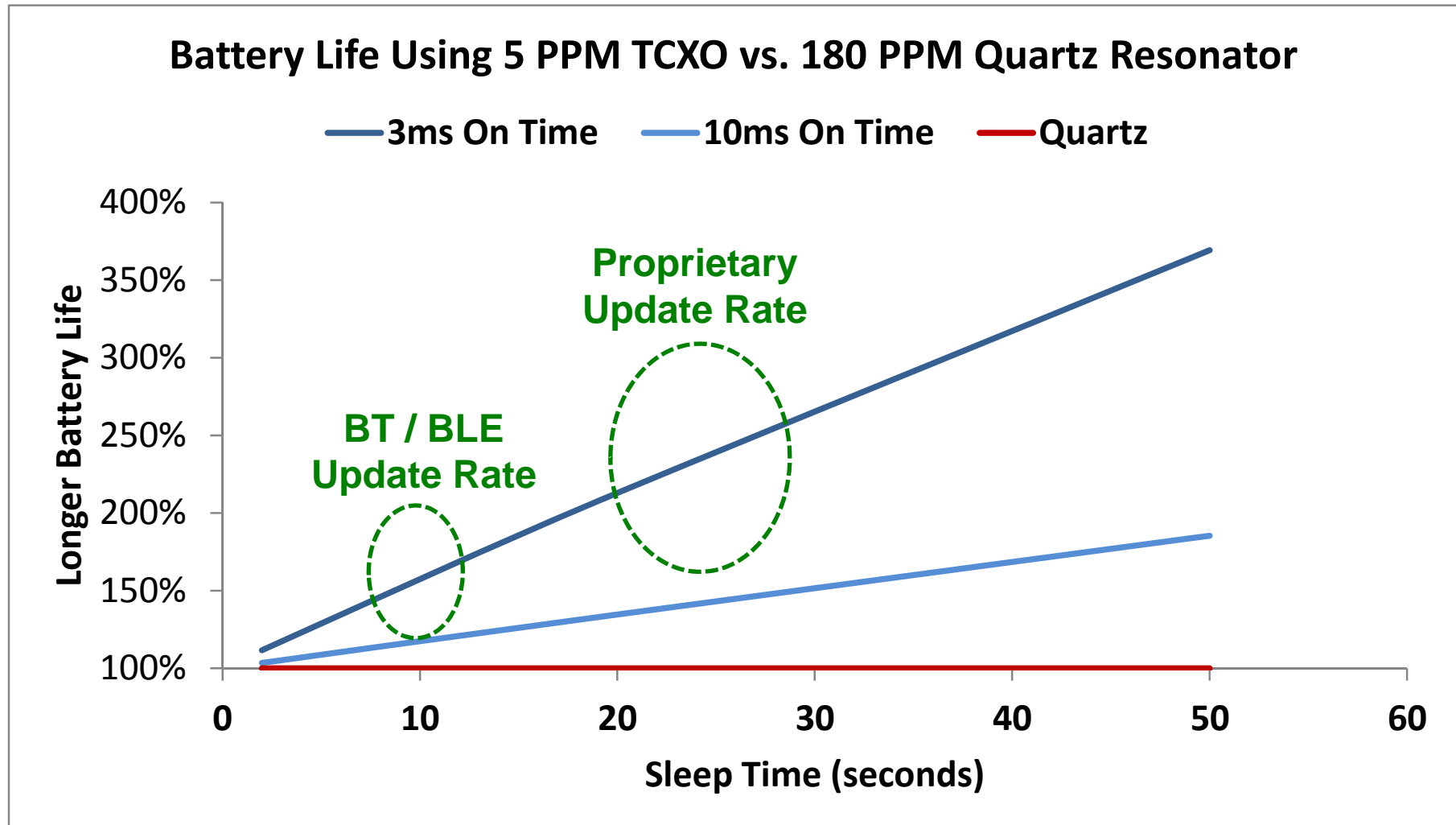


- Problem: Frequent network connections consume power, limits battery life.
- Solution: 5 PPM 32kHz sleep-clock maximizes battery life
- On Time and Sleep Time are defined in BLE standards
- Early On Time is penalty due to clock inaccuracy (worse stability)
- Tighter Stability → Shorter Early On Time → Lower Power

Uncertainty due to  
Sleep Clock Stability



# Battery Life Comparison – 5 PPM MEMS TCXO vs. 180PPM Quartz Resonator



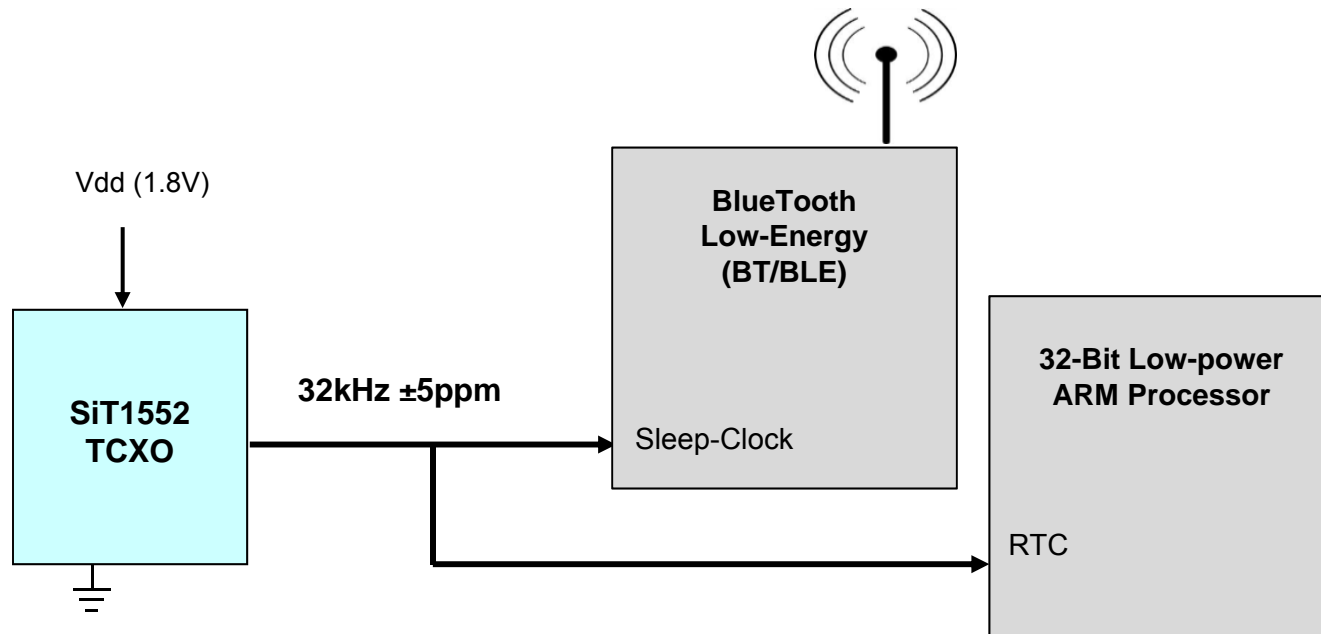
Comparing Battery Life by using 5 PPM 32 kHz TCXO compared to 180 PPM 32 kHz Resonator

# SiT1552 Beats Quartz TCXOs



Parameter	SiTime SiT1552	Kyocera KT3225T	Epson TG-3530
Area (mm <sup>2</sup> )	1.3	8	50.5
Frequency Stability Over Temp (ppm)	± 5	± 5	± 5
Temperature Range (°C)	-40 to 85	-40 to 85	-20 to 70
Current (µA)	1 typ 1.5 max	1.5 typ 4 max	1.7 typ 4 max
Start up time (s)	0.3	3	3
Supply Voltage (V)	1.5 to 4.5	2 to 5.5	2.2 to 5.5
Supply Sensitivity (ppm/V)	± 0.25	± 1	± 1

# 32 kHz TCXO Drives Multiple Loads



# Target Applications



## Sport Fitness



## Personal Medical Devices



## Accessories



## Internet of Things (IoT)





# Summary



- 32 kHz MEMS Temperature Compensated Oscillator (TCXO)
  - Time-keeping
  - Power Management and control
- Replaces quartz resonators (X), oscillators (XO) and TCXOs
- Best-in-class 5 PPM frequency stability over -40 to +85°C
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80% Share of MEMS Timing



**Product Leader**

Programmable – 200K Part Numbers