Precision Timing Solutions

Autonomous Ground Vehicles (AGVs)

Precision Timing in Autonomous Ground Vehicles

Use of autonomous ground vehicles (AGVs) and unmanned ground vehicles (UGVs) is rapidly growing as multiple industries race to replace repetitive, labor intensive, and dangerous tasks, improving efficiency, productivity, and safety.

Key Considerations

- Wide temp range
- EMI resilience
- Temp stability
- Low phase noise

While the terms AGV and UGV are often used interchangeably, there are a few differences. One key difference is that AGVs are used within buildings, such as in warehouses while UGVs are primarily used outdoors. Other key differentiators are:

AGVs

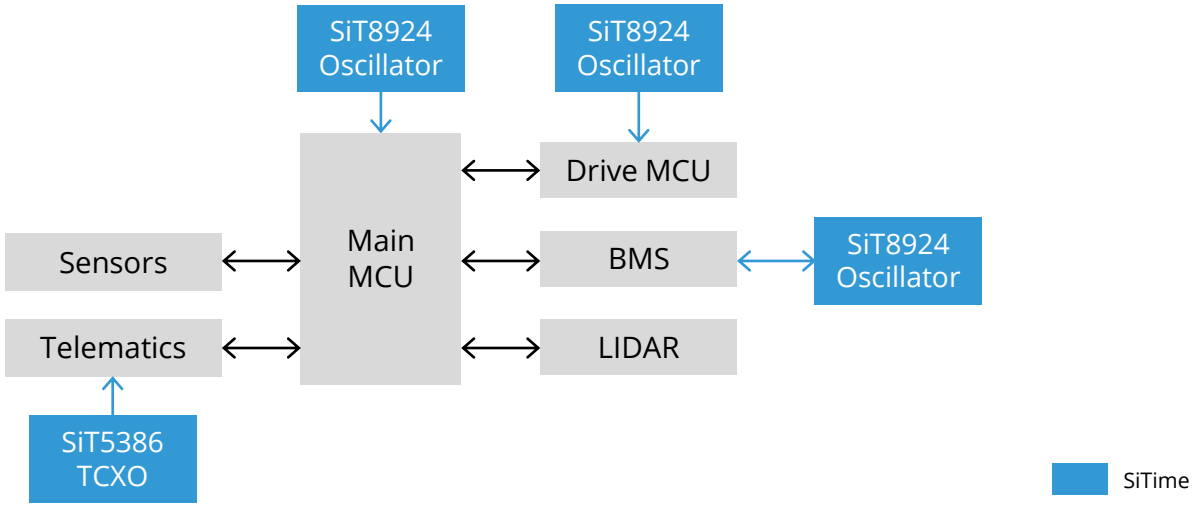
- Operate within buildings
- Navigation with LIDAR...
- ...or guided paths
- Communicate wirelessly
- Battery operated

UGVs

- Operate outdoors
- Use GNSS
- Communicate wirelessly
- Use video
- Battery and/or fuel operated

AGVs and UGVs are complex systems that can operate near humans and in harsh environments. Each of the sub-systems must perform to exact specification under unforgiving conditions. This requires the timing components meet stringent requirements. Component size, EMI, low phase noise and stability are key considerations in designing these systems.

AGV Block Diagram



AGVs and UGVs are driven by a main microcontroller (MCU). The main MCU interconnects to several subsystems: sensors, telematics, drive MCU, battery management system (BMS), Lidar etc. The clocking requirements for these subsystem can be fulfilled with the SiT8924 oscillator. Telematics typically requires a clock with high stability over the temperature range, such as the SiT5386 Super-TCXO which features ±0.1 ppm stability over -40°C to +105°C. The SiT9025 oscillator features spread spectrum clocking (SSC) to reduce EMI.

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Featured Automotive Grade Products – please refer to the Selector Guide for more options.

Type	Product	Frequency	Key Features	Key Values
Single-ended oscillator	SiT8924	1 to 110 MHz	• Up to -55°C to +125°C • ±20 ppm stability • 2016, 2520, 3225 packages	• High reliability • Extended temperature range • Small footprint
	SiT9025	1 to 150 MHz	• Up to -55°C to +125°C • Spread spectrum • Configurable rise / fall times • 2016, 2520, 3225 packages	• High reliability • Extended temperature range • EMI Reduction
Differential oscillator	SiT9396	1 to 220 MHz	• Low jitter: < 150 fs RMS[1] • ±30, ±50 ppm stability • LVPECL, LVDS, HCSL, Low-power HCSL, FlexSwing™ • -40°C to +125°C • 2016, 2520, 3225 packages	• High reliability • Low jitter • Enables interfaces with demanding jitter requirements, such as PCI-Express and 10 GB Ethernet
	SiT9397	220 to 920 MHz		
Super-TCXO	SiT5386	1 to 60 MHz	• 1 to 220 MHz • ±0.1, ±0.2, ±0.25 ppm stability • ±1 ppb/°C frequency slope • -40°C to 105°C • Low jitter: 0.31 ps RMS[1] • Optional voltage or digital frequency control	• High accuracy • Excellent frequency stability even with fast temperature gradients • No GNSS signal loss or V2X disconnect, as the MEMS resonator is not subject to "micro-jump" like crystal oscillators
	SiT5387	60 to 220 MHz		
32.768 kHz oscillator	SiT1881	32.768 kHz	• ±20, ±50, ±100 ppm stability • 1.14 to 3.63 V supply • < 490 nA consumption • -40°C to +125°C • 1.2 x 1.1 mm • < 115 ms startup time	• Low power • Small footprint • Excellent stability • Faster start-up time than 32.768 kHz tuning-fork crystals • High reliability for functional safety applications

[1] 12 kHz to 20 MHz integration range

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Featured Industrial Products – please refer to SiTime.com or contact us for more options.

Type	Product	Frequency	Key Features	Key Values
Single-ended oscillator	SiT8021	1 to 26 MHz	• -40°C to +85°C • ±20 ppm stability • 1.5 x 0.8 package	• High reliability • Extended temperature range • Small footprint
	SiT9025	1 to 150 MHz	• Up to -55°C to +125°C • Spread spectrum • Configurable rise / fall times • 2016, 2520, 3225 packages	• High reliability • Extended temperature range • EMI Reduction
Differential oscillator	SiT9376	1 to 220 MHz	• Low jitter: < 150 fs RMS[1] • ±30 or ±50 ppm stability • LVPECL, LVDS, HCSL, Low-power HCSL, FlexSwing™ • -40°C to +125°C • 2016, 2520, 3225 packages	• High reliability • Low jitter
	SiT9377	220 to 920 MHz		
Super-TCXO DCXO/ VCXO	SiT5356	1 to 60 MHz	• ±0.1, ±0.2, ±0.25 ppm stability • ±1 ppb/°C frequency slope • -40°C to 105°C • Low jitter: 0.31 ps RMS[1] • Optional voltage or digital frequency control	• High accuracy • Excellent frequency stability even with fast temperature gradients
	SiT5357	60 to 220 MHz		
32.768 kHz oscillator	SiT1811	32.768 kHz	• ±20, ±50, ±100 ppm stability • 1.14 to 3.63 V supply • < 490 nA consumption • Up to -40°C to +105°C • 1.2 x 1.1 mm • < 115 ms startup time	• Low power • Small footprint • Excellent stability • Faster startup time than 32.768 kHz tuning-fork crystal enables faster system startup

[1] 12 kHz to 20 MHz integration range

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SiTime Advantages

SiTime devices offer the following benefits over quartz crystals, which are particularly important in automotive.

- 50x better reliability. Apart from reducing the amount of field failures, better reliability translates into a lower FIT rate. This provides better hardware safety metrics in an FMEDA, the quantitative analysis required as part of a functional safety assessment.
- 30x better resilience to shock, vibration and electromagnetic interference, due to the smaller size (0.4 x 0.4 mm) and lower mass of MEMS resonators compared to crystals. When not causing a permanent damage to the crystal, shock and vibration can induce jitter in a crystal oscillator. Jitter can be detrimental to the bit error rate of a high-speed link. Better resilience of SiTime oscillators ensures a low error rate regardless of operating conditions.
- Better frequency accuracy, 10x lower aging, and excellent stability over temperature – down to ±20 ppm (XO devices) over -40 to +125°C and ±0.1 ppm (TCXO devices) over -40 to +105°C.
- SiT9025 features EMI reduction features: spread spectrum and configurable rise/fall times.

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