Automotive LiDAR

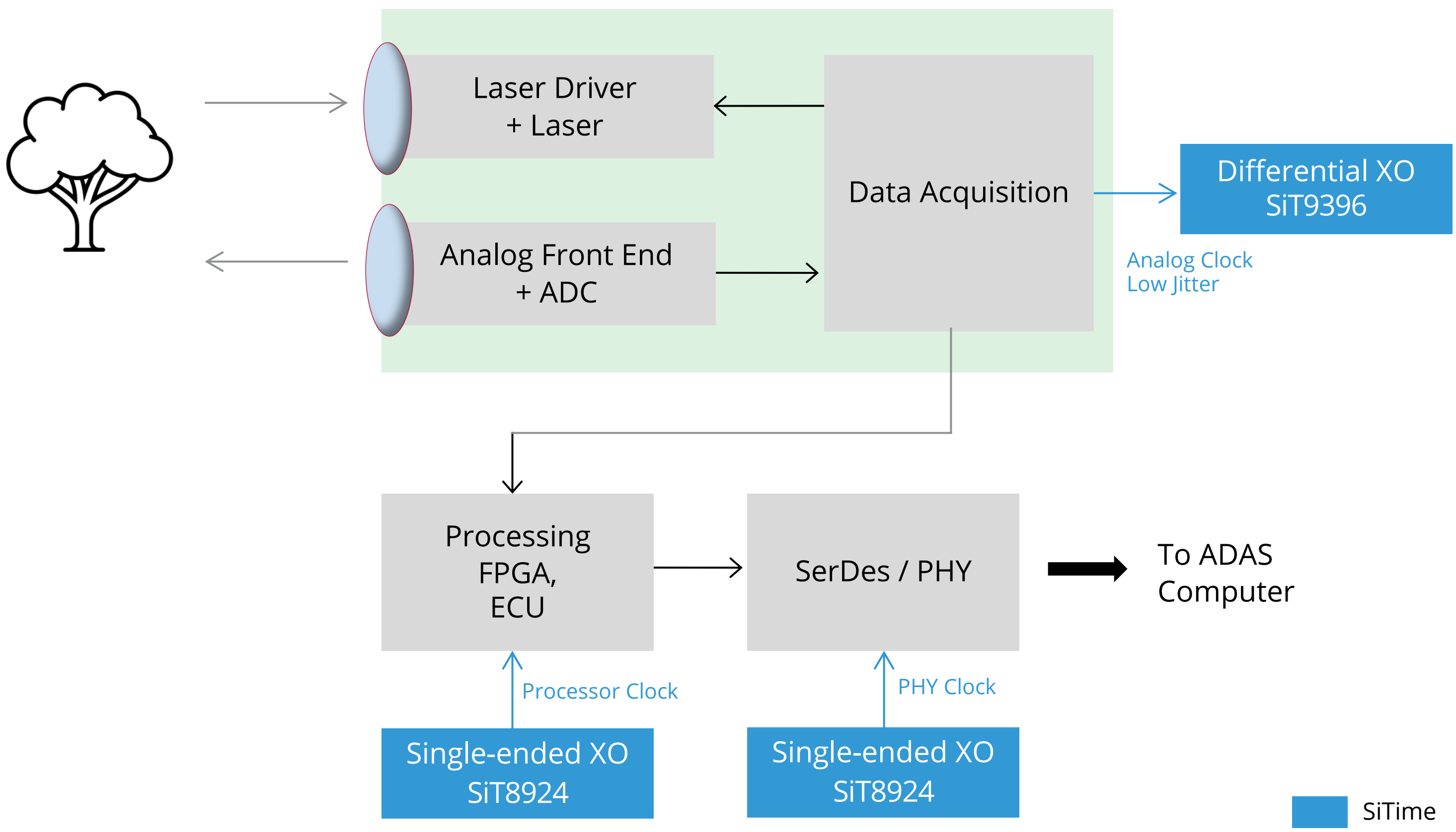
Precision Timing in Automotive LiDAR Systems

LiDAR, together with radar and camera vision, is one of the key sensing elements of ADAS systems. LiDAR (light detection and ranging) determines range by targeting an object with laser and measuring the time for the reflected light to return to the receiver. LiDAR systems scan the vision field vertically and horizontally, some can scan 360°, hence creating a 3D representation of the environment around a vehicle.

Key Considerations

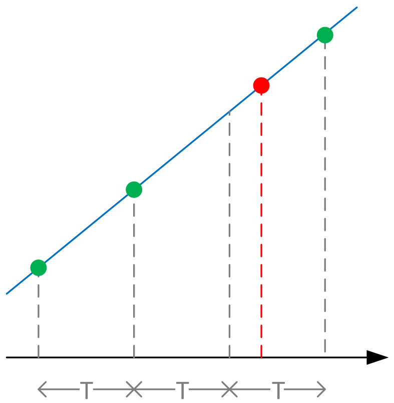
- Reliability and functional safety
- Low jitter
- Frequency stability and dF/dT
- High temperature

Block Diagram



At the core of a LiDAR system are a solid-state laser source, a detector and the analog front end (AFE). An ADC samples the signal received by the AFE. After processing, the data collected by the LiDAR system is sent to a domain controller or ADAS computer via a PHY. Many different interfaces exist, for instance Ethernet, FPD-Link (TI) or GMSL (Analog Devices). Open standards such as Automotive Serdes Alliance (ASA) or MIPI A-PHY are emerging. Depending on the interface, either a single ended or a differential clock will be needed.

Several measurement methods exist: Time of flight (ToF), frequency modulated continuous wave, or time-to-digital conversion (TDC). Precision timing plays a big role to ensure accuracy of the system. The low jitter of the SiT9396 / SiT9397 make those devices ideal to clock the analog part of LiDAR applications.



When an ADC is used, jitter causes quantization errors. When excessive jitter is present on a clock, in other words when a clock edge comes too early or too late, an ADC samples the incoming signal at the wrong moment. Incorrect values in the data stream can significantly hamper the functionality of a system.

The excellent dynamic performance of SiTime silicon MEMS oscillators facilitate SOTIF compliance of the system. The MEMS oscillators ensure that clocks remain within spec over its entire lifetime, regardless of environmental changes.

- Temperature range -40°C to +125°C
- Well controlled frequency stability: < ±30 ppm over the full temperature range, including 10 years aging (SiT939x), down to ±0.1 ppm for TCXO (SiT538x)
- Excellent frequency response to rapid temperature changes dF/dT, down to < 3.5 ppb/°C (SiT538x)

SiTime Advantages

All SiTime devices offer the following advantages over quartz crystals, which are particularly important for automotive applications:

- 50x better reliability. Apart from reducing the amount of field failures, the 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.
- 100x 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.
- MEMS oscillators typically have a faster start-up time than crystal oscillators.

MEMS Timing Solutions

Automotive LiDAR

Featured 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 • EMI reduction features • Small footprint • Low power • Low jitter enables highest speed links
	SiT9025	1 to 150 MHz	• Up to -55°C to +125°C • Spread spectrum • Configurable rise / fall times • 2016, 2520, 3225 packages	
	SiT1625	44 standard frequencies	• -40°C to +125°C • ±25, ±30, ±50 ppm stability • 1612, 2016, 2520, 3225 packages • 500 fs RMS jitter[1] • 2.3 mA typ. current consumption	
Differential oscillator	SiT9396	1 to 220 MHz	• Low jitter: < 150 fs RMS[1] • ±30 ppm or ±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 DCXO/ VCXO	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		

[1] 12 kHz to 20 MHz integration range

Learn more about Automotive solutions from SiTime

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