

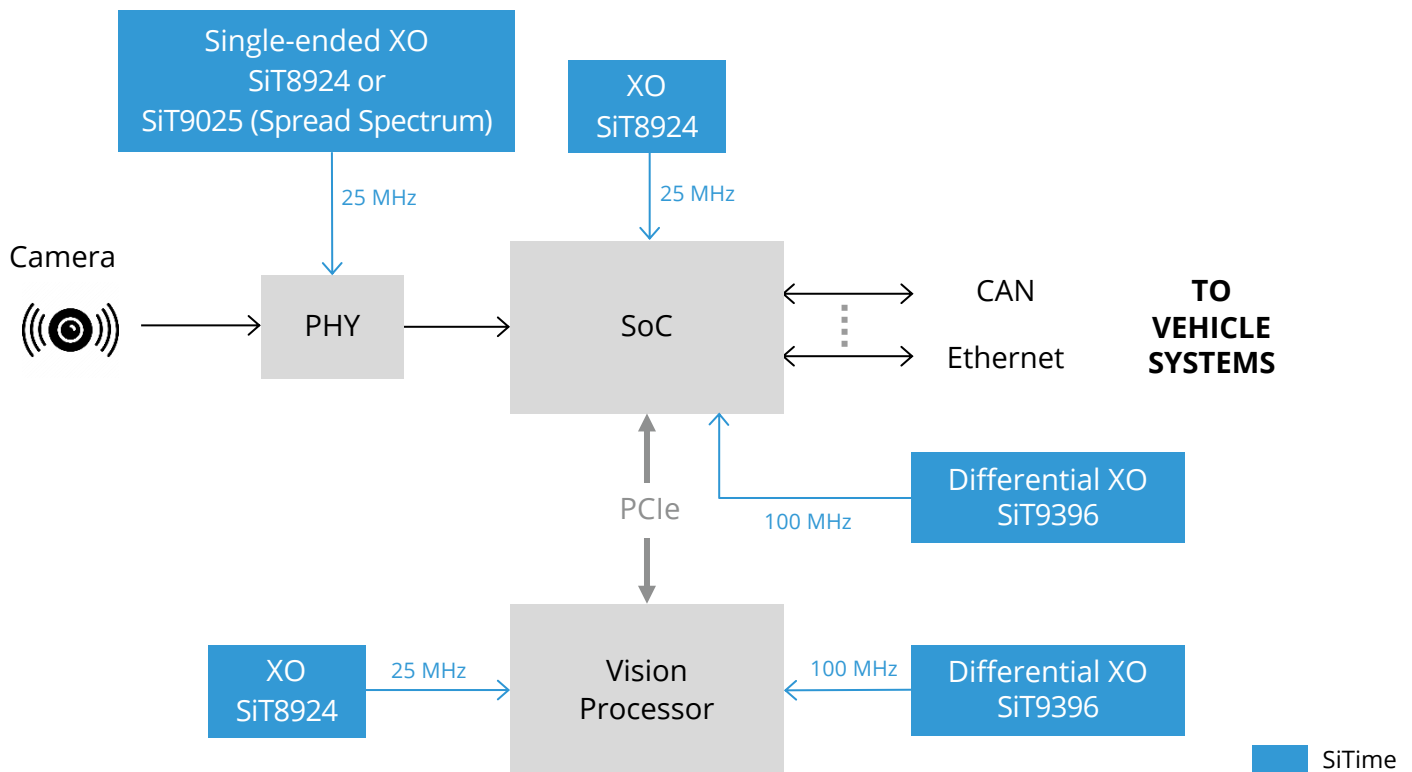
Precision Timing in Driver Monitoring Systems

The driver monitoring systems (DMS), also known as driver attention monitor, is a vehicle safety system which assesses the driver's alertness. It warns the driver in case of drowsiness, lack of attention, using a cell phone, etc. and applies the brakes if needed. Euro NCAP mandates DMS for all new type approvals from 2022 onwards.

Key Considerations

- Reliability
- Functional safety and SOTIF
- Low jitter
- High temperature

Block Diagram



A camera, either infrared or visible wavelength, monitors the driver's face. Data is sent to an image processing system based on an SoC and a machine-learning vision processor, which can be either internal to the SoC or external as shown here. In the latter case, data transfer between the two is usually done via a PCI-Express interface, which offers both the required low latency and high bandwidth.

The DMS is connected to other vehicle systems (Instrument cluster, drivetrain electronics, etc.) through CAN, Flexray and/or Ethernet interfaces.

The clock requirements of the driver monitoring system depicted here are as follows:

- **PHY:** either a single-ended clock for interfaces such as FPD Link (TI), GMSL (Analog Devices), or a differential clock for interfaces such as MIPI A-Phy (Valens)
- **SoC, Vision Processor:** single-ended clock
- **PCI-Express interface:** 100 MHz HCSL or LP-HCSL clock with jitter level compatible with the considered PCI-Express generation. Clock jitter outside specifications create transmission errors on the bus!
- As of 2022, PCI-Express Gen 4 is common in automotive applications. The corresponding jitter requirement is 0.5 fs RMS phase noise, integrated over 12 kHz to 20 MHz. SiTime [SiT9396](#) oscillator meets this requirement with margin to spare.

Compared to other automotive applications, driver monitoring systems are less demanding in terms of clocking. Still, a few points remain important:

- System level functional safety and SOTIF needs to be guaranteed
- Temperature range of -40°C to +105°C or more is mandatory
- Clock jitter needs to be within spec

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, 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.
- With crystal-based oscillators, shock and vibration usually translate into increased clock jitter. This is due to mechanical coupling of vibrations into the crystal.
- Silicon MEMS oscillators are 100x more resilient to shock, vibration and electromagnetic interference than crystal-based devices, due to the smaller size (0.4 x 0.4 mm) and lower mass of MEMS resonators compared to crystal resonators. Consequently, jitter and bit error rate of data busses remain controlled even under harsh conditions. SOTIF (Safety of the Intended Functionality) is maintained regardless of the operating conditions. Physical non-reversible damage of the oscillator is also prevented.

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	<ul style="list-style-type: none"> Up to -55°C to +125°C ±20 ppm stability 2016, 2520, 3225 packages 	<ul style="list-style-type: none"> High reliability Extended temperature range EMI reduction features Small footprint Low power Low jitter enables highest speed links
	SiT9025	1 to 150 MHz	<ul style="list-style-type: none"> Up to -55°C to +125°C Spread spectrum Configurable rise / fall times 2016, 2520, 3225 packages 	
	SiT1625	44 standard frequencies	<ul style="list-style-type: none"> -40°C to +125°C ±25, ±30, ±50 ppm stability 1612, 2016, 2520, 3225 packages 500 fs RMS jitter¹ 2.3 mA typ. current consumption 	
Differential oscillator	SiT9396	1 to 220 MHz	<ul style="list-style-type: none"> Low jitter: < 150 fs RMS¹ ±30 ppm or ±50 ppm stability 	<ul style="list-style-type: none"> High reliability Low jitter Enables interfaces with demanding jitter requirements, such as PCI-Express and 10 GB Ethernet
	SiT9397	220 to 920 MHz	<ul style="list-style-type: none"> LVPECL, LVDS, HCSL, Low-power HCSL, FlexSwing™ -40°C to +125°C 2016, 2520, 3225 packages 	
Super-TCXO DCXO/ VCXO	SiT5386	1 to 60 MHz	<ul style="list-style-type: none"> 1 to 220 MHz ±0.1, ±0.2, ±0.25 ppm stability ±1 ppb/°C frequency slope -40°C to 105°C 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Low jitter: 0.31 ps RMS¹ Optional voltage or digital frequency control 	

¹ 12 kHz to 20 MHz integration range



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