Timing Enables the Future of Optical Modules, Datacom

July 2020

Si Time®

Lowest Jitter 70 fs, Smallest by 35%

MEMS Oscillators
for Optical Modules and Data Communications

SiTime
SiT9501

1.6 mm

2.0 mm

SiTime

SiTime Timing Makes 5G Vision a Reality

10x
Faster

Better jitter, phase noise

10,000x
More Traffic

10-100x
More Devices
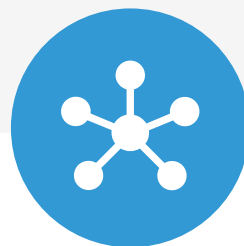
Better environmental resilience

50x
Lower Latency

Zero
Perceived Downtime

Higher reliability, lower power

90%
Less Energy

SiTime Empowers 5G Network Connectivity

5G RAN

RRH / AAU
Router
Fronthaul
MEC Server
DU
Router
Small Cells
Midhaul
MEC Server
CU
Carrier Grade Switch
Router
Microwave
Router
Router
Metro/Edge Network
Core Network
MEC Server
Router
Backhaul
Router
Data Center
Servers
Switch

Optical Modules Used Everywhere

- **M** 25G to 50G, Fronthaul
- **M** 50G to 100G, Midhaul
- **M** 100G to 800G, Metro / Data Center
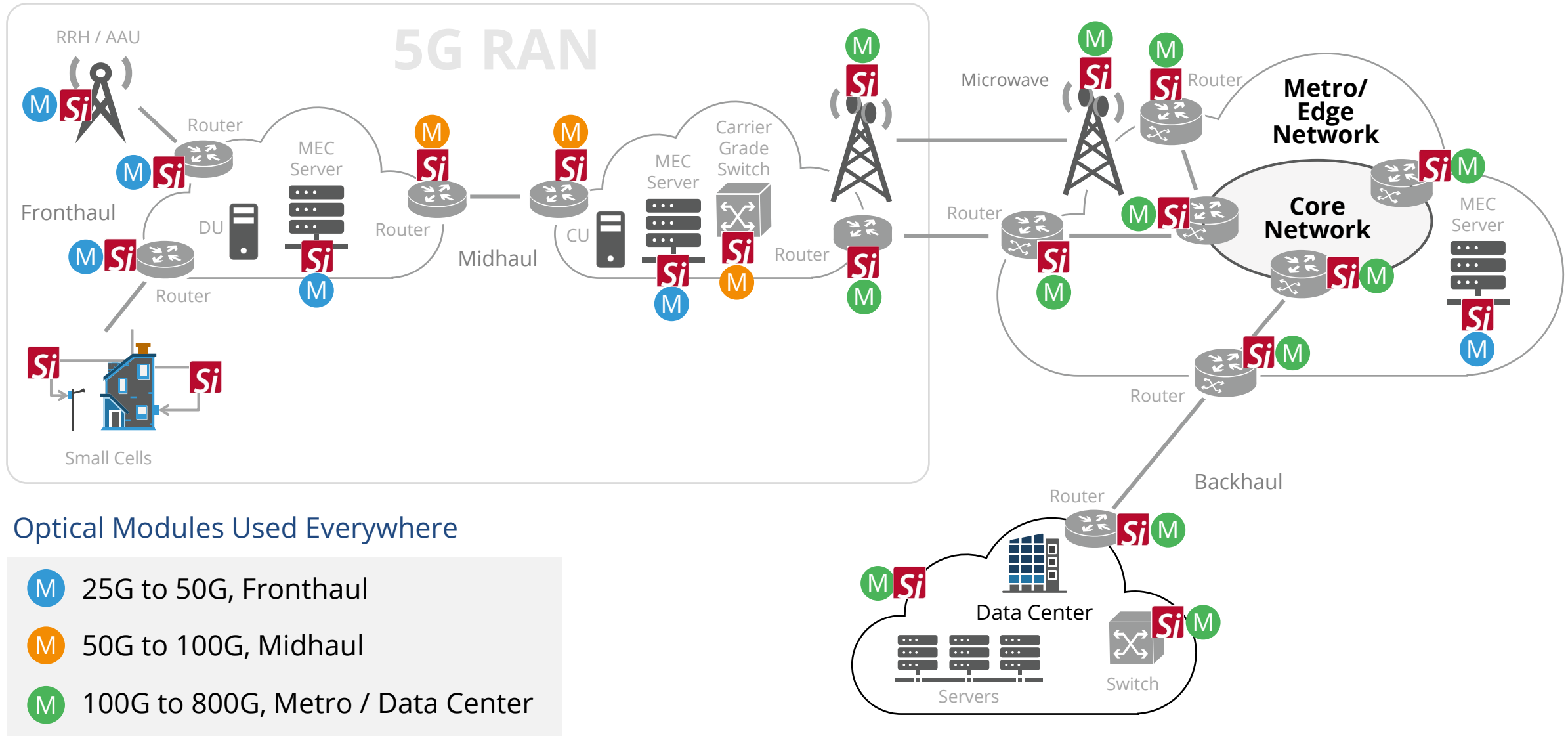
SiTime Solves Timing Problems in 5G Infrastructure

Network Devices	5G Requirement	SiTime Value	SiTime Products
Optical Modules	• 4x faster • Less power/bit • Denser designs	• Lowest-jitter • 2x more robust to supply noise • 50% smaller	SiT9501 XO
Switches, Routers, Radios	• 10x tighter time synchronization • Outdoor deployment • Higher reliability	• 4x better dF/dT • 20x better g-sensitivity, 105 °C • 40x better MTBF	Elite TCXO Emerald OCXO

Note: dF/dT measures the change in frequency with changes in temperature

State-of-the-art MEMS, PLL Deliver Ultra-low Jitter, Eliminates Spurs
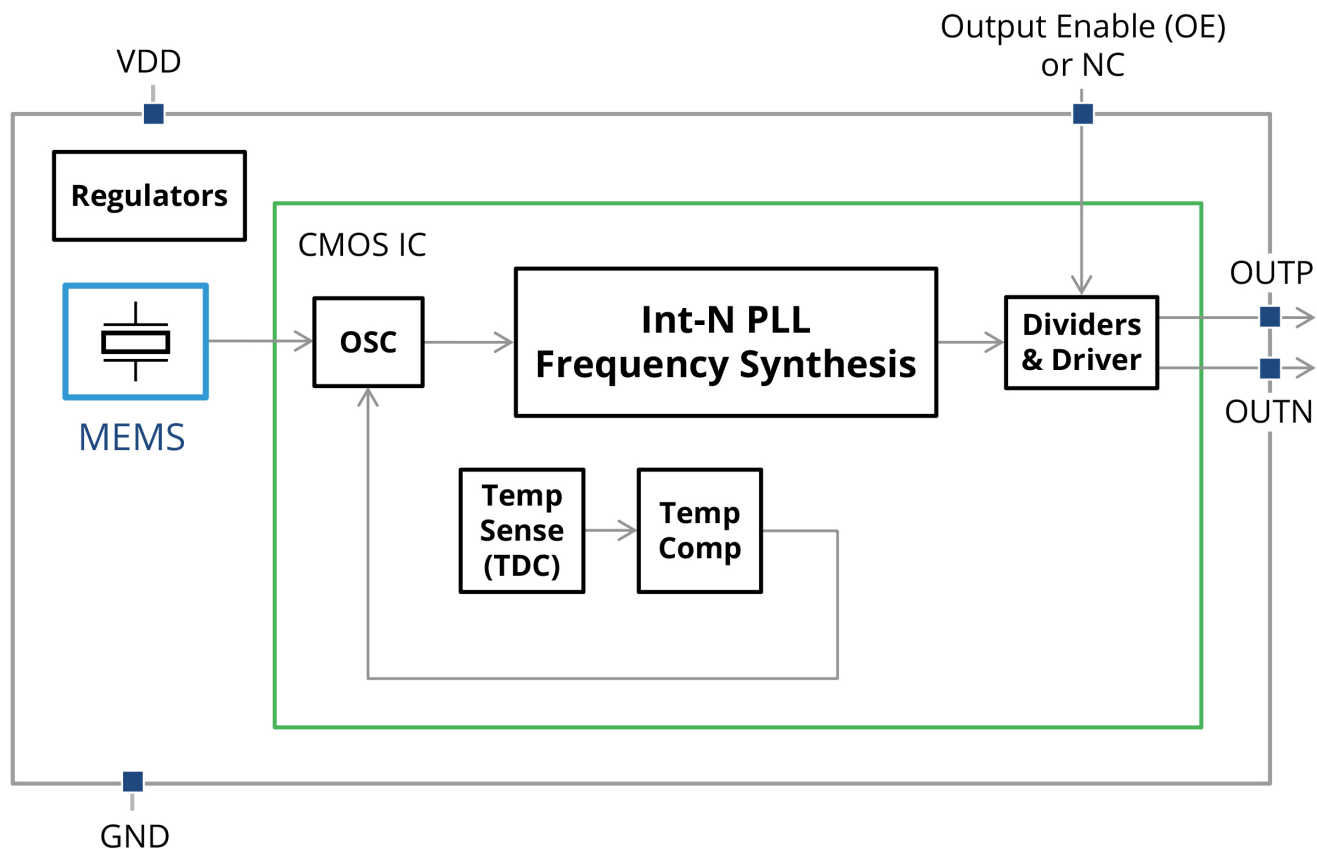
Integrated MEMS Resonator

- Eliminates quartz related issues
- 40x better MTBF reliability
- 20x better *g*-sensitivity

Ultra-low Noise Analog

- 25 MHz to 644.53125 MHz
- 0.01 ps/mv best-in-class PSNR
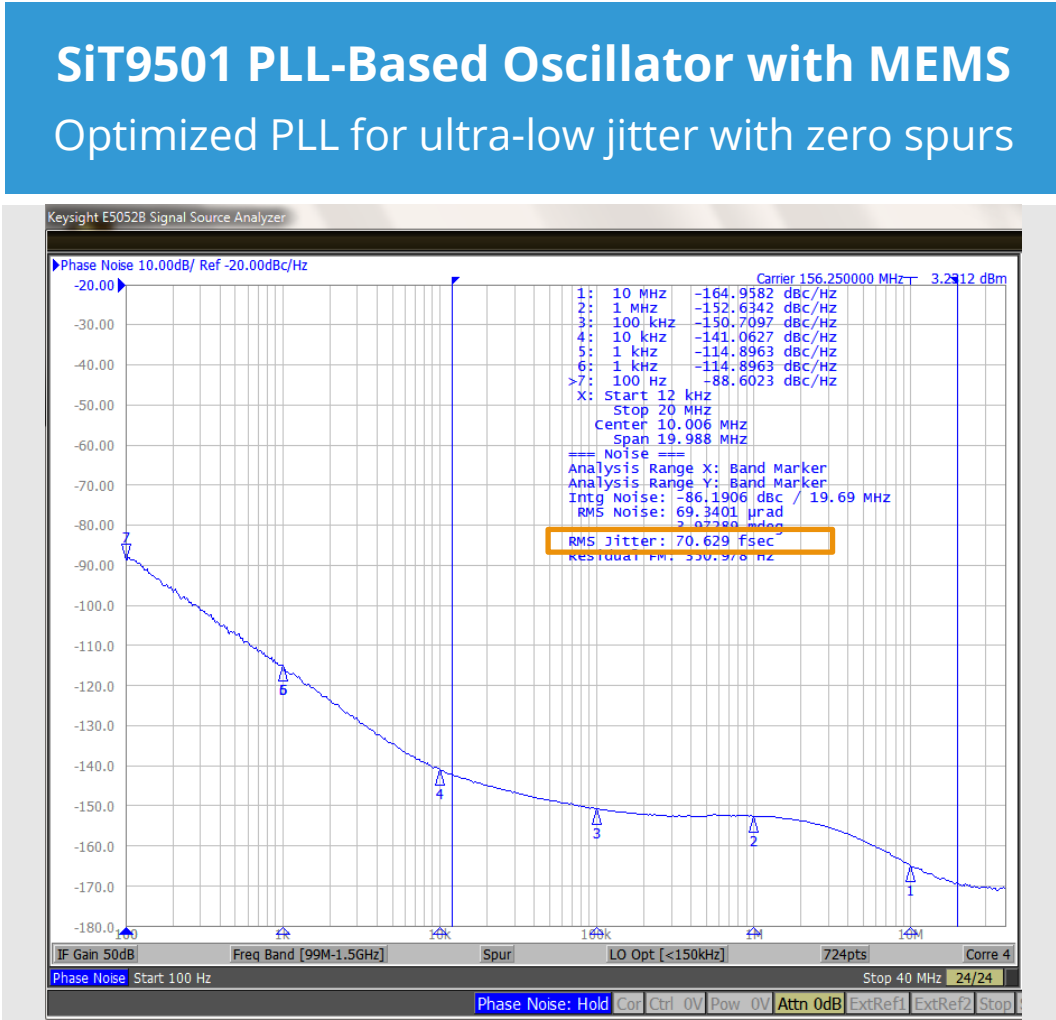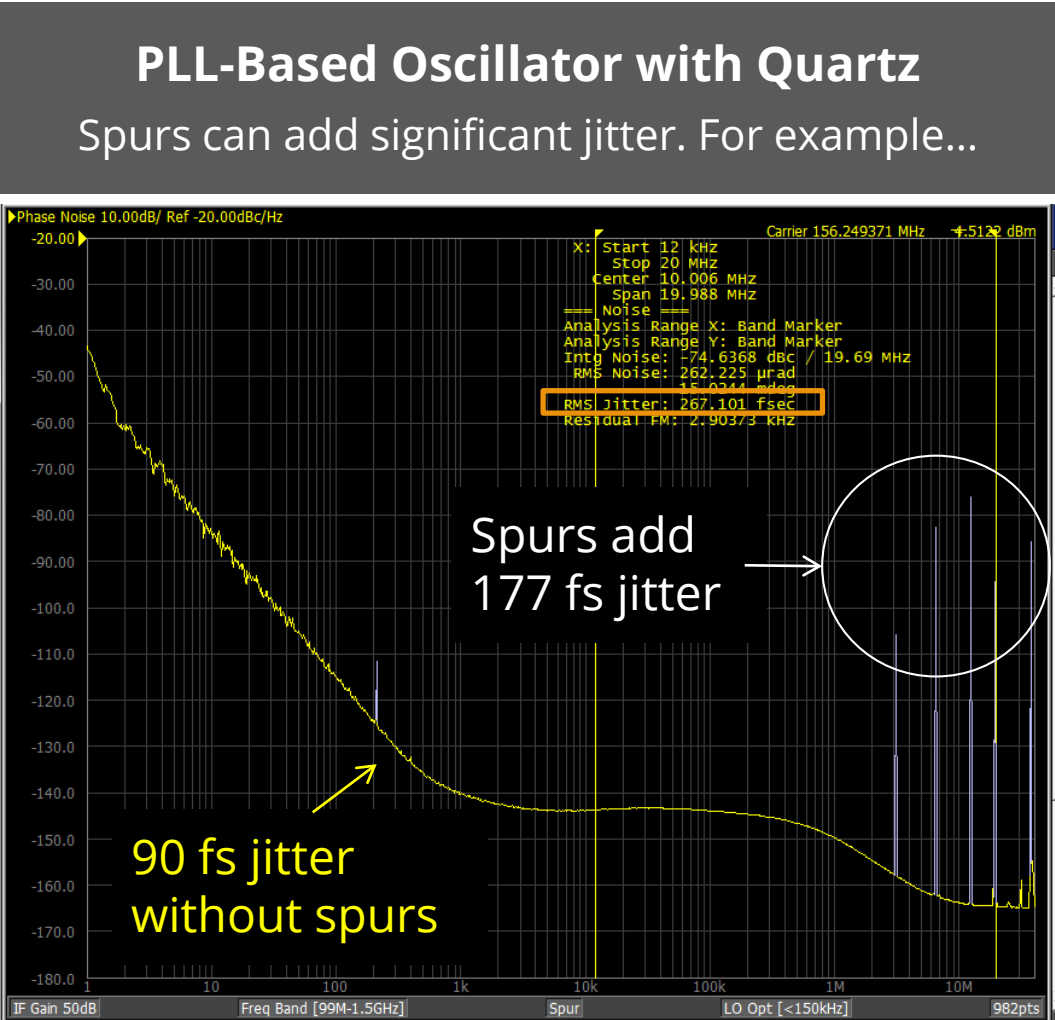- Ultra-low jitter with no spurs

- 70 fs – **Lowest jitter** improves BER

- 2.0x1.6 mm – **35% smaller** speeds development

- 0.01 ps/mV **best-in-class PSNR** improves BER

- 43 mA **best-in-class LVPECL power** reduces operating costs

- FlexSwing – **Programmable swing** enables low-power designs

QSFP Optical Module

Other common form factors:

- QSFP28, QSFP+, QSFP-DD
- CFP, CFP2, CFP4, CPAK
- OSFP

PLL-Based Oscillator with Quartz
Spurs can add significant jitter. For example...

Spurs add 177 fs jitter

90 fs jitter without spurs

SiT9501 PLL-Based Oscillator with MEMS
Optimized PLL for ultra-low jitter with zero spurs

SiT9501 Wins Against Quartz Solutions

Attribute	XO non-PLL based	XO PLL-based	SiT9501 PLL-based
Resonator technology	Quartz	Quartz	SiTime MEMS
No phase noise spurs	Yes	No	Yes
Resistant to shock, vibration	No	No	Yes 10x Better
Resistant to supply noise	No	Yes	Yes
Smallest package size (mm)	2.5 x 2.0	2.5 x 2.0	2.0 x 1.6 Save 35% area
Reliability	Good	Good	Best
Programmable swing	No	No	Yes – FlexSwing
Integrated LVPECL bias resistor	No	No	Yes – FlexSwing Save 50% area
Programmability	No	No	Yes

Smallest Differential Oscillator Solution

3.9 mm

4.9 mm

C

R

R

50%

SMALLER
FOOTPRINT

2.5 mm

3.5 mm
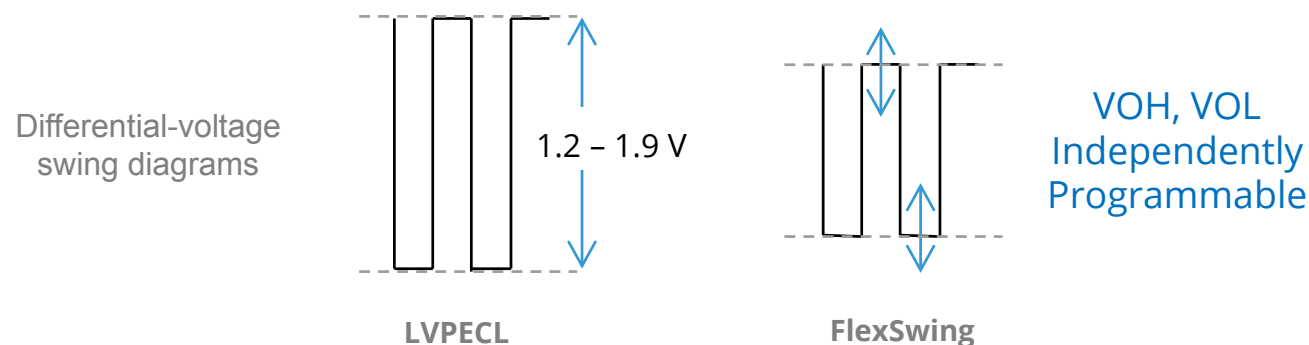
C

SiTime
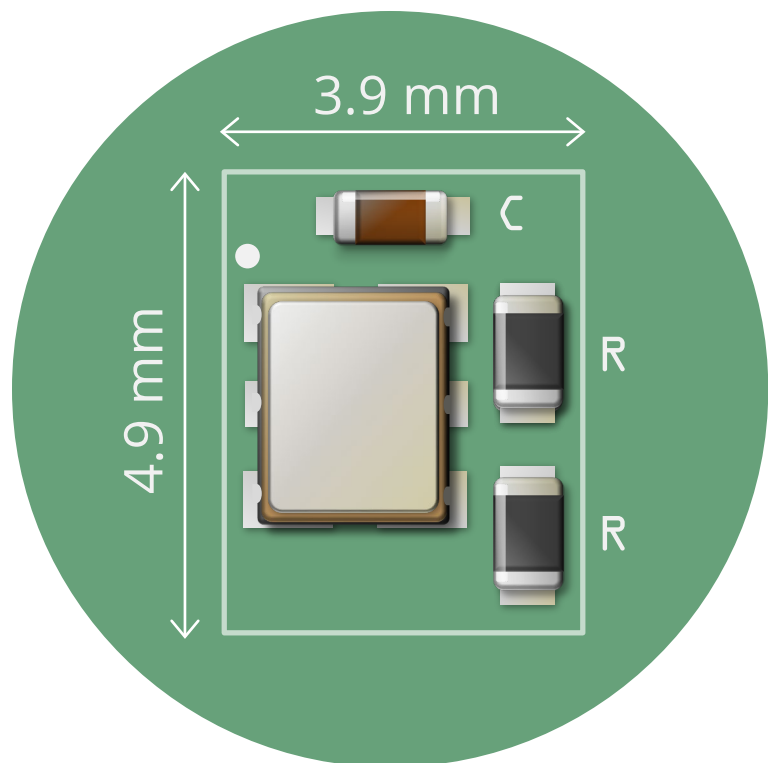
Quartz 2.5 x 2.0 mm
plus LVPECL source-bias resistors
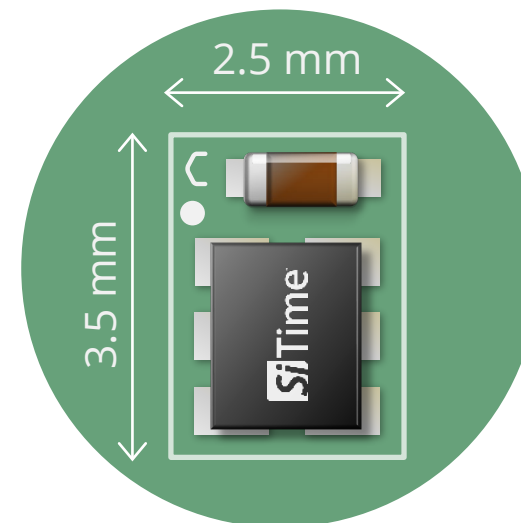
SiT9501 2.0 x 1.6 mm with integrated
LVPECL source-bias resistors

SiTime

SiT9501 FlexSwing Driver Reduces System Power

- Output levels are programmable to enable compliance with low-voltage chipsets

Differential-voltage swing diagrams

1.2 – 1.9 V

LVPECL

VOH, VOL Independently Programmable

FlexSwing

- 28% less power using 1.8 V supply compared to 2.5 V

- 3.5x lower load current with optimum termination

OUTP — Zo = 50 Ω — D+
OUTN — Zo = 50 Ω — D-

R₁ VT R₂
C₁ 0.1 μF R₃
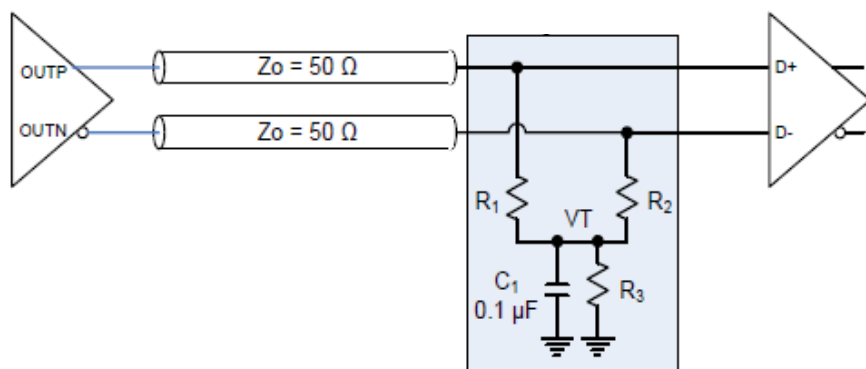
Swing Option	Termination (Ohm)	Load Current (mA, typ)
LVPECL, V_swing = 1.6 V • VH = VDD – 0.9 V • VL = VDD – 1.7 V	R3 = 50	28
FlexSwing, V_swing = 1 V * • VH = VDD – 1.8 V • VL = VDD – 2.3 V	R3 = 220	7.5

* FlexSwing order code "WB"

SiTime – "One Stop Shop" for Differential XOs

Stability	Phase Jitter	Package	Signal	Voltage	Temp	Other Features
±10 ppm	70 fs rms	2 x 1.6 mm	LVPECL	1.8 – 3.3 V	-20 to 70°C	0.001 – 1 GHz
±20 ppm	200 fs rms	2.5 x 2 mm	LVDS	2.5 – 3.3 V	-40 to 85°C	SSXO for EMI
±25 ppm	230 fs rms	3.2 x 2.5 mm	HCSL	1.8 V	-40 to 105°C	PCIe Gen 1-5
±50 ppm	600 fs rms	5 x 3.2 mm	LP-HCSL	2.5 V		
		7 x 5 mm	FlexSwing	3.3 V		

SiTime MEMS Differential Oscillator Portfolio

13 Year Ship History to Comms, Enterprise, Cloud

OPTICAL MODULES
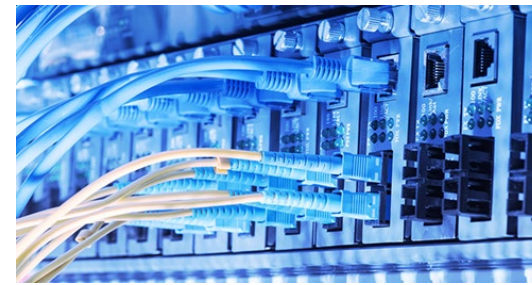

Small size, Low Power

DATA CENTERS

Low Jitter, Integrated LDO

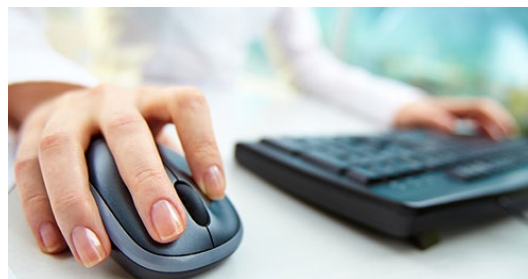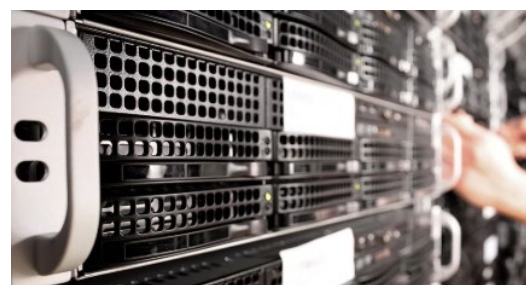### 10G/100G/400G COMM

Resilient to Supply Noise

COMPUTING

Low EMI Emission

SERVERS, STORAGE

Short Lead Time