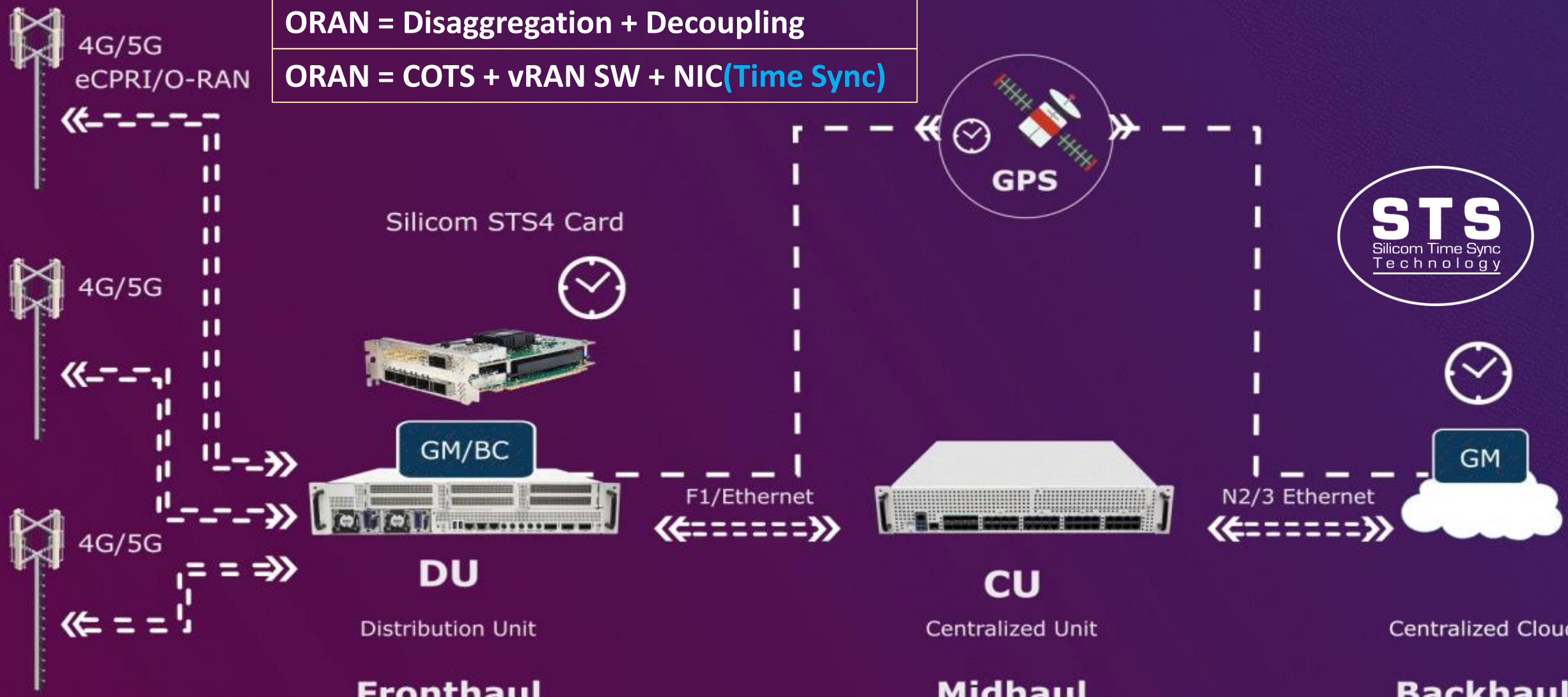
Silicom Ltd.
Connectivity Solutions

OPEN RAN VIRTUALIZED ARCHITECTURE FOR CONNECTIVITY & TIMING DISTRIBUTION

O-RAN Reference Architecture

ORAN = Disaggregation + Decoupling

ORAN = COTS + vRAN SW + NIC(Time Sync)



STS - Carrier Grade Time Distribution

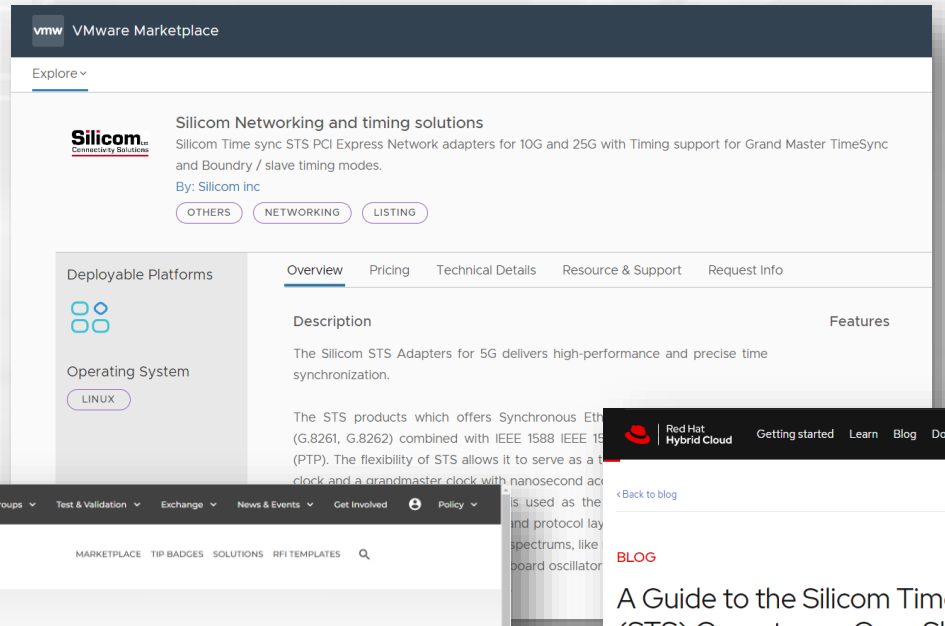
- Wide portfolio of STS NIC cards – Port density and speed
  - 8*10G / 8*25G / 12*10G/25G / 2*100G
- Supports IEEE1588v2/PTP over Ethernet/IPv4/IPv6
- Clock types: T-GM / T-BC / T-TSC
- Supported OS / Environments –
  - Kubernetes / Redhat® OpenShift® / VMware Photon™ Platform / Rocky / Ubuntu / CentOS
- Incorporates best in class Microchip PTP stack and servo algorithm
- Extremely good holdover performance
  - w/o SyncE: **8 hours** <1.5us @+/-3°C
  - w/o SyncE: **8 hours** <1.6us @+/-5 °C
- Comprehensive integration: GNSS, SyncE and PTP
- GNSS as a standard (optional: L1/L2 or L1/L5)
- Cutting edge accurate & robust timing
  - Master ITU-T G.8272 Class B
  - BC/Slave ITU-T G.8273.2 Class C
  - BC/Slave ITU-T G.8273.4 Class B

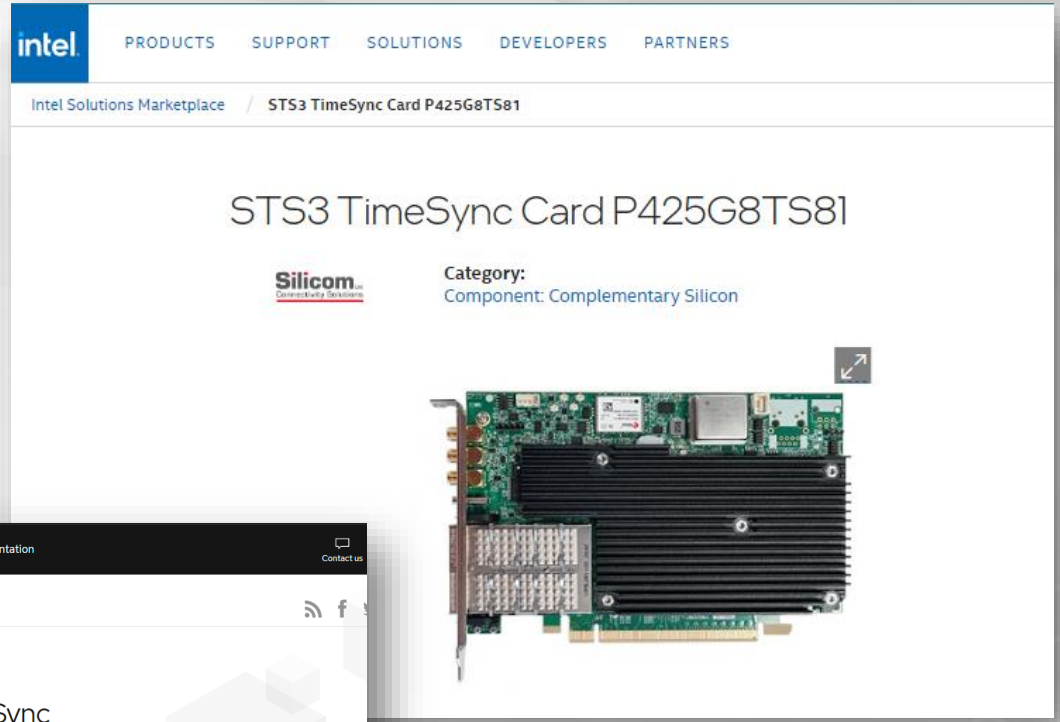
STS Time Sync NIC based on Intel E810

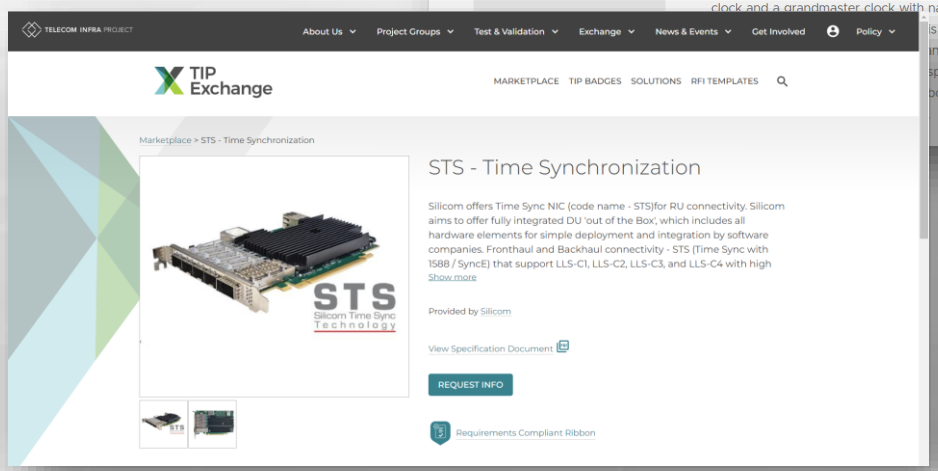
	STS2	STS3	STS3A	STS4
Interface	8x 10G/1G	8x 25G/10G	2x 100G	4x 25GbE + 8x 1/10GbE
Cabling	XR, SR, F5	XR, SR, F5, L5		XR, ZS
PCIe	4.0 x16(x8)	4/0 x16(x8, x8 – Bifurcated)	4.0 x16(x8, x8 – Bifurcated)	4.0 x16(x8, x8 – Bifurcated)
Controller	Intel® Ethernet Controller E810-CAM2	x2 Intel® Ethernet Controller E810-CAM1	x2 Intel® Ethernet Controller E810-CAM1	x1 Intel® Ethernet Controller E810-CAM1 x1 Intel® Ethernet Controller E810-CAM2
Form Factor	FHHL	FHHL	FHHL	FHHL (Dual Slot)
SRIOV Capable	Yes	Yes	Yes	Yes
GNSS	Yes	Yes	Yes	Yes
IEEE 1588, SyncE	Yes	Yes	Yes	Yes
Hold Over	8 Hours	8 Hours	8 Hours	8 Hours
T-BC	Yes	Yes	Yes	Yes
T-GM	Yes	Yes	Yes	Yes
T-TSC	Yes	Yes	Yes	Yes
PN	P410G8TS81-XR	P425G8TS81-XR	P4CG2TS81-XR	P425G410G8TS81-XR
				

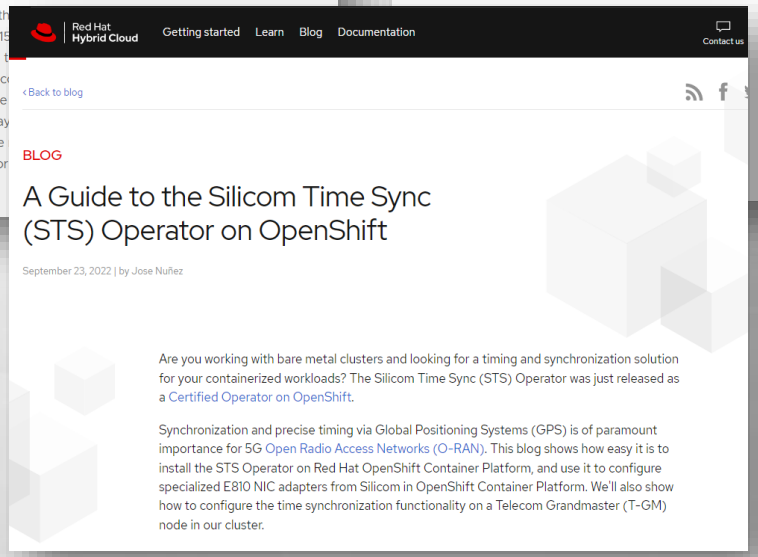
Software support and Integration

- Intel
- Red Hat
- VMware
- Wind River
- TIP









Marbella

Status: Pre-production

CPU	Intel® Xeon® D-1700 processor (4/8/10 - Cores)*
Memory	3x Channel DDR4 (1DPC)
Storage	eMMC (8GB-256GB) 2x M.2 SSD Riser
Network	4x 10/25G SFP28 4x 10G SFP+ 4x 2.5GbE RJ45 (one shared with BMC)
PCIe Expansion	x16 PCIe Gen4 FHFL Card x8 PCIe Gen3 HHHL Card
Other Expansion	Custom Modules for 4G/5G, Timesync
I/O	2x USB3.0 USB/RJ45 Console Port
Security	TPM2.0 Hardware root of trust
BMC	Aspeed AST2600
Other	Two programmable buttons Programmable RGB LED's
Form Factor	1RU, <12" Depth
Power Supply	Dual Redundant with Dying Gasp

* Future C5000 support

Seville

Status: Design

CPU	Intel® Xeon® D-2700 processor (10-20 Cores)
Memory	Up to 256GB DDR4
Storage	eMMC Supports Dual NVMe
Network	8x 25G SFP28 8x 10GbE RJ45 1x 1GbE MGMT with BMC
I/O	2x USB3.0/2.0 Console: Cisco RS232 RJ45
PCIe Expansion	Two X16 PCIe Gen4 FH ¾ Length
Security	TPM 2.0 Hardware Root of Trust Intrusion Switch
Other	1x LED Two Buttons (Reset/Power)
Power	2x 500W AC Power Supply

Palma B

Status: Production

CPU	3rd Generation Intel® Xeon® Scalable Processors, Socket P+, 4189 pin, Single Socket
Chipset	LBG-R, C621A
Memory	Supports up to 16 DIMMs/ DDR4 with ECC, 8 DDR channel controllers
	DDR Maximum Speed 3200 MT/s
Storage	M.2 NVME
PCIe 4.0 Slots	6x Slots x16/8 4.0 Full Height Half Length in 2U Chassis
Host Mgmt.	1GbE RJ45 on Management Card, Shared with BMC.
	In line management via Time Sync NIC
USB 3.0	2xFront, 2x Internal Vertical
Serial Console	RJ45 connector using RS232 signaling direct connection to BMC, via Mux / pass through the x86
TPM	TPM 2.0
ROT	Support
Power Supply	1+1 redundant DC -48V hot swappable power supply 800W
Form Factor	2U and 1U rackmount Form Factor EIA 19”
	Depth: 389/385mm, including mountings/ without mounting ears
Time Synchronization	12Ports, 8x 10GbE via 2xQSFP+, 4x 25GbE via 1xQSFP28
	T-GM, T-BC, T-TSC
	RF In, 1PPS In/Out, 10Mhz In/Out SMA on Chassis Front Panel
Layer 1/FEC	Silicom 5G/4G FEC Pomona Lake PCIe x16 3.0
Operating Temperature	-20°C – 55°C (-4°F - 131°F)

Poll 1

Which use case does your company require Time Synchronization for?

1. Industrial Automation
2. Synchronization of Storage Systems
3. 5G Radio Access Network (RAN)
4. Other

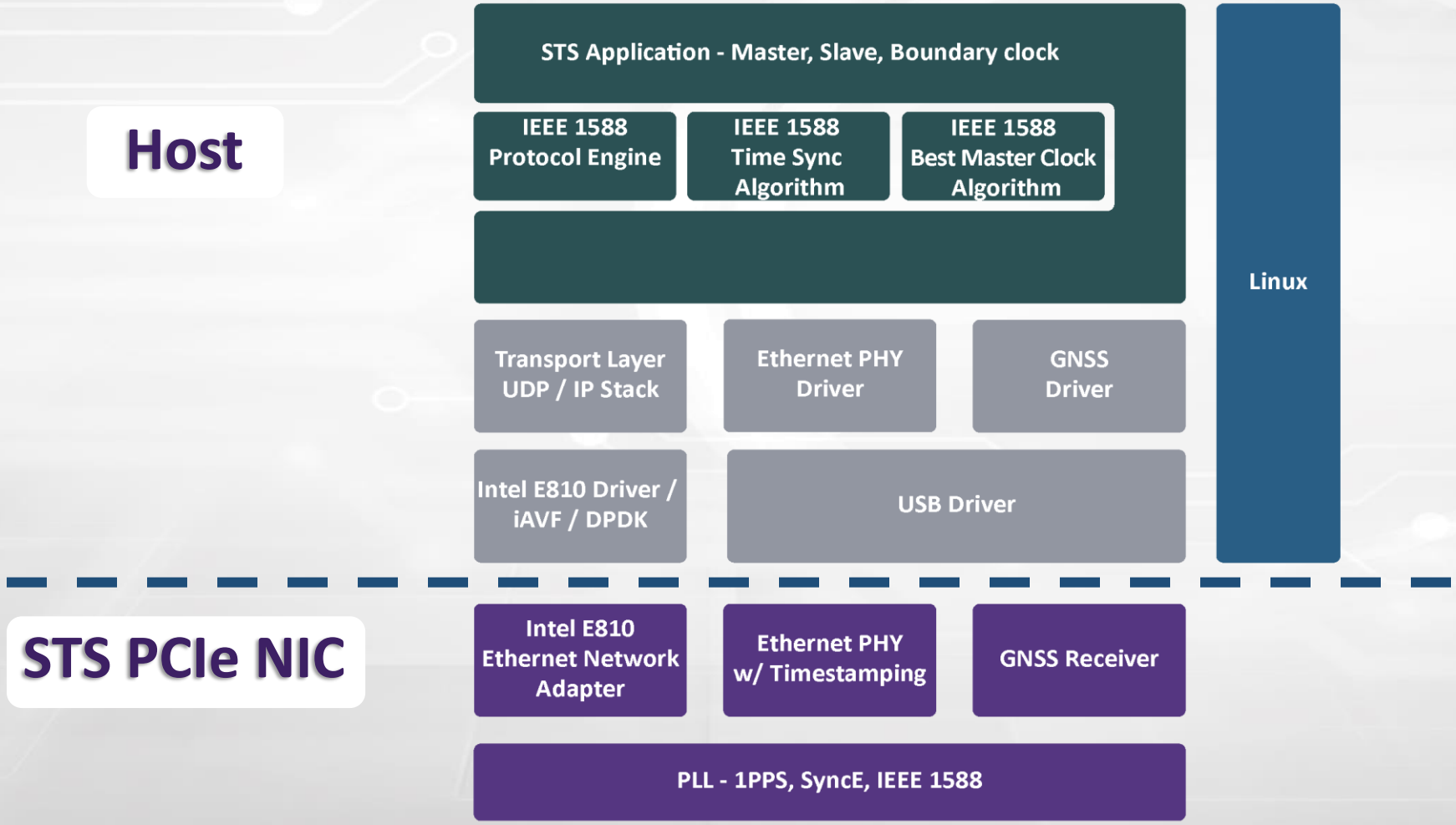
Poll 2

Which deployment model is typically used for time synchronization in a 5G DU system?

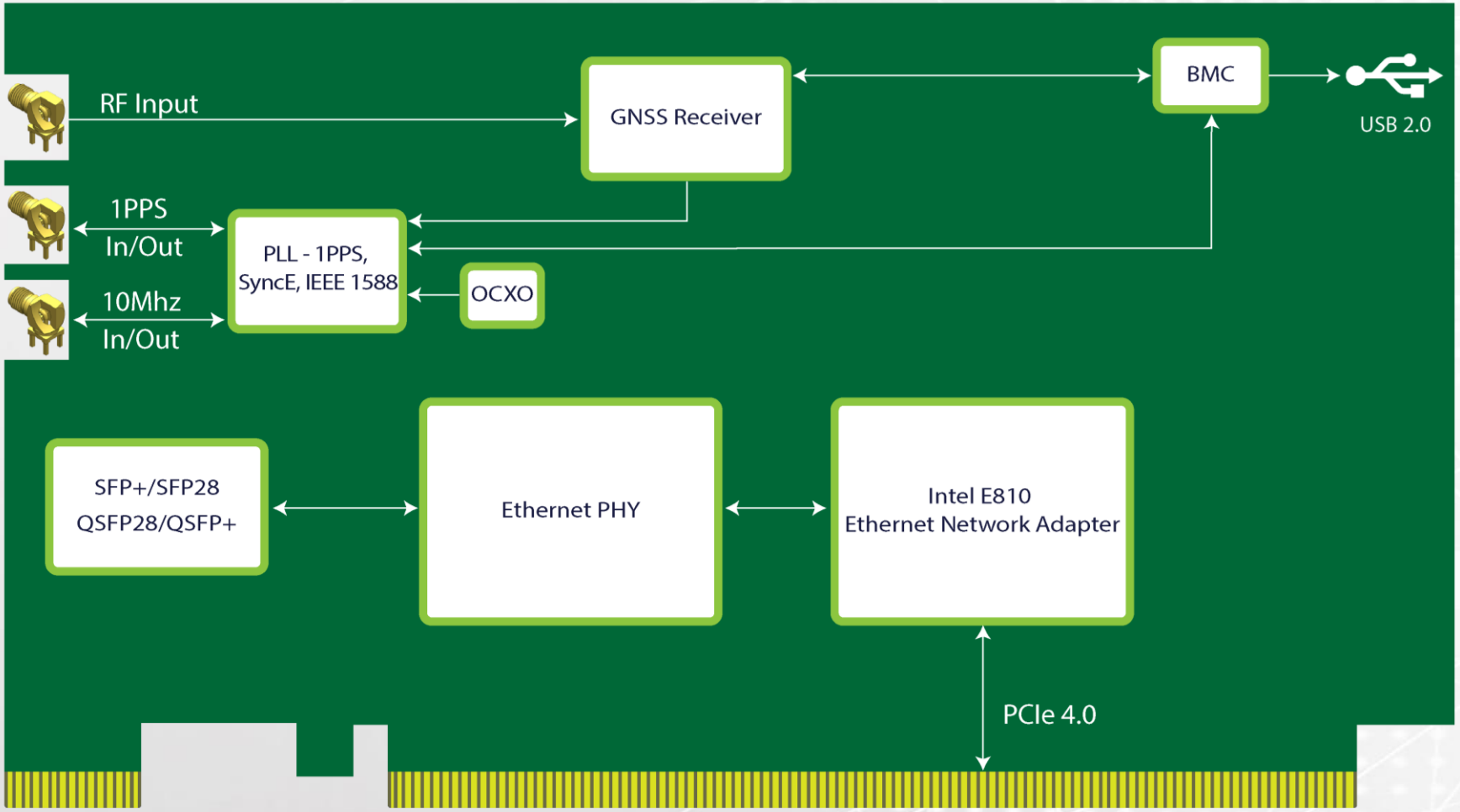
1. Master
2. Boundary
3. Transparent
4. Other

STS NIC High Level Architecture – HW/SW

Decoupling



Silicom Time Sync NIC HW Architecture



Red Hat Openshift Worker Node with STS Card

OpenShift Master / Controller node

OpenShift Worker node

Red Hat Enterprise Linux CoreOS

STS Silicom Time Sync Technology Silicom Card HW

sts-operator-config cr

sts-config cr

watches

watches

Silicom controller Pod

Manager

creates

sts-nfd cr

watches

Nfd controller Pod

Manager

watches

creates

Triggers creation

Timing Sync Pod

grpc_tsync

tsyncd

gpsd

phc2sys

system

sts-plugin Pod

sts-plugin

nfd-worker Pod

nfd-worker

HW Clock adjustments

/dev/ttyACM

/dev/ptp<x>

/sys/bus/pci

Quality PLL + OCXO

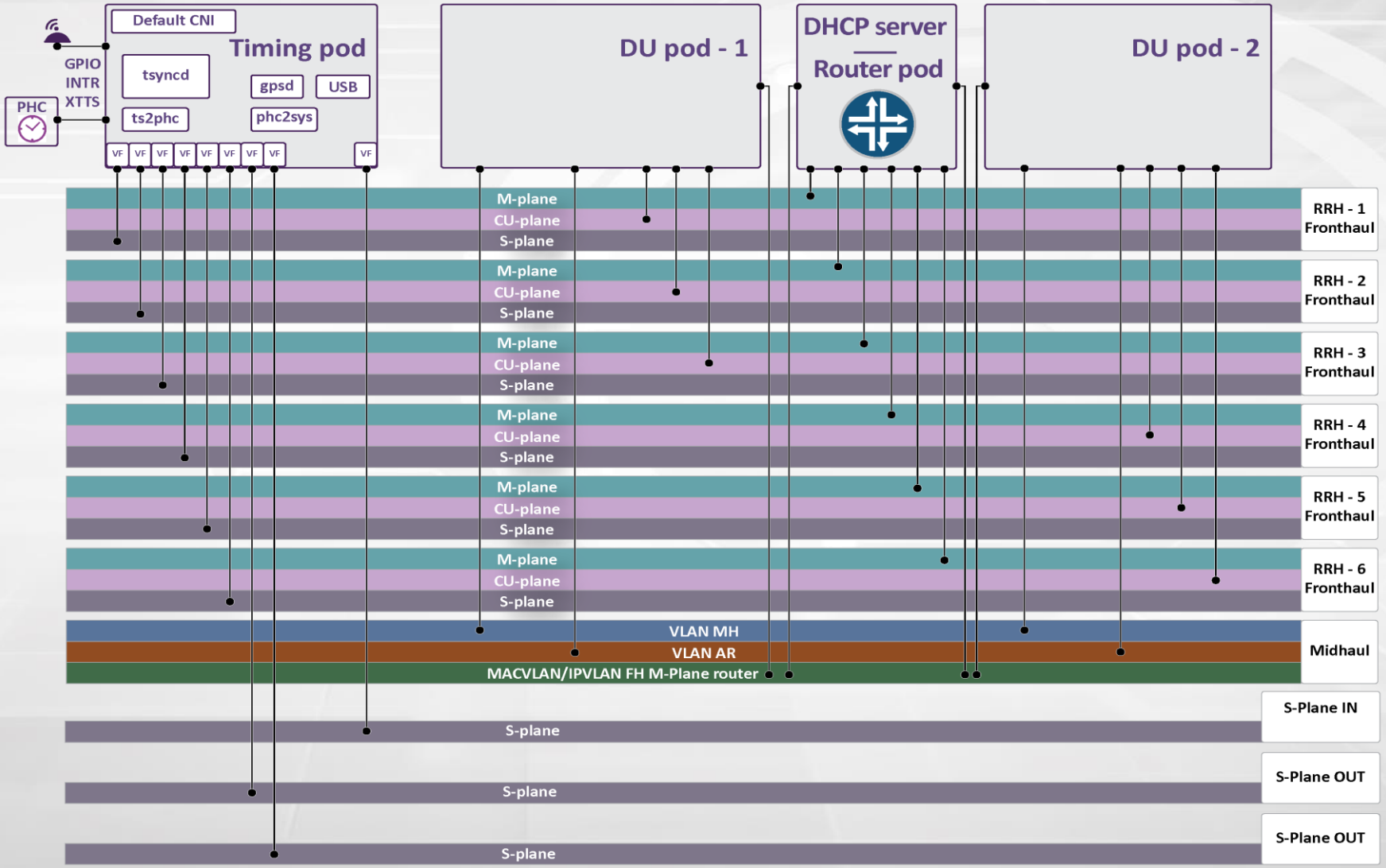
GNSS RECEIVER U-BLOX

E810 Controller

PTP, SyncE Time Stamper PHY

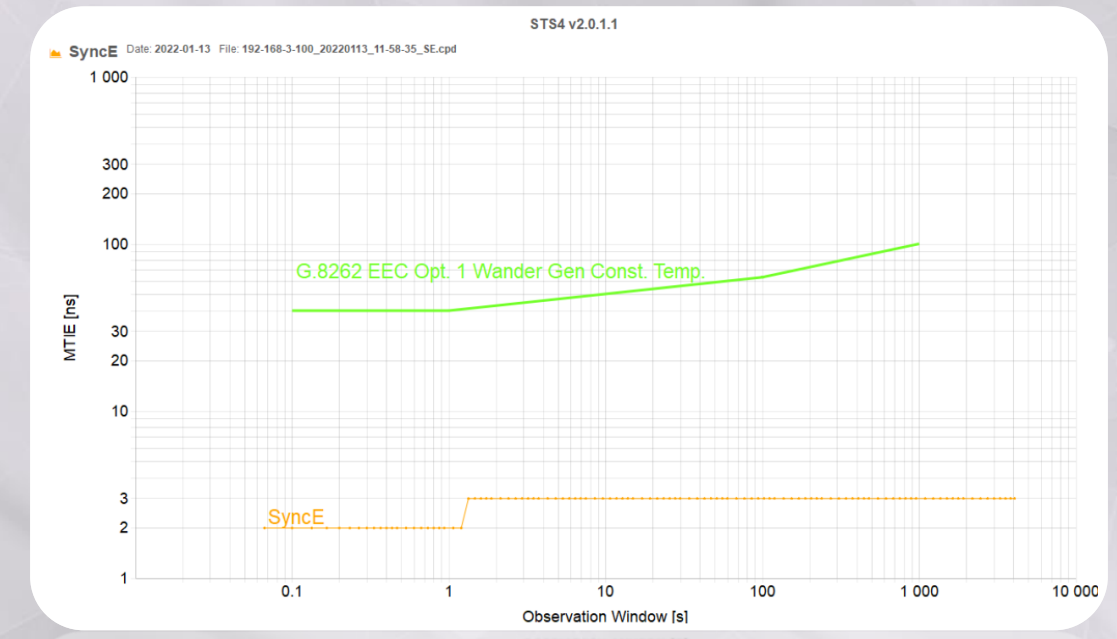
https://cloud.redhat.com/blog/a-guide-to-the-silicom-time-sync-sts-operator-on-openshift

DU Server Virtualized Architecture – An Example



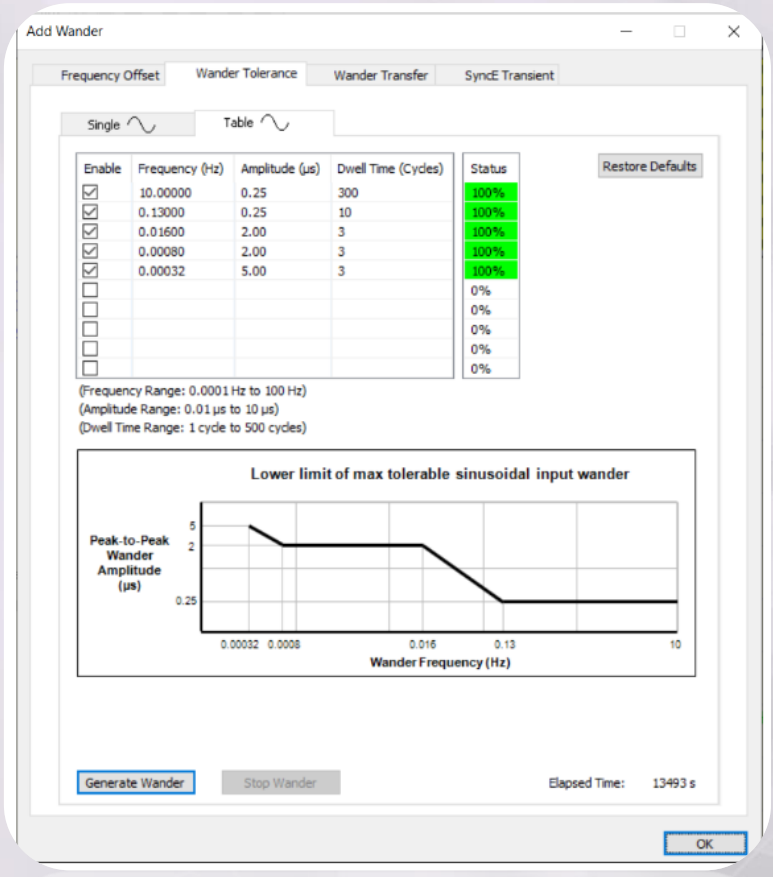
Compliance Report - G.8262

Wander generation – G.8262 Section 8.1

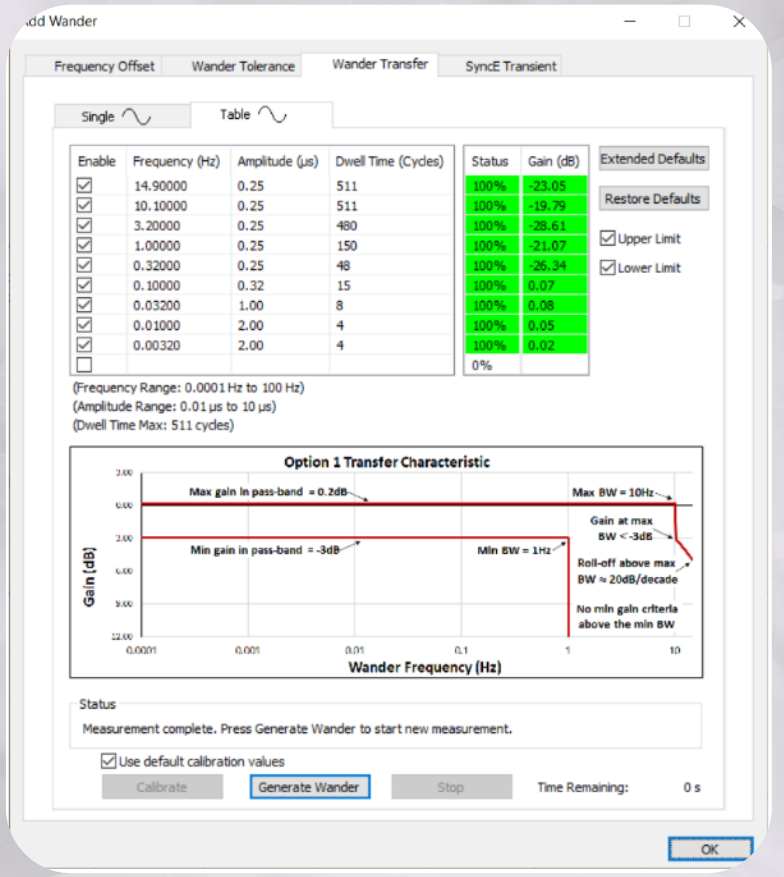


Compliance Report - G.8262

Wander tolerance – G.8262 Section 9.1

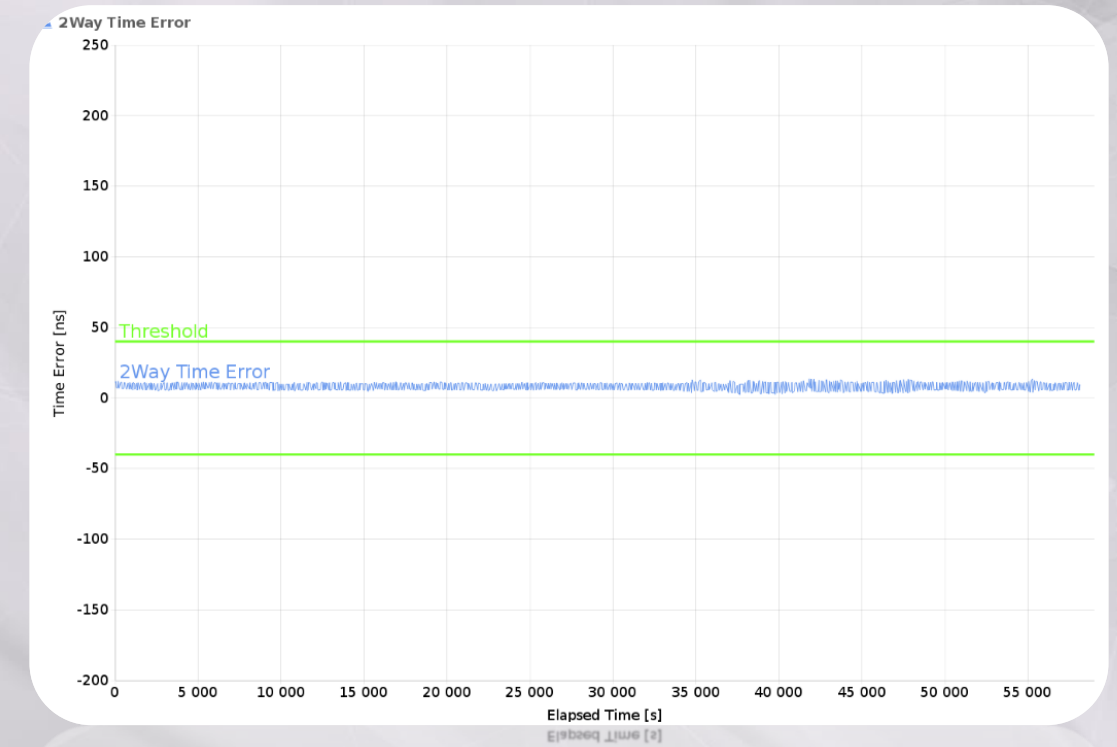


Noise transfer – G.8262 Section 10.1



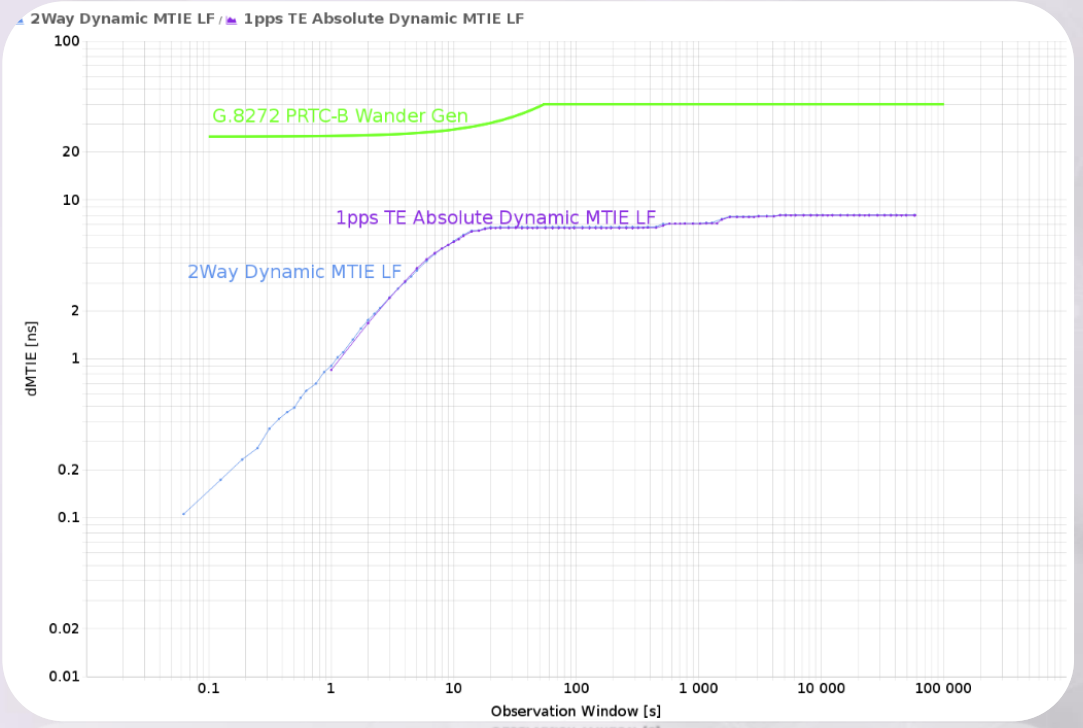
Compliance Report - G.8272 PRTC-B

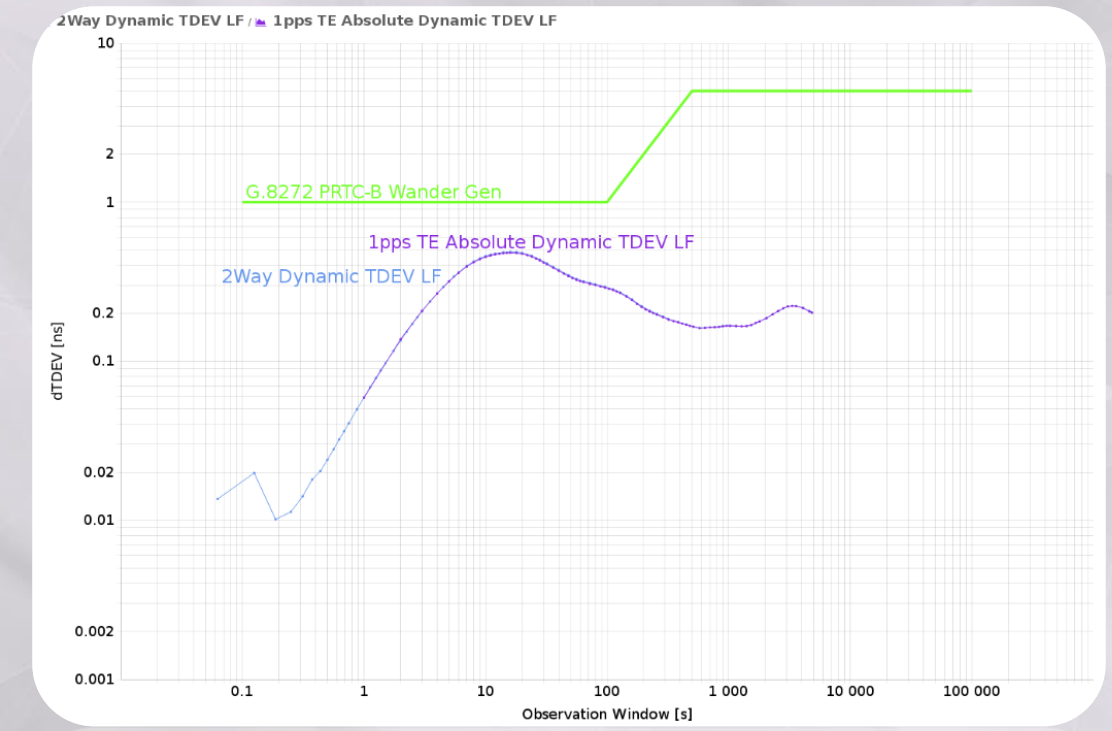
Slot	2Way
Description	
Measurement Start	2022-06-12 14:06:26 (local instrument time)
Measurement Stop	2022-06-13 06:15:21 (local instrument time)
Mask Time Error	0.04 µs
Mask Result	Pass
Mask Time Error (Filtered)	0.04 µs
Mask Result	Pass
Mask Avg Time Error (cTE)	0.04 µs
Mask Result	Pass
Mask Dynamic TE LF	0.04 µs
Mask Result	Pass
Mask Dynamic TE HF	0.2 µs
Mask Result	Pass
Mask Dynamic MTIE LF	G.8272 PRTC-B Wander Gen
Mask Dynamic MTIE LF Result	Pass
Mask Dynamic TDEV LF	G.8272 PRTC-B Wander Gen
Mask Dynamic TDEV LF Result	Pass



Compliance Report - G.8272 PRTC-B

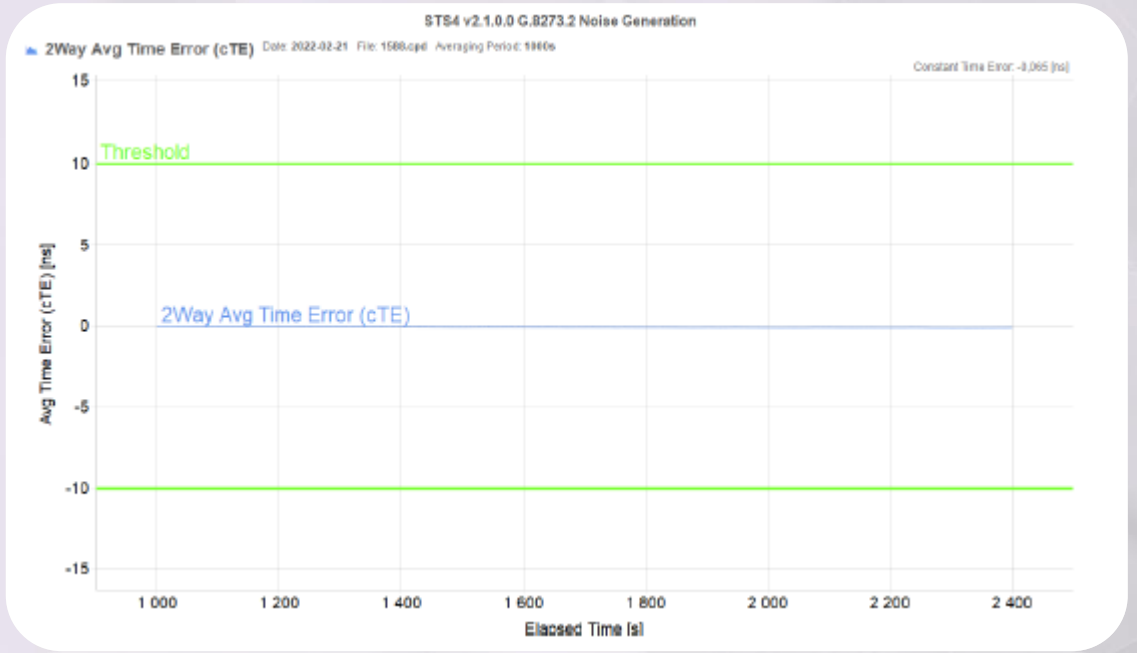
Wander generation – 2Way & 1PPS



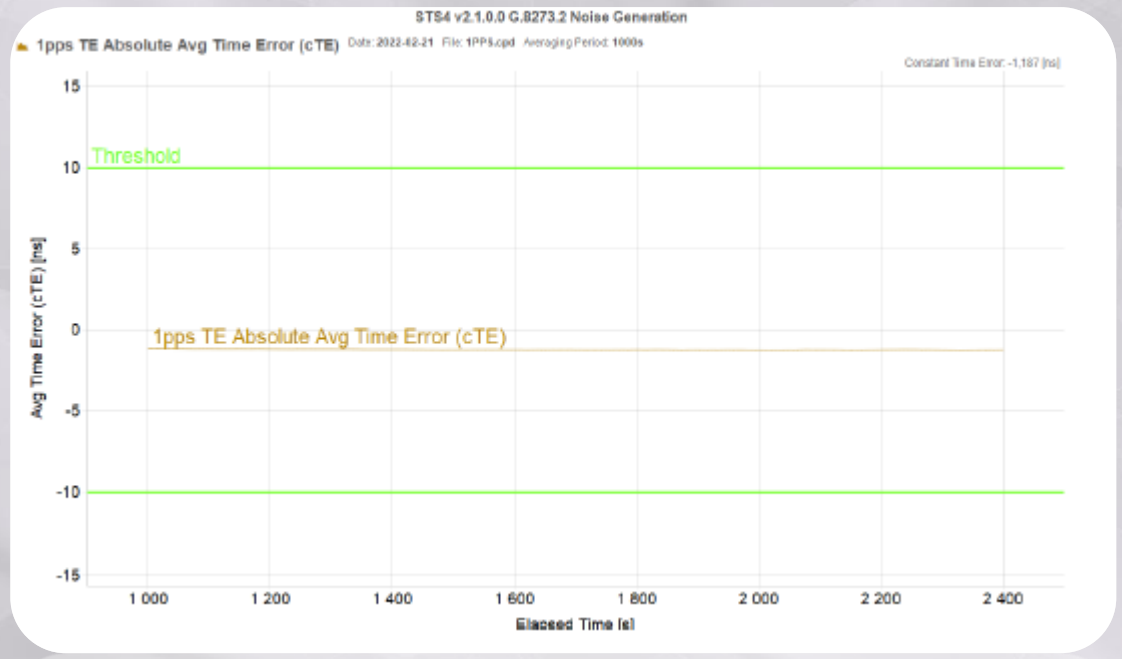


Compliance Report - G.8273.2 Class-C

Noise Generation - 2Way Avg Time Error (cTE)

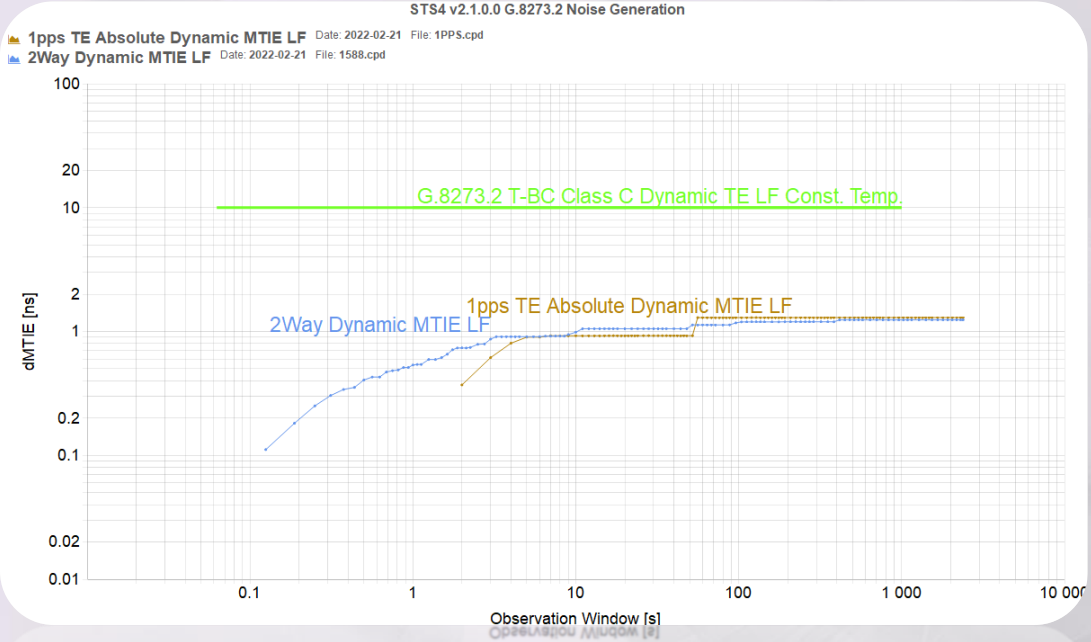


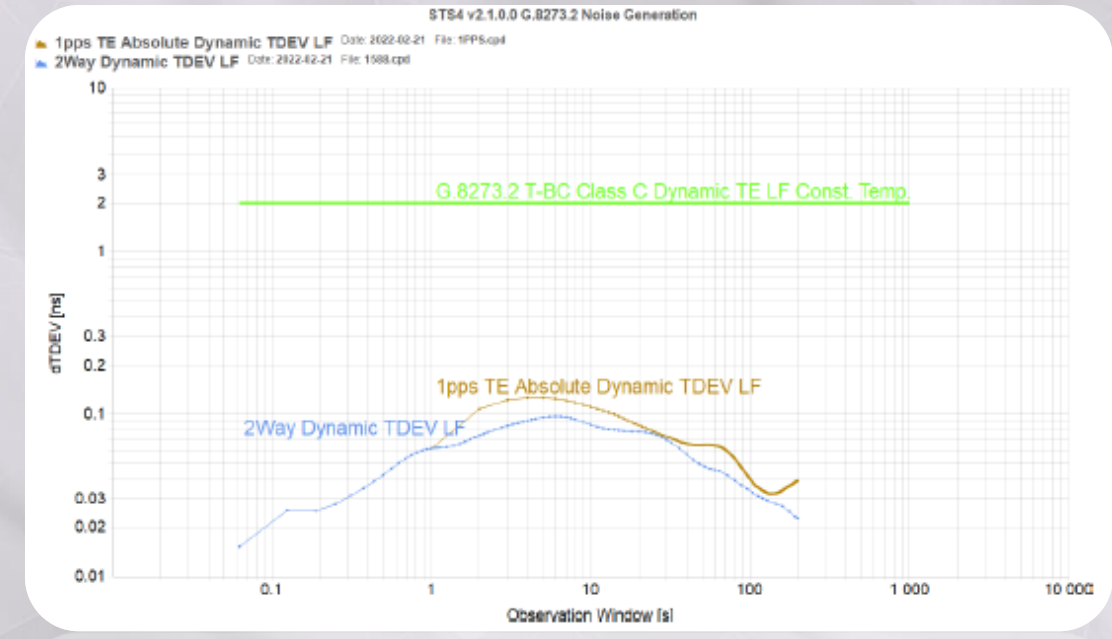
Noise Generation – 1PPS Time Error (cTE)



Compliance Report - G.8273.2 Class-C

Dynamic Time Error – 2Way & 1PPS

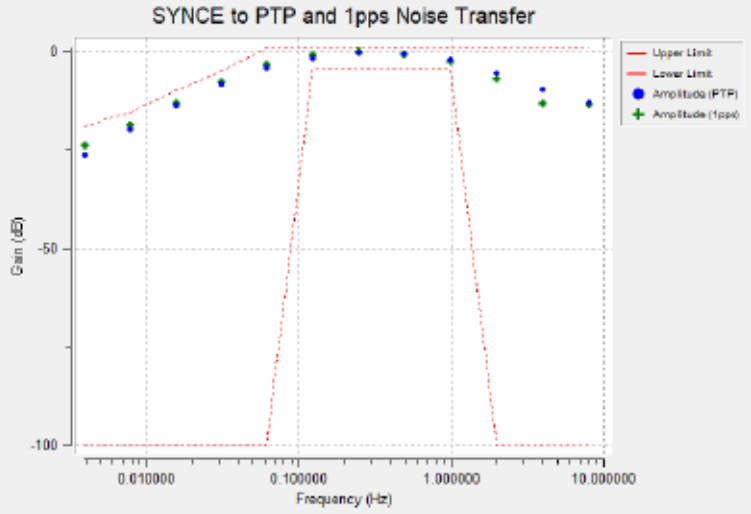




Compliance Report - G.8273.2 Class-C

Time Noise Transfer – Section 7.3

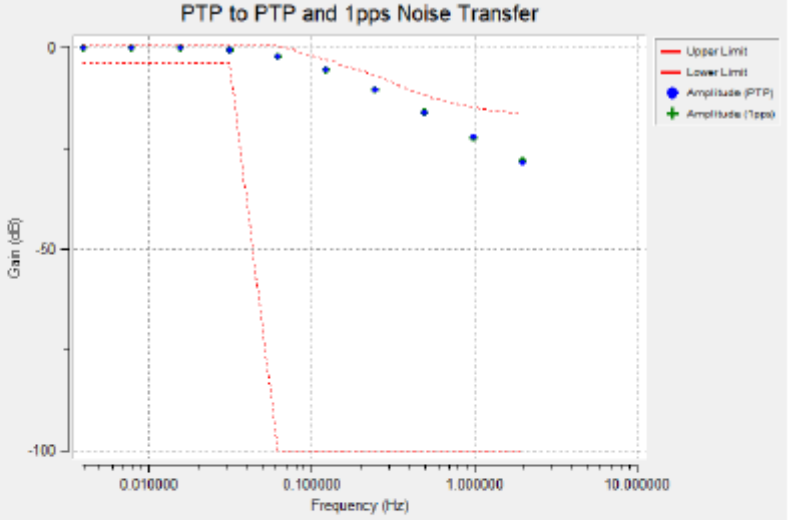
Calnex
Insight and Innovation



Serial Number	00026175
Version	X.10.40.18;FIRMWARE
Date	2022-02-22
Time	07-45-10
Instrip	192.168.3.100
Guiip	localhost
Type	SyncE-BOTH
PtpPoints	ALL
SyncEPoints	ALL
CableDelay	10
LineRate	10GBE
Interface	OPTICAL
Reference	EXT_10M
TwoStep	FALSE
SettlingTime	120
RecoveryTime	50
1ppsThreshold	1.0
LimitsEnabled	TRUE
AutoNegotiate	FALSE
SyncE	TRUE
ReProcess	FALSE
Filter	LSQ
SimulatedData	FALSE
GraphingYAxis	GAIN

Freq (Hz)	Ampl (pk-pk ns)	PTP Meas (pk-pk ns)	PTP Gain (dB)	1pps Meas (pk-pk ns)	1pps Gain (dB)	LL (gain dB)	UL (gain dB)	PTP Pass/Fail	1pps Pass/Fail
0.00391	2000.0	96.78	-26.30	127.35	-23.92	-100	-18.98	PASS	PASS
0.00781	2000.0	202.42	-19.90	232.72	-18.68	-100	-15.39	PASS	PASS
0.01563	2000.0	409.25	-13.78	439.77	-13.16	-100	-10.03	PASS	PASS
0.03125	1000.0	382.92	-8.34	412.63	-7.69	-100	-4.96	PASS	PASS
0.06156	500.0	313.50	-4.05	339.65	-3.36	-100	0.75	PASS	PASS
0.12313	250.0	205.73	-1.69	227.41	-0.82	-4.44	1.14	PASS	PASS
0.24625	250.0	236.29	-0.49	248.50	-0.05	-4.44	1.14	PASS	PASS
0.4925	250.0	234.46	-0.56	235.72	-0.51	-4.44	1.14	PASS	PASS
0.985	250.0	197.53	-2.05	186.53	-2.54	-4.44	1.14	PASS	PASS
1.985	250.0	132.42	-5.52	111.09	-7.05	-100	1.14	PASS	PASS
3.985	250.0	81.42	-9.74	54.56	-13.22	-100	1.14	PASS	PASS
7.985	250.0	56.10	-12.98	53.14	-13.45	-100	1.14	PASS	PASS

Calnex
Insight and Innovation



Serial Number	00026175
Version	X.10.40.18;FIRMWARE
Date	2022-02-22
Time	10-04-14
Instrip	192.168.3.100
Guiip	localhost
Type	PTP-BOTH
PtpPoints	ALL
SyncEPoints	ALL
CableDelay	10
LineRate	10GBE
Interface	OPTICAL
Reference	EXT_10M
TwoStep	FALSE
SettlingTime	120
RecoveryTime	50
1ppsThreshold	1.0
LimitsEnabled	TRUE
AutoNegotiate	FALSE
SyncE	TRUE
ReProcess	FALSE
Filter	LSQ
SimulatedData	FALSE
GraphingYAxis	GAIN

Freq (Hz)	Ampl (pk-pk ns)	PTP Meas (pk-pk ns)	PTP Gain (dB)	1pps Meas (pk-pk ns)	1pps Gain (dB)	LL (gain dB)	UL (gain dB)	PTP Pass/Fail	1pps Pass/Fail
0.00390625	200.0	199.81	-0.01	200.09	0.00	-3.74	0.63	PASS	PASS
0.0078125	200.0	199.36	-0.03	199.16	-0.04	-3.74	0.63	PASS	PASS
0.015625	200.0	196.20	-0.17	196.25	-0.16	-3.74	0.63	PASS	PASS
0.03125	200.0	185.37	-0.66	185.29	-0.66	-3.74	0.63	PASS	PASS
0.0615625	200.0	156.24	-2.14	156.39	-2.14	-100	0.63	PASS	PASS
0.123125	200.0	106.21	-5.50	106.08	-5.51	-100	-3.10	PASS	PASS
0.24625	200.0	59.86	-10.48	59.88	-10.48	-100	-6.94	PASS	PASS
0.4925	200.0	30.95	-16.21	31.00	-16.19	-100	-12.04	PASS	PASS
0.985	200.0	15.50	-22.21	15.32	-22.31	-100	-15.14	PASS	PASS
1.985	200.0	7.47	-28.55	7.98	-27.98	-100	-16.48	PASS	PASS

THANK YOU

www.silicom-usa.com

contact@silicom.info

Silicom Ltd.
Connectivity Solutions