TSN 工业4.0 电信-5G IEC-61850 智能电网 MiFID II

NTS-5000 Rb ocxo

NTP/PTP IEEE1588 Modular Time Server

模块化时间服务器

- PTP IEEE1588 Grandmaster
- NTP 时间服务器STRATUM1
- ePRTC* PRTC PRC Clock
- GNSS 干扰* 检测
- GNSS 欺骗* 检测
- 攻击 自动开启Holdover
- HOLDOVER Rubidium OCXO
- NTP v4(RFC5905-09) v3(RFC1305)
- SNTP v4(RFC4330) v3(RFC2030)
- PTP IEEE1588 White Rabbit*
- SyncE 支持Expander 1-4
- LAN 2x 100Mbps 软件时间戳
- LAN 1GbE* PHY 硬件时间戳
- LAN 10GbE* 带软件时间戳
- 私有 PTP-堆栈/NIC(LAN)
- IRIG-B AM &DCLS
- DCF77 decoded/PF-仿真
- 远程 HTTP(S) SSH TELNET
- SNMPv3 MIB2 RADIUS
- OUT 1PPS 10MHz 2.048Mbps
- CRYPTO MD5 RSA DSA SSL
- 冗余 电源
- 冗余 GNSS接收器*

safetime
先进的网络安全同步技术

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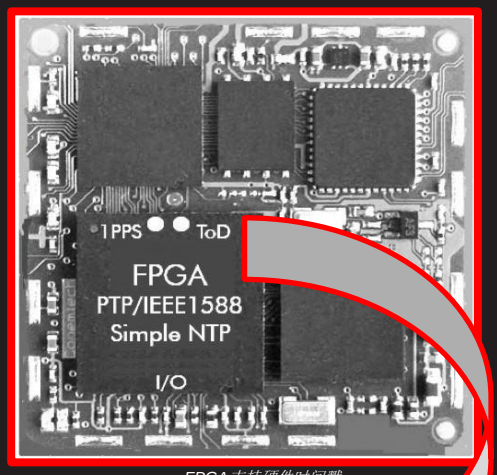
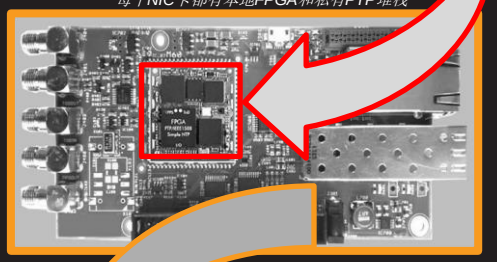
*额外的功能需要额外的硬件或者固件升级



FPGA支持硬件时间戳

每个NIC卡都有本地FPGA和私有PTP堆栈



NTS-5000是铷和**NTS-5000LITE**是OCXO holdover经典网络设备。它使用NTP，IEEE1588协议提供时间（*ToD* time of a day）和***频率参考***。它使用**SyncE***, PTP, 10 MHz信号来稳定终端网络设备的时钟频率。标准的配置包括**LAN1-2 100/10Mbps**，可分别升级为**1GbE***或**10GbE***。另外**8x1GbE**(为成对LAN：3-4、5-6、7-8、9-10)可供选择。8x 1GbE(LAN3*-10*)是特殊的网络接口卡(NIC)。它们位于相互独立的**EXPANDERS 1-4***中。它们支持IEEE1588**硬件时间戳**和默认、电信、电力、广播等配置文件。内置**Rubidium(铷)**或**OCXO**(LITE)振荡器可确保在丢失GNSS信号时保持时间。Expander NIC可以产生输出1PPS或unframed E1 2.048Mbps。

NTS-5000是21世纪的网络安全的典范

与目前市场上的其他产品相比，NTS-5000是目前市场上唯一一款标准配置支持GNSS**抗干扰/抗欺骗**的设备。当GNSS干扰/欺骗攻击时，智能NTS-antenna会直接向时间服务器ANT1和ANT(2)输入端发送特殊的警报信息。它让时间服务器NTS-5000提前切换到内部的holdover时钟（Rubidium/OCXO），拒绝来自GNSS的错误数据。一旦攻击结束，NTS-5000就会切换回正常的GNSS同步模式。 NTS-5000可以选择配备特殊的LEVEL-3**安全时间抗干扰/抗欺骗子系统**。Level-1是天线，Level-2是射频有源器件，Level-3是带有GNSS NMEA183模拟输出的防火墙装置。NTS-5000的真正创新之处在于EXPANDER1-4 NIC的物理网络隔离。每块NIC都有自己的**私有**PTP**堆栈**和**专属**FPGA。事实上，这使得每一块NIC 1-4都是自主的时间服务器，彼此之间的信息100%隔离。1-4 NIC的同步是由内部的**模拟信号PPS/ToD**支持的（中间没有TCP/IP）。这样看似普通的不显眼的功能，但却是确保工业4.0 TSN网络安全的关键因素。

4个NIC(EXPANDER 1-4)是自主时间服务器。与主板的模拟通信PPS+ToD（无TCP/IP）。

为什么黑客无法成功？

典型的IEEE1588设备共享单个FPGA芯片。它还共享所有资源，包括PTP/NTP栈、RAM等。在DDoS攻击的情况下，单个FPGA将被阻断，破坏同步过程的稳定性。NTS-5000在每个NIC都使用私有的FPGA。此外，所有NIC都是自治的Grand master，它们是100%信息隔离的（无TCP/IP）。

最佳的同步性能

专有的FPGA可确保同事服务的所有不同网络的最佳性能。这样就可以为每个连接到EXPANDER 1-4 NIC的每个网络设置不同的**PTP配置文件**：

- 数据通信 (默认配置文件, HA*)
- 电信 ITU-T G.8275.1 / G8275.2
- 电力 IEEE C37.238 / IEC 61850-9-3
- 广播 SMPTE 2059.2

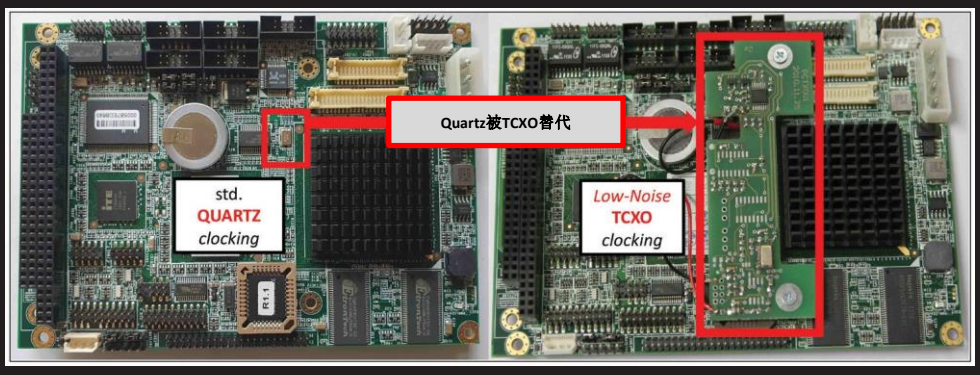
性能得到专业计量市场（NMI）的肯定

自主的EXPANDER grandmaster技术(Expander1-4中的NIC）提高了网络性能并确保同步稳定性。伦敦证券交易所(LSE)的NPL MiFID II 2017测试报告证实，Elproma的精度优于50ns(在50 km暗光纤距离下测量)。此测试结果由NPL Public在ION/PTTI 2017会议上公布。

Elproma正在提升标准Holdover模式

标准Holdover是铷(Rubidium)或OCXO振荡器，确保在GNSS信号缺失时UTC的准确性和稳定性。Elproma真正的创新之处在于通过用TCXO取代标准的石英振荡器来提高holdover操作。它的作用就是提高稳定性并增加holdover时间。

Standard holdover	Rb	SI	OCXO	SI
1s	0,1	ns	5	ns
1minute	10	ns	300	ns
1hour	30	ns	500	ns
1day	1	µs	50	µs
1week	10	µs	2	ms
1month	0,2	ms	50	ms
1 year	16	ms	1,5	s



Boosted holdover	TCXO & Rb	SI	TCXO & OCXO	SI
1s	0,1	ns	3	ns
1minute	9	ns	150	ns
1hour	25	ns	250	ns
1day	0,7	µs	25	µs
1week	9	µs	1,2	ms
1month	0,2	ms	25	ms
1 year	12	ms	0,9	s

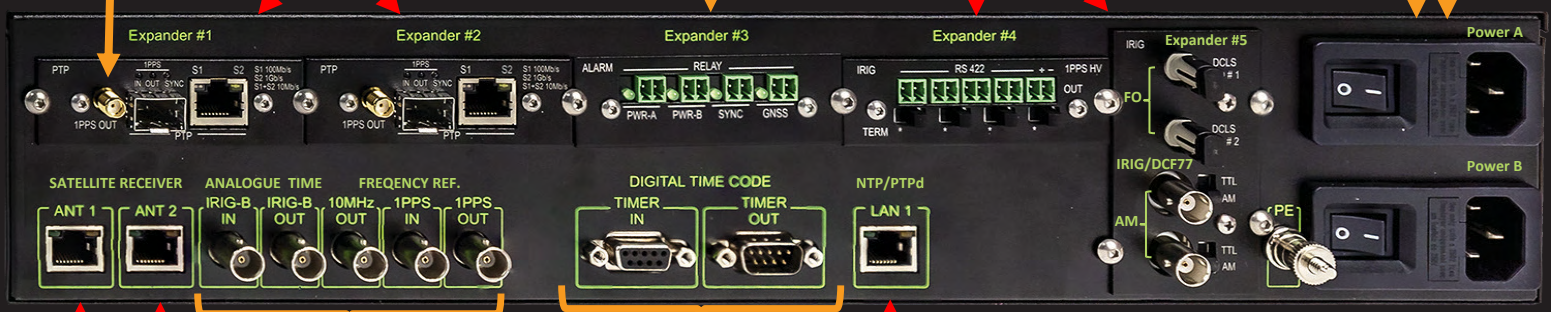
Clocks
2.048 MHz
ITU G.703.13

IEEE1588 & (S)NTP
Master & Slave
HW-stamping

Alarm Relays
PWR A & B
SYNC GNSS

IRIG-B or DCF77
AM or,
DCLS (incl. fiber)

Redundant PWR
AC and/or DC
from 24V to 300V



2x smart-ANT

Sync I/O

Time Code I/O

2x (LAN1/LAN2) w software stamping

Hardware

#Expander	Supported Functionality	Connector Type
Expander #1	ETH 1GbE w/ HW-stamping => IEEE1588/SyncE/(S)NTP Master & Slave *or* ETH 10GbE w/ SW-stamping => IEEE1588 PTPd/(S)NTP Master & Slave	RJ45 & SFP SFP
Expander #2	ETH 1GbE w/ HW-stamping => IEEE1588/SyncE/(S)NTP Master & Slave *or* ETH 10GbE w/ SW-stamping => IEEE1588 PTPd/(S)NTP Master & Slave	RJ45 & SFP SFP
Expander #3	ETH 1GbE w/ HW-stamping => IEEE1588/SyncE/(S)NTP Master only *or* Alarm RELAYS x4	RJ45 & STP TB 2pin
Expander #4	ETH 1GbE w/ HW-stamping => IEEE1588/SyncE/(S)NTP Master only *or* RS422 x4 TIME-CODE DCF77 w/ 1PPS HV *or* RS422 x4 TIME-CODE DCLS IRIG-B w/ 1PPS HV *or* 10MHz 2x INPUT for **ePRTC** *or* Fiber Optic 1x TIME-CODE DCF77 Electric TTL 1x TIME-CODE DCF77 RF 77.5kHz emulation AM DCF77	RJ45 & STP TB 2pin TB 2pin BNC ST TB 2pin BNC
Expander #5	Fiber Optic 2x TIME-CODE DCLS IRIG-B Electric TTL 2x TIME-CODE DCLS or AM	ST BNC

IEEE1588 Profiles

Protocol	Profile	Standard ref.	Availability on
IEEE1588 PTP HW-stamps	Default	PTPv2 IEEE1588:2008	Expander 1 LAN3-LAN4 Expander 2 LAN5-LAN6 Expander 3 LAN7-LAN8 Expander 4 LAN9-LAN10
	Telecom	ITU-T G.8265.1 Freq. ITU-T G.8275.1 Freq. ITU-T G.8275.2 Phase & Freq.	Expander 1 LAN3-LAN4 Expander 2 LAN5-LAN6 Expander 3 LAN7-LAN8 Expander 4 LAN9-LAN10
	Power	IEEE C37.238-2011 (v1) IEEE C37.238-2017 (v2) IEEE 61850-9-3 via C37.238	Expander 1 LAN3-LAN4 Expander 2 LAN5-LAN6 Expander 3 LAN7-LAN8 Expander 4 LAN9-LAN10
	Broadcast	SMPTE ST 2059-2 AES67* Media (option)	Expander 1 LAN3-LAN4 Expander 2 LAN5-LAN6 Expander 3 LAN7-LAN8 Expander 4 LAN9-LAN10
	TSN Industry 4.0	IEEE 802.1AS** (option)	Expander 1 LAN3-LAN4 Expander 2 LAN5-LAN6 Expander 3 LAN7-LAN8 Expander 4 LAN9-LAN10
SyncE	all PTP profiles	ITU-T G.8261	Expander 1 LAN3-LAN4 Expander 2 LAN5-LAN6 Expander 3 LAN7-LAN8 Expander 4 LAN9-LAN10

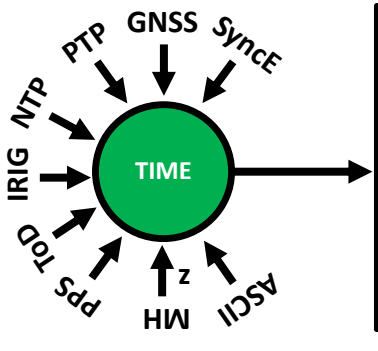
TIME-CODES

TIME-CODE	Description	Connector	Expander
IRIG-B AM	Amplitude Modulated (analogue)	BNC 50Ω	MAINBOARD
IRIG-B DCLS RS422	Pulse Width Coded (digital DCLS)	TB (2-pin) 100Ω .. 120Ω	EXPADNER 4
IRIG-B DCLS Fiber Optic	Pulse Width Coded (digital DCLS)	ST Fiber Optic	EXPANDER 5
DCF77 RF simulation	77.5kHz (3868.3m wavelength)	BNC 50Ω 3..5mV$_{pp}$	EXPANDER 4
DCF77 Electric TTL	Demodulated DCF77	TB (2-pin) RS232	EXPANDER 4
DCF77 Fiber Optic	Demodulated DCF77	ST	EXPANDER 5
GNSS	NMEA183 & 1PPS	RJ45 (ANT1 .. ANT2)	MAINBOARD

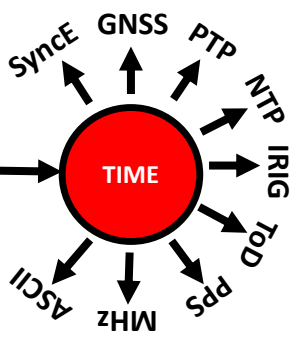
Oscillators

	HQ OCXO	Rubidium (Rb)
Output frequency	10MHz sine wave	10MHz sine wave
Short term stability [1s]	< 1x 10E^{-11} s	< 2x 10E^{-11} s
Short term stability [100s]	< 2x 10E^{-11} s	< 2x 10E^{-12} s
Average aging	< 5x 10E^{-10} s per day	< 5x 10E^{-11} s per month
Stratum-1 Level Holdover	0.5 day (12 hours)	3 days (72 hours)
PPS-out	<not available>	< 10ns
Warm-up since power-on	1min	10min

INPUT



NTS-5000 function:
GRANDMASTER
CONVERTER
SLAVE
GPS & DCF77 SIMULATION
TIME-CODE GENERATOR
TIME-SCALE TRANSLATION



OUTPUT

标准产品包括1个智能天线。也支持选择2个智能NTS-Antenna以确保冗余性。天线包括内置GNSS接收器。内部NTS-Antenna精度优于5ns。最终精度取决于选择的GNSS接收器（可替换模块）。Elproma可以支持选择抗干扰、欺骗。

Antenna 产品手册下载 PDF

Network Time Protocol NTP v2, v3, v4 LAN1-2:

RFC1305
RFC1119
RFC5905
RFC5906
RFC5907
RFC4330
RFC2030

Precision Time Protocol PTP IEEE1588 LAN3-10:

配置文件

Default	
Telecom	ITU-I G.8265.1
	ITU-I G.8275.1
	ITU-I G.8275.2
Power	IEEE C37.238
	IEC 61850-9-3*
Broadcast	ASMPTE 2059.2
金融**	HA/White Rabbit**

性能

GNSS synchronization precision /1PPS-in stability @ 2-sigma/< 5ns
ELPROMA PTP master-2-slave synchronization accuracy @ LAN < 25ns
Network performance at full load (all std. LAN intefaces) 9000 req/s
Max. concurrent NTP clients served at 1024 polling rate 9,200,000

Standard I/O	ANT	LAN	PPS	10Mhz	IRIG-B AM	IRIG-B DCLS
Factory defaults	2x RJ45	2x RJ45	2x BNC	1x BNC	2x BNC	2x DSUB-9 (TTL)
Sync INPUT	2	2	1	0	1	1
OUTPUT	(NMEA183)	(see above)	1	1	1	1
	(RJ45)	(RJ45 & SFP)	(BNC 50 Ohm)	(BNC 50 Ohm)	(BNS 50 Ohm)	(DSUB-9 pin)

Special I/O 2x USB 2.0 (for firmware upload) 3x RS232 (DSUB-9) 2x ANT1-2 OUTPUT (NMEA183 EMULATION)

IEEE802.3 Network Interfaces		LAN1-2	LAN3*-4*	LAN5*-6*	LAN7*-8*	LAN9*-10*
Network Interface Expander #No		#0 (MAIN)	#1 (EXPANDER)	#2 (EXPANDER)	#3 (EXPANDER)	#4 (EXPANDER)
Network Cards	Speed	10/100Mbps	1GbE	1GbE	1GbE	1GbE
	Update to 1Gb (RJ45)	10/100/1000Mbps				
	Update to 1Gb (SFP)	10/100/1000Mbps				
	Update to 10Gb (SFP)	YES*	NO	NO	NO	NO
	Connector Ended	LAN1: RJ45	LAN3: SFP	LAN5: SFP	LAN7: SFP	LAN9: SFP
		LAN2: RJ45	LAN4: RJ45	LAN6: RJ45	LAN8: RJ45	LAN10: RJ45
Timestamping		SOFTWARE	HARDWARE	HARDWARE	HARDWARE	HARDWARE
SyncE		NO	ITU-T G.8261	ITU-T G.8261	ITU-T G.8261	ITU-T G.8261
IEEE1588:2008	Precision Time Protocol	PTPd	PTP v2	PTP v2	PTP v2	PTP v2
PTP Clock mode		MASTER & SLAVE	MASTER & SLAVE	MASTER & SLAVE	MASTER only	MASTER only
IEEE1588 PTP Profiles	DEFAULT	YES	YES	YES	YES	YES
	TELECOM	NO	ITU-T G.8265.1	ITU-T G.8265.1	ITU-T G.8265.1	ITU-T G.8265.1
		NO	ITU-T G.8275.1	ITU-T G.8275.1	ITU-T G.8275.1	ITU-T G.8275.1
		NO	ITU-T G.8275.2	ITU-T G.8275.2	ITU-T G.8275.2	ITU-T G.8275.2
	POWER	NO	IEEE C37.238	IEEE C37.238	IEEE C37.238	IEEE C37.238
	POWER UTILITY	NO	IEC61850-9-3	IEC61850-9-3	IEC61850-9-3	IEC61850-9-3
(Supported via IEEE C37.238) =>	BROADCAST	NO	SMPTE 2059.2	SMPTE 2059.2	SMPTE 2059.2	SMPTE 2059.2
	BROADCAST	NO	AES67**	AES67**	AES67**	AES67**
	TSN	NO	IEEE 802.1AS**	IEEE 802.1AS**	IEEE 802.1AS**	IEEE 802.1AS**
	PTP #SLAVE	UNLIMITED	32std./128**	32std./128**	32std./128**	32std./128**
			256**/450**	256**/450**	256**/450**	256**/450**
Concurrent clients at 1024 NTP pool		9mln clients				
NTP Network Time Protocol support		NTP/SNTP	(S)NTP v4	(S)NTP v4	(S)NTP v4	(S)NTP v4
NTP server compatybility to CLIENTS		NTP/SNTP	NTP/SNTP	NTP/SNTP	NTP/SNTP	NTP/SNTP
		CHRONY	CHRONY	CHRONY	CHRONY	CHRONY

EXPANDER	MAIN #0	EXPANDER #1	EXPANDER #2	EXPANDER #3	EXPANDER #4	EXPANDER #5
10GbE SW-stamping	NO	SFP	SFP	NO	NO	NO
1GbE HW-stamping	NO	SFP+RJ45	SFP+RJ45	SFP+RJ45	SFP+RJ45	NO
2.048 MHz G.703.13bps	NO	YES (unframed)*	YES (unframed)*	YES(unframed)*	YES(unframed)*	NO
IRIG-B DCLS	D-SUB9	NO	NO	NO	4xTB RS422	2x BNC TTL5V 50Ohm
					1xTB PPS HV	2x ST FIBER OPTIC
IRIG-B AM	2x BNC TTL5V	NO	NO	NO	NO	2x BNC TTL 5V 50Ohm
DCF77 AM (emulation)	NO	NO	NO	NO	1x BNC	NO
DCF77 DCLS (emulation)	NO	NO	NO	NO	TB2 (TTL) ST	NO
RELAYS	NO	NO	NO	4xTB ALARM	NO	NO

振荡器精度 $10E^{-11}$[s] (24h) **振荡器老化** $10E^{-11}$[s] (1 month)

Remote Configuration • SNMPv3 MIB-2 • RADIUS • HTTP • HTTPS • SSH • TELNET • NTPQ/NTPDC • DHCP • MODBUS**

尺寸/环境

- Size: 484x 300x 88,8 mm (rack'19 2U)
- Operating temp: -55°C to +80°C (receiver)
- Operating temp: 0°C to +60°C (server)
- Storage temp: -55°C to+80°C
- Humidity: up to 95%
- MTBF 391000 hours

电源

- Power: 110-230 VAC, 120-370 VDC (1A)
- Telecom (48VDC) option: 20-70 VDC (2A)
- Max. power NTS-5000 Rb & OCXO: 80W
  NTS-500 LITE OCXO (no Rubidium) 60W

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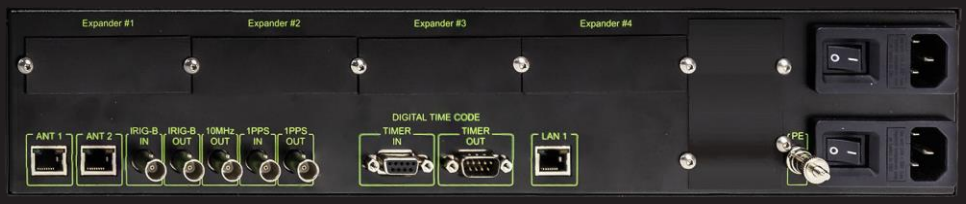
*额外的功能需要额外的硬件或者固件升级。 ** 新的即将到来的PTP/IEEE1588配置文件，固件免费更新将在Q4/2021提供

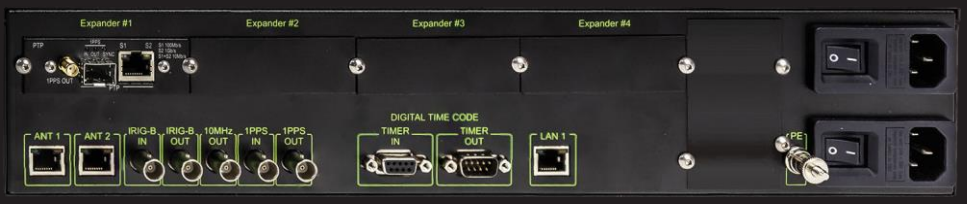
数据中心&金融 —— 最受欢迎配置

DATACOM1：2x100/10Mbps (Software Time-Stamping) LAN1&LAN2



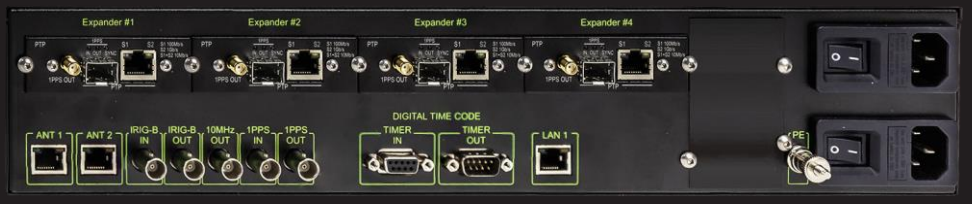
DATACOM2：1x10GbE(LAN1) + 1x100/10Mbps LAN2 (Software Time-Stamping)

DATACOM4：2x1GbE LAN3-4 (Hardware Time-Stamping) + DATACOM1 config

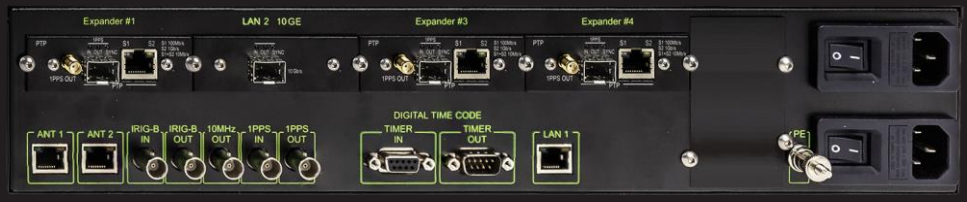


DATACOM5：4x1GbE LAN3-6 (Hardware Time-Stamping) + DATACOM1 config

DATACOM7：8x1GbE LAN3-LAN10 (Hardware Time-Stamping) + DATACOM1



DATACOM9：6x1GbE LAN3-8 (Hardware Time-Stamping) + DATACOM2"(LAN2)



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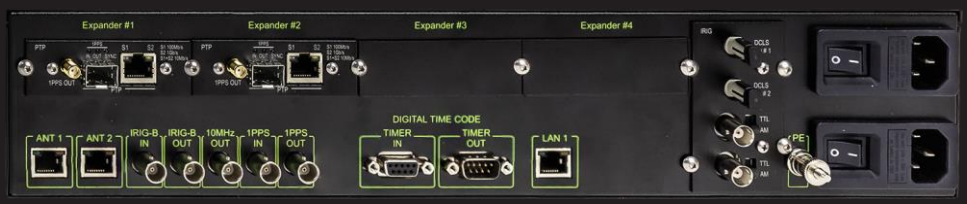
智能电网&工业4.0 —— 选定配置

SMART-GRIDS1 4xIRIG-B DCLS rs422 (Expander #4) basis on DATACOM-5 conf.

SMART-GRIDS2 2xDCLS Fiber 2xDCLS TTL (Exp. #5) basis on DATACOM-5 conf.



SMART-GRIDS3 is a summary of 2x& 3 item above

SMART-GRIDS4 is like SMART-GRIDS3 with extra 4x ALARM RELAY

SMART-GRIDS CUSTOM1 - This is PTP SLAVE generating IRIG like SMARTGRIDS4

SMART-GRIDS CUSTOM2 - This is PTP SLAVE + CUSTOMS1 (above) + 10GbE out

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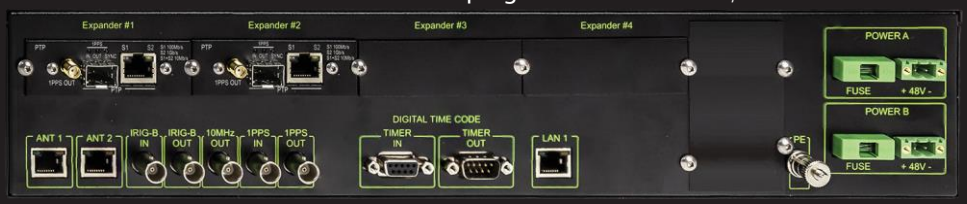
电信 Lte/5G —— 选定的最受欢迎配置

TELECOM-1 PRTC-A 2x100/10Mbps, 48VDC NTP-Server w/ PTPd support

TELECOM-3 PRTC-A 2x10GbE,48VDC SW-stamping NTP-Server w/ PTPd support

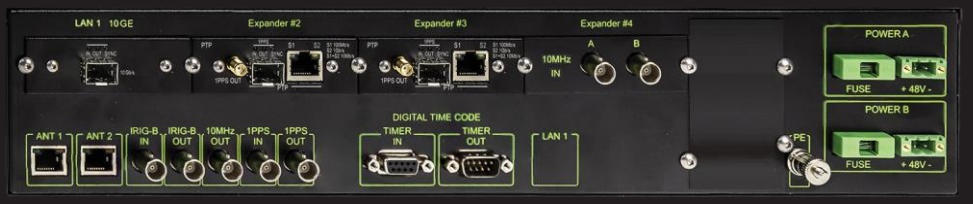
TELECOM-5 PRTC-A 4x1GbE HW-stamping Autonomous NTP/PTP GrandMasters



TELECOM-7 PRTC-A 8xGbE HW-stamping Autonomous NTP/PTP GrandMasters

TELECOM-8 PRTC-A 2x10GbE, 4xGbE HW-stamping Autonomous GrandMasters

TELECOM-9 ePRTC 1x10GbE, 4xGbE HW-stamping Autonomous GrandMasters



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