Calnex **Sentinel**

100M / 1G / 10G / Over-the-Air

Calnex
Insight and Innovation

The all-in-one field sync tester

For 3G/4G/5G Mobile Backhaul, E911/Critical Infrastructure, Datacenters, Financial Networks and Power Comms

Lab quality performance in an easy-to-use, portable package

Simultaneous Measurements

- 1 pps/frequency
- PTP/SyncE
- Over-the-Air (4G LTE TE)
- NTP (PDV + 2wayTE)

Protocol Check

Analyze PTP protocol compliance to ITU-T Standards (G.8265.1/ G.8275.1/G.8275.2)

Clear Pass/Fail metrics for easy analysis

- ITU-T, standards-based, vendor limits
- Detailed measurement report in PDF format

Easy Test Setup

1. Run health check to auto discover signals and check PTP protocol compliance
2. Start all measurements at the same time

Capture and Replay

Measure the network and send measurements back to the lab/vendor to replay and fix issues

Remote Operation

Monitor from NOC/Office

Embedded GNSS Receiver and Rubidium (Rb)

Highly stable and precise GNSS disciplined Rb

Platform Highlights

- PTP, NTP, SyncE and TDM in one box
- Measure ALL parameters at the SAME time:
  - Network Time Error, network PDV, network Wander (SyncE, TDM) and clock output (frequency and phase)
  - Identify what the issue is and where it's coming from (network, switch, nodeB etc.)
- Flexible network connection options:
  - As a pseudo-slave connected to network switches
  - As a network monitor, monitoring live network PDV and Time Error
- Long-term measurement capability to find intermittent issues
- Ethernet for control, USB connectivity for external storage

SDH/SONET Network Test

- Simultaneous measurement of multiple TDM (PDH/SDH/Sonet) signals
- Speed up TDM network sync testing
- Improve efficiency of debug
- Standard industry masks per G.811/G.812/G.813/G.823/G.824

3G/4G/5G Network Test

Built-in Pass/Fail limits when measuring the network for:

- Node-B: Ericsson RBS6000, Huawei 3900, NSN Flexi, etc.
- eNodeB: Huawei, ZTE, Ericsson, AlcatelLucent, NSN, etc.
- Small Cells supporting PTP or NTP
- Cell-site Routers and PTN (Cisco ASR901, ALu 7705-SAR, Tellabs 860x, Huawei PTN, etc.)
- Boundary Clocks (BCs) and Transparent Clocks (TCs)

Test networks for Frequency and Phase:

- ITU-T G.8265.1 for Frequency
- G.8275.1, G.8275.2 for Time/Phase

Standard industry masks and packet metrics:

- ITU-T G.8261.1/G.8271.1/G.8271.2
- MTIE/TDEV/MAFE/FPP/FPC/TE/pktSelected2WayTE

Test networks with Boundary Clocks and Transparent Clocks:

- Qualify your existing network – identify how many BCs/TCs you need
- Validate network and equipment performance to ITU-T limits
- Test that the network is suitable for LTE-A and TDD-LTE
- Pinpoint which BC/TC contributes significant timing error

Ideal for pre-deployment, troubleshooting, and post-deployment maintenance

Advanced capabilities and intuitive operation means engineers at all skill levels can use Sentinel with total confidence.

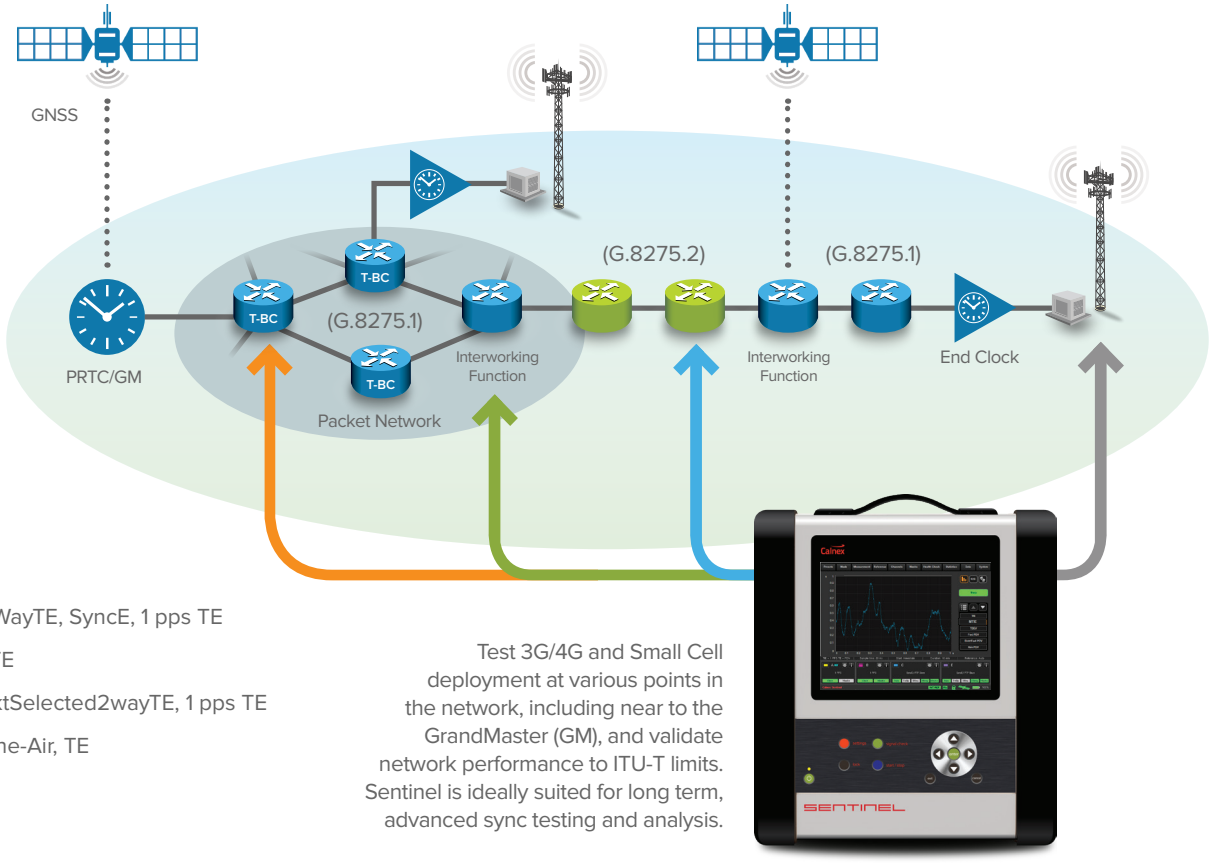
- Simultaneous sync measurements including PTP 2WayTE/PDV + SyncE + Clock measurements (frequency + 1 pps TE)
- Supports G.8265.1, G.8275.1, G.8275.2 and default PTP profiles
- In-depth PTP protocol capture and analysis
- Measure multiple GM's simultaneously
- Time Error analysis – 2WayTE, pktSelected2WayTE, 1 pps, cTE, dTE (LF/MTIE/TDEV)
- PDV analysis – FPP, MAFE, MATIE, Packet Distribution
- SyncE Wander (MTIE/TDEV) and SyncE ESMC QL analysis
- NTP PDV + 2WayTE analysis (NTP Pseudo Client)
- Extensive analysis of PDV/TE/Clock metrics (using CAT) with report generation

CAT

The Calnex Analysis Tool (CAT) provides powerful insight into network and device performance. All your measurement results are now in one place, and you can view multiple graphs simultaneously for easier correlation of your results.

- Enhanced graphics makes it easy to evaluate ITU-T metrics such as Time Error (cTE, dTE), MTIE and TDEV against ITU-T masks
- Customisable multi-graph window lets you rapidly select measurements and channels for detailed analysis
- One button generation of reports in PDF format: Pass/Fail statistics and details of failures
- Share captures and results with vendors for fast, efficient and accurate troubleshooting

Keep up with network evolution and deliver the fast, stable service your customers demand

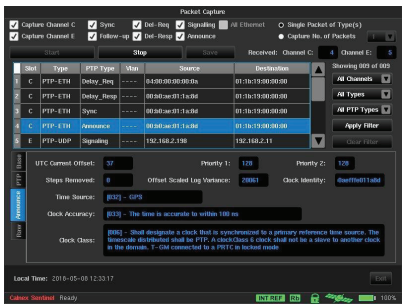


- PTP 2WayTE, SyncE, 1 pps TE
- 1 pps TE
- PTP pktSelected2wayTE, 1 pps TE
- Over-the-Air, TE

Test 3G/4G and Small Cell deployment at various points in the network, including near to the GrandMaster (GM), and validate network performance to ITU-T limits. Sentinel is ideally suited for long term, advanced sync testing and analysis.

Protocol and Signal Analysis

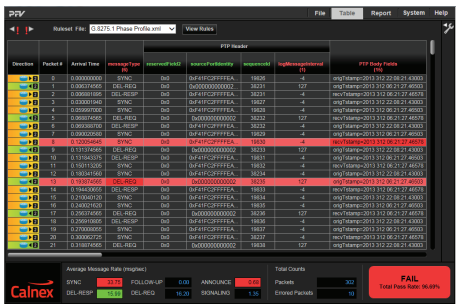
- Selectable ITU-T and IEEE profiles
- Automatic detection of signals present
- Checks that Master/Slave addresses are correct
- Checks Domain is correctly set
- Checks signalling messages are received in Unicast mode
- Checks Sync, Del-Req, Del-Resp and Announce messages have been received



Packet Capture and Decode

Capture and decode Signalling, Sync, Del-Req, Del-Resp and Announce messages to help identify:

- Configuration issues – such as mismatch domain number configured for Master and Slave
- Protocol Implementation issues – such as the log interval of Del-Resp does not reflect the real packet rate as expected in multicast mode
- Protocol Signalling issues – such as signalling messages do not repeat after the negotiated contract period
- Capture and decode Announce messages – provides detailed information about the PTP GM which is fundamental to build up the Master-Slave clock hierarchy



PTP Protocol Analysis

Analyze PTP protocol for conformance to standards or user-defined profiles with the PTP Field Verifier (PFV).

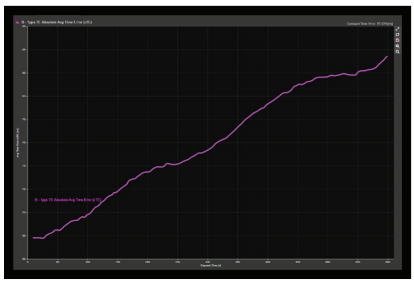
- Automatic Pass/Fail indication – check captured PTP messages against a pre-defined set of rules, with clear Pass/Fail alerts
- Check transmitted PTP messages for compliance with ITU-T, IEEE and user-defined standards and rules – areas of non-conformance immediately visible
- Flexible XML rules allow full customisation of pass criteria
- Full report generation capability

Now measure sync from the radio signal – and from your car

Time Error Over-the-Air

How do you know if your Small Cells conform to 3GPP standards? With TDD and FDD systems implementing newer LTE features such as eICIC and CoMP, measuring the sync accuracy of a Small Cell/eNodeB is crucial. It's also quite a challenge, particularly when these network devices often lack a physical 1 pps output.

However, with Sentinel's non-invasive Over-the-Air test capability you can now measure, with precision, the Time Error between Small Cells/EnodeBs and Sentinel's reference to ensure they meet the 3GPP's ≤3 µs phase alignment limit.

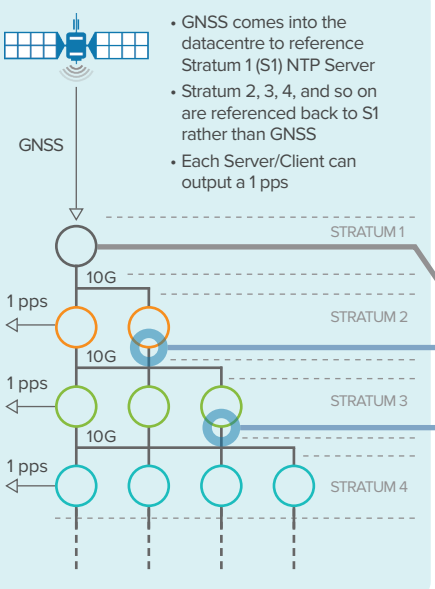


Evaluate OTA measurements using the CAT, including

- Time Error
- Frequency accuracy

PTP and NTP timing for datacenters

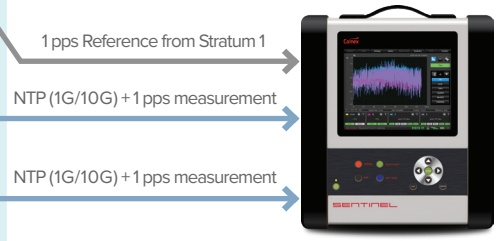
How do you ensure your datacenter is synchronized? Datacenters are evolving to cope with the global demand of connectivity and cloud storage, playing a huge part in the future of 5G. And PTP and NTP are key synchronization technologies that are critical in the performance of a datacenter.



- GNSS comes into the datacentre to reference Stratum 1 (S1) NTP Server
- Stratum 2, 3, 4, and so on are referenced back to S1 rather than GNSS
- Each Server/Client can output a 1 pps

High line rates and dedicated IPv6 networks are the new normal and the very nature of a datacenter is becoming ever more critical. Testing sync within datacenters will have some challenges – no GNSS within the building, therefore no measurement reference, while NTP requirements can be beyond legacy implementations making it difficult to prove time/phase accuracy.

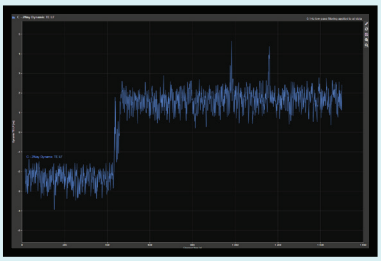
Sentinel can test NTP/PTP 2way TE without access to GNSS. Plus, should you need to move Sentinel around the datacenter, simply take a reference from a GM/Stratum 1 Server to discipline the PRS-10 Rb and test in holdover mode.



All measurements can be made simultaneously:

- 2 x packet ports (2 x independent Pseudo NTP Clients or PTP Slaves)
- 2 x clock ports (2 x independent 1 pps measurements)

Use the CAT for a clearer picture . . .



LTE-A/TDD LTE

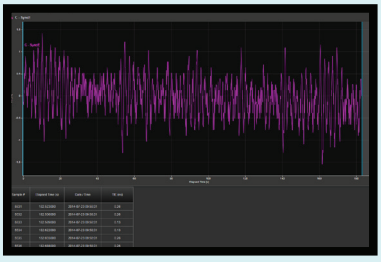
- PTP/1 pps MaxITEI
- PTP/1 pps dTE
- pktSelected2wayTE (APTS/PTS)

LTE-FDD/3G

- PDV FPP
- 16 ppb frequency wander
- MTIE/TDEV

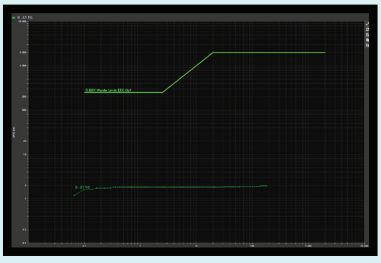
Financial/Power Networks

- NTP PDV distribution
- NTP 2wayTE



SyncE

- E1/T1 wander
- MTIE/TDEV
- ESMC



TDM/Legacy

- E1/T1 wander
- MTIE/TDEV
- SSM

Specifications

Clock Module Specifications

Pre-defined Signal/Clock Types	• 1 pps (PTP slave recovered clock). • 8 kHz (frame clock). • 64 kHz/64 kb/s (E0/DS0). • 1.544 MHz/1.544 Mb/s (T1/DS1 clock/data). • 2.048 MHz/2.048 Mb/s (E1 clock/data). • 5 MHz/10 MHz (frequency reference). • 25 MHz/125 MHz/156.25 MHz (SyncE clock rate). • 34 Mb/s (E3), 45 Mb/s (DS3). • 155.52 MHz/155 Mb/s (STM-1/STS-3 clock/data).
User-defined Clock Types	From 0.5 Hz to 200 MHz in 0.5 Hz steps. Note: symmetrical, unipolar clock signals.
Measurement Ports	Number of Ports: 2 per module. Connector: BNC. Impedance: 75 Ω, VSWR <2:1 or 1 MΩ. Voltage Range: ±5.00 V. Sensitivity: 60 mVpp. Signal Type: Symmetrical pulse (clock signal); Unsymmetrical repetitive pulse (clock signal); HDB3-coded data (data signal); AMI B8ZS, B3ZS (data signal). Frequency Measurement: TIE accuracy 1 ns. 1 pps: Constant TE measurement accuracy with reference to GNSS ±75 ns.
Test Modes (MTIE and TDEV Masks)	Masks can be applied for TIE, MTIE and TDEV graphs. PRC/SSU/SEC: Masks for G.811/G.812/G.813-clocks (ETSI 300 462-3). Networks: According to G.823/G.824/G.8261/G.8261.1 SyncE: According to G.8261, G.8262 ANSI-standard: DS1 and OC-N masks.
Graph Display	Display Modes: TIE, MTIE, TDEV. Update Rate: Approx. once/10 seconds. Number of Graphs: Up to 6 graphs of the same type can be over-laid on screen. Color coded. Masks on Screen: Up to 6 MTIE and TDEV masks according to selected test mode. Pass/Fail result available for each mask.

Ethernet Specifications

Synchronous Ethernet	SyncE clock measurement. Conformance to G.8261 and G.8262 masks (MTIE/TDEV). Extract and graph ESMC message (SSM). Generate and change ESMC.
PTP (1588) and NTP	Network 2-way TE, Forward (Sync) PDV, Reverse (DelReq) PDV and Network Delay. Raw PDV (*vs* time and distribution graphs). Selected Packet PDV (*vs* time and distribution graphs). Cluster/band packet selection. Pseudo-slave Mode or Monitor Mode. 5 ns resolution timestamp. Captured PDVs can be replayed on Calnex Paragon-X for troubleshooting. **PTP (1588):** Layer 2 Multicast and Layer 3 (UDP/IPv4, UDP/IPv6) Multicast/Unicast. **NTP:** Layer 3 (UDP/IPv4/IPv6) Multicast/Unicast.
Measurement Ports	Number of Ports: Maximum of 2. Connector: RJ45 for 10/100/1000 Base-T, SFP/SFP+ for 100M/1G/10G Optical (SFP/SFP+ not supplied).

OTA Module Specifications

Measurement Accuracy	±150 ns.
Operating Frequencies	Up to 3.5 GHz.
LTE Bands	TDD and FDD.
Metrics	TIE and Absolute TE.

Platform Specifications

Reference Clock	Built-in Rubidium reference or external reference input 1 MHz, 5 MHz or 10 MHz.
Internal Data Storage	Up to 32G.
External Data Storage	USB memory stick.
Start/Stop	Via START/STOP key.
Signal Check Parameters	Signal type (Clock, Data or Unknown); Frequency (for clock signals); Pulse width (for data signals); Voltage peak-peak (min. 120 mVp-p).
Display	Colour TFT, 8.4”, 800 x 600 pixels, resistive touchscreen.

Platform Specifications (continued)

	Internal Rb Clock
Stability	Output frequency accuracy (7 mins to warmup): 1×10^{-9} Ageing (1 day): $<1 \times 10^{-12}$ Ageing (1 year): $<5 \times 10^{-10}$
	GNSS-disciplining
Built-in GNSS Module	12 channels, TRAIM GNSS receiver, high sensitivity. GPS, GLONAS, Beidou, Galileo.
Time Accuracy	±15 ns at 1σ after 24 hours lock.
Frequency Accuracy	2×10^{-12} averaged over 24 hours.
GNSS Disciplining Modes	Always disciplining, always in holdover, disciplining only between measurements. Requires 6 hours discipling if disconnected from GNSS for <1 week; 12 hours if >1 week. Requires 1 hour disciplining if using Cs quality 1 pps (from any state).
	External References
Frequency Reference Input (std)	Input Frequency: 10 MHz, 5 MHz or 1 MHz. Voltage Range: 0.1 Vrms to 5 Vrms. Impedance: Approx. 50 Ω.
External 1 pps Timing Input	Voltage Range: 0 V to 0.8 V (Low), 2 V to 3.3 V (High) into 50 Ω. Required Accuracy: ±100 ns to UTC.
GNSS Timing Reference	Antenna Input: N-type connector. DC-feed: +5 V on centre pin to active GNSS antenna.
	Output References
Reference Frequency Output	Reference Frequency: 10 MHz sine-wave. Output Levels: 1 Vrms in 50 Ω. Impedance: Approx. 50 Ω.
1 pps Output	Source: Internal Rubidium oscillator. Output Logic Levels: TTL levels in 50 Ω.
E1/T1 Output	Connector: Clock: BNC. Data: Isolated BNC. Frequency: 2.048/1.544 MHz, 2.048/1.544 Mb/s. Output Level: Accurate to G.703 ±1.2 V ±10% in 75 Ω.
	Interfaces
USB Device Port	Connector: Std USB type B. USB Version: 2.0
USB Host Port	Connector: Std USB type A. Maximum Supply Current: 400 mA. USB Version: 2.0
Ethernet	Communication Port: RJ45, 10/100 Base-T. Protocol: DHCP, FTP, VNC.
Remote Operation	Remote operation via VNC. Event Log: On screen log of measurement start/stop, duration, alarms, loss of data, loss of communication link, etc. Log can be saved as text file. Report Generation: Printable, custom-designed measurement report in pdf format. Security: Password secured access.
	Environmental Data
Operating Temperature	0°C to 40°C. (30°C when charging Rb backup-battery.)
Safety	EN 61010-1: 2010.
EMC	EN 61326: 2013.
Power Supply	Line Voltage: 100 to 240 Vrms ±10%, 50 Hz to 60 Hz, <100 W.
Optional Battery Backup	3 hours autonomy for Rubidium only to maintain internal timebase accuracy during transport mode.
	Mechanical Data
	Fold-out stand. Shock resistant cabinet.
Dimensions (w x h x d)	320 x 388 x 126 mm (12.6” x 15.3” x 5”).
Weight	Net <7 kg (15 lb); Shipping with transport case <16 kg (35 lb).

Specification is subject to change without notice.

Ordering Information

Calnex Sentinel Sync Analyzer with built-in GNSS receiver. Needs minimum of one measurement option (module/port).

Included with shipment: Calnex Analysis Tool (CAT), GNSS antenna, antenna cable (20 m), hard transport case, user manual on USB, line power cord, 1-year warranty and support.

Configurable Options

- Option 610: Clock module 1 pps/E1/T1, any clock from 0.5 Hz up to 200 MHz with 0.5 Hz step.
- Option 615: 100M/1G packet port (PTP/NTP/SyncE). Can order maximum of 2 x Opt. 615. Includes SyncE/ESMC analysis for 100M/1G optical and electrical rates.
- Option 616: 100M/1G/10G packet port (PTP/NTP/SyncE). Can order maximum of 2 x Opt. 616. Includes SyncE/ESMC analysis for 100M/1G/10G optical and electrical rates.
- Option 620: PTP and NTP PDV measurement software (one license per instrument).
- Option 630: Internal battery backup for Rubidium.
- Option 700: Over-the-Air (OTA) Time Error measurement module.

Optional Accessories

- Option 75: 120 Ω balanced RJ45 to 75 Ω unbalanced BNC impedance converter (balun).
- Option 133: External 1 pps/ToD/frequency converter accessory.
- Option 511: Carry-on bag.
- Option 812: One year extension of product warranty.
- Option 813: Two years extension of product warranty.

Related Products

Tempo and Tempo-c

- Provides canned tests for quick testing
- Test PTP, SyncE and legacy networks
- Verify Ethernet performance in either loop-back or peer-to-peer mode
- Simulate realistic traffic conditions
- Rugged and lightweight (<2 kg)

Calnex Paragon-X

- Test PTP (1588), SyncE, NTP, CES and OAM up to 10GbE
- Stress-test equipment with real network profiles from field tests to debug network issues
- Complete standards compliance testing to ITU-T G.826x/827x
- Test PTP Ordinary Clocks, Boundary Clocks and Transparent Clocks

Calnex Paragon-neo

- Delivers high accuracy sub-nanosecond timing measurements at rates up to 100GbE
- Capture and decode PTP packets for analysis and Time Error testing
- Prove SyncE jitter and wander performance to ITU-T G.8262.1/G.8262
- Evaluate MTIE/TDEV pass/fail results to ITU-T G.8262.1/G.8262 masks
- Control ESMC (SSM) message generation for testing to ITU-T G.8264

Calnex Solutions is a global leader in Test and Measurement solutions for next-generation telecom networks. For more information on the Calnex test equipment, and to take advantage of Calnex's extensive experience in Packet Sync and OAM testing technologies, contact Calnex Solutions today:

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