The SmartSSU: Specifically Designed for SDH Networks

Symmetricom Innovation for 21st Century Network Timing

55400A Network Synchronization Unit

Symmetricom™
Heartbeat of the Net

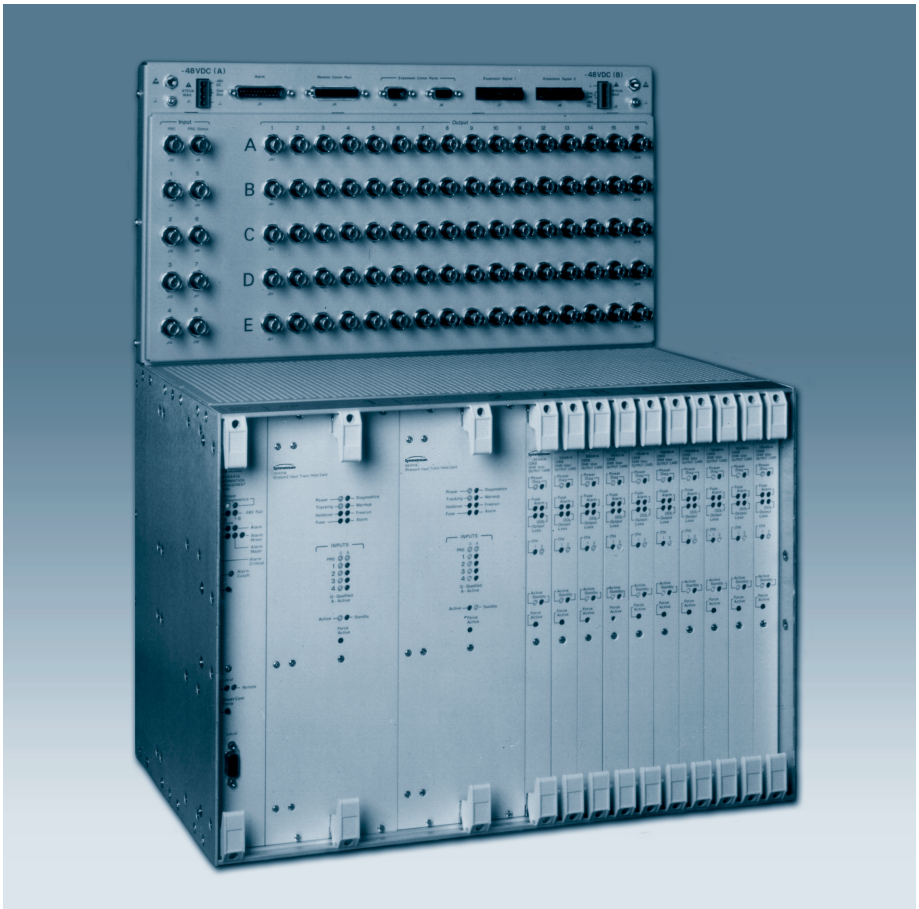
55400A Network Synchronization Unit

Symmetricom's 55400A Network Synchronization Unit — called the SmartSSU — is a modular, fully redundant timing distribution system for 2048 k/bits primary rate networks. The unit tracks incoming timing references, qualifies the signals against network timing standards, then filters and distributes precise timing to all equipment in the node. Incoming reference signals may come from cesium standards, GPS reference sources or E1 signals. The SmartSSU meets ETSI and ITU-T synchronization standards and provides holdover that exceeds the requirements for stratum-2 transit and local node performance.

The unit comes with a master subrack for up to 80 1:1 protected outputs. Expansion subracks are available for up to 400 1:1 protected outputs. Ideally suited where SDH technology is being deployed or expanded, the SmartSSU provides the high-quality timing needed by SDH and digital wireless networks.

SDH networks need better timing

If you are like most service providers, you've expended huge financial resources to deploy SDH technology. But until you upgrade your timing network to support this new technology adequately and to solve the unique timing problems of SDH, you risk poor quality on high-revenue data services.



The 55400A Network Synchronization Unit (SmartSSU) is designed specifically to provide the better timing needed on SDH networks.

Key Feature/Benefit Summary

Feature	Page	Benefit
Rearrangement of inputs with zero phase hits on the output The SmartSSU switches from one input to another with <1 ns phase hit on the output.	8	Better quality timing in real-life conditions
Ignores errored seconds to create more stable timing The SmartSSU "rides out" or ignores jitter problems for up to 15 seconds without switching.	9	
Synchronization status messaging (SSM) supported on inputs and outputs Input card decodes digital timing inputs that carry embedded SSM codes; E1 output card reencodes outputs to reflect the status of the SSU's timing quality.	11, 18	
Simple, integrated design provides unprecedented SSU reliability:		Fewer failures and maximum network uptime
• SmartClock technology adds intelligence to reliable quartz for superior holdover.	9, 15	
• 1:1 protected outputs mean each card has its own backup.	11	
• Surface-mount technology used for greater reliability.		
• Greater functionality on a single card means fewer cards and therefore fewer failure-prone board connectors.		
• Hot-swappable cards mean greater uptime.		
• Nine timing reference inputs ensure an available signal.		
Powerful, real-time monitoring and management capabilities to identify and solve synchronization problems in real time:		Ability to identify and recover from failures quickly
• "Instrument-on-a-chip" makes real-time MTIE, TDEV and frequency deviation measurements to give more accurate information than any other SSU.	9, 20	
• Real-time alarms inform you of problems both locally and remotely.		
• Vast memory of up to 1,000 events.	12	
• Large set of TL-1 commands.	13	
Upgradable and expandable to support future growth while protecting existing investments:		Built-in migration path
• Firmware upgrades can be downloaded without interrupting operation.	13	
• Built-in synchronization monitoring, ready for integration with network management.	9, 20	
• Built-in connectivity for data communication networks.	13	
• Nine inputs and up to 80 protected outputs per subrack.	6	

Cause of poor synchronization

Synchronization is the means of keeping all digital equipment in a communications network operating at the same rate. Poor synchronization is caused either by differences in timing accuracy among clocks at different network levels or by phase movements, called jitter and wander. These phase movements distort the network's timing as it is distributed from one node to another. As the frequency drifts, quality of service problems increase.

SDH synchronization networks need to be carefully planned to avoid these SDH timing problems. For example, SDH network elements are particularly sensitive to the short-term jitter generated by pointer adjustments. Self-healing ring topologies can cause timing loops to occur. And chaining of clocks can cause excessive wander accumulation.

Innovative, new approach needed

To maintain high quality of service on your network, you need an innovative, new approach to sychronization distribution. You need to improve the timing currently provided by embedded clocks that are not sufficient to support next-generation technologies.

The SmartSSU—Designed Specifically for SDH Networks

Symmetricom's synchronization supply unit (SSU), the 55400A Network Synchronization Unit, is the only SSU designed specifically for SDH networks. Called the SmartSSU, the unit distributes better quality timing and overcomes problems that frequently occur in real-life networks. The SmartSSU maximizes output reliability and has powerful, built-in monitoring and management capabilities. The unit is the first SSU with a built-in migration path that allows you to evolve to the advanced networks of the future while protecting your existing investments.

The following pages describe how the SSU will support your network today, and in the years ahead. Additional information on synchronization to help you successfully launch SDH is available in product brochures, specifications and application notes listed on the back of this brochure.

To guarantee maximum uptime, 21st century networks need a completely new synchronization supply unit (SSU) design — with better quality timing, built-in comprehensive monitoring and management tools, and upward scalability.

Better quality timing

The SmartSSU component of our SmartSync product family is designed to distribute the better quality timing needed in real-life, modern networks. The SmartSSU offers unprecedented performance that leads to maximum signal availability and network uptime.

Events such as jitter, excessive pointer adjustments, operator errors, GPS failure or transmission problems in the network can cause slips. To provide insurance from slips, the SmartSSU has zero phase variances on the output signal upon rearrangement of the inputs. The unit will also "ride out" or ignore errored seconds to create more stable timing.

Maximum network uptime

Innovations built into the SmartSSU guarantee the highest possible network availability. Unique reliability features include greater functionality on a single card (fewer cards means you stock fewer spares), use of surface-mount rather than through-hole technology, intelligent quartz oscillator technology and 1:1 protected outputs.

On those rare occasions when a failure does occur, the SmartSSU's powerful, real-time monitoring and management takes over. Unique features that identify and solve problems in real time include Symmetricom's proprietary "instrument-on-a-chip" that monitors input timing performance to give more accurate information than any other SSU.

Our sophisticated alarm processing informs you of problems both locally and remotely. The SmartSSU's vast memory of up to 1,000 events lets you research problems so they can be quickly identified and repaired, then avoided in the future. The industry's largest set of TL-1 commands lets you remotely manage virtually every function of each unit on your entire network of SmartSSUs.

Built-in migration path

Anticipating your need to upgrade and grow, we designed our modern SSU with a built-in migration path. You can evolve to the advanced networks of the future while protecting your existing investments. You can add capabilities without replacing the entire unit, as is required with older designs.

To support your growth, the SmartSSU has 9 inputs and up to 80 outputs per subrack. When standards change, you can download firmware upgrades while the unit is operating. When you need to integrate your SSUs with your datacom network, LAN, TP4 and X.25 connectivity options are built in. And when you want to integrate your SSUs with your sync network management, synchronization monitoring is already built into the SmartSSU.

Master Subrack

Simple, integrated design provides greater functionality and redundancy

The Master Subrack holds the SmartSSU's individual input, output and management cards, which are described on the following pages. Input and output connectors, power connectors, and alarm, expansion and remote communications interfaces are installed on the master subrack.

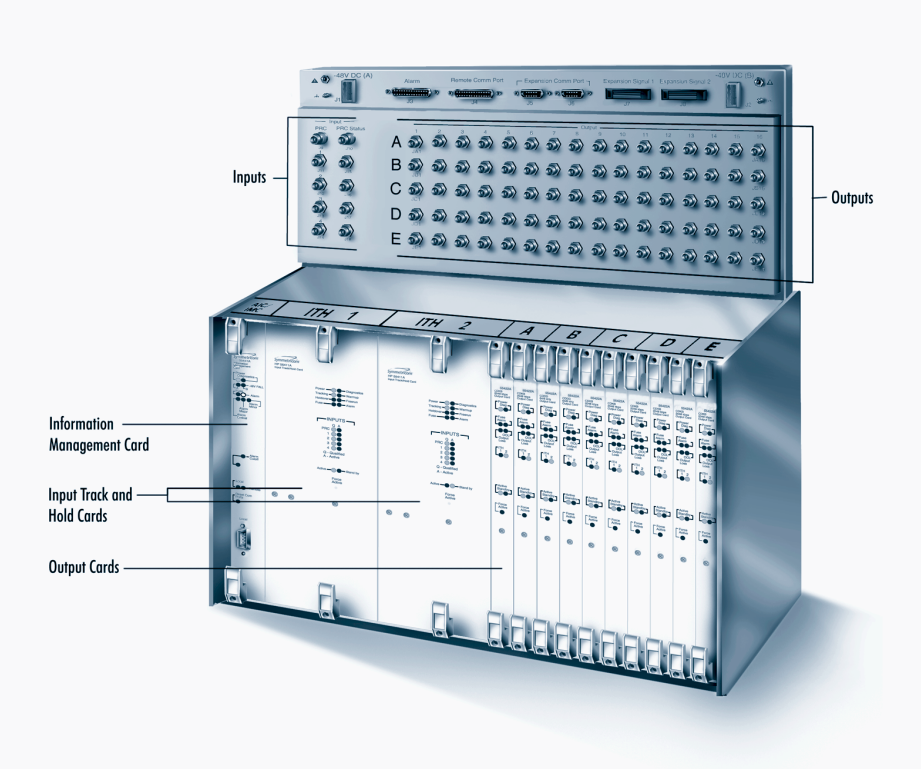
Up to nine inputs

Up to nine external reference signals from equal or higher levels of your network enter the SmartSSU through the input connectors on the master subrack. You can also use any input to monitor synchronization quality from other offices in your network.

The primary reference clock (PRC) input signal can be 5 or 10 MHz. The remaining eight inputs can be any combination of 2048 k/bits or 2048 kHz signals. All input signals go to both input track and hold cards.

Up to 80 outputs

Up to five pairs of output cards can be installed to provide 80 outputs per SSU.



Mini-power supply on each card

Customer-supplied, redundant –48 Vdc office batteries are attached to the two power connectors to provide power for the SmartSSU. Because power supplies are susceptible to failure, both sources of 48 volts are distributed directly to a "mini-power-supply" on each card. By converting power on each card rather than on a single power supply that feeds all cards, the SmartSSU offers much higher reliability. If a power supply fails on one card, it will affect only that card and not the entire SSU.

Connector options

The standard unit comes with BNC connectors. Siemens connectors are also available as an option for the 2048 k/bits and 2048 kHz inputs and all of the outputs.

Alarm interfaces

The SSU's alarm system is connected through the alarm interfaces to visual and audible alarm indicators either on the rack or elsewhere in the office where the SSU is installed.

Expansion subrack

For offices that require more than the 80 outputs, you can add up to four expansion subracks, each with 80 1:1 protected outputs. In its fully expanded configuration, the SSU offers a total of 400 1:1 protected outputs.

A modified management card, called the Communication Card, and modified input track and hold cards, called Synchronization Cards, essentially "extend" the backplane of the master subrack.

This design lowers the cost of expansion and simplifies network management architecture. The expansion subrack uses inputs from the master subrack. Output cards are identical to those in the master subrack, and full redundancy is maintained.

Remote communications interface

The SSU connects to the remote network management system through the remote communications interface, allowing the SmartSSU to be managed as a network element.

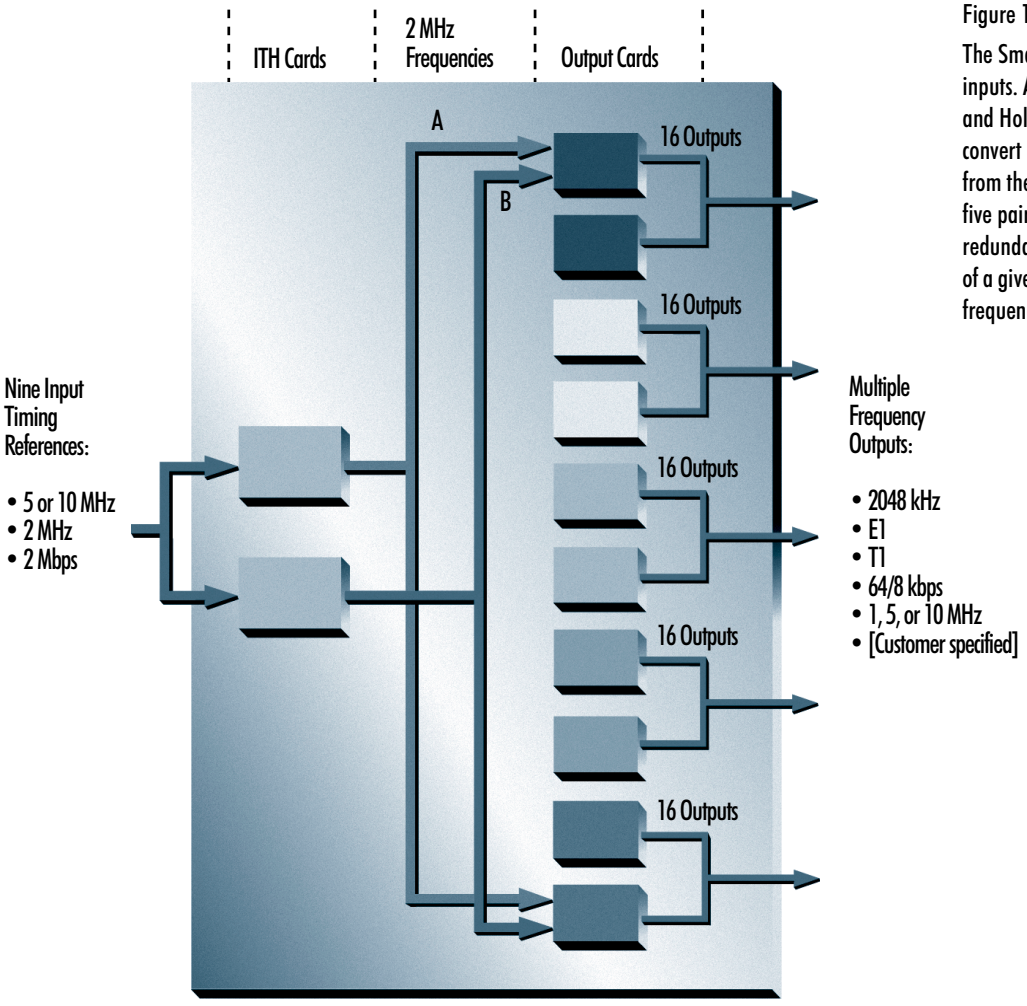


Figure 1. SSU Architecture

The SmartSSU has up to nine timing reference inputs. All inputs go to two, redundant Input Track and Hold (ITH) Cards which select an input and convert it to 2 MHz. Two redundant sources of 2MHz from the ITH cards are provided to each of the SSU's five pairs of 1:1 protected Output Cards. Two redundant output cards provide up to 16 outputs of a given frequency. Each pair can output a different frequency to the network.

Input Track and Hold Card

ITH Card designed for higher quality timing in real-life network conditions.

The Input Track and Hold (ITH) card:

- Monitors the quality of input timing
- Selects an input based on user-configurable criteria
- Decodes sync status messaging (SSM) codes, if any (see page 18)
- Filters the selected input
- Provides stable timing to the SSU's output cards
- Provides holdover in the event all input signals are unusable

The SmartSSU has a pair of ITH cards. Both cards receive all nine input signals and monitor the quality of input timing. One card is active; the other is in standby mode. The active card selects a good timing input, then filters the input and distributes a stable frequency to the output cards. The ITH Card also reports the status of all inputs to the Information Management Card.

The two ITH Cards operate in master/slave configuration and track each other in phase, allowing you to swap cards while the SSU is online. The cards' oscillators provide holdover in the event all input signals are unavailable.

The ITH Card is available with different oscillators or clocks, offering different stability levels during holdover as shown in the specifications on page 21. Your decision will depend on the level of system performance you require in the event that all input references fail.

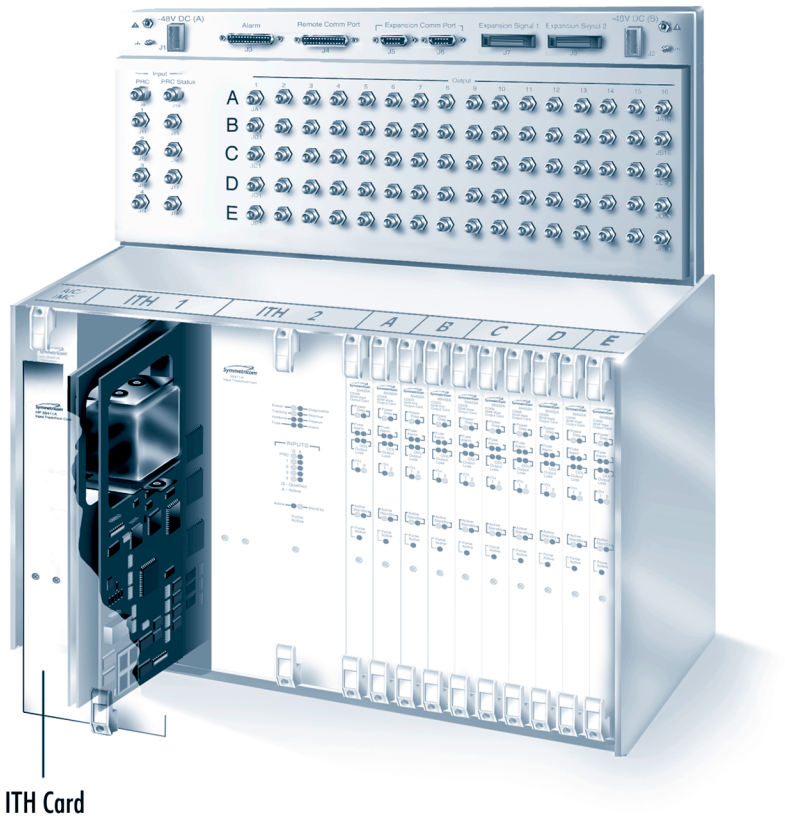
Alarm status is shown on the front of the card and is transferred from the ITH Cards to the Information Management Card.

Unique features and benefits

These unique features are designed into the ITH Cards to give you the most reliable timing available from any SSU:

Rearrangement of inputs with zero phase hits

Several times each day, events occur that require rearrangement of the input signal or switching from a bad input signal to a good one. The SmartSSU is steady as a rock, switching from one input to another with <1 ns phase hit on the output. This exceptional phase control of the output is accomplished by using a direct digital frequency synthesizer (DDFS-based architecture). (See "SmartClock," page 15.)



ITH Card

Card switchover with minimal phase hits

When you need to swap an input card, when an input card fails or when you force a card from stand-by to active mode, outputs will not change by more than 15 ns upon input card switchover.

Ride out or ignore errored seconds

On modern SDH networks, constant jitter causes severely errored seconds on the input signal. When errored seconds occur, most SSUs will immediately switch inputs, creating additional frequency instability throughout the network.

The SmartSSU is designed to look at the degree of jitter and duration of the errored second. The SmartSSU then "rides out" or ignores the jitter problem for up to 15 seconds (user-selectable) without switching to another input signal. Beyond 15 errored seconds, the SmartSSU automatically switches inputs.

Frequent, comprehensive monitoring

Symmetricom's high-precision measurement technology is built into the ITH Card to provide more accurate information than any other SSU. A high-speed "Instrument on a Chip" makes real-time MTIE, TDEV and frequency deviation measurements. These measurement results are compared to the programmable thresholds described below to determine the quality of timing inputs. The results are used to help select inputs. Results are also stored on the Information Management Card for use in post-event troubleshooting. (See "Instrument on a Chip," page 20.)

Programmable thresholds

The ITH Card comes from the factory with programmable MTIE and TDEV thresholds (test limits). Default thresholds are based on the ITU-T G.812 standard. Users can program thresholds to match their network requirements.

SmartClock holdover

In the rare event all timing signals from higher-level timing sources are lost or unusable, the ITH Card operates in holdover mode to avoid frame slips or loss of data. While in this mode, the ITH Card continues to deliver accurate, stable timing signals to the output cards. SmartClock technology adds intelligence to the oscillator to significantly improve its performance during holdover. (See "SmartClock," page 15.)

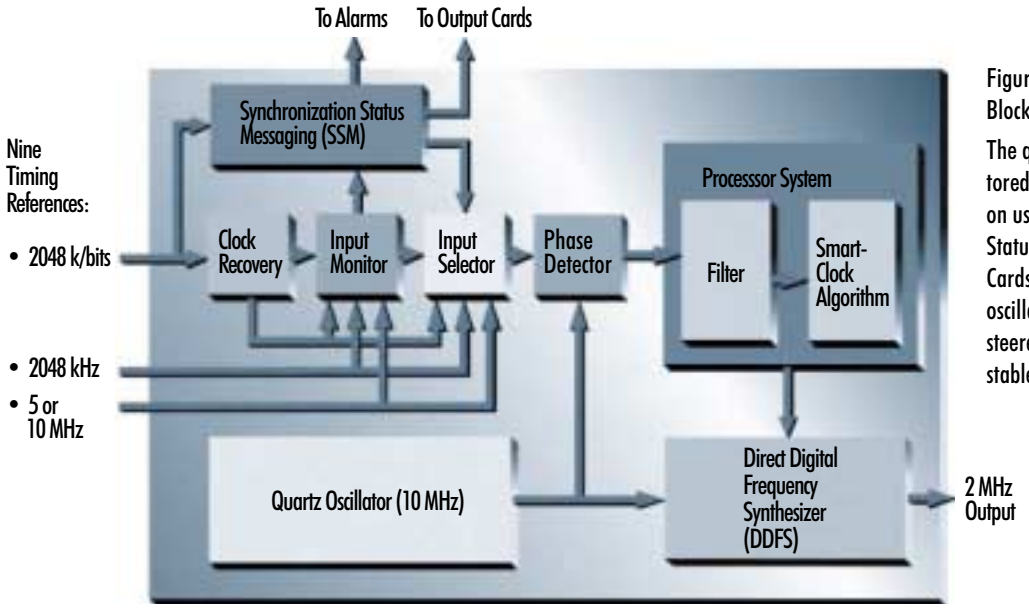


Figure 2. Input Track and Hold Card Simplified Block Diagram

The quality of up to nine timing references is monitored in the ITH Card, which selects an input based on user-configurable criteria. Any Synchronization Status Messaging is decoded and sent to the Output Cards. The input is monitored and compared to the oscillator frequency and filtered. A synthesizer steered by the SmartClock algorithms then provides stable timing to the SmartSSU's Output Cards.

Output Card

Output Card provides hitless, unperturbed timing.

The SmartSSU's Output Cards:

- Receive a stable frequency from the ITH Card
- Reinstate SSM codes, if any
- Provide unperturbed timing to the output connectors

Redundant pairs of Output Cards (up to five pairs) provide up to 16 1:1 protected outputs per pair. If the active card in the pair fails, its standby card immediately takes over with <15ns phase hit on the output (or if a single output signal on the active card fails).

The Output Cards can provide any combination of outputs:

- 2048 kHz
- E1
- T1
- 64/8 k/bits
- Programmable 1, 5 or 10 MHz

Alarm status is shown on the front of the card and transferred from the Output Cards to the management card.

Important features and benefits

Important features of the Output Card that ensure hitless, stable outputs for the network are:

Sophisticated alarm monitoring

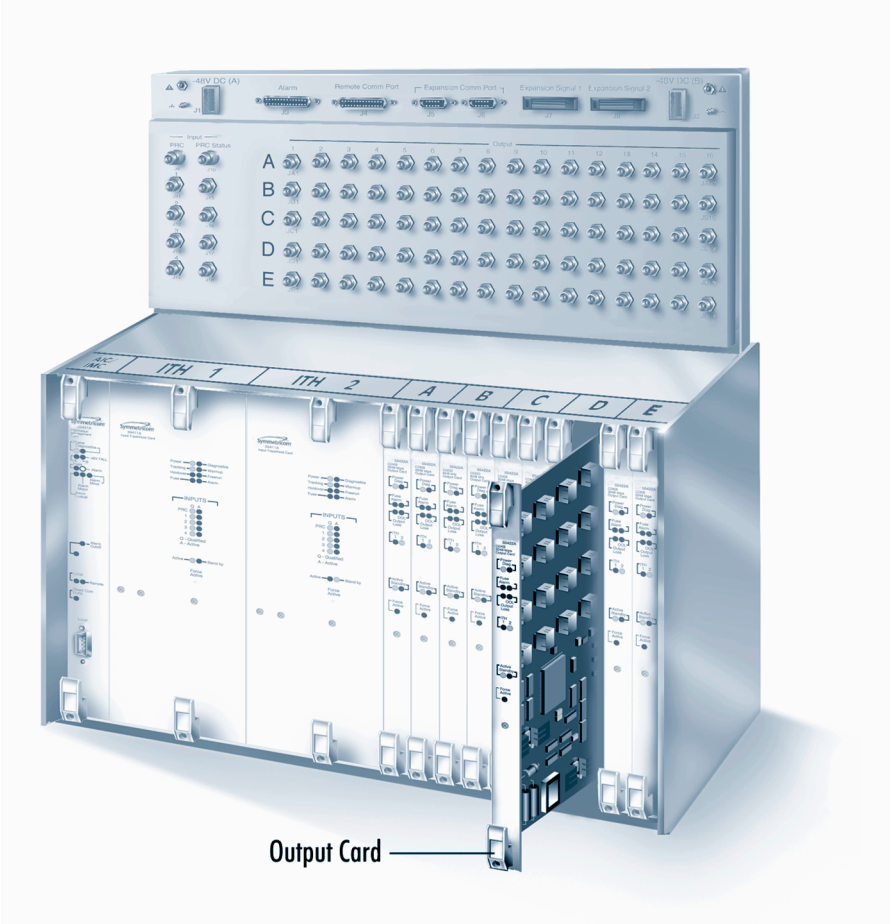
Alarms are set in the output cards to notify you when an output signal is lost, output signal levels do not meet specifications or an Output Card fails. All alarm information is transferred to the Information Management or Alarm Interface Card for comprehensive local or remote monitoring.

Squelching of outputs

If the ITH Card is in holdover so long that the oscillator does not meet specifications or the output voltage levels fall out of specification, the output card squelches or turns off the outputs, ensuring that substandard outputs will never be sent to the network.

Remote management of outputs

Each individual output can be disabled or enabled remotely, giving you an important tool to manage the path — or synchronization trail — over which timing is distributed in your network.



Supports synchronization status messaging (SSM)

The SmartSSU's E1 input and output cards support SSM, which is a digital code embedded in the signal to indicate the quality of the synchronization trail (path of timing through the network). When the digital timing inputs carry embedded SSM codes, the SmartSSU's ITH Card will decode the message. The ITH Card can be configured to use SSM as the criteria to select the best input as a reference.

The E1 output signal then carries this SSM code to reflect the quality of the synchronization trail. (See "SSM," page 18.)

Up to 80 redundant outputs per SSU

The SmartSSU provides a higher number of outputs, enabling you to provide timing for up to 80 network elements and distribution links from a single unit. The output cards use surface mount technology to get more outputs on each card. Outputs are 1:1 protected, providing a high level of redundancy. Expansion racks can be added for up to 400 1:1 protected outputs.

Traffic Re-Sync Card retimes traffic-bearing signals.

A traffic re-sync card retimes a signal that is carrying traffic as well as timing, thereby eliminating jitter and wander. The need to re-time a signal often occurs in local offices with older, PDH network elements that cannot use external clock timing.

The Traffic Re-Sync Card is plugged into one of the ten Output Card slots. Incoming signals are retimed to the stability of the SmartSSU. Up to four signals can be retimed per re-sync card.

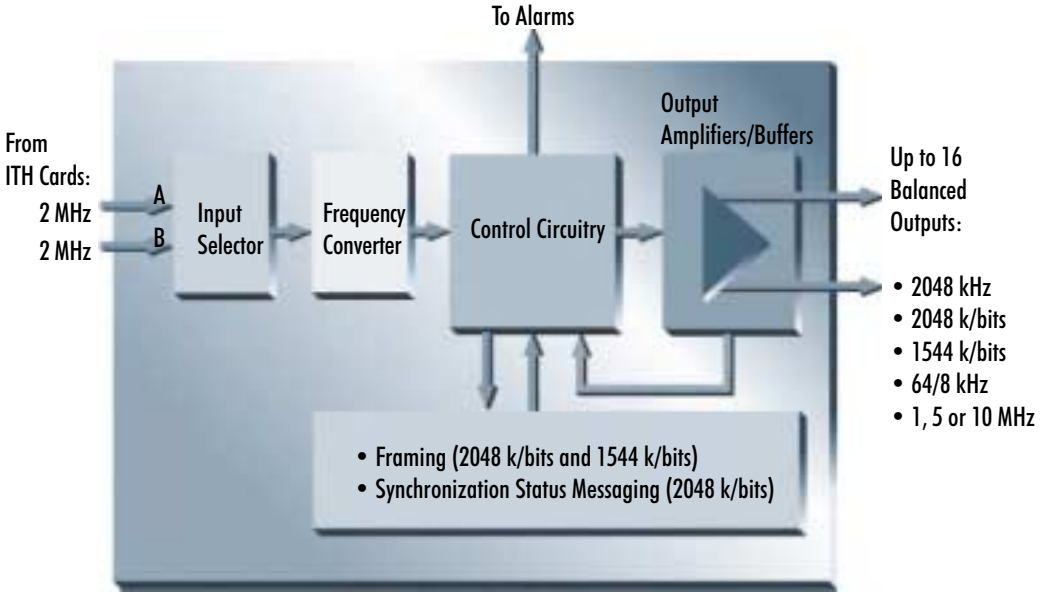


Figure 3. Output Card Simplified Block Diagram

The two redundant ITH Cards each provide 2 MHz to each Output Card which selects a signal and converts it to the desired format and frequency. When needed, signals are framed and Synchronization Status Messaging is reencoded. Up to sixteen balanced outputs of the same frequency are then provided to the network from each of five different types of cards.

Network Information Management Card

Powerful card makes SmartSSU a managed network element.

The gateway to the SmartSSU, the Network Information Management (NIM) Card collects status information from the input and output cards and interfaces with the synchronization network management system. Working with the sync management system, the card performs these tasks:

- Configures the hardware
- Sets input selection priority
- Sets alarm thresholds
- Processes and issues alarms
- Stores events
- Provides datacom network connectivity
- Outputs reports
- Manages system faults
- Provides SSU administration for security and inventory of assets

The NIM Card collects and processes alarm signals from all other cards in the master and expansion subracks to determine whether the alarm state is minor, major or critical. Alarms can be reported on the card's LED indicators, in the central office through externally wired lights or horns, and to the synchronization network management system or a local PC.

Unprecedented management capability

The powerful NIM Card stores and reports meaningful information easily. Large amounts of data — including memory of up to 1,000 events — give you unprecedented capability for local and remote management.

When connected to the synchronization network management software, the NIM Card provides visibility and control over the SmartSSU from your network management center. When connected to a local PC, the card gives your technicians access to all of its data to help them install or perform maintenance on the SSU. In local offices, the card also connects with local alarms to report SSU status.

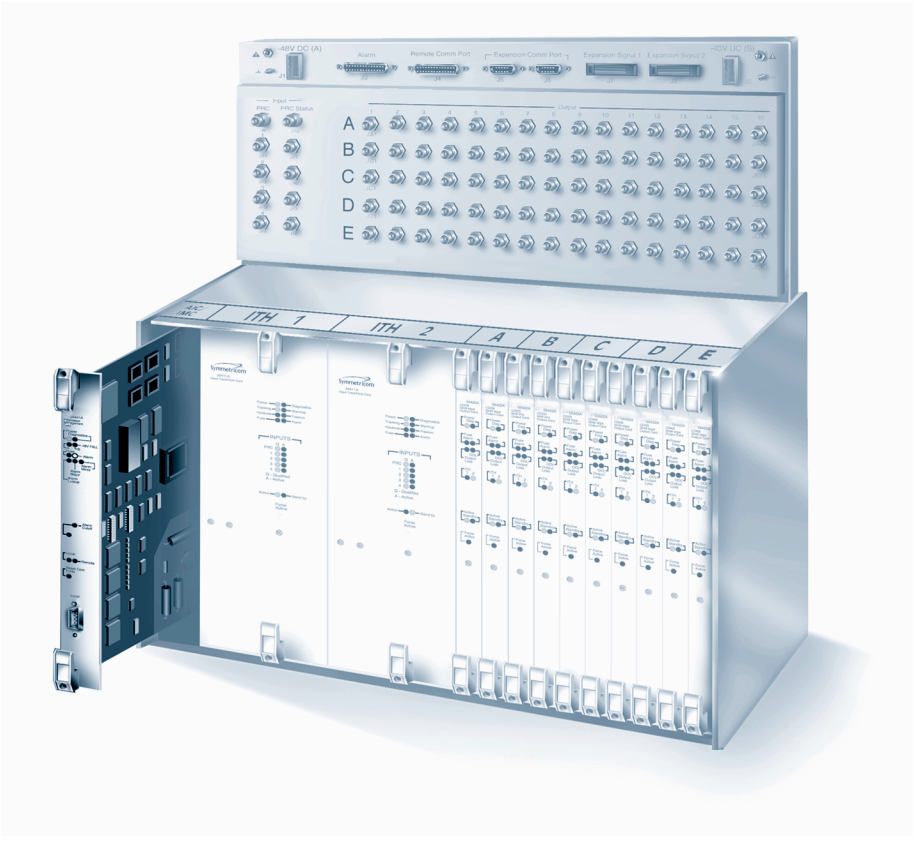
Maintenance costs are reduced and quality of service improved when you combine network synchronization management with the NIM Card's capabilities to quickly identify the precise nature and location of a problem.

Unique features and benefits

The SmartSSU's NIM Card has capabilities not found in other SSUs:

Full, remote management capabilities

In addition to providing local alarm and status information, the management card is ready for full synchronization network management. No new firmware, cards or SSUs are required. This card transfers real-time, remote SSU alarm and performance



information to your sync network management system. Important parameters like MTIE and TDEV are automatically computed to measure timing quality. (See "Open System Management Framework," page 16.)

Network connectivity

Built-in LAN, TP4 or X.25 connectivity makes it easy for you to integrate the SmartSSU with your existing data communications network.

Largest set of TL-1 commands

The SmartSSU has the largest set of TL-1 commands available to help you obtain complete information on network timing status. With nearly 60 commands you can easily access the SSU's vast memory as well as its measurement, configuration and alarm capabilities.

Downloadable firmware with memory protection

When you download firmware upgrades while the SSU is operating, a memory protection feature ensures that a working copy of the firmware is always available. After the NIM Card verifies that the newly downloaded firmware is operating correctly, the old firmware is erased from the card.

Stores up to 1,000 events

The SmartSSU has a vast memory of 1,000 events stored on the management card. When synchronization-related service problems are reported, you can research events so that problems can be quickly identified and repaired.

Highly programmable

Users can program alarms, specific time constants for filtering of each input, and threshold levels for MTIE and TDEV.

Cesium-status indicator

A cesium-status indicator on the master subrack provides one more way for the NIM Card to identify whether the cesium signal is good or bad.

Three levels of security

To maintain integrity, three levels of security are built into the SmartSSU. Your system administrator can assign appropriate access to maintenance technicians and system engineers.

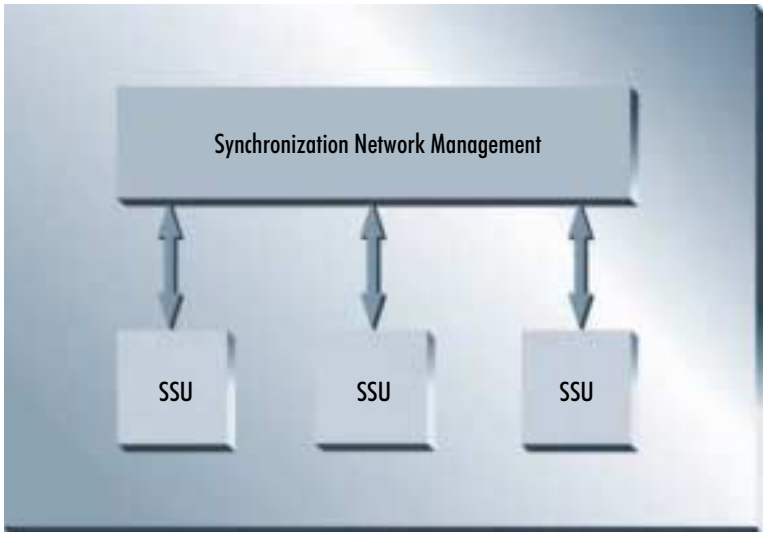


Figure 4. The NIM Card is ready to transmit real-time SSU alarm and performance information to the remote synchronization network management system (see Open System Management Framework, page 16).

Support

SmartSSU is backed up by Symmetricom warranty, training and support.

Symmetricom understands the importance of system availability and the impact of poor quality of service on your business. To help you maximize uptime and maintain service quality, we offer a comprehensive warranty, training, service and support.

Our highly qualified engineers will perform an audit to assess the current status of your network timing and help you develop a sync network plan that will take you into the SDH future. We can help you troubleshoot and maintain your network of SSUs 24 hours a day, seven days a week.

Contact Symmetricom for additional information on synchronization audit and planning services, extended warranties, training and service contracts.

SmartClock Improves Oscillator Performance

SmartClock technology improves the performance and accuracy of low-cost oscillators, enabling Symmetricom to offer highly-accurate timing units at a cost that allows deployment throughout a telecom network. To achieve this improved performance, SmartClock adds intelligence in the form of firmware algorithms to oscillators that are referenced to GPS or other time-reference signals.

Steered mode

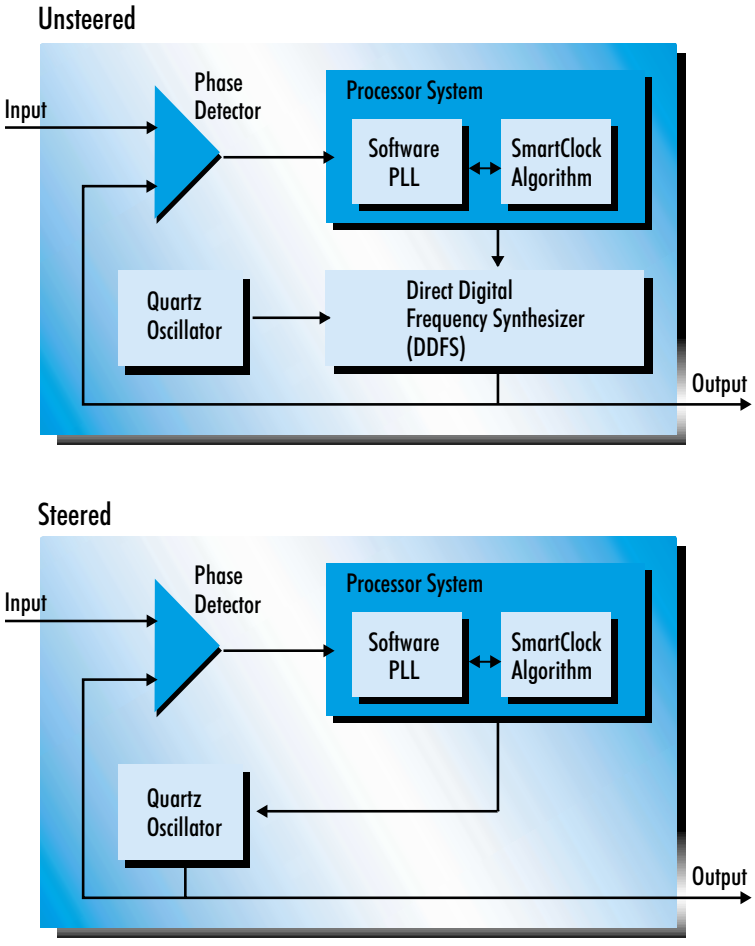
In its steered implementation, SmartClock technology compares the frequency of an oscillator to the reference signal. SmartClock then uses this information to adjust the oscillator frequency to match the reference signal.

SmartClock also learns the effects of aging and temperature on the oscillator when it is locked to the reference signal. If the incoming reference signal is lost, SmartClock uses its memory to intelligently steer or adjust the oscillator as needed so that it continues to distribute highly stable synchronization outputs. When the reference signal is restored, the unit automatically relocks.

Unsteered mode

In the unsteered version of SmartClock that is used in the SmartSSU, performance is improved by adjusting the output frequency of a Direct Digital Frequency Synthesizer (DDFS) that uses the quartz oscillator as its timebase. SmartClock continuously compares the frequency of the selected input signal to that of the oscillator. When SmartClock knows the measured difference, it uses this information to program the DDFS to generate the desired output frequency. By programming the DDFS instead of changing the oscillator, we allow the quartz oscillator to age naturally and predictably.

During holdover, SmartClock uses its memory to adjust the DDFS as needed. The result is a highly stable signal during holdover.



Advantages of DDFS

When SmartClock is used to program the DDFS, it can correct the frequency of the output in very small increments on the order of 10^{-14}, thereby minimizing jitter on the signal.

Additionally, DDFS offers the advantage of a wider tuning range than is available in voltage-controlled oscillators. Occasionally, an incoming frequency is far away from the oscillator frequency, making it out of tune. When DDFS is used to receive the out-of-tune signal, its wide tuning range enables DDFS to pull in and lock to the incoming signal.

OSMF Provides TMN Compliance and Single View of Sync Network

To offer high quality telecom services and at the same time generate high revenues, service providers need to manage their networks very efficiently. By providing a view and control of the entire synchronization network, the Open System Management Framework is an important tool to provide the superior functionality, support, and fast problem resolution being demanded by end users today.

OSMF is an open network management product running on HP-UX and based on the defacto telecommunication industry standard platforms of HP OpenView DM and Oracle. OSMF manages the SmartSSUs that are at remote locations in the synchronization network using TCP/IP, X.25 or TP4 connections.

OSMF is designed specifically to facilitate the management of fault, performance, configuration and security in compliance with the ITU-T Telecommunications Management Network* (TMN) standards. OSMF is used to monitor the topology of the sync network and manage the configuration of the individual SSUs in the network. OSMF receives and displays alarms and other events. It collects and graphically displays important network performance data to help in trend analysis.

Key capabilities and features of OSMF are:

- Easy-to-use graphical user interface (GUI) for executing the complex tasks of configuration, monitoring and setting thresholds.
- Graphical representation of synchronization network topology shows synchronization trails and uses color coding to indicate alarms and status of SSUs.
- Security functions control and protect access to SSUs and define management domains for the network management center operators.
- Correlation services that ensure operators work on root-cause alarms rather than wasting time on related alarms.
- Q Adapter functionality for communication with higher level management systems.

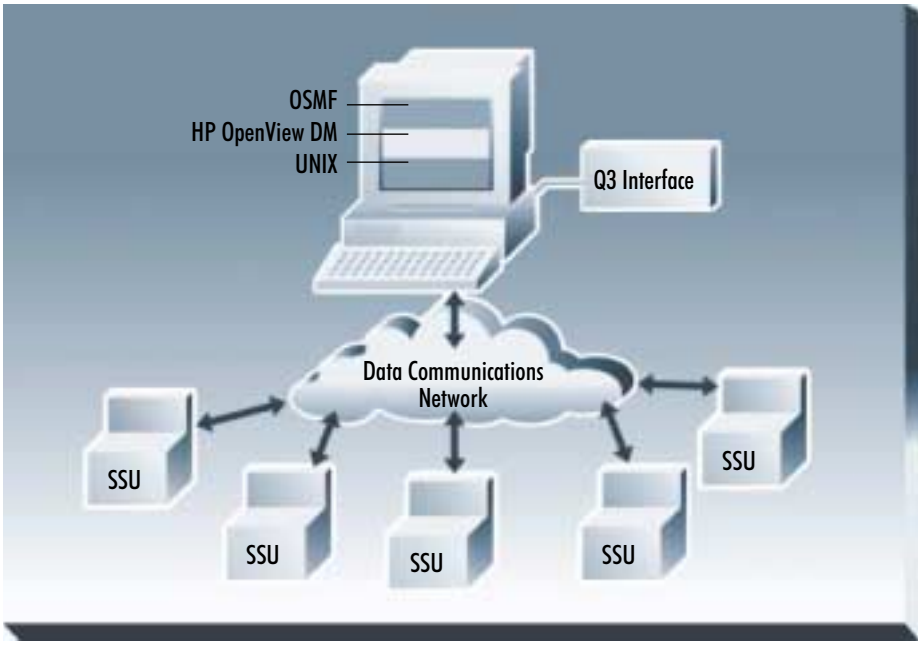
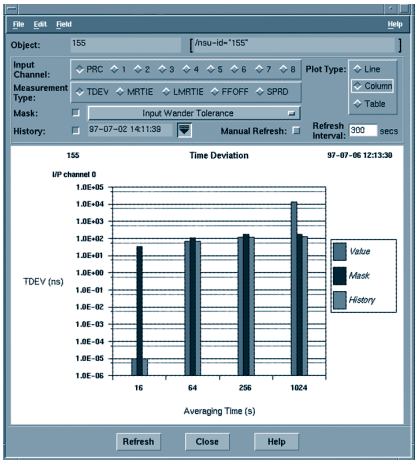
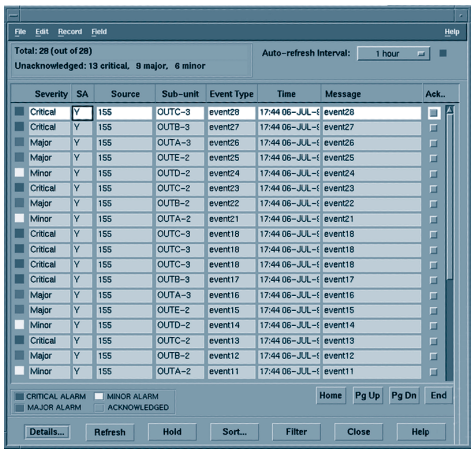


Figure 5. OSMF makes your entire sync network visible and manageable from a single, remote location through your data communications network (DCN). OSMF runs on HP OpenView DM and HP-UX.

OSMF is also available for local office applications and for small networks using NT. To commission SSUs and perform local troubleshooting, service providers install 55450A LocalCraft Terminal on a lap-top running Windows.® To manage small networks, service providers install the OSMF on a PC or workstation running NT, then add modem and multiplexer options to view SSUs remotely.

*TMN defines activities that aid in managing a telecommunications network, including links between the network management system and service and business management systems. According to ITU-T, TMN is intended to support a wide variety of management areas, including planning, installation, operations, administration, maintenance and provisioning of telecommunications networks and services. (See TMN hierarchy illustration.)





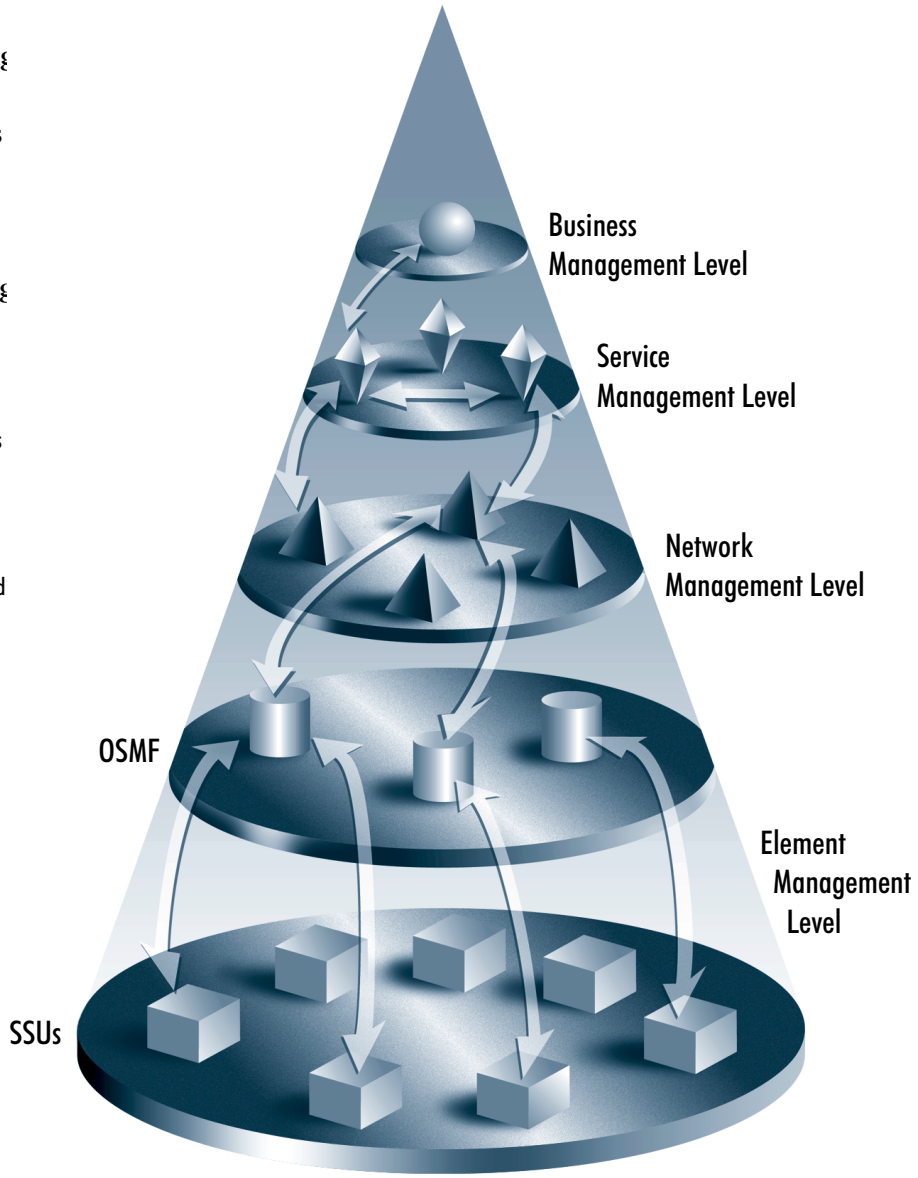


Figure 6. In TMN heirarchy, OSMF resides between the network management and element management levels

Synchronization Status Messaging (SSM)

Identifies Quality and Source of Network Timing

Synchronization Status Messaging (SSM) was developed to help network managers maintain high-quality synchronization needed on SDH networks. The purpose of SSM is to help network elements (NE) avoid timing loops and to help SSUs select the best available clock.

SSM is implemented when the quality level of the original clock source (stratum 1, 2, 3, etc.) is inserted as a digital "synchronization status message" into the SDH signal overhead (see Table 1).

To protect against timing loops, the NE encodes an automatic "do not use" (DNU) SSM code on the signal when it is returned to the NE from which it came (see Figure 7).

To select the best available clock, SSUs use SSM to decide which timing reference to select or whether the holdover of the SSU clock is better than any of the incoming signals.

Table 1. SSM Timing Quality Levels

Quality Level	Acronym	Priority
Primary Reference Clock	PRC	Highest
SSU Transit Node	SSU T	
SSU Local Node	SSU L	to
SDH Equipment Clock	SEC	
Do Not Use	DNU	Lowest

SSM Technology assigns one of these quality messages to each signal, telling the NE or SSU where the signal originated and whether to use it for timing.

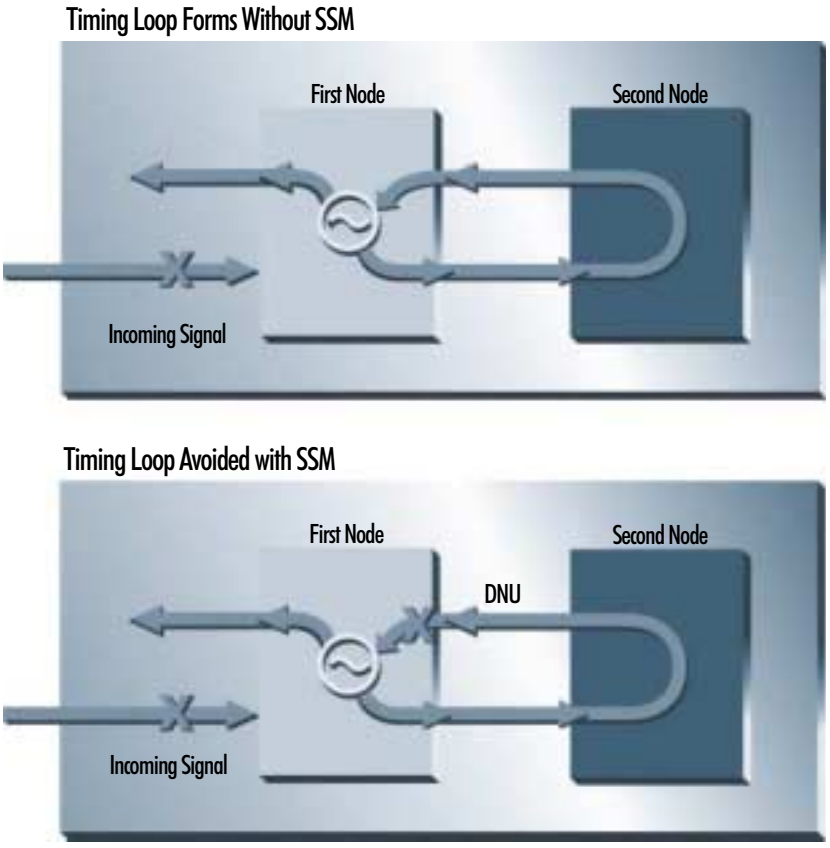


Figure 7. Simple Timing Loop

To avoid a simple timing loop, SSM technology always assigns a "do not use" (DNU) message when a signal is returned to the network element from which it came.

When the NE passes a 2048 kbit/s signal to the SSU, SSM is passed directly on the signal to the SSU. The SSU then passes the SSM that corresponds to the best quality source along to the next NE in the chain.

When the NE passes a 2048 kHz signal to the SSU, SSM is passed to the SSU indirectly. The incoming SSM is diverted from the NE to the network management system, then passed along to the SSU through the synchronization network management system (see Figure 8). The SSU then returns the SSM that corresponds to the best quality source back to the network management system where it is passed along to the next NE in the chain.

SSM is also a valuable tool for troubleshooting. As a signal travels through the network, its SSM indicates if timing is degraded or in holdover, helping technicians identify errors or holdover that have occurred upstream.

SSM capability is included in the basic design of the SmartSSU. This means that wherever a SmartSSU is located in your network, you take advantage of this important technology to ensure high quality timing.

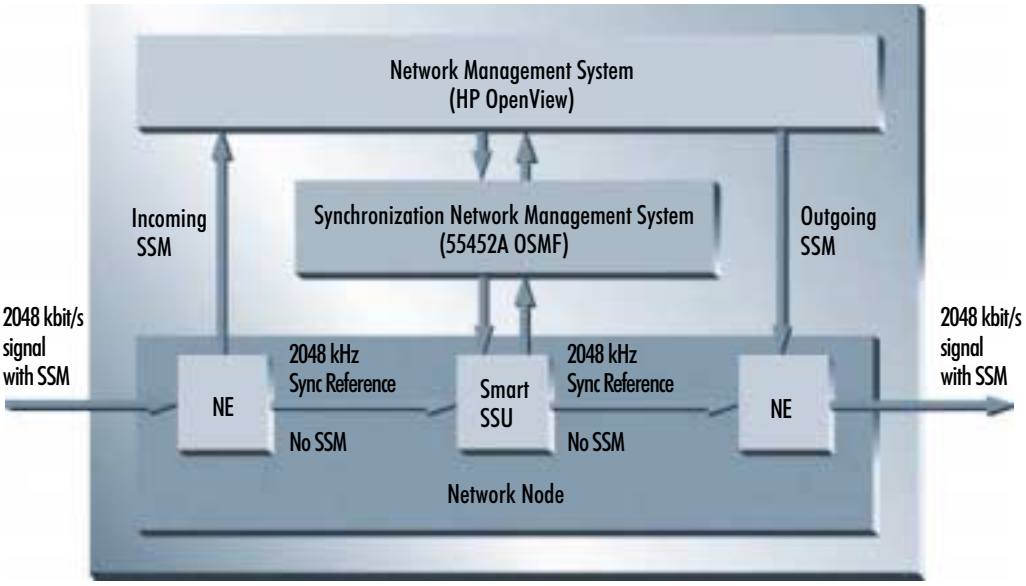


Figure 8. Network Management System's Role in SSM

The incoming SSM is diverted to the network management system, then passed to the SSU. After the SSU has selected the best quality timing source, it returns that source's SSM to the network management system where it is distributed downstream to the network.

"Instrument on a Chip" Analyzes Jitter and Wander

Using Symmetricom's High-Precision Measurement Technology

In the SmartSSU, engineers have enhanced the technologies that revolutionized phase measurement and placed them on a chip. The result is a powerful tool that monitors the performance of SSU reference inputs in real time and ensures compliance with standards.

Breakthrough modulation domain analyzer (time interval analyzer) technology is modified in the instrument-on-a-chip to measure jitter and wander in real time and with sliding observation windows. The high resolution chip continuously monitors inputs, taking a phase measurement 204 times/second on each input signal. Using this phase data, it calculates MTIE, TDEV and frequency deviation.

Measurements are plotted against programmable masks for immediate review of results using OSMF or LocalCraft Terminal synchronization management software (see Figure 9).

When the frequency reaches the programmable threshold level (see Figure 10), an alarm is generated. Many network managers set the alarm thresholds low, giving themselves early warning of a problem before the SSU fails to meet specifications and quality of service is impacted.

Default thresholds are set to the ITU-T G.812 standard.

The capability of the chip to make measurements in real time is particularly important for selecting inputs. Those inputs that don't meet criteria set by the user can be immediately rejected.

Measurement results are also stored on the SmartSSU's Network Information Management Card. OSMF synchronization management software uses the SSU's performance history to analyze signal trends and quickly identify the source and degree of a problem so that it can be promptly fixed.

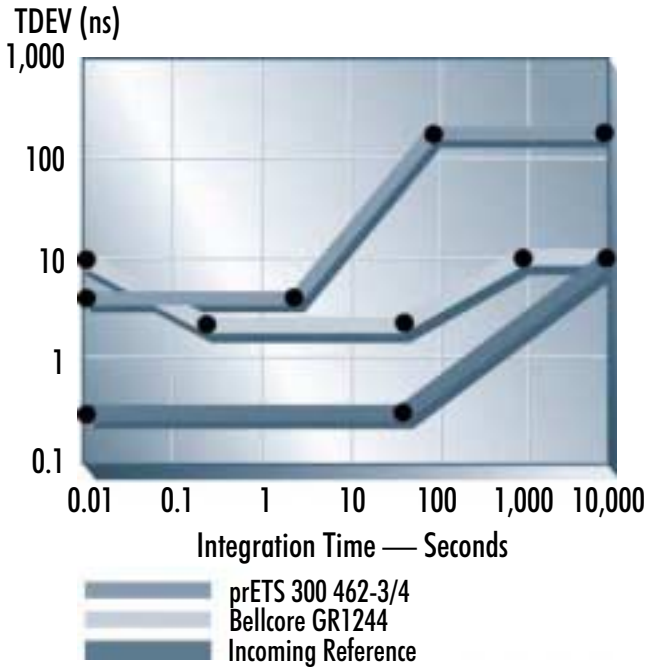


Figure 9. TDEV Measurement

Measurements made by the SmartSSU's "Instrument-on-a-chip" are plotted against a programmable TDEV mask for immediate review of results using OSMF or LCT management software.

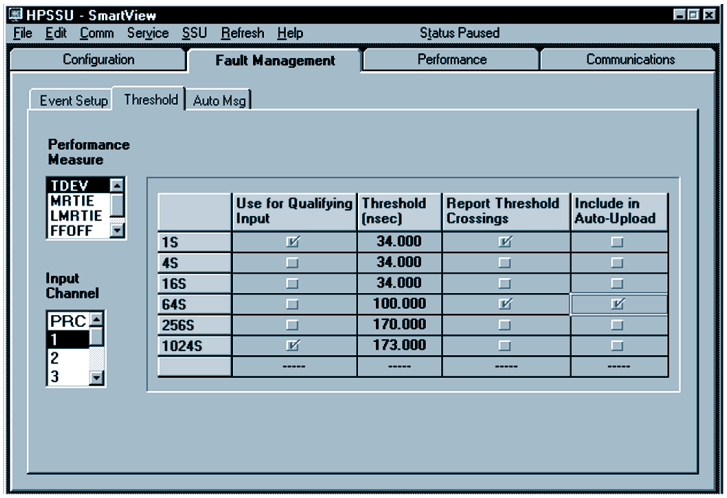


Figure 10. Fault Management Window

Threshold levels and alarm criteria are set by the user from this Fault Management window either locally using LCT or remotely using OSMF.

Key Standards and Specifications

The SmartSSU meets all industry standards including ITU G.812; prETS300 462-3/4 and exceeds ANSI requirements for stratum-2 and ITU transit node and local node holdover stabilities.

SmartSSU—55400A Network Synchronization Unit

Inputs/outputs per subrack	Up to nine reference inputs, 1:1 protected. Up to 80 outputs, 1:1 protected
Expansion rack capability	Four additional subracks, up to 80 1:1 protected outputs each
Reference inputs	One 5 or 10 MHz PRC, 50 Ω; One PRC status, TTL input; Up to eight, any combination of: — 2048 kHz per ITU-T G.703, table 10, 120 or 75 Ω — 2048 kbit/s HDB3, CCS or CAS, with or without CRC4, 120 or 75 Ω
Jitter/wander input tolerance	Complies with ITU-T G.823
Internal reference	Quartz crystal oscillator or rubidium
Holdover stability	At 25°C after 10 days of continuous operation Enhanced Stratum 2 (rubidium): $\pm 2.0 \times 10^{-11}$ /day Enhanced Transit Node (quartz): $\pm 1.0 \times 10^{-10}$ /day for three days Transit Node (quartz): $\pm 5.0 \times 10^{-10}$ /day Stratum 3E and Local Node (quartz): $\pm 1 \times 10^{-8}$ /day
Outputs (16 per card)	— E1 2048 kbit/s (programmable framing) per ITU-T G.703, table 6, 120 and 75 Ω — 2048 kHz per ITU-T G.703, table 10, 120 and 75 Ω — 64/8 kbit/s composite clock per ITU-T Recommendation G.703 section 1, 120 Ω
Outputs (8 per card)	— T1 1544 kbit/s (fixed framing) per ITU-T G.703, table 4, 100 Ω — 1, 5, 10 MHz, 50 Ω — Traffic re-sync, (4 outputs retimed, 4 outputs passthrough)
Output phase variation	Reference switchover: <1 ns ITH card switchover: <15 ns Output card switchover: <15 ns ITH card failure: <15 ns
Alarm interface	Relay closure: Open and closed contacts Severity: Critical, major and minor Usage: With and without alarm cutoff
Management ports	Language: TL-1 Local: RS-232D, DCE Remote: — LAN: TCP/IP: 10Base-T (physical), IEEE 802.3 and Ethernet (link layer), TCP/IP (layers 3 and 4), RJ-45 connector — X.25: V.24 DTE (physical), CCITT Rec. X.25, LAPB DTE (frame layer), CCITT Rec. X.25, PLP (packet layer) — TP4
System supply voltage	Dual redundant inputs, –36 Vdc to –57 Vdc
Power requirements (Fully loaded)	Cold start: 3.0 A After warm-up: 7.0 A (maximum)
Operating temperature	–5 to 45°C
Weight and mounting	18 kilograms fully loaded. Mounting meets ETSI and EIA specifications.

Input Specifications — Reference

The 55400A has up to nine user-configurable input references. One of the nine can be used for either a 5- or 10-MHz input, while the other eight can be any combination of 2048 kHz or 2048 kbit/s inputs.

Description	Specification
5 or 10 MHz PRC	
Number of Inputs	1
Input Signal Type	Sine Wave or Square Wave
Input Signal Parameters Monitored	MRTIE and TDEV, FFOFF1, and SPREAD2
Input Impedance	50Ω
Reference Input Frequency	5 or 10 MHz
Input Protection	1:1
Input Sensitivity	0.5 V peak-to-peak
Damage Level	5.0 V rms
PRC Status	
Number of Inputs	1
Input Signal Type	TTL input
2048 kHz Input	
Number of Inputs	Up to 8 total 2048 kHz or 2048 kbit/s
Input Signal Type	2048 kHz per ITU-T G.703, Table 10
Input Signal Parameters Monitored	MRTIE, TDEV, FFOFF1, and SPREAD2
Input Impedance	75Ω unbalanced, 120Ω balanced (option)*
Input Signal Level	
75Ω	Per ITU-T G.703, Table 10
120Ω	Per ITU-T G.703, Table 10
Input Signal Jitter and Wander Tolerance	Complies with ITU-T G.823
Input Protection	1:1
Disqualification Threshold	–24 dB (typical)
Damage Level	2.5 V peak
2048 kbit/s Input	
Number of Inputs	Up to 8 total 2048 kbit/s or 2048 kHz
Input Signal Type	Framed 2048 kbit/s HDB3
Framing Protocols	CCS or CAS, with or without CRC4
Input Signal Parameters Monitored	MRTIE, TDEV, FFOFF1, SPREAD2, LOS, AIS, and OOF
Input Impedance	75Ω balanced, 120Ω unbalanced (option)*
Input Signal Level	
75Ω	Per ITU-T G.703, Table 6
120Ω	Per ITU-T G.703, Table 6
Input Signal Jitter and Wander Tolerance	Complies with ITU-T G.823
Input Protection	1:1
Disqualification Threshold	–32 dB of cable loss (typical)
Damage Level	3.5 V peak

[1] FFOFF = Fractional Frequency Offset

[2] SPREAD = Frequency Spread between channels

*Inline Balun transformer must be ordered (part numbers: 1250-2739 for Siemens connectors or 1250-2735 for BNC connectors).

Input Performance Monitoring

The reference inputs described on the previous page are each monitored continuously at a rate of 204 samples per second. MTIE has observation periods of 1 second, 1 minute, 15 and 30 minutes, and 1, 2, 8, and 24 hours. The results are updated every 15 minutes. TDEV has integration times of 1, 4, 16, 64, 256, and 1024 seconds. The results are updated every 2 to 50 minutes.

Specifications for Wander Generation 55412B, 55413B Cards

Figure 11.

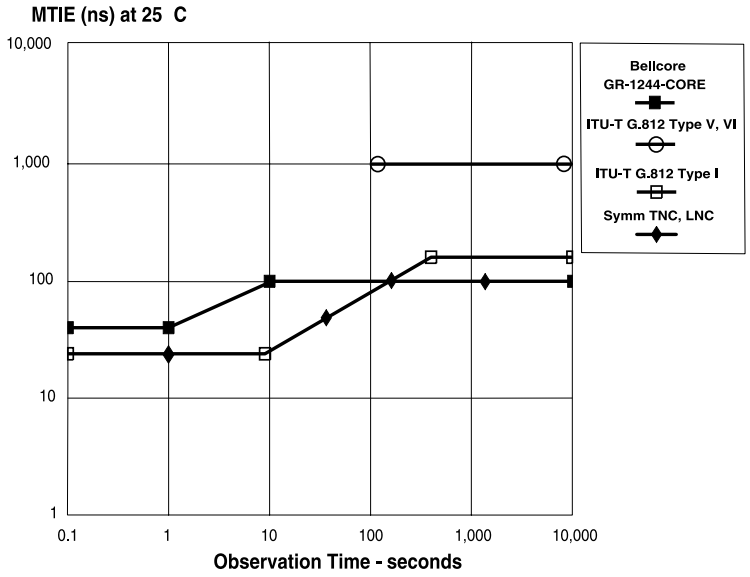
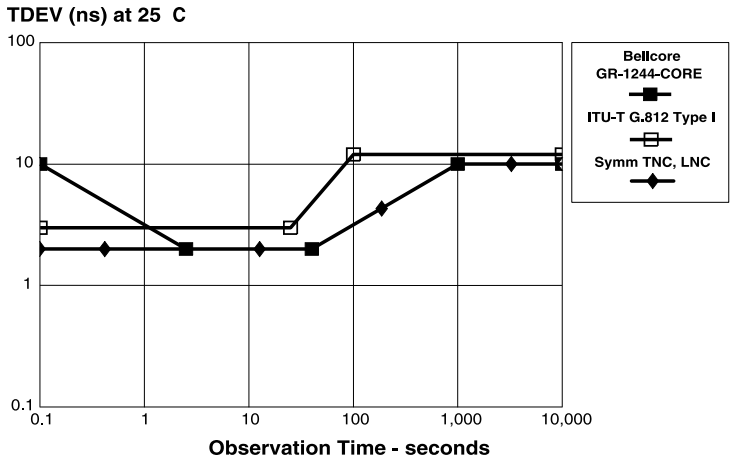


Figure 12.



Specifications for Wander Generation 55414B, 55415B Cards

Figure 13.

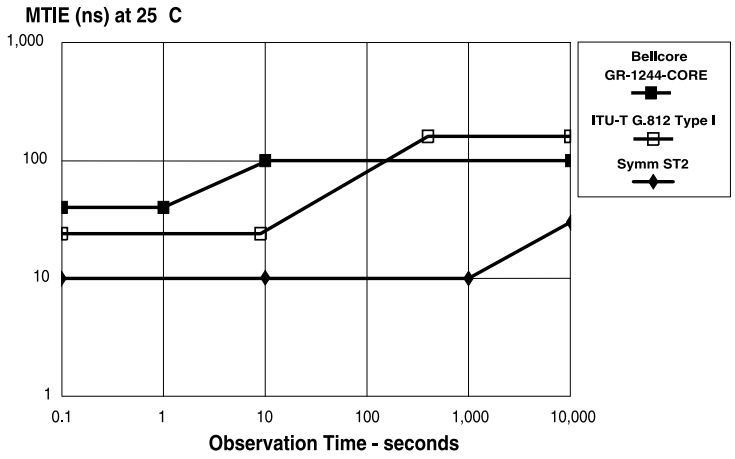
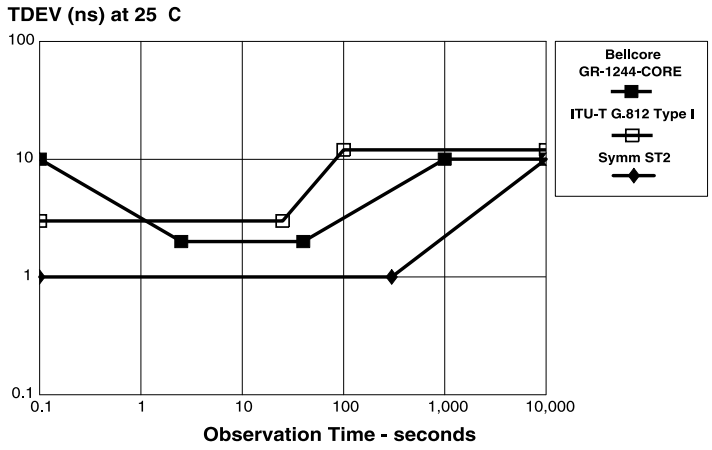


Figure 14.



Input Track and Hold Cards

The 55400A NSU offers four different Input Track and Hold Cards. All are identical in functionality and differ only by their performance as indicated in the specifications shown below. These cards are used in the master subrack in hot-exchangeable redundant pairs. All the Input Track and Hold Cards perform the following functions: Input, Input Protection, Monitoring, Input Selection and Rearrangement, Filtering, Tracking, Holdover, and Switchover.

55412B Transit Node Input Track and Hold Card

Description	Specification
Oscillator	Quartz
Clock Holdover Stability (@25°C) Compliant to ITU-T G.812/Transit Node	$\pm 5.0 \times 10^{-10}$/day
Pull-in Range (programmable)	$\pm 4.6 \times 10^{-6}$ (default)
Warmup Time	30 minutes
Non-volatile Memory Battery Backup	10-year minimum lifetime

Individual System Card Specifications

55413B Local Node Input Track and Hold Card

DESCRIPTION	SPECIFICATION
Oscillator	Quartz
Clock Holdover Stability (@25°C) Compliant to ITU-T G.812/Local Node	$\pm 1.0 \times 10^{-8}$/day
Pull-in Range (programmable)	$\pm 4.6 \times 10^{-6}$ (default)
Warmup Time	30 minutes
Non-volatile Memory Battery Backup	10-year minimum lifetime

55414B Enhanced Stratum 2 Input Track and Hold Card Rubidium

DESCRIPTION	SPECIFICATION
Oscillator	Rubidium with SmartClock Technology
Accuracy	$\pm 5 \times 10^{-10}$
Clock Holdover Stability (@25°C)	$\pm 2 \times 10^{-11}$/day
Pull-in Range (programmable)	$\pm 1.6 \times 10^{-8}$ (default)
Warmup Time	30 minutes
Non-volatile Memory Battery Backup	10-year minimum lifetime

55415B Enhanced Transit Node Input Track and Hold Card

DESCRIPTION	SPECIFICATION
Oscillator	Quartz with SmartClock Technology
Clock Holdover Stability (@25°C)	$\pm 1.0 \times 10^{-10}$/day for three days
Compliant to:	ETSI prETS 300 462-4 ITU-T G.812Level-II ANSI stratum-2
Pull-in Range (programmable)	$\pm 4.6 \times 10^{-6}$ (default)
Warmup Time	≤2 hours
Non-volatile Memory Battery Backup	10-year minimum lifetime

Output Card — Specifications

The 55400A has six standard output cards available. The 55471A card is different from the others because it alone accepts input signals as well as provides outputs. Of its eight channels, four will retime the input signals and four will only buffer the input signals. The specifications are shown below.

55481B Clock Distribution Output Card 2048 kbit/s

Description	Specification
Output Type	2048 kbit/s per ITU-T G.703 Table 6
Waveform	75Ω, 120Ω, per ITU-T G.703 Table 6
Wave Shape	Rectangular wave, per ITU-T G.703 Figure 15
Impedance	75Ω unbalanced, 120Ω balanced
Drive Capability	0 to 200 meters of cable (0.8 mm) or RG-59
Framing	CCS or CAS, with or without CRC4
Squelched Outputs	Yes
Number of Outputs	16
Programmable Traffic Pattern	Traffic value with no more than 1 zero
Phase Variation due to Output Card Failure	≤ 1μs

55482A Clock Distribution Output Card 2048 kHz

Description	Specification
Output Type	2048 kHz per ITU-T G.703 Table 10
Waveform	75Ω, 120Ω, per ITU-T G.703 Table 10
Wave Shape	Square wave, per ITU-T G.703 Figure 21
Impedance	75Ω unbalanced, 120Ω balanced
Drive Capability	0 to 200 meters of cable (0.8 mm) or RG-59
Squelched Outputs	Yes
Number of Outputs	16
Phase Variation due to Output Card Failure	≤ 1μs

55488A Clock Distribution Card 2048 kHz and 2048 kbit/s

Description	Specification
Outputs 1 to 8	*2048 kHz*
Output Type	2048 kHz per ITU-T G.703 Table 10
Waveform	75Ω, 120Ω, per ITU-T G.703 Table 10
Wave Shape	Square wave, per ITU-T G.703 Figure 21
Outputs 9 to 16	*2048 kbit/s*
Output Type	2048 kbit/s framed per ITU-T G.703 Table 6
Waveform	75Ω, 120Ω, per ITU-T G.703 Table 6
Wave Shape	Rectangular, per ITU-T G.703 Figure 15
Framing	CCS or CAS, with or without CRC4
Programmable Traffic Pattern	Traffic pattern with no more than 1 zero

55488A Clock Distribution Card 2048 kHz and 2048 kbit/s (continued)

DESCRIPTION	SPECIFICATION
All Outputs	
Impedance	75Ω unbalanced, 120Ω balanced
Drive Capability	0 to 200 meters of cable (0.8 mm) or RG-59
Squelched Outputs	Yes

55483A Composite Clock Distribution Output Card 64/8 kHz

DESCRIPTION	SPECIFICATION
Output Type	Interface at 64 kbit/s as per ITU-T Recommendation G.703 section 1
Line Code	Bipolar, return-to-zero
Test Load Impedance	120Ω resistive (Tables 1 & 3, G.703) 110Ω resistive (Table 2, G.703)
Pulse Amplitude	1.0 V ±0.1 V
Pulse Shape	Per mask in ITU-T G.703, Figure 5b and Figure 9
Drive Capability	0 to 450 meters of twisted pair cable (0.8 mm)
Squelched Outputs	Yes
Number of Outputs	16

55471A Traffic Re-Synchronization Card

DESCRIPTION	SPECIFICATION
Input Types	2048 kbit/s, CCS or CAS multiframe, with or without CRC-4 multiframe, conforming to ITU-T G.704
Input Electrical	Conforms to ITU-T G.703 section 6
Input Tolerance	Conforms to ITU-T G.823
Output Types	Same as input types
Output Electrical	Conforms to ITU-T G.703 section 6
Input Signal Parameters Monitored	Loss of Signal (LOS) and Out of Frame (OOF)
Input Sensitivity	-13 dB
Damage Level	3.5 V peak
Output Signal Type	2048 kbit/s, framed per ITU-T G.703 Table 6, with HDB3 encoding
Buffer Size	2 frames, 512 bits
Buffer Hysteresis	256 bits
Delay (retimed signal path)	131 μs (nominal) 256 μs (maximum)
Number of Outputs	8 (4 retimed, 4 passthrough)

55484A Clock Distribution Output Card 1/5/10 MHz

DESCRIPTION	SPECIFICATION
Output Type	1/5/10 MHz selectable
Pulse Amplitude	2.4 V peak-to-peak
Impedance	50Ω unbalanced
Squelched Outputs	Yes
Number of Outputs	8 (Outputs 9 through 16 on subrack)
Phase Variation due to Output Card Failure	≤1μs

55485B Clock Distribution Card 1544 kbit/s

DESCRIPTION	SPECIFICATION
Output Type1544 kbit/s framed per ITU-T G.703, Table 4	
Waveform	100Ω per ITU-T G.703, Table 4
Wave Shape	Rectangular, per ITU-T G.703, Figure 10
Impedance	100Ω resistive, unbalanced
Drive Capability	0 to 200 meters of cable (0.8 mm) or RG-59
Framing	D4 or ESF
Squelched Outputs	Yes
Number of Outputs	16

55441A Information Management Card

The 55441A Information Management Card is ordered whenever local or remote control of the 55400A Network Synchronization Unit is needed. The 55441A provides ports for computer communication with the 55400A. RS-232C and RS-232D serial data ports facilitate status reporting and control. One port for local use is wired as a DCE and is located on the front of the card. The other port for remote use is wired as a DTE and is located on the connector panel of the master subrack. Alarm signals from all the other cards are received at the 55441A card which processes these to report alarm status. Event log memory on the 55441A card provides storage of alarm and performance data for up to 1,000 of the most recent events.

DESCRIPTION	SPECIFICATION
Number of Ports	2
Port Types	
Local	RS-232D, DCE
Remote	RS-232C, DTE
Communication Parameters	
Baud Rate	1200, 2400, 9600, and 19,200
Number of Bits	8
Parity	None
Stop Bits	1
Hardware Flow control (selectable)	CTS/RTS/DSR/DTR/RI/CD
Language	TL-1
Event Log	
Capacity	Stores at least 1000 events
Battery Backup	10-year minimum lifetime
Alarm Relay Contact Ratings	
Switching Power	60 W, 62.5 VA
Switching Voltage	60 Vdc, 30Vac
Switching Current	1 A maximum
Critical, Major, and Minor; with or without alarm cutoff	Open and closed contacts
ACO (alarm cutoff) Switch - front panel	Pushbutton, when pressed silences the audible alarm and lights the ACO LED.

Functions of the card include:

- Configuration of the equipment
- Downloading firmware for the Information management and Input Track and Hold Cards
- Sending event and alarm messages
- Setting input priority tables
- Setting alarm thresholds
- Retrieving input monitoring information

Two pushbutton switches are also located on the front panel, one for Alarm Cutoff (silences the audible alarms) and one for Reset Communication Ports (resets the local and remote communication ports).

55442A Network Information Management Card

The 55442A Network Information Management Card provides the functionality of the 55441A Information Management Card plus either a LAN interface or an X.25 interface port (Option 002). A rack alarm port has been added. The 55442A does not support modems or remote port. It supports only X.25 on the remote port.

Description	Specification
LAN Interface	10Base-T (physical) IEEE 802.3 and Ethernet (link layer) TCP/IP (layers 3 and 4)
X.25 Interface (Option 002)	V.24 DTE (physical) CCITT Rec. X.25, LAPB DTE (frame layer) CCITT Rec. X.25, PLP (packet layer)
TP4 Interface (Option 003	10Base-T (physical) IEEE 802.3 and IEEE 802.2 (link layers) ISO 8473 (network) ISO 8073 (transport)
Expanded memory option (Option 004)	Available for all network versions. Supports acquisition of up to 24 hours of continuous time interval error data.

Master and Expansion Subrack Specifications

55401D Master Subrack and Connector Panel

The 55401D Master Subrack is ETSI compliant and houses all the individual cards to the 55400A Network Synchronization Unit.

DESCRIPTION	SPECIFICATION
Subrack Power Inputs — dual	–36 Vdc to –57 Vdc
Dimensions — H × W × D	533 mm × 435 mm × 275 mm
Connectors — outputs	BNC are standard (Siemens 75Ω 1.6/5.6 optional) Grounded outputs
Mounting	ETSI or EIA racks

Connector Panel

The connector panel for the 55400A is located on the 55401D Master Subrack. Cabling into and out of this subrack is performed at the top of this panel. Connectors provided are:

- Dual Power inputs
- Alarm Relays
- Reference Inputs (up to 9)
- Remote Communications Ports (2)
- Outputs (80)
- Expansion Communication Ports (2)
- Expansion Signal (2)
- Primary Reference Status

Standard output connectors are BNC's, the Siemans 1.6/5.6 75Ω are optional (others available). The 55441A Information Management Card and 55442A Network Information Management Card (NIMC) local serial communication port connections are made directly on that card. Contact Symmetricom for any custom connector requirements.

55402D Expansion Subrack

The 55402D Expansion Subrack is used with the 55401D Master Subrack. Up to four 55402D Expansion Subracks may be used with the master subrack. Each expansion subrack has up to 80 1:1 outputs available enabling one to have a total of 400 1:1 outputs maximum.

When using the 55402D Expansion Subrack, two 55419A Expansion Synchronization Cards and one 55443A Expansion Communication Card must be included. The Master Subrack must have either the 55441A or 55442A card.

DESCRIPTION	SPECIFICATION
Subrack Power Inputs — dual	–36 Vdc to –57 Vdc
Dimensions — H × W × D	532 mm × 435 mm × 275 mm
Connectors — outputs	BNC are standard (Siemens 75Ω 1.6/5.6 optional) Grounded outputs
Mounting	ETSI or EIA racks

55419A Expansion Synchronization Card

When expanding the 55400A NSU beyond its master subrack configuration (greater than 80 1:1 outputs) the 55402D Expansion Subrack requires two 55419A Expansion Synchronization Cards. This card provides the necessary synchronization links between the 55402D Expansion Subrack and the 55401D Master Subrack. Two cards are necessary to maintain redundancy of in-service functions.

55443A Expansion Communication Card

The 55443A Expansion Communication Card is needed when expanding the 55400A NSU beyond 80 1:1 outputs. This communication card provides the necessary communication link between the 55402D Expansion Subrack and the 55401D Master Subrack. One card is required with each expansion subrack.

Warranty Information

12 month return-to-Symmetricom (bench)

Synchronization Management

55450A Local Craft Terminal Software

The 55450A Local Craft Terminal is a Windows® 95/NT application software package that provides a local graphical user interface for controlling, configuring, and monitoring 55400A NSUs one at a time.

Key Features:

- Full management capability
  - –Input and Output configuration
  - –Fault management
  - –Performance
  - –Security
- Real time management
- Graphical representation of 55400A NSU
- Online help

Open Synchronization Management Framework

55452A Open Synchronization Management Framework (OSMF) incorporates all the key features of the 55450A and more, but on a network-wide basis. Its architecture is based upon HP OpenView, Oracle and UNIX, with full LAN, X.25 and TP4 connectivity directly to the 55400A NSU.

In addition to this 55400A brochure, application notes, product brochures and specifications are available. Contact your local Symmetricom sales office for the following:

Product	Description
55460A	Network Sync Audit Service and Planning
55300A	GPS Telecom Primary Reference Source ("GPS SmartPRS")
55450A, 55451A, 55452A	Open System Management for High Quality Synchronization
Application Note Title	
APP/STN-BC	Synchronizing Telecommunications Networks: Basic Concepts
APP/STN-SDH/SONET	Synchronizing Telecommunications Networks: Synchronizing SDH/SONET
APP/STN-FSP	Synchronizing Telecommunications Networks: Fundamentals of Synchronization Planning
APP/SCT	Symmetricom SmartClock Technology: Improving Oscillator Long-Term Stability for Synchronization Applications

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B/55400A/D/0900/5M