# Sync Defender

## Network Time Server

## User Manual

Version 2.0

Model versions:
Sync Defender 50
Sync Defender 100
Sync Defender 200

Firmware versions 02-01-01 and above

worldtime SOLUTIONS

## SAFETY PRECAUTIONS

To reduce the risk of fire, or electric shock, ***DO NOT*** allow the Sync Defender to be exposed to rain or moisture.

To avoid the risk of electric shock, ***DO NOT*** open the enclosure.

This unit is designed to be installed into an equipment rack or on a suitable flat surface. ***DO NOT*** install this product on an uneven surface.

To prevent damage to the unit, clean ***ONLY*** with a dry cloth.

Use this product ***ONLY*** with the supplied power cord. If the power cord becomes damaged, consult a qualified electrician for advice.

The plug on the supplied power cord is intended to serve as a disconnect device. The socket-outlet should be installed near the equipment and should be easily accessible.

This product may contain a coin / button cell battery. ***DO NOT INGEST BATTERY, CHEMICAL BURN HAZARD!*** If the coin / button cell battery is swallowed, it can cause severe internal burns in just two hours and can lead to death. Keep new and used batteries away from children. If you think batteries might have been swallowed, or placed inside any part of the body, seek immediate medical attention.

## CERTIFICATION

CE

In accordance with European Directives *2014/35/EU (The Low Voltage Directive)*, *2014/30/EU (The Electromagnetic Compatibility Directive)* and 2014/53/EU (The Radio Equipment Directive, the Sync Defender is in conformity with the applicable requirements of *BS EN 62368-1: 2024, BS EN 55032: 2015 +A1:2020 and BS EN 55035: 2017 +A11:2020*.

A copy of the EU Declaration of Conformity may be downloaded from our website.

## RoHS COMPLIANCE

World Time Solutions Limited works with it's suppliers to ensure all products comply with the Restriction of Hazardous Substances (RoHS) directive.

## DISPOSAL

Please dispose of this unit properly. To minimize pollution and help protect the environment, this unit should be recycled.

## EXTERNAL TIME SOURCES

The Sync Defender is designed to continue operating if an external time source is unavailable, though some time-related functions may be affected.

Where a GNSS or radio time code signal is used, World Time Solutions Limited accepts no liability for any loss arising from the unavailability or inaccuracy of such signals, as these are provided by third parties outside our control.

## COPYRIGHT



## TRADEMARKS

*Microsoft*, *Windows*, *Windows 10* and *Windows 11* are either registered trademarks or trademarks of Microsoft Corporation in the United States and other countries.

All other registered trademarks and trademarks are property of their respective owners.

## SOFTWARE LICENCE

This product contains proprietary World Time Solutions Limited software. This proprietary World Time Solutions Limited software is supplied under the *World Time Solutions Limited Software Licence Agreement*.

To obtain further information and/or a copy of the software licence please visit:

`www.worldtimesolutions.com`

## LIMITED WARRANTY

The Sync Defender network time server is guaranteed against failure due to faulty parts or workmanship for a period of five (5) years from date of purchase.

In the event of product failure due to faulty parts or workmanship within the warranty period, World Time Solutions Limited, at its own discretion, will either (a) repair the product, (b) supply a replacement product, (c) supply a functionally equivalent replacement product, or (d) refund the purchase price of the product.

The limited warranty will not apply if (a) the product has not been installed or operated as per our instructions, (b) the product has been modified in anyway.

In the event of failure, the Sync Defender should be returned to the manufacturer for inspection and repair. Please visit our support pages for further details:

`www.worldtimesolutions.com/support.html`

## TECHNICAL SUPPORT

To obtain help with the installation or operation of the Sync Defender, please visit our web site at:

`www.worldtimesolutions.com/support.html`

# Contents

# 1 - Introduction

## 1.1 - Introducing Sync Defender

Sync Defender is the ideal solution for secure synchronised timing on computer networks. Available with one to five timing LAN ports, Sync Defender enables secure synchronised dependable timing on up to five separate physical networks.

## 1.2 - How Sync Defender enhances the security of your network

Sync Defender enhances the security of your network providing a trusted stable stratum 1 NTP time source behind your firewall. Sync Defender helps safeguard the integrity of your systems with its security hardened design. It incorporates a proprietary network stack built from the ground up to provide secure stable timing. As a result of this intentional design methodology, the timing LAN ports only implement the essential protocols needed for timing.

Sync Defender further strengthens the resilience of your network by offering a choice of reference inputs, antenna upgrades and enhanced holdover performance oscillators.

## 1.3 - Simplified theory of operation

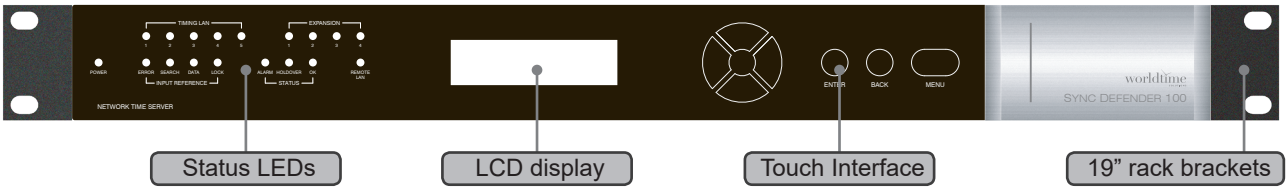
Sync Defender acquires stable and secure time data from Global Navigation Satellite Systems (GNSS). Once data has passing strict error checking, a dedicated security-hardened timing LAN then serves this time data to devices on your network.

## 1.4 - Modular design

Sync Defender allows you to future-proof your system architecture with its scalable modular design. You can easily add additional LAN cards as your network grows, allowing you to securely synchronise up to five separate physical networks.

A range of optional expansion cards are also available, enabling secure synchronisation of your network with industrial systems and other equipment.

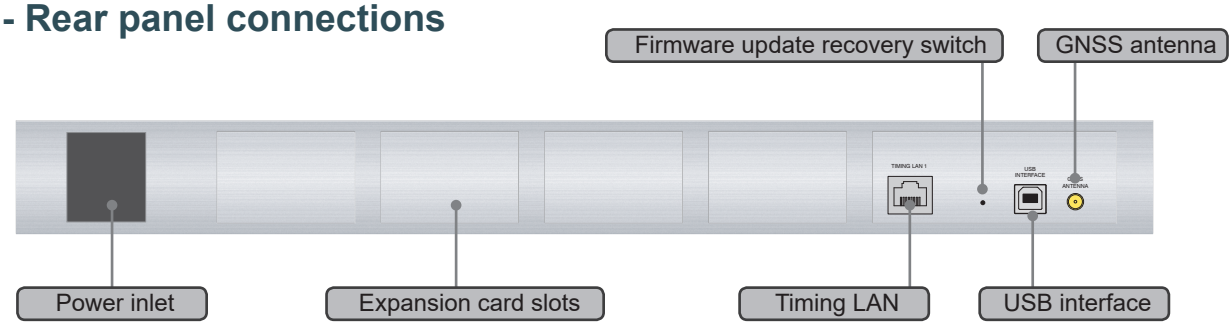
## 1.5 - Front panel layout




| LED marking | Function |
|---|---|
| POWER | Indicates system power status |
| TIMING LAN | Timing LAN link and data status |
| EXPANSION | Expansion card output status |
| ERROR | Input reference error detected |
| SEARCH | Input reference unsynchronised |
| DATA | Input reference data received |
| LOCK | Input reference locked |
| ALARM | System alarm |
| HOLDOVER | System running in holdover mode |
| OK | System OK |

*Table 1.1 - Status LEDs*

## 1.6 - Rear panel connections




## 1.7 - Package contents

Your Sync Defender is supplied with the following accessories:

- Power cord
- 19” rack mount brackets and fixing screws
- Ethernet patch cable
- USB cable
- GNSS patch antenna
- Quick start guide

## 1.8 - Optional upgrades

### 1.8.1 - Timing reference options

Sync Defender is available with a flexible choice of time reference options. The SD-101-GNSS decoder cards provides multi-constellation GNSS support. With 32 satellite parallel tracking and class-leading high-performance design, the SD-101-GNSS synchronises Sync Defender to within 30 nsec of UTC. The SD-101-GNSS card incorporates anti-jamming technology and offers selectable support for GPS, GLONASS and Galileo. The card provides real time diagnostics, active antenna monitoring and user programmable cable delay compensation. A SD-101-GNSS decoder card is fitted to all standard configuration Sync Defender models.

Sync Defender enables you to strengthen the resilience of your network by adding a second SD-101-GNSS card as a dual redundant live backup. Depending on your specific needs, the second card can be configured as an identical live backup, or you can choose to configure each card to use a different GNSS constellation.

The SD-102-EXT external time reference interface card adds support for a GPS6000 system. By moving the RF decoding from within the Sync Defender to a remote GPS6000 system, the majority of the antenna cable link can be made using existing structured cabling, rather than dedicated RF coaxial cables. In large buildings, this can reduce installation costs and simplify the installation process significantly.

### 1.8.2 - Antenna upgrades

The SD-105-ANT high gain anti-jam timing antenna can be installed in place of the standard GNSS patch antenna. This antenna upgrade provides improved operation in the most demanding weak signal and hostile RF environments. You can purchase the anti-jam timing antenna with a choice of coaxial cable lengths to suit your installation needs. The SD-105-ANT high gain anti-jam timing antenna also enables the integration of a lightning arrester into your Sync Defender system. The lightning arrester protects your Sync Defender and connected networking equipment against damage from a lightning strike or surge event.

### 1.8.3 - Oscillator upgrades

Sync Defender is available with a choice of three oscillator upgrade options to provide improved holdover performance during periods of synchronisation loss. The SD-301-TCXO offers economical holdover performance providing stable timing during short periods of synchronisation loss. The SD-301-TCXO is fitted as standard on the Sync Defender 100 and Sync Defender 200 models. The SD-302-OCXO provides a good balance between cost and performance, offering improved holdover performance at a competitive price. The

SD-303-OCXO-HS delivers superb holdover performance, allowing Sync Defender to continue performing seamlessly during extended periods of synchronisation loss.

### 1.8.4 - Additional timing LANs

The SD-401-ETH timing LAN card adds an additional Ethernet port and delivers the capability to securely synchronise an additional physical network from your Sync Defender. The SD-401-ETH timing LAN card incorporates its own processor running its own security-hardened network stack. This ensures isolation between your networks and guarantees bandwidth availability on all ports. All models of Sync Defender have one timing LAN integrated onto the motherboard. The Sync Defender 200 model has one SD-401-ETH timing LAN card fitted as standard, providing two timing LANs in total. Optionally, a further three SD-401-ETH cards may be fitted, enabling Sync Defender 200 to provide secure synchronised timing on up to five separate physical networks.

### 1.8.5 - Industrial outputs

Sync Defender is available with a range of optional expansion cards providing high accuracy time synchronisation for industrial systems and other equipment.

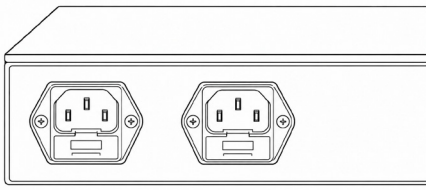
- The SD-420-232 expansion card adds a serial time and date output and PPS output at RS-232 signal levels. The data can be transmitted in one of 27 different data formats.
- The SD-421-485 expansion card provides a serial time and date output as RS-485 signal levels. The serial data can be transmitted in one of 27 different data formats.
- The SD-425-PPS expansion card offers a high accuracy pulse per second (PPS) output.
- The SD-426-IRIG expansion card provides a 1KHz amplitude modulated IRIG-B timecode output.

Further expansion cards are available to special order.

### 1.8.6 - Power supply options

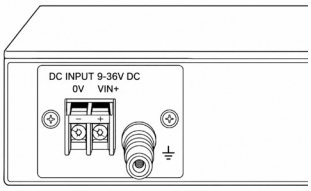
Sync Defender is available with a choice of power supply options if the standard universal 100-250V AC mains power supply is not suitable for your application.

- The SD-501-DUAL-MAINS option provides a second 100-250V AC power supply, delivering dual redundancy for mission-critical installations. Under normal operation, the Sync Defender draws power from the primary supply. Should the primary supply fail, the system seamlessly switches to the secondary supply without interruption. In the event that either supply fails, an alert is displayed on the LCD and the alarm buzzer activates.



*Dual redundant mains power option*

- The SD-502-DC-9-36 option provides a 9-36V DC power input in place of the standard AC power supply.




*DC power supply option*

- The SD-503-DC-NEG-48 option provides a negative 48V DC power input, in place of the standard mains power supply.

Other power supply options are available to special order.

# 2 - Installation

## 2.1 - Installing the GNSS patch antenna

To ensure reliable operation, the GNSS antenna needs to have at least a partial view of the sky. Increasing the amount of sky visible will improve system performance. The antenna should be mounted either externally (in a protected position) or in an internal position with a view of the sky (for example, on a window ledge).

If you choose to mount your antenna internally, best operation will be achieved by choosing a window facing towards the equator. Please ensure the window is not coated with a metallised film as this may disrupt the GNSS signals.

Having chosen a suitable installation location, secure the GNSS antenna in position using the adhesive tape supplied.

## 2.2 - Installing the optional anti-jam GNSS timing antenna

The optional anti-jam GNSS timing antenna should be installed externally, with the maximum possible sky visibility. For most installations, the ideal location will be the roof of your building. The antenna has been designed to withstand extreme temperatures, rain, snow and sunlight.

Ideally, the antenna should have a clear uninterrupted 360 deg view of the horizon. For installations where an unobstructed view of the sky is not practical, the antenna should be installed with as large a view as possible of the sky towards the equator. Installing the antenna with a substantially reduced view of the sky will degrade system performance and may increase synchronisation time.

The antenna should be mounted with the top of the dome facing directly upwards and secured using the antenna bracket. Care should be taken to ensure the fixings used (not supplied) as suitable for the application.

The antenna should be connected to the lightning arrester using the appropriate length TNC/TNC coaxial cable (available separately). For installations where a lightning arrester is not used, the antenna should be connected directly to the Sync Defender using the appropriate length TNC/SMA coaxial cable (available separately).

***WARNING: WHEN INSTALLING THE ANTENNA WITHOUT A LIGHTNING ARRESTER, THE ANTENNA MUST NOT BE INSTALLED IN A POSITION WHERE IT MAY BE SUBJECTED TO A DIRECT LIGHTNING STRIKE.***

To prevent moisture penetrating the RF connection, the coaxial cable connection to the antenna should be sealed using the supplied self-amalgamating tape. The tape should fully cover the coax heat shrink and the TNC connector, and should finish on the antenna mounting thread. The tape should be supplied in successive half-lapped layers working up towards the antenna. To ensure good sealing of the RF connection, the tape should be gently stretched as applied.

## 2.3 - Installing the optional lightning arrester

The optional lightning arrester provides surge protection for your Sync Defender. It should be connected inline between the external antenna and the Sync Defender. The lightning arrester should be installed internally as the point where the antenna cable enters the building.

***PLEASE NOTE: THE LIGHTNING ARRESTER MUST NOT BE INSTALLED EXTERNALLY.***

It is important that the lightning arrester is grounded to a low impedance ground system for proper operation.

The lightning arrester is supplied with a separate instruction sheet with full installation instructions. Please consult this separate instruction sheet when installing your lightning arrester.

## 2.4 - Installing your Sync Defender in a 19” rack

Sync Defender is supplied with side fixing brackets to enable installation into a 1 U high 19” rack slot. To mount your Sync Defender into a 19” rack, fix the brackets to the side of the enclosure using the supplied M5 screws. The Sync Defender can then be installed into the rack using appropriate fixings.

## 2.5 - Connecting the antenna to your Sync Defender

Connect the antenna cable to the SMA type RF connector on the rear of your Sync Defender. The input is labelled ‘GNSS ANTENNA’.

## 2.6 - Dual redundant time reference

If your Sync Defender has the dual redundant time reference option, both antennas should be separately installed as per the instructions above. There will be two GNSS antenna inputs on the rear of your Sync Defender. Connect an antenna to each GNSS antenna input.

## 2.7 - Connecting to a GPS6000 system

The SD-102-EXT external time reference interface card adds the capability to connect a remote GPS6000 system *(see section 1.8.1)*. Please refer to the GPS6000 user manual for installation instructions.

## 2.8 - Connecting power

### 2.8.1 - Standard mains power

Standard Sync Defender units are fitted with a universal 100-250V AC mains power supply. Your Sync Defender has been supplied with a power cord suitable for connection to the mains power supply in your location. Before connecting to a mains power supply, please check compatibility between your local mains power supply and the power supply rating as stated on your Sync Defender.

***CAUTION! DOUBLE POLE/NEUTRAL FUSING! THE IEC MAINS POWER INLET ON THE REAR OF YOUR SYNC DEFENDER IS DOUBLE FUSED. FUSES SHOULD ONLY BE REPLACED WITH THOSE OF THE SAME TYPE/RATING AND BY QUALIFIED PERSONNEL.***

### 2.8.2 - Dual mains power option

The SD-501-DUAL-MAINS option equips your Sync Defender with two independent mains input connectors. For full redundancy, both inputs should be connected to a suitable AC mains power source. Before connecting, check the power supply rating stated on the product to ensure your mains supply is compatible. For maximum protection, each input should ideally be fed from a separate, independent mains circuit.

### 2.8.3 - DC power supply option

The SD-502-DC-9-36 option equips your Sync Defender with a 9-36V DC power input in place of the standard mains power supply. Connect your DC supply to the terminal block on the rear panel, ensuring the polarity is correct. Before connecting, check the power supply rating stated on the product label to confirm compatibility. A separate ground terminal is also provided and should be connected to a suitable earth point.

### 2.8.4 - Negative 48V DC power supply option

The SD-503-DC-NEG-48 option equips your Sync Defender with a negative 48V DC power input in place of the standard mains power supply. Connect your DC supply to the terminal block on the rear panel, ensuring the polarity is correct. Before connecting, check the power supply rating stated on the product label to confirm compatibility. A separate ground terminal is also provided and should be connected to a suitable earth point.

### 2.8.5 - Non-standard supply options

If your Sync Defender has been supplied with a non-standard power option, please refer to the separate instructions provided.

## 2.9 - Connecting the timing LAN

The timing LAN port on your Sync Defender should be connected to an Ethernet switch on your TCP/IP network. The connection should be made using the supplied patch cable (or similar).

Please note that your Sync Defender may have multiple timing LAN ports.

## 2.10 - Connecting the USB interface

The USB interface enables remote configuration of your Sync Defender using the supplied Windows application. The USB interface also provides secure firmware upgrade capability.

The USB interface should be connected to a Windows PC using the supplied USB type A to type B cable.

## 2.11 - Optional outputs

Sync Defender is available with arrange of additional optional outputs. Please refer to chapter 7 for installation information specific to your optional output.

# 3 - Setup and configuration

## 3.1 - Minimum setup configuration steps

Once your Sync Defender has been installed, as a minimum, you should complete the following configuration steps.

- Complete the Guided Security Setup
- Setup the timing LAN
- Set the local time zone

The above steps are explained in more details in the following sections.

## 3.2 - Guided security setup

When you first boot your Sync Defender, the Guided Security Setup procedure will automatically run. This guides you through setting up some mandatory security settings. You will be required to select a Front Panel Trust Level, a USB Interface Trust Level and, if required, passwords and a recovery pin. You can also optionally adjust the Time Reference Trust Level. *Please refer to section 5.1 for more details.*

## 3.3 - Setting up the time reference

The time reference on your Sync Defender comes preconfigured with settings suitable for a typical installation. If required, these settings can be adjusted as detailed below.

### 3.3.1 - Time reference trust level

The Time Reference Trust Level is a simple method to configure how much you want your Sync Defender to trust its time reference. It is set as part of the Guided Security Setup procedure or alternatively can be modified in the ADVANCED SETUP > SECURITY SETTINGS menu.

When you change the Time Reference Trust Level, you are actually configuring three different Time Reference settings; the GNSS Anti-jamming Mode, the GNSS Time Discontinuity Allowance and the GNSS Oscillator Steering Allowance. Please refer to the sections below and chapter 5 for more details.

### 3.3.2 - Anti-jamming mode

The first time your Sync Defender is booted, it automatically performs a self-survey to calculate its location as accurately as possible. Once this survey is complete, your Sync Defender stores this location data and then switches to a fixed location mode. In fixed location mode, Sync Defender uses data from one satellite vehicle only. This provides the most stable and accurate time data, but leaves the system vulnerable to GNSS spoofing.

With anti-jamming mode enabled, Sync Defender compares data from two satellite vehicles. This greatly reduces the vulnerability to GNSS spoofing, whilst still enabling highly accurate timing. Your Sync Defender is supplied with GNSS anti-jamming mode enabled. This setting can be disabled in the ADVANCED SETUP > TIME REFERENCE menu. However, for most installations, we would advise this setting should not be changed.

Note that the GNSS anti-jamming mode is also configured automatically as part of the time reference trust level *(see above and section 5.6)*.

### 3.3.3 - Time discontinuity allowance

The Time Discontinuity Allowance is a function to limit the maximum time jump your Sync Defender will accept from a time reference source after initial synchronisation is complete. Three settings are available. In ANY mode, Sync Defender will accept any time jump and resync to the new time. In SMALL CHANGE ONLY mode, time jumps are limited to one second or less. In NO CHANGE mode, the time cannot jump.

| Time discontinuity allowance | Maximum time jump |
|---|---|
| ANY | No limit to allowed time jumps |
| SMALL CHANGE | Time jumps limited to one second or less |
| NO CHANGE | Time jumps not permitted |

*Table 3.1 - Time discontinuity allowance*

If the time reference jump is outside the allowed range, Sync Defender will switch to holdover mode and flag an alarm. The Time Discontinuity Allowance can be modified in the ADVANCED SETUP > TIME REFERENCE menu. Note that the Time Discontinuity Allowance is also configured automatically as part of the time reference trust level *(see above and section 5.6)*.

Please note that the availability of this feature is partially dependent on the specific oscillator option fitted to your Sync Defender and may not be configurable on your unit.

### 3.3.4 - Oscillator steering allowance

All versions of Sync Defender have adjustable oscillators that enable the system to make small changes to its own clock frequency and maintain synchronisation with its time reference. This trimming prevents small time discontinuity issues and ensures timestamps are contiguous. The Oscillator Steering Allowance is a function to limit the maximum adjustment the Sync Defender can make to its oscillator frequency. Two options are available. As standard, the Oscillator Steering Allowance is set to FULL STEERING. In TIGHT LIMIT STEERING mode, the adjustment range of the oscillator is highly restricted. If the time reference attempts to steer the oscillator outside the allowed range, Sync Defender will switch to holdover mode and flag an alarm.

The Oscillator Steering Allowance can be modified in the advanced setup > time ref menu. Note that the Oscillator Steering Allowance is also configured automatically as part of the time reference trust level *(see above and section 5.6)*.

Please note that this feature relies heavily on the stability of the oscillator in your Sync Defender. Tight limit steering can only be enabled on models fitted with an OCXO oscillator. In addition, we would advise that this feature only be adjusted as part of the time reference trust level.

### 3.3.5 - Antenna cable delay compensation

Your Sync Defender is capable of providing time data accurate to within 30 nsec of UTC. At this level of accuracy, talking account of cable lengths becomes critical. Every metre of cable between the GNSS antenna and your Sync Defender causes an additional error of approximately 5 nsec. For longer cable lengths, this accumulated error can become very significant.

If you are using your Sync Defender for a high accuracy application, for example with the optional PPS (pulse per second) output card, you may wish to add a correction for errors due to cable propagation delays.

Once the total antenna cable length has been entered, your Sync Defender applies a time offset to correct for cable propagation delays. The antenna cable delay compensation may be set in the ADVANCED SETUP > TIME REFERENCE menu.

### 3.3.6 - GNSS constellation

Sync Defender supports multiple GNSS constellations; GPS, GLONASS and Galileo. As standard, your Sync Defender is programmed to operate from the GPS constellation only. If required, this can be adjusted in the ADVANCED SETUP > TIME REFERENCE menu.

### 3.3.7 - Active antenna monitoring

The GNSS RF input on your Sync Defender incorporates open/short monitoring and active short circuit protection. If required, the monitoring feature can be disabled in the ADVANCED SETUP > TIME REFERENCE menu. Please note that disabling active antenna monitoring only disables the notifications. The active short circuit protection cannot be disabled.

### 3.3.8 - Time reference sync prefer

If your Sync Defender has dual time references fitted, the Time Reference Sync Prefer feature allows you to select which sync source is the default. This setting can be adjusted in the ADVANCED SETUP > TIME REFERENCE menu.

### 3.3.9 - Feature availability

Some of the above features may not be present on your Sync Defender if you have an alternative time reference option fitted. If your Sync Defender has dual time references, some of the above features will be duplicated.

## 3.4 - Setting up the timing LAN

If your Sync Defender has multiple timing LANs, the following settings will be repeated for each timing LAN. An additional separate submenu is provided for each additional timing LAN.

### 3.4.1 - Enabling DHCP on the timing LAN

DHCP enables your Sync Defender to obtain network address settings automatically from a DHCP sever on your network. To enable DHCP support, access the SYSTEM SETUP > TIMING LAN 1 menu and set DHCP to ENABLED.

With DHCP enabled, the IP ADDRESS, SUBNET MASK and GATEWAY screens will show the IP settings obtained from the DHCP sever.

### 3.4.2 - Programming static IP settings

Access the SYSTEM SETUP > TIMING LAN 1 menu and ensure DHCP is set to disabled. The IP address, subnet and gateway settings can then be adjusted using the multi-function switches.

### 3.4.3 - Enabling NTP broadcast support

In a typical computer network, NTP operates in Unicast mode; an NTP client requests the time and the Sync Defender responds directly to this request. However, in certain applications, it may be desirable to configure the Sync Defender to operate in NTP broadcast mode.

When operating in NTP broadcast mode, as well as responding directly to Unicast requests, Sync Defender additionally broadcasts NTP messages to all devices on the local subnet. Broadcast messages are transmitted every 64 seconds. NTP broadcast mode can be enabled via the SYSTEM SETUP > TIMING LAN 1 menu.

### 3.4.4 - Enabling NTP authentication

Authentication attaches a Message Authentication Code (MAC) to each NTP packet, allowing the receiving device to confirm that the packet came from a trusted server and has not been altered.

Please refer to chapter 8 for details of enabling authentication support on your Sync Defender.

## 3.5 - Setting the local time zone

Sync Defender maintains a time count for both UTC/GMT and local time. The UTC count is used as a reference for network timing. The local time is shown on the LCD display and can be used as a reference for the serial output option and other option cards.

Sync Defender converts between UTC and your local time automatically. Find your time zone from the preprogrammed list in appendix D then select this time zone in the SYSTEM SETUP > TIME ZONE menu. Once your Sync Defender has synchronised to GNSS satellites, your local time will be shown on the front panel display. Any seasonal summertime/wintertime changes will occur automatically.

## 3.6 - Holdover configuration

If the time reference in your Sync Defender loses synchronisation, Sync Defender automatically switches to HOLDOVER mode where the time count is maintained by the internal oscillator. If your Sync Defender has been in HOLDOVER mode continually for an extended period of time, the system will switch to ALARM mode. In ALARM mode, Sync Defender tells connected equipment that it is unsynchronised.

Sync Defender is available with a range of oscillator upgrade options to improve stability whilst in holdover mode. The length of time your Sync Defender will remain in holdover mode is configurable. Note that the available range is dependent on the oscillator option fitted.

The chart below shows the holdover alarm delay range for the standard Sync Defender models and oscillator options.

| Model version/ oscillator option | Default holdover alarm delay | Programmable range |
|---|---|---|
| Sync Defender 50 | 5 mins | 1 min - 4 hours |
| Sync Defender 100 | 2 hours | 1 min - 12 hours |
| Sync Defender 200 | 2 hours | 1 min - 12 hours |
| SD-302-OCXO | 6 hours | 1 min - 48 hours |
| SD-303-OCXO-HS | 12 hours | 1 min - 96 hours |

*Table 3.2 - Holdover alarm delay range*

The holdover alarm delay can be adjusted in the ADVANCED SETUP > OSCILLATOR menu.

## 3.7 - Front panel trust level

The 'Front Panel Trust Level' dictates the lock-down level of the front panel touch interface. The front panel trust level is set as part of the Guided Security Setup when you first boot your Sync Defender. Alternatively, the front panel trust level can be modified in the ADVANCED SETUP > SECURITY SETTINGS menu. *Please refer to chapter 5 for more details*.

## 3.8 - USB interface trust level

The 'USB Interface Trust Level' dictates the lock-down level of the USB interface. The USB interface trust level is set as part of the Guided Security Setup when you first boot your Sync Defender. Alternatively, the USB interface trust level can be modified in the ADVANCED SETUP > SECURITY SETTINGS menu. *Please refer to chapter 5 for more details*.

## 3.9 - Passwords & recovery pin

The front panel touch interface and USB interface on your Sync Defender can be password protected to prevent unauthorised access. *Please refer to chapter 5 for more details*.

## 3.10 - Setting the time and date manually

If your Sync Defender has no active time reference, you can set the time and date manually via the SYSTEM SETUP > ADVANCED > UTILITIES menu. Note that the time zone must be programmed prior to adjusting the time and date *(see "Setting the local time zone" in section 3.5 above)*.

## 3.11 - Seasonal summertime/wintertime changes

Sync Defender performs automatic seasonal summertime/wintertime changes *(see "Setting the local time zone" in section 3.5 above)*.

## 3.12 - Leap seconds

The average rotational speed of the earth is very slowly decreasing and therefore the average length of a solar day is very slowly increasing. Leap seconds are occasionally added to the UTC time count to ensure alignment with solar day observations.

Your GNSS synchronised Sync Defender performs leap seconds automatically. However, if your Sync Defender has no active GNSS time reference, you can manually program a leap second via the SYSTEM SETUP > ADVANCED > UTILITIES menu. The leap second can be positive (where a second is added) or negative (where a second is removed). If programmed, the leap second event will occur once only at the end of the following June or December (whichever occurs first) and then be erased.

## 3.13 - Low power mode

When low power mode is enabled, Sync Defender switches off the LCD display backlight after a short period of touch switch inactivity. Low power mode can be enabled in the SYSTEM SETUP > ADVANCED > UTILITIES menu.

## 3.14 - Disabling audible indications

Your Sync Defender produces audible switch press confirmation sounds to improve usability. If preferred, these audible switch press confirmation sounds can be disabled in the SYSTEM SETUP > ADVANCED > UTILITIES menu.

Sync Defender produces audible alarm notifications. These can also be adjusted in the SYSTEM SETUP > ADVANCED > UTILITIES menu.

## 3.15 - Setting the LCD contrast

The LCD contrast may be adjusted to help improve display visibility at different viewing angles. The LCD contrast can be adjusted in the SYSTEM SETUP > ADVANCED > UTILITIES menu.

## 3.16 - Restoring factory settings

Your Sync Defender can be reset to factory default settings via the Factory Reset function in the SYSTEM SETUP > ADVANCED > UTILITIES menu.

## 3.17 - Optional outputs

Sync Defender is available with arrange of optional output cards. *Please refer to chapter 7 for setup details*.

## 3.18 - Real-time clock option

The Real-time clock option allows your Sync Defender to maintain a time count during periods of power failure. Power-on behaviour can be adjusted via the REAL-TIME CLOCK menu.

### 3.18.1 - Real-time clock battery replacement

The battery fitted to the Real-time Clock (RTC) option should only be replaced by suitably qualified service personnel.

To maintain correct operation and ensure safety, the replacement battery must be of the same type as originally supplied. In most cases, the RTC option is fitted with a CR2032 coin cell battery. However, battery types may vary between hardware revisions. Before replacing the battery, always refer to the battery type marking on the RTC option PCB and install only the specified battery type.

Using an incorrect battery type may result in malfunction or damage to the equipment.

Dispose of used batteries in accordance with local regulations and recycling requirements.

# 4 - Status and operation

## 4.1 - Checking the status of your Sync Defender

The front panel status LEDs provide quick and easy visual indication of the status of your Sync Defender. More detailed status information is available via the font panel LCD.

## 4.2 - Error and status info on the LCD

If your Sync Defender is operating normally, the front panel LCD will display the time and date. If an error mode is detected, the LCD will show the relevant error message. More detailed information can be accessed via the LIVE STATUS submenu.

## 4.3 - System power status

The system power status of your Sync Defender can be visually checked via the front panel POWER LED. Sync Defender is continually monitoring its internal power systems. If operation is normal, the POWER LED will be solid white. If Sync Defender detects a problem with any of the power systems, the POWER LED will flash and an error message will appear on the front panel LCD.

More detailed power status information can be accessed via the LIVE STATUS submenu.

## 4.4 - Time reference status

The status of the time reference in your Sync Defender can be visually checked via the front panel INPUT REFERENCE LEDs. In normal operation, the LOCK LED will be solid white and the DATA LED will flash once per second. If the time reference is not synchronised, but otherwise the system is working normally, the SEARCH and ERROR LEDs will flash and an error message will be displayed on the front panel LCD. If the system is not working normally (for example an antenna problem is detected), the ERROR LED will fast flash and an error message will be displayed on the front panel LCD.

More detailed information regarding the time reference status can be accessed via the LIVE STATUS submenu.

## 4.5 - System status & holdover

The operational status of your Sync Defender can be visually checked via the front panel STATUS LEDs. If the system is synchronised and operating normally, the OK LED will be solid white. If the system has lost synchronisation recently, the HOLDOVER LED will be solid white and an error message will be displayed on the front panel LCD. If the time is not set or the system has lost synchronisation for an extended period, the ALARM LED will flash and an error message will be displayed on the front panel LCD.

More detailed information regarding system status can be accessed via the LIVE STATUS submenu.

## 4.6 - Timing LAN status and bandwidth utilisation

The status of the timing LANs on your Sync Defender can be visually checked via the front panel TIMING LAN LEDs. If the timing LAN is connected to your network and a link detected, the relevant TIMING LAN LED will be illuminated. The TIMING LAN LED flashes as data is detected.

Any relevant error status massages regarding the timing LAN will be displayed on the front panel LCD. More detailed information regarding the timing LAN status can be accessed via the LIVE STATUS submenu. Additionally, live timing LAN bandwidth utilisation data can be displayed also accessed via the LIVE STATUS submenu.

## 4.7 - Expansion card status

The status of any expansion cards can be visually checked via the front panel EXPANSION LEDs. *Please refer to the relevant section of chapter 7 for details relating to your specific card*.

## 4.8 - GNSS operation

Sync Defender uses multiple GNSS satellite constellations to obtain accurate time and date information. GNSS systems operate at very high frequencies (in the GHz range) and rely on a line-of-sight between the satellites and the antenna. The reliable operation of the GNSS decoding in your Sync Defender is heavily dependent on sensible antenna installation. Please follow the installation instructions in chapter 2 carefully to ensure trouble-free operation.

## 4.9 - Holdover operation

When operating normally, Sync Defender uses GNSS satellites as a time reference. If your Sync Defender loses synchronisation with the GNSS satellites, the system automatically switches to holdover mode where the time count is maintained by the internal oscillator. The stability of your Sync Defender whilst in holdover mode is entirely dependent on the oscillator fitted to your specific unit. The length of time Sync Defender will remain in holdover mode is configurable by the user. *For more information, please refer to section 3.6.*

## 4.10 - What is NTP?

NTP (Network Time Protocol) is a networking protocol that enables the synchronisation of computer clocks across data networks. Sync Defender uses NTP to synchronise client devices on a local area network.

## 4.11 - NTP client accuracy

Sync Defender provides NTP timestamps that are typically accurate to with 30 microseconds of UTC/GMT. However, the synchronisation accuracy of your NTP clients is dependent on many additional factors. These include network architecture, utilisation, delays and jitter. On a typical network, NTP clients using a Sync Defender as an NTP reference would be expected to be synchronised to within 200 microseconds to 2 msec of UTC on a local area network.

## 4.12 - NTP broadcast mode

Network Time Protocol normally operates in Unicast mode. In Unicast mode, an NTP client requests the time and the Sync Defender responds directly to this request. When operating in NTP broadcast mode, as well as responding directly to Unicast requests, Sync Defender additionally broadcasts NTP messages to all devices on the local subnet. *Please refer to section 3.4 for more details.*

## 4.13 - Viewing system information

Detailed information regarding your Sync Defender system can be viewed in the SYSTEM SETUP > ADVANCED SETUP > SYSTEM INFO menu.

## 4.14 - Viewing system firmware version

The firmware version of your Sync Defender system can be viewed in the SYSTEM SETUP > ADVANCED SETUP > SYSTEM INFO menu.

## 4.15 - Viewing uptime

The uptime of your Sync Defender can be viewed in the STATISTICS menu.

## 4.16 - System statistics

Detailed statistics data can be viewed in the STATISTICS menu.

# 5 - System security

Your Sync Defender incorporates a range of security features, most of which are preconfigured and running transparently in the background without any input from the user. However, there are some additional security features which are programmable by the user. Some of these features must be actively selected by the user. Others come preconfigured, but may be adjusted if required. This chapter details these user programmable security features.

## 5.1 - Guided security setup

Sync Defender incorporates some programmable security features that must be set by the user. When you first boot your Sync Defender, the guided security setup procedure will prompt you to actively select these mandatory settings. You will be guided through setting a Front Panel Trust Level, a USB Interface Trust Level and, if required, passwords and a recovery pin. You can also optionally adjust the Time Reference Trust Level.

Your Sync Defender will not operate until the guided security setup procedure has been completed.

## 5.2 - Front panel trust level

Sync Defender has a front panel touch interface to enable easy system setup. Depending on the physical security of your server room, it may be desirable that this interface has a level of password protection or is even fully disabled. The 'Front Panel Trust Level' dictates the lock-down level of the front panel touch interface. One of five trust levels must be actively selected by the user. The chart below details the available trust levels.

| Front panel trust level | Function |
|---|---|
| 5 | No security |
| 4 | Password required for advanced setup |
| 3 | Password required for all setup |
| 2 | Password required for live status & stats |
| 1 | Touch interface disabled |

*Table 5.1 - Front panel trust levels*

If your server room is locked down and secure, trust level 5 would be a good choice to allow engineers quick and easy access to your Sync Defender. For less secure environments, a lower trust level would normally be advisable.

The front panel trust level is set as part of the Guided Security Setup when you first boot your Sync Defender. Alternatively, the front panel trust level can be modified in the ADVANCED SETUP > SECURITY SETTINGS menu.

## 5.3 - USB interface trust level

Sync Defender has USB connection to enable configuration and firmware updates. Depending on the physical security of your server room, it may be desirable that the USB interface is password protected. The 'USB Interface Trust Level' dictates the lock-down level of the USB interface. One of five trust levels must be actively selected by the user. The chart below details the available trust levels.

| USB interface trust level | Function |
|---|---|
| 5 | No security |
| 4 | Password required for advanced setup |
| 3 | Password required for all setup |
| 2 | Password required for live status & stats |
| 1 | USB interface disabled |

*Table 5.2 - USB interface trust levels*

If your Sync Defender is located in a secure environment, trust level 5 would be a good choice to allow engineers easy access to your Sync Defender. For less secure environments, a lower trust level may be more suitable.

The USB Interface Trust Level is set as part of the Guided Security Setup when you first boot your Sync Defender. Alternatively, the USB Interface Trust Level can be modified in the ADVANCED SETUP > SECURITY SETTINGS menu.

## 5.4 - System passwords

Sync Defender can only be configured via two methods; 1) the front panel touch switches and 2) the USB interface. If required, access to both of these interfaces can be password protected or even fully disabled.

When you first boot your Sync Defender, the guided security setup procedure will prompt you to select a Front Panel Trust Level and a USB Interface Trust Level. If either of these settings are set to any level other than the highest setting (trust level 5), you will be prompted to enter a password. The front panel password and USB interface password are both unique, but can be the same password if you wish.

Both the front panel password and USB interface password can

be modified or the relevant trust levels adjusted in the ADVANCED SETUP > SECURITY SETTINGS menu.

When setting a password, you will also need to enter a recovery pin. The recovery pin enables either password to be reset if required.

## 5.5 - Using the password recovery pin

If a password has been mislaid, the password can be reset and access to your Sync Defender restored via the password recovery pin. The recovery pin is entered using the front panel touch interface via the ADVANCED SETUP > SECURITY SETTINGS menu. Alternatively, if your Sync Defender is set to a low trust level and access to the advanced setup menu is restricted, follow the on-screen prompts to recover the password and enter the recovery pin.

## 5.6 - Time reference trust level

Sync Defender incorporates many features to ensure secure synchronised timing on your network. However, any time server is always reliant on the operation of its time reference to be able to provide stable timing. The Time Reference Trust Level is a simple method to configure how much you want your Sync Defender to trust its time reference.

When you change the Time Reference Trust Level, you are actually configuring three different Time Reference settings; the GNSS Anti-jamming Mode, the GNSS Time Discontinuity Allowance and the GNSS Oscillator Steering Allowance. These three settings all have a direct effect on the security of the Sync Defender system timing. For most installations, selecting one of the five Time Reference Trust Levels would be the most optimal way to configure your Sync Defender. However, the three settings can be manually adjusted if required. *Please refer to chapter 3 for more details*.

The chart below details the five Time Reference Trust Levels.

| Time reference trust level | Anti-jamming mode | Time discontinuity allowance | Oscillator steering allowance |
|---|---|---|---|
| 5 | DISABLED | ANY | FULL |
| 4 | ENABLED | ANY | FULL |
| 3 (TCXO / OCXO) | ENABLED | SMALL CHANGE | FULL |
| 2 (TCXO / OCXO) | ENABLED | NO CHANGE | FULL |
| 1 (OCXO only) | ENABLED | NO CHANGE | TIGHT ONLY |

*Table 5.3 - Time reference trust levels (model dependent)*

Sync Defender comes preset with the Time Reference Trust Level set to level 4. This is a good choice for most installations. It includes GNSS anti-jamming and spoofing support, but otherwise fully trusts the time reference.

However, there are situations in which it may be advisable to select a lower trust level. For example, for more mission critical applications, trust level 1 would give you much tighter control over the time on your network. In normal operation, the oscillator in your Sync Defender would be steered by the time reference, but only within very tight limits. If the time reference jumps in time, or tries to steer the oscillator frequency too far, your Sync Defender will switch to holdover mode and flag an alarm.

The Time Reference Trust Level also provides flexibility on dual sync input systems, where each sync input has its own trust level setting. For the main time reference, you may wish to trust a certain GNSS constellation completely but with anti-spoofing capability (trust level 4). The second time reference could be configured to use a different backup constellation with a lower trust level (trust level 1, where time jumps aren't allowed and steering is within tight fixed limits). This provides a good balance between time reference redundancy and security of your timing. If your preferred GNSS system fails, you still get backup timing, but are not trusting this without question.

Please note that the lower settings rely on the stability of the oscillator and as such are not available on all Sync Defender models. The strictest setting (Time Reference Trust Level 1) is only available on models with an OCXO oscillator.

The Time Reference Trust Level can be adjusted as part of the Guided Security Setup when you first boot your Sync Defender. Alternatively, the Time Reference Trust Level can be modified in the ADVANCED SETUP > SECURITY SETTINGS menu.

## 5.7 - Timing LAN security

The timing LAN on your Sync Defender is powered by a proprietary network stack built from the ground up to provide secure stable timing. The security hardened design of the timing LAN ensures that only the essential protocols needed for timing are supported. It is not possible to access or configure Sync Defender via the timing LAN. Security features implemented by the timing LAN cannot be disabled or adjusted by the user.

# 6 - Remote access

Sync Defender is purposely designed to provide a secure time solution for your network.  Remote access to Sync Defender is intentionally highly locked down.

## 6.1 - Remote access via the timing LAN

It is not possible to remotely access or configure any settings via the timing LAN.

## 6.2 - Remote serial port access

The optional RS-232 and RS-485 serial ports on your Sync Defender transmit time and date data in one of 27 different serial formats.  It is not possible to access Sync Defender or configure any settings remotely via the serial port.

## 6.3 - Accessing the Sync Defender via USB

Sync Defender has a dedicated USB connection to enable configuration and firmware updates.  If required, this connection can be password protected *(see chapter 5 for more details).*

# 7 - Optional outputs

## 7.1 - Ethernet timing LAN card

The optional SD-401-ETH Timing LAN card provides an additional timing LAN for your Sync Defender. Up to four timing LAN cards may be fitted in one Sync Defender unit (model dependent). If your Sync Defender has optional SD-401-ETH timing LAN cards fitted, additional Timing LAN submenus will appear in the SYSTEM SETUP menu. The setup and operation of the SD-401-ETH timing LAN is identical to the onboard timing LAN fitted to all models of Sync Defender. Please refer to earlier chapters for installation and configuration details.

## 7.2 - RS-232 output

The optional SD-420-232 RS-232 expansion card provides a serial data output and PPS (pulse per second) output at RS-232 signal levels. If your Sync Defender has the optional RS-232 output card fitted, additional submenus will appear in the SYSTEM SETUP menu.

### 7.2.1 - Connecting to the RS-232 output

The RS-232 serial output option has a female DB-9 (DE-9) D-Sub (DTE) connector. Table 7.1 shows the pin connections.

| Pin | Signal | Source | Description |
|---|---|---|---|
| 1 | PPS | Output | Pulse Per Second |
| 2 | TXD | Output | Transmitted data |
| 3 | RXD | Input | Received data |
| 5 | GND | Input | Signal ground |
| 4, 6 - 9 | unused | - | - |

*Table 7.1 - SD-420-232 option card RS-232 serial port pin connections*

### 7.2.2 - RS-232 data message format

RS-232 serial data is transmitted in one of 27 different formats. The message format can be adjusted in the SYSTEM SETUP > SERIAL PORT menu. Available message formats are listed in appendix C.

### 7.2.3 - RS-232 transmission parameters

RS-232 messages can be transmitted at various different baud rates and with different numbers of data bits, stop bits and parity settings. All of these parameters can be adjusted by the user in the SYSTEM SETUP > SERIAL PORT menu. Table 7.2 lists the available

transmission parameters.

RS-232 data messages are transmitted aligned with the second edge. The serial port can be user-programmed to output an RS-232 data string every second, or periodically.

When set to the 'on demand' repetition rate, the serial port will only output serial data on receipt of a valid transmission request character. Valid characters are 's' (0x73), 'S' (0x53), 't' (0x74), 'T' (0x54) and '?' (0x3f). The data transmission starts on the second edge after a valid request character has been received.

| Serial Output Menu Option | Description Of Function | Available options |
|---|---|---|
| Message format | Format of RS-232 data messages. | Please refer to appendix C |
| Baud rate | Data transmission speed (bits per second) | 1200, 2400, 4800, 9600, 19200 |
| Data bits | Number of data bits | 7, 8 |
| Parity | Error checking | none, odd, even |
| Stop bits | Number of stop bits | 1, 2 |
| Repetition rate | Time period between message transmissions | 1 sec, 1 min, 5 mins, 1 hr, 24 hours (at 00:00), 24 hours (at 03.30), on demand |
| Serial port time zone | Time & date to which the RS-232 output is referenced | local, utc |

*Table 7.2 - SD-420-232 option card RS-232 output options*

### 7.2.4 - RS-232 time zone

As standard, the serial port transmits RS-232 time and date information referenced to the local time zone *(please refer to section 3.5 for further details)*. If required, RS-232 data can be referenced to UTC by adjusting the 'Serial port time zone' in the SERIAL PORT setup menu.

### 7.2.5 - RS-232 serial port PPS output

The RS-232 level PPS output is configured via the SYSTEM SETUP > PPS OUTPUT menu.

| PPS Output Menu Option | Description Of Function | Available options |
|---|---|---|
| PPS output polarity | The polarity of the RS-232 PPS output pulse | standard, inverted, disabled |
| PPS pulse width | Length of each PPS pulse | 20 msec, 100 msec, 200 msec |

*Table 7.3 - SD-420-232 option card RS-232 PPS output menu options*

PPS (pulse per second) data is available on pin 1 of the RS-232 output port. When enabled, the PPS pin provides a short pulse every second, aligned with the second edge. PPS data is transmitted at RS-232 signal levels.

When set to standard output polarity, the pin is normally at a negative voltage level (RS-232 logic state 1). At the start of the second edge, the pin switches to a positive voltage level (RS-232 logic state 0). After the PPS pulse has ended, the pin switches back to a negative voltage level.

When set to inverted operation, pin polarity is the opposite of standard operation (normally held at logic state 0, switching to logic state 1 at the second edge).

The width of the PPS pulse may be adjusted from 20 msec to 200 msec.

### 7.2.6 - Checking the status of the RS-232 card

The status of the RS-232 output card can be visually checked via the relevant front panel EXPANSION LED. If the card is detected, the LED will be illuminated. As the card is outputting data, the LED will flash.

## 7.3 - RS-485 output

The optional SD-421-485 RS-485 expansion card provides a serial data output at RS-485 signal levels. If your Sync Defender has the optional RS-485 output card fitted, an additional SERIAL PORT submenu will appear in the SYSTEM SETUP menu.

### 7.3.1 - Connecting to the RS-485 output

The RS-485 serial output option has a three pin terminal block connector. Table 7.4 shows the pin connections.

| Label | Source | Description |
|---|---|---|
| A | Output | RS-485 data A (non-inverting) |
| B | Output | RS-485 data B (inverting) |
| GND | - | Ground ref. |

*Table 7.4 - SD-421-485 option card RS-485 serial port pin connections*

### 7.3.2 - RS-485 data message format

RS-485 serial data is transmitted in one of 27 different formats. The message format can be adjusted in the SYSTEM SETUP > SERIAL PORT menu. Available message formats are listed in appendix C.

### 7.3.3 - RS-485 transmission parameters

RS-485 messages can be transmitted at various different baud rates and with different numbers of data bits, stop bits and parity settings. All of these parameters can be adjusted by the user in the SYSTEM SETUP > SERIAL PORT menu. Table 7.5 lists the available transmission parameters.

RS-485 data messages are transmitted aligned with the second edge. The serial port can be user-programmed to output an RS-485 data string every second, or periodically.

When set to the 'on demand' repetition rate, the serial port will only output serial data on receipt of a valid transmission request character. Valid characters are 's' (0x73), 'S' (0x53), 't' (0x74), 'T' (0x54) and '?' (0x3f). The data transmission starts on the second edge after a valid request character has been received.

| Serial Output Menu Option | Description Of Function | Available options |
|---|---|---|
| Message format | Format of RS-485 data messages. | Please refer to appendix C |
| Baud rate | Data transmission speed (bits per second) | 1200, 2400, 4800, 9600, 19200 |
| Data bits | Number of data bits | 7, 8 |
| Parity | Error checking | none, odd, even |
| Stop bits | Number of stop bits | 1, 2 |
| Repetition rate | Time period between message transmissions | 1 sec, 1 min, 5 mins, 1 hr, 24 hours (at 00:00), 24 hours (at 03.30), on demand |
| Serial port time zone | Time & date to which the RS-485 output is referenced | local, utc |

*Table 7.5 - SD-421-485 option card RS-485 output options*

### 7.3.4 - RS-485 time zone

As standard, the serial port transmits RS-485 time and date information referenced to the local time zone *(please refer to section 3.5 for further details)*. If required, RS-485 data can be referenced to UTC by adjusting the 'Serial port time zone' in the SERIAL PORT setup menu

### 7.3.5 - Checking the status of the RS-485 card

The status of the RS-485 output card can be visually checked via the relevant front panel EXPANSION LED. If the card is detected, the LED will be illuminated. As the card is outputting data, the LED will flash.

## 7.4 - PPS output

The optional SD-425-PPS Pulse Per Second expansion card provides a high accuracy PPS (pulse per second) output. If your Sync Defender has the optional PPS output card fitted, an additional PPS OUTPUT submenu will appear in the SYSTEM SETUP menu.

### 7.4.1 - Connecting to the PPS output

The PPS output is available on the rear BNC connector and is output at TTL levels into 50 ohms.

### 7.4.2 - Configuring the PPS output

The PPS output is configured via the SYSTEM SETUP > PPS OUTPUT menu.

| PPS Output Menu Option | Description Of Function | Available options |
|---|---|---|
| PPS output polarity | The polarity of the PPS output pulse | standard, inverted, disabled |
| PPS pulse width | Length of each PPS pulse | 20 msec, 100 msec, 200 msec |

*Table 7.3 - SD-425-PPS option card PPS output menu options*

### 7.4.3 - Checking the status of the PPS output card

The status of the PPS output card can be visually checked via the relevant front panel EXPANSION LED. If the card is detected, the LED will be illuminated. As the card is outputting data, the LED will flash.

## 7.5 - IRIG-B output

The optional SD-426-IRIG output expansion card provides a 1KHz amplitude modulated IRIG-B timecode output. If your Sync Defender has the optional IRIG-B output card fitted, an additional IRIG-B OUTPUT submenu will appear in the SYSTEM SETUP menu.

### 7.5.1 - Connecting to the IRIG-B output

The IRIG-B output is available on a rear BNC connector. The output is a 3V p-p into 50 ohms

### 7.5.2 - Checking the status of the IRIG-B output card

The status of the IRIG-B output card can be visually checked via the relevant front panel EXPANSION LED. If the card is detected, the LED will be illuminated. As the card is outputting data, the LED will flash.

# 8 - NTP authentication

Authentication attaches a Message Authentication Code (MAC) to each NTP packet. This allows the receiving device to confirm that the packet came from a trusted server and has not been altered. For authentication to work, both the server and the client must be configured with matching credentials.

Sync Defender supports NTP authentication on all timing LANs. Authentication is enabled or disabled on a per-port basis, with a central Key Store providing key data for all ports. Authentication is available using SHA1 and MD5 cryptographic hash functions.

## 8.1 - The NTP Key Store

The NTP Key Store contains the key data for all timing LANs. The Key Store can be accessed in the SYSTEM SETUP > ADVANCED SETUP menu. Once in the NTP Key Store menu, use the up/down arrows and the Enter switch to navigate through the key store options (add a key / view keys / delete a key / exit).

To add a key, begin by entering a value in the Key ID field, then select the desired hash function from the available options. Next, enter the key data in the Key Data field. Once complete, press Enter to save the key to the Key Store.

To view the keys, use the Left/Right arrows to scroll through the key data.

To delete a key, first select the key using the Left/Right arrows, then press Enter to delete the key.

## 8.2 - Enabling NTP authentication

Once the NTP key data has been added to the Key Store, NTP authentication can be enabled or disabled on a specific timing LAN via the SYSTEM SETUP > TIMING LAN menu.

# A - Specifications

## A.1 - Model variations and option codes

| Model Variations: | |
|---|---|
| Sync Defender 50: | 1 timing LAN, GNSS support |
| Sync Defender 100: | 1 timing LAN, TCXO, GNSS support |
| Sync Defender 200: | 2 timing LANs, TCXO, GNSS support |

| Time Reference Options: | |
|---|---|
| SD-101-GNSS: | Multi-constellation GNSS decoder card |
| SD-102-EXT: | External time reference interface card |
| SD-103-RTC: | Real-time clock module |

| Oscillator Options: | |
|---|---|
| SD-301-TCXO: | TCXO oscillator |
| SD-302-OCXO: | OCXO oscillator |
| SD-303-OCXO-HS: | High stability OCXO oscillator |

| Output Options: | |
|---|---|
| SD-401-ETH: | Timing LAN card |
| SD-420-232: | RS-232 expansion card |
| SD-421-485: | RS-485 expansion card |
| SD-425-PPS: | Pulse per second output expansion card |
| SD-426-IRIG: | IRIG-B timecode output expansion card |

| Dual Redundant Mains / DC Power Input Options: | |
|---|---|
| SD-501-DUAL-MAINS: | Dual redundant mains power |
| SD-502-DC-9-36: | 9-36V DC power supply |
| SD-503-DC-NEG-48: | Negative 48V DC power |

| Antenna Options, Cables and Accessories: | |
|---|---|
| SD-105-ANT: | High-gain anti-jam timing antenna |
| SD-106-BRK: | L bracket for timing antenna |
| SD-107-SRG: | Standard lightning arrester |
| SD-108-SRG-PLUS: | Advanced lightning arrester |
| SD-201-TT03: | 3m TNC-TNC antenna / arrester cable |
| SD-202-TT10: | 10m TNC-TNC antenna / arrester cable |
| SD-203-TT25: | 25m TNC-TNC antenna / arrester cable |
| SD-211-TS03: | 3m TNC-SMA arrester / SD cable |
| SD-212-TS10: | 10m TNC-SMA arrester / SD cable |
| SD-213-TS25: | 25m TNC-SMA arrester / SD cable |

## A.2 - Performance specifications

| Timing LAN Specifications: | |
|---|---|
| Supported protocols: | NTP v2/v3/v4, SNTP v3/v4, DHCP |
| NTP authentication: | SHA1, MD5 |
| NTP performance: | 5000 NTP packets per sec (each port, unauthenticated) |
| NTP timestamp accuracy: | Within 30 µsec of internal timebase |
| Link speed: | 10Base-T / 100Base-TX auto-sensing |

| Holdover Performance (at 20 °C, after 24 hours GPS sync): | |
|---|---|
| SD-301-TCXO: | 2 msecs per day |
| SD-302-OCXO: | 500 µsec per day |
| SD-303-OCXO-HS: | 75 µsec per day |

| Firmware Update Port: | |
|---|---|
| Update port: | USB spec. 2.0 compliant type B full speed |

| Internal GNSS decoder (version SD-101-GNSS) Specifications: | |
|---|---|
| GNSS engine: | 32 satellite parallel tracking |
| GNSS constellations: | GPS, GLONASS, Galileo |
| Min. acquisition sensitivity: | -148dBm (cold start) |
| Min. tracking sensitivity: | -160dBm |
| Synchronised accuracy: | 30 nsec (1 sigma) |
| RF input: | SMA connector |

| Front Panel: | |
|---|---|
| Display: | 20 x 2 alphanumeric backlit LCD |
| Keypad: | Capacitive touch sensing |
| Status LEDs: | 18 x white status LEDs |

| PPS Expansion Card (SD-425-PPS) Specifications: | |
|---|---|
| PPS accuracy: | 50 nsec |
| Output: | BNC, TTL into 50 ohms |

| RS-232 Expansion Card (SD-420-232) Specifications: | |
|---|---|
| RS-232 data accuracy: | 50 µsec |
| RS-232 PPS accuracy: | 1 µsec |
| Connector: | DB-9 (DE-9) female D-Sub (DCE) |

| RS-485 Expansion Card (SD-421-485) Specifications: | |
|---|---|
| RS-485 data accuracy: | 50 µsec |
| Connector: | Detachable screw terminal block |

| IRIG-B Expansion Card (SD-426-IRIG) Specifications: | |
|---|---|
| Data format: | 1KHz amplitude modulated IRIG-B |
| Output: | BNC, 3V p-p into 50 ohms |

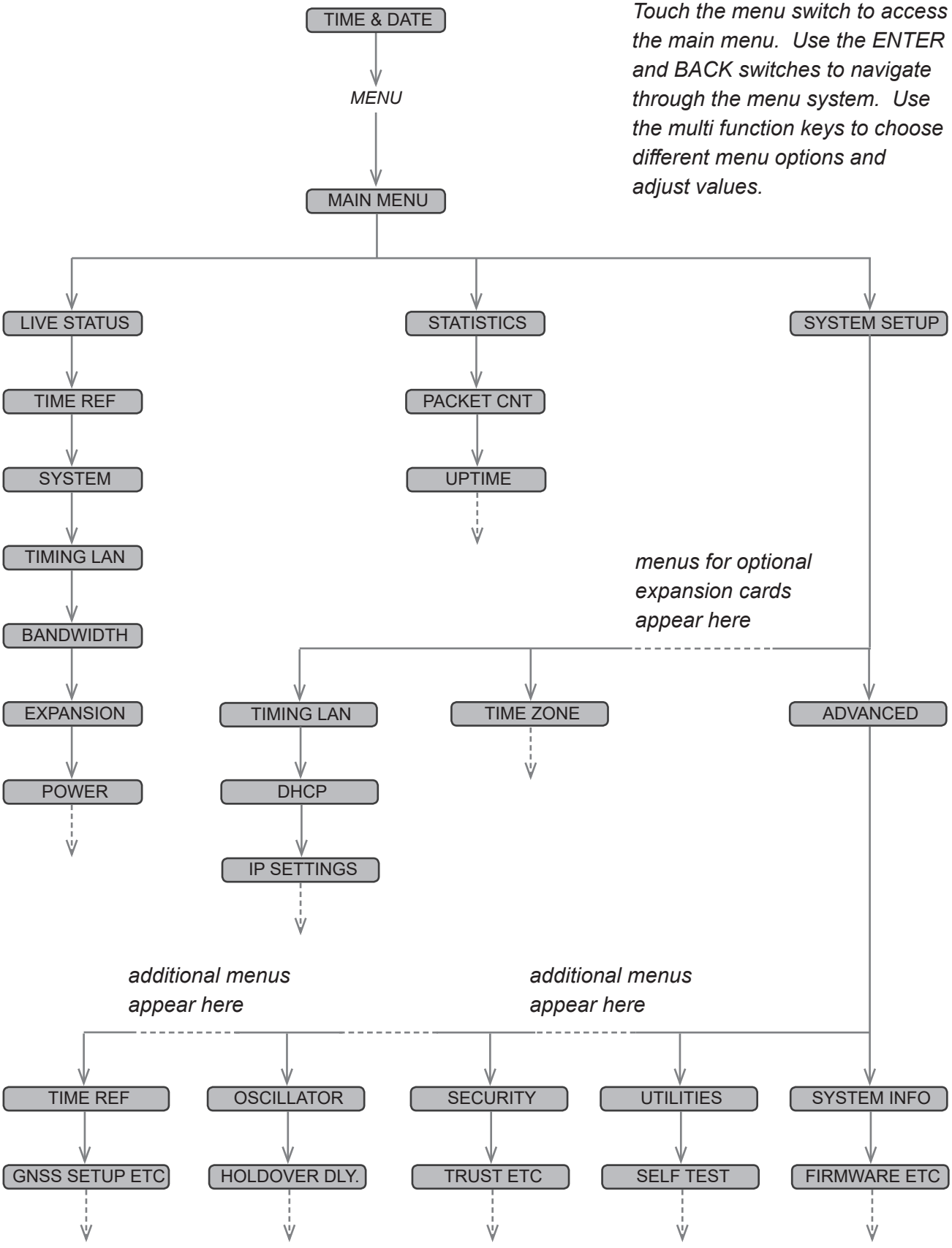
## A.3 - Mechanical specifications and approvals

| Mechanical, Electrical and Environmental Specifications: | |
|---|---|
| Enclosure dimensions: | 430 x 220 x 44 mm (excl. rack brackets) |
| 19” rack configuration: | 1 U high 19” rack mounting |
| Enclosure weight: | 3 kg |
| Packed weight: | 4 kg |
| Power consumption: | < 40 watts |
| Power inlet: | 100-250VAC 50/60Hz dble. fused IEC C14 |
| Optional 2nd power inlet: | 100-250VAC 50/60Hz dble. fused IEC C14 |
| Operating temperature: | 0 to 50 ºC |
| Relative humidity: | 0% - 95%, noncondensing |
| Warranty: | 5 years from date of supply |

| Certification Approvals: | |
|---|---|
| Safety requirements: | BS EN 62368-1: 2024 |
| Emission requirements: | BS EN 55032: 2015 +A1:2020 |
| Immunity requirements: | BS EN 55035: 2017 +A11:2020 |
| Radio equipment directive: | EN 303 413: V1.2.1 (2021-04) |
| CE / UKCA: | Meets all applicable directives |
| RoHS: | RoHS compliant |

*(Specifications subject to change without notice)*

# B - Menu structure



# C - Serial formats

The table below lists the available message formats for the optional RS-232 and RS-485 serial ports. Please refer to chapter 7 for further details.

| No. | Message format | Notes |
|---|---|---|
| 1 | World Time Solutions standard format | |
| 2 | World Time Solutions long format | |
| 3 | World Time Solutions short format | |
| 4 | NMEA GGA | |
| 5 | NMEA RMC | |
| 6 | NMEA ZDA | |
| 7 | Spectracom NetClock/2 format 0 | |
| 8 | Spectracom NetClock/2 format 1 | |
| 9 | Spectracom NetClock/2 format 2 | |
| 10 | Spectracom NetClock/2 format 3 | |
| 11 | Spectracom NetClock/2 format 4 | |
| 12 | EES M100 | |
| 13 | EES M201 | |
| 14 | Meinberg Standard time string | |
| 15 | Computime Time String | |
| 16 | Sysplex 1 | |
| 17 | Wtn. format 1 | |
| 18 | Wtn. format 1 (without status) | |
| 19 | Wtn. format 2 | |
| 20 | Wtn. format 2 (with day of week) | |
| 21 | Racal XGU | |
| 22 | Tecton Darlex | (03:30 & 03:31 only) |
| 23 | TAIP AL (Altitude / Vertical Velocity) | |
| 24 | TAIP CP (Compact Position) | |
| 25 | TAIP LN (Long Navigation) | |
| 26 | TAIP PV (Position / Velocity) | |
| 27 | TAIP TM (Time / Date) | |

*Table C.1 - Serial port message formats*

# D - Time zones

The table below lists the preprogrammed time zones. Time zone offsets followed by a * character indicates that the time zone has daylight saving changes.

| UTC Offset | City / Time Zone |
|---|---|
| 0 | UTC/Reykjavik |
| 0* | London/Dublin/Lisbon |
| 0* | Casablanca |
| +1 | Lagos/Algiers |
| +1* | CET/Paris |
| +2 | Cape Town/Johannesburg/Harare |
| +2* | Athens/Sofia |
| +2 | Cairo |
| +2* | Jerusalem |
| +2* | Beirut |
| +2* | Amman |
| +3 | Khartoum/Nairobi/Baghdad |
| +3* | Moscow (old) |
| +3.5* | Tehran |
| +4 | Dubai/Moscow |
| +4.5 | Kabul |
| +5 | Karachi |
| +5.5 | Mumbai/New Delhi |
| +5.75 | Kathmandu |
| +6 | Almaty/Dhaka |
| +6.5 | Yangon |
| +7 | Bangkok/Jakarta |
| +8 | Singapore/Hong Kong/Beijing |
| +8* | Perth |
| +9 | Seoul/Tokyo |
| +9.5 | Darwin |
| +9.5* | Adelaide |
| +10 | Brisbane |
| +10* | Vladivostok |
| +10* | Melbourne/Canberra/Sydney |
| +11 | - |
| +12 | Suva |
| +12* | Kamchatka/Anadyr |
| +12* | Auckland |
| +12.75* | Chatham Island |
| +13 | - |
| +14 | Kiritimati |

*Table D.1 - Preprogrammed Time Zones*

| UTC Offset | City / Time Zone |
|---|---|
| -10 | Honolulu |
| -9 | - |
| -9* | Anchorage |
| -8 | - |
| -8* | Vancouver/San Francisco |
| -7 | Phoenix |
| -7* | Edmonton/Denver |
| -6 | Guatemala/San Salvador/Managua |
| -6* | Winnipeg/Houston/Chicago |
| -6* | Mexico City |
| -5 | Lima/Kingston/Bogota |
| -5* | New York/Toronto/Nassau |
| -5* | Havana |
| -4.5 | Caracas |
| -4 | Santo Domingo/La Paz/San Juan |
| -4* | Halifax |
| -4* | Santiago |
| -3.5* | Newfoundland |
| -3 | - |
| -3* | Brasilia/Sao Paulo |
| -3* | Montevideo |
| -3 | Buenos Aires |
| -2 | - |
| -1 | - |

*Table D.1 - Preprogrammed Time Zones (cont..)*

# E - Firmware updates

The system firmware in your Sync Defender can be updated via the USB interface using the “Sync Defender Update Tool” Windows PC software. To update the system firmware in your Sync Defender, please complete the procedure below.

I. Download the “Sync Defender Update Tool” to your Windows PC.

II. Run the installer and follow the on-screen prompts to install the “Sync Defender Update Tool” on your PC.

III. Apply power to your Sync Defender and connect to your Windows PC via the USB port.

IV. Download the new firmware release version to your Windows PC.

V. Unzip the new firmware release version.

VI. Run the “Sync Defender Update Tool” software.

VII. Select the new firmware release folder.

VIII. Click the “Install Update” button to update the firmware in your Sync Defender.

# F - Troubleshooting

If you are experiencing problems with your Sync Defender, please run the hardware self-test procedure in the SYSTEM SETUP > ADVANCED > UTILITIES menu.

| Problem | Possible Cause | Solution |
|---|---|---|
| Time synchronisation error | Time reference not synchronised | Check time reference status *(see section 4.4)* |
| | | Check antenna installed correctly *(see chapter 2)* |
| | Cabling fault | Check time reference status *(see section 4.4)* |
| Not responding to NTP requests | No connection to network | Check connection to network switch/hub |
| | | Check patch cable integrity |
| | Sync Defender time not set | Refer to Time synchronisation error section above |
| | | If not using a GNSS antenna, manually set local time and date *(see section 3.10)* |
| Liquid crystal display hard to read | Contrast set incorrectly | Adjust LCD contrast *(see section 3.15)* |
| Liquid crystal display backlight switching off automatically | Low power mode enabled | Disable low power mode *(see section 3.13)* |
| Optional RS-232 output not functional | RS-232 output configured incorrectly | Check all RS-232 output settings *(see section 7.2)* |
| Optional RS-485 output not functional | RS-485 output configured incorrectly | Check all RS-485 output settings *(see section 7.3)* |
| Optional PPS output not working as expected | PPS output configured incorrectly | Check PPS settings *(see section 7.4)* |

*Table F.1 - Troubleshooting guide*

# G - Revision history

| Version | Description | Date |
|---|---|---|
| 2.0 | Added NTP authentication.<br>Updated optional power supply section.<br>Added RTC battery replacement details.<br>Clarified wording of Time Discontinuity SMALL_CHANGE operation. | June 2026 |
| 1.2 | Added RTC and power options.<br>Added advanced lightning arrester option.<br>Added holdover specs for oscillator upgrades. | Feb 2025 |
| 1.1 | Amended Firmware Updates section.<br>Updated Certifications. | Aug 2024 |
| 1.0 | First release | Oct 2023 |

# Index

## Symbols



## A



## B



## C



## D



## E



## F



## G



## H



## I

## L



## M



## N



## O



## P



## Q



## R



## S

## T



## U



## W

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