

Time Synchronization & Timekeeping

Time synchronization lets you synchronize the internal clocks of all networked PowerLogic™ ION™ meters and devices. Once synchronized, all data logs have timestamps that are relative to a uniform time base. This allows you to achieve precise sequence-of-events and power quality analyses. To synchronize clocks, use ION Setup or ION Enterprise™ software, a Network Time Protocol (NTP) server, a Global Positioning System (GPS) receiver or supported 3rd party protocols to broadcast time signals across the network.

 **NOTE**

The information in this technical note applies to ION devices. Devices not based on ION architecture are not covered by this document.

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Additional Information

- ◆ Your meter’s technical documentation
- ◆ *ION Reference*
- ◆ *TCP/IP Network Connectivity* technical note
- ◆ *DLMS/COSEM and ION Technology* technical note

Introduction

Time synchronization signals are broadcast periodically over the network; each meter continually assesses its ability to remain synchronized with the incoming broadcasts. Over a brief period, each meter learns how its internal timing differs from that of the broadcast source and adjusts its timekeeping to compensate. Very accurate time synchronization is achieved with this method.

Meters at modem sites are synchronized each time they are connected. The longer the duration between connections, the larger the error in time synchronization. In the extreme case, this can result in missing or duplicated logs. If this occurs, you can increase the frequency of connections: install GPS receivers at the remote sites, or arrange for a direct ION Setup or ION Enterprise software connection.

It is important that only one method of time synchronization be used on each network. If multiple methods are used, the timestamps will differ for the sites and devices using separate time synchronizing methods.

Before you configure time synchronization on your network, you should familiarize yourself with the Clock module settings. Once you have done this, you can decide which synchronization method you want to use.

 **NOTE**

Time Synchronization is disabled by default with ION Enterprise. In order to use time synchronization with an ION device, the feature must be enabled from Management Console for that device. Refer to "Enabling or Customizing Time Synchronization" on page 6 for instructions.

Clock Module Settings

The Clock module controls an ION meter's internal clock. In order to correctly set up time synchronization with your single meter or network, you need to configure the Clock module's Setup registers to correspond to the type of time synchronization you desire. Use ION Setup or ION Enterprise software or the meter's front panel Setup menu to configure the Clock module.

Clock Source Used for Synchronization

The *Clock Source* setup register has three settings from which to choose, depending on the method of time synchronization.

◆ LINE FREQUENCY:

When the *Clock Source* is set to monitor the ISO Grid Operation line frequency, each meter auto-corrects the internal clock based on the measured line frequency. Over a long period of time, this form of time keeping is highly accurate. If a power outage occurs, the clock automatically synchronizes with the meter's internal crystal until power is restored. Once the power is restored, the clock once again synchronizes with the line frequency. Most ION meters synchronize with the line frequency by default.

◆ INTERNAL:

If you prefer having the meter itself provide timekeeping, set the *Clock Source* setup register to INTERNAL. The clock then synchronizes to the meter's internal crystal.

◆ COMM:

Use this for the *Clock Source* if you set the *Sync Source* setup register (see below) to a COM port to receive GPS time synchronization signals.

Type of Time Used for Synchronization

The *Time Sync Type* setup register specifies whether time synchronization signals are received in Coordinated Universal Time (UTC) or Local Time.

◆ UTC:

Coordinated Universal Time is the standard time common to every place in the world. Formerly and still widely called Greenwich Mean Time (GMT), UTC nominally reflects the mean solar time along the Earth's prime meridian. It is expressed using a 24-hour clock but can be converted into a 12-hour clock (AM and PM). The time kept on the ION meter is always UTC (24-hour clock). When using UTC, the *TZ Offset* and *DST Offset* setup registers (see below) are not required. The *Time Sync Type* setup register is set to UTC by default.

◆ LOCAL:

This setting requires that the time zone offset and DST offset are filled in correctly. Thus, Local time is basically the UTC adjusted for time zone and daylight savings time. There are some DNP masters and GPS receivers that use Local time; for these only, change the *Time Sync Type* from its default setting to LOCAL.

Time Zone Adjustment

The *TZ Offset* register specifies the time zone applicable to the area in which the meter resides. It is obtained by adding or subtracting the appropriate number of hours and minutes (hh:mm) from UTC time.

Daylight Savings Time Adjustment

The *DST Offset* register holds the Daylight Savings Time offset applicable to the meter’s location. The *DST Offset* is the amount of time in hours and minutes (hh:mm) that the clock is adjusted when Daylight Savings Time begins.

 **NOTE**

The setup registers, *DST Offset* and *TZ Offset* have no affect on the information recorded by a meter’s data and event recorders. These recorders always use UTC as their timestamped reference.

Communications Port Used for Synchronization

The *Time Sync Source* setup register specifies which communications port receives time synchronization signals. Only signals received on the selected port are used for time synchronization; all other time synchronization signals are ignored. Signals can be received on the following ports:

- ◆ COM1¹
- ◆ COM2¹
- ◆ COM3¹
- ◆ COM4¹
- ◆ 10Base-T Ethernet port²
- ◆ IRIG-B³

¹ On ION meters with the *Serial Port* register (Communications modules), you must use the default setting (8N1) in order to time synchronize via the meter’s serial ports.
² GPS Time Synchronization cannot be used with the Ethernet port, since time synchronization accuracy cannot be guaranteed; there is no way to determine when a packet will arrive over the Ethernet.
³ Optional IRIG-B GPS Time Synchronization available on selected meters only. See the *IRIG-B GPS Time Synchronization* Product Option document for configuration details.

You can perform meter time synchronization via an Ethernet connection using one of the following *Time Sync Source* setup register settings:

Ethernet Synchronization Setup Register Options

Ethernet	Accepts time synchronization signals over any Ethernet connection
Ethernet – ION	Only accepts time synchronization signals over the Ethernet via the specified protocol
Ethernet – DNP	
Ethernet – MODBUS	

Time can be synchronized using ION, DNP 3.0, Modbus and DLMS protocols. GPS time synchronization uses special protocols defined for the type of GPS receiver you are using. The following table summarizes the time synchronization sources:

Source of Synchronization used for the <i>Time Sync Source</i> Register	Protocol Register in the Communications Module	Time Sync Type Register in the Clock Module	Clock Source Register in the Clock Module
ION	ION	UTC ¹	LINEFREQ, INTERNAL
DNP	DNP	UTC/LOCAL	LINEFREQ, INTERNAL
MODBUS	MODBUS	UTC/LOCAL	LINEFREQ, INTERNAL
Arbiter 1092	GPS:ARBITER GPS:ARBITER-VORNE	UTC/LOCAL	COMM
Symmetricom XL-DC series (was True Time XL-DC series)	GPS:TRUETIME/DATUM	UTC/LOCAL	COMM
Symmetricom ExacTime series (was Datum ExacTime series)	GPS:TRUETIME/DATUM	UTC/LOCAL	COMM
Clark GPS-200-ASCII	GPS:TRUETIME/DATUM	UTC/LOCAL	COMM
DLMS	DLMS	UTC/LOCAL ²	LINEFREQ, INTERNAL

¹ Note that ION time synchronization only uses the UTC setting; the LOCAL setting cannot be used.

² This register is not used with DLMS.

Time Synchronization: ION Enterprise, ION Setup, GPS or NTP

Use ION Setup or ION Enterprise software for systems where time synchronization is not critical:

- ◆ ION Enterprise can synchronize a meter's clock to within ± 16 ms (typical) of other meters in a serial network.
- ◆ ION Setup can be used for manual "one-time" timesyncs to an individual meter. It uses your computer's clock.

Use a **GPS receiver** if you require time synchronization to within ± 1 ms of Coordinated Universal Time (UTC), or within ± 2 ms (typical) of other meters in the network. If you install a GPS receiver, you will need an additional serial network.

Use an **NTP server** for systems where time synchronization is not critical. NTP can synchronize a meter's clock to within ± 1 sec (worst case) of other meters in an Ethernet network.

ION Enterprise Time Synchronization and ION Devices

While ION Enterprise provides for scheduled time synchronization, it is disabled by default and must be configured through Management Console. The communications port and protocol used for communications between ION Enterprise and the networked ION devices is automatically used to send time synchronization signals to all connected ION devices. ION Enterprise sends out a time sync packet and the time is set once the packet is received.

Time synchronization values are set when sites or Ethernet devices are defined in an ION Enterprise network. You enable time synchronization or set custom intervals for any device in any site through Management Console.

Enabling or Customizing Time Synchronization

1. Start Management Console.
2. From the System Setup Pane, select Sites or Devices:
 - ◆ Select **Sites** if you want to customize a particular serial, modem, or Ethernet Gateway site.
 - ◆ Select **Devices** if you want to customize an individual Ethernet device.
3. Right-click the device or site you want to configure and select Configure Device (or Configure Site). The Device Configuration (or Site Configuration) dialog box appears.
4. Right-click inside the dialog box and select Advanced Properties.
5. Configure the Time Synch fields (i.e., Time Synch ION Enabled, Time Synch Interval Ethernet) as required for your system.
6. Click **OK** to save your changes.

The default time synchronization interval of 3,600 seconds (displayed in milliseconds) is acceptable for most ION Enterprise installations.

NOTE

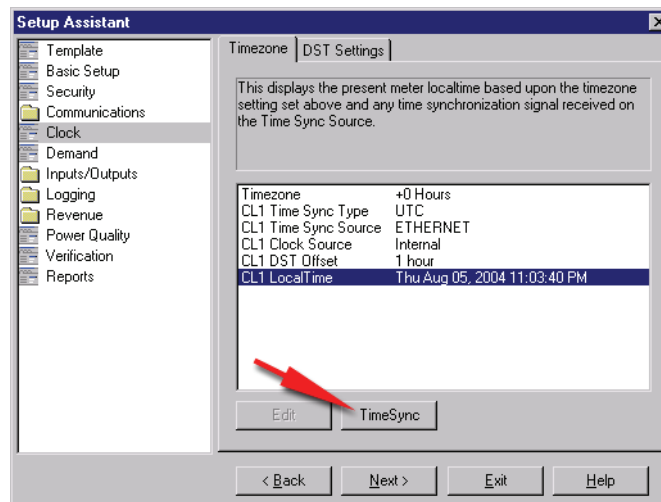
You need appropriate permissions to configure the meters on your network. Refer to the *ION System Security* technical note for details on software and meter security.

ION Setup Time Synchronization

Use ION Setup for initial time synchronization (when putting the meter into service) or when manual time syncs are required. ION Setup uses the computer's time. Note that ION Setup will not timesync automatically -- you must perform the following instructions every time you want to synchronize this meter.

Performing a Timesync using ION Setup

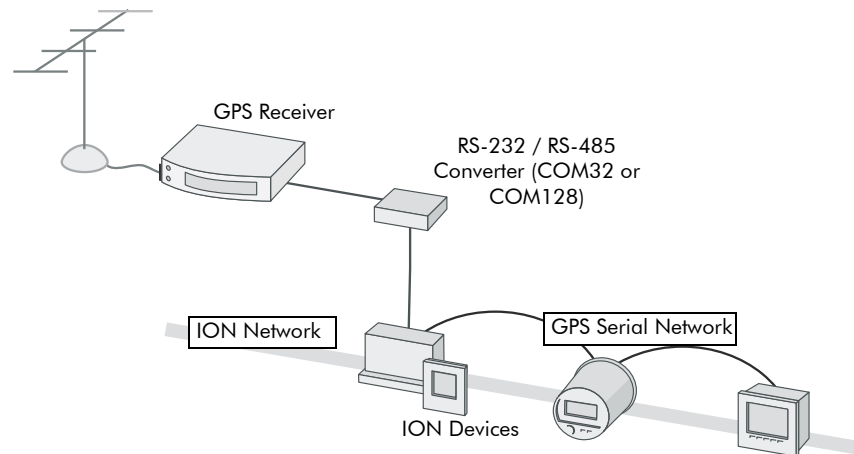
1. Connect to your meter in ION Setup, using Basic Mode.
2. Click on the Setup Assistant and navigate to the Clock folder.
3. Select Time Sync Source and click **Edit**. Choose the communication port you are currently using to connect to the meter (ETHERNET in this example).
4. Click **TimeSync** to synchronize the meter's clock to the computer.



GPS Time Synchronization

A dedicated serial network is required to implement a GPS scheme. If you are already using a serial link for communications with ION Enterprise, you need a second serial network to transport GPS signals.

Either RS-232 or RS-485 networks can be used for GPS time synchronization, though RS-485 is recommended if more than two meters are being synchronized. If your GPS receiver output is RS-232, use the COM32 or equivalent RS-232/RS-485 converter that does not buffer communications. The COM128 is not recommended if used in Repeater Mode.



Configuring for GPS Time Synchronization

To implement GPS time synchronization, use the Designer component of ION Enterprise to configure the Clock module and the Communications module:

1. Start Designer (ensure **Options > Show Toolbox** is selected). Double-click the Clock module.
2. Set the Clock module's *Clock Source* setup register to **COMM**.
3. Specify which COM port will receive time synchronization signals by setting the *Time Sync Source* setup register in the meter's Clock module. Note that Ethernet can not be used with GPS time synchronization. Only signals received on the port specified are used for synchronization.
4. Specify the receiver you want to use by selecting it from the *Protocol* setup register in the receiving port's Communications module (see table below).

You may need to modify the *Time Sync Type* setup register to **LOCAL**, if a DNP Master is sending time broadcasts in local time.

NOTE

Ensure that the Quality character of the GPS receiver is enabled. Contact your GPS vendor for instructions.

Supported GPS Receivers

The following receivers are supported. Standard models of these receivers are sufficient, as long as they have RS-232 ports — additional options are available, but not required:

GPS Receiver	Comm Module Protocol Register Setting
Symmetricon XL-DC series (was True Time XL-DC series)	GPS:TRUETIME/DATUM
Symmetricon ExacTime series (was Datum ExacTime series)	GPS:TRUETIME/DATUM
Arbiter 1092	GPS:ARBITER GPS:ARBITER-VORNE
Clark and Associates GPS-200-ASCII	GPS:TRUETIME/DATUM

For more information about supported GPS receivers, see the manufacturers' web sites: <http://www.arbiter.com> and <http://www.symmetricon.com>

NOTE

Meters with the IRIG-B time synchronization option accept input from any GPS receiver that outputs unmodulated IRIG-B time code data. See the *IRIG-B GPS Time Synchronization* product option document for meter configuration details.

GPS Time Synchronization Format

Any GPS receiver may be used as a time synchronization source, as long as the receiver outputs the ASCII time string (shown below) every second and has On Time Mark (OTM).

Use the table below to select the appropriate *protocol* register for each OTM type.

On Time Mark (OTM)	Protocol Register
Start bit of <SOH>	GPS:ARBITER
Start bit of <CR>	GPS:TRUETIME/DATUM
Start bit of <BEL>	GPS:ARBITER-VORNE

During normal operation of a GPS time synchronizing system, time signals are sent out once per second as an ASCII string containing the time.

The ASCII time string for GPS:ARBITER and GPS:TRUETIME/DATUM is the following:
<SOH>DDD:HH:MM:SSQ<CR><LF>

The ASCII time string for GPS:ARBITER-VORNE is the following:

44HHMMSS<CR><LF>

55DDD<CR><LF>

11NN<CR><LF>

<BEL>

Explanation of GPS:ARBITER & GPS:TRUETIME/DATUM ASCII Time String

ASCII Time String: <SOH>DDD:HH:MM:SSQ<CR><LF>	
<SOH>	start of header (ASCII 01 _{hex})
DDD	day of the year
HH	hours
MM	minutes
SS	seconds
Q	quality flag
<CR>	carriage return (ASCII 0D _{hex})
<LF>	line feed (ASCII 0A _{hex})

Explanation of GPS:ARBITER-VORNE ASCII Time String

ASCII Time String (below left) ¹	
44HHMMSS<CR><LF>	UTC/local time
55DDD<CR><LF>	day of the year
11NN<CR><LF>	out-of-lock time in minutes
<BEL>	<BEL> = hex 07

¹ Explanation of <CR> and <LF> is the same as in the previous table.

The bytes in the time string must transmit continuously for the time synchronization signals to be received correctly. When using a GPS receiver for time synchronization, it is best to use it at 9600 baud rather than a higher baud rate. This reduces the chance of bytes being interrupted and provides the best accuracy, since the accuracy of the OTM depends on the baud rate.

NTP Time Synchronization

To implement NTP time synchronization, your meter must be connected to an Ethernet network with access to an NTP server.

See the *TCP/IP Network Connectivity* technical note and the Clock module description in the *ION Reference* for more information on configuring NTP time synchronization with ION meters.

3rd Party Protocol Time Synchronization

For more information on time synchronization through 3rd party protocols, see the technical note or protocol document which discusses the particular protocol.

Diagnostics and Event Logging

The meter's Diagnostics module includes output registers that provide time synchronization diagnostics. Events are logged by the meter's Clock module, Communications modules, and Diagnostics module in response to time synchronization events.

Diagnostics Module Output Registers

- ◆ *Time Sync Source*

This register is ON if the internal clock synchronizes with the line frequency or GPS, and it is OFF if the internal clock synchronizes with its own internal crystal.

- ◆ *GPS Receiver Status*

This register is ON if the GPS receiver is locked onto a time source and OFF if the lock is lost. This information is received directly from the GPS receiver; the register is NOT AVAILABLE if the GPS time synchronization is not used.

- ◆ *Time Sync Count*

This register indicates how many time synchronization signals have been received. The value increases with each signal received.

- ◆ *Time Since Last Time Sync*

This register displays the amount of time, in seconds, since the last time synchronization signal was received.

- ◆ *Time Sync Diag (time sync diagnostics)*

This register displays the difference, in microseconds, between the timestamp in a synchronization signal and the time in the device's clock when the signal is received. The displayed value is a sliding window average over the last five time synchronization signals received.

- ◆ *Time Sync Status*

This register is ON if a time synchronization signal is acquired, and OFF if the signal has been lost. The Diagnostics module calculates the average interval for the last five signals received, considering the signal lost if no signals are received in two times the average interval.

Event Logging

The following events appear in the Event Log:

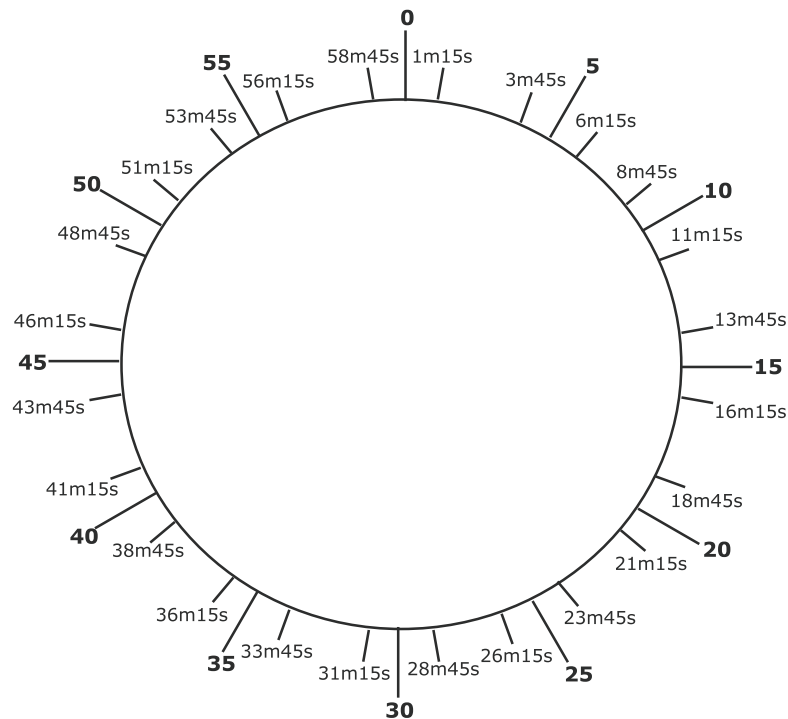
- ◆ Time sync acquired — generated when the first time sync signal is received (Diagnostics module's Time Sync Status register goes ON).
- ◆ Time sync lost event — generated if no time sync signals are received in two times the average interval of the last five signals (Diagnostics module's Time Sync Status register goes OFF).
- ◆ GPS locked — generated when the GPS receiver locks onto a time source (Diagnostics module's GPS Status register goes ON).

- ◆ GPS unlocked — generated when the GPS receiver loses its lock on a time source (Diagnostics module's GPS Status register goes OFF).
- ◆ Time set event — generated when a time synchronization signal is interpreted as a time set, and the meter's clock is reset. Two events are recorded: one with the timestamp before the clock was set, and one with the timestamp after the clock was set.

Time Synchronization Blackout

Time synchronization blackout is defined as a period when time synchronization cannot occur. Utilities often record power usage at regular, predetermined intervals. For example, the utility may schedule a recording every five minutes during an hour period (i.e. 5, 10, 15, 20,..., 55, 60). If a time sync moves the meter clock forward, the meter may miss one of the recording intervals. If a time sync moves the meter clock backwards, the meter may get two records with the same timestamp. The time synchronization blackout feature seeks to protect the time before and after these recording intervals by not sending out any time sync signals at those times.

ION Enterprise has time synchronization blackouts enabled automatically even though time syncing is disabled by default in ION Enterprise. The blackout intervals are every five minutes as follows: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55. Each blackout is 2 minutes and 30 seconds in duration. This duration is distributed evenly before and after the interval. The diagram below illustrates the time synchronization blackout feature in ION Enterprise.



If a regularly scheduled time sync is not sent because of a blackout interval, the software continues trying to send the time synchronization signal every 15 seconds until the blackout period expires and the time sync is sent.

Changing Default Blackout Settings

In order to change the default settings for the interval or the blackout duration, you must edit the registry of the computer where ION Enterprise is installed.

CAUTION

Only edit the registry information detailed here. Making changes to other registry settings can have undesirable, possibly detrimental, effects on your system.

There are two registry entries that control the time-synchronization blackout behavior.

Create the following registry REG_DWORD values under the HKEY_LOCAL_MACHINE\Software\Schneider Electric\ION Enterprise\<version_number> key:

TimesyncBlackoutInterval_mins

Default value: 5

This entry is specified in minutes. It must have a value greater than 1 in order for time-synchronization blackouts to occur. A value of 60 or greater configures blackouts to occur once an hour.

TimesyncBlackoutDuration_secs

Default value: 150 (2 minutes 30 seconds in seconds)

This entry is specified in seconds. A value of 0 (zero) disables the blackout feature. This entry cannot have a value greater than or equal to 3600 (one hour).

NOTE

If you want to disable the blackout feature but keep time synchronization enabled, set the TimesyncBlackoutDuration_secs register to 0.

There are certain settings for these registry entries that can disable time synchronization in general (not just the blackout feature). These are as follows:

- ◆ TimesyncBlackoutInterval_mins < 1
- ◆ TimesyncBlackoutDuration_secs >= 3600 (1 hour)
- ◆ TimesyncBlackoutDuration_secs (the value converted to minutes) >= TimesyncBlackoutInterval_mins

Do not use any of these settings to disable time synchronization. If you want to disable time synchronization for a particular device, use Management Console. Refer to “Enabling or Customizing Time Synchronization” on page 6.

Time-Synchronization Blackout Considerations

- ◆ Remember to specify TimesyncBlackoutInterval_mins in minutes and TimesyncBlackoutDuration_secs in seconds.
- ◆ If your blackout values conflict or are out of range, an error is sent to the system log database. If time synchronization signals are not occurring, check the system log to see if there's an error message about your blackout values.
- ◆ When reviewing time synchronization messages in the system log, remember that the time in the message is not the time to which the meter was time synced, but rather it is the time the message was posted to the system log. The message is posted after the meter is time synced.