Chapter 43

# Time and leap seconds

TEC/NOT/072

This technical note describes how leap seconds and year information are set by Curtiss-Wright products and is divided into the following sections:



## 43.1 Time standards available for use with Curtiss-Wright products

Now that three standards of time can be used in the Acra KAM-500, better care can be taken to account for leap seconds.

The three standards times are:

- **TAI:** Temps Atomique International is the international atomic time scale based on a continuous counting of the International System of Units (SI) second. TAI is currently ahead of UTC by 36 seconds. TAI is always ahead of GPS by 19 seconds. Precision Time Protocol packet timestamp and Precision Time Protocol version 1 (PTPv1) is based on TAI.
- **UTC:** Coordinated Universal Time, known as Greenwich Mean Time (GMT), or Zulu time. Local time differs from UTC by the number of hours of your time zone. UTC is occasionally adjusted by lengthening or shortening the last minute of a month by one second because it is based on earth time. The world does not rotate uniformly, which causes a drift in UTC time. Of the 24 leap seconds that were added from 1972 to 2008, most were conveniently applied at the end of the last minute of the year. However, nine occurred on the 31st of June in various years. IENA packet timestamp time is based on UTC.
- **GPS:** Global Positioning System time is the atomic time scale implemented by the atomic clocks in the GPS ground control stations and the GPS satellites themselves. GPS time was zero at 0:00, 6-Jan-1980 and since it is not perturbed by leap seconds GPS is now ahead of UTC by 17 seconds.

In summary, the leap seconds for July 2016 are:

TAI = UTC + 36 seconds

GPS = UTC + 17 seconds

TAI = GPS + 19 seconds

## 43.2 Packet timestamps

The Acra KAM-500 offers two types of Ethernet packets, that is, IENA and iNET-X. For more information on Ethernet packets, see *TEC/NOT/067 - IENA and iNET-X packet payload formats*.

This document refers to the timestamps of these packets.

### 43.2.1 IENA timestamps

These 48-bit timestamps are associated with the oldest unit of data in the payload. It represents the time of the current year, in microseconds, since the 1st January. In the case of analog data, the timestamp relates to the earliest sample contained in the payload.

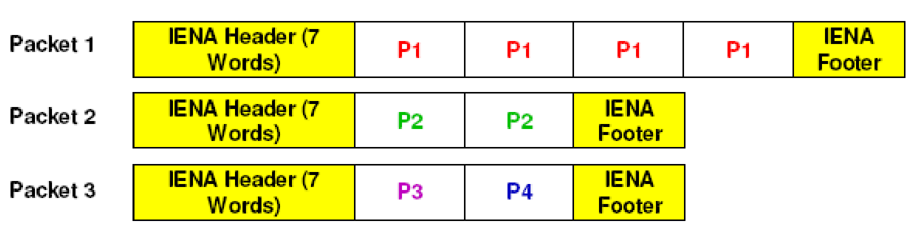


*Figure 43-1: IENA packet content*

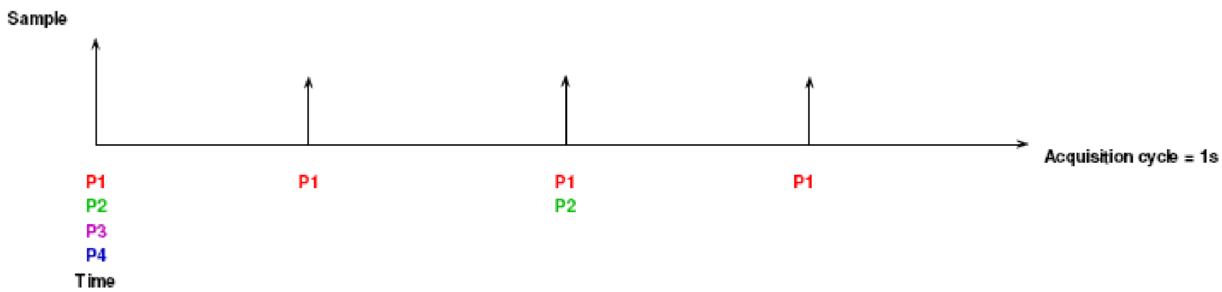


*Figure 43-2: Example of IENA timestamp*

### 43.2.2 iNET-X PTP timestamps

These 64-bit timestamps are associated with the oldest unit of data in the payload. In the case of analog data, the timestamp relates to the earliest sample contained in the payload. For bus monitor data, the timestamp relates to the first and earliest bit or message captured on the bus. The time format used is unsigned IEEE 1588-2004 Precision Time Protocol version 1 (PTPv1) format using PTP epoch where:

- Bits [0:31] time = second count since January 1st 1970

- Bits [32:63] time = nanosecond count since start of second


*Figure 43-3: iNET-X packet content*

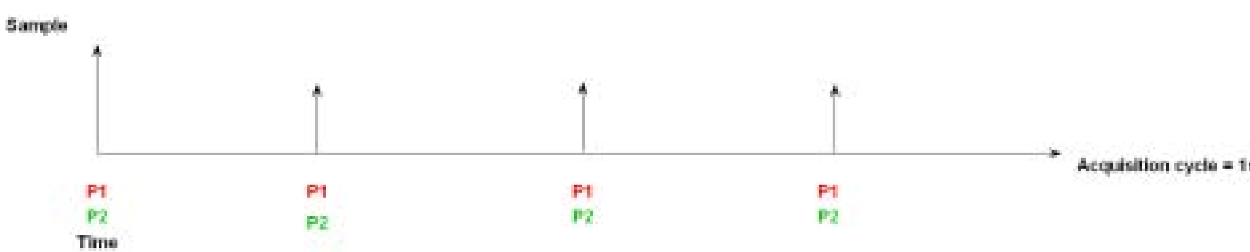


*Figure 43-4: Example of iNET-X placed packets timestamp*

## 43.3 Leap seconds

Leap seconds are used to align UTC with various reference times (for example, GPS, PTP). For correct translation from any reference time to UTC the correct number of leap seconds must be applied during the conversion. The International Earth Rotation and Reference Systems Service adds leap seconds to UTC at regular intervals. Typically leap seconds can be added on June 30 or December 31, but the UTC standard provides for leap seconds to be applied at the end of any month.

### 43.3.1 IENA and PTPv1: mid-year leap seconds and IENA time

The network switch PTPv1 Grandmaster reports the number of seconds by which UTC currently differs from PTP time, but does not report whether any of theses differences occurred since this year began.

A problem arises when an IENA transmitter, such as a KAD/BCU/105, starts transmitting after a leap second has occurred during the current year. IENA time is based on the start of the current year in UTC. This means an IENA transmitter must calculate when the current year began.

If an IENA transmitter starts to synchronize with a network switch PTPv1 Grandmaster during the second half of a year, it does not know whether a leap second was applied in June of the current year.

For this reason, the IENA transmitter always calculates the start of the current year by assuming every hour since the start of the year has had 3,600 seconds.

### 43.3.2 iNET-X: network switch PTPv1 Grandmaster and IRIG

Year data is not transmitted in IRIG. As iNET-X requires year data, it is set by the network switch PTPv1 Grandmaster.

### 43.3.3 iNET-X: network switch PTPv1 Grandmaster and GPS

GPS requires the number of leap seconds between UTC and GPS. When first powered up, if the GPS onboard receiver does not know how many leap seconds to apply, within 12.5 minutes it receives a correction from GPS satellites. When this is applied, the time steps back the appropriate number of leap seconds.

If the leap seconds are not set, or are not set with the exact same leap seconds on the network switch PTPv1 Grandmaster, the KAD/BCU/XXX Ethernet controller module synchronized with PTPv1 resets because it must adjust its clock by more than 500µs. This causes data acquisition to cease until the next two-second boundary, that is, packets are lost.

This happens once after power-up and once when the module synchronizes with a time master.

### 43.3.4 Time code modules with GPS input and leap seconds

A time code module with GPS input, such as the KAM/TCG/102, requires the number of leap seconds between UTC and GPS. When first powered up, if the GPS onboard receiver does not know how many leap seconds to apply, within 12.5 minutes it receives a correction from GPS satellites. When this is applied, the time steps back the appropriate number of leap seconds.

Each KAM/TCG/102/D has programmable leap seconds. The KAM/TCG/102/C has 13 hard-coded leap seconds. That is, if this module is used in November 2012, it steps back two seconds within 12.5 minutes (as it receives a correction from the GPS satellites).

## 43.4 Examples of leap year settings

A single Acra KAM-500 chassis with IRIG time source from a KAM/TCG/102 with the time server set to Master.

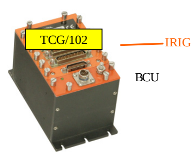


*Figure 43-5: Year is set by the KAM/TCG/102 if iNET-X is used to transmit packets*

A single Acra KAM-500 chassis with GPS time source from a KAM/TCG/102 with the time server set to Master.

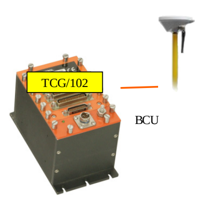


*Figure 43-6: Leap Seconds are set by the KAM/TCG/102*

KAD/BCU/XXX Ethernet controller modules synchronized with a network switch PTPv1 Grandmaster connected to GPS.

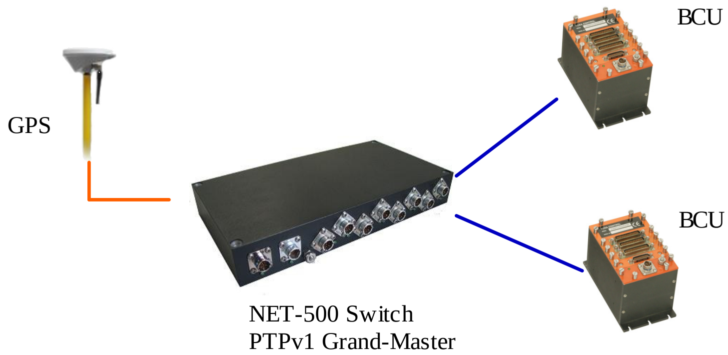


*Figure 43-7: Leap Second is set by the network switch PTPv1 Grandmaster*

KAD/BCU/XXX Ethernet controller modules synchronized with a network switch PTPv1 Grandmaster connected to IRIG.

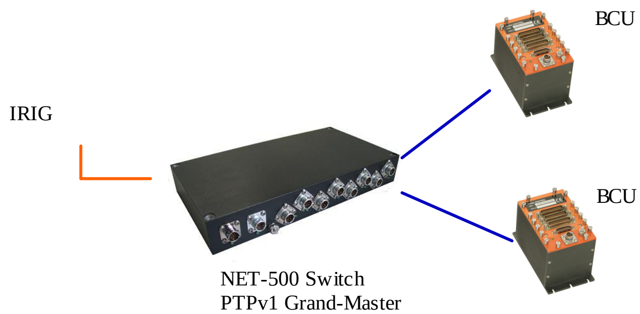


*Figure 43-8:* Year is set by the network switch PTPv1 Grandmaster

KAD/BCU/XXX Ethernet controller modules synchronized with a network switch PTPv1 Grandmaster connected to an IRIG signal received from a KAM/TCG/102 with the time server set to Master.

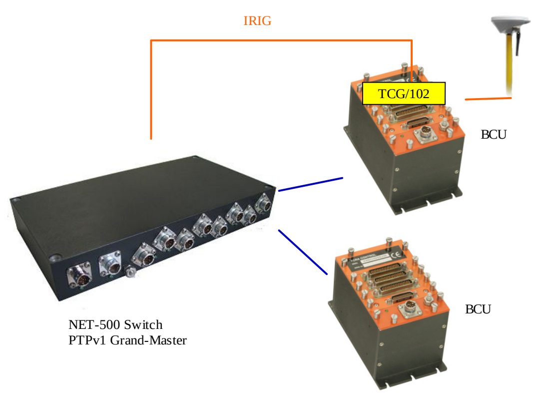


*Figure 43-9: Leap Seconds are set by the KAM/TCG/102; year is set on the KAM/TCG/102*

KAD/BCU/XXX Ethernet controller modules synchronized with a network switch PTPv1 Grandmaster connected to an IRIG signal received from a KAM/TCG/102 with the time server set to Master. The year must be set by both the network switch PTPv1 Grandmaster and the KAM/TCG/102.

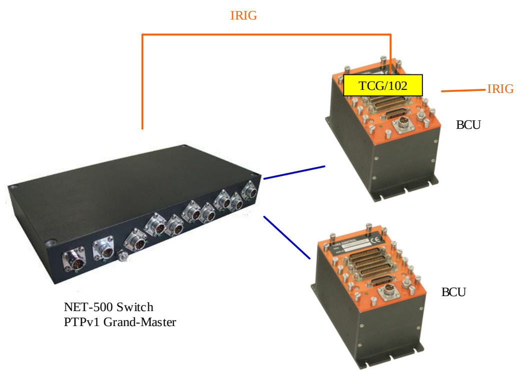


*Figure 43-10: Year must be set by the KAM/TCG/102 and on the network switch PTPv1 Grandmaster*

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**NOTE:** In a synchronized PCM distributed system where the year is not carried over X_SYNC, the KAD/ETH/102 has an option to capture the Year from PTPv1.

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