Chapter 63

Using the KAD/BCU/140/D

TEC/NOT/093

The KAD/BCU/140/D is a key Acra KAM-500 module, which acts as a backplane controller, KAM-500 system programmer, and optionally as a PTP client or PTP Grandmaster.

This paper is divided into the following sections:

63.1 Overview

The KAD/BCU/140/D is a full-duplex 100BaseTX Ethernet Acra KAM-500 backplane controller, programmer, and IENA/iNET-X packet generator. It can also act as an IEEE 1588-2004 Precision Time Protocol version 1 (PTPv1) client or PTP Grandmaster, or as an IEEE Std 1588-2008 Precision Time Protocol version 2 (PTPv2) client. The KAD/BCU/140/D also features a dual Ethernet output for packet transmission.

63.1.1 Backplane Controller

- Must be placed in slot J2
- Can be placed in any Acra KAM-500 chassis
- Can program and control any Acra KAM-500 module

63.1.2 Programmer

- Programs the chassis via Ethernet using Trivial File Transfer Protocol (TFTP)
- Responds to PING / ARP
- IPv4 protocol and user-assigned IP address supported
- Factory-programmed with a unique MAC address

63.1.3 Ethernet packet generation

- Generates packets which are compliant with the published IENA/iNET-X standards (UDP compliant)
- Can transmit UDP/IP packets of different sizes, at different rates, and to different destinations, such as multicast, unicast and/or broadcast
- Supports iNET-X packetizer packets for bus monitor cards (aperiodic transmission)
- Packet transmission with minimal latency. The IENA/iNET-X packet is transmitted when all parameters values in an IENA/iNET-X packet are present in the Current Value Table (CVT).

63.1.4 PTP client or PTP Grandmaster

- Can act as a PTP client synchronizing with a network time source using PTPv1 or PTPv2
- Can act as a PTPv1 Grandmaster

63.2 Setting up the KAD/BCU/140/D in DAS Studio 3

The KAD/BCU/140/D is configured using DAS Studio 3 software. Program system, program IP address, discover system and verify system tools are available within the DAS Studio GUI.

DAS Studio 3 is used to create a configuration which contains the various elements which make up your data acquisition system. You may use this configuration file to manage and program these elements. To see how hardware is represented in the DAS Studio 3 graphical user interface, see Figure 1 in the *DAS Studio 3 User Manual.*

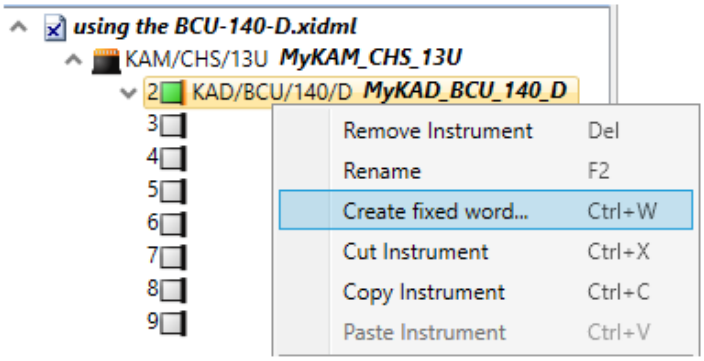
The following sections explain the settings and options available in DAS Studio 3 for the KAD/BCU/140/D.

63.2.1 Creating a fixed data word

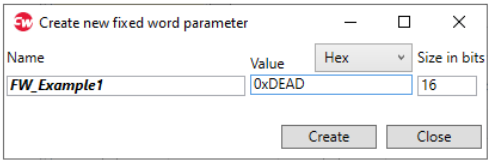
Fixed data words are programmable 16-bits registers with fixed values. There are up to 1024 fixed data words available, and these words are typically used as debug markers in hexadecimal. Fixed data words can be useful, for example, to identify packages or PCM frames and the version of XidML files.

Refer to the following to create a fixed data word in DAS Studio.

1. In the Navigator, right-click the **KAD/BCU/140/D** instrument and then click **Create fixed word**.



The following window appears.



2. Change the parameter name, value and size in bits as required.

NOTE: Alternatively, fixed data words can be created using the **Setting** and **Processes** tabs in DAS Studio; the above simpler method is recommended.

63.2.2 Settings tab – Time monitoring parameters

The following set of time parameters can be used to monitor the time in the system or backplane time.

Parameter Type	Parameter Name
DayOfYear	*P_MyKAD_BCU_140_D_DayOfYear*
IrigTime48	*P_MyKAD_BCU_140_D_IrigTime48*
IrigTime48 : TimeHi	*MyTimeHi*
IrigTime48 : TimeLo	*MyTimeLo*
IrigTime48 : TimeMicro	*MyTimeMicro*

Figure 63-1: Time monitoring parameters

Table 63-1: Parameter descriptions

Setting	Description
DayOfYear	Day of the year from 1 to 366.
IrigTime48	IrigTime48 is a 48-bit register consisting of three 16-bit time registers: TimeHi, TimeLo, and TimeMicro. It represents hours, minutes, seconds, and micro seconds at the start of the acquisition cycle. Note: This can be referred to as KAM-500 backplane time; time format is UTC.

Table 63-1: Parameter descriptions (continued)

Setting	Description
TimeHi, TimeLo, and TimeMicro	Same description as IrigTime48 but split into three 16-bit registers. Note: These registers are implemented to provide compatibility with legacy systems.

NOTE: Time registers from the KAD/BCU/140/D are only updated once per acquisition cycle, therefore sampling faster only shows stale data. For example, if the acquisition cycle is 10 Hz and the time registers are sampled at 100 sps, only 1 out of 10 samples show updated time; the rest are stale (repeated) data.

63.2.3 Settings tab – System monitoring parameters

The following set of parameters can be used to monitor the status and health of the system.

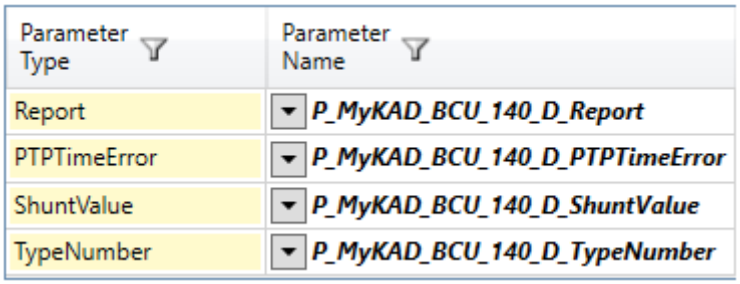


Figure 63-2: System monitoring parameters

Table 63-2: Parameter descriptions

Setting	Description
Report	Bit 0 (Out Of Sync) and bit 1 (Time Source Lost) provide important information regarding system synchronization to PTP. Bits 4 (Module Reset), bits 6/7 (Rx Overflow/Error) and bit 8 (Invalid configuration) provide information related to possible logical and/or hardware failures. Bit 11 and 12 (Ethernet Link 0/1 Down) show connection to a device (link down). Bit 15 (Event) flags when an error or out of sync indication should be considered. Note: Bits 0 to 14 do not reset after an event has been flagged, therefore any error with bit 15 set to logic 0 can be considered a past event and therefore ignored. For further information regarding these registers, see the *KAD/BCU/140/D* data sheet.
PTPTimeError	This register shows the error between the PTP Grandmaster (or a KAM/TCG/xxx module) and the KAD/BCU140/D's PTP Time measured in nanoseconds. It is in the two's complement register, which means it can have a positive or negative value. Note: This register should show a value between 0 and +/- the value of Synchronization Level setting, see "63.2.6 Settings tab – PTP time settings" on page 5.
ShuntValue	This register is used to display the mode that the KAD/BCU/140/D is running. See "63.6.5 KAD/BCU/140/D Shunt Mode and shunt parameter explained" on page 16.
TypeNumber	This register shows the type number of the module which is a unique fixed word in hexadecimal. It can be used as a fixed word or marker, and it is considered to be a debug register.

NOTE: It is strongly recommended adding the Report parameter to the user IENA/iNET-X packets as this parameter contains important system information such as the synchronization status of the system.

63.2.4 Settings tab – fixed data words

There are two tabs required to add fixed data or to remove fixed data: Settings tab, to define the value of the fixed data, and Processes tab to change the name of the fixed data word.

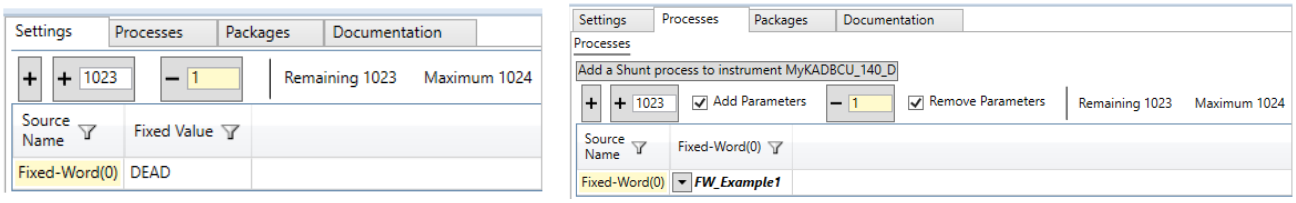


Figure 63-3: Fixed word shown in Settings tab and in Processes tab

To create a fixed data word, see “63.2.1 Creating a fixed data word” on page 2.

To add or remove one or multiple fixed data words, click the corresponding + or - buttons in the following figure and then change its value in hexadecimal format as required.

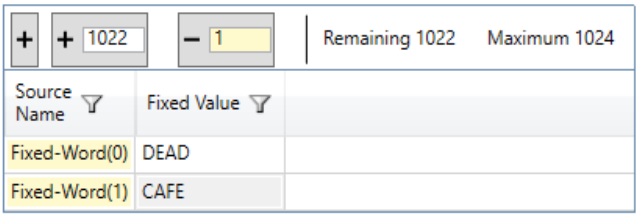


Figure 63-4: Two fixed words (hex) added in the Settings tab

Table 63-3: Settings tab descriptions

Setting	Description
Source Name	This field cannot be edited. Source name of the fixed word follows this pattern: Fixed-Word(x) where x can be 0 to 1023.
Fixed Value	Any hexadecimal value with four digits, that is, between 0 (0x0000) and 65535 (0xFFFF). To change the name of the fixed word, see “63.2.10 Processes tab – fixed data words” on page 8.

63.2.5 Settings tab – IP address, leap year and IENA Only System

The IP address, leap year and IENA Only System parameters are described in the following table.

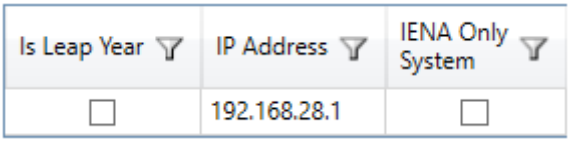


Figure 63-5: Settings for IP address, leap year and IENA Only System

Table 63-4: Settings descriptions

Setting	Description
Is Leap Year	For IENA systems, select this check box when the current year is a leap year. This will add an extra day to the year. This setting is not required when the KAD/BCU/140/D is time seeded from either GPS (for example from a KAM/TCG/105 in the chassis) or PTP (acting as PTP client) or the system is running as standalone (free running). In a KAD/BCU/140/D if **IENA Only System** is enabled, then selecting **Is Leap Year** sets the default year for PTP timestamps at 2000. However if **Is Leap Year** not selected, then the year 2001 is used instead. Note: Leap years are 2020, 2024 and every four years.

Table 63-4: Settings descriptions (continued)

Setting	Description
IP Address	The default (factory) IP address of the KAD/BCU/140/D is 192.168.28.1; this can be changed using the IP Programmer tool in DAS Studio 3. The IP address showing in this field must correspond to the physical IP address of the BCU, otherwise an error appears during programming. Use the Discovery tool in DAS Studio to create a XidML file showing the IP address of the connected hardware. Note: IP addresses must be unique system wide. Changing the IP Address field does not physically modify the IP address of the KAD/BCU/140/D. To change the IP address, see “Chapter 7 - IP Address Programmer” in the *DAS Studio 3 User Manual*.
IENA Only System	This legacy option is required when IENA packets and legacy KAM/TCG/xxx modules previous to the KAM/TCG/102/D are used. Basically, this setting tells the controller whether it can *trust* the PTP_DAYS register from the KAM/TCG/102/D module. For more information, see “Using the KAD/BCU/140 with a KAM/TCG/xxx” in the *KAD/BCU/140/D* data sheet.

63.2.6 Settings tab – PTP time settings

The PTP time settings are described in the following table.

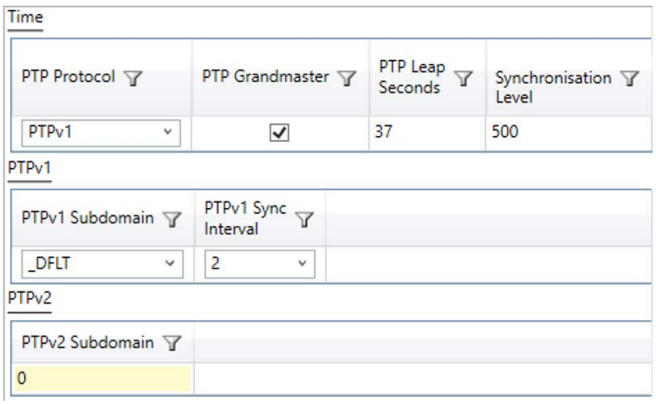


Figure 63-6: PTP Time settings

Table 63-5: Settings descriptions

Setting	Description
PTP Protocol	Determines the supported protocol (PTPv1 or PTPv2). The KAD/BCU/140/D can act as either. PTPv1 client PTPv1 Grandmaster PTPv2 client - Delay Request See the iNET-X handbook for further information. Note: Option PTPv2 client - Delay P2P has not been tested.
PTP Grandmaster	Determines whether the module acts as a PTP Grandmaster. Only PTPv1 Grandmaster is supported.
PTP Leap Seconds	Current offset between PTP time and UTC time in seconds. The time in the KAM-500 backplane is UTC while iNET-X packets use TAI time format. This setting is required when generating iNET-X packets. This setting is ignored when the KAD/BCU/140/D acts as a PTP client because the leap seconds information is transmitted in PTP time packets by the external PTP Grandmaster. If in doubt, set the leap seconds corresponding to the current year. In 2023 the current leap seconds is 37 seconds however this might change in the future. For more information, see “63.7.5 Time formats in KAM-500 backplane” on page 23.

Table 63-5: Settings descriptions (continued)

Setting	Description
Synchronization Level	When the KAD/BCU/140/D is working as a PTP client, the unit considers itself in sync if the last calculated offset from its time master is less than this value. Units are nanoseconds. This value can be monitored with the PTPTimeError register (see “63.2.3 Settings tab – System monitoring parameters” on page 3). Synchronization Level should be set to a minimum of 1500 ns when using a KAM/TCG/xxx as time master in the same chassis; this is due to the 1 usec granularity of the KAM-500 backplane time registers. For more information, see “Using the KAD/BCU/140 with a KAM/TCG/xxx” in the *KAD/BCU/140/D* data sheet.
PTPv1 Subdomain	Name of the PTPv1 subdomain to use. This setting is only available when PTP Protocol is set to PTPv1. For more information, see the *iNET-X Handbook*.
PTPv1 Sync Interval	Interval in seconds between sync messages. This setting is only available when PTP Protocol is set to PTPv1. When the KAD/BCU/140/D acts as PTPv1 Grandmaster the value of this setting should be kept to the default 2 seconds. For more information, see “PTP Protocol” in the *KAD/BCU/140/D* data sheet.
PTPv2 Subdomain	Name of the PTPv2 subdomain to use. This setting is only available when PTP Protocol is set to PTPv2. For more information, see the *iNET-X Handbook*.

63.2.7 Settings tab – Mode and Shunt

Mode and Shunt Mode related parameters are described in the following table.

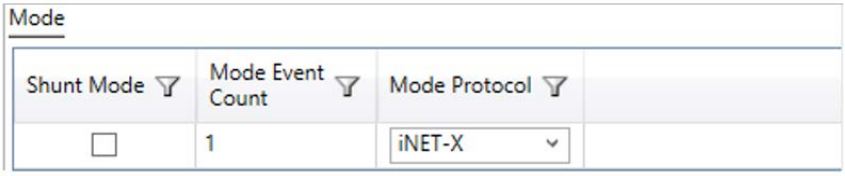


Figure 63-7: Mode settings

Table 63-6: Settings descriptions

Setting	Description
Shunt Mode	Enables Shunt Mode operation in the KAD/BCU/140/D. For more information, see “63.6.5 KAD/BCU/140/D Shunt Mode and shunt parameter explained” on page 16.
Mode Event Count	This setting is applicable when a KAD/BCU/140/D is configured to transmit Shunt Mode packets to other KAD/BCU/140/Ds on the network. It defines the number of Shunt Mode packets to be transmitted to other KAD/BCU/140/D in the system. For more information, see “63.6.5 KAD/BCU/140/D Shunt Mode and shunt parameter explained” on page 16.
Mode Protocol	This setting is applicable when a KAD/BCU/140/D is configured to transmit Shunt Mode packets to other KAD/BCU/140/D in the network. It defines the format of the Shunt Mode packets transmitted by the KAD/BCU/140/D. Choices are IENA or iNET-X.

Table 63-7: Related documentation

Document	Description
TEC/NOT/083	Using the KAM/MEM/113 (for usage in combination with a KAM/MEM/113)
TEC/NOT/077	Using shunting processes in Ethernet systems (for usage as shunt calibration)

63.2.8 Settings tab – IENA fragmentation

IENA fragmentation is an advanced setting and is described in the following table.

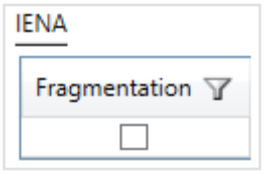


Figure 63-8: IENA fragmentation

Table 63-8: Setting description

Setting	Description
Fragmentation	This is an advanced setting, which allows the KAD/BCU/140/D to create IENA packages greater than 1514 bytes, which are then fragmented into smaller packages. The KAD/BCU/14/D supports Ethernet packet fragmentation, however it is not recommended. For more information on fragmentation support and why it is not recommended, see “Packet fragmentation” in the *KAD/BCU/140/D* data sheet.

NOTE: DAS Studio does not allow fragmentation in iNET-X packets.

63.2.9 Processes tab – Shunt

The Processes tab allows to add a Shunt process used to change the mode running in the KAD/BCU/140/D.

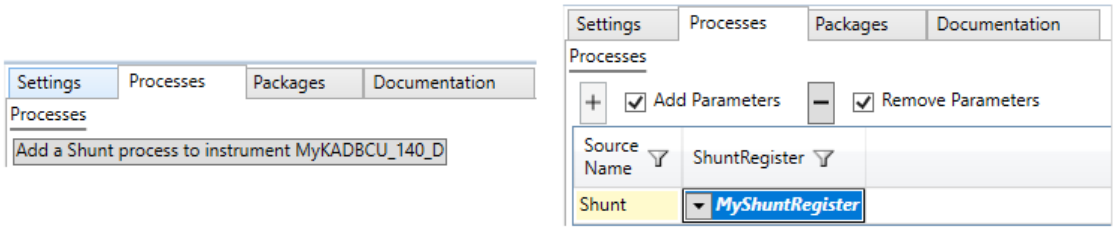


Figure 63-9: Adding a Shunt register

Table 63-9: Setting description

Setting	Description
ShuntRegister	This register can be used to either trigger the transmission of shunt sode packets or to control the operation of the KAM/MEM/113. It uses the Least Significant bits (LSB bits 0 to 3) of an existing parameter in the backplane to change the format. For more information, see “63.6.5 KAD/BCU/140/D Shunt Mode and shunt parameter explained” on page 16.

A typical example of associating a shunt source parameter with a shunt process, is to use a discrete low discrete parameter from a KAD/DSI/102/B.

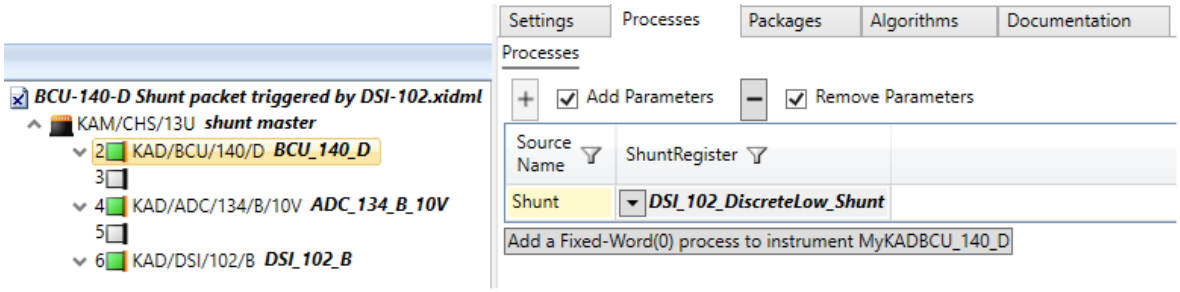


Figure 63-10: Example of shunt register process associated to an existing parameter

Table 63-10: Related documentation

Document	Description
TEC/NOT/083	Using the KAM/MEM/113 (for usage in combination with a KAM/MEM/113)
TEC/NOT/077	Using shunting processes in Ethernet systems (for usage as shunt calibration)

63.2.10 Processes tab – fixed data words

To create a fixed data word the recommended way, see “63.2.1 Creating a fixed data word” on page 2.

Alternatively, to add a fixed data word manually, click the **Add a Shunt process to instrument MyKADBCU_140_D** button in the Processes tab as shown in the following figure.

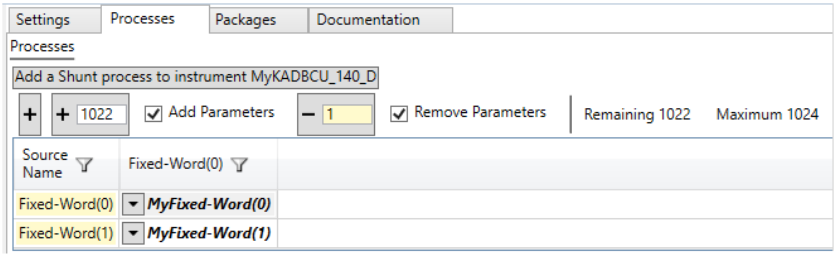


Figure 63-11: Fixed words in the processes tab

Table 63-11: Setting description

Setting	Description
Fixed word	This process allows up to 1024 fixed words to be added and to change the default name (if required). The default value can be changed in the Settings tab as explained in “63.2.4 Settings tab – fixed data words” on page 3.

63.2.11 Packages tab - Adding IENA/iNET-X packets

Users can add or remove IENA/iNET-X packets from the Packages tab. The tab is comprised of four panes: Channels, Package Properties, Content, and Placed Data as shown in the following figure.

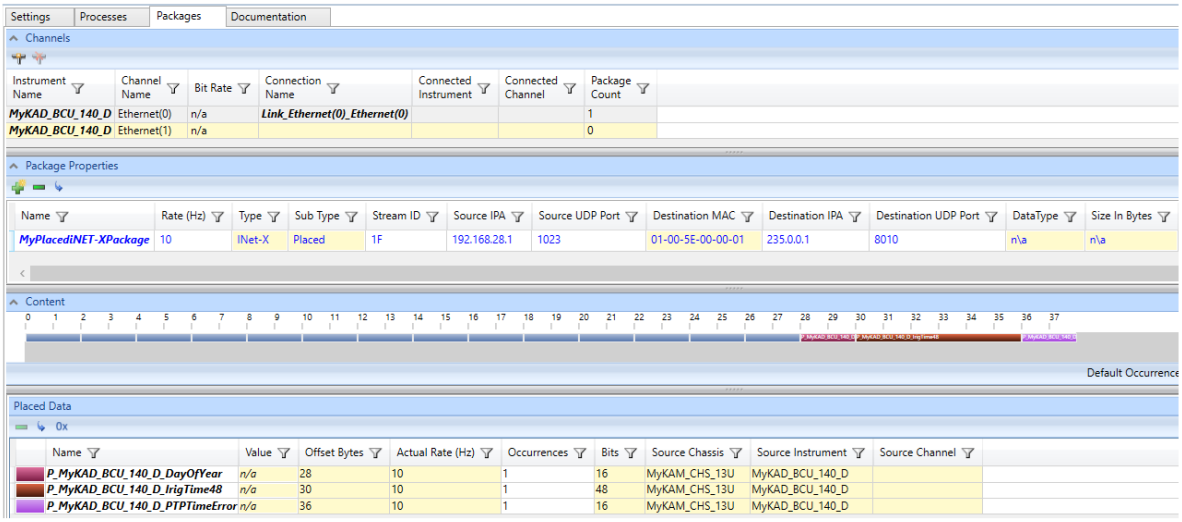
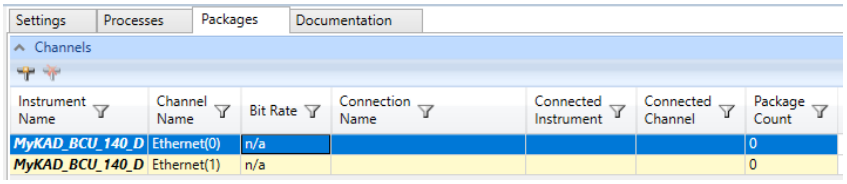


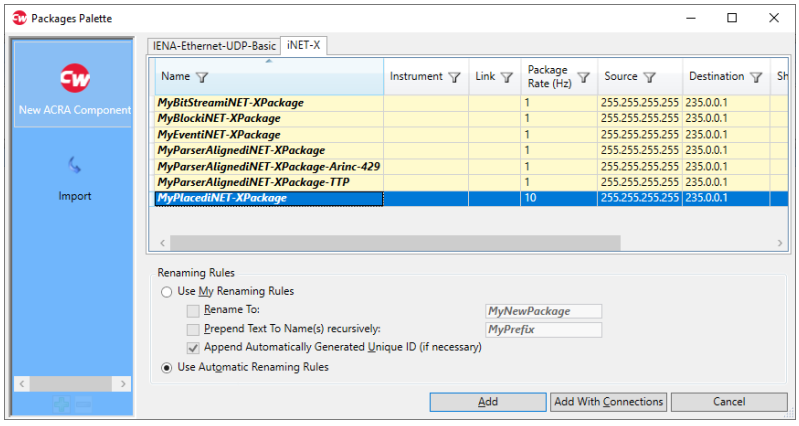
Figure 63-12: Example of iNET-X package in the Packages tab

Refer to the following to add a new iNET-X packet.

1. On the **Packages** tab, click **Ethernet(0)**.

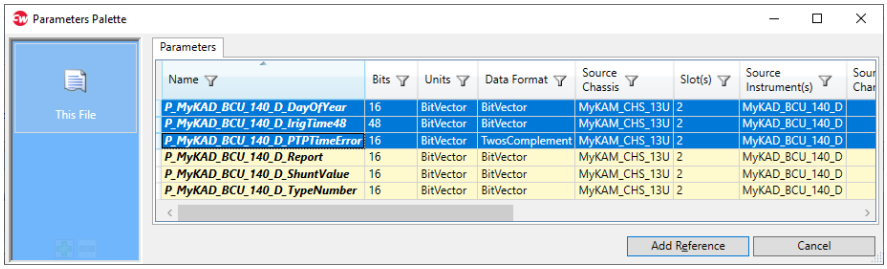


2. In the **Packages Properties** pane, click the arrow .
Packages Palette opens.

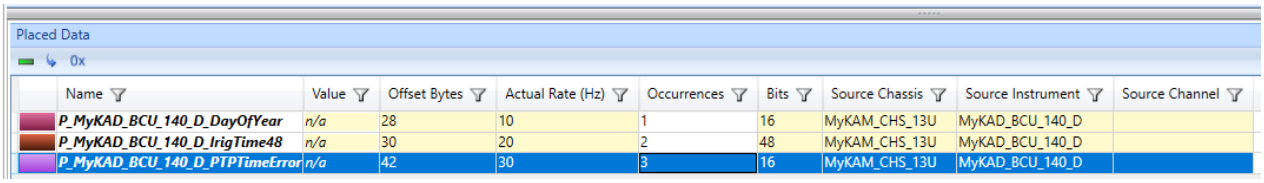


3. Select the **MyPlacediNET-XPackage** placed packet template and then click **Add**.
A new iNET-X placed package appears in the **Package Properties** section. All fields are filled with default values.
4. To add parameters to the package, in the **Placed Data** pane. click the arrow .
Parameter Palette opens.

5. Select the required parameters and then click **Add Reference**.



6. By default all parameters are set with one occurrence in the packet meaning the sampling frequency is the same as the Package Rate. You can modify the sampling rate by changing the occurrences as per the following basic formula:
Parameter sampling rate (sps) = Package Rate (Hz) × Occurrences



To understand the difference between building shorter or larger packets and keeping the same sampling rate for a given parameter, see “63.7.6 Latency vs bandwidth when setting up packets” on page 23.

NOTE: Package Generator is not recommended to be used to create Ethernet packages, especially in large and/or multisink systems.‘

Table 63-12: Related documentation

Document	Description
DAS Studio 3 User Manual	See “Chapter 3 - Network example” section and “Chapter 5 - Adding packages from the Navigator” for more information regarding creating Ethernet packages in the KAD/BCU/140/D
TEC/NOT/067	IENA and iNET-X packet payload formats
iNET-X Handbook	Learn about the structure of IENA and iNET-X packets supported by the KAD/BCU/140/D

63.3 Setting an IP address in DAS Studio 3

Simple Network Management Protocol (SNMP) protocol is used to program the IP address of the KAD/BCU/140/D.

To change the IP address, see “Chapter 7 - IP Address Programmer” in the *DAS Studio 3 User Manual*.

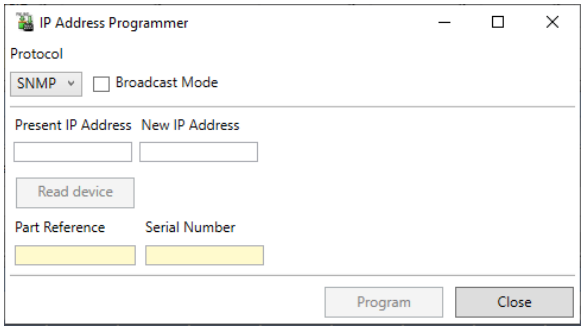


Figure 63-13: DAS Studio IP Address Programmer tool

NOTE: IP Address Programmer can be used in SNMP Broadcast Mode, which allows updating the IP address of a device on a different subnet to the PC.

For more information, see “Chapter 2 - Options” of the *DAS Studio 3 User Manual*.

Table 63-13: Related documentation

Document	Description
TEC/NOT/058	Overview of SNMP and using third party SNMP tools.
iNET-X Handbook	Learn about the SNMP network protocol.
KAD/BCU/140/D	See the “SNMP support” section to learn more about the SNMP command used to set the IP address of the module.

63.4 System synchronization

As explained previously, synchronization is achieved via an external PTPv1 or PTPv2 source. A PTP Grandmaster such as the NET/SWI/101/C is necessary to achieve synchronization. The basic PTP time messages in both versions of the protocol are: Sync, Delay_Request, Follow_Up, and Delay_Response. To get the most from networked KAM-500 data acquisition systems, it is essential to use PTPv1 and PTPv2 compatible Ethernet switches with transparency.

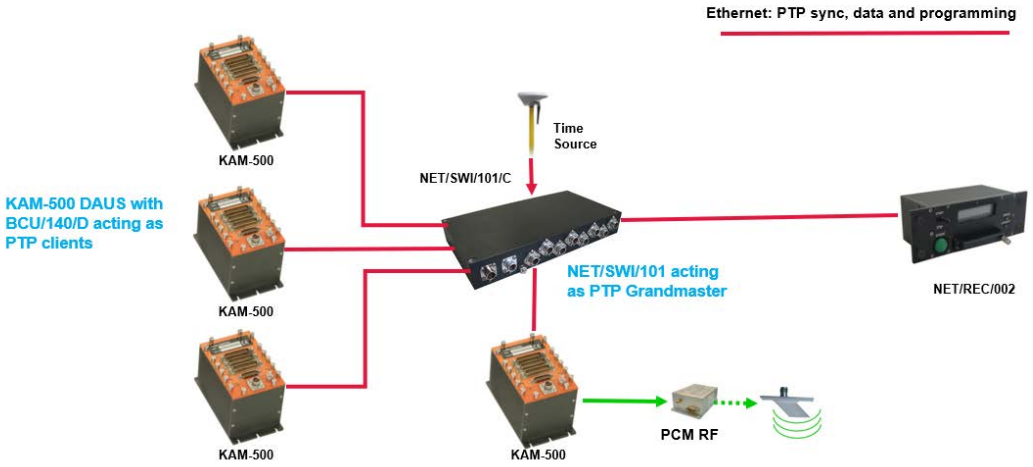


Figure 63-14: Typical system synchronized with PTP and optional network recorder and PCM telemetry link

The KAD/BCU/140/D outputs a TTL signal called PPS Out (Pulse Per Second), which can be used to check synchronization with other IEEE 1558 compatible equipment in the network such as a network recorder.

For more information on IEEE 1588 Precision Time Protocol (PTP), see the *iNET-X Handbook*.

63.4.1 Clock adjustment algorithm and backplane reset

The KAD/BCU/140/D, when configured as a PTP client, can adjust its clock to eliminate the offset between its clock and the clock in the IEEE 1588 Grandmaster. When calculating the offset, if the magnitude of the offset is greater than 500 microseconds (µs), the KAD/BCU/140/D calculates the correct time and corrects its clock. In this situation the data acquisition ceases until the next two-second interval. This is known as a backplane reset and it can take up to two seconds. During the backplane reset, all parameters in the system are affected and the package sequence of the IENA/iNET-X packet/s resets to zero. An offset less than 500 µs is corrected by adjusting the clock speed until the offset is eliminated. When the KAD/BCU/140/D eliminates the offset, it does not suffer from the residual error of the previous method. However, there is a limit to how much the clock speed can be adjusted, so this is only suitable for small adjustments.

A typical example of backplane reset is when a KAM-500 containing a time module such as a KAM/TCG/105 connects to GPS causing the system to jump in time as illustrated in the following figure.

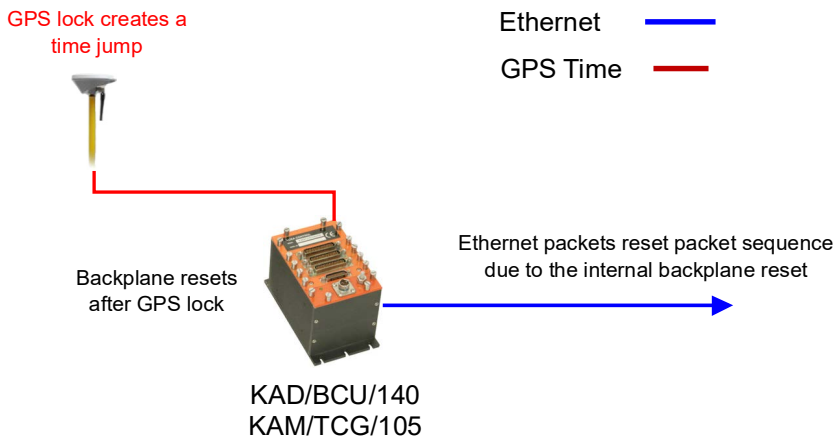


Figure 63-15: Internal KAM-500 time gets reset due to time event

To learn about the different acquisition cycles available, see “Networked Acra KAM-500 system and acquisition cycles” in the *KAD/BCU/140/D* data sheet.

TIP! Monitor the Report parameter to confirm possible backplane reset events.

63.5 Aperiodic transmission

Bus monitoring is an asynchronous task by nature and there might be bursts of traffic, constant traffic, or no traffic at all in the bus. A packetizer module can monitor 100% of the traffic in the bus and it uses the bandwidth efficiently by generating packetizer packets only when there is incoming traffic, that is, no incoming traffic means no data output from the module.

The KAD/BCU/140/D supports aperiodic transmission for bus parser modules. This feature is known as packetization and the user modules supporting this feature are known as packetizer modules.

Examples of typical packetizer modules are KAD/ABM/103 (ARINC-429), KAD/MBM/10x (MIL-STD-1553), and KAD/UBM/103 (serial bus).

Table 63-14: Related documentation

Document	Description
TEC/NOT/067	IENA and iNET-X packet payload formats
KAD/BCU/140/D	“Packetization and transmission” section of the data sheet
Data sheets of KAM-500 packetizer modules	
iNET-X Handbook	

63.5.1 Configuring packetizer packets in DAS Studio 3

There are no specific settings in the KAD/BCU/140/D to configure packetizer packets. Packetizer support is enabled in the Settings tab of each packetizer module.

An example of configuring a packetizer module using a KAD/ABM/103 (ARINC-429 bus monitor) is shown in the following figure.

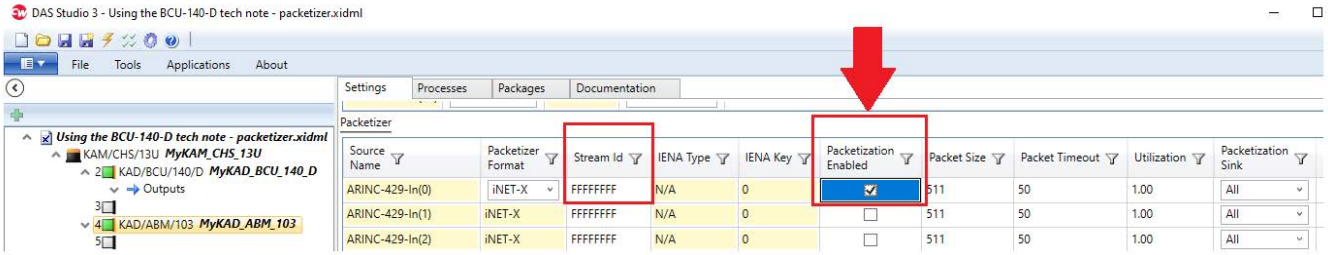


Figure 63-16: KAD/ABM/103 packetizer channel 0 enabled; stream ID at default

Initially a packetizer packet is not shown in the Packages tab of the KAD/ABM/103. Once the compiler is run, the packet is created and appears in the KAD/BCU/140/D Packages tab.

The following figure shows a packetizer packet (**Parser aligned** sub type) from a KAD/ABM/103 module and a user packet (**Placed** sub type).

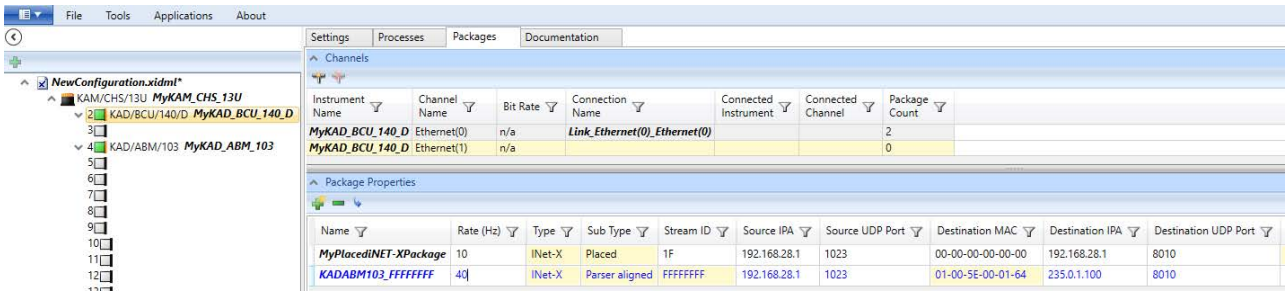


Figure 63-17: Example of packetizer packet from KAD/ABM/103 packetizer

63.6 Applications

63.6.1 Standalone chassis system with time module

In a single chassis system, a time code generator module such as KAM/TCG/105, can be used to seed time to the KAM-500 backplane. In this situation the KAM/TCG/105 is known as the time master in the KAM-500 standalone chassis.

The KAM/TCG/105 can take time from external GPS, IRIG-B time, or from the internal system clock (free run).

The timestamp in the IENA/iNET-X packets generated by the KAD/BCU/140/D takes the time from the KAM-500 backplane.

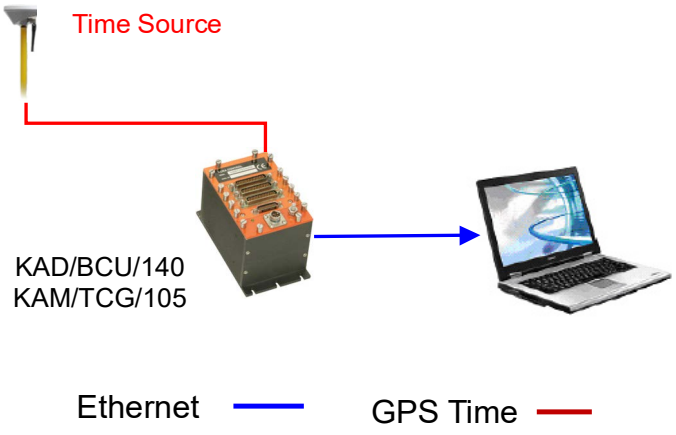


Figure 63-18: Single chassis system with KAM/TCG/105

In this scenario, UTC, TAI, and GPS time formats are used, therefore you must set leap seconds parameters of both the KAD/BCU/140/D and KAM/TCG/105 correctly in the Settings tab of DAS Studio. For more information, see “63.7.5 Time formats in KAM-500 backplane” on page 23.

NOTE: A standalone chassis system can be set up without a time module. In this scenario the KAD/BCU/140/D becomes the time master. As time master it cannot be seeded by external time sources and the backplane time starts from 0 on power up.

63.6.2 Networked system with KAD/BCU/140/D acting as PTP Grandmaster and using a KAM-500 switch module

The KAD/BCU/140/D can be optionally set as PTP Grandmaster. When no time module is present in the chassis, the system time starts from zero on power up. When the KAD/BCU/140/D is set to act as PTP Grandmaster, the system can be easily upgraded to a network distributed system by adding a network switch such as NET/SWI/001, which acts as a 7:1 port data aggregator and a PTP transparent switch.

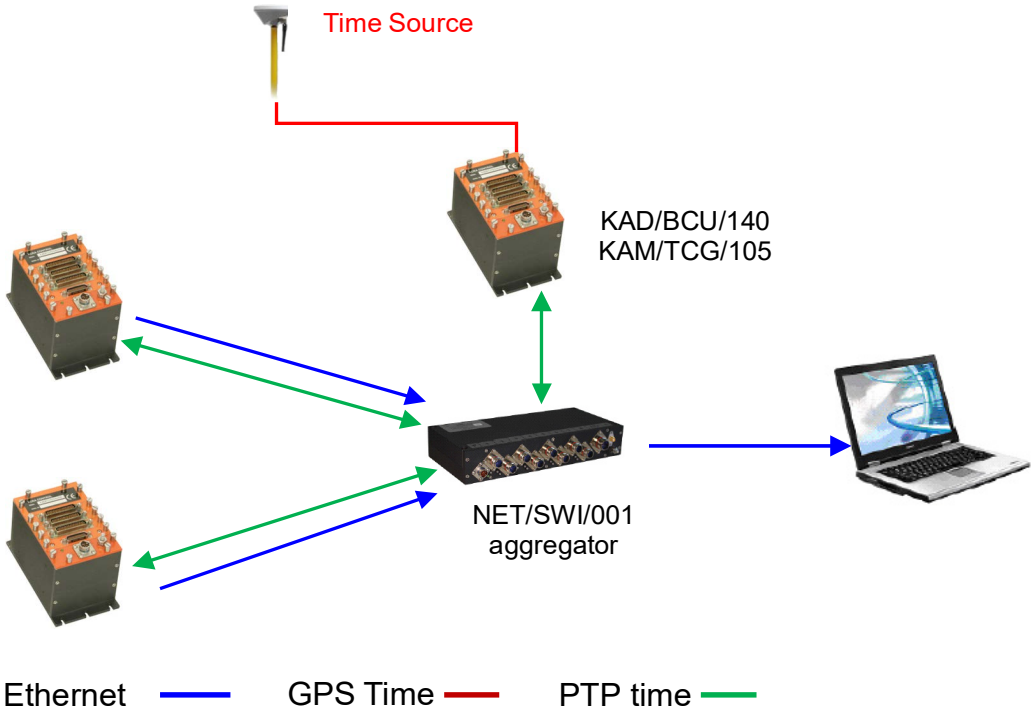


Figure 63-19: Single chassis system with an optional KAM/TCG/105 acting as PTP time master

NOTE: In this scenario, using a NET/SWI/101/C is normally not required due to the redundant functionalities of the NET/SWI/101/C and the KAM/TCG/105, such as providing position and time information available in GPS messages.

63.6.3 Networked system with KAD/BCU/140/D acting as PTP slave

One of the most common configurations of the KAD/BCU/140/D in a distributed systems is shown in the following figure.

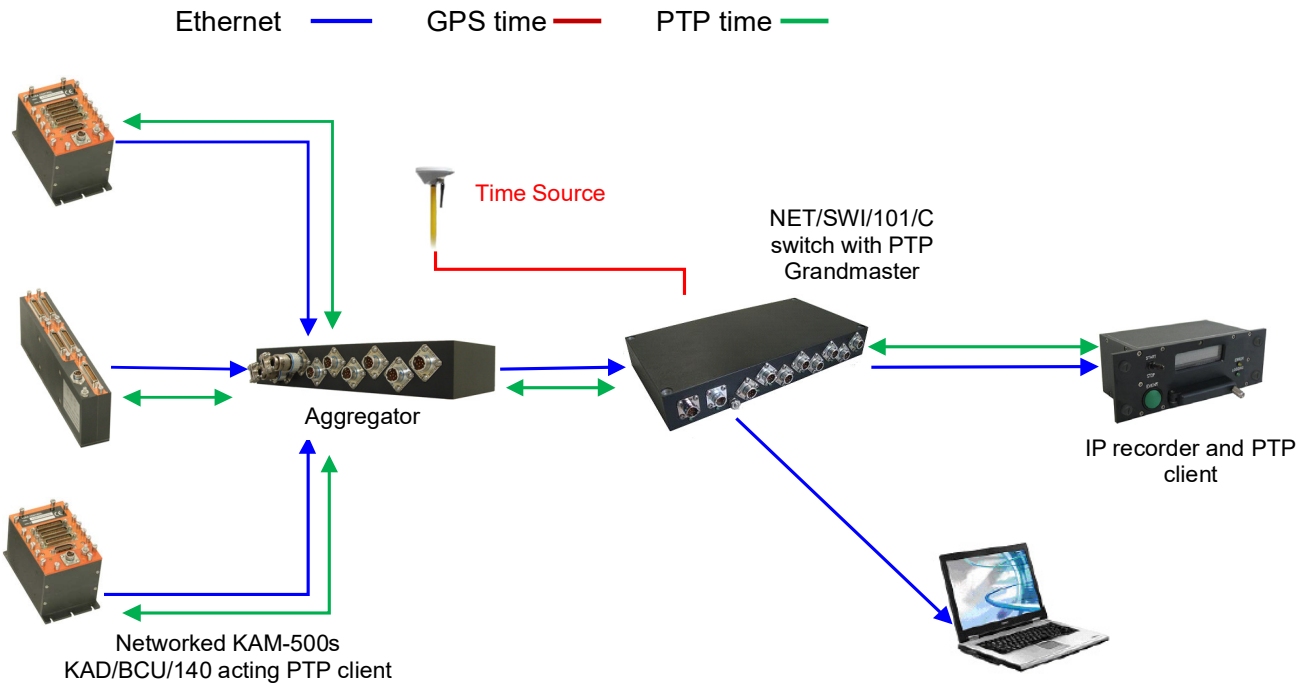


Figure 63-20: Distributed system with NET/SWI/101/C acting as PTP time master

In this scenario, the NET/SWI/101/C acts as the PTP Grandmaster, while other network hardware—such the KAD/BCU/140/D in the KAM-500 chassis and network recorders—act as PTP clients. The NET/SWI/101/C can take time from external GPS, IRIG-B, time or from the internal system clock (free run).

63.6.4 Networked system with KAD/BCU/140/D acting as PTP Grandmaster with an internal switch

The following configuration shows a KAD/BCU/140/D acting as PTP Grandmaster with an internal KAM-500 switch module, KAD/SWI/108 in place of an external switch. The KAD/SWI/108 is a four port KAM-500 programmable Ethernet switch module with PTP transparency.

In the following figure, an external chassis is connected to the switch and the second KAD/BCU/140/D is set as PTP client. The system can be easily expanded with more network hardware such as KAM-500 DAUs and network recorders by adding more KAD/SWI/108s to the main chassis.

The KAD/EBM/102/B is required in the system to parse data from the remote units; it acts as part of the Multi Chassis Scheduler (for information on MCS, see *TEC/NOT/075 - Using DAS Studio 3 to configure the KAD/EBM/102*).

The KAM/MEM/113 (data recorder module in PCAP format) and KAD/ENC/106 (PCM transmitter module) are shown as optional additional data sinks and are added to the diagram for illustration purposes.

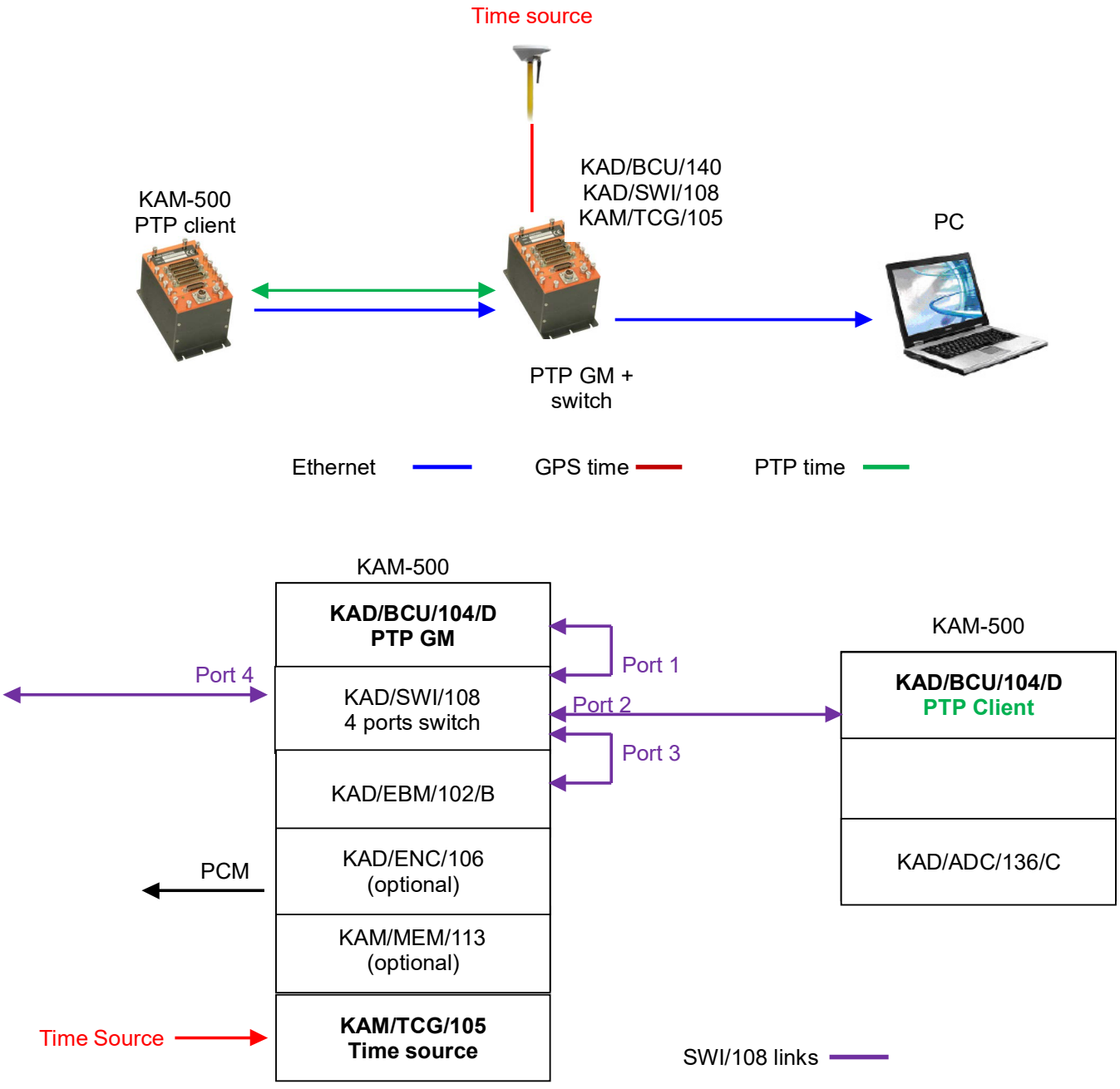


Figure 63-21: Distributed system with KAD/BCU/140/D acting as PTP time master with an internal switch

TIP! The presence of a KAM/TCG/105 time module in this system is recommended.

63.6.5 KAD/BCU/140/D Shunt Mode and shunt parameter explained

The KAD/BCU/140/D acting as backplane controller can run in up to 15 different modes or configurations, however most of them are reserved. By default, the KAD/BCU/140/D runs mode 0, which can be changed when the controller is enabled for Shunt Mode. Changing the BCU's mode implies changing settings in some modules within the KAM-500 chassis or in a remote networked KAM-500 chassis. The main advantage of Shunt Mode is the KAM-500 does not need to be reprogrammed, and some settings in the system can be modified with the use of an external device, for example an electrical switch.
Shunt Mode in the KAD/BCU/140/D can be used in two scenarios:

Scenario 1: To apply shunt calibration in a system with KAM-500s using analog modules with support for classic shunt, such as KAD/ADC/134/B.

Scenario 2: Controlling a KAM/MEM/113 PCAP recorder module. Shunt Mode allows to format the CF card, idle, and run in standard mode.

NOTE: The word “shunt” might be misleading but is retained for legacy reasons. This register is used for mode (format) switching; shunt is one of the modes of operation.

63.6.5.1 How to enable Shunt Mode

To enable Shunt Mode in the KAD/BCU/104/D, see “63.2.7 Settings tab – Mode and Shunt” on page 6.

63.6.5.2 How to monitor Shunt Mode

To monitor the mode the KAD/BCU/140/D is running, confirm the ShuntValue parameter is available in the Settings tab as explained in “63.2.3 Settings tab – System monitoring parameters” on page 3. In normal operation this register should show value 0; typical values for shunt operation are 2, 4, and 8.

63.6.5.3 How to change the mode in Shunt Mode

To change the mode the KAD/BCU/140/D is running, the Shunt Register available in the Processes tab must be associated with an internal parameter as explained in “63.2.9 Processes tab – Shunt” on page 7.

This register can be used to either trigger the transmission of Shunt Mode packets (see Scenario 1 below) or to control the operation of the KAM/MEM/113 (see Scenario 2 below). In both cases it must be associated to another parameter already existing in the KAM-500 backplane such as a KAD/DSI/xxx module or a fixed data word. Alternatively, the mode can be changed by a Shunt packet transmitted from a PC.

63.6.5.4 Scenario 1: Shunt Mode used with classic Shunt

Analog modules such as KAD/ADC/134/B, KAD/ADC/135/B, and KAD/ADC/136/C have classic shunt capabilities, that is, a high accuracy resistor on the module that can be activated as a shunt resistor. When Shunt Mode is enabled, you do not need to re-program the system to enable shunt; analog modules with shunt capabilities in a large distributed system can be placed into Shunt Mode simultaneously. To achieve this, one KAD/BCU/140/D in the system transmits over the network an internal multicast Ethernet packet referred as **Shunt Mode packet** containing the mode number to the rest of the controllers in the network. The number and type of packets transmitted is set by the registers Mode Event Count and Mode Protocol as explained in “63.2.7 Settings tab – Mode and Shunt” on page 6.

All KAD/BCU/140/D modules receiving the Shunt Mode packet will change their mode of operation (default 0) to the one set in the incoming packet. A typical value for Shunt Mode is 4.

As shown in the following figure, a digital module such KAD/DSI/102 can be used to trigger the Shunt Mode packet by mapping the last four digits (LSBs) of its status register to the KAD/BCU/140/D’s Shunt Register parameter. In this scenario, an external electrical switch can be connected to the inputs of the KAD/DSI/102/B; you can change the value of Shunt Mode by changing the value of the first four channels, for example, logic 0010 applied to channels 3 to 0 respectively, will set the KAD/BCU/140/D in format 2.

All DAUs in the network change mode simultaneously upon reception of the shunt mode packet

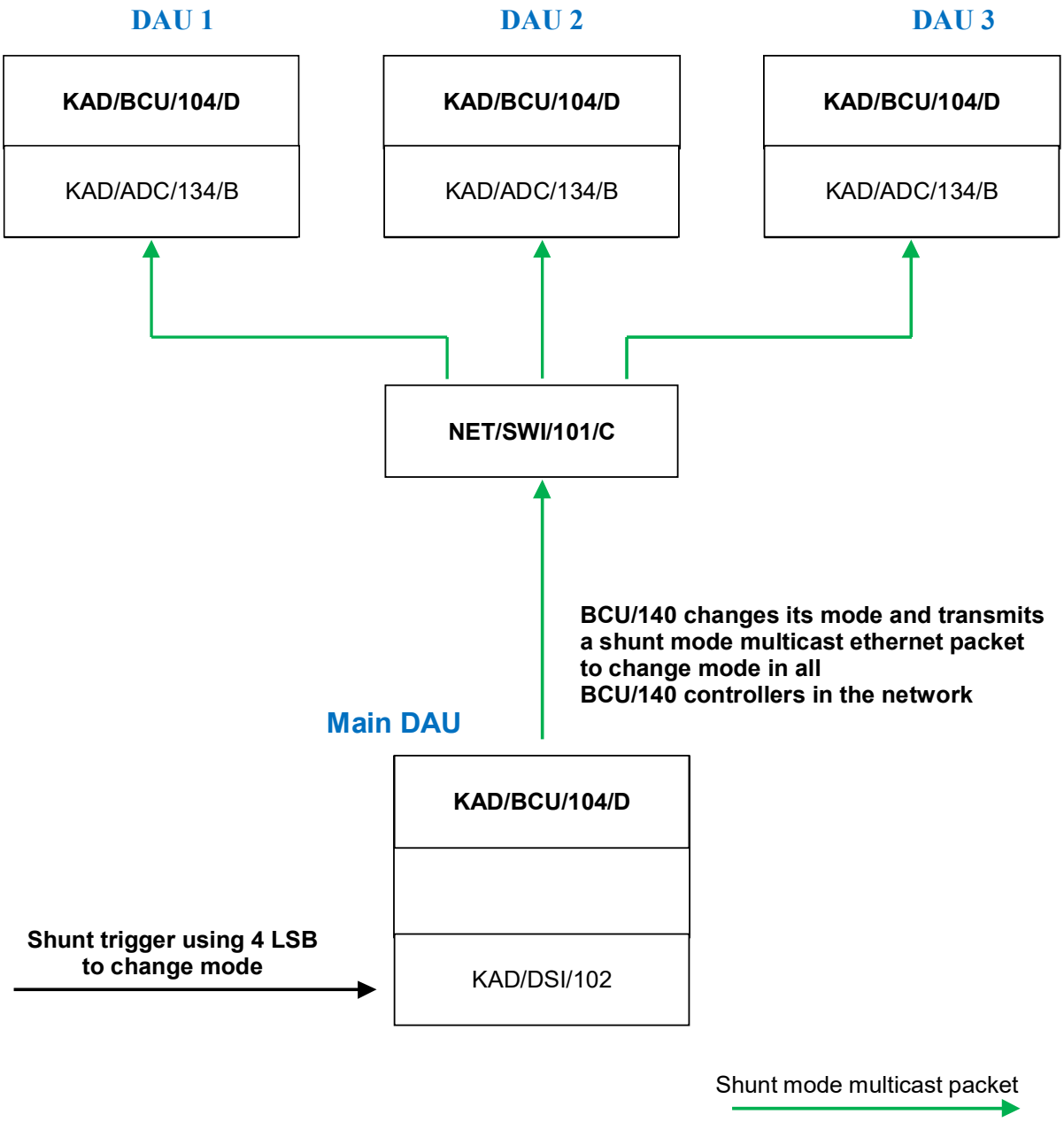


Figure 63-22: Distributed system with KAD/BCU/140/D receiving Shunt Mode packet using a KAD/DSI/102 and an electrical switch to trigger externally

Similarly, the Shunt Mode packet can be transmitted from a PC using appropriate software. For more information regarding how to transmit Shunt Mode packets from a PC, request *TSD/AC/021 transmitting a packet from a PC to change mode* from Curtiss-Wright support (acra-support@curtisswright.com).

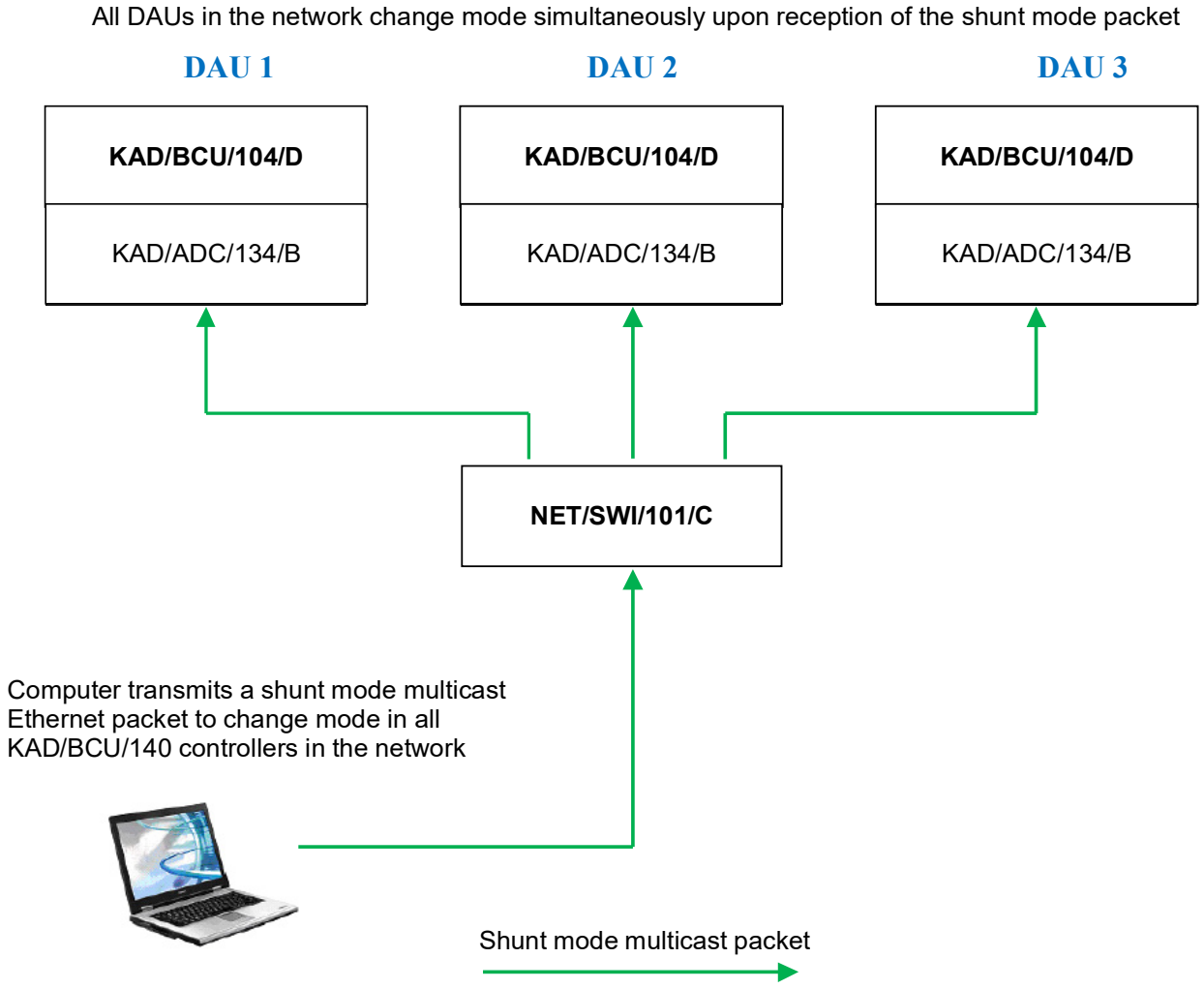


Figure 63-23: Distributed system with KAD/BCU/140/D receiving Shunt Mode packet from a PC

IMPORTANT: When the Shunt Mode packet is received, the KAD/BCU/140/D resets its backplane at it could take up to two seconds for the system to recover from this event.

63.6.5.5 Scenario 2: Shunt used with MEM/113

The Shunt Register parameter can be used to control the operation of the KAM/MEM/113 module. Unlike in Scenario 1, the KAM/MEM/113 is typically present on one chassis per system, the KAD/BCU/140/D is inserted in the same chassis as the KAM/MEM/113, and it receives the **Shunt Mode packet** instead of transmitting it. Typically, this packet is sent by a PC or it can be triggered by a KAD/DSI/102 module as shown in the following figure.

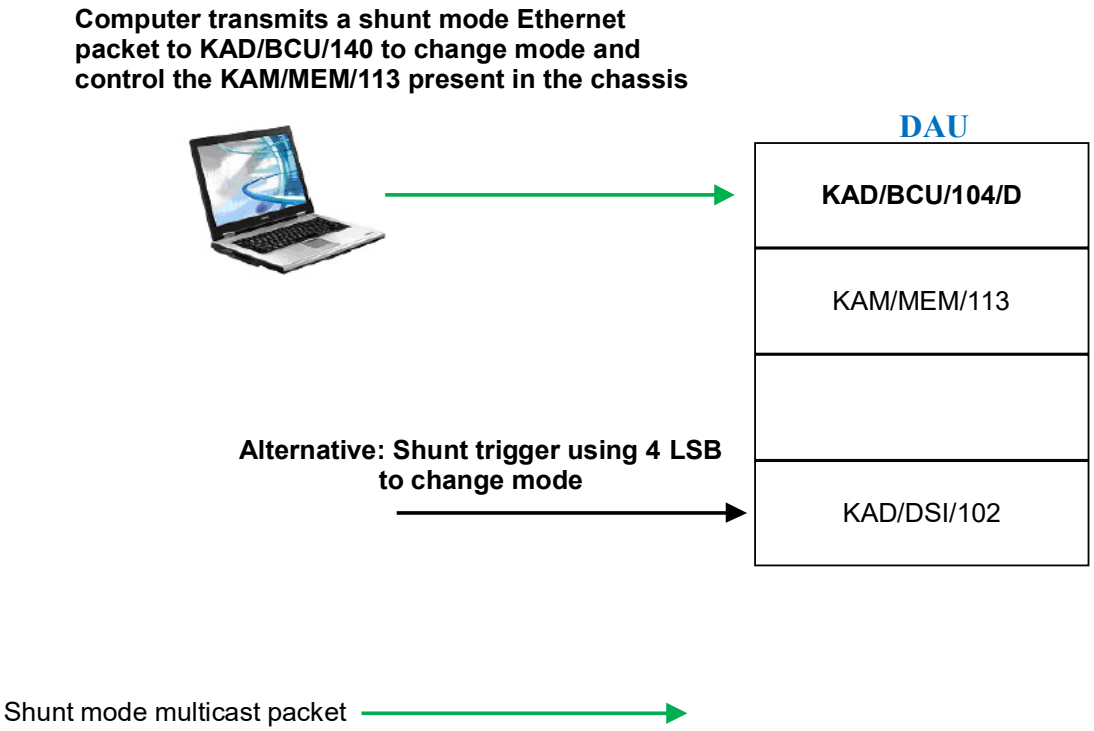


Figure 63-24: KAD/BCU/140/D receiving Shunt Mode packet from a PC and/or KAD/DSI/102 module

For further information, see *TEC/NOT/083 - Using the KAM/MEM/113*.

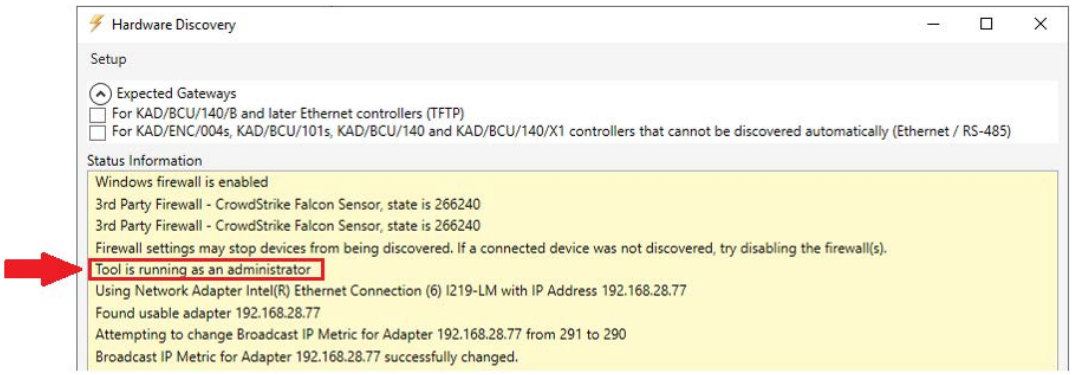
IMPORTANT: When the Shunt Mode packet is received, the KAD/BCU/140/D resets its backplane at it could take up to two seconds for the system to recover from this event. As a result, an undesired event might be created in the KAM/MEM/113.

63.7 FAQ, Common problems, and troubleshooting guide

63.7.1 Problems programming, pinging, or discovering the system

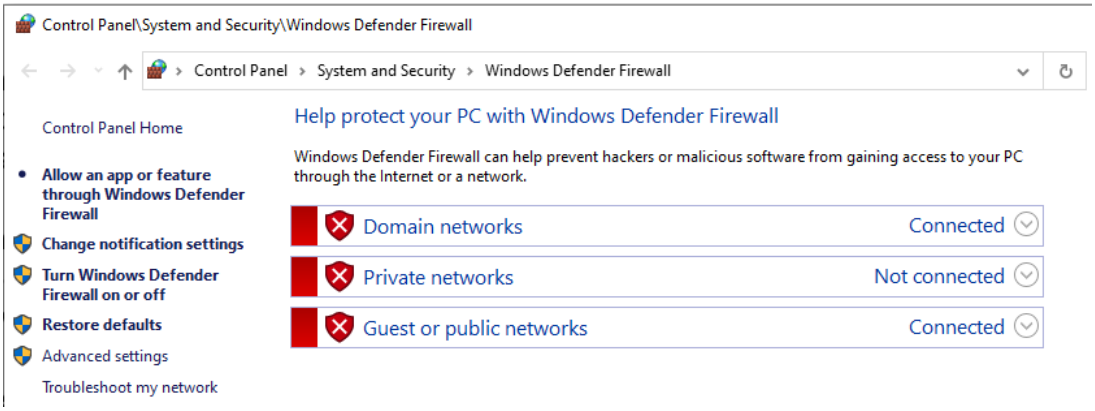
Problems programming, pinging, or discovering the KAM-500 via KAD/BCU/140/D could be due to a number of reasons.

1. **Administration privileges**. When the system cannot be pinged or programmed, the main cause is lack of administration privileges. To ensure DAS Studio is run as computer administrator: From **DAS Studio**, open **Message Viewer** and confirm **Tool is running as administrator** as shown below.



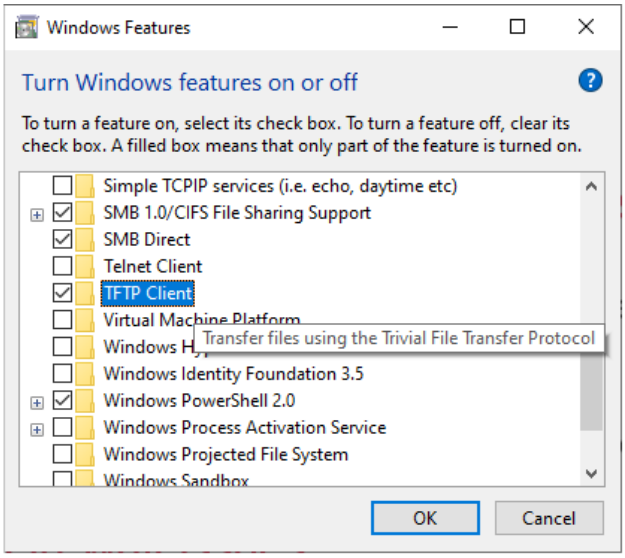
2. **Firewall**. When the system cannot be pinged and/or discovered it may be a firewall issue. From **DAS Studio**, open **Message Viewer** and check if following is shown: **Firewall report ; Windows firewall is enabled**
If yes, then disable the antivirus and firewall on the PC.

For testing purposes, ensure all firewall software in the PC is disabled, including Microsoft Firewall bundled with Windows operating system. The following picture shows a disabled firewall under Windows.



Once the system is operational, the recommendation is to turn on Firewall protection on and add exceptions to the Firewall for ksetup.exe and other DAS Studio related tools.

3. **TFTP service**. When the system cannot be programmed, ensure the Windows TFTP service is enabled. The KAD/BCU/140/D programs the KAM-500 chassis via Ethernet using Trivial File Transfer Protocol (TFTP) and this service needs to be enabled in Windows.



NOTE: See *DAS Studio Installation Guide* for details on how to enable the TFTP service.

4. Using KAD/BCU/140/D's mirror port for PTP/Programming. A common mistake is to use the mirror port (redundant) of the KAD/BCU/140/D to program the system. As explained in the "Getting the most from the KAD/BCU/140" section of the data sheet, this port cannot be used to program the system and does not get synchronized with PTP, in other words, this port is output only.

   TIP! DAS Studio allows to connect Ethernet(1), in the Packages tab, to another Ethernet device such as NET/SWI/101/C, however it does not allow to add packets to this port.

63.7.2 No data for about two seconds

A two-second jump in data and/or time when monitoring the output of a KAD/BCU/140/D in real time or checking the recorded data, indicates the possibility of a backplane reset, which could happen when the time source jumps for more than 500 microseconds. When the backplane resets, the sequence number of the Ethernet package resets to zero. Additionally, the BCU stays momentarily out of sync, therefore monitoring the KAD/BCU/140/D Report word at this time can be useful to confirm and debug this kind of problem. When a backplane reset is detected, first check the external time source, and when using PTP, ensure the PTP format (PTPv1 or PTPv2) programmed in the KAD/BCU/140/D matches the grandmaster. Additionally, check the Report register for out of sync (bit 0) or loss of sync (bit 1) events.

63.7.3 Problem loading files into IADS

In DAS Studio the same parameter can be placed in different packages at the same or different rate, however IADS RT Station does not allow this practice. In this case, an error similar to the following shows up in giving the name of the duplicated parameter and the Stream ID or package key.

[ERROR] : Invalid Acra Ethernet packet configuration: parameter P_MyKAD_BCU_140_D_IrigTime48 appears in multiple packages (0x1111, 0x2222).

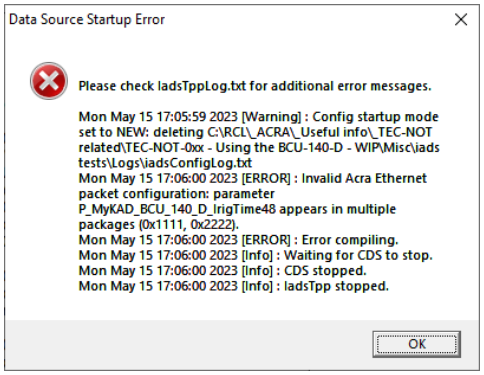


Figure 63-25: IADS issues an error when a parameter appears in two packets

The workaround—without modifying the XIDML task file—is to deselect packets in the IADS start up wizard until the parameters only appear in one of the selected packets. To identify the packets that need to be filtered out, check the name against the stream ID in DAS Studio.

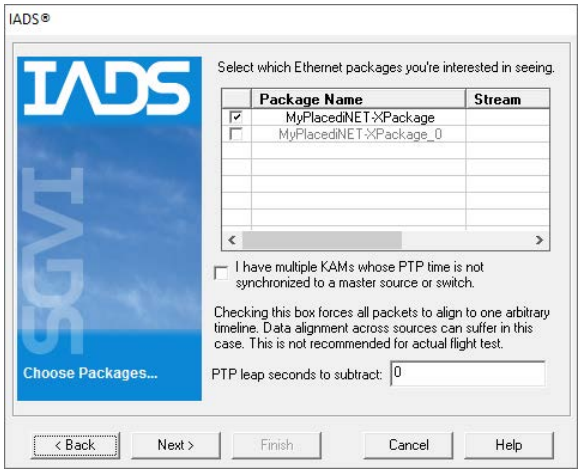


Figure 63-26: One of the packages with duplicated parameters is disabled in IADS startup wizard

63.7.4 Autonegotiation

The KAD/BCU/140 is 100BaseTX full-duplex only and uses auto-negotiation (auto) to set the transmission speed. Ensure the Ethernet device it connects to, such as a NET/SWI/101, NET/REC/00x, KAD/SWI/108 or 3rd party Ethernet devices, also use auto-negotiation and not fixed speed, otherwise packets may be dropped.

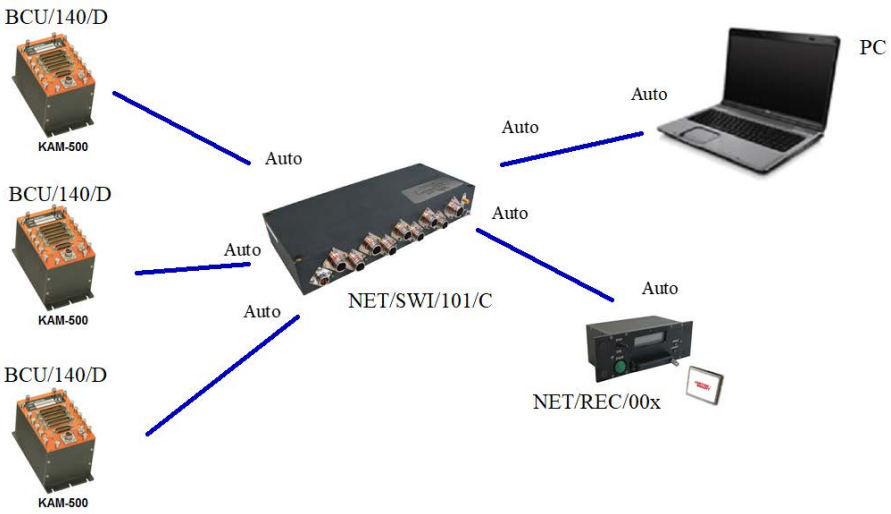


*Figure 63-27: Set the connection speed to KAD/BCU/140/D in the NET/SWI/101 to **Auto***

63.7.5 Time formats in KAM-500 backplane

There are three time formats used in the KAM-500 backplane:

- UTC time is used by:
  - The KAM-500 backplane. That is, High, Low, and Micro time registers
  - IENA packets
- TAI time is used by
  - PTP synchronization protocol
  - iNET-X packets
- GPS time is used by
  - GPS cards such KAM/TCG/102 and KAM/TCG/105

As mentioned in earlier sections in this document, there are leap second adjustments required to sync all these time formats.

In 2023, UTC is ahead of TAI by 37 seconds; this is added to the KAD/BCU/140/D in the PTP **Leap Seconds** field.

GPS time is ahead of UTC by 18 seconds, and this is added to the KAM/TCG/10x in the **Leap Seconds** field.

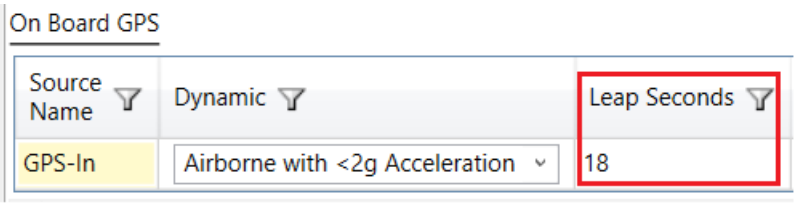


Figure 63-28: KAM/TCG/105 Leap Seconds

Table 63-15: Related documentation

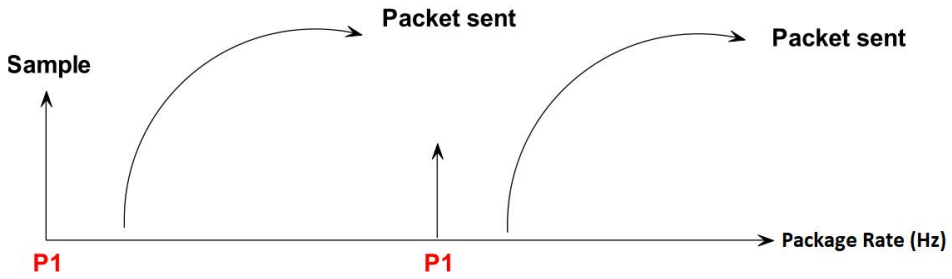
Document	Description
TEC/NOT/072	Time and leap seconds
KAD/BCU/140/D	“Leap seconds” section of the data sheet
iNET-X Handbook	

63.7.6 Latency vs bandwidth when setting up packets

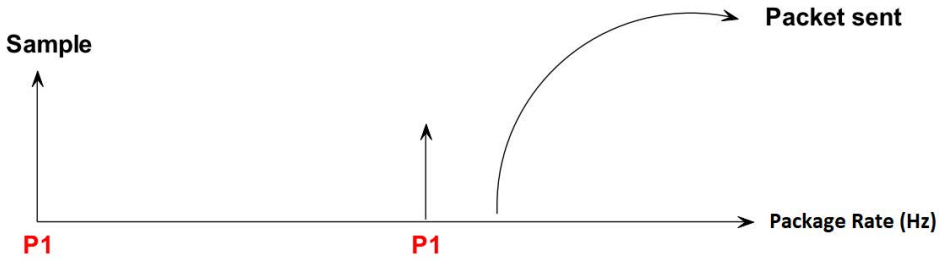
The number of occurrences of the parameter in the package determines the sampling rate of a parameter which is calculated as follows:

Parameter Sampling Rate = Package rate (Hz) * Occurrences in a package

The recommended packet size is less than 1514 bytes in order to avoid fragmentation. The difference between Package rate (Hz) and the Occurrences in a package is explained in the following graphs.



Scenario 1: two packages are transmitted with 1 occurrence each – Less latency and higher overhead.



Scenario 2: one package is transmitted with 2 occurrences – Increased latency but less overhead.

The sampling rate of P1 is the same in both scenarios. Each sample of P1 in scenario 1 is transmitted as soon as the package is ready, however in scenario 2 the Ethernet package is only transmitted when the second sample of P1 is ready. This means scenario 1 has a shorter latency but uses a higher bandwidth in the network because two packets with the UDP header (about 40 bytes) have to be transmitted. Scenario 2 has a lower bandwidth as it only needs to send one packet.

In general, the recommendation is to create medium size packets keeping a balance between latency and bandwidth. Short and/or very frequent packets could potentially create congestion in the network. DAS Studio uses 511 bytes default size as data payload for packetizer packets.

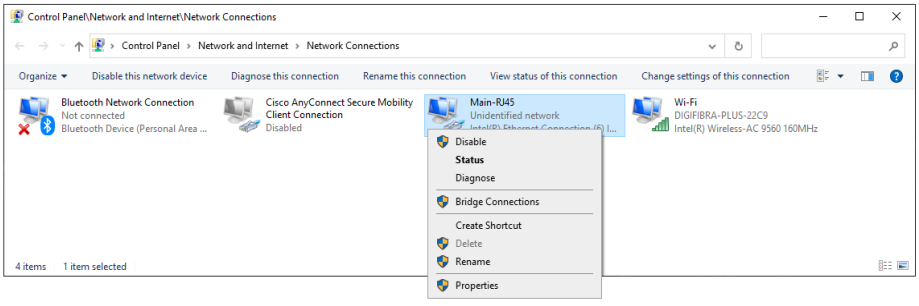
NOTE: Packet rates over 1 Khz may cause the PC Ethernet adapter to drop packets.

63.7.7 Setting up the network on the PC

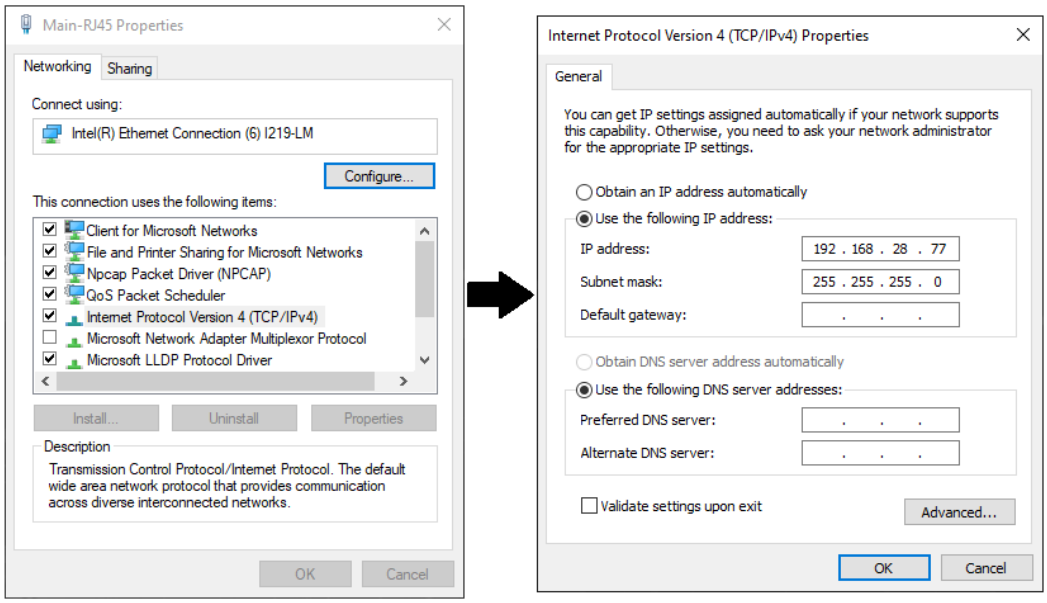
In most scenarios, the PC being used to assign the KAD/BCU/140/D IP address uses the same subnet as the newly assigned module IP address. This is necessary for DAS Studio's IP address tool to prompt the user to perform a test on the IP address.

The following example refers to a KAD/BCU/140/D with the default IP address 192.168.28.1. The IP address of the PC can be set to an unused IP address within same subnet, for example, 192.168.28.77. For that, go to network connections in your PC and follow the steps:

1. In the **Control Panel** go to **Network Connections**.
2. Right-click the network interface connected to the controller and then click **Properties**.



3. Select **Internet Protocol Version 4 (TCP/IPv4)** and then click **Properties**.
4. Set the IP as shown in the Properties dialog.



5. (Optional) Once both PC and KAD/BCU/140/D's IP addresses are set, ping the BCU in order to check the connection as explained in "63.7.8 Testing the connection with the PC" on page 25.

TIP! In order to find out the PC's IP address and all Ethernet devices, run the command **ipconfig /all** from Windows command prompt.

NOTE: IP Programmer tool can be used using **SNMP Broadcast Mode**, which allows updating the IP address of a device on a different subnet to the PC. For further information see "Chapter 2 - Options" and "Chapter 7 - IP Address programmer" in the *DAS Studio 3 User Manual*.

63.7.8 Testing the connection with the PC

The KAD/BCU/140/D has auto MDI-X (also known as "auto-crossover") functionality allowing it to operate either with a straight through or a crossover cable without any configuration.

Before programming the unit, check the connection between the PC and the KAD/BCU/140/D. You can do this by pinging the module from the Windows command prompt.

To ping the KAD/BCU/140/D, do the following:

1. Click **Start** and type **Cmd** and then select **Command Prompt**, **Run as administrator**.
2. Type ping, followed by the IP address of the KAD/BCU/140/D.
   If the PC is able to connect to the KAD/BCU/140/D, you get a response similar to that displayed here.

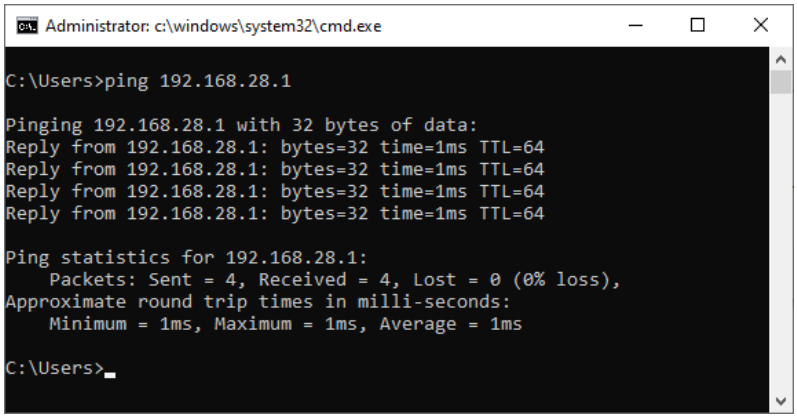


Figure 63-29: Successful ping to the KAD/BCU/140/D from the PC's command line (as admin)

If the ping determines that the PC can communicate with the KAD/BCU/140/D, the module has been successfully configured and is able to receive packets. If there is a problem and the PC is unable to communicate with the KAM-500 chassis, the response is similar to that shown in the following figure.

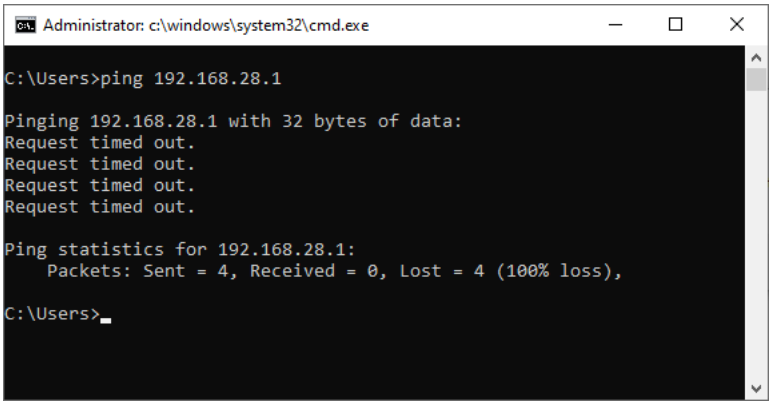


Figure 63-30: Unsuccessful ping to the KAD/BCU/140/D

If a ping has not been successful, make the following checks:

- Check that the correct IP address is being used in the ping command.
- Check that the PC being pinged is on the same subnet as the KAD/BCU/140/D.
- Check that no antivirus or firewall software is interfering with the communication.
- Power down the KAM-500 chassis and check the wiring.

NOTE: Third party software such Wireshark can also be used to check the connection to the KAD/BCU/140/D.

63.7.9 Programming the KAM-500 system

The KAD/BCU/140/D programs the KAM-500 chassis via Ethernet using TFTP.

To learn how to program the KAM-500 system refer to the following documentation:

DAS Studio 3 User Manual, "Chapter 6 - Program - verify and program configuration Data". This chapter explains how to use the Verify and Program tools.

iNET-X Handbook - To learn about the technical details of the TFTP network protocol.

63.7.10 IENA/iNET-X specification

IENA/iNET-X packets have different types such as IENA or iNET-X messages. The KAD/BCU/140/D supports both packet types. Refer to *TEC/NOT/067 - IENA and iNET-X packet payload formats* and the *iNET-X Handbook* to learn about the formats of IENA and iNET-X packets produced by the KAD/BCU/140/D

63.7.11 Alignment of distributed acquisition cycles and system synchronization

In a networked data acquisition system, all chassis with KAD/BCU/140 controllers are able to acquire data synchronously by synchronizing their acquisition cycles using PTPv1 or PTPv2. The requirement is that their acquisition cycles are aligned according to the following criteria:

- The start of an even second must coincide with the start of an acquisition cycle. This implies that all acquisition cycles must divide evenly into two seconds.
- Acquisition cycles must be a multiple of 125 ns long and greater than 100 ns.

The following figure shows different DAUs with different acquisition cycles as they would look after synchronization.

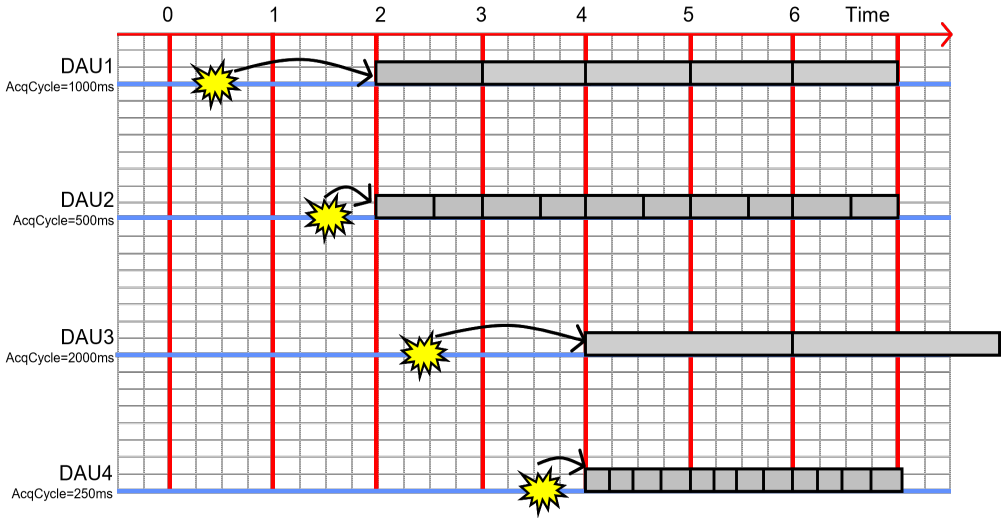


Figure 63-31: DAU acquisition cycles after synchronization – Acquisition cycles 0.5, 1, 2 and 4 Hz

When two or more controllers synchronize to a PTP Grandmaster, their even second boundaries happen at the same time. As acquisition cycles are aligned to these boundaries, acquisition cycles of the same length start at the same time, even though they are on different DAUs.

To learn more about the different acquisition cycles available, see “Networked Acra KAM-500 system and acquisition cycles” in the *KAD/BCU/140/D* data sheet.

The concept of acquisition cycle is hidden in DAS Studio’s implementation of the KAD/BCU/140. The value of the acquisition cycle is transparently chosen by DAS Studio’s compiler and only package rate is available in the GUI. Typically, the rate of the acquisition cycle is the minimum common denominator of all package rates in the system. In the above example, DAS Studio 3 silently picks 2000 ms (slowest rate) as the acquisition cycle of the system.

The acquisition cycle used shows up in the Message Viewer as **Ticks per cycle**, a tick being equal to 125 ns due to the 8 MHz clock implemented in the KAM-500 backplane. This means, for example, that Ticks per cycle 1000000 corresponds to an acquisition cycle of 8 Hz.

63.8 Related documentation and support

The KAD/BCU/140/D is a complex module which uses different technologies implemented in KAM-500 modules. Most of the documentation mentioned in this section is available in the Documentation folder of DAS Studio’s installation files as well as DAS Studio’s data sheet folder typically available in this path: C:\ACRA\DASStudio\3.4.xx\Datasheets.

Table 63-16: Summary of applicable documentation

Setting	Description	Applicable to
DOC/MAN/030	DAS Studio 3 User Manual	Navigating DAS Studio GUI; adding IENA/iNET-X packages.
iNET-X Handbook	iNET-X Handbook	Master reference for technical concepts mentioned in this technical note particularly network-related technology and network protocols.

Table 63-16: Summary of applicable documentation (continued)

Setting	Description	Applicable to
TEC/NOT/003	IRIG-B time code format	Leap year settings and time sources.
TEC/NOT/058	Overview of SNMP and using third party SNMP tools	Setting up the IP address of the KAD/BCU/140/D and discovering network hardware.
TEC/NOT/067	IENA and iNET-X packet payload formats	Package types format description.
TEC/NOT/072	Time and leap seconds	Time settings, time formats, and leap seconds.
TEC/NOT/075	Using DAS Studio 3 to configure the KAD/EBM/102	How to configure the KAD/EBM/102/B to support Multi Chassis Scheduler (MCS) configurations.
TEC/NOT/077	Using shunting processes in Ethernet systems	KAD/BCU/140/D Shunt Mode when used for shunt calibration.
TEC/NOT/083	Using the KAM/MEM/113	Shunt Mode settings to control the KAM/MEM/113 module.
TEC/NOT/085	Using the KAM/TCG/105 and KAM/TCG/106	Leap year settings and time protocols.
TSD/AC/021 (optional)	Transmitting a packet from a PC to change mode	Shunt scenarios 1 and 2 explained in this document when transmitting a Shunt Mode packet from a PC. Note: TSD documents are not Curtiss Wright controlled documentation.

For additional questions or assistance, contact Curtiss-Wright support (acra-support@curtisswright.com).