Chapter 28

Using the KAD/BCU/105

TEC/NOT/053

This paper introduces the KAD/BCU/105 module, how to set it up using KSM-500 software, how to configure the module IP address, 1588 synchronization and its application.

This paper discusses the following topics:

28.1 Overview

The KAD/BCU/105 is a full-duplex 100BaseTX Ethernet Acra KAM-500 backplane controller, programmer and packet generator.

28.1.1 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

28.1.2 Programmer

- Programs the chassis via Ethernet
- Can be PING / ARP, IP is user-assigned
- IP v4 protocol is supported
- Factory-programmed with a unique MAC address

28.1.3 Packet generator

- Generates packets which are compliant with the published IENA standard (UDP compliant)
- Can transmit packets at different rates; can transmit packets of different sizes to different destinations such as multicast, unicast and or broadcast
- Minimal latency; when all parameters values in an IENA packet are present in the Current Value Table (CVT), the IENA packet is transmitted

28.2 Using KSM-500 to configure the KAD/BCU/105

To configure the KAD/BCU/105, kSetup and kProgram software are required.

28.2.1 Setting parameters

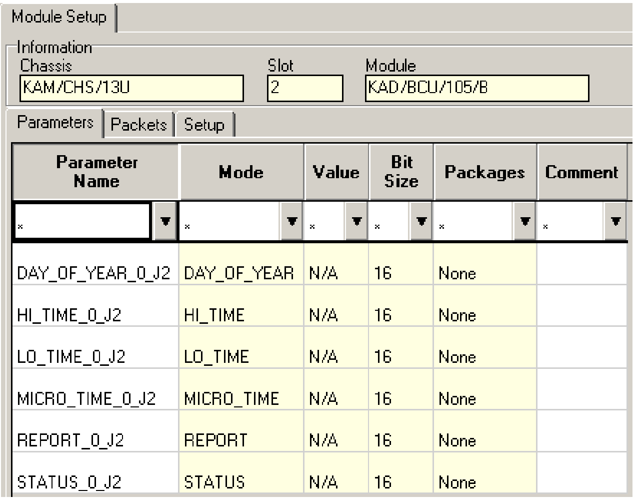
Both default parameters and fixed data parameters can be set. To view and or set parameters for the KAD/BCU/105, select the module in the Task Explorer pane of kSetup.

28.2.1.1 Default parameters

The following figure shows the default parameters listed on the Parameters tab. The Mode, Value, Bit Size and Packages values for all default parameters are factory-set and cannot be edited. You can however edit names in the Parameter Name column. Double-click a Parameter Name field to insert the desired name. For details of register definitions described as Mode in kSetup, see the *KAD/BCU/105* data sheet.

28.2.1.2 Fixed data parameters

To add fixed data or to remove a fixed data, right-click and select the desired option. To edit values for the new parameter, double-click on the relevant field in the Value column and insert a 16-bit hexadecimal value.



Chassis: KAM/CHS/13U

Slot: 2

Module: KAD/BCU/105/B

Parameter Name	Mode	Value	Bit Size	Packages	Comment
DAY_OF_YEAR_0_J2	DAY_OF_YEAR	N/A	16	None	
HI_TIME_0_J2	HI_TIME	N/A	16	None	
LO_TIME_0_J2	LO_TIME	N/A	16	None	
MICRO_TIME_0_J2	MICRO_TIME	N/A	16	None	
REPORT_0_J2	REPORT	N/A	16	None	
STATUS_0_J2	STATUS	N/A	16	None	

Figure 28-1: Default parameters

NOTE: The time registers cannot be transmitted into the IENA packets. However, this is not required as IENA has a 48-bit time stamp.
Curtiss-Wright recommends placing the REPORT parameter into an IENA packet (for information, see “28.2.2.3 Placing parameters in packets” on page 4). The REPORT parameter has important information such as the synchronization status. The REPORT parameter cannot be read over the Acra KAM-500 system, that is, it is not available for any other sink such as a KAM/MEM/103.

28.2.2 Adding IENA packets

You can add or remove IENA STANDARD packets on the Packets Tab (see Figure 28-2 on page 3). You can also edit Packet Names, Packets per Acquisition Cycle, Destination IP Address, Destination Port and Mac Address fields for any packet. For details of the IENA packet description, see “Appendix 2: IENA specification” on page 10.

To add a packet, right-click on the spreadsheet, select **Add Packet** then select **IENA STANDARD** and complete the fields described in the following table.

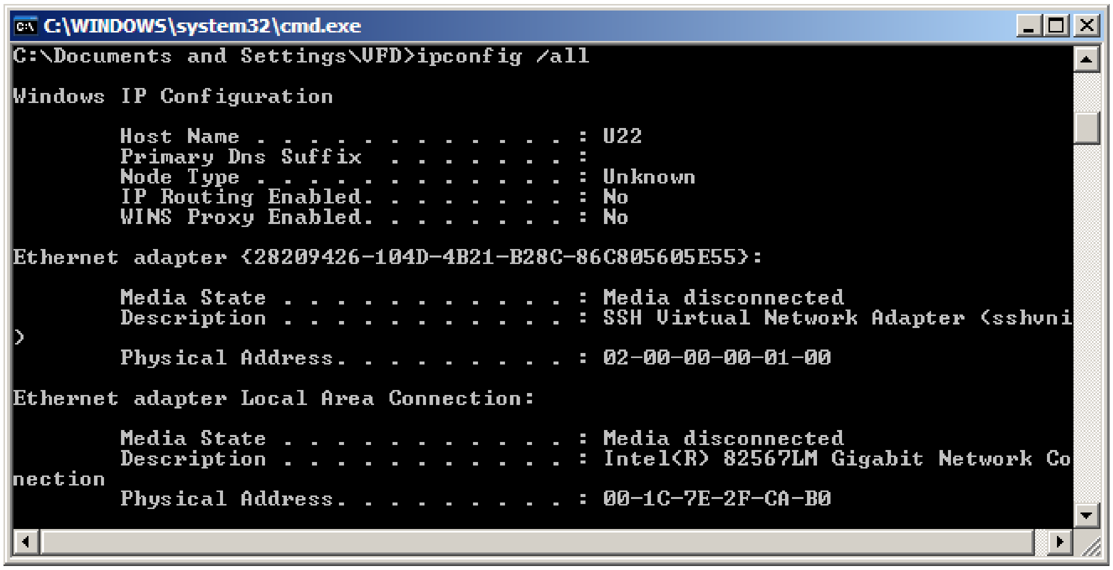
Table 28-1: Adding/removing packets

Field name	Description
Packet Name	Name which identifies packet being transmitted
Packet Type	IENA STANDARD is the only packet type supported; double-click IENA STANDARD to open the packet setup definition
Packets per Acquisition Cycle	The number of packets per acquisition cycle; this number drives the sampling rate for the parameters transmitted into this packet
Destination IP Address	The destination IP address can be unicast, broadcast or multicast
Destination Port	The destination port can be any value between 0 to 65535 except what is specified in RFC 1700 (see “Appendix 1: Well known ports” on page 10); ensure your decommutation PC firewall allows UDP packets to be received on this port
MAC Address	The destination MAC address; when a multicast IP address is used, this field is automatically generated by the software and is read-only

NOTE: When using a multicast destination IP address on a network distributed system, the KAD/BCU/105 reports an event on the REPORT parameter on bit 7: Unexpected Ethernet frame received. This bit is set because the KAD/BCU/105 receives multicast packets coming from other sources.

Always create a packet with an instance of one for Packets per Acquisition Cycle. XidML doesn’t include the concept of acquisition cycle. For example, if you only create a packet with 512 for packets per acquisition cycle, after closing kSetup, the number of acquisition cycle is multiplied to 512 and the packets per acquisition cycle changes to one.

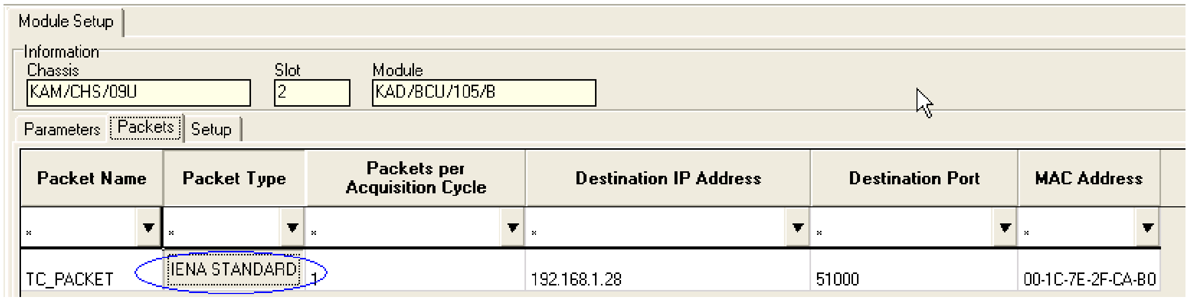
To determine the MAC address used by your laptop, type **IPConfig/all** in a Windows command prompt. IPConfig returns the MAC address as Physical Address. In the example below, the Physical Address is 00-1C-7E-2F-CA-B0.



```
C:\Documents and Settings\VFD>ipconfig /all

Windows IP Configuration

        Host Name . . . . . . . . . . . . : U22
        Primary Dns Suffix  . . . . . . . :
        Node Type . . . . . . . . . . . . : Unknown
        IP Routing Enabled. . . . . . . . : No
        WINS Proxy Enabled. . . . . . . . : No

Ethernet adapter {28209426-104D-4B21-B28C-86C805605E55}:

        Media State . . . . . . . . . . . : Media disconnected
        Description . . . . . . . . . . . : SSH Virtual Network Adapter (sshvni
)
        Physical Address. . . . . . . . . : 02-00-00-00-01-00

Ethernet adapter Local Area Connection:

        Media State . . . . . . . . . . . : Media disconnected
        Description . . . . . . . . . . . : Intel(R) 82567LM Gigabit Network Co
nection
        Physical Address. . . . . . . . . : 00-1C-7E-2F-CA-B0
```

28.2.2.1 Configuring IENA packets

To configure an IENA packet, double-click an IENA STANDARD cell in the Packet Type column on the Packets tab (see the following figure).



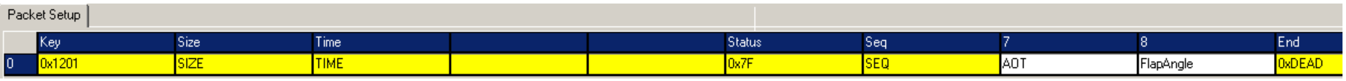
Chassis: KAM/CHS/09U
Slot: 2
Module: KAD/BCU/105/B

Packet Name	Packet Type	Packets per Acquisition Cycle	Destination IP Address	Destination Port	MAC Address
TC_PACKET	IENA STANDARD	1	192.168.1.28	51000	00-1C-7E-2F-CA-B0

Figure 28-2: Configuring IENA packets

28.2.2.2 Editing IENA keys

To edit the IENA Key or IENA End key, double-click the Key cell or the End cell (see the following figure).



	Key	Size	Time			Status	Seq	7	8	End
0	0x1201	SIZE	TIME			0x7F	SEQ	AOT	FlapAngle	0xDEAD

Figure 28-3: Editing IENA keys

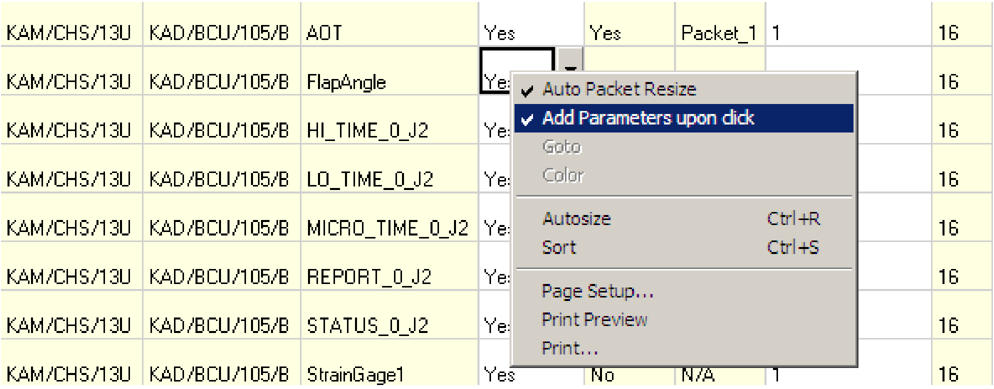
NOTE: To modify the IENA Key or the IENA End, ensure Add Parameters upon click is not selected (for Add Parameters option, see the following figure).
The IENA key must be unique for each IENA packet type generated.
The IENA End has the same value for all the packets coming from the module.

28.2.2.3 Placing parameters in packets

You can manually place parameters in a packet if you want to specify the position of that parameter in the packet. For subsequent placements, each additional parameter is placed to the right of its predecessor.

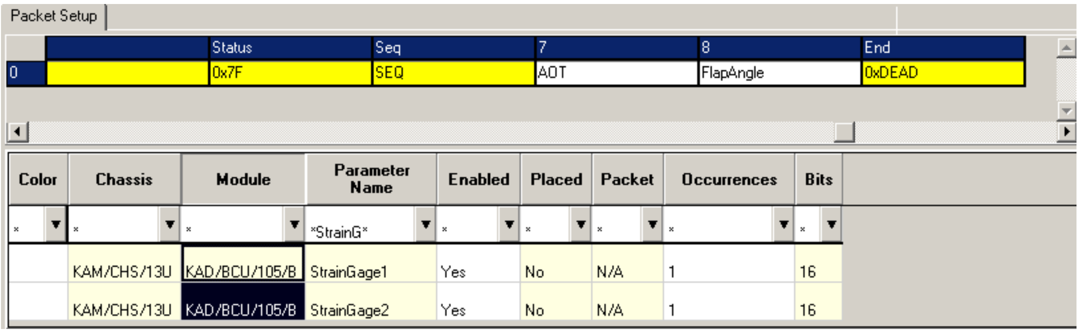
To manually place a parameter, do the following:

1. On the Packet Setup tab, right-click and ensure **Auto Packet resize** and **Add Parameters upon click** are checked.



KAM/CHS/13U	KAD/BCU/105/B	AOT	Yes	Yes	Packet_1	1	16
KAM/CHS/13U	KAD/BCU/105/B	FlapAngle	Ye				16
KAM/CHS/13U	KAD/BCU/105/B	HI_TIME_0_J2	Ye				16
KAM/CHS/13U	KAD/BCU/105/B	LO_TIME_0_J2	Ye				16
KAM/CHS/13U	KAD/BCU/105/B	MICRO_TIME_0_J2	Ye				16
KAM/CHS/13U	KAD/BCU/105/B	REPORT_0_J2	Ye				16
KAM/CHS/13U	KAD/BCU/105/B	STATUS_0_J2	Ye				16
KAM/CHS/13U	KAD/BCU/105/B	StrainGage1	Yes	No	N/A	1	16

2. For the packet concerned, click on the spreadsheet to select a parameter.
3. Click on the byte to the right of the location you wish to place the parameter.
   For example, to place StrainGauge1 and StrainGage2 to the right of the FlapAngle parameter: Select StrainGauge1 and StrainGage2 then click on 0xDEAD.



	Status	Seq	7	8	End
0	0x7F	SEQ	AOT	FlapAngle	0xDEAD

Color	Chassis	Module	Parameter Name	Enabled	Placed	Packet	Occurrences	Bits
*	*	*	*StrainG*	*	*	*	*	*
	KAM/CHS/13U	KAD/BCU/105/B	StrainGage1	Yes	No	N/A	1	16
	KAM/CHS/13U	KAD/BCU/105/B	StrainGage2	Yes	No	N/A	1	16

4. Complete the fields described in the following table.

Table 28-2: IENA packet settings

Field name	Description
Color	Not available
Chassis	Chassis label from where the parameter comes from; read-only field
Module	Module label from where the parameter comes from; read-only field
Parameter Name	Name of the parameter; read-only field
Enabled	Set to No prevents you from placing the parameter in the packet
Placed	Set to Yes when the parameter is placed into a packet
Packet	Packet label where the parameter is placed
Occurrences	Number of occurrences of the parameter in the packet; this number drives the parameter sampling rate; the same number of occurrences is recommended for all the parameters within the same packet
Bits	Number of source bits for the parameter

28.2.3 Setting up the KAD/BCU/105

After IENA packets have been configured, you can set up the KAD/BCU/105 to transmit the newly configured packets. When setting up the module, you must specify the Module IP address, Module Port and Time to live per packet. This information is required before it is possible to assign the IP address of the module.

On the Setup tab, complete the fields described in the following table.

Table 28-3: Module setup

Field name	Description
Module IP address	When set, the module can be pinged; for details of pinging the module, see “28.3.1 Testing the connection between PC and the KAD/BCU/105” on page 6
Module Port	Any value between 0 to 65535, except what is specified in RFC 1700 (see “28.6.1 Appendix 1: Well known ports” on page 10); ensure your programming PC firewall allows this port
Time to live (s)	An advanced configuration field which determines how long a packet from the module ‘lives’ in the network, in the event that it does not reach its destination

NOTE: The Module IP Address field does not assign the IP address for the KAD/BCU/105; this field is used only to program the chassis. For information on assigning the IP address, see “Assigning the IP address” on page 6.

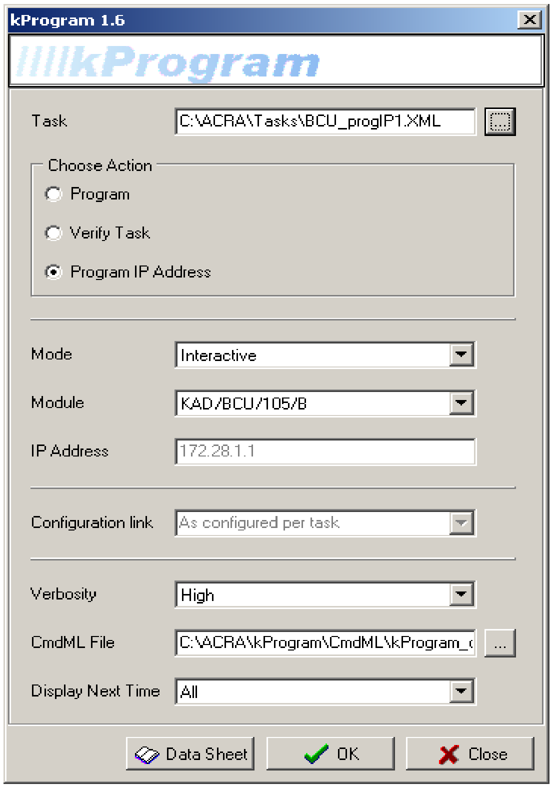
28.3 Assigning the IP address

If the KAD/BCU/105 top block pin 7 is connected to BVDD, the KAD/BCU/105 assumes a default hard-wired IP address—239.0.0.0 is used, as it is an administratively scoped IP multicast address.

To assign the IP address for KAD/BCU/105, do the following:

1. Launch kProgram.
2. In the **Task** field, browse for the task file required.
3. Select the **Program IP address** radio button.

4. In the **CmdML File** field, select the xidML file with the KAD/BCU/105 module IP address that you want to assign to.
   After the xidML file is selected, the IP Address field displays the IP address taken from the xidML file.



Task: C:\ACRA\Tasks\BCU_progIP1.XML

Choose Action
○ Program
○ Verify Task
● Program IP Address

Mode: Interactive

Module: KAD/BCU/105/B

IP Address: 172.28.1.1

Configuration link: As configured per task

Verbosity: High

CmdML File: C:\ACRA\kProgram\CmdML\kProgram_c

Display Next Time: All

5. Click **Ok**.
6. Connect IP_ASSIGN (pin 7) to BVDD (pin 4) and then click **OK** onscreen.
7. Disconnect IP_ASSIGN (pin 7) from (pin 4) BVDD and click **OK** onscreen.
8. To verify the new IP address, click **Yes**.

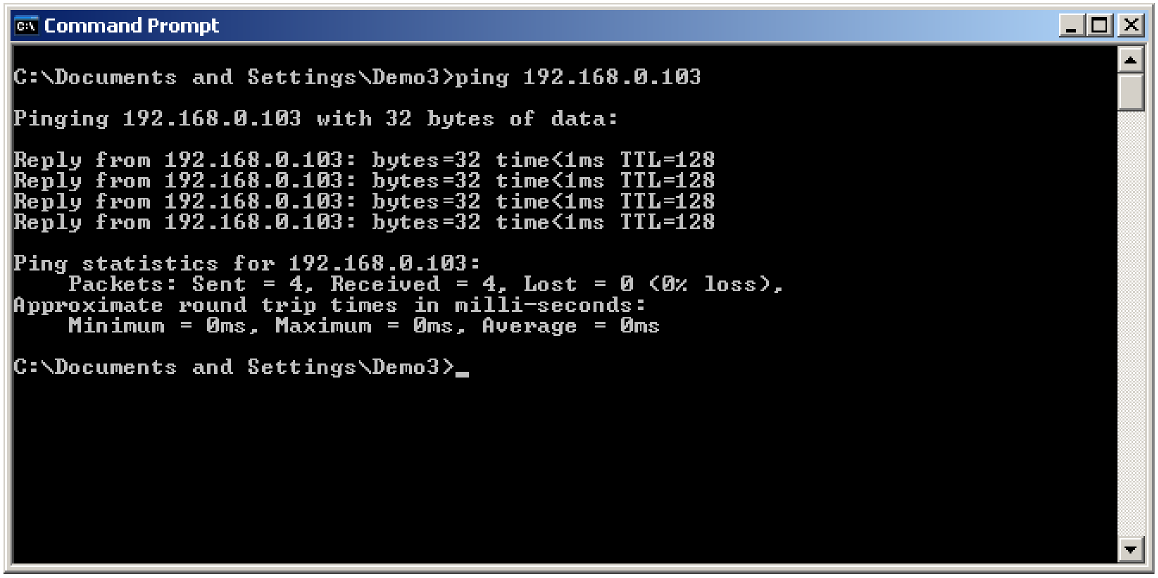
NOTE: Ensure the PC being used to assign the KAD/BCU/105 IP address uses the same subnet as the newly assigned module IP address. This is necessary for when kProgram prompts you to perform a test on the IP address.
The KAD/BCU/105 has auto-crossover capability; it operates either with a straight through or a crossover cable without being preset to do so.

28.3.1 Testing the connection between PC and the KAD/BCU/105

Before programming the unit, check the connection between the PC and the KAD/BCU/105. You can do this by pinging the module from the Windows command prompt.

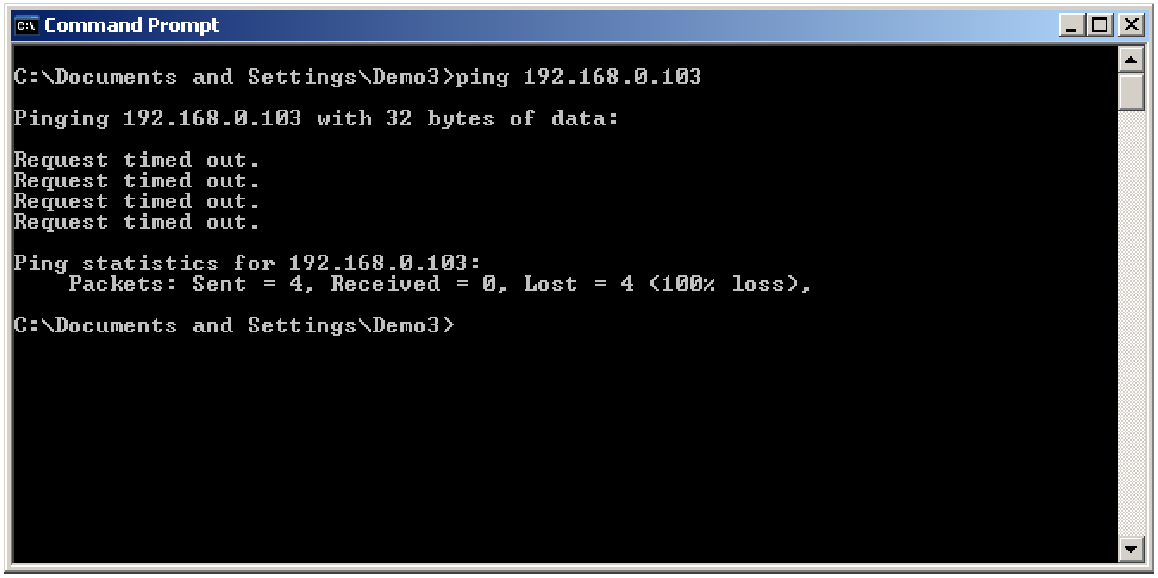
To ping the KAD/BCU/105, do the following:

1. Click **Start**, **Run**.
2. Type **cmd** and click **OK**.
3. At the C:\ prompt, type **ping**, followed by the IP address of the KAD/BCU/105.
   If the PC is able to connect to the KAD/BCU/105, you get a response similar to that displayed here.



```
C:\Documents and Settings\Demo3>ping 192.168.0.103

Pinging 192.168.0.103 with 32 bytes of data:

Reply from 192.168.0.103: bytes=32 time<1ms TTL=128
Reply from 192.168.0.103: bytes=32 time<1ms TTL=128
Reply from 192.168.0.103: bytes=32 time<1ms TTL=128
Reply from 192.168.0.103: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.0.103:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Documents and Settings\Demo3>_
```

If the ping determines that the PC can communicate with the KAD/BCU/105, 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 Acra KAM-500 chassis, the response is similar to that shown here.



```
C:\Documents and Settings\Demo3>ping 192.168.0.103

Pinging 192.168.0.103 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.0.103:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Documents and Settings\Demo3>
```

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 pinging PC is on the same subnet as the KAD/BCU/105
- Power down the Acra KAM-500 chassis and check the wiring

28.3.2 Programming the KAD/BCU/105

When the ping has determined that a connection between the PC and the KAD/BCU/105 is established, use kProgram to program the KAD/BCU/105. For information on using kProgram, see the *kProgram* data sheet.

28.4 1588 Synchronization

Synchronization is achieved via an external IEEE 1588 Precision Time Protocol (PTP) v1 source. A 1588 grandmaster such as the NET/SWI/002 is necessary to achieve synchronization. For more information on IEEE 1588, see “28.6.3 Appendix 3: Introduction to IEEE 1558” on page 10.

NOTE: To get the most from networked Acra KAM-500 data acquisition systems, it is essential that IEEE 1558-compatible Ethernet switches are used.

28.4.1 Alignment of distributed acquisition cycles

It is possible to synchronize packets from multiple Data Acquisition Units (DAUs) if 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
- Acquisition cycles must be greater than 100 µs long

The following figure shows different DAUs with different acquisition cycles—this illustrates how they should look after synchronization.

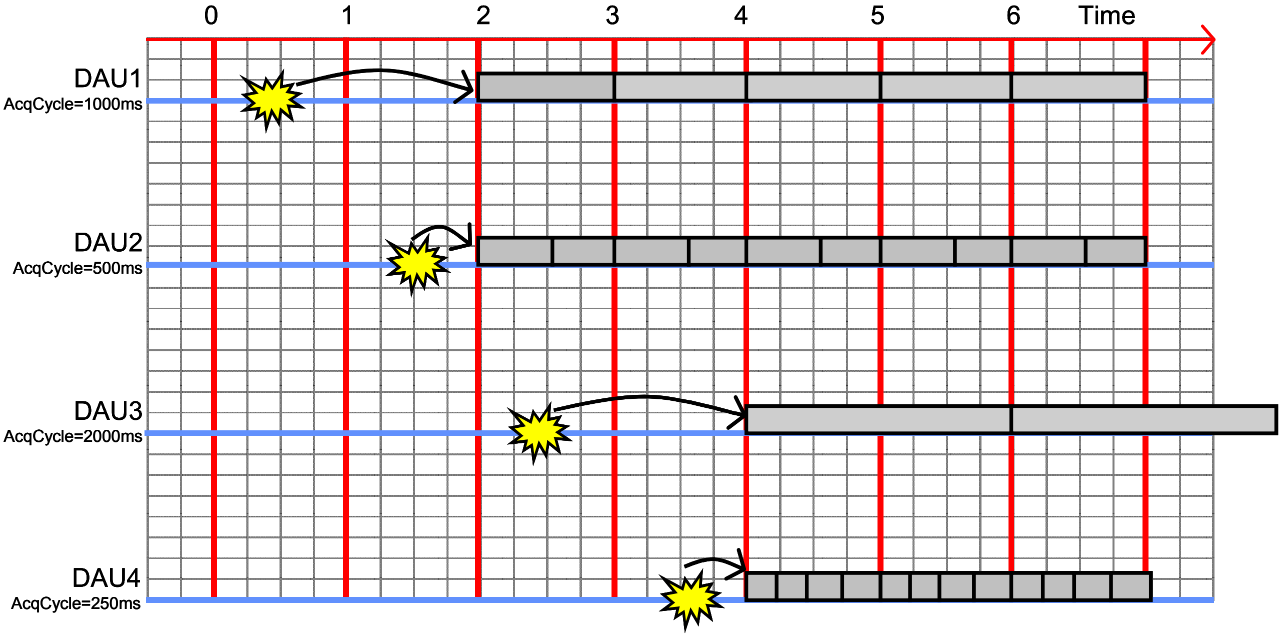


Figure 28-4: DAU acquisition cycles after synchronization

When two or more controllers synchronize to a 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 (for possible acquisition cycle frequencies, see the *KAD/BCU/105* data sheet).

28.4.2 Clock adjustment algorithm

There are two mechanisms by which the KAD/BCU/105 can adjust its clock to eliminate the offset between its clock and the clock in the grandmaster.

If the magnitude of the offset is greater than 500 µs, the KAD/BCU/105 calculates the correct time as the current clock value plus the offset, and sets its clock to that value. There is a residual error of a few microseconds, due to the time taken to do the calculation, which is calculated and corrected when more PTP messages are received.

An offset less than 500 µs is corrected by adjusting the clock speed until the offset is eliminated. When the KAD/BCU/105 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.

28.5 Applications

28.5.1 Single chassis system

In a single chassis system, a time code generator module, for example KAD/TCG/102, or a real-time clock module, for example KAD/RTC/003, can be used to seed the time into the Acra KAM-500 chassis. The time in the IENA output from the KAD/BCU/105 is derived from the time code generator module or the real-time clock module.

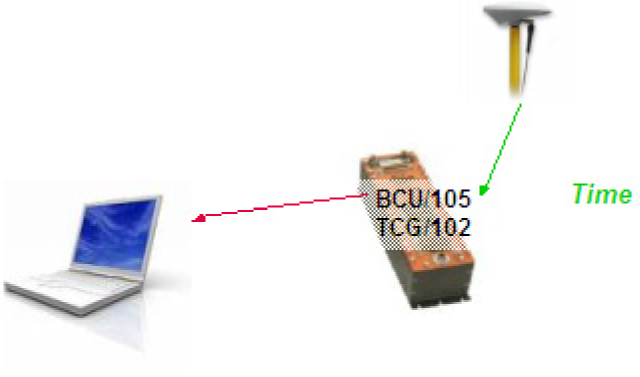


Figure 28-5: Single chassis system

28.5.2 Distributed system

In a distributed system, to synchronize the chassis with the KAD/BCU/105, an IEEE 1588 v1 grandmaster is necessary. The NET/SWI/002 can act as a grandmaster and has a GPS input to seed the time to the PTP packets.

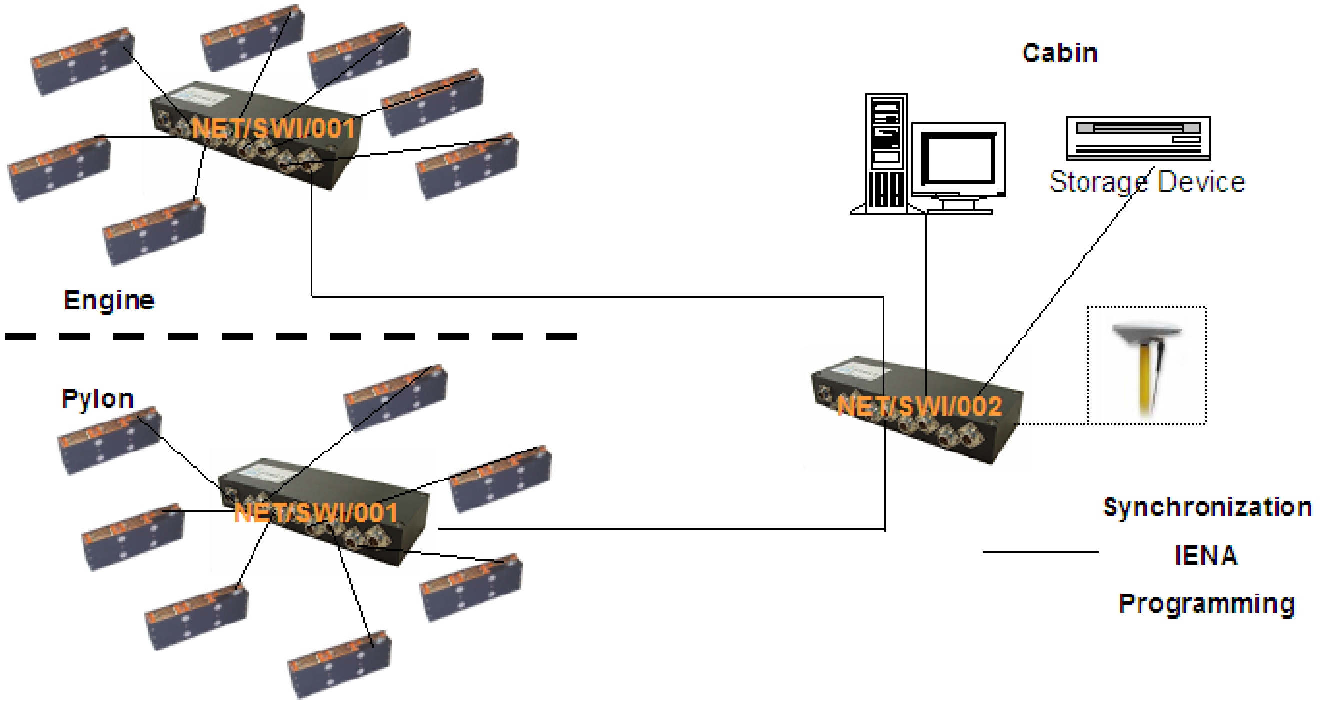


Figure 28-6: Distributed system

28.6 Appendix

28.6.1 Appendix 1: Well known ports

For a list of well known port numbers, refer to http://www.iana.org/assignments/port-numbers.

28.6.2 Appendix 2: IENA specification

IENA packets have different types such as IENA STANDARD or messages. The KAD/BCU/105 supports only IENA STANDARD packets. The IENA STANDARD packet is the payload of a UDP datagram.

28.6.2.1 IENA data header

The following table shows the IENA data header fields with corresponding size and description. You must define the Key value for each additional IENA STANDARD packet created.

Table 28-4: IENA data header fields

Field	Size	Description
Key	16 bits	Key in IENA STANDARD packet indicates the type of data in the packet and how data is structured within that packet; this key is a user input
Size	16 bits	Number of data words in the packet; automatically calculated by the module when packet is built
Time	48 bits	Time of sampling of first data sample in packet in straight binary microseconds
Status	16 bits	Reserved
Seq	16 bits	Value that increments for each packet of a given key

28.6.2.2 IENA data footer

The following table shows the size and description of the IENA data footer end field. Once the value is changed, the change applies to all IENA STANDARD packets defined in the module setup.

Table 28-5: IENA data footer end field

Field	Size	Description
End	16 bits	This is a constant value; a typical value for this is 0xDEAD

28.6.3 Appendix 3: Introduction to IEEE 1558

IEEE 1588 provides fault-tolerant synchronization for different clocks in the same network. IEEE 1588 involves minimal bandwidth consumption, processing power and setup; this is accomplished by use of PTP. PTP synchronizes all clocks within a network by adjusting clocks to the highest quality clock.

IEEE 1588 defines value ranges for the standard set of clock characteristics. The grandmaster clock algorithm determines which clock is the highest quality clock within the network. The grandmaster clock then synchronizes all other clocks (slave clocks) in the network. If the grandmaster clock is removed from the network, or is determined by the grandmaster clock algorithm to no longer be the highest quality clock, the algorithm then redefines what the new grandmaster clock is and adjusts all other clocks accordingly. No administrator input is required for this readjustment as the algorithm provides fault-tolerant synchronization.

Bidirectional Multicast Communication is used by the slave clocks to synchronize to the IEEE 1588 grandmaster clock. The grandmaster sends a sync packet, containing the grandmaster's clock value at the time the sync packet was sent. As there may be delays between the time when the grandmaster reads its clock to build the packet and when the packet is sent, this timestamp may be approximate. The grandmaster may therefore also send a follow-up packet containing the exact time that the sync packet left the grandmaster.

The following figure shows an example of the 1588 sequences.

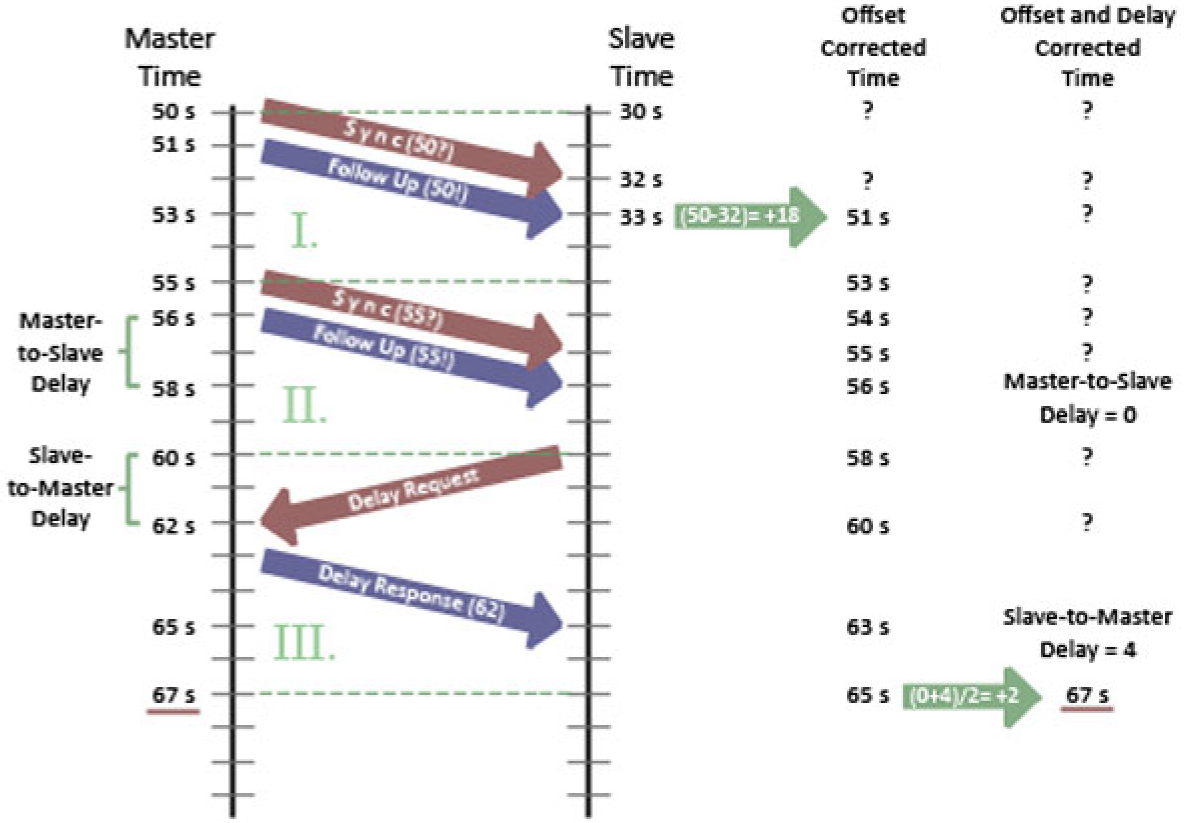


Figure 28-7: 1588 packets sequence

The delay between master and slave sync packets, and vice versa, implies that IEEE 1588 operates on the assumption that network propagation delay is symmetrical. It is because of this assumption that a slave can determine and readjust for the propagation delay. To do this, the slave creates a delay request packet and timestamps it upon departure. The master clock then timestamps the packet upon receipt and sends it back to the slave, a delay response packet. The network propagation delay is then determined by finding the delay between these timestamps.

The sending and receiving process of the synchronization packets allows the slave clock to accurately measure the offset between the slave's own clock and the master clock.

Standard methods of clock adjustment implementation are not outlined by IEEE 1588; it provides only a standard protocol for the exchange of messages between clocks. The benefit of this is that clocks from different manufacturers are able to synchronize with each other.

28.6.3.1 1588 PTP packet formats

This section outlines PTP packet formats for the standard message header, sync/delay requirement, follow-up and delay response.

PTP standard message header

	0	1	2	3
	0 1 2 3 4 5 6 7	8 9 10 11 12 13 14 15	16 17 18 19 20 21 22 23	24 25 26 27 28 29 30 31
0	PTP version		Version Network	
4	Subdomain			
8				
12				
16				
20	Message Type	Source comm tech		
24	source uuid			
28	Source Port		Sequence id	
32	Control	Reserved =00	Flags	
36	Reserved = 00 00 00 00			

PTP sync and delay_req

	0	1	2	3
	0 1 2 3 4 5 6 7	8 9 10 11 12 13 14 15	16 17 18 19 20 21 22 23	24 25 26 27 28 29 30 31
38	Origin ts (sec)			
42	Origin ts (nsec)			
46	Epoch number		Current UTC offset	
50	"00	GM Comm tech		
54	GM Clock UUID			
58	GM Port ID		GM Seq ID	
62	"00	"00	"00	GM Clock Stratum
66	GM Clock ID			
70	"00	"00	GM Clock Variance	
74	"00	GM Preferred	"00	GM Boundary
78	"00	"00	"00	Sync interval
82	"00	"00	Local Clock Variance	
86	"00	"00	Local Steps Removed	
90	"00	"00	"00	Local Clock Stratum
94	Local Clock ID			
98	"00	Parent Comm Tech		
102	Parent UUID			
106	"00	"00	Parent Port Field	
110	"00	"00	Estimated Master Variance	
114	Estimated Master Drift			
118	"00	"00	"00	UTC Reasonable

PTP follow-up

	0	1	2	3
	0 1 2 3 4 5 6 7	8 9 10 11 12 13 14 15	16 17 18 19 20 21 22 23	24 25 26 27 28 29 30 31
38	"00	"00	Associated Seq ID	
42	Precise Origin ts (sec)			
46	Precise Origin ts (nsec)			

PTP_delay_resp

<table>
<tr><td></td><td colspan="8">0</td><td colspan="8">1</td><td colspan="8">2</td><td colspan="8">3</td></tr>
<tr><td></td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td></tr>
<tr><td>38</td><td colspan="32">Delay Receipt ts (sec)</td></tr>
<tr><td>42</td><td colspan="32">Delay Receipt ts (nsec)</td></tr>
<tr><td>46</td><td colspan="8">"00</td><td colspan="8">Req Source Comm Tech</td><td colspan="16"></td></tr>
<tr><td>50</td><td colspan="32">Req Source UUID</td></tr>
<tr><td>54</td><td colspan="16">Req Source Port ID</td><td colspan="16">Req Source Seq ID</td></tr>
</table>

Table 28-6: PTP terms

Field name	Description
Version PTP	Value of the PTP standard implemented by the clock issuing the message
Version Network	Version number of the network specific portions of the PTP standard implemented by the clock issuing the message
Subdomain	Value of the subdomain from the default data set; may have two functions in an implementation Can act as a magic number to increase confidence that the message is a PTP event or PTP general message Can act as a unique identifier distinguishing event or general messages in a given subdomain
Message Type	Event messages - Sync or Delay_Req have a value of 0x01 General messages - Delay_resp, Follow-up or Management messages value 0x02
Source Communication Technology	Value of the port_communication_technology of the source port data set issuing the message
Source UUID	Value of the port_uuid_field of the port data set issuing the message
Source Port UUID	Value of the port_id_field of the port data set of the port issuing the message
Sequence Id	Event messages - the value of the last_sync_event_sequence or the port data set issuing the message General - last_general_event_sequence_number of the port data set issuing the message

Control	ControlField enumeration
	PTP_SYNC_MESSAGE =0
	PTP_DELAY_REQ_MESSAGE =1
	PTP_FOLLOWUP_MESSAGE =2
	PTP_DELAY_RESP_MESSAGE =3
	PTP_MANAGEMENT_MESSAGE =4
	Reserved 5-255

Flags	MSB is bit 15 (15-7) Reserved (6) PTP_SYNC_BURST: In a delay_Req message is true if the sender is requesting a burst of sync messages; in a sync or follow-up message is true if this is part of such a burst (5) Parent stats (4) PTP_EXT_SYNC – external timing of the default data set (3) PTP_ASSIST – clock_followup_capable default data set (2) PTP_BOUNDARY_CLOCK (1) PTP_LI_59 – leap_59 of global properties data set (0) PTP_LI_61 – leap_61 of global properties data set

28.6.3.2 PTP message intervals

The most complex specification deals with how often slave clocks issue Delay_Req messages:

- Randomized to reduce network and master clock processing loads
- Randomization is first over multiple sync intervals and second within the selected interval

From section 7.11 of the PTPv1 standard, the following timing rules apply for the various messages:

Given the constants:

- Sync_interval = {1,2,4 … etc}
- PTP_SYNC_INTERVAL_TIMEOUT = 2 ^ sync_interval
- PTP_SYNC_RECEIPT_TIMEOUT = 10 x 2 ^ sync_interval
- PTP_DELAY_REQ_INTERVAL = 30
- PTP_RANDOMIZING_SLOTS = 18
- AVERAGING_INTERVAL = PTP_SYNC_INTERVAL_TIMEOUT x PTP_DELAY_REQ_INTERVAL

28.6.4 SYNC

Table 28-7: SYNC

On receipt	Processed at a rate of no less than one per PTP_SYNC_INTERVAL_TIMEOUT
On transmission	The clock sends a sync message within PTP_SYNC_INTERVAL_TIMEOUT/(2 x PTP_RANDOMIZING_SLOTS)

28.6.5 FOLLOW_UP

Table 28-8: FOLLOW_UP

On receipt	Processed at a rate of no less than two per PTP_SYNC_INTERVAL_TIMEOUT
On transmission	The clock sends a sync message within PTP_SYNC_INTERVAL_TIMEOUT/PTP_RANDOMIZING_SLOTS after sending the sync message

28.6.6 DELAY_REQ

Table 28-9: DELAY_REQ

On receipt	Processed at an average rate of no less than (PTP_RANDOMIZING_SLOTS-2) messages per PTP_SYNC_INTERVAL_TIMEOUT over the AVERAGING_INTERVAL
On transmission	Within PTP_SYNC_INTERVAL_TIMEOUT/ PTP_RANDOMIZING_SLOTS after the event requiring the issuance of the Delay_Req

28.6.7 Frequency of DELAY_REQ

When required for the delay computation, a clock issues the Delay_Req within a time window *T* where:

A clock generates two random numbers *R* and *Q*

R is in the range 2 to PTP_DELAY_REQ_INTERVAL, that is, 2 - 30

Q is in the range 2 to PTP_RANDOMIZING_SLOTS, that is, 2 - 18

The window occurs in the time interval P, beginning the Rth receipt after the generation of R, of a sync message form the current master clock.

Within the time interval P, the window T is a closed interval Qx∆T to (Q+1)x∆T

The time window width ∆T is the PTP_SYNC_INTERVAL_TIMEOUT/ PTP_RANDOMIZING_SLOTS

28.6.8 DELAY_RESP

Table 28-10: DELAY_RESP

On receipt	Processed at an average rate of no less than (PTP_RANDOMIZING_SLOTS-2) messages per PTP_SYNC_INTERVAL_TIMEOUT over the AVERAGING_INTERVAL
On transmission	Within PTP_SYNC_INTERVAL_TIMEOUT/ (2xPTP_RANDOMIZING_SLOTS) after the event requiring the issuance of the Delay_Resp

28.7 Glossary

IP address

The address of a device attached to an IP network (TCP/IP network). Every client, server and network device must have a unique IP address for each network connection. The format of an IP address is a 32-bit numeric address, written as four numbers separated by periods. Each number can be zero to 255. For example, 1.160.10.240 could be an IP address.

IP subnet addressing

Routers, or gateways, are used to separate networks. The router breaks the network into multiple subnets. This result may seem familiar as Class A, B, and C addresses have a self-encoded or default subnet mask built in; class A network address - 255.0.0.0: class B network address - 255.255.0.0: class C network address - 255.255.255.0.

MAC address

A hardware address which uniquely identifies each node of a network. In IEEE 802 networks, the Data Link Control (DCL) layer of the OSI reference model is divided into two sublayers—the Logical Link Control (LLC) layer and the Media Access Control (MAC) layer. The MAC layer interfaces directly with the network medium. Consequently, each different type of network medium requires a different MAC layer.

Port

A number used, in conjunction with the IP address, to indicate one end of an ethernet conversation. Some port numbers are reserved for particular services. The port number identifies what type of port it is. For example, a server listening for HTTP traffic listens on port 80. Port numbers range from 0 to 65536, but only port numbers 0 to 1024 are reserved for privileged services and designated as well known ports. For more information, see http://www.iana.org/assignments/port-numbers.

Switch

A device that can route data only to the nodes (and links) for which the data is intended. Using a switch eliminates the possibility of collisions on a node link. Also, as long as the total bandwidth available to data leaving the switch is the same as, or greater than, the total bandwidth of data entering the switch, there is no data loss.

UDP

User Datagram Protocol. An unreliable connection-less transport protocol which doesn't provide a guarantee that packets will arrive, or that they will arrive in the order in which they were sent. UDP is widely used for streaming audio and video, voice over IP (VoIP) and videoconferencing.

This page is intentionally blank