![Alta dt data technologies logo]

APMP User's Guide

March 17, 2016

Rev –

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INTRODUCTION

This User's Guide details the use of the Alta Passive Monitor Protocol (APMP) feature on AltaDT eNet devices. APMP provides autonomous bus monitoring on 1553 busses or banks of ARINC-429 (A429) channels. When operating in APMP mode, the eNet device will monitor its 1553 bus(ses) for traffic, copy the message's AltaDT 1553 Common Data Packet (CDP) into a UDP packet, then transmit the UDP packet on its Ethernet connection. In the case of an A429 bus the AltaDT Receive Packets (RXPs) for the A429 words will be transmitted in the APMP UDP packets. See Table 1 for references to detailed explanations relating to terminology used in this document.

TABLE 1- ADDITIONAL APMP REFERENCES

	Reference Document • Section name
APMP Overview	AltaView User's Manual • Appendix F - 4.3 Basic Operations AltaAPI User's Manual • Alta Passive Monitor Protocol (APMP)
APMP UDP Packet Format	AltaAPI User's Manual • APMP Packet Format • ARINC RX APMP UDP Packets
1553 Common Data Packet (CDP) Format	AltaCore 1553 Quick Reference Guide AltaAPI User's Manual • APMP 1553 CDP Packet Format-CDP
A429 Receive Packet (RXP) Format	AltaCore ARINC Quick Reference Guide
IRIG Time Values	AltaCore-1553 Specification User's Manual • Bit 9: ENET APMP Insert PE/IRIG Time • Root IRIG Time High & Low: 0x0024/28
Interval Timer Values	AltaCore-1553 Specification User's Manual • Bit 10: ENET APMP Insert PE/Interval Timer • Root Interval Timer: 0x004C

Once APMP is enabled on an eNet device, the device's firmware continuously captures 1553 messages and/or A429 label data from the busses the device is connected to and sends the captured data in UDP packets over the device's Ethernet connection – no further interaction via AltaAPI functions or AltaView is necessary. Any Client computer connected to the eNet device's Ethernet network may then receive the UDP packets and extract the 1553 or A429 message data for archiving, or analysis in real-time. See Table 2 for data latency information.

<div align="center">

TABLE 2- APMP PACKET LATENCIES

</div>

	Latency
ARINC-A429	Fills UDP packet with up to 85 RXPs (ARINC-429 words), or 200 msecs (whichever comes first)
MIL-STD-1553	One CDP (1553 message) per UDP packet sent within 10 usec after message completion

BASIC APMP OPERATIONS USING ALTAVIEW

The quickest method to begin utilizing the APMP function is to configure an eNet device to begin broadcasting APMP packets at power-up and then use AltaView to view the message data contained in the packets.

When an eNet 1553 channel is configured to enable APMP at power-up, the device will automatically begin operating as a 1553 Bus Monitor (BM) to capture traffic on the 1553 bus.   When a bank of A429 channels is configured to enable APMP at power-up, the eNet device will automatically begin operating as an ARINC-429 receiver (RX), capturing all message labels on all channels in the bank.

Sub-sections below will discuss:

1. PROGRAMMING APMP SETTINGS IN FLASH
2. MONITORING APMP TRANSMISSIONS
3. **LIMITATIONS TO ENABLING APMP IN FLASH**

PROGRAMMING APMP SETTINGS IN FLASH

The first step is to program the eNet device's APMP settings into flash memory. The procedure for programming APMP settings is illustrated in the following steps:

1. In AltaView, open the eNet device's Global Channel
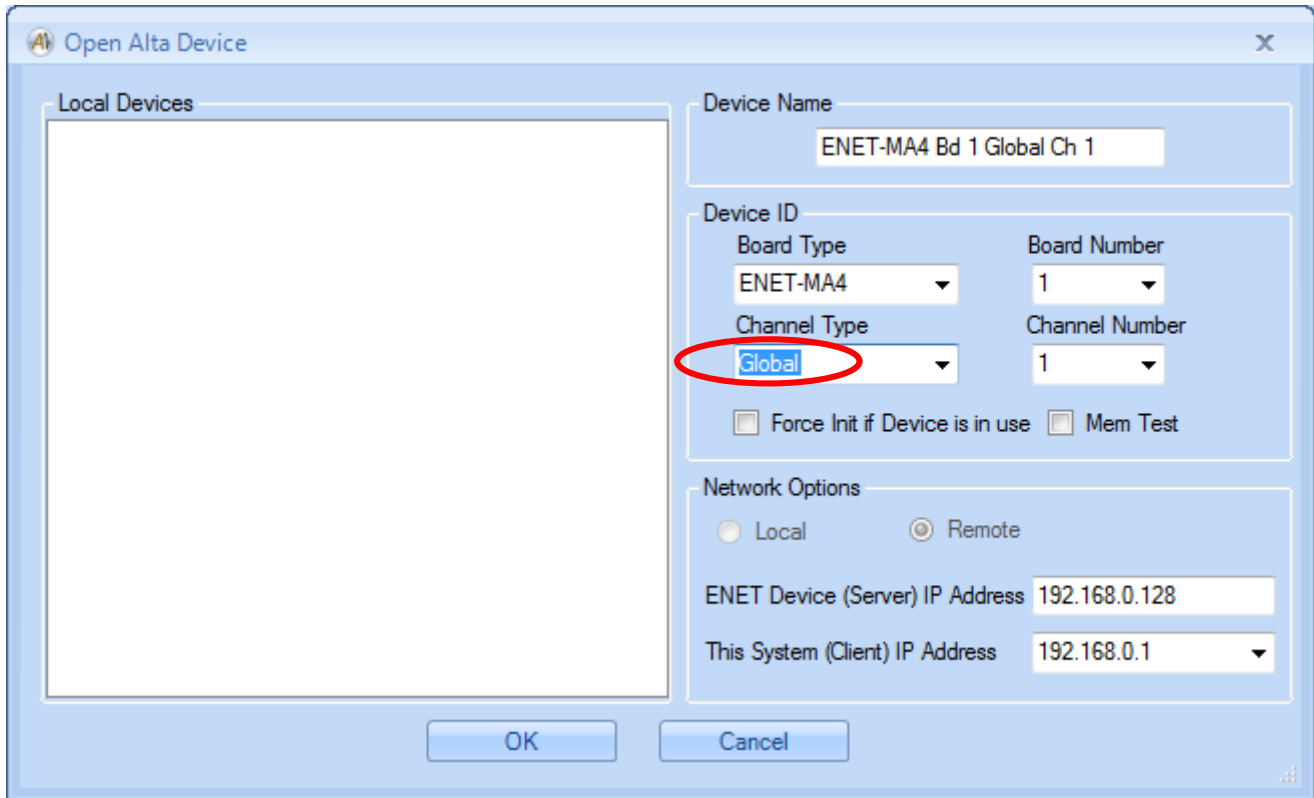
2. This will open the Global tab and enable the 'ENET Config' function. Click on 'ENET Config':

3. AltaView will read the IP/MAC Address and APMP configuration information from the eNet device's Flash and display it in the EN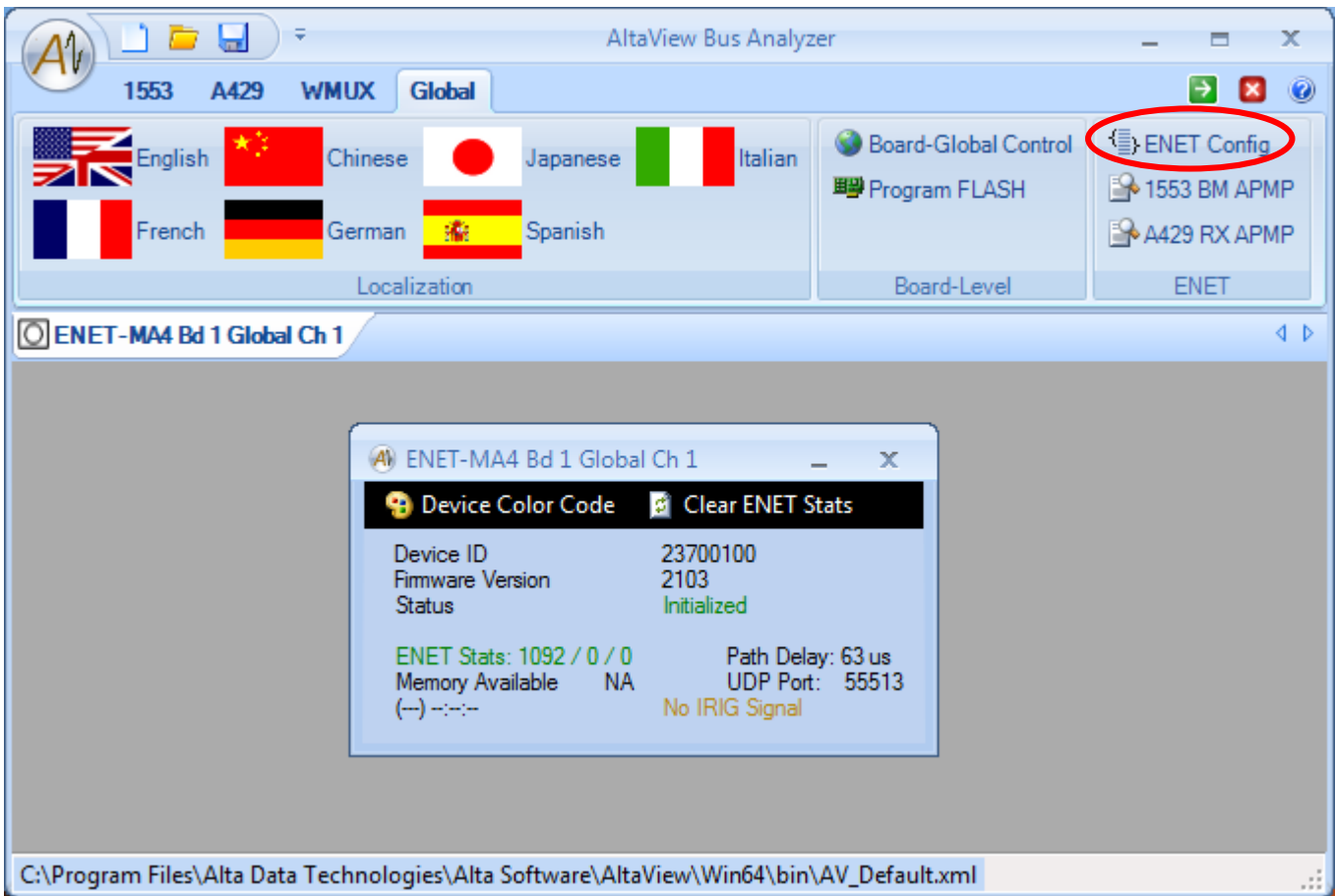ET Config window. (An eNet-MA4 device was used for this illustration, therefore the New Settings combo boxes for 1553 Channel 1, 1553 Channel 2 and A429 Bank 1 are all active.)

New IP Address

If multiple eNet devices will be connected to the same network (whether using APMP or not), each device will need to be assigned a unique IP address.

<table>
<tr><td align="center">NOTE

Be sure to label the device with the new IP address. If the newly programmed IP address is forgotten, refer to the device's hardware manual for instructions to temporarily set the IP address back to the factory default (192.168.0.128) so that the IP address may be reprogrammed again.</td></tr>
</table>

APMP Device

Each 1553 Channel and/or A429 Bank that will be transmitting APMP packets on the network will need a unique APMP Device #. The APMP Device # determines the client/server UDP ports to be used for APMP transmissions. Up to four 1553 channels (1553 Devices #1-4) and an additional four A429 banks (A429 Devices #1-4) can be transmitting APMP packets on the same network.

APMP Dest IP Addr & MAC

By default APMP packets are sent as broadcast messages on the network. If the Client computer's firewall blocks broadcast messages and disabling the firewall is not an option, APMP packets may be addressed to a specific IP/MAC address by entering the desired IP and MAC addresses in this box.

APMP BM

If this box is checked, the 1553 Channel/A429 Bank assigned to the selected APMP Device # will power-up with APMP enabled for the selected channel(s). As soon as 1553 traffic (or ARINC-429 traffic in the case of an A429 bank) is detected on the corresponding physical bus, APMP packets will begin transmitting over the device's Ethernet connection. No AltaAPI or AltaView intervention is required to start APMP transmissions. See LIMITATIONS TO ENABLING APMP for more detail.

After clicking OK, a message will be displayed indicating that flash is being programmed on the device. When programming is complete, the operator will be instructed to cycle power on the eNet device to initialize the device with the new settings.
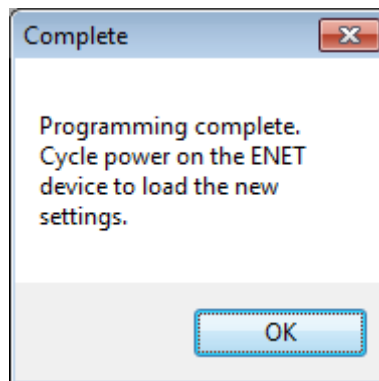
After cycling power, the channels/banks for which the 'APMP BM' box was checked, will then automatically begin monitoring their busses for traffic and transmitting APMP UDP packets as messages are received on the channel.

MONITORING APMP TRANSMISSIONS

AltaView provides viewers for 1553 APMP and A429 APMP packets. The AltaView APMP Viewers are strictly Ethernet monitors that use BSD UDP sockets to capture APMP packets transmitted by eNet devices. The Viewers do not communicate with an eNet device directly – they simply monitor Ethernet ports on the Client computer for APMP transmissions.

NOTE

There are a few restrictions to be aware of when using the AltaView APMP Viewers:

1. *DO NOT* 'Open' the eNet device in AltaView to use the APMP Viewers. The APMP Viewers *cannot* be used to monitor for APMP transmissions from a 1553 channel or A429 bank that is currently 'Open' in AltaView. AltaView's 'Open Device' uses the AltaAPI functions `ADT_L1_1553_InitDefault` and `ADT_L1_A429_InitDefault` to initialize the eNet device; both of which disable APMP functionality.

2. An AltaView APMP Viewer cannot be used on the same Client computer on which another application is also monitoring for APMP transmissions from the same eNet 1553 channel or A429 bank. Only one application on a Client computer may be monitoring a specific APMP port at a time. See Table 3 for APMP port numbers.

To capture and view APMP packets using AltaView open the Global tab and select the viewer for the applicable protocol:

1. 1553 BM APMP VIEWER
2. **A429 RX APMP VIEWER**
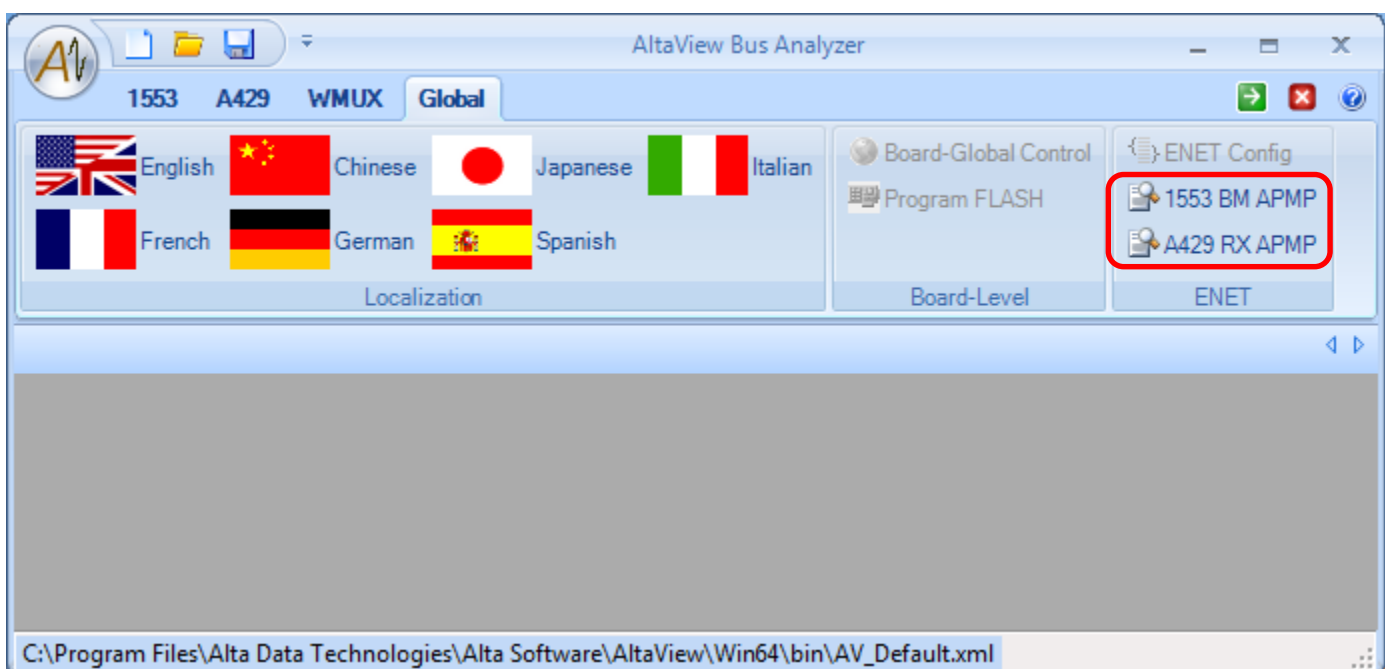
1553 BM APMP Viewer

<div>

NOTE

If AltaView was used to 'Open Device' on the channel to be monitored then the device will not transmit APMP packets for that 1553 channel since AltaView uses the AltaAPI function `ADT_L1_1553_InitDefault` to initialize the channel which clears the 'APMP Enable' bit. The device must be closed and power cycled on the device to re-enable the APMP function.

</div>

1. Selecting the '1553 BM APMP' button opens a BM APMP Control Panel. Click on the 'Connect' button.

<div>

NOTE

An APMP 'Connect' does **not** affect the 'Device In-Use' status of the 1553 channel. The 'Connect' only selects the UDP port number to be monitored for APMP packets. (See Table 3 for specific information regarding UDP port assignments.) To monitor for APMP packets from multiple 1553 channels, simply open another BM APMP Control Panel by clicking the '1553 BM APMP' button again for each of the 1553 APMP devices to be monitored.
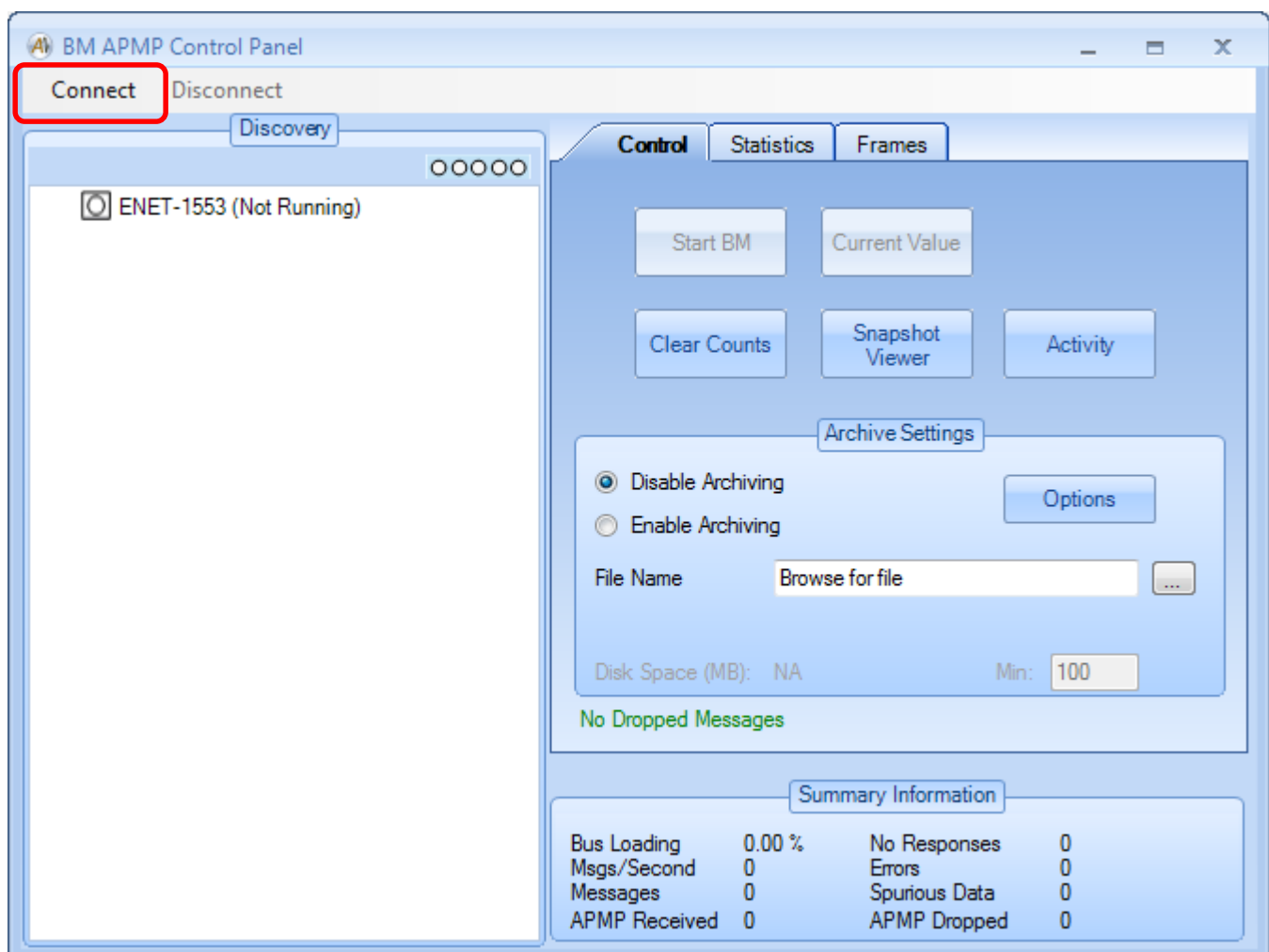
</div>

2. Enter the same IP Addresses that would be used when 'Open Device' is selected from the Logo Button. Select the APMP Device # that was assigned to the 1553 channel during 'ENET Config' of the Global channel.
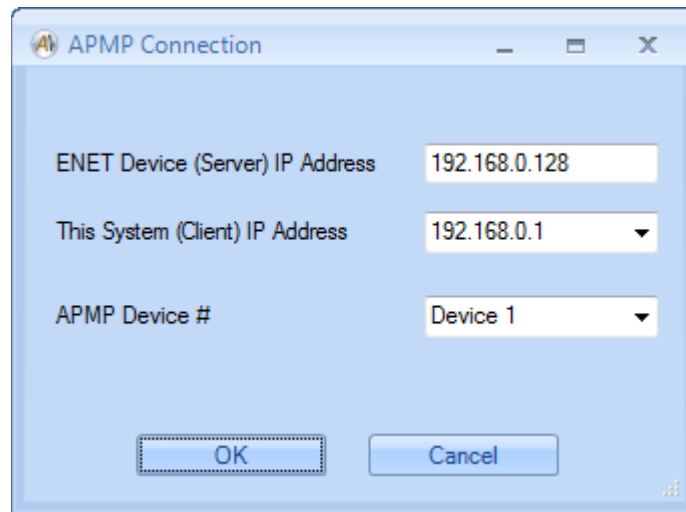
3. The Control Panel will now identify the Device for which it is monitoring for APMP packets. The APMP Control Panel works very much like the standard BM Control window. The Archive option extracts the 1553 CDP data from the APMP packets to create a .cdp file that can be viewed with the standard BM File Viewer.
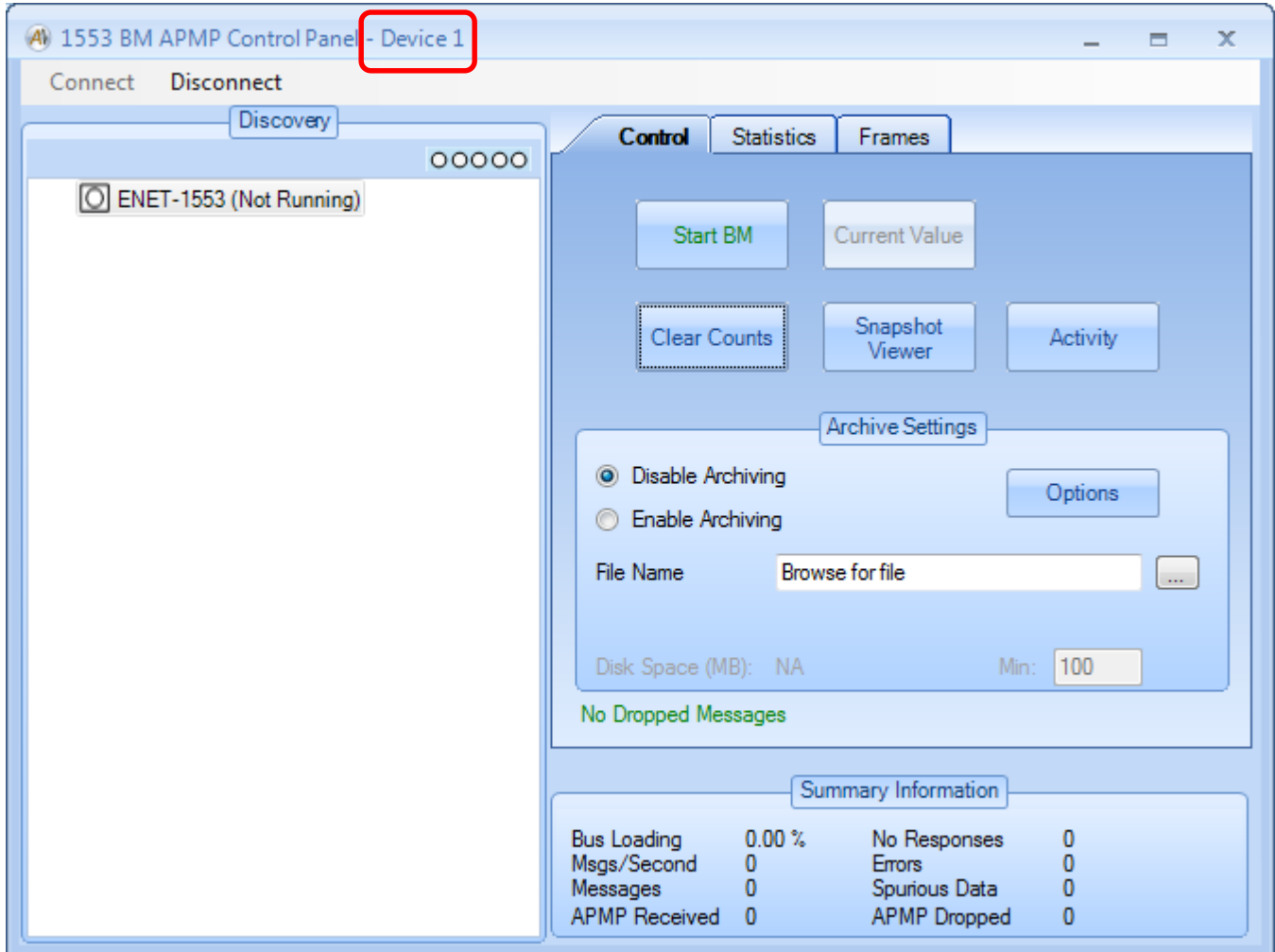
4. When the Start BM button is clicked, the APMP monitor begins capturing and decoding APMP packets to display 1553 bus activity:
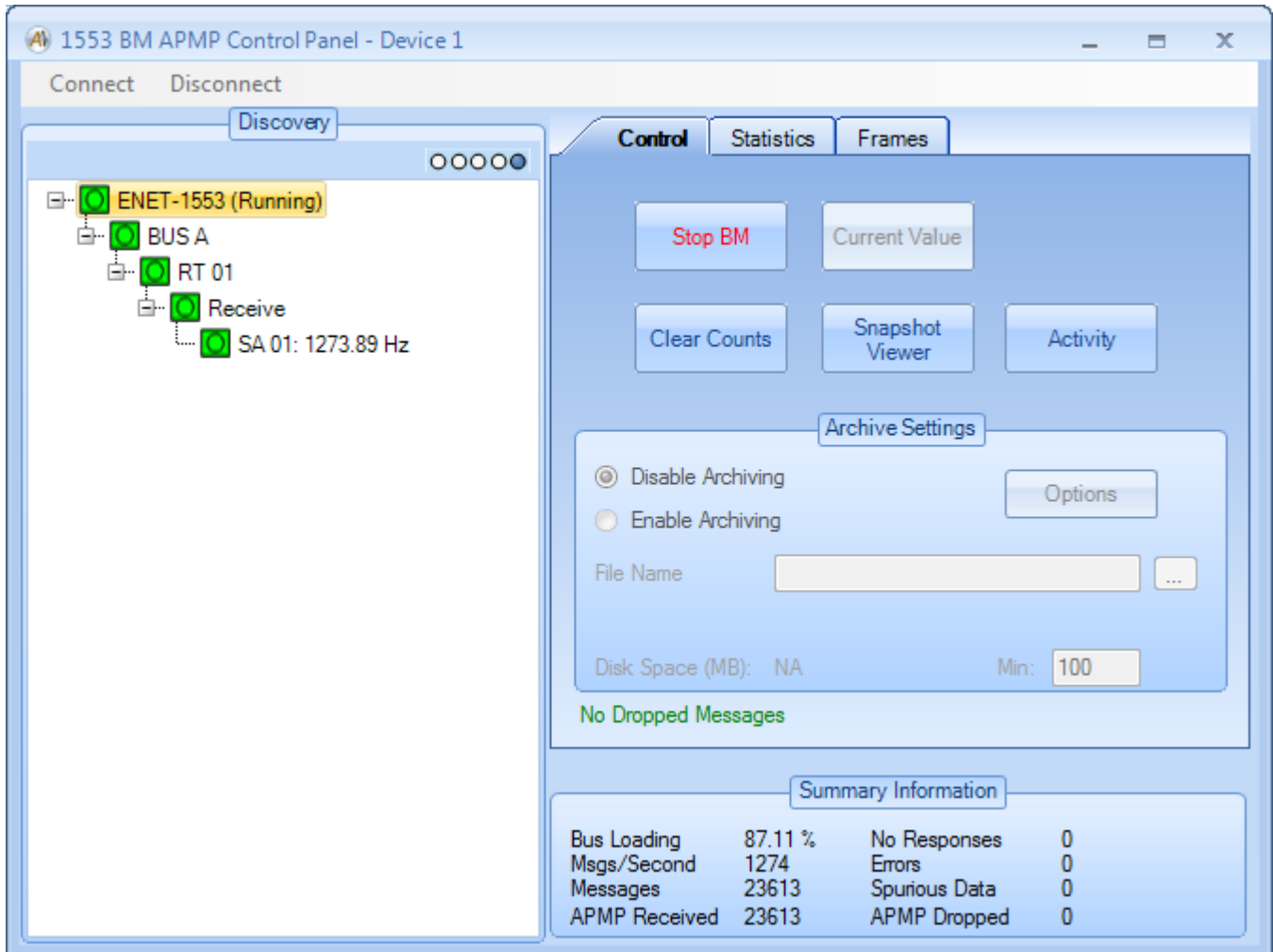
Not Seeing Any Bus Traffic?

Try disabling the Windows Firewall on the AltaView host computer.

The default destination IP Address for APMP packets is 255.255.255.255 (broadcast) and many Firewalls block broadcast messages. See page 6 for instructions on how to transmit APMP packets to a specific IP address.

A429 RX APMP Viewer

> **NOTE**
>
> If AltaView was used to 'Open Device' on the A429 bank to be monitored then the device will not transmit APMP packets for that bank of A429 channels since AltaView uses the AltaAPI function `ADT_L1_A429_InitDefault` to initialize the channel which clears the 'APMP On' bit. The device must be closed and power cycled on the device to re-enable the APMP function.

1. Selecting the 'A429 RX APMP' button from the Global tab opens an A429 RX APMP Control Panel. Click on the 'Connect' button.

> **NOTE**
>
> An APMP 'Connect' does **not** affect the 'Device In-Use' status of the A429 bank. The 'Connect' only selects the UDP port number to be monitored for APMP packets. (See Table 3 for specific information regarding UDP port assignments.) To monitor for APMP packets from multiple A429 banks, simply open another A429 RX APMP Control Panel by clicking the 'A429 RX APMP' button again for each of the A429 APMP devices to be monitored.
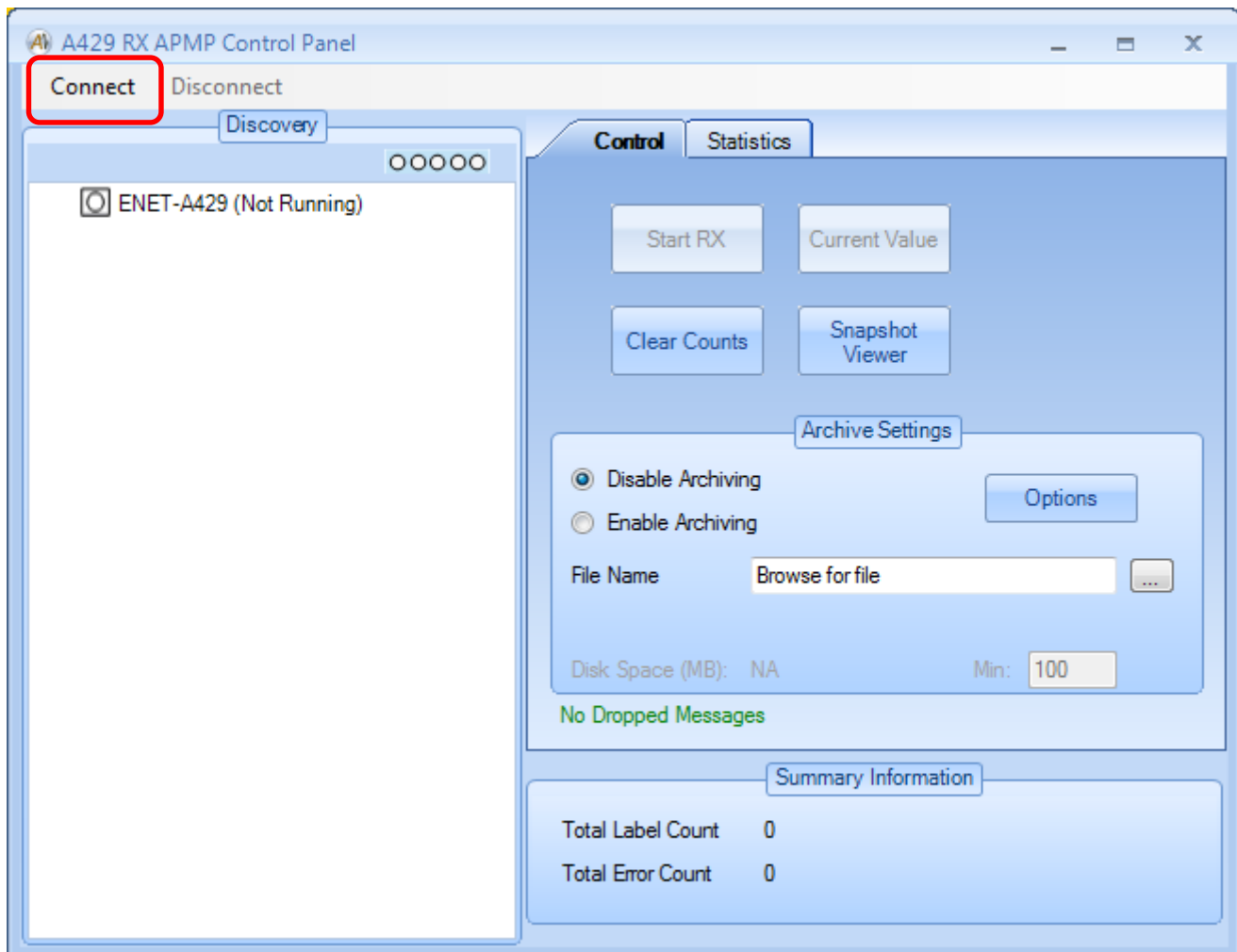
2. Enter the same IP Addresses that would be used when 'Open Device' is selected from the Logo Button. Select the APMP Device # that was assigned to the A429 bank during 'ENET Config' of the Global channel.
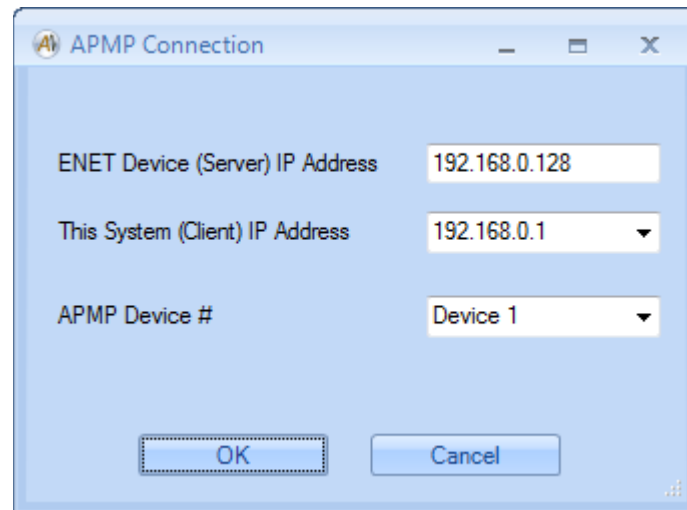
3. The Control Panel will now identify the Device for which it is monitoring for A429 APMP packets. The APMP Control Panel works very much like the standard RX Control Panel window. The Archive option extracts the A429 RXP data from the APMP packets to create a .rxp file that can be viewed with the standard RX File Viewer.
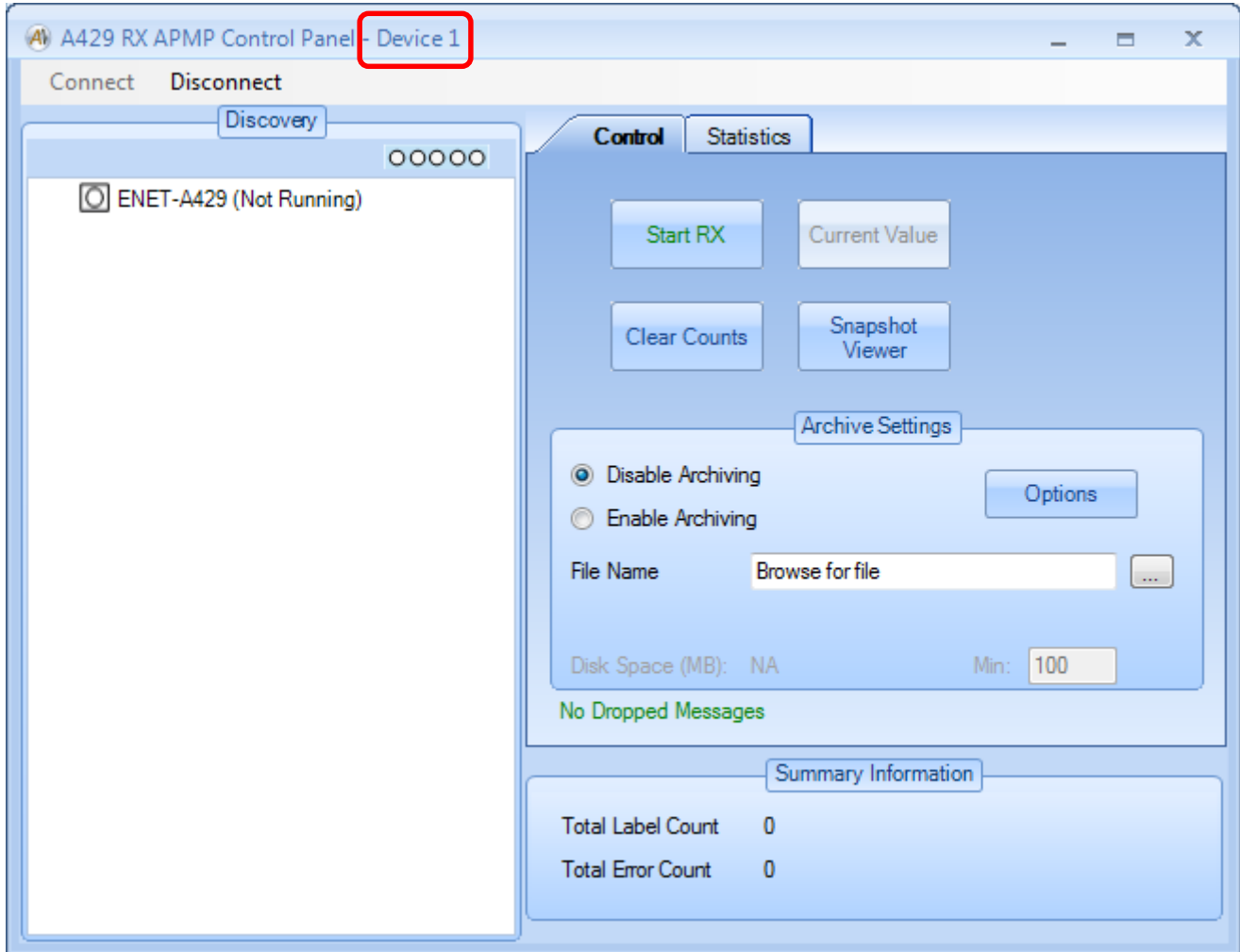
4. When the Start RX button is clicked, the APMP monitor begins capturing and decoding APMP packets to display A429 bus activity:
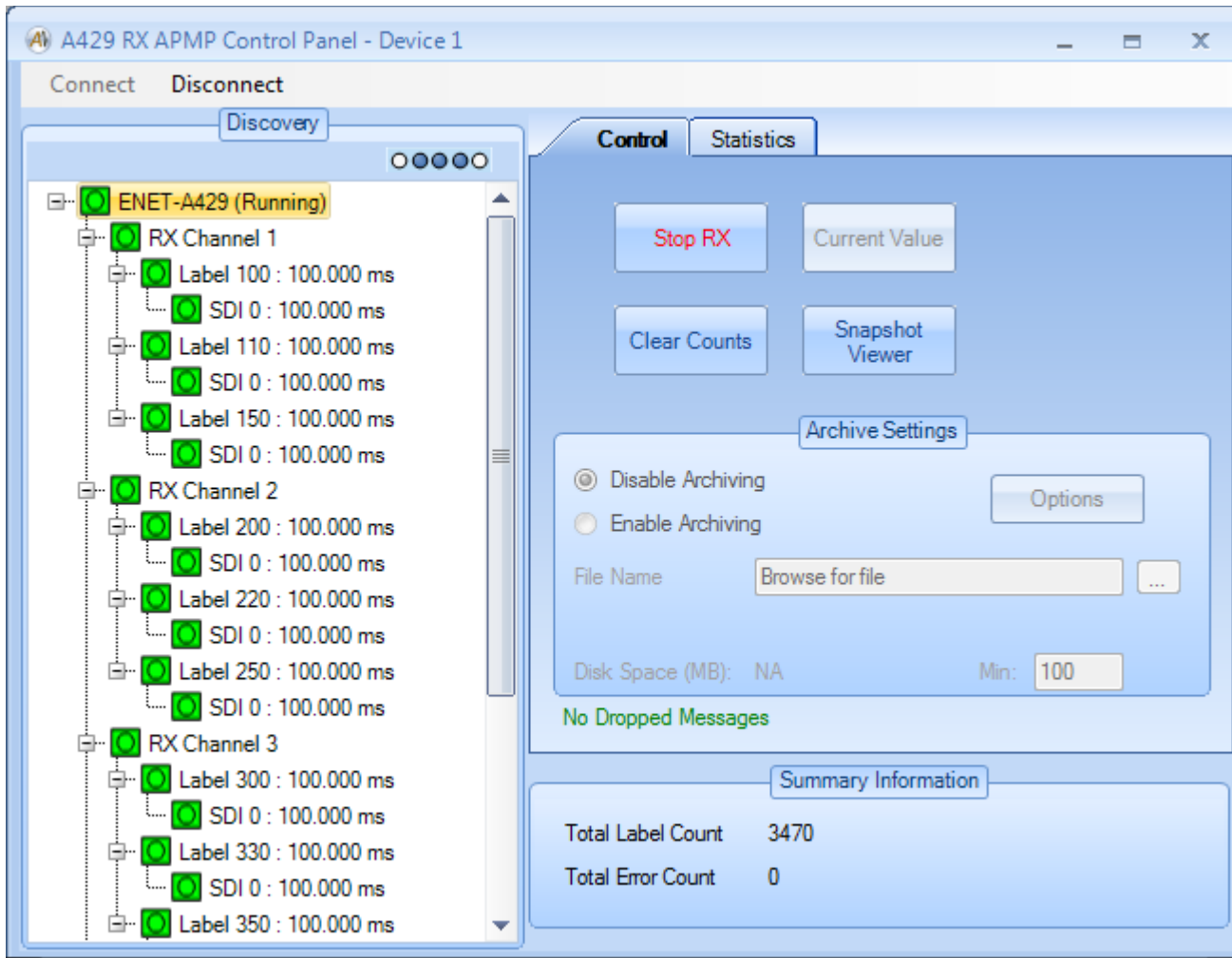
Not Seeing Any Bus Traffic?

Try disabling the Windows Firewall on the AltaView host computer.

The default destination IP Address for APMP packets is 255.255.255.255 (broadcast) and many Firewalls block broadcast messages. See page 6 for instructions on how to transmit APMP packets to a specific IP address.

LIMITATIONS TO ENABLING APMP IN FLASH

A429 Banks -

1. At power-up a RX is started on every channel in the bank and monitoring for bus traffic begins immediately.
2. Each RX in an A429 bank is configured for high-speed operation (100Kbps).
3. APMP mode is turned off on *all* channels in an A429 bank if a call is made to either of the AltaAPI functions `ADT_L1_A429_InitDefault` or `ADT_L1_A429_InitDefault_ExtendedOptions`. If AltaAPI function calls will be controlling operation of *any* of the channels in an A429 bank, then each channel for which APMP is to be enabled in that A429 bank must be configured through AltaAPI to re-enable APMP.

1553 Channels –

1. There is no RT/SA filtering – *all* messages transmitted on Bus A *and* Bus B are captured.
2. APMP mode is turned off for a 1553 channel when a call is made to AltaAPI functions `ADT_L1_1553_InitDefault` or `ADT_L1_1553_InitDefault_ExtendedOptions`. APMP would have to be re-enabled through AltaAPI.

Monitoring APMP with Wireshark™

Available for download from the AltaDT website (www.altadt.com/customers) are Wireshark™ dissectors for both 1553 APMP packets and A429 APMP packets. The download also includes a how-to guide to install the dissectors and interpret the displayed APMP packets.

Monitoring APMP Packets via Client Application

Any Client computer on the same Ethernet network as an eNet device may monitor the network for APMP packet transmissions (see Table 3 below for APMP port assignments).

TABLE 3 - APMP UDP PORT NUMBERS

	Device #1	Device #2	Device #3	Device #4
ENET-1553 APMP Server Port Number	56512	56514	56516	56518
ENET-1553 APMP Client Port Number	56513	56515	56517	56519
ENET-A429 APMP Server Port Number	56768	56770	56772	56774
ENET-A429 APMP Client Port Number	56769	56771	56773	56775

The programs listed below provide examples of how to capture APMP packets and archive the message data to a file. These examples use native operating system BSD UDP sockets to capture APMP packets – linking in the AltaAPI is not necessary.

```
ADT_L1_A429_ex_capture_APMP_pkts.c

ADT_L1_1553_ex_capture_APMP_pkts.c
```

The program below is an advanced C# example that illustrates how to use a priority queue to sort received APMP packets by sequence number. APMP does not employ a command/response protocol to ensure the transmitted packets are received. The more complex the network the eNet device is connected to (i.e., intranet or internet connections), the more likely packets may be received out of order, or even not at all. The example illustrates how to identify a dropped packet condition.

```
ADT_L1_DOTNET_1553_ex_APMPreceiver.cs
```

<div style="border:1px solid black; padding:10px;">

Not Capturing Any APMP Packets?

Try disabling the Firewall on the client computer.

The default destination IP Address for APMP packets is 255.255.255.255 (broadcast) and many Firewalls block broadcast messages.

</div>

Advanced APMP Operations Using AltaAPI

AltaAPI may be used to configure APMP to non-default settings and/or to control exactly when APMP begins monitoring for messages.

ASSIGNING IP/MAC ADDRESS AND APMP DEVICE NUMBER

Each 1553 channel or A429 bank that is to have APMP enabled will need to be assigned a unique Device #. To use AltaView to set a device's IP/MAC Addresses and a channel's APMP Device #, follow the steps in the section 'PROGRAMMING APMP SETTINGS IN FLASH' **except** leave the 'APMP BM' box *unchecked*.
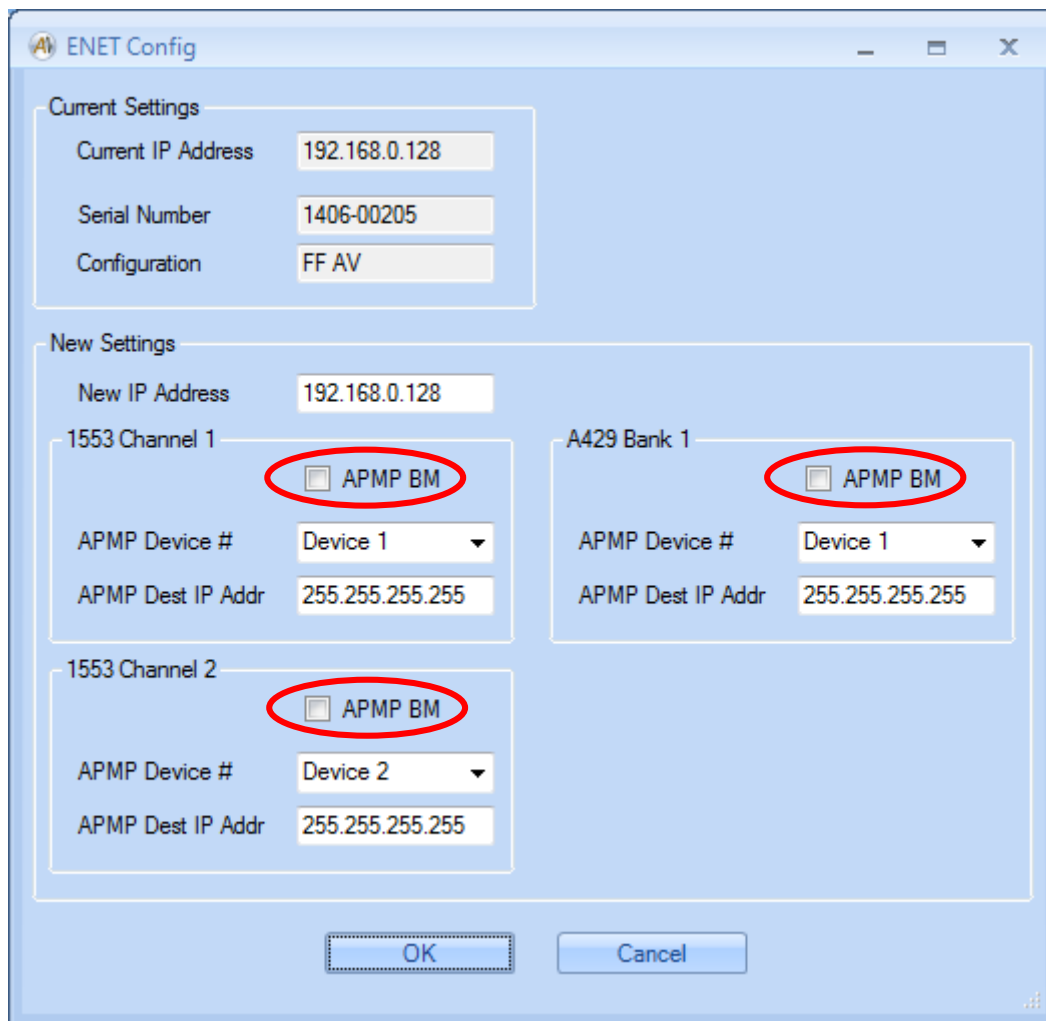
After an APMP Device # has been assigned, refer to the sections indicated below to enable APMP transmissions for the device:

1. API APMP Setup - 1553 Channels
2. API APMP SETUP – A429 Banks

API APMP Setup - 1553 Channels

For a 1553 channel, APMP is an extension of the Bus Monitor (BM) function. Therefore, AltaAPI may also be used to filter for messages addressed to specific RTs and SAs, as well as control when to start and stop APMP transmissions. The example in the file indicated below illustrates how to customize APMP settings:


```
ADT_L1_1553_ex_APMP_API_Init.c
```


Below are links to additional information regarding each of the AltaAPI functions demonstrated in the example code above:

1. Define 1553 Message Filters,
2. Create the 1553 BM Buffer(s),
3. Select Time Reference Source for 1553 APMP,
4. Enable 1553 APMP,
5. Start 1553 BM, and
6. Stop 1553 BM

NOTE

This process does **not** reprogram APMP settings in flash memory. When power is removed from the device, or the device is re-initialized, all APMP settings will reset from flash.

Define 1553 Message Filters

```
ADT_L1_1553_BM_FilterWrite (ADT_L0_UINT32 devID,
                            ADT_L0_UINT32 rtAddr,
                            ADT_L0_UINT32 rxFilters,
                            ADT_L0_UINT32 txFilters)
```

The default configuration is to capture all messages transmitted to every SA on every RT, as well as all mode code commands. Filters may be created to capture messages addressed to select RTs/SAs.

NOTE

1. Each filter applies to messages returned to the standard BM with calls to
   `ADT_L1_1553_BM_ReadNewMsgs`, **AND**
2. The same filters also apply to messages transmitted in APMP packets.

Example Filters:

- Receive SA 21

```
ADT_L1_1553_BM_FilterWrite (DEVID, RT_ADDR, 0x00200000, 0x00000000);
```

- Transmit SA 3

```
ADT_L1_1553_BM_FilterWrite (DEVID, RT_ADDR, 0x00000000, 0x00000008);
```

- All receive SAs and all transmit SAs on an RT

```
ADT_L1_1553_BM_FilterWrite (DEVID, RT_ADDR, 0xFFFFFFFF, 0xFFFFFFFF);
```

Create the 1553 BM Buffer(s)

```
ADT_L1_1553_BM_BufferCreate (ADT_L0_UINT32 devID,
                             ADT_L0_UINT32 numMsgs)
```

APMP only requires one BM buffer for processing APMP packets – as soon as a message is written into the BM queue, the message is also written to an APMP UDP packet and transmitted on its Ethernet connection. If BM messages will also be read using the function `ADT_L1_1553_BM_ReadNewMsgs`,   then the number of BM buffers allocated must be sufficient enough to queue up captured messages between calls to `ADT_L1_1553_BM_ReadNewMsgs` without overwriting messages in the queue before they can be read.

Select Time Reference Source for 1553 APMP

NOTE

If IRIG Time or an External Clock pulse is not being input into the eNet device this step should be skipped.

```
BM_CSR |= ADT_L1_1553_BM_CSR_ENET_APMP_PEIRIG;
```
OR
```
BM_CSR |= ADT_L1_1553_BM_CSR_ENET_APMP_PEINTV;
```

Use of an external time reference is a system specific requirement and experience indicates this feature is rarely used with our AltaDT devices. But for systems that do utilize a system-wide time reference, the APMP function provides the capability to include reference timestamps in the APMP packets. Reference timestamping is optional and only one of the options above may be selected.

When an IRIG time code is received, the PE Time value is latched and these two time reference values are written into the APMP packet if the `ADT_L1_1553_BM_CSR_ENET_APMP_PEIRIG` option is selected.

If the `ADT_L1_1553_BM_CSR_ENET_APMP_PEINTV` option is selected, the value of the Interval Timer and the value of PE Time are latched and written into the APMP packet as the 1553 message's CDP words are written into an APMP packet.

PE Time is the delta time (in 20 nanosecond ticks) since startup. This is the reference time used to time stamp 1553 messages as they are captured from the 1553 bus. The Time Tag High and Time Tag Low words in the 1553 CDP structure represent the PE Time when the message was captured.

See Table 1 for references to detailed discussions on APMP packet structures and time reference options.

Enable 1553 APMP

```
        options = BM_CSR | ADT_L1_1553_BM_CSR_ENET_APMP_ENABLE;


        ADT_L1_1553_BM_Config (ADT_L0_UINT32 devID,
                               ADT_L0_UINT32 options)
```

APMP transmissions are enabled by setting Bit 8 in the SM Control/Status register (CSR). The value in the 'options' parameter is or'd into the current value of the SM CSR.

Start 1553 BM

```
        ADT_L1_1553_BM_Start (ADT_L0_UINT32 devID)
```

The eNet device's BM function begins executing and as 1553 messages are captured from the bus, the message CDPs are copied into APMP packets, the reference time values written to the APMP packet (if a reference time option was selected) and then the APMP packet is transmitted in a UDP packet on the eNet device's Ethernet connection. No further intervention is required from AltaAPI once APMP is started. It is not necessary to call `ADT_L1_1553_BM_ReadNewMsgs` unless the Client application also needs to monitor the 1553 bus.

Stop 1553 BM

There are two methods to stop APMP transmissions:

1. AltaAPI function `ADT_L1_1553_BM_Stop`

    `ADT_L1_1553_BM_Stop (ADT_L0_UINT32 devID)`

    `ADT_L1_1553_BM_BufferFree (ADT_L0_UINT32 devID)`

    BM message capture and APMP transmissions may be halted and restarted as necessary with calls to `ADT_L1_1553_BM_Stop` and `ADT_L1_1553_BM_Start`.   Once bus monitoring is no longer required, then `ADT_L1_1553_BM_BufferFree` should be called to deallocate buffer memory on the eNet device.

2. AltaAPI function `ADT_L1_1553_BM_Config`

    `options = BM_CSR ^ ADT_L1_1553_BM_CSR_ENET_APMP_ENABLE;`

    `ADT_L1_1553_BM_Config (ADT_L0_UINT32 devID,`
    `                       ADT_L0_UINT32 options)`

    To halt APMP transmissions on the Ethernet network, but allow the BM function to continue capturing 1553 messages, the 'APMP Enable' bit can be cleared in the Root SM CSR. See note below regarding the BM CSR.

NOTE

If any of the functions listed below have been enabled in the Root SM CSR be sure to maintain a local copy of the Root SM CSR (BM_CSR in the example above) to ensure these functions remain in effect after APMP is disabled:

1.   Start BM on message trigger - `ADT_L1_1553_BM_CSR_MSGTRGON`
2.   Start BM on external trigger - `ADT_L1_1553_BM_CSR_WAITEXTTRG`
3.   Store spurious data - `ADT_L1_1553_BM_CSR_STORESPURDATA`
4.   Store Interval Timer in BM CDP - `ADT_L1_1553_BM_CSR_INTVLTMRRSVD3`

API APMP Setup – A429 Banks

After assigning an A429 bank an APMP Device #, AltaAPI may be used to set the channel bit rates and select a time reference option for APMP packets. The example in the file indicated below illustrates how to customize APMP settings:

```
ADT_L1_A429_ex_APMP_API_Init.c
```

Below are links to additional information regarding each of the AltaAPI functions demonstrated in the example code above:

1. Create the Multi-Channel RX Buffer,
2. Initialize the RX Channels,
3. Select Time Reference Source for A429 APMP,
4. Enable A429 APMP,
5. Start A429 RX, and
6. Stop A429 RX

NOTE

This process does **not** reprogram APMP settings in flash memory. When power is removed from the device, or the device is re-initialized, all APMP settings will reset from flash.

Create the Multi-Channel RX Buffer

```
ADT_L1_A429_RXMC_BufferCreate (ADT_L0_UINT32 devID,
                               ADT_L0_UINT32 numRxP)
```

When an A429 word is received, the word is copied into a RX packet (RXP) along with a control/status word and a time tag. (See Table 1 for references to detailed descriptions of A429 RXP and APMP data structures.) If the receiving channel was initialized with the `ADT_L1_A429_API_RX_MCON` option, the RXP will also be copied into the multi-channel (MC) buffer. Then if APMP is enabled, the RXP will be copied into an APMP packet. Refer to Table 2 for information on APMP packet latencies.

If AltaAPI will also be used to process RXPs from the MC buffer then a sufficient number of RXPs must be allocated to ensure RXPs are not over-written between calls to `ADT_L1_A429_RXMC_ReadNewRxPs`. As long there is at least one RXP allocated for the MC buffer, then the eNet device will be able to transmit APMP packets.

Initialize the RX Channels

```
ADT_L1_A429_RX_Channel_Init (ADT_L0_UINT32 devID,
                             ADT_L0_UINT32 RxChanNum,
                             ADT_L0_UINT32 BitRateHz,
                             ADT_L0_UINT32 numRxP,
                             ADT_L0_UINT32 includeInMcRx)
```

This AltaAPI function is used to set a channel's bit rate and include the channel's data in the MC buffer.

To include the channel's RX data in APMP packets, the `includeInMcRx` parameter must be set to `ADT_L1_A429_API_RX_MCON`. A429 words received on channels initialized with the `includeInMcRx` parameter set to zero(0), will **not** be transmitted in the APMP packets.

If label data received on the channel will be also be processed by AltaAPI calls, then a sufficient number of RXPs must be allocated to ensure RXPs are not overwritten in the RX queue between calls to `ADT_L1_A429_RX_Channel_ReadNewRxPs`. As long there is at least one RXP allocated for the channel's RX buffer, then the eNet device will be able to transmit APMP packets.

Channel initialization examples:

```
/* Setup Channel 1 for low-speed bit rate, and APMP transmissions. */
status = ADT_L1_A429_RX_Channel_Init(DEVID, 0, 12500, 100,
                                     ADT_L1_A429_API_RX_MCON);


/* Setup Channel 2 for high-speed bit rate, but NO APMP transmissions. */
status = ADT_L1_A429_RX_Channel_Init(DEVID, 1, 100000, 100, 0);


/* Setup Channel 3 for high-speed bit rate, and APMP transmissions */
status = ADT_L1_A429_RX_Channel_Init(DEVID, 2, 100000, 100,
                                     ADT_L1_A429_API_RX_MCON);


/* Setup Channel 4 for low-speed bit rate, and APMP transmissions.
 * This RX is only being used as a bus monitor to transmit labels in
 * APMP packets so only 1 RXP is needed.*/
status = ADT_L1_A429_RX_Channel_Init(DEVID, 3, 12500, 1, ADT_L1_A429_API_RX_MCON);
```

Select Time Reference Source for A429 APMP

```
┌─────────────────────────────────────────────────────────────────────────────┐
│                                   NOTE                                        │
│ If IRIG Time or an External Clock pulse is not being input into the eNet device this step should be │
│ skipped.                                                                      │
└─────────────────────────────────────────────────────────────────────────────┘
```

```
        APMP_Time_Options = ADT_L1_A429_PECSR_ENET_APMP_PEIRIG;
    OR
        APMP_Time_Options = ADT_L1_A429_PECSR_ENET_APMP_PEINTV;
    OR
        APMP_Time_Options = 0;
```

Use of an external time reference is a system specific requirement and experience indicates this feature is rarely used with our AltaDT devices. But for systems that do utilize a system-wide time reference, the APMP function provides the capability to include reference timestamps in the APMP packets. Reference timestamping is optional and only one of the options above may be selected. The selected time reference value is written to the APMP packet just prior to transmission.

When an IRIG time code is received, the PE Time value is latched and these two time reference values are written into the APMP packet if the `ADT_L1_1553_BM_CSR_ENET_APMP_PEIRIG` option is selected.

If the `ADT_L1_1553_BM_CSR_ENET_APMP_PEINTV` option is selected, the value of the Interval Timer and the value of PE Time are latched and written into the APMP packet.

PE Time is the delta time (in 20 nanosecond ticks) since startup. This is the reference time used to time stamp A429 data words as they are captured from the ARINC-429 bus. The Time Tag High and Time Tag Low words in the A429 RXP structure represent the PE Time when the message was actually captured from the bus.

Since an A429 APMP packet my contain multiple RXPs, the delta time between an individual RXP's timetag and the APMP packet PE timetag may be subtracted from the packet's IRIG or Interval Timer value to determine the actual reference time at which the ARINC-429 data word was received on the channel.

See Table 1 for references to detailed discussions on APMP packet structures and time reference options.

Enable A429 APMP

To enable APMP for a bank of A429 channels, the 'APMP On' bit must be set in the Root PE CSR register. The example code below illustrates the AltaAPI calls required to enable APMP.

```
/* Read the Root PE CSR. */
status = ADT_L1_ReadDeviceMem32(DEVID, ADT_L1_A429_PE_ROOT_CSR, rootCsr, 1);


/* OR-in the APMP "on" bit and reference time options. */
rootCsr |= (APMP_Time_Options | ADT_L1_A429_PECSR_ENET_APMP_ENABLE);


/* Write back the Root PE CSR. */
status = ADT_L1_WriteDeviceMem32(DEVID, ADT_L1_A429_PE_ROOT_CSR, rootCsr, 1);
```

Start A429 RX

```
ADT_L1_A429_RX_Channel_Start (ADT_L0_UINT32 devID,
                              ADT_L0_UINT32 RxChanNum)
```

When this function is called the RX begins capturing all A429 data words that are transmitted on the channel specified in the RxChanNum parameter.

The eNet device will also begin transmitting the received labels in APMP packets on its Ethernet connection if the following conditions are true:

1. ADT_L1_A429_API_RX_MCON was specified in the call to ADT_L1_A429_RX_Channel_Init for the RxChanNum parameter, and
2. The 'APMP On' bit is enabled in the Root PE CSR.

Stop A429 RX

There are two methods to halt APMP transmissions:

1. AltaAPI function ADT_L1_A429_RX_Channel_Stop

```
ADT_L1_A429_RX_Channel_Stop (ADT_L0_UINT32 devID,
                             ADT_L0_UINT32 RxChanNum)
```

After ADT_L1_A429_RX_Channel_Stop is called, the channel specified in the RxChanNum parameter will no longer capture ARINC-429 words on its physical bus. APMP functionality is **not** disabled by this AltaAPI function – APMP packets will continue to be transmitted for any other channels in the A429 bank that are still operating in APMP mode.

2. Clear the 'APMP On' bit in the Root PE CSR

```
/* Read the Root PE CSR. */
status = ADT_L1_ReadDeviceMem32(DEVID, ADT_L1_A429_PE_ROOT_CSR, &rootCsr, 1);

/* Exclusive OR-in the APMP "on" option to clear the APMP On bit. */
rootCsr ^= ADT_L1_A429_PECSR_ENET_APMP_ENABLE;

/* Write back the Root PE CSR. */
status = ADT_L1_WriteDeviceMem32(DEVID, ADT_L1_A429_PE_ROOT_CSR, &rootCsr, 1);
```

To halt APMP transmissions for all channels in the A429 bank, while the individual channels continue to receive ARINC-429 data, simply clear the 'APMP On' bit in the Root PE Control Register as shown in the example code above.