DDR/LPDDR Memory Analysis Window

User Guide

KEYSIGHT TECHNOLOGIES

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1 Overview

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To analyze the captured DDR/LPDDR memory data, you can use various tabs available in the DDR/LPDDR Memory Analysis window.

NOTE

You need the software license option **B4661A-4FP DDR3/4 and LPDDR2/3/4 Performance Analysis** to get the full feature set and capabilities of the DDR/LPDDR Memory Analysis window. Without this license, it is possible to compute only limited memory transactions from the captured data.

DDR/LPDDR Memory Analysis Window – An Overview

Using the Memory Analysis window, you can perform post processing on the captured memory data. In the different tabs and panes of a Memory Analysis window, you can:

- compute and view decoded memory transactions from the captured data (See page 21).
- analyze the captured memory traffic statistics categorized on the basis of memory commands (See page 43).
- visualize an SDRAM operation as a set of commands sent in a sequence (See page 51).
- obtain an overview of the SDRAM's Refresh and Self-Refresh cycles (See page 56) by analyzing its refresh data over a period of time.
- obtain a graphically represented overview of memory accesses (Reads and Writes) across memory locations (See page 67).
- obtain a statistical as well as a graphical representation of various performance measurements for data transfer rates and memory utilization.
- obtain an overview of your SDRAM's mode registers' values and compare these values in various ways (across ranks or with immediate previous settings or with values at another time instance). (See page 90)

Supported SDRAMs

In the DDR/LPDDR Memory Analysis window, you can analyze the data captured for the following generations of SDRAMs.

- DDR3
- DDR4
- DDR5
- LPDDR2
- LPDDR3
- LPDDR4
- LPDDR4x
- LPDDR5
- GDDR6

NOTE For GDDR6, the Memory Analysis window supports only the command/address information capture and analysis. The GDDR6 data (DQ) capture and analysis is not supported.

Broad Steps for Analyzing Memory Data

1. Capture the memory data.
2. Add the DDR/LPDDR Memory Analysis window instance to the logic analyzer setup with captured data in the Logic and Protocol Analyzer GUI. You can add this window's instance to a logic analyzer module such as U4154A/B or U4164A, data import module, a DDR Bus Decoder tool or an LPDDR Bus Decoder tool. You should NOT attach it to a Decoder such as DDR or LPDDR Decoder or a Filter tool. (Decoders can make the Compute operation take longer without providing any additional benefit. Filtering can impair some of the memory analysis features if some data such as clock speeds is filtered.)
3. Configure the SDRAM setup in the Memory Analysis window (See page 11).
4. Compute the decoded memory transactions and memory data analysis charts from the captured data in the Memory Analysis window (See page 21).
5. Analyze the data presented in the Memory Analysis window.
6. Customize the charts settings and redraw charts, if required in the Memory Analysis window.

2 Configuring the SDRAM Setup

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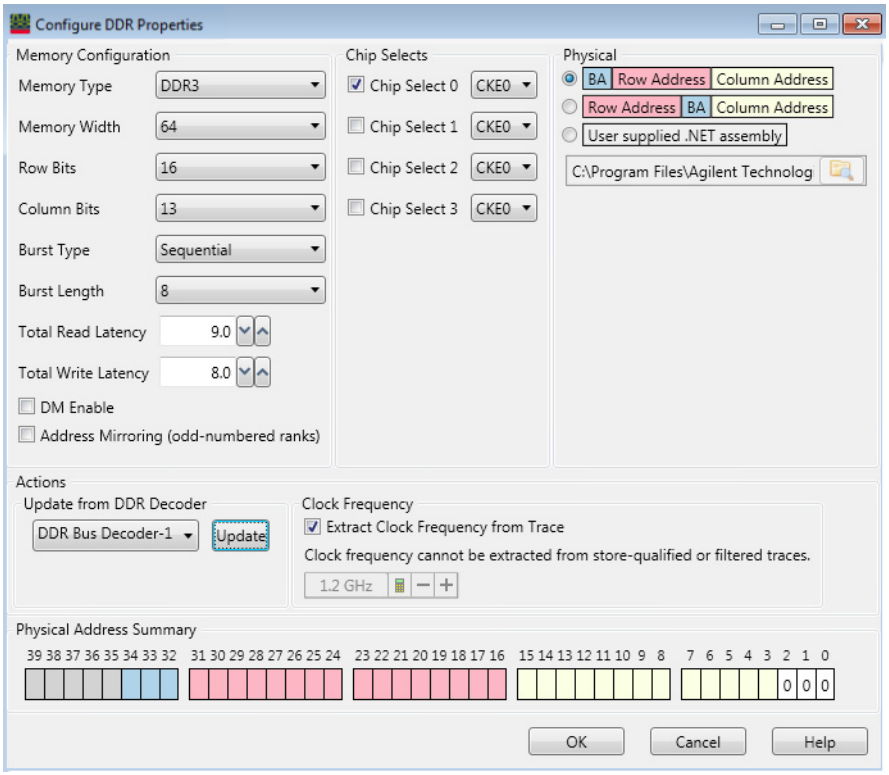
To ensure that the memory transactions are decoded accurately from the captured data, you need to specify the SDRAM configurations applicable for the captured memory data.

You use the **Configure DDR Properties** dialog box in the Memory Analysis window to set up/modify/verify the configuration information about the SDRAM for which data is captured.

NOTE If a DDR/LPDDR Bus Decoder tool is available in your logic analyzer configuration setup, the SDRAM details are automatically updated from this decoder tool into the Configure DDR Properties dialog.

To configure and verify the SDRAM setup

1 Click the **Configure DDR Properties...** button displayed in the Memory Analysis window's toolbar. The **Configure DDR Properties** dialog box is displayed.



2 Set the following fields in the **Memory Configuration** section:

Field	Description
Memory Type	Select the DDR / LPDDR generation to which the SDRAM under test belongs.
Memory Width	This field is used to compute physical addresses. For memory widths greater than 8 bits, the column address is padded with the appropriate number of 0 bits. You can see how this works by examining the Address Summary at the bottom of the dialog as you select different memory widths.
Row Bits	Select the width (in bits) of the row address as supported by your SDRAM under test. The number of bits defines the address mask. The address value cannot exceed the value of the address mask. You may refer to your SDRAM's data-sheet for the number of row address bits.
Column Bits	Select the width (in bits) of the column address as supported by your SDRAM under test. The Column Address bus generally consists of fewer bits than the Row Address. The number of bits defines the address mask. The address value cannot exceed the value of the address mask. You may refer to your SDRAM's data-sheet for the number of column address bits.
Multi-speed Mode Decode	This checkbox is displayed only when you select **LPDDR5** in the Memory Type listbox. Select this checkbox if you want to decode an LPDDR5 bus running at multiple clock speeds. By selecting this checkbox, you can specify all relevant bus settings at each possible clock speed for your DUT. This feature allows you to ensure that the decode is performed correctly when bus settings change with the change in the system clock speed. Refer to the topic "To configure the setup to handle multiple system clock speeds" on page 15 to know more about this feature.

Field	Description
Multi-speed Input File Name	This field is displayed only when you select the **Multi-speed Mode Decode** checkbox, that is, when you enable the multiple clock speeds mode for LPDDR5 decode. You use this field to browse and select the XML input file in which you define the set of bus settings such as CAS latency and CAS Write Latency to be used for each possible clock speed of the DUT. This input file is required to perform correct decode at each clock speed using the set of system settings that you defined specifically for that clock speed. Based on the bus settings that you specify in this input file, the bank organization valid for each clock speed is displayed as a list below the Multi-speed Input File Name field. The format for this file should be as per the format provided in the topic ""LPDDR5 Multiple Clock Speeds Decode - XML File Structure and Elements" on page 16". You may also refer to an example of this XML file included in this topic.
Bank Group Bits	Select the number of active Bank Group bits applicable for your SDRAM DIMM. A bank group corresponds to a separate DRAM on a DIMM. This field is only applicable for DDR4 / DDR5 and therefore enabled only when you select **DDR4** or DDR5 from the Memory Type list-box.
Burst Type	Select the order of the bytes after the Read/Write Command (Sequential or Interleaved). While decoding transactions, this setting is used to calculate and display the appropriate physical address for each memory cycle.
Burst Length	Select the burst length applicable for your SDRAM that is, how many data bytes are written to or read from the SDRAM after a write or a read command is given along with row and column address. The burst length options vary depending on the memory type. The option **On the Fly** is available for DDR3, LPDDR4 LPDDR4x, and DDR5 and indicates that burst length can vary for each read/write command. If you select this option, the decoding software automatically determines if the burst length of the operation is 16 or 32.
Total Read Latency	Specify the number of full clock cycles between the time that a read command appears on the bus and the time when valid data from SDRAM appears on the data bus. This value represents the total read latency for your system and therefore should include parameters that affect total read latency.
Total Write Latency	Specify the number of full clock cycles between the time that a write command appears on the bus and the time when valid data from SDRAM appears on the data bus. This value represents the total write latency for your system and therefore should include parameters that affect total write latency.
DM Enable	Enables write data masking. This option is available only when the DM_W bus exists. If DM Enable is selected, the decoding software applies the DM_W bits to the DATA_W bits before displaying the write data value in the Memory Analysis window. For example, if: DM = enabled Memory Width = 32 DM_W = 0000 0011 DATA_W = 0123 4567 then the decoded data will be displayed as: mem write 0x 0123 45--
Address Mirroring (Odd Numbered Ranks)	Select this checkbox if the Address Mirroring has been enabled on your SDRAM under test that is, if the address bus is mirrored to achieve optimum routing of the address bus on DDR multi rank modules.
Rank Addressing...	This button is displayed only when you select **DDR4_RDIMM or DDR5** from the **Memory Type** listbox. You use this button to select the appropriate rank addressing mode option based on the rank addressing being used for your DDR4 RDIMM or DDR5 device. In the **Standard** DDR4 rank addressing, there is one CS# (chip select) line for each rank. In the **3DS** rank addressing, there is only one CS# line for all the ranks. Therefore, the logical value of the C (Chip ID) bits is used to identify the rank being addressed in the decode. The number of Chip ID bits to be used for rank identification is as per the 3DS specifications. From the available 3DS rank addressing options (2-high, 4-high, or 8-high), select the appropriate option based on whether your 3DS device has two, four, or eight logical ranks. Based on the rank addressing mode that you select, the appropriate number of chip selects are displayed and enabled in the Configure DDR Properties dialog. For instance, if you select the Quad CS rank addressing mode, four chip selects are enabled by default.
Chip Selects	From this section, select the checkboxes for the chip selects that are being used for the SDRAM. For the transaction decoding to be correct, make sure that the chip selects that are being used in the system must be enabled and unused chip selects must not be enabled. For each of the selected chip select, select the Clock Enable (CKE) control signal applicable for that chip select.

Field	Description
Physical	From this section, select the physical address construction that matches the physical address construction used by your SDRAM. The physical address order indicates the order in which the SDRAM address components (Row address, Column address, Bank address, and Rank) are used together to form the Physical address. If your system constructs addresses using a convention different from the displayed options, you need to create a .NET assembly to translate between a physical address and the various fields which make up a bus address. If this is the case, select **User supplied .NET assembly** to allow you to define a custom physical address order format for the SDRAM. Refer to the topic To customize physical address construction in the DDR Bus Decoder Online help to know more about creating a custom algorithm.
Update from DDR Decoder	If you have a Keysight DDR Decoder or LPDDR Decoder tool added to your Logic Analyzer configuration setup, then the **Update from DDR Decoder** section is displayed in the Configure DDR Properties dialog box. The list-box available in this section allows you to select the DDR or LPDDR Decoder tool's instance available in your logic analyzer setup. Clicking the **Update** button displayed next to this list-box updates the SDRAM configurations from the selected decoder tool's instance to the Configure DDR Properties dialog.
Clock Frequency	You can: ▪ either use the clock frequency as detected and extracted from the captured data, or ▪ manually specify the clock frequency that should be used while decoding memory transactions. When specifying the clock frequency manually, ensure that you specify the maximum clock frequency applicable for the trace. If you have used Store Qualifiers while capturing data or filtered the captured data, then you need to manually specify the clock frequency as some states may have been filtered out.
Physical Address Summary	A pictorial representation of how physical addresses will be constructed based on the inputs that you provide in the Configure DDR Properties dialog box for Memory Width, Row Bits, Column Bits, and physical address construction.

To configure the setup to handle multiple system clock speeds

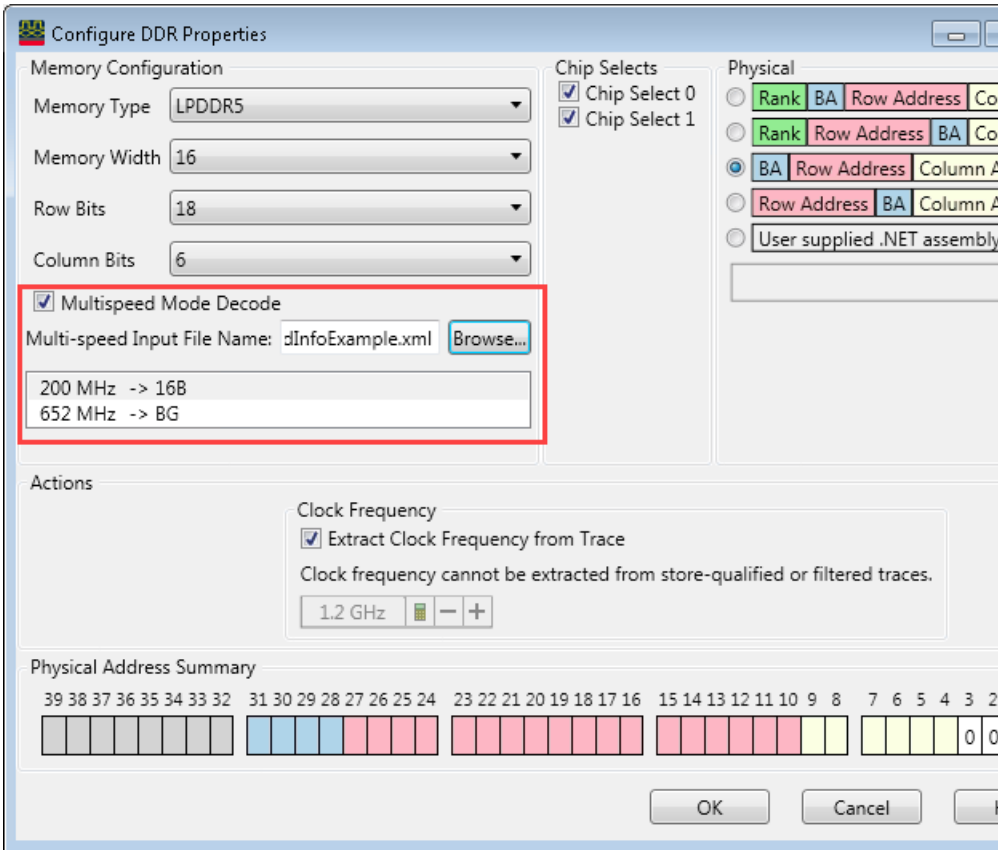
The Memory Analysis window supports decoding an LPDDR5 bus running at a single clock speed or multiple clock speeds.

This topic describes how to configure the setup in the Memory Analysis window when your LPDDR5 bus implementation is running at varying system clock speeds.

1 Select the **Multi-speed Mode Decode** checkbox in the **Configure DDR Properties** dialog box. (This checkbox is displayed only when you select LPDDR5 in the Memory Type listbox.)

2 On selecting this checkbox, the **Multi-speed Input File Name** field is displayed. Click the **Browse** button displayed with this field to browse and select the XML input file in which you have defined the bus settings for each possible clock speed of the DUT. (See the next topic on page 16 to know about the format of this XML file.)

   The decoder then displays the bank organization applicable for each clock speed of your DUT based on the details provided in the XML input file.



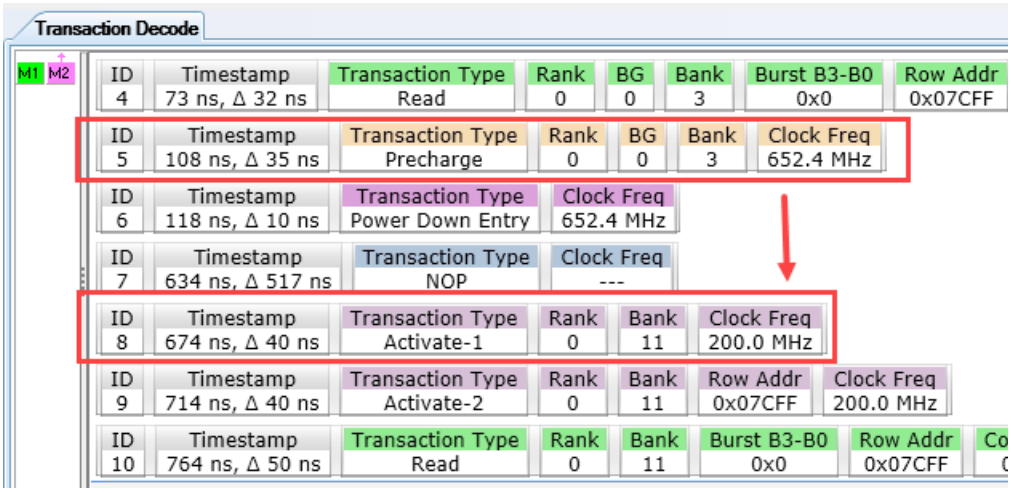
3 Click **OK** after specifying the required setup details in the Configure DDR Properties dialog box.

4 Compute the memory transactions.

NOTE When you compute memory transactions with the Multi-speed Mode Decode enabled, the decoder does not show any data in the Details or Mode Registers Overview tabs. This is because all data-related features are disabled in the multiple clock speeds mode to avoid displaying data that is likely to be invalid with the changing clock speeds.

When the clock speed change is encountered in the trace, the decoder automatically uses the bus settings defined for that clock speed in the XML input file and performs the decode using these specific settings for that portion of trace.

Notice that in the example decode shown below, the decoder automatically and appropriately shows the transition from one bank organization to another when the system clock speed changes.



LPDDR5 Multiple Clock Speeds Decode - XML File Structure and Elements

You can create/edit this XML file using any text editor. This topic describes the format and hierarchy of the XML elements to be followed for this XML file.

NOTE The Memory Analysis Viewer uses only the <BankOrganization> element from this XML file to handle multiple system clock speeds.
Other elements available in this XML file are used by the DDR/LPDDR Post Process Compliance tool to generate accurate compliance results for systems changing clock speeds.

XML Elements Hierarchy

The XML elements shown below are for a set of bus settings to be used for a particular clock speed. Depending on the clock speeds possible for your DUT, you can replicate this set with different settings in the XML file.

```
<SystemClockSpeeds>
    <SystemClockSpeed>
        <BankOrganization/>
        <CasLatency/>
        <CasWriteLatency/>
        <DQODT/>
        <DVFSC/>
        <LinkECC/>
        <WCKRatio/>
```

```
<Mode/>
<RefreshRate/>
<WCKPST/>
<RDQSPST/>
<tWCK2DQO/>
<WCKFreeRunningMode/>
```

XML Elements Description

These XML elements are described in the table below.

XML Element	Description	Attributes
<SystemClockSpeeds>	The multiple clock speeds settings XML file begins with the <SystemClockSpeeds> element. This element allows you to define one or more sets of bus settings mapped to the possible clock speeds for your DUT.	-
<SystemClockSpeed>	Contains the set of following bus settings to be applied for the clock speed that you specified in the *Value* attribute. ▪ <BankOrganization> - Possible values are 8B, 16B, BG ▪ <CasLatency> ▪ <CasWriteLatency> ▪ <DQODT> - Possible values are Disabled or Enabled. ▪ <DVFSC> - Possible values are Disabled or Enabled. ▪ <LinkECC> - Possible values are Disabled or Enabled. ▪ <WCKRatio> - Possible values are 2:1, 4:1. ▪ <Mode> - Possible values are X8 Mode, X16 Mode. ▪ <RefreshRate> - Possible values are Ref8x, Ref6x, Ref4x, Ref3_3x, Ref2_5x, Ref2_0x, Ref1_7x, Ref1_3x, Ref1x, Ref0_75x, Ref0_5x, Ref0_25x, Ref0_25xD, Ref0_125x, Ref0_125xD. ▪ <WCKPST> - Possible values are 2.5, 4.5, 6.5. ▪ <RDQSPST> - Possible values are 0.5, 2.5, 4.5. ▪ <tWCK2DQO> - Maximum value of tWCK2DQO in ns. ▪ <WCKFreeRunningMode> - Possible values are Disabled or Enabled.	*Value - A String representing the clock speed for which the set of bus settings is applicable.* Example <SystemClockSpeed Value="200">

XML File Example

This topic includes an example of the XML input file created in the required format to decode as per the multiple clock speeds of the DUT.

```
<SystemClockSpeeds>
  <SystemClockSpeed Value="200">
      <!-- 8B, 16B, BG -->
      <BankOrganization>16B</BankOrganization>
      <CasLatency>8</CasLatency>
      <CasWriteLatency>4</CasWriteLatency>
      <!-- Disabled, Enabled -->
      <DQODT>Disabled</DQODT>
      <!-- Disabled, Enabled -->
      <DVFSC>Disabled</DVFSC>
```

```
        <!-- Disabled, Enabled -->
        <LinkECC>Disabled</LinkECC>
        <!-- 2:1, 4:1 -->
        <WCKRatio>2:1</WCKRatio>
        <!-- 2Gb, 3Gb, 4Gb, 6Gb, 8Gb, 12Gb, 16Gb, 24Gb, 32Gb -->
        <Density>8Gb</Density>
        <!--X8 Mode, X16 Mode -->
        <Mode>X16 Mode</Mode>
        <!-- Ref8x, Ref6x, Ref4x, Ref3_3x, Ref2_5x, Ref2_0x,
        Ref1_7x, Ref1_3x, Ref1x, Ref0_75x, Ref0_5x, Ref0_25x,
        Ref0_25xD, Ref0_125x, Ref0_125xD -->
        <RefreshRate>Ref1x</RefreshRate>
        <!-- 2.5, 4.5, 6.5 -->
        <WCKPST>2.5</WCKPST>
        <!-- 0.5, 2.5, 4.5 -->
        <RDQSPST>0.5</RDQSPST>
        <!-- tWCK2DQO max value in ns -->
        <tWCK2DQO>1.6 </tWCK2DQO>
        <!-- Disabled, Enabled -->
        <WCKFreeRunningMode>Disabled</WCKFreeRunningMode>
    </SystemClockSpeed>
    <SystemClockSpeed Value="652">
        <BankOrganization>BG</BankOrganization>
        <CasLatency>15</CasLatency>
        <CasWriteLatency>8</CasWriteLatency>
        <DQODT>Disabled</DQODT>
        <DVFSC>Disabled</DVFSC>
        <LinkECC>Disabled</LinkECC>
        <WCKRatio>4:1</WCKRatio>
        <Mode>X16 Mode</Mode>
        <RefreshRate>Ref1x</RefreshRate>
        <WCKPST>2.5</WCKPST>
        <RDQSPST>0.5</RDQSPST>
        <tWCK2DQO>1.6</tWCK2DQO>

        <WCKFreeRunningMode>Disabled</WCKFreeRunningMode>
```

```
    </SystemClockSpeed>
</SystemClockSpeeds>
```

3 Computing Decoded Memory Transactions and Memory Data Analysis Charts

Disabling a Memory Analysis Tab / 23

NOTE **Before you start computing the decoded transactions and charts, ensure that you have correctly configured the memory settings as per your SDRAM configurations. Failing to do so can result in an inaccurate decoding of transactions.**

To compute memory transactions:

1 Click the **Show** button on the Memory Analysis instance in the Overview window to access the Memory Analysis window.

The **DDR/LPDDR Memory Analysis** window is displayed.

2 In the **Data Range** group-box, specify the start and end points of the captured memory data for which you want to compute decoded memory transactions and charts. Only the specified range of data is analyzed to compute data. Following options are available for setting this data range.

- **Beginning and End of data** - This data range selection ensures that the entire trace is used for the computation of memory transactions and charts.
- **Trigger** - Selecting Trigger in the data range ensures that memory transactions are computed from the point in the captured data where the trigger condition was met.
- **Markers** - Selecting markers in the data range ensures that memory transactions are computed for the specific portion of captured data defined by markers.

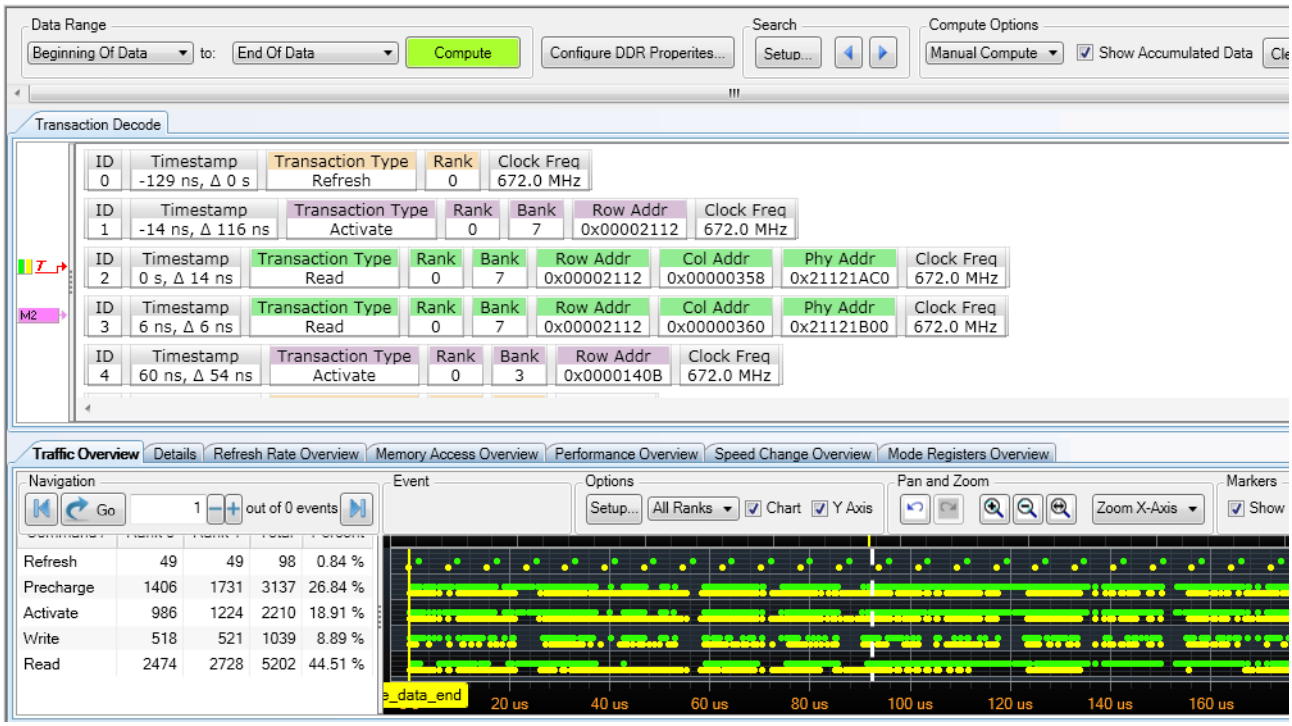
3 From the **Compute Options** groupbox, set the appropriate compute options.

- **Manual Compute** - Use this option if you want to manually start the computation of decoded memory transactions and memory data analysis charts by clicking the Compute button.
- **Compute All on Run** - Use this option if you want to automatically start the computation of decoded memory transactions and analysis charts in background while the logic analyzer module is capturing memory data. This allows you to perform a compute for all the tabs in the DDR/LPDDR Memory Analysis window automatically after the data capture is complete. It thereby helps you perform a faster compute than performing a manual compute after the data is captured.

- **Compute and Accumulate on Run** - Use this option if you want to automatically start the computation as well as accumulation of decoded memory transactions and analysis data while the logic analyzer module is capturing memory data. For each consecutive run, the computed data is accumulated. The data accumulation is applicable only to the Traffic Overview, Memory Access Overview, and Performance Overview tabs.
- **Show Accumulated Data** - Select this checkbox if you want to display the computed data that has been accumulated after each consecutive run. Accumulated data is available for display only in the Traffic Overview, Memory Access Overview, and Performance Overview tabs.
- **Clear** - Click this button to clear the computed data that has been accumulated and displayed in the applicable tabs.
- **Setup** - Click this button to access the DDR Accumulate Dialog used for setting the accumulated data options.

4 If you selected **Manual Compute** in the previous step, click the **Compute** button displayed with the Data Range fields.

On clicking Compute, the transactions are decoded from the specified data range of memory trace. Then, statistics and charts are computed from these decoded transactions and results are displayed.



NOTE The **Clock Freq** field is displayed for the decoded memory transactions in the upper pane only if you selected the E**xtract Clock Frequency from Trace** checkbox in the Configure DDR Properties dialog box while configuring your SDRAM setup.

Disabling a Memory Analysis Tab

By default, on clicking Compute, the data in all Memory Analysis tabs is computed. In case you do not want to use data in a specific tab, you can disable that tab. This excludes the tab from the Compute operation and thereby eliminates the time taken to compute and draw chart for that tab from the total compute time.

You disable a tab using the Enable/Disable button  displayed in the tab's header. The tabs for which the Disable feature is not available, this button is not displayed.

When you disable a tab, the chart is cleared and any computed data in that tab is lost. You can re-enable a disabled tab and compute again to regenerate the data and chart for that tab.

NOTE

Hiding a tab using the **Show/Hide Tabs** drop-down list-box at the top of the Memory Analysis window does not exclude the hidden tab from the Compute operation. The tab is only hidden from display but its data is still computed when you click Compute.

4 Filtering Decoded Memory Transactions

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Using Custom Transaction Types in Filtering / 36
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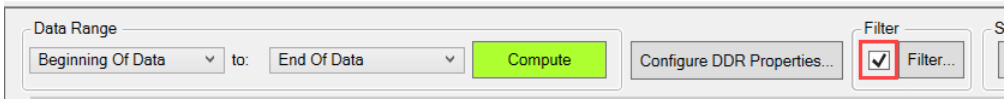
The **Filter** feature allows you to filter the display of the decoded memory transactions in the upper pane of the Memory Analysis window as per the filtering criteria defined by you.

Using this feature, you can show/hide transactions as per your choice and focus on the transactions that are currently of significance to you for analysis and debug.

To enable the Filter feature

By default, the Filter feature is disabled to eliminate the processing time needed for filtering during the Compute process. If you do not need to filter the display, then it is recommended to keep the Filter feature disabled to avoid increasing the Compute time.

1 To enable filtering, select the **Filter** checkbox displayed at the top of the Memory Analysis window.

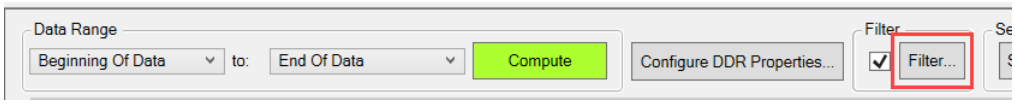


NOTE When you enable filtering for the first time for the computed transaction decode of a trace, you need to recompute that transaction decode. This allows the filtering feature to work for the transaction decode of that trace.

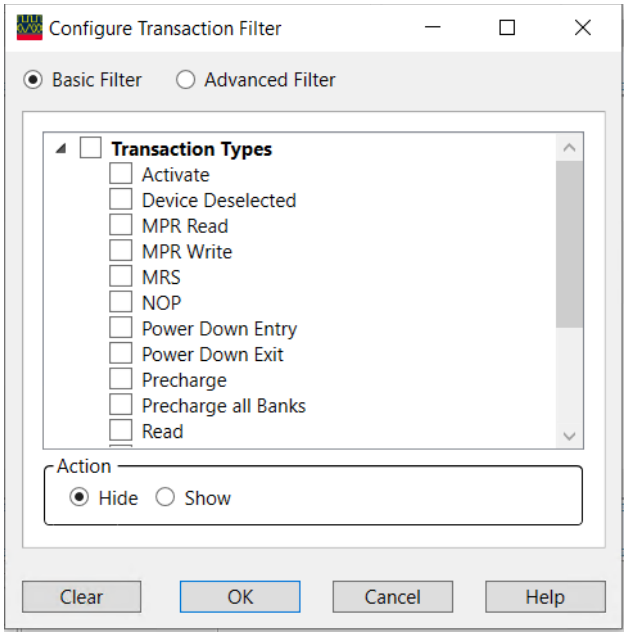
To define the filtering criteria

When you select the Filter checkbox, the **Filter** button gets enabled to allow you to define the filtering criteria.

1 Click the **Filter** button to configure filtering options.

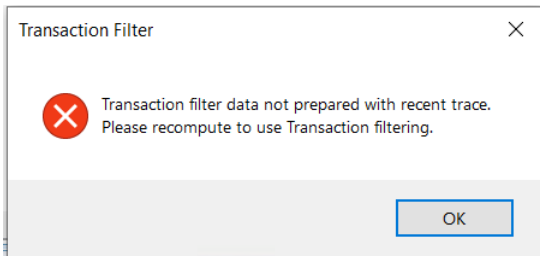


The **Configure Transaction Filter** dialog box is displayed.



2 Select the filtering mode, condition(s), and action. See the "Configure Transaction Filter Dialog" on page 31 for details on basic and advanced filters and examples.

At times, the following error is displayed when you click the Filter button. This indicates that the current transactions decode was computed with the Filter checkbox deselected. Therefore, you need to recompute the decode with the Filter checkbox selected.



NOTE

- Filtering does not remove any transactions from the computed list of decoded transactions but only filters the display of transactions as per the defined filtering criteria.

- At any time, you can deselect the Filter checkbox to remove the filter and bring back all the transactions into the display.

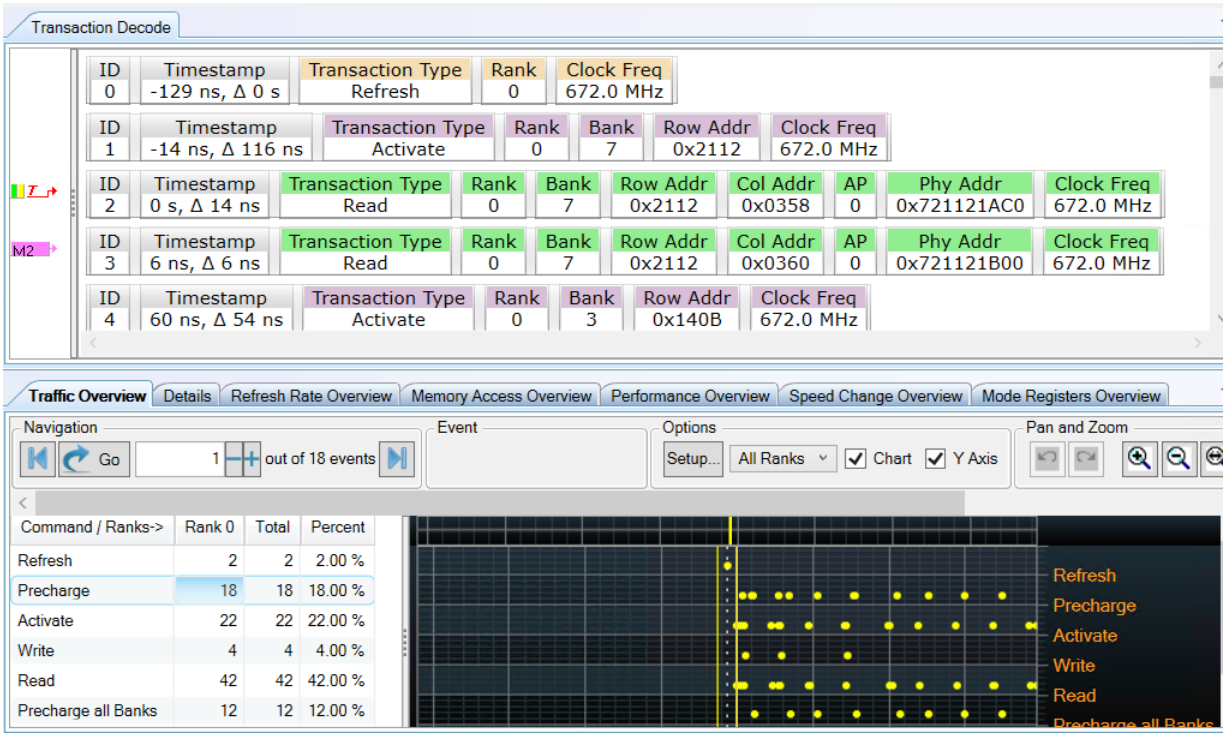
- Filtering does not have any impact on the data displayed in the tabs in the lower pane of the Memory Analysis window. If the transaction corresponding to an event occurrence / marker in the lower pane is filtered, then the navigation takes you to the transaction closest to that filtered transaction in the upper pane.

Filtering Transactions Decode - Example

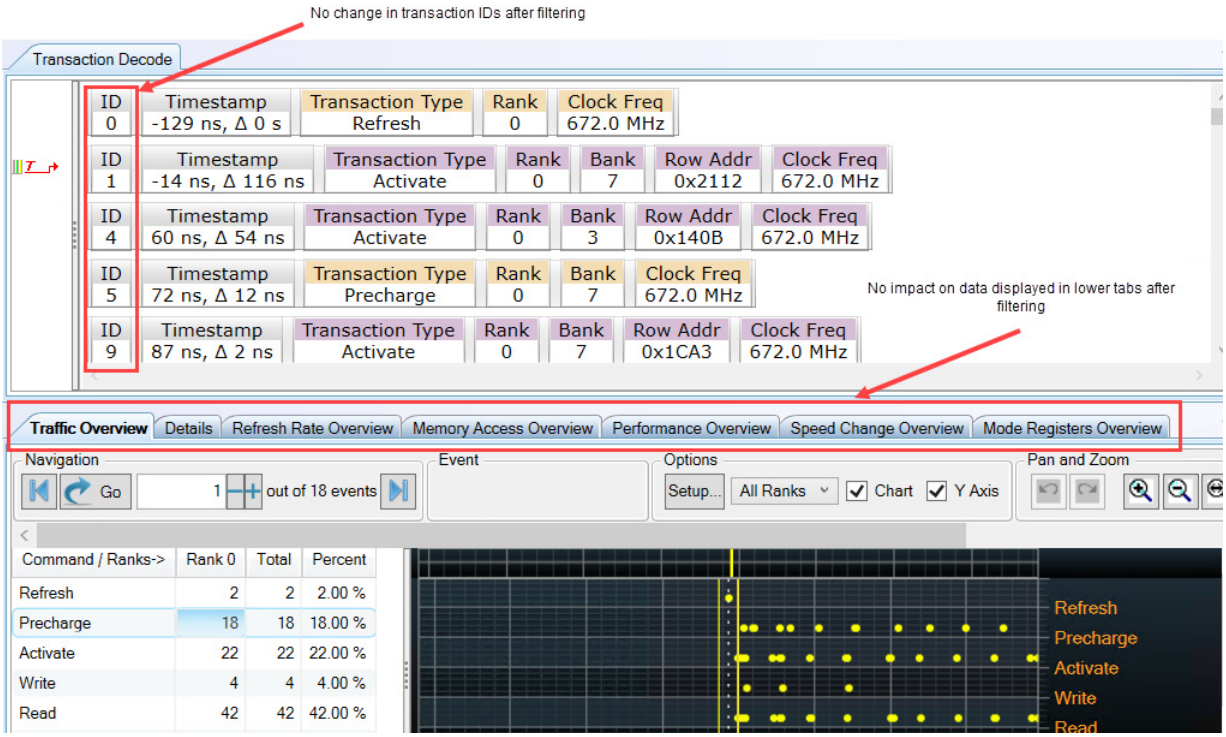
The screens below show the transactions decode before and after applying a basic filter.

In this example, a simple filter condition has been applied to hide all Read transactions from the display.

Refer to the "Configure Transaction Filter Dialog" on page 31 for more examples on basic and advanced filters.



<Transaction decode before filtering>

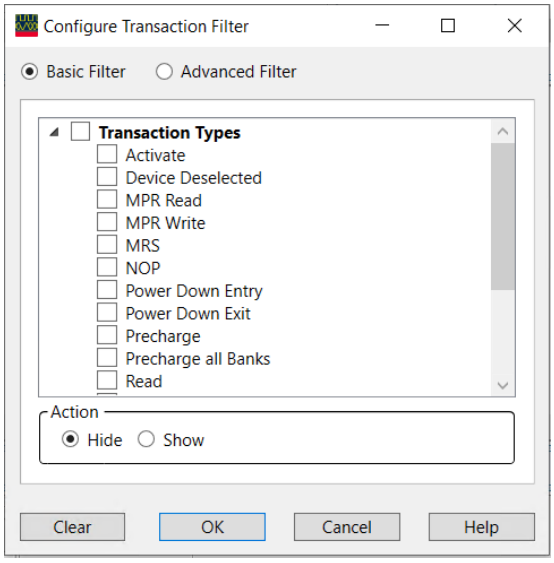


<Transaction decode after filtering>

Configure Transaction Filter Dialog

Use this dialog box to define the filtering criteria to filter transactions in the upper pane of the Memory Analysis window.

You access this dialog box by clicking the **Filter** button displayed at the top of the Memory Analysis window. This button gets enabled when you select the **Filter** checkbox.



Filtering Modes

The following two modes are available for filtering.

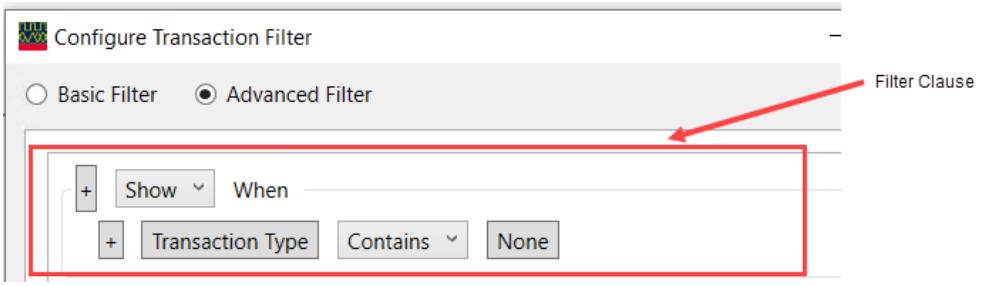
Basic Filter	Advanced Filter
Lets you define simple filtering criteria to support basic filtering based on transaction type(s).	Lets you define complex filtering criteria to support advanced filtering such as: - filtering based on specific field(s) in the transactions. - defining multiple filter clauses. - defining multiple filters within a clause. - using custom transaction types in filters (only available when filtering ONFi transactions in the ONFi Analysis window)
The list of transaction types displayed for the filtering criteria is fixed and predefined as per the memory bus type.	The list of transaction types and fields displayed for the filtering criteria is dynamic and as per the transaction types and fields available in the decode.

To define a basic filter

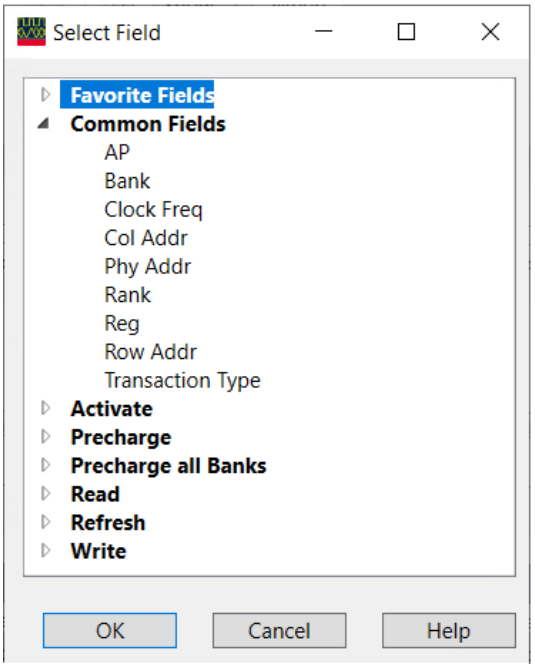
1 Click **Basic Filter** in the **Configure Transaction Filter** dialog box.
2 Select the transaction type(s) from the list.
3 Select either **Show** or **Hide** as the Action to show or hide transactions of the selected transaction type(s).
4 Click **OK**.

To define an advanced filter

1 Click **Advanced Filter** in the **Configure Transaction Filter** dialog box.
Each filter clause has a filter action (Show / Hide) and filter condition(s).



2 To define a filter condition, click the **Transaction Type** button in the filter clause.
The **Select Field** dialog box is displayed. The list of transaction types and their associated fields displayed in this dialog box is as per the transaction types and fields available in the decode.



NOTE

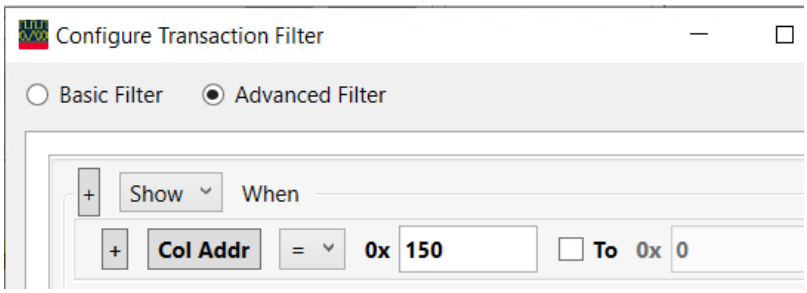
In this dialog box, the fields are grouped under “Favorite Fields”, “Common Fields”, and individual transaction types. So, it is possible that the same field can appear under more than one grouping in the tree list. Irrespective of the grouping from which you select a field, the filter condition will apply to any transaction that contains that field in the transaction decode. For example, BG and Bank fields are grouped under “Favorite Fields”, “Common Fields” and “Activate”. Regardless of the group from which you select these fields, the resulting filter expression and filter results will be the same.

3 Select the field on which you want to base the filter condition and click **OK**.

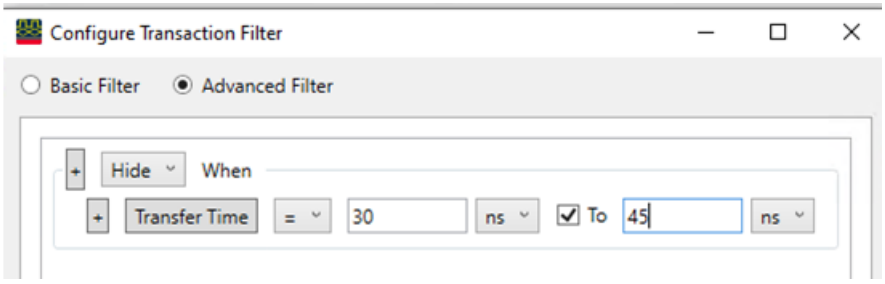
4 Select the filter expression operator for the field. Based on the type of field, you have the option of operators such as **Contains**, **Does not Contain**, **=**, or **!=** (not equal).

5 Specify the value for the field. Based on the type of field, you can specify values such as:

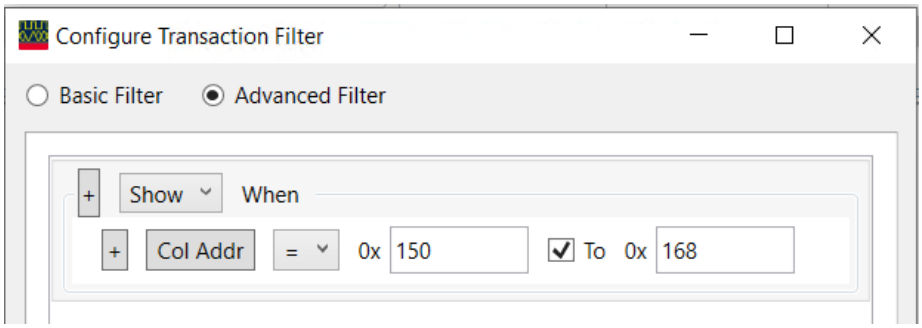
- Decimal numbers
- Hexadecimal numbers (0x prefixed)



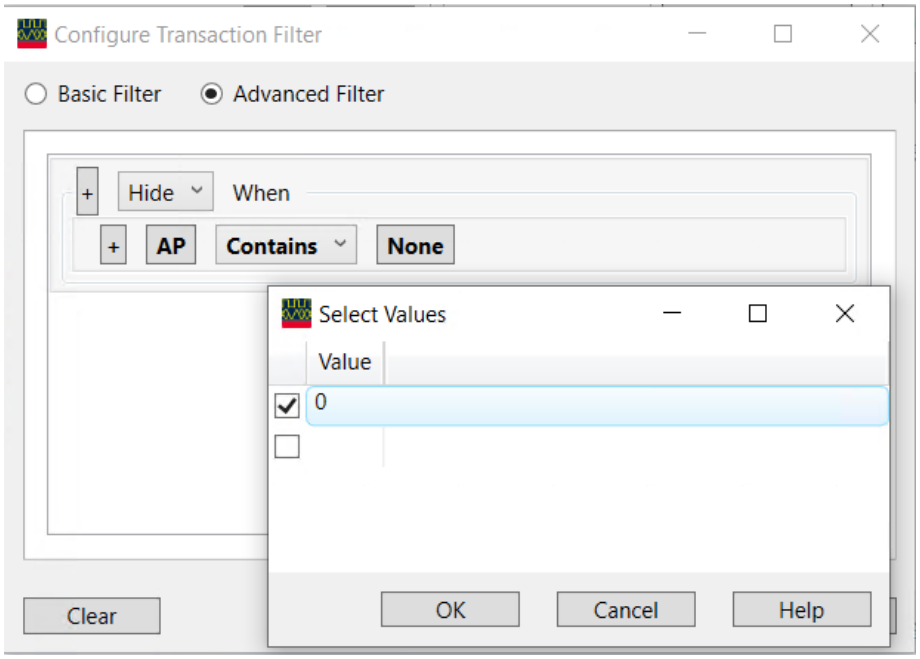
- Time-based (with time units)



- Range of values - To specify a range of values for a field, select the **To** checkbox in the filter expression and specify the start and end values for the range.



- For fields that have relatively small number of possible values, the values are presented as a list in the **Select Value** dialog box. You can access this dialog box by clicking **None** in the filter expression. This list of values is as per the values available for that field in the trace. For example, if the trace has 0 as the value of the AP field, then only 0 will be displayed as an option in this list for the AP field.



You can either select a value from this list or specify your own value by selecting the last empty checkbox in the list.

6 Click **OK**.

To Insert Multiple Filter Conditions Within a Filter Clause

1 Click the **+** sign displayed with the filter condition and select "**Insert Filter After**" or "**Insert Filter Before**".

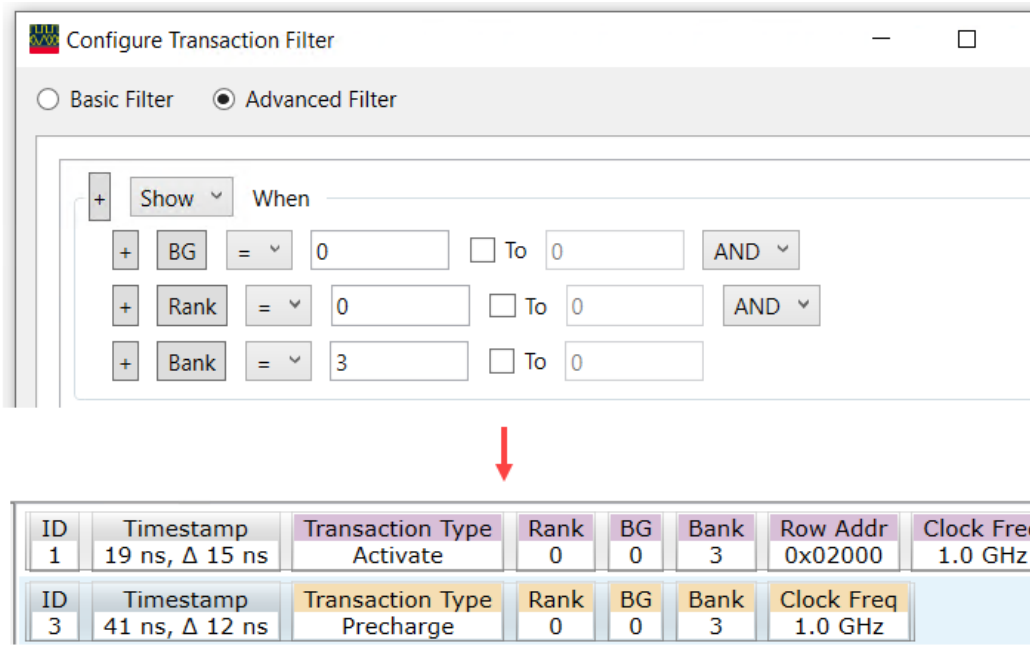
2 Define the filter clause.

3 Select the "**AND**" or "**OR**" as the conditional operator for the filter conditions defined in the filter clause.

NOTE The choice of AND or OR conditional operator is applied across all filter conditions that you define within a filter clause.

You can insert as many filter conditions as you want in a filter clause.

The filter clause displayed below shows only those transactions for which all three filter conditions are met.



To Insert Multiple Filter Clauses in the Filtering Criteria

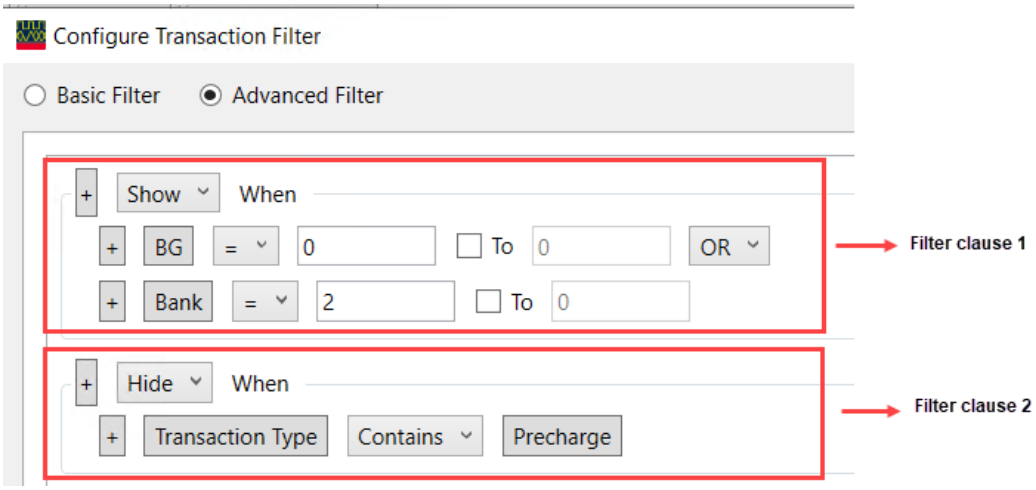
1 Click the **+** sign displayed with the filter action and select **Insert Filter Clause After** or **Insert Filter Clause Before**.

2 Define filter clauses as per your requirements.

You can define as many filter clauses as you want to support complex filtering expressions which may not be possible using multiple conditions within a single filter clause.

For complex filtering requirements, multiple filter clauses ensure the sequential execution of these filter clauses while also providing the flexibility of using the And or Or conditional operator across conditions of individual filter clauses.

For example, the filter setup shown below has two filter clauses. This filter criteria will show transactions that have either BG = 0 or Bank = 2 and that do not belong to the transaction type Precharge.



Using Custom Transaction Types in Filtering

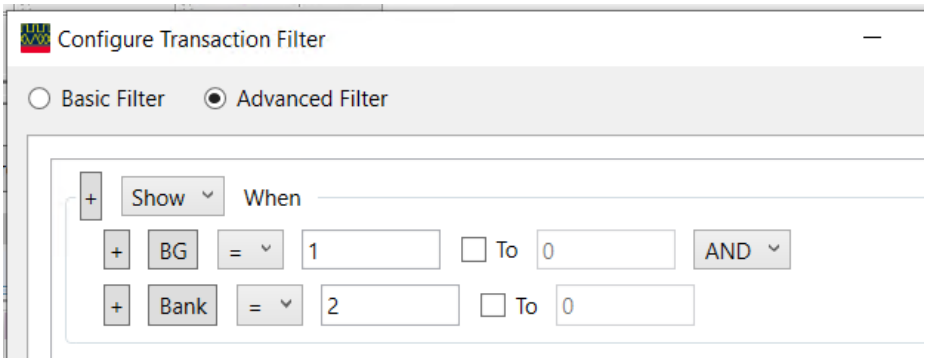
The ONFi decode (in the ONFi Analysis window) allows you to define custom transaction types. Therefore, the custom transaction types are included in the transaction types list presented for defining an Advanced filter for an ONFi decode only.

NOTE **The transaction types list for a basic filter for an ONFi decode is predefined. Custom transaction types are not displayed in this list.**

Advanced Filter Examples

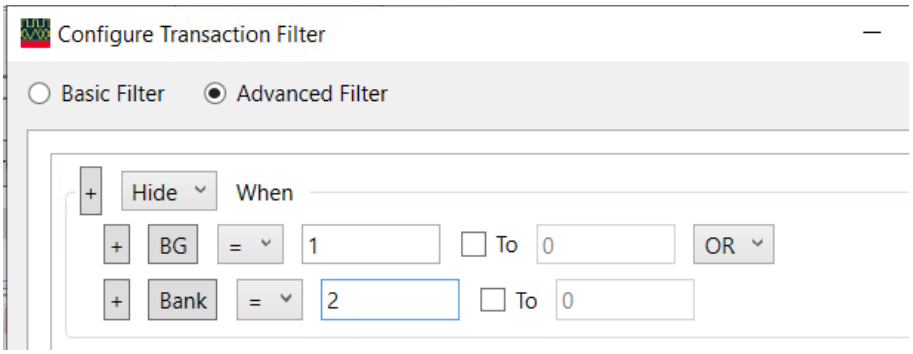
Here are a few examples to describe important aspects of how the advanced filtering works.

Example 1 - To show transactions with BG = 1 and Bank = 2



Only transactions with BG=1 and Bank=2 will be shown. The transactions that do not have the fields BG and Bank do not meet the filtering criteria and are therefore not shown.

Example 2 - To hide transactions with BG = 1 and Bank = 2



Transactions with BG=1 or Bank=2 will be hidden. Also, the transactions that do not have the fields BG or Bank do not meet the filtering criteria and are therefore not hidden.

To Clear Filter

On clicking the **Clear Filter** button at the bottom of the Configure Transaction Filter dialog box:

- all filter settings that you specified for the Basic and Advanced filters are cleared from the dialog box.
- the display of transactions is returned to the unfiltered state.

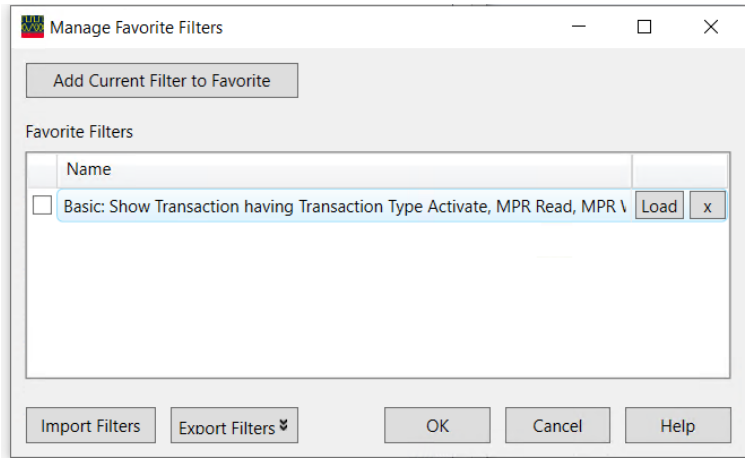
To Manage Filters

To avoid redefining your favorite filters, you can save your filter setups for future use.

1 Click the **Manage Filters** button at the bottom of the Configure Transaction Filter dialog box.

The **Manage Favorite Filters** dialog box is displayed.

2 Click the **Add Current Filter to Favorite** button to add the currently defined Basic and Advanced filter setup to the list of favorite filters for the current trace.



3 Accept the default name for the filter in the list or specify a different name.

4 Click **OK** to confirm the addition of filter setup.

5 Click **OK** to confirm the changes to the Configure Transaction Filter dialog box.

On saving the logic analyzer configuration file, this newly added filter gets saved with it.

To load a saved filter

When you load a logic analyzer configuration file, the filter(s) that you saved with it are available for use with this configuration file.

1 Click the **Manage Filters** button in the Configure Transaction Filter dialog box.

2 Select the filter setup that you want to load from the **Favorite Filters** list and click **Load**.

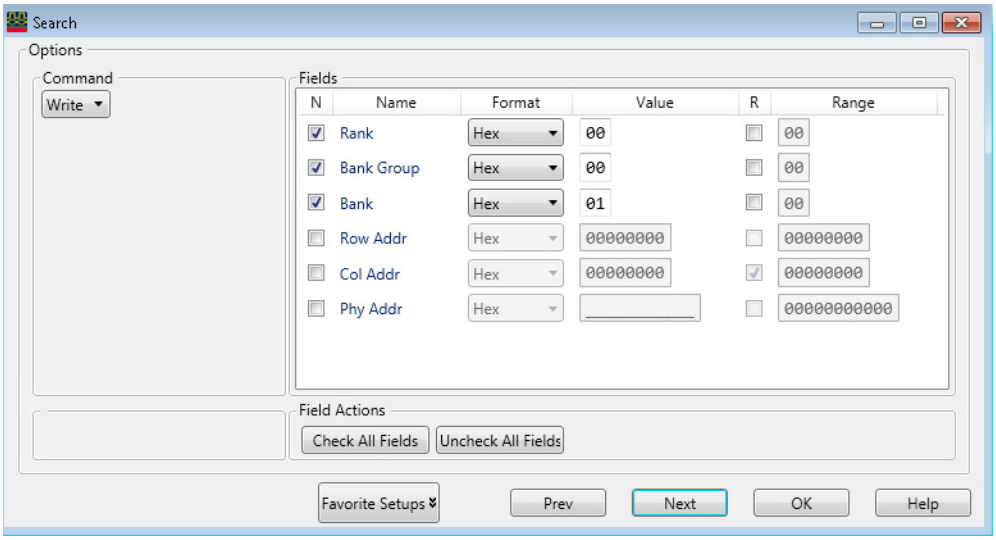
To export and import filters

When you save a filter, it is available for use later only with that logic analyzer configuration file with which it was saved. However, if you want to use your favorite filters with other logic analyzer configurations and setups as well, then you can export all or specific filters from the favorite filters list to an .xml file. You use the **Export Filters** button in the Manage Favorite Filters dialog box to accomplish this. To load these later, click the **Import Filters** button in the Manage Favorite Filters dialog box and open the .xml file in which you exported the filters.

5 Searching for Specific Memory Commands

You can quickly search for a memory command of interest from the list of decoded memory transactions displayed in the upper pane of the Memory Analysis window. You can use the **Search** section in the Memory Analysis tool-bar to accomplish this.

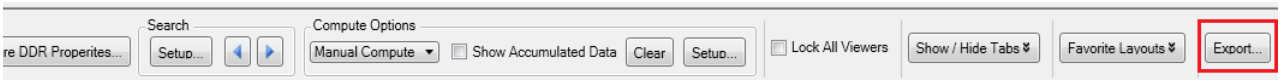
To define your search criteria, you can choose the required memory command from the list of available memory commands in the **Search** dialog and further refine this criteria by specifying field values for the selected command.



To know how to use the search feature and then view search results, click the **Help** button in the Search dialog box.

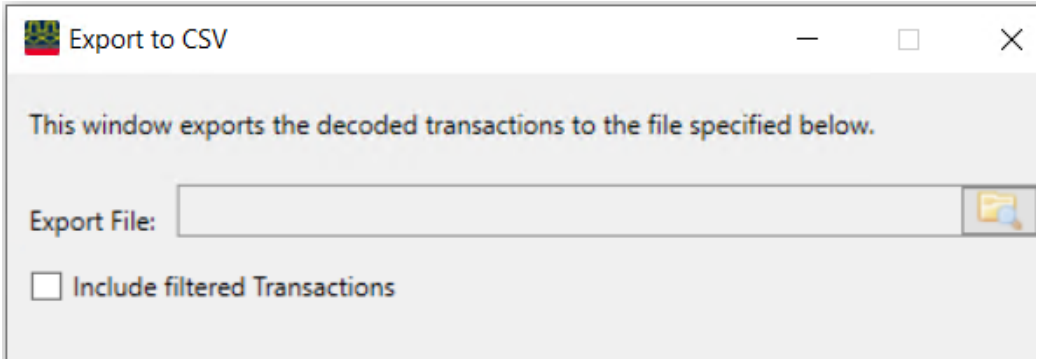
6 Exporting Decoded Memory Transactions

You can quickly export decoded memory transactions displayed in the upper pane of the Memory Analysis window to a specified .csv file. You can use the **Export** button in the Memory Analysis toolbar to accomplish this.



On clicking the Export button, the Export to CSV dialog box is displayed in which you can specify the path and name of the CSV file to which you want to export the decoded memory transactions.

The transactions are exported in the same format in which these are displayed in the Memory Analysis window. By default, the transactions that you have filtered out using the Filter feature are not included in the exported data. However, if you want to include the filtered transactions as well in the exported data, then select the **Include Filtered Transactions** checkbox.



7 Analyzing Memory Traffic Statistics

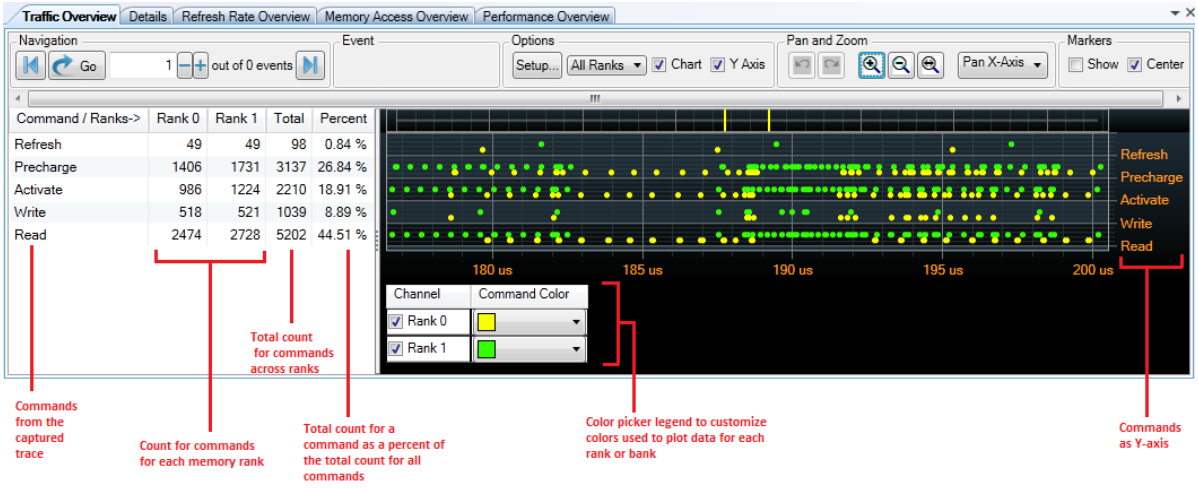
Selecting the Commands to be Included in Traffic Overview / 45
Categorizing Memory Traffic Statistics as per Memory Banks or Ranks / 46
Viewing and Customizing a Traffic Overview Chart / 47
Navigating Through Traffic Overview and Decoded Memory Transactions / 49

You can use the **Traffic Overview** tab in the Memory Analysis window to view and analyze the traffic statistics for the memory data captured and displayed in the upper pane of that window.

On clicking the Compute button, the following data is computed in the tab's left and right panes.

- For each memory command found in the captured trace, the tab displays a count of the number of times the memory command was sent to the SDRAM. The count of each command is further categorized on the basis of either memory ranks or on the basis of banks within a particular memory rank to which the command was sent.
- The tab also displays a traffic overview chart in which a count of memory commands found in the captured trace is plotted over the period of time as X-axis and the command types as Y-axis. Different customizable colors are used to plot count of commands for different banks or ranks.

The following screen displays a sample memory traffic statistics categorized on the basis of available memory ranks.



The following subsequent topics in this help book describe the usage of the Traffic Overview tab in detail.

- Selecting the Commands to be Included in Traffic Overview (See page 45)
- Categorizing Memory Traffic Statistics as per Memory Banks or Ranks (See page 46)

- Viewing and Customizing a Traffic Overview Chart (See page 47)
- Navigating Through Traffic Overview and Decoded Memory Transactions (See page 49)

See Also

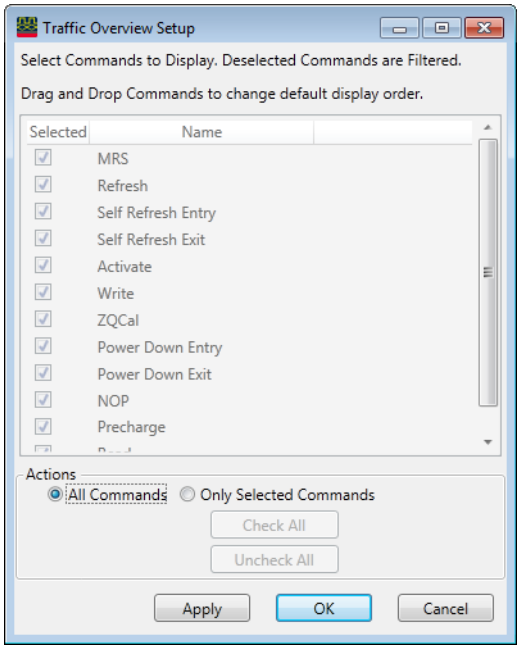
- Placing Markers in a Memory Analysis Chart (See page 101)
- Panning / Zooming a Memory Analysis Chart (See page 105)

Selecting the Commands to be Included in Traffic Overview

You can choose the memory commands for which you want the traffic statistics and traffic overview chart to be displayed in the Traffic Overview tab. By default, all commands are selected for data display.

1 Click the **Setup...** button under the **Options** groupbox in the **Traffic Overview** tab.

The **Traffic Overview Setup** dialog box is displayed with the list of all the available memory commands. The **All Commands** radio button is selected by default which means all commands are selected for display.



2 To filter out commands from the display in the Traffic Overview tab, click the **Only Selected Commands** radio button in the **Actions** groupbox.

3 De-select the checkbox for each command that you do not want to include in the traffic statistics.

NOTE You can also change the order in which a command is displayed in the traffic overview chart's Y-axis. To do so, drag and drop that command in the required sequence in the list of commands shown in the Traffic Overview Setup dialog.

4 Click **Apply** to confirm the changes or click **OK** to confirm the changes and close the dialog box. Click **Cancel** to close the dialog box without applying changes.

The changed selection of commands is reflected in the traffic statistics and chart.

Categorizing Memory Traffic Statistics as per Memory Banks or Ranks

In the Traffic Overview tab, you can categorize memory traffic (commands) statistics on the basis of either memory ranks or on the basis of banks within a particular memory rank.

To change categorization

- From the **Options** gruopbox in the tab, click the **Ranks** drop-down list-box.

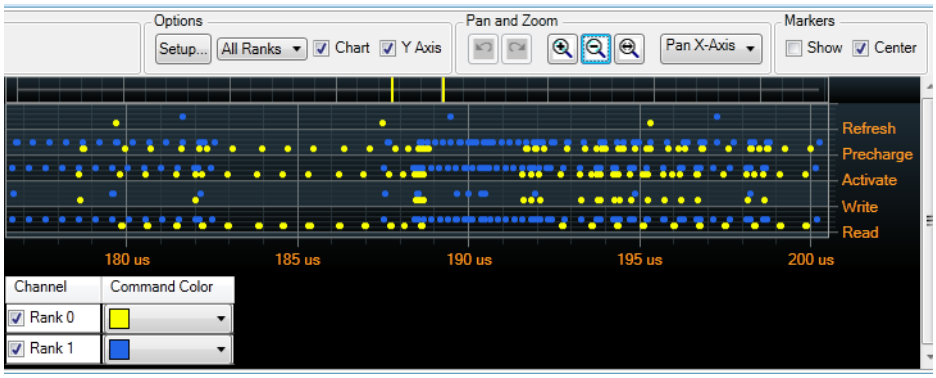
  The **All Ranks** option in the list-box is the default categorization in which the count of the number of times a DDR command was sent is displayed at the rank level. This categorization is useful for a multi-rank memory configuration.

  If you want to change the categorization to individual banks level within a rank, then select that particular rank from the list-box. This categorization is useful to analyze traffic within a particular rank and to drill down to banks level.

Viewing and Customizing a Traffic Overview Chart

The computed memory traffic statistics displayed in the left pane of the **Traffic Overview** tab is also available as a chart in the tab's right pane.

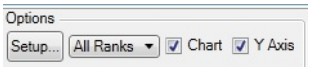
For each memory command type found in the trace, there is a row in the chart. This row is used to plot the number of commands of that type sent over a period of time to individual memory banks or ranks. Color coding is used to differentiate command counts based on ranks or banks (as per your categorization selection). For instance, in the below screen, yellow and blue colors are used to represent command counts for Rank 0 and Rank 1 respectively.



Some of the ways of customizing a traffic overview chart are described in this topic.

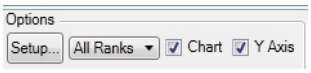
To display a traffic overview chart

By default, the traffic overview chart is displayed. To show/hide this chart, select/de-select the **Chart** checkbox from the **Options** groupbox in the Traffic Overview tab.



To hide the Y-axis (command types) in the traffic overview chart

Deselect the **Y Axis** checkbox from the **Options** groupbox in the **Traffic Overview** tab.

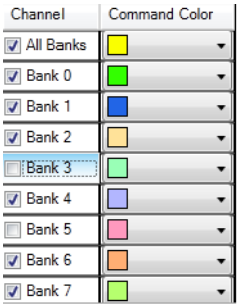


To view or change the color coding used in the traffic overview chart

The Color Picker Legend displays the currently applied color coding for the chart.

1 To display the Color Picker Legend, right-click anywhere in the plotted chart area and select **Show Color Picker Legend**.

The currently used color coding for each bank or rank (as per your categorization choice) is displayed in the Color Picker Legend.



2 To change the color coding for a bank/rank, click the Command Color drop-down and select the new color.

The commands count for that bank/rank is changed to the new color in the chart.

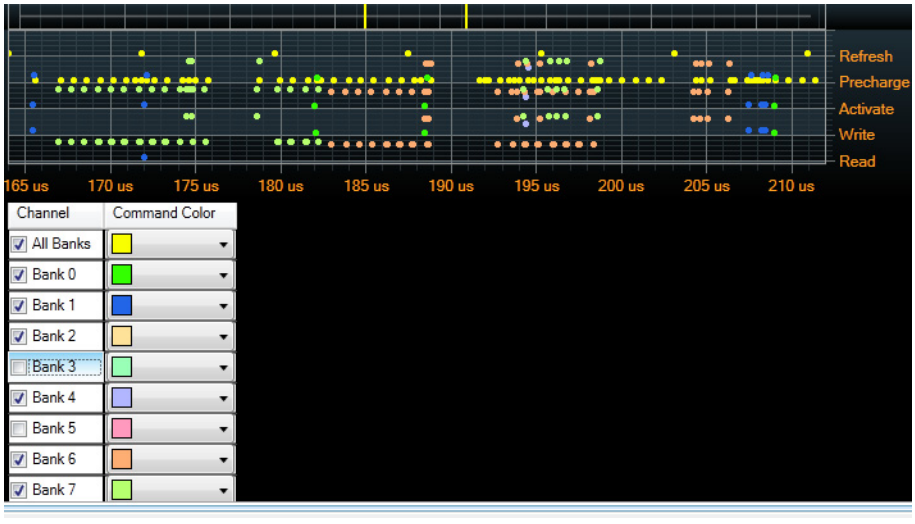
To show/hide data for a bank/rank from the traffic overview chart

By default, the command counts for all the applicable memory banks/ranks are displayed in the chart. You may want to hide the command counts for some of the banks/ranks to focus only on specific bank(s)/rank9s) of interest.

1 Right-click anywhere in the plotted chart area and select **Show Color Picker Legend**.

2 Select/de-select the checkbox for a bank or a rank to show/hide the command counts for that bank/rank in the chart.

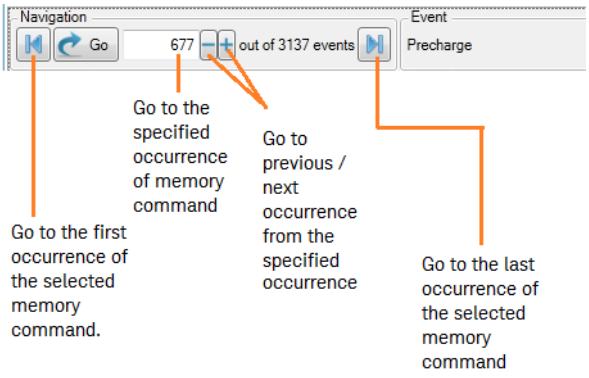
The chart is updated to reflect your selections of banks/ranks.



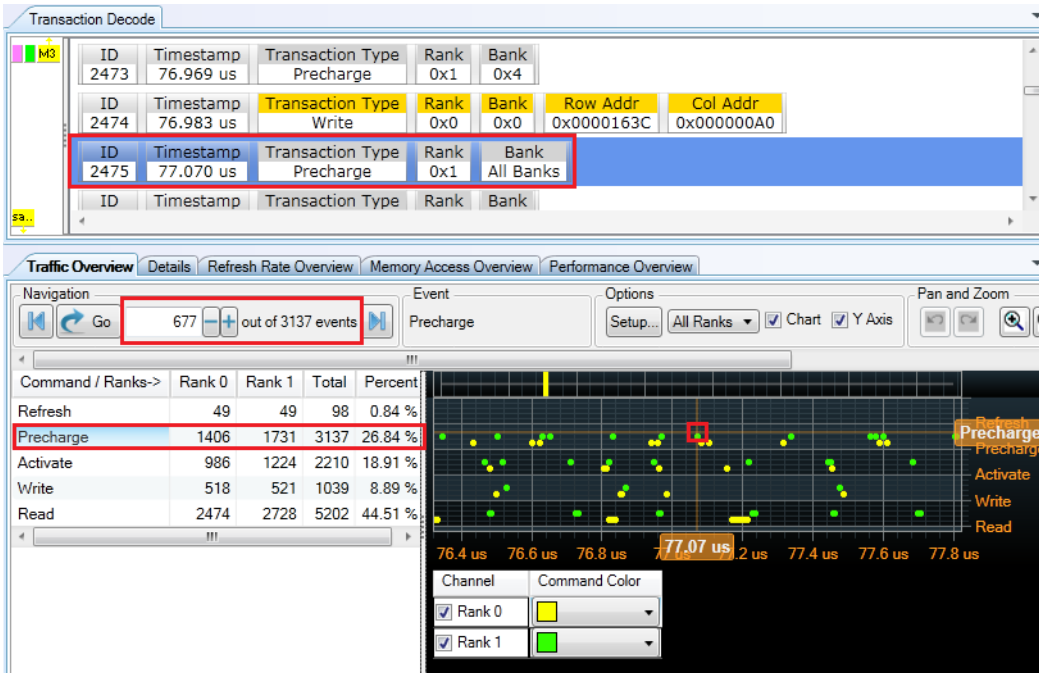
NOTE The **All Banks** option in the Color Picker Legend is used for the memory commands applicable for all the banks of a particular rank.

Navigating Through Traffic Overview and Decoded Memory Transactions

You use the Navigation tool-bar in the Traffic Overview tab to navigate from a specific occurrence of a memory command event to its applicable memory transaction in the upper pane. Simultaneously, the traffic overview chart display also moves to the point at which the specific command event is plotted in the chart.



For instance, in the following screen, there are total 3137 Precharge commands across ranks and you want to navigate directly to the 677th Precharge command in the trace To do so, you can select the Precharge command type in the Traffic Overview left pane and then type 677 in the Navigation text box and click Go. This takes you directly to the 677th Precharge transaction in the upper pane of the Memory Analysis window. The chart display is also simultaneously moved to the 677th occurrence of the Precharge command.

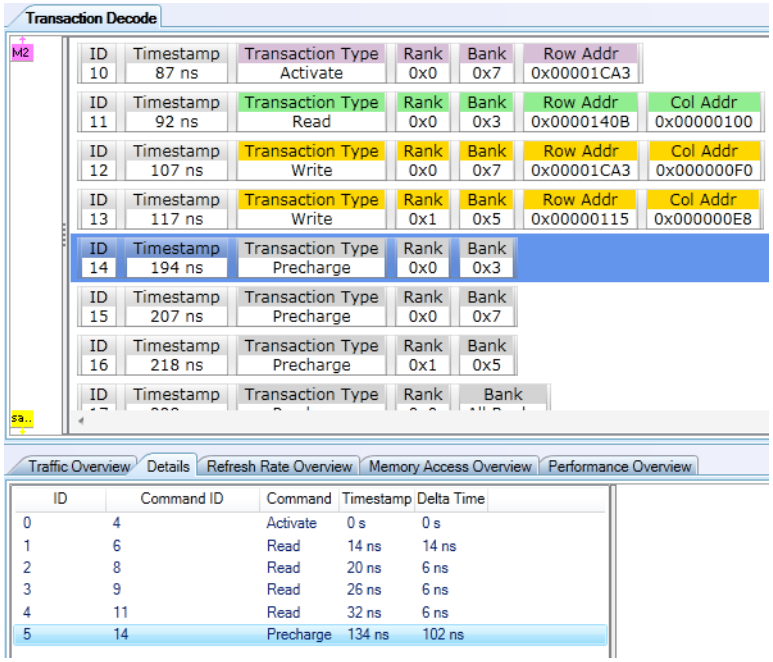


8 Viewing Memory Commands as a Sequential Set

An SDRAM operation comprises of a number of commands sent in a specific sequence. In the upper pane of the Memory Analysis window, memory transactions (commands) are decoded and listed in a time-wise order of their occurrence. At times, you may want a segregated view of the complete sequential set of transactions (commands) that comprise a specific SDRAM operation. You can use the **Details** tab in the Memory Analysis window to view this complete sequential set of commands sent for a specific SDRAM operation.

On selecting a decoded transaction row in the **Transaction Decode** tab of the Memory Analysis window, the Details tab lists all the memory commands applicable for that transaction in a sequential flow.

The following screen displays the complete sequence of commands applicable for the Precharge transaction highlighted in the upper pane. In this sequence, an Activate command to open the row is followed by Read commands and the SDRAM sequence ends with the Precharge command to close the row.



The following table describes the fields displayed in the Details tab.

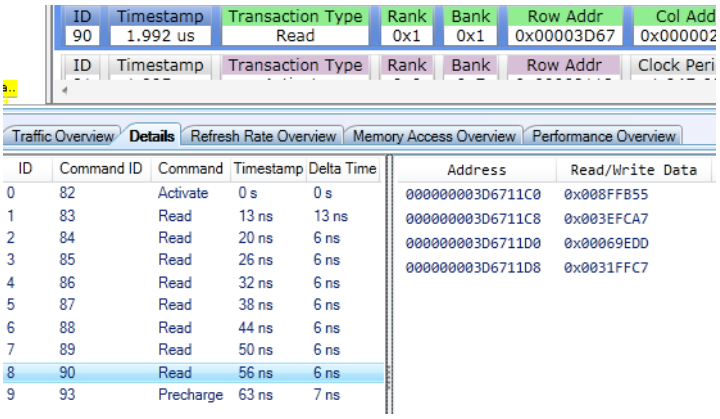
Field	Description
ID	Identifier assigned to a command in the command set to indicate the command's order in the sequential flow for the SDRAM operation.
Command ID	The identifier of the transaction in the upper pane to which the command maps to.
Command	The memory command in the sequential flow.
Timestamp	Displays the timestamp for the command relative to the timestamp of the first command in the set of commands shown in the Details tab. The first command's timestamp is taken as 0s in the command ste shown in the Details tab.
Delta Time	Displays the difference between the timestamp of the command and the previous command in the set of commands shown in the Details tab.

9 Viewing Details of a Read or a Write Transaction

For a Read or a Write Transaction, you can view the details (memory address and Read/Write Data) for the individual Read or Write commands comprising that transaction.

These details are displayed in the **Details** tab of the Memory Analysis window. On selecting a command, its details are displayed in the right pane of the Details tab.

The sample screen below displays the details of a memory Read transaction.



10 Analyzing Refresh Performance of an SDRAM

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Overview

The Refresh Rate Overview tab in the Memory Analysis window allows you to analyze the performance of refresh cycles and self-refresh operations of an SDRAM.

In this tab, the SDRAM's refresh statistics and graphs are generated from the captured trace. These graphs and statistics can help you assess if the SDRAM's refresh cycles and self-refresh operations meet the expected refresh requirements.

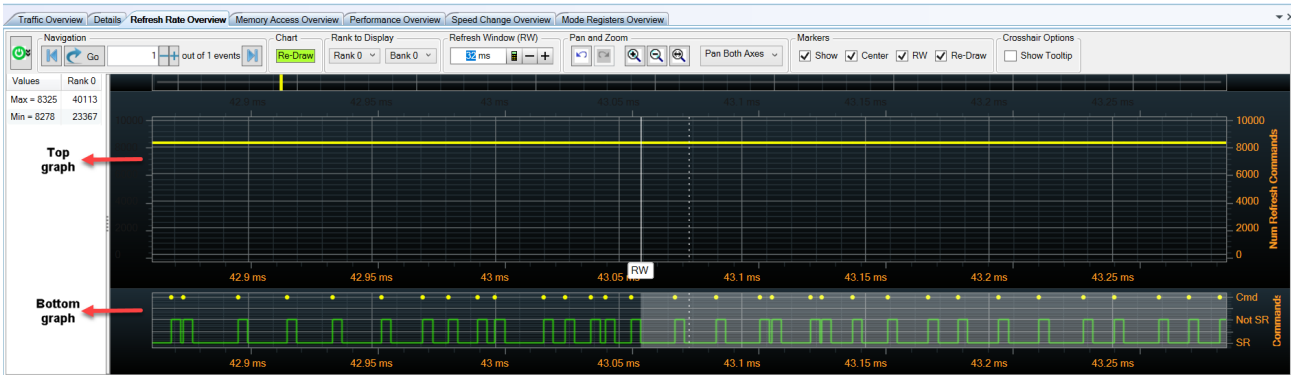
For the generation of graphs, you need to specify the width of the Refresh Window (RW) based on which sampling is done and refresh commands are plotted.

A Refresh (REF) command or an entry/exit from the self refresh mode in the captured trace is considered a Refresh event for these graphs. These commands and events are plotted in the applicable Refresh Window in the graphs.

For details, see "Understanding the Refresh Window Width" on page 59

Understanding and Interpreting the Refresh Graphs and Statistics

The sample screen below shows an SDRAM's refresh information displayed in the Refresh Rate Overview tab's left and right panes.



Refresh rate statistics in the left pane

The left pane displays the rank-wise Refresh commands for the sampled Refresh Windows. The statistics are displayed as:

Value	Description
Max	Shows the maximum number of Refresh commands found in a sampled Refresh Window of a rank. Also displays the number of sampled Refresh Windows that have this maximum number of Refresh commands.
Min	Shows the minimum number of Refresh commands found in a sampled Refresh Window of a rank. Also displays the number of sampled Refresh Windows that have this minimum number of Refresh commands.
You can also use the Refresh statistics to navigate to a specific Refresh Window of interest in the graphs.	

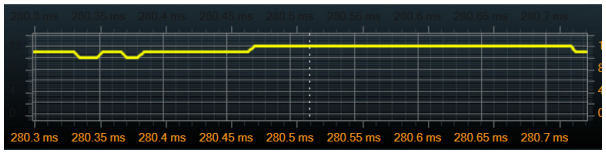
Refresh graphs in the right pane

The right pane displays the following two graphs for the selected rank.

Top Graph

The top graph shows the number of Refresh commands found in each sampled Refresh Window.

- The X-axis in the graph represents time and is used for plotting the time interval for a sampled Refresh Window.
- The Y-axis in the graph represents the total number of Refresh commands found in each sampled Refresh Window.

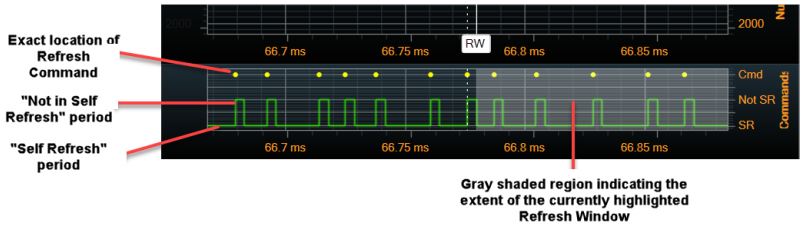


Bottom Graph

The bottom graph shows:

- the exact locations of Refresh commands found in the trace. These commands are represented by dots on the top of the graph. Notice that the yellow dots have been used in the sample graph below to represent the exact locations of Refresh commands.
- the Self Refresh entry and exit periods found in the trace. These periods are represented in the graph as low and high square waves respectively.
  - The low square wave represents the time period when the DUT was in Self Refresh (SR).
  - The high square wave represents the time period when the DUT was not in Self Refresh (Not SR).

  Notice that the green colored low and high square waves have been used in the sample graph below to represent the Self Refresh entry and exit periods.
- the extent of the Refresh Window that the RW marker is currently pointing to. This extent is represented by a gray shaded region.



See Also
"Analyzing Refresh Windows using the RW Marker" on page 60

NOTE At times, you may notice that some of the Refresh packets towards the end of the trace have not been considered while drawing the Refresh Rate top graph. This happens when towards the end of the trace, there is no longer enough time in the trace to plot a full refresh window out of it. As a result, the Top graph may end a little earlier than the Bottom graph that plots the exact locations of Refresh commands.

See Also
- Placing Markers in a Memory Analysis Chart (See page 101)
- Panning / Zooming a Memory Analysis Chart (See page 105)

Understanding the Refresh Window Width

Refresh commands are plotted in the applicable Refresh Windows in the graphs. These Refresh Windows are constructed using the default 32 ms or a user-specified time interval. This time interval includes only the time when the DUT was NOT in Self Refresh.

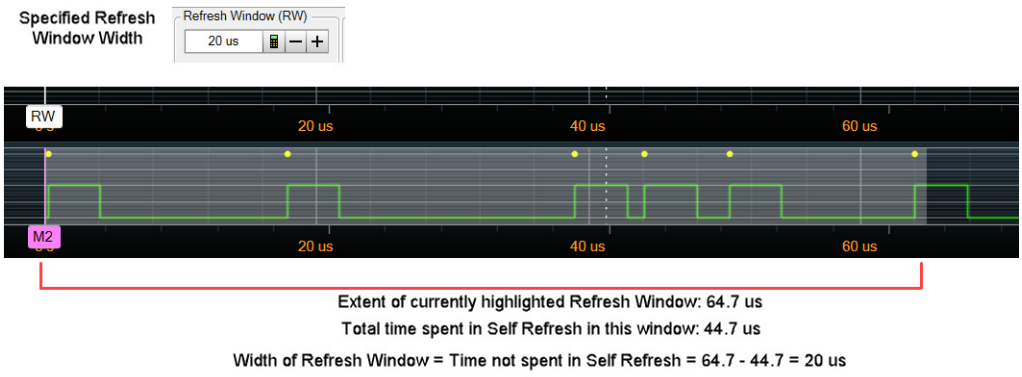
For instance, if you specify 42 ms as the Refresh Window width, then each Refresh Window will be constructed with 42 ms of time that was not spent in Self Refresh.

Why Refresh Windows are displayed with varying time spans/extents in the graph?

Though the same Refresh Window width that you specified is used to construct all windows, the time span/extent of these windows varies across the graph. This is because Self Refresh time periods are not considered for calculating the time duration of these windows.

When a Self Refresh period is found, the extent/span of the impacted Refresh Window is extended to exclude the Self Refresh period. And since Self Refresh periods vary across the trace, it results in Refresh Windows with the same time duration but varying time spans/extents in the graph.

The graphic below illustrates how Refresh Windows are displayed with different time spans but still have the same width that you specified.



To change the Refresh Window width

1 In the **Refresh Rate Overview** tab, click the  icon or the  icons displayed in the **Refresh Window (RW)** section to change the Refresh Window time interval.

2 Click the **Re-Draw** button to redraw the graphs as per the change.

Analyzing Refresh Windows using the RW Marker

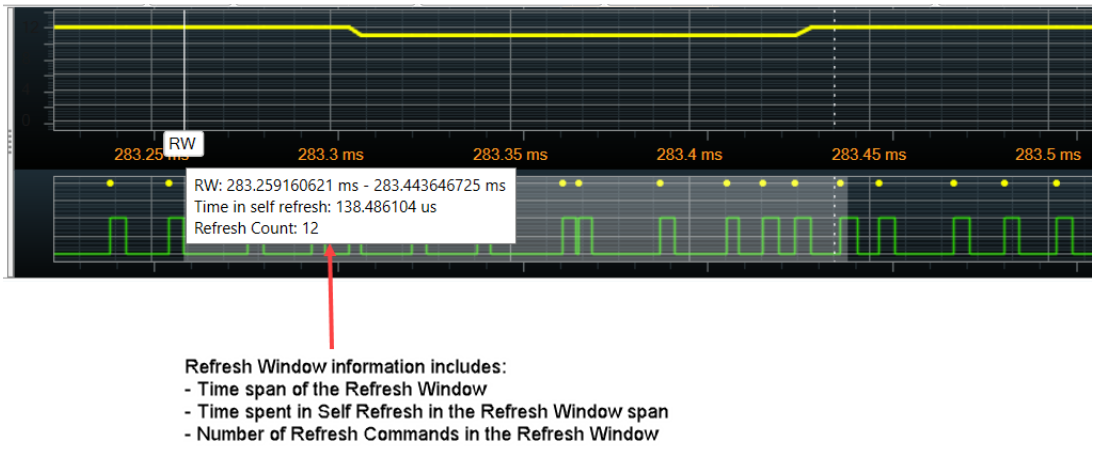
You can use the RW (Refresh Window) marker to highlight and quickly analyze a particular Refresh Window in the graph.

The RW marker marks the start of a Refresh window in the top graph and displays the extent of that Refresh Window as a shaded gray region in the bottom graph.

You can manually move this marker by dragging it to a new location in the graph. Moving the RW marker highlights the Refresh Window that begins at the location of the RW marker.

The RW marker always “snaps” to the start of a sampled Refresh Window in the graph.

You can hover the mouse on the RW marker label to get the statistics of the currently highlighted Refresh Window as shown below. Notice that the RW marker, extent of the Refresh Window, and window statistics are displayed in gray.



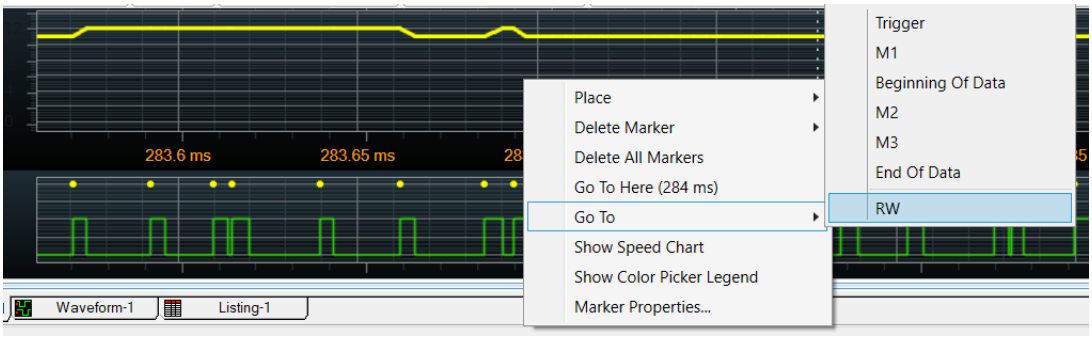
NOTE

When analyzing Refresh Windows using the RW marker, you may notice that the span of Refresh Windows vary across the graph. This is because the Self Refresh periods are not included when calculating the time duration of a Refresh Window.

If a Self Refresh period is found, it is ignored and the time after the Self Refresh ends is used to complete the width of the Refresh Window as per the specified Refresh Window time interval.

See “Understanding the Refresh Window Width" on page 59 to know more.

If the RW marker is not visible in the section of the graph currently displayed on screen, you can quickly go to the marker by right-clicking anywhere in the graph, clicking Go To and then selecting RW.



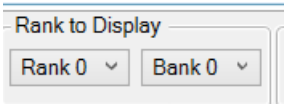
Changing the Rank/Bank for which Refresh Graphs are Displayed

The left pane of the Refresh Rate Overview tab displays the refresh statistics on a per rank basis. The statistics is displayed for all the memory ranks applicable for the captured trace.

The graphs displayed in the right pane are specific to the particular rank and bank that you currently selected in the tab.

To change the rank or bank for which graphs are to be displayed

1 In the Refresh Rate Overview tab, select the required rank and the bank (if applicable) from the Rank to Display listbox.



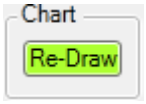
2 Click the **Re-Draw** button to draw the graphs for the changed rank/bank.

Redrawing Refresh Rate Graphs

You may need to re-draw the graphs in the Refresh Rate Overview tab so that these graphs reflect the current settings and selections that you made in the tab. For example, redrawing is needed when:

- you have changed the width of the Refresh Window.
- you have changed the rank/bank for which you want the graphs to be displayed.

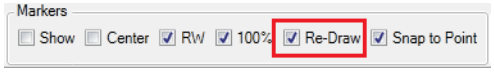
To redraw graphs, click the **Re-Draw** button in the Chart section of the tab.



Showing/Hiding the Re-Draw Indicator

Whenever there is a need for redrawing graphs, the software displays the **Re-Draw Needed** indicator at the top-left corner of the graphs.

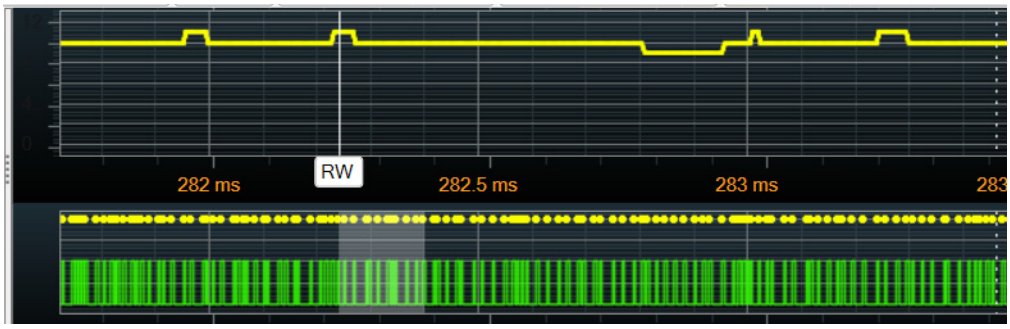
The indicator is displayed only if the **Re-Draw** checkbox is selected.



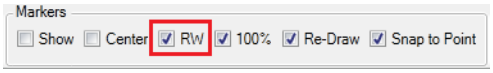
Customizing Refresh Rate Graphs

Showing/Hiding the RW Marker

The **RW** (Refresh Window) marker marks the start of a Refresh window in the top graph and displays the extent of that Refresh window as a shaded gray region in the bottom graph.



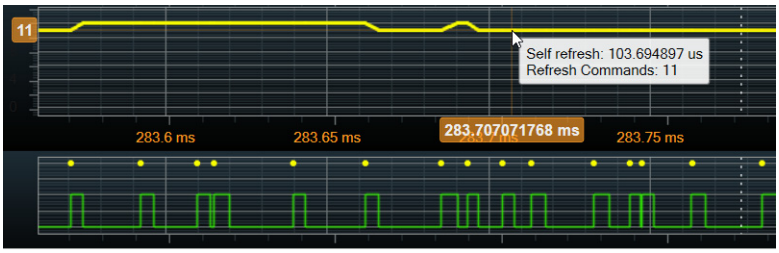
To show/hide this marker from the graphs, use the **RW** checkbox.



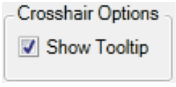
Showing/Hiding Tooltips

On hovering the mouse over the plotted data in the two graphs, tooltips are displayed for the plotted data on which the mouse pointer is currently placed. These tooltips provide the following information:

- The total time spent in Self Refresh in the Refresh Window. This total time may include multiple separate Self Refresh Enable periods and may include a partial period at the end of the Refresh Window.
- The number of Refresh commands found in the Refresh Window.



To show/hide the tooltips, click the Show Tooltip checkbox in the Crosshair Options section.



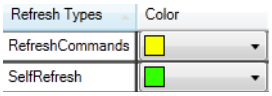
Changing the Colors Used in Graphs

In the top and bottom graphs, two colors are used. Both graphs show the Refresh commands with one color. The other color is used for self-refresh periods and self-refresh event locations in the bottom graph.

The Color Picker Legend displays the currently applied color coding for the graphs.

1 To display the Color Picker Legend, right-click anywhere in the plotted graphs area and select Show Color Picker Legend.

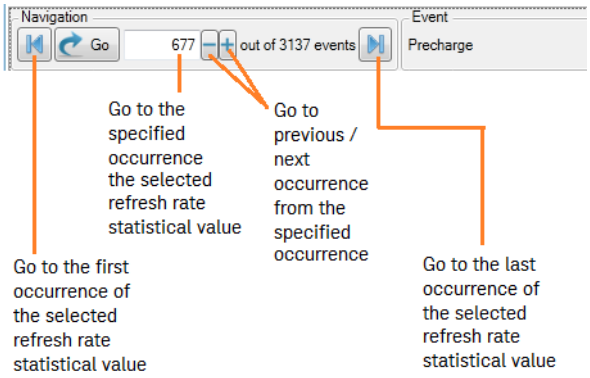
The currently used color coding for Refresh and Self-Refresh is displayed in the Color Picker Legend.



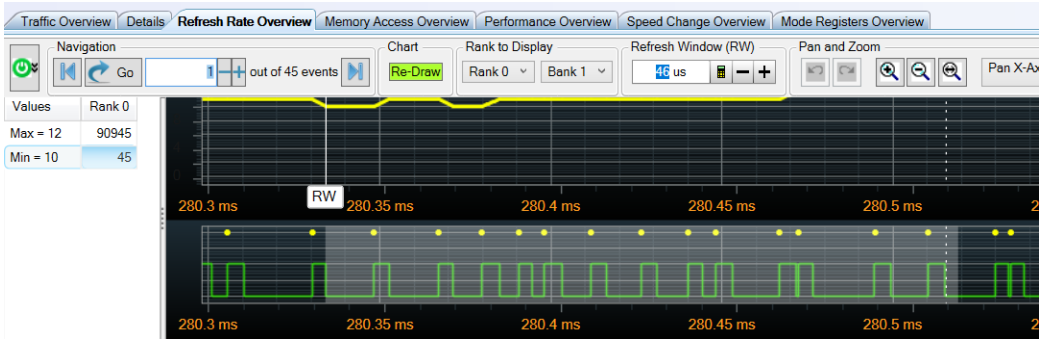
2 To change the color coding, click the **Color** drop-down and select the new color.

Navigating to a Specific Refresh Window in the Graph

You use the Navigation toolbar in the Refresh Rate Overview tab to navigate from a specific refresh rate statistical value to its applicable refresh window in the graphs on the right and its applicable memory transaction in the upper pane.



For instance, in the following screen, there are total 45 instances of Refresh Windows for Rank 0 that have the minimum Refresh commands. To navigate directly to the 1st instance of the Refresh Window with minimum Refresh commands, you can select the value displayed for Rank 0 in the Min row, then type 1 in the Navigation text box and click Go. This takes you directly to the location in the graph applicable for the 1st Refresh window having the minimum Refresh commands. Simultaneously, the Refresh command applicable for this window is also highlighted in the memory transactions listed in the upper pane.



Navigating Through a Graph

To navigate through a graph horizontally, that is X-axis, select the Pan X-axis option displayed at the top of the Refresh Rate Overview charts pane.

To navigate through a graph vertically, that is Y-axis, select the Pan Y-axis option displayed at the top of the Refresh Rate Overview charts pane.

You can then use the mouse to drag the graph's display horizontally/vertically.

11 Viewing Distribution of Read/Write Accesses Across Memory Locations

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Changing the Color Coding Scheme used for Plotting Memory Access Counts / 73
Changing the Number of Display Buckets used in the Chart / 74
Redrawing the Memory Access Graph / 75

Overview

The **Memory Access Overview** tab in the Memory Analysis window displays a chart depicting a graphical representation of memory accesses in either of the following two formats (as per your selection).

- The count of memory accesses (Read/Write commands) across memory cells of a selected rank.

  In this chart, a memory cell is represented as a combination of a row (within a bank) and a column. The Y-axis shows bank and row addresses and the X-axis shows column addresses. For a specific memory cell, its access count is based on the read/write commands found in the trace for that memory cell. The access count for memory cells is depicted in the chart using a defined color coding. The chart can help you analyze the general distribution of memory accesses across memory locations and can also pinpoint the locations experiencing maximum hits (Refer to Chart 1 below).

- The count of memory accesses (Read/Write commands) across rows of a selected rank over a period of time.

  This can give you a quick visibility to a row address that is being highly or most frequently accessed at a particular time and can also help you analyze the order in which row addresses were accessed over a period of time. The Y-axis shows bank and row addresses and the X-axis shows time. For a specific row, its access count is shown over a period of time based on the read/write commands found in the trace for that row. The access count for rows is depicted in the chart using a defined color coding (Refer to Chart 2 below).

NOTE

Depending on the X-Axis that you select for the chart, the data representation in the chart changes to either chart 1 or chart 2 shown below. Refer to the topic Changing the X-axis and Y-axis for the Memory Access Chart to know more (See page 72).

Also, you can place Markers in the chart only when you selected Time as the X-Axis of the chart. Markers can only represent Time and therefore when you select Col Addr as the X-axis, there are no Markers available in the chart.

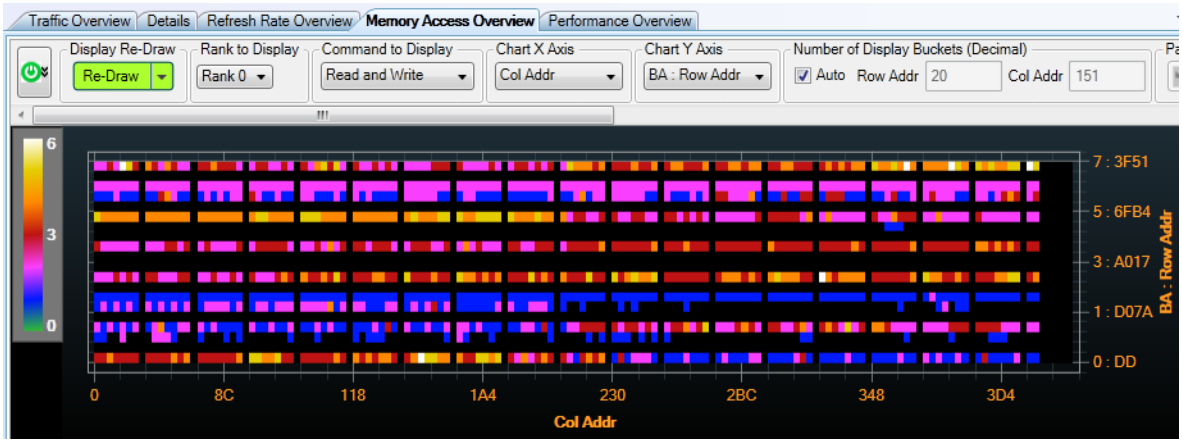


Figure 1 Chart 1 Showing the count of memory accesses across memory cells

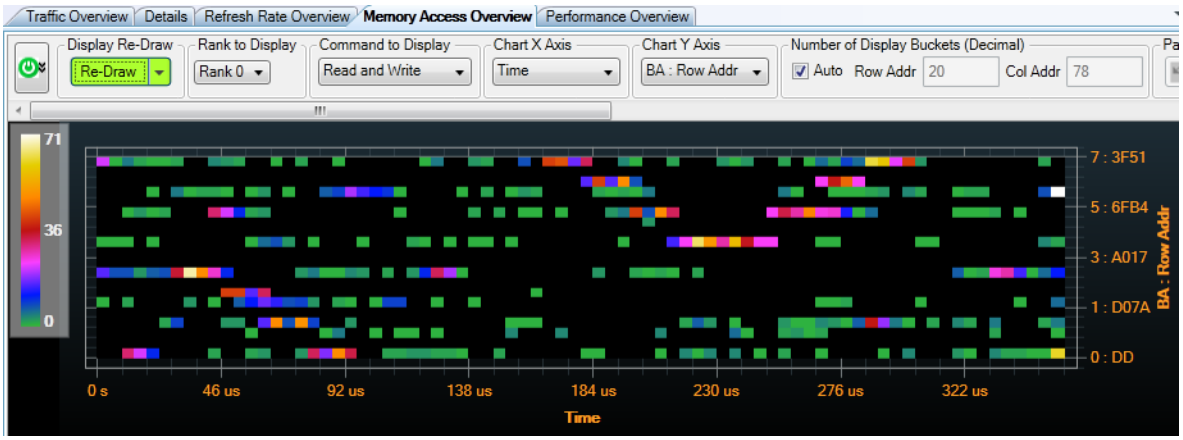
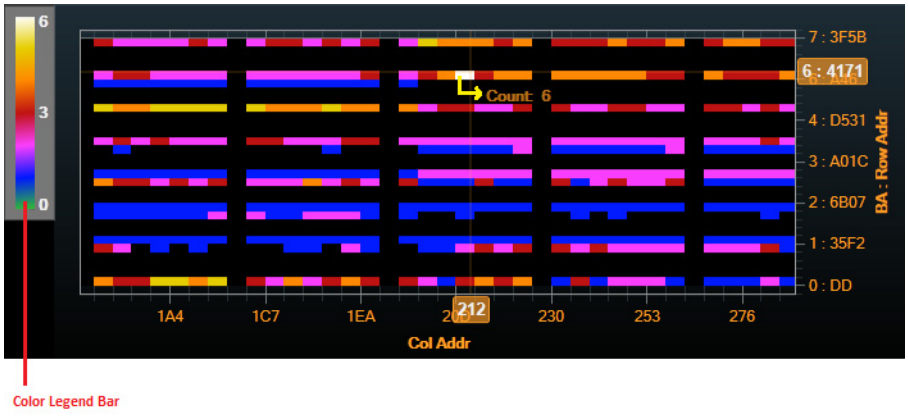


Figure 2 Chart 2 showing the count of memory accesses for rows over a period of time

NOTE Irrespective of the color coding theme that you select for memory access counts, the count of zero is always displayed using the black color.

Viewing the Access Count for a Particular Memory Cell

When you hover the mouse over a plotted memory cell, the row and column applicable for that plotted memory cell in the chart are displayed. If you have enabled the tooltips in the chart, then the count of memory accesses applicable for that memory cell is also displayed. In the following screen, the access count of 6 is shown for the memory cell at the 4171 row in bank 6 and 212 column combination. As per the color legend bar shown in the extreme left of the chart, the count 6 is represented using the White color.



NOTE Though color coding can give you a quick glance of the memory access patterns in the chart, you can also view the exact memory access count for any plotted location in the chart. For this, you can use the memory access count tooltips in the chart. To display these tooltips, select the **Show Tooltip** checkbox in the Memory Access Overview tab.

Viewing the Access Count for a Row at a Specific Time

When you hover the mouse over a plotted memory row, the row and time applicable for that plotted memory area in the chart are displayed. If you have enabled the tooltips in the chart, then the count of memory accesses applicable for that row/time combination is also displayed. In the following screen, the access count of 90 is shown for the 2285 row in bank 7 at 292 us time. As per the color legend bar shown in the extreme left of the chart, the count 90 is represented using the White color.

See Also

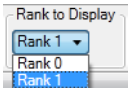
- Placing Markers in a Memory Analysis Chart (See page 101)
- Panning / Zooming a Memory Analysis Chart (See page 105)

Selecting the Rank and Command(s) for which Memory Access Chart is Displayed

To change rank

The chart in the Memory Access Overview tab shows memory accesses for a particular rank.

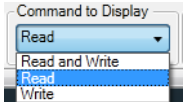
All the applicable memory ranks are displayed in the **Rank to Display** listbox. You can select a rank from this listbox and then click Re-Draw to draw the chart for the changed rank.



To change command

The chart in the Memory Access Overview tab shows memory accesses for Read, Write, or both Read and Write commands.

You can select the command(s) for which you want to plot memory accesses in the chart using the **Command to Display** listbox and then click Re-Draw to draw the chart for the changed command(s).



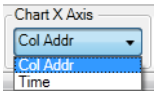
Changing the X-axis and Y-axis for the Memory Access Chart

To change X-axis

By default, the memory access chart has Column address as X-axis and Row Address as Y-axis. This is useful in viewing the count of memory accesses across memory cells.

If, however, you want to view the count of memory accesses for rows over a period of time, then you need to change the X-axis of the chart to Time.

To change the X- axis, use the **Chart X Axis** listbox in the Memory Access Overview tab and then redraw the chart.

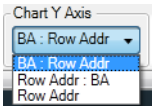


To view how the chart varies on changing the X-axis, refer to Viewing the Distribution of Read/Write Accesses Across Memory Locations (See page 67).

To change Y-axis

The Y-axis always displays row addresses. You can however, change the format in which you want the row addresses to be displayed in the Y-axis.

You choose one of the following three row address formats for Y-axis from the **Chart Y-axis** listbox and then redraw the chart to reflect the change.



- **BA: Row Addr**: Bank number followed by row address
- **Row Addr: BA**: Row address followed by bank address
- **Row Addr**: No bank address is displayed in this option.

Changing the Color Coding Scheme used for Plotting Memory Access Counts

There are three color coding themes available in the Memory Access Overview tab that you can select to represent different memory access counts with different colors.

- **Classic** - The standard color palette is used for the memory access counts.
- **Temperature** - Memory accesses are color-coded on a color scale from cold to hot (blue to red) for lower memory access counts to higher memory access counts.
- **Blue/Red** - Memory accesses are color-coded only in shades of blue and red for lower memory access counts to higher memory access counts.

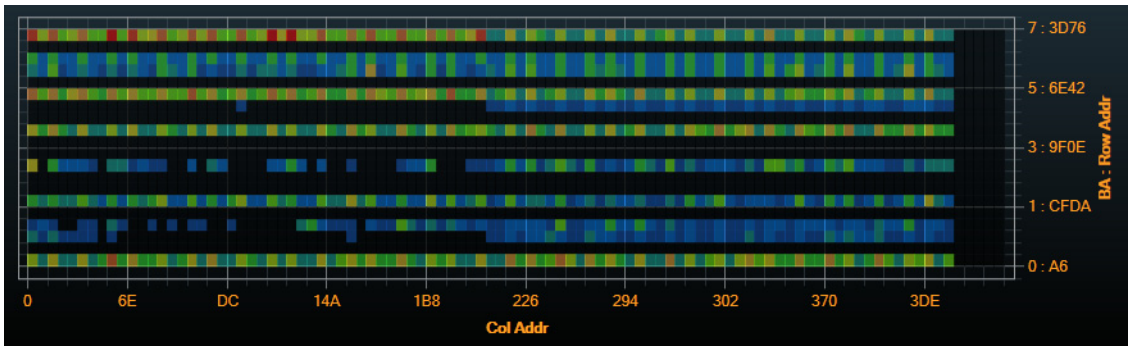
For each of the above-mentioned color coding themes, you can select one of the following color distribution patterns.

- **Linear** - Uses a uniform gradient of colors across the entire range of memory access counts.
- **Logarithmic** - Uses a more elaborate gradient of colors for lower memory access counts.
- **Exponential** - Uses a more elaborate gradient of colors for higher memory access counts.

NOTE Irrespective of the color coding theme that you select for memory access counts, the count of zero is always displayed using the black color.

Viewing the Grid Lines on the Plotted Chart Area

When you want to view the grid lines on the plotted chart area, you can select the **Transparent** checkbox displayed in the **Color Options** section and then re-draw the chart for the grid lines to be visible.



Changing the Number of Display Buckets used in the Chart

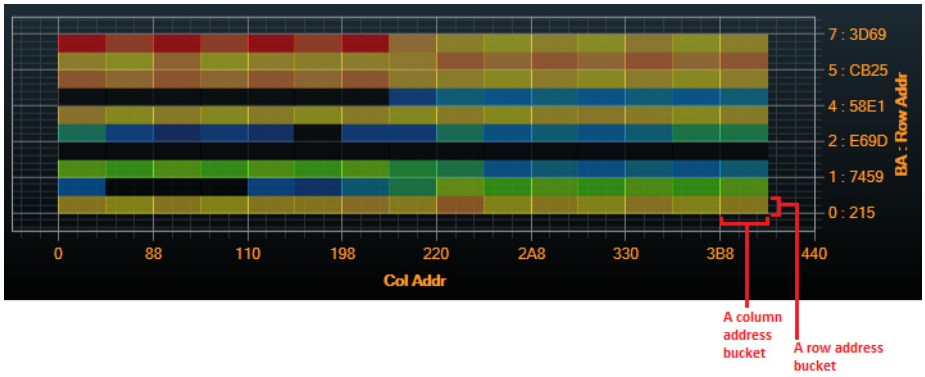
You can customize the number of Row and Column address buckets that should be used in the chart for plotting memory accesses.

The number of Row and Column addresses available in the captured trace may surpass the number of pixels available in the chart for plotting. In such situations, you can define the number of horizontal and vertical buckets to be used in the chart to accommodate plotting for all the applicable row and column addresses.

While creating the chart, all the available row and column addresses to be plotted are spread/contained in the specified number of buckets. For example, if you specify 12 buckets to be used for Row addresses, then the data for all the available row addresses in the trace is organized into 12 equal row address buckets in the chart.

The larger the number of buckets you specify to be used in the chart, the fewer will be the addresses contained in each bucket thereby yielding more granularity but making the plotted data scarce.

The following screen illustrates an example of 10 row address buckets and 15 column address buckets used in the chart.



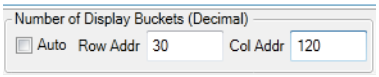
Automatically Determining the Number of Display Buckets to be used in the Chart

You can select the **Auto** checkbox displayed in the **Number of Display Buckets** section to allow the software to automatically determine the number of row and column address buckets to be used in the chart. When the Auto option is selected, 10 pixels are used for each row and column bucket in the chart.

When the chart is drawn based on the Auto option, the number of display buckets calculated and used in the chart are displayed in the Number of Display Buckets section.

Manually Specifying the Number of Display Buckets to be used in the Chart

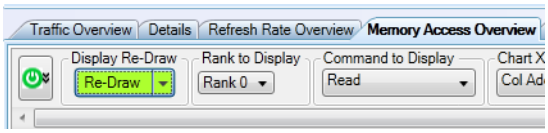
When you deselect the **Auto** checkbox in the **Number of Display Buckets** section, the textboxes for specifying the Row and column address buckets are enabled for editing. You can specify the number of buckets in these textboxes and redraw the chart to reflect the changes.



Redrawing the Memory Access Graph

Once the graph has been generated in the Memory Access Overview tab, you may need to re-draw the graph so that it reflects the current settings and selections that you made in the tab. For instance, changing the rank, x-axis, y-axis, color legend option, or the commands to be displayed in the graph requires you to redraw the graph.

To redraw graphs, click the **Re-Draw** button at the top of the tab.



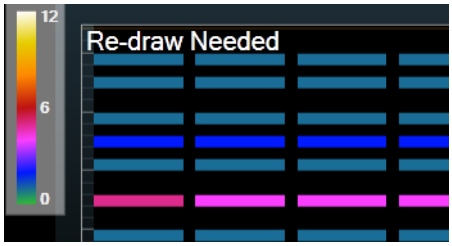
The drop-down displayed with this button provides you two options to redraw:

- **Redraw Current Range** - Redraw Current Range redraws the range of data that is currently displayed. This is particularly useful when, for example, you have selected “Zoom Both Axes” and then zoomed a selected rectangular area of the chart. This makes the buckets bigger. If you then select “Redraw Current Range” it redraws only the range that you zoomed in using the number of currently selected display buckets. This gives you a more detailed, or finer granularity view of the range you zoomed.
- **Redraw Full Range** - Redraw Full Range redraws using the full range of addresses that occur in the trace or the range of the trace that you selected for computing memory data.

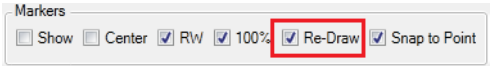
  The “Undo Zoom” and “Redo Zoom” buttons apply only to changes since the last Redraw. You cannot “Undo Zoom” to what you had before the last Redraw.

Showing/Hiding the Re-Draw Indicator

Whenever there is a need for redrawing graphs, the software displays the **Re-Draw Needed** indicator at the top-left corner of the graphs.



The indicator is displayed only if the **Re-Draw** checkbox is selected.



12 Analyzing Memory Performance Measurements

Memory Performance Measurements Definitions / 79
Viewing Instantaneous and Total Data Rates in Memory Performance Charts / 80
Changing the Sampling Rate for the Memory Performance Chart / 82
Displaying or Hiding Chart Series for a Memory Performance Measurement / 83
Changing the Color Coding for a Memory Performance Chart / 84

You can use the **Performance Overview** tab in the Memory Analysis window to view and analyze the SDRAM's performance in terms of data transfer rates and percentage of memory utilization over time.

In this tab, various performance measurements are generated from the decoded memory transactions in the upper pane of the Memory Analysis window. Each of these measurements are presented:

- as an overall effective value for a period of time (in the left pane).
- as a chart series showing sampled values for the measurement over the period of time (in the right pane).

To generate these measurements, the captured memory data is sampled as per the specified sampling rate. Statistics is then computed from these samples and the computed measurement for each sample is plotted in the chart series created for that measurement.

By default, a chart series is displayed for each measurement and color coded as per the color selected for that measurement.

If required, you can hide a particular measurement's chart series.

In the following screen, notice the chart types used for graphically presentation of different performance measurements in the Charts pane.

See Also
- Placing Markers in a Memory Analysis Chart (See page 101)
- Panning / Zooming a Memory Analysis Chart (See page 105)

Memory Performance Measurements Definitions

The following table lists the performance measurements available in the **Performance Overview** tab of the Memory Analysis window.

Performance Measurement	Definition	Calculated as...
Total Data Rate	Shows the overall data transfer rate applicable for all the read and write commands in the decoded transactions displayed in the upper pane of the Memory Analysis window.	(Number of Read commands found in trace + Number of Write commands found in trace) * Memory Width (in bytes) times Burst Length / Time between the Timestamp of the first command to the Timestamp of the last command in the decoded transactions This can be represented as: (R + W) * D / T
Read Data Rate	Shows the data transfer rate applicable for all the read commands in the decoded transactions displayed in the upper pane of the Memory Analysis window.	(Number of Read commands found in trace) * Memory Width (in bytes) times Burst Length / Time between the Timestamp of the first command in Transactions to the Timestamp of the last command in the decoded transactions This can be represented as: R * D / T
Read Inst. Data Rate	Shows the instantaneous data transfer rate applicable for a particular read command in the decoded transactions displayed in the upper pane of the Memory Analysis window. For this data rate, the time between the Timestamp of the current instance of the Read command to the Timestamp of the next instance of Read command in the transactions is used. As this measurement aims at the data transfer rate for a specific instance of a read command, an overall effective data rate is not applicable for it. The left pane therefore, does not display any value for this measurement but you can check the instantaneous data rate for each instance of read command in the applicable chart series on the right.	Memory Width (in bytes) times Burst Length / Time between the Timestamp of the current Read command to the Timestamp of the next Read or Write command in the transactions This can be represented as: D / I
Write Data Rate	Shows the data transfer rate applicable for all the write commands in the decoded transactions displayed in the upper pane.	(Number of Write commands found in trace) * Memory Width (in bytes) times Burst Length / Time from the Timestamp of the first command in Transactions to the Timestamp of the last command in the decoded transactions This can be represented as: W * D / T
Write Inst. Data Rate	Shows the instantaneous data transfer rate applicable for a particular write command in the decoded transactions displayed in the upper pane of the Memory Analysis window. For this data rate, the time between the Timestamp of the current instance of the Write command to the Timestamp of the next instance of Write command in the transactions is used. As this measurement aims at the data transfer rate for a specific instance of a write command, an overall effective data rate is not applicable for it. The left pane therefore, does not display any value for this measurement but you can check the instantaneous data rate for each instance of write command in the applicable chart series on the right.	Memory Width (in bytes) times Burst Length / Time between the Timestamp of the current Write command to the Timestamp of the next Read or Write command in the transactions This can be represented as: D / I
Utilization @ <Max clock frequency> (%)	The percentage of memory utilization in read and write commands over the time duration applicable for the decoded transactions. The memory utilization is calculated based on the Clock period. Clock Period is either the maximum clock frequency found in the trace or a clock frequency manually specified by you in the **Maximum Clock Frequency** field at the top of the tab. You should specify a maximum clock frequency value manually if the maximum value is not detected from the trace.	(((Number of Read commands found in trace + Number of Write commands found in trace) * Memory Width (in bytes) times Burst Length) / ((Time between the Timestamp of the first command to the Timestamp of the last command in the decoded transactions / Clock period) * Memory Width in bytes) *100 This can be represented as: ((R + W) * D) / (T / C * M) * 100 (%)

Viewing Instantaneous and Total Data Rates in Memory Performance Charts

For Total Data Rate, Read Data Rate, and Write Data Rate

These are plotted as sampled chart series. Hovering the mouse on a sampled point in the chart highlights the exact time and the data rate (in MBytes/sec) applicable for that sampled point in chart.

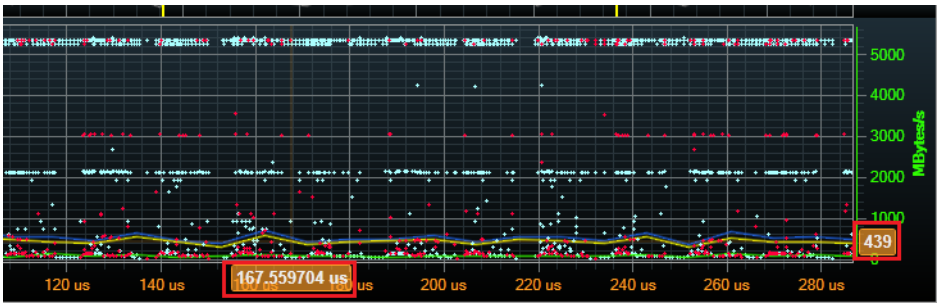


Figure 3 Read Data Rate at a point in time

For Read or Write Instantaneous Data Rates

These are plotted as scatter charts. As these measurements aim at the data transfer rate for a specific instance of read/write command, an overall effective data rate is not applicable for these. The left pane therefore, does not display any value for these measurements. Hovering the mouse on a point in the scatter chart highlights the exact time and instantaneous data rate for that particular instance of read/write command.

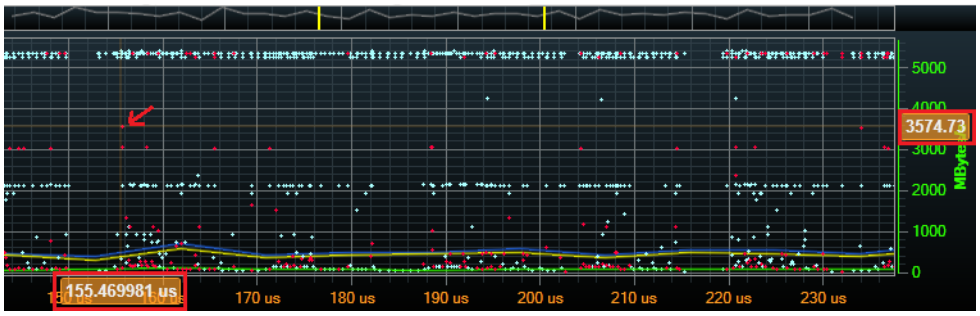


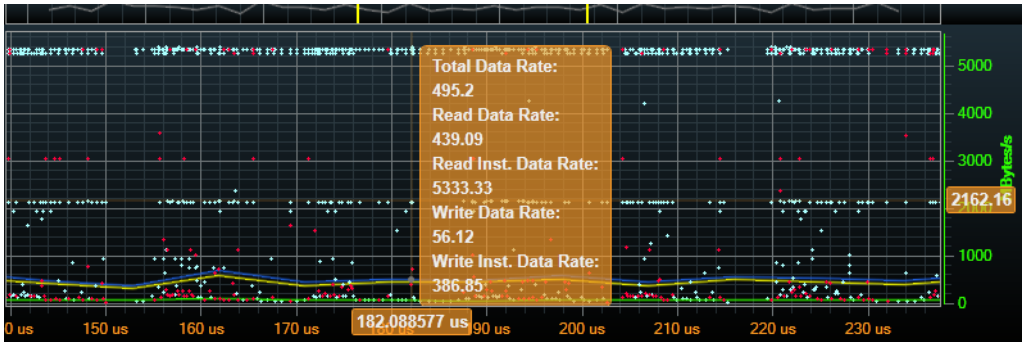
Figure 4 Instantaneous Write Data Rate for an instance of a Write command

Displaying Tooltips in Charts

If you want to view the complete set of data rate measurement values applicable for a particular plotted point in a chart, you can enable the display of tooltips using the **Show Tooltip** checkbox on top of the charts pane.

The data for only those measurements are displayed in tooltips for which charts are displayed.

Notice that all the data rates applicable at the highlighted plotted point in the chart are included in the tooltip.



Changing the Sampling Rate for the Memory Performance Chart

The decoded memory transactions are sampled on the basis of the set sample rate to create memory performance chart series in the Performance Overview tab of the Memory analysis window. Each sample that is computed from the trace is plotted on the chart of that performance measurement.

NOTE **Though sampling is done for all performance measurements, the instantaneous measurements are an exception to sampling. The Read Inst. Data Rate and Write Inst. Data Rate measurements are not sampled. Rather these are computed and plotted as scatter charts for each and every instance of Read and Write commands found in the decoded transactions.**

By default, the sample rate is set to 10 us. You can change this sample rate and can re-sample the trace as per the changed sample rate.

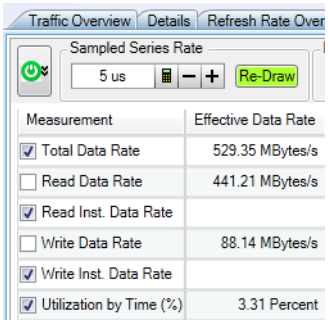
- To change the sample rate for a memory performance chart
  a Access the **Performance Overview** tab.
  b Click the  button displayed in the **Sampled Series Rate** section on the top of the tab.
  c In the **Time** dialog box, specify the value and unit for the sample rate. The permissible range for sample rate is 1 us to 100 ms.
  d Click **OK**.
- To regenerate the chart based on the new sample rate, click the **Re-Draw** button displayed with the **Sampled Series Rate** field at the top of the tab.

Displaying or Hiding Chart Series for a Memory Performance Measurement

By default, a chart is displayed for each performance measurement in the Performance Overview tab of the Memory Analysis window.

In situations, when you want to focus only on specific measurement(s), you can hide the chart series for the other measurements which are currently not of interest.

To hide the chart series of a performance measurement, deselect the checkbox displayed with that measurement in the left pane.



To display the chart series again, select the checkbox for that measurement.

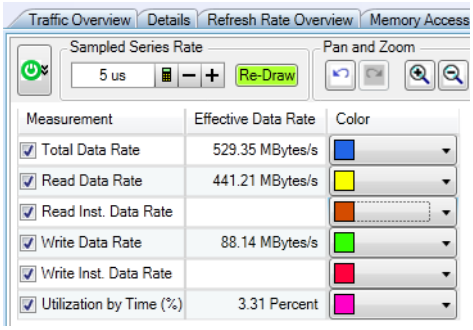
NOTE

You may hide the percent chart area displayed for the Utilization @ <Max clock frequency> % measurement by right-clicking anywhere in the Charts pane and selecting **Hide Percent Chart**.

If the Percent Chart area is hidden, then selecting or deselecting the checkbox displayed with the Utilization @ <Max clock frequency> % measurement does not display or hide its percent chart.

Changing the Color Coding for a Memory Performance Chart

For each performance measurement, the currently assigned color for its charting is displayed in the **Color** listbox. You can change this color and select a new color from the listbox. The color used for its charting is instantly changed as per your new color selection.



13 Analyzing Clock Speed Changes for an SDRAM

Navigating to an Entry Point or a Transition Point for a Specific Clock Frequency / 87

You can analyze the clock speed changes for an SDRAM using the **Speed Change Overview** tab in the Memory Analysis window.

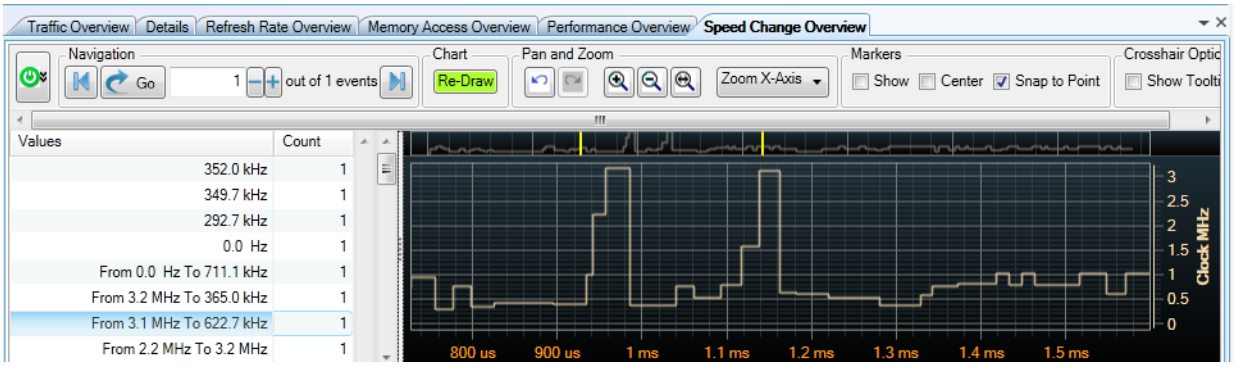
In this tab, the statistics for SDRAM's clock frequencies and frequency changes are detected from the captured trace and displayed as a chart over a period of time.

NOTE

If you have used Store Qualifiers or Filters for the captured data, then all states may not be available in the trace. This may impact the correct calculation of clock frequency and frequency changes in the Speed Change Overview tab.

Also, the Clock Speed Change chart is useful only when you have selected the **Clock Frequency from Trace** checkbox in the Configure DDR Properties dialog box and if there are frequency changes in the trace. In the absence of these two, the Clock Speed Change chart will only be a straight line indicating the same frequency.

The sample screen below shows an SDRAM's clock speed changes over a period of time.



Left Pane

The left pane in the Speed Change Overview tab displays:

- the values for the clock frequencies found in the captured data.
- the transitions from one clock frequency to another found in the captured data.

For each of these clock frequency values and clock frequency transitions, the number of occurrences found in the trace are displayed under the **Count** column in the left pane.

Right Pane

The right pane in the Speed Change Overview tab displays a chart of entry points to various clock frequencies found in the trace as well as transitions from one clock frequency to another over a period time.

Navigating to an Entry Point or a Transition Point for a Specific Clock Frequency

From a clock frequency value displayed in the left pane, you can navigate quickly to an occurrence in the chart for the entry / transition into that clock frequency value. You use the Navigation bar to accomplish this.

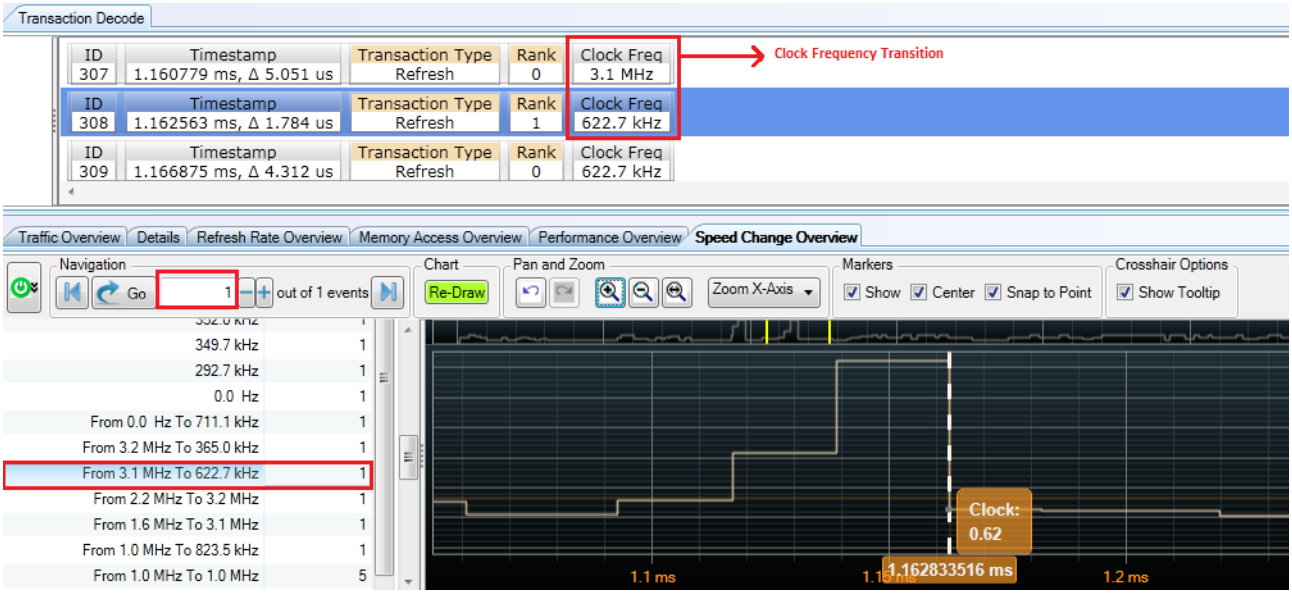
1 Click the clock frequency value or a clock frequency transition from the list in the left pane to which you want to navigate.

2 In the Navigation bar, type the occurrence number for the clock frequency value / transition to which you want to navigate.

3 Click **Go**.

The location in the chart applicable for the specified occurrence of the selected clock frequency / transition is shown in the center of the chart. If you have selected the Center marker, then this exact location is marked using the Center marker making it easy for you to locate it.

Simultaneously, the memory command applicable for this clock frequency entry point / clock frequency transition is also highlighted in the memory transactions listed in the upper pane.



See Also
- Placing Markers in a Memory Analysis Chart (See page 101)
- Panning / Zooming a Memory Analysis Chart (See page 105)

14 Analyzing Mode Registers Values

Overview / 90
Filtering Mode Register Commands / 92
Displaying Mode Registers Values at Currently Selected Transaction / 93
Comparing Mode Registers Values / 95
Navigating to a Specific Mode Register Access Transaction / 98
Exporting Mode Registers Overview Data / 99

Overview

The **Mode Registers Overview** tab of the DDR/LPDDR Memory Analysis window displays the following data for mode registers:

- The left pane provides an overview of which mode registers were accessed and a count of how many times these were accessed in the trace. For a multi-rank SDRAM, these counts are displayed for mode registers of each rank. Using these counts, you can also quickly navigate to a specific mode register access in the trace.
- The right pane displays one of the following values based on your selected display option.
  - either a snapshot of the SDRAM's mode registers settings in effect at the time of the currently selected transaction in the trace.
  - or a comparison of the state of mode registers at the currently selected transaction in the trace with those at a marker or at a prior transaction in the trace.

NOTE The right pane displays mode register values for only those registers for which accesses were found prior to the transaction that has been selected for display/comparison of mode register values.

The sample screen below displays mode registers access overview on the left and the mode registers settings in effect at the currently selected transaction in the upper pane.

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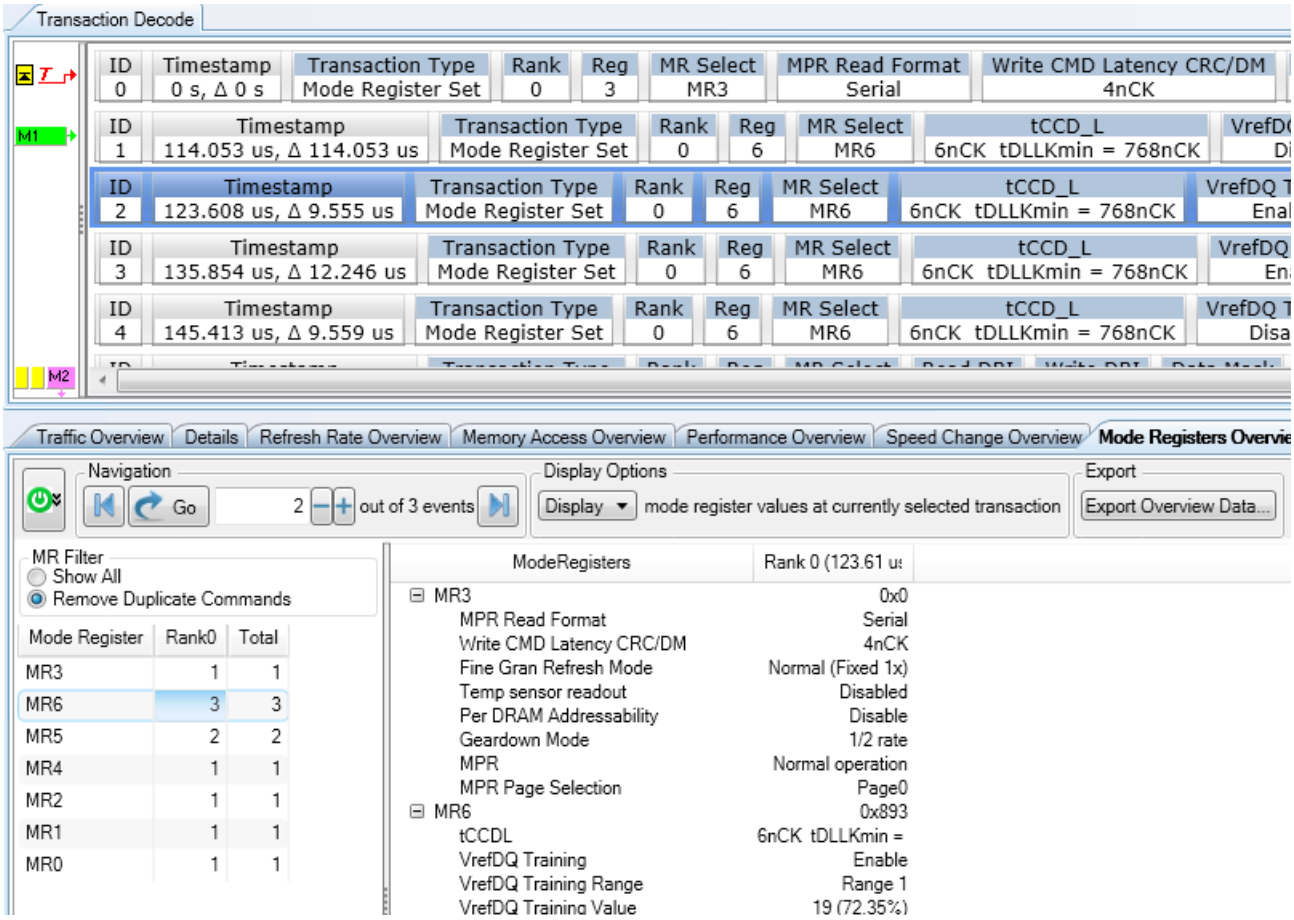


The data displayed in this tab can help you get an insight into the state of the various operating parameters of the SDRAM that have been configured using various mode registers accesses. The comparison of the mode registers values can help you understand and debug the SDRAM's behavior due to mode register value changes.

The following memory commands that are issued to set or modify mode registers of an SDRAM are included in the data displayed in the Mode Registers Overview tab:

- Mode Register Set command
- Mode Register Write command
- Mode Register Read command

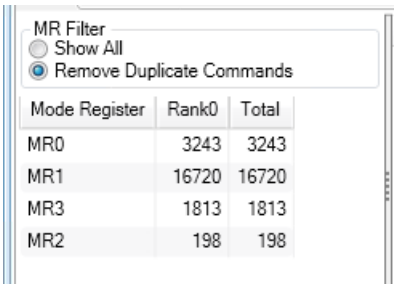
The subsequent topics in this chapter describe the usage of the Mode Register Overview tab in detail.

Filtering Mode Register Commands

At times, a Mode Register command with the same set of values is issued repeatedly for a register resulting in duplicate MR commands in the captured data.

You can eliminate these duplicate Mode Register commands from the count of commands shown in the left pane of the Mode Register Overview tab by enabling the filtering option.

To enable filtering, select the **Remove Duplicate Commands** option from the **MR Filter** section in the left pane.



Clicking the **Show All** option disables the filtering and includes duplicate commands in the counts displayed in the left pane.

Filtering does not filter or delete duplicate commands from the transaction decode displayed in the upper pane of the DDR/LPDDR Memory Analysis window.

Displaying Mode Registers Values at Currently Selected Transaction

1 Select the transaction of interest from the computed transactions displayed in the upper pane of the Memory Analysis window.

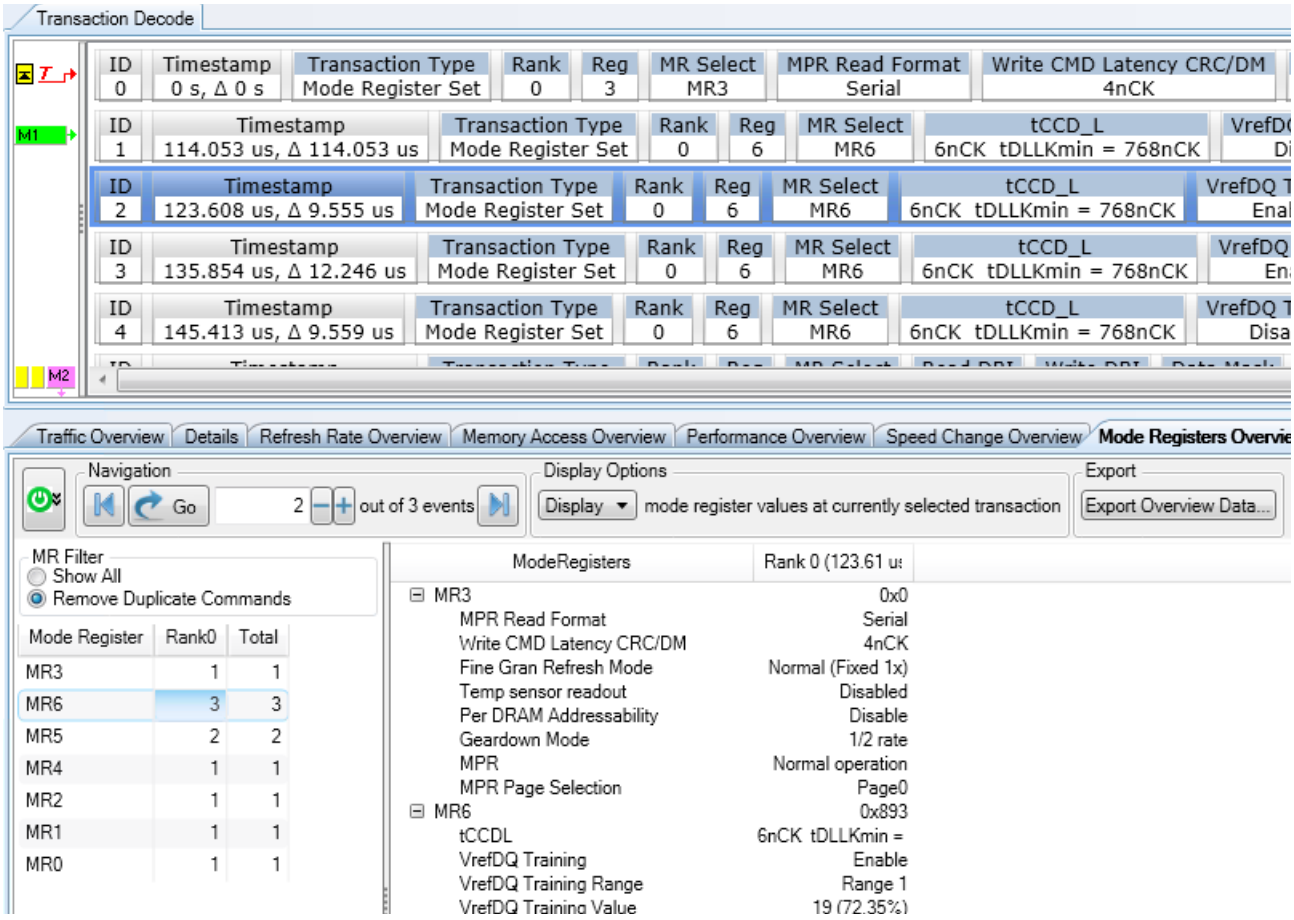
2 Click the **Mode Registers Overview** tab.

3 From the **Display Options** section of this tab, select **Display**.

The mode registers values effective at the time of the currently selected transaction are displayed in the right pane of the tab.

NOTE

The values for only those mode registers are displayed for which access transactions prior to the currently selected transaction exist in the trace. Therefore, if the trace contains no mode register accesses prior to the currently selected transaction, then no mode registers values will be displayed. Similarly, if there are no mode register accesses throughout the trace, then no values are displayed in this tab regardless of which transaction is selected in the upper pane.

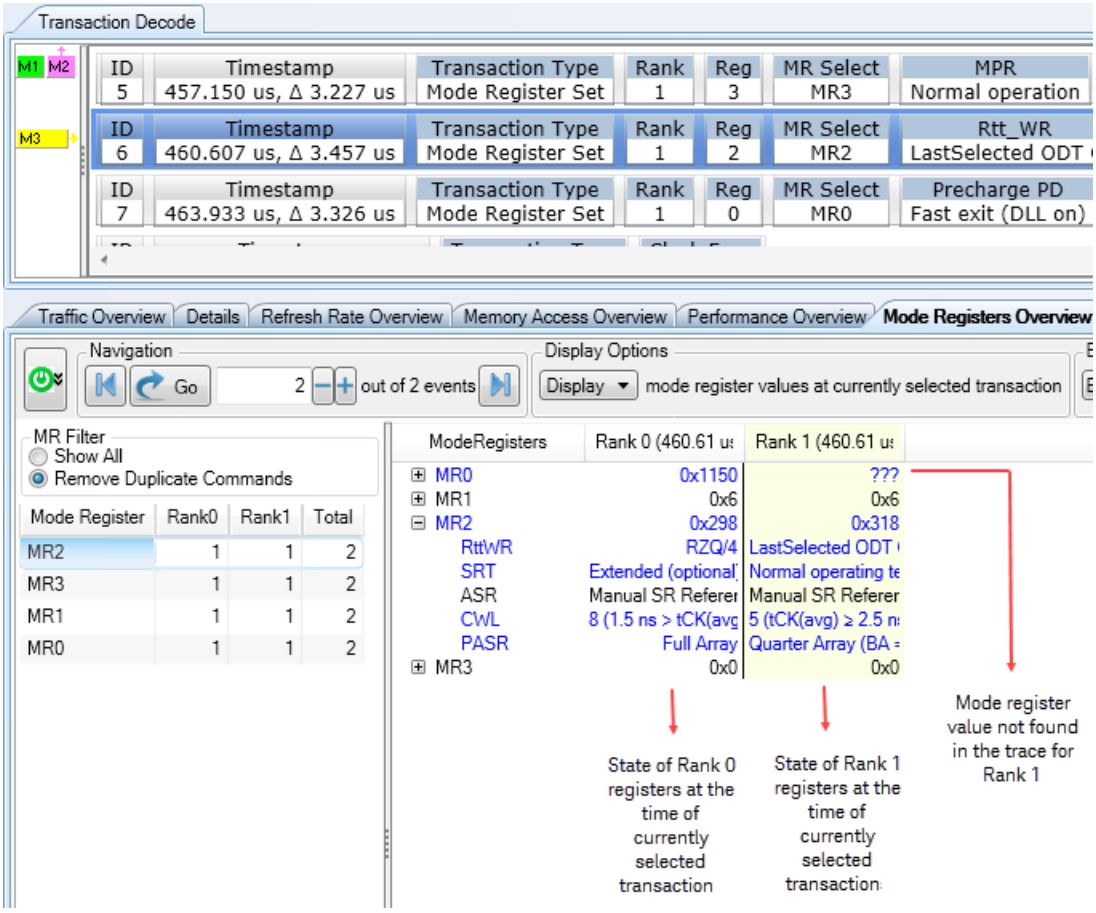


For a Multi-rank SDRAM

If you have multi-rank data, then the mode registers values effective for each rank at the time of the currently selected transaction are displayed in the right pane of the tab.

The differences in mode register settings across ranks are shown with blue text.

NOTE If the relevant mode registers data (at the time of currently selected transaction in the trace) is available for one rank but unavailable for other rank(s), then "???" is shown for the unavailable mode register values of rank(s).



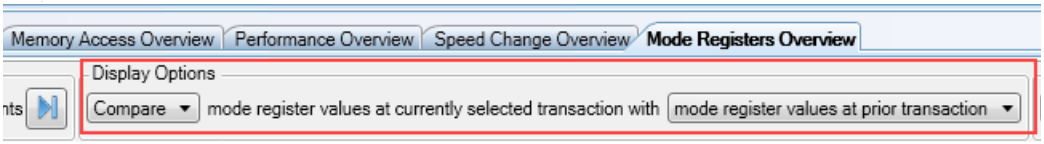
Comparing Mode Registers Values

You can compare mode register values at two different points in time in the trace (currently selected transaction with immediate previous transaction or currently selected transaction with a marker location).

1 Select the transaction of interest from the computed transactions displayed in the upper pane of the Memory Analysis window. This transaction is considered the current transaction for the comparison of mode register values.

2 Click the **Mode Registers Overview** tab.

3 From the **Display Options** section of this tab, select **Compare**.



4 Choose from the following two compare options available in the second listbox in the Display Options section.

- **mode register values at prior transaction** – On selecting this option, the following two sets of mode registers values are compared and displayed with differences highlighted in blue:
  - The values of mode registers effective at the time of the transaction currently selected in the upper pane.
  - The values of mode registers effective at the time of the transaction immediately previous to the currently selected transaction in the upper pane.
- **mode register values at marker** – On selecting this option, the following two sets of mode registers values are compared and displayed with differences highlighted in blue:
  - The values of mode registers effective at the time of the transaction currently selected in the upper pane.
  - The values of mode registers effective at the time of the marker location that you selected from the last listbox in the Display Options section of the tab.

The sets of mode register values being compared are arranged in the order of their timestamps of occurrence. The set of values with an earlier timestamp is displayed before the set with a later timestamp. This is applicable irrespective of the selected compare option.

"???" Displayed in the Compared Mode Registers Data

The compared mode register data displayed in the right pane contains values for only those mode registers for which accesses were available in the trace prior to the transactions being used for comparison. If the data for a mode register is available only for one of the two transactions being used for comparison. then "???" is shown for the unavailable mode registers values.

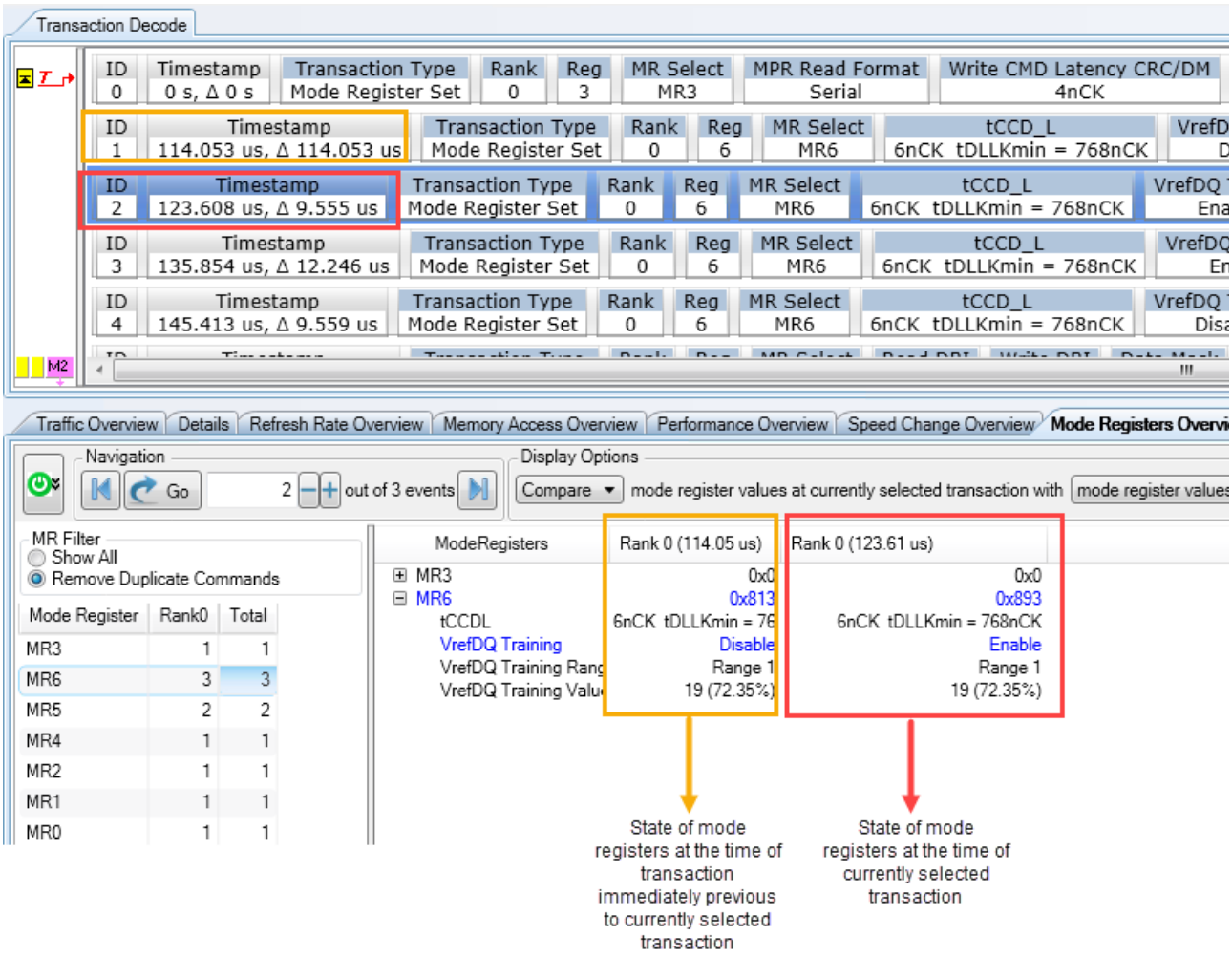
Similarly, when comparing mode registers values for multiple ranks at two different points in time in the trace, "???" is shown for the mode register values that are unavailable for a rank.

Mode Registers	Rank[0]Time(-34.470 us)	Rank[0]Time(-34.457 us)
⊞ MR0	0x5240	0x5240
⊞ MR1	???	0x5300
⊟ MR3	???	0x5340
MPR	???	Normal operation
MPR Loc	???	Predefined pattern

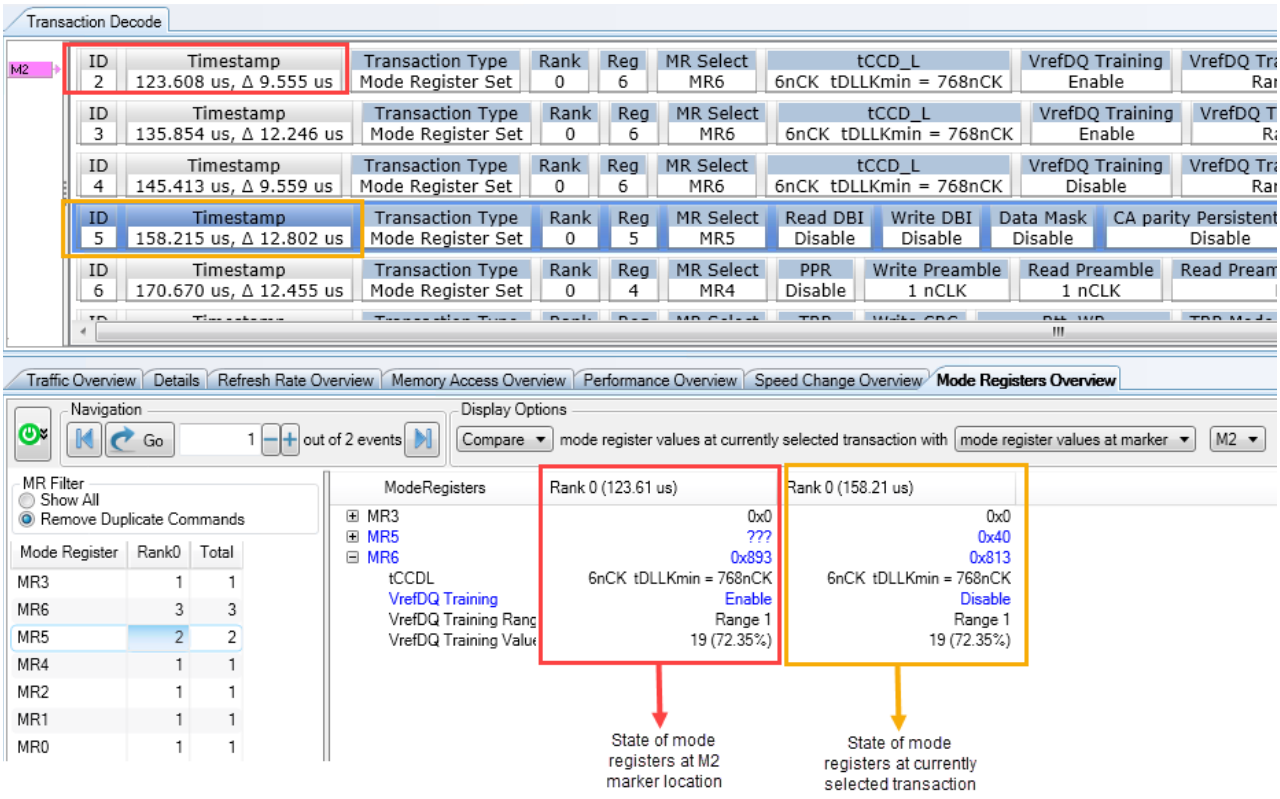
Examples - Mode Registers Values Comparison

The following are some examples of the mode registers comparison data on selecting different compare options.

Comparing Mode Registers Values at Current Transaction with Prior Transaction



Comparing Mode Registers Values at Current Transaction with a Marker Location



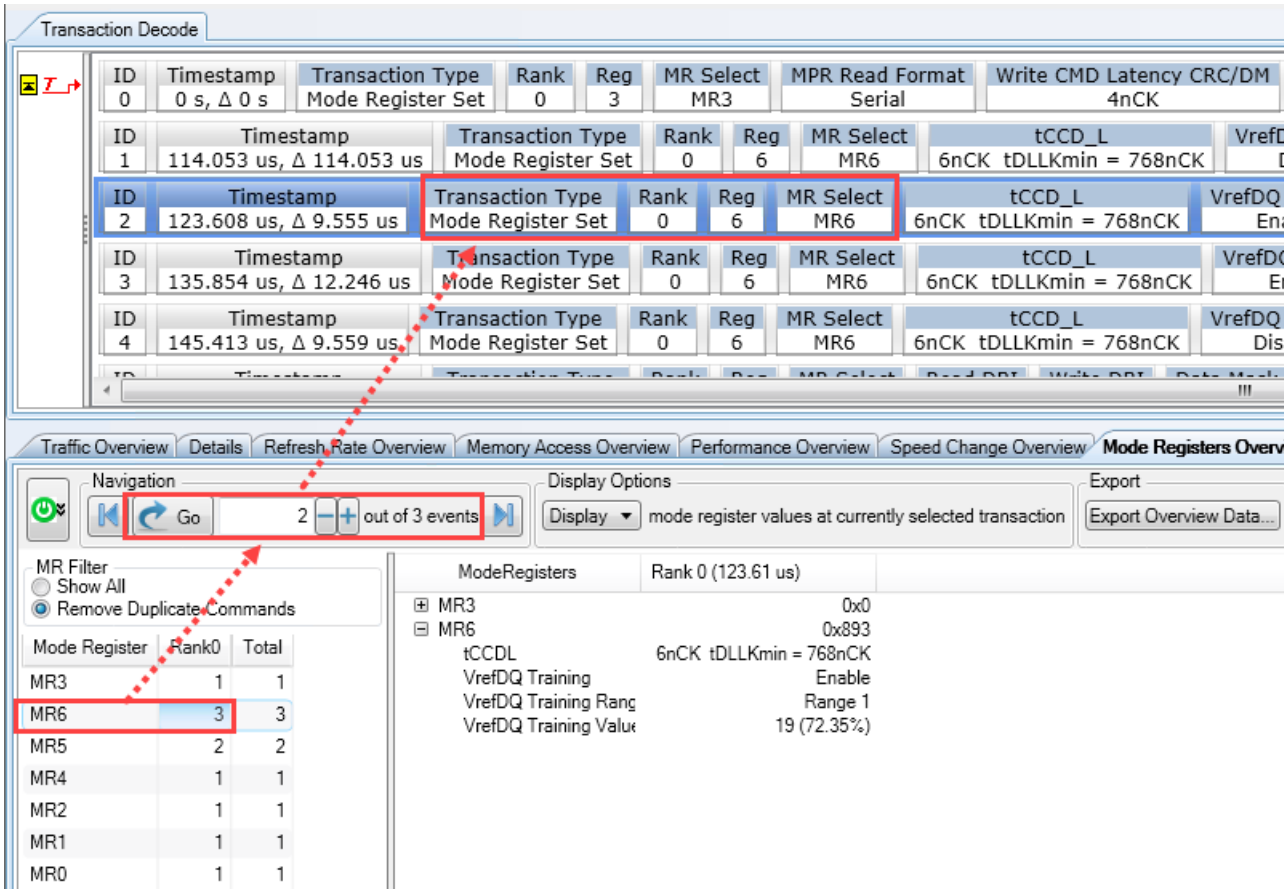
Navigating to a Specific Mode Register Access Transaction

You can use the mode registers listed in the left pane of the Mode Registers Overview tab to quickly navigate to a specific mode register access transaction in the upper pane. The display in the right pane also simultaneously changes to the mode registers values effective at the time of that transaction.

To navigate using the left pane of the Mode Registers Overview tab.

1 Select the mode register from the left pane of the Mode Registers Overview tab.

2 In the Navigation bar in the tab, type the specific occurrence of the mode register command event to which you want to navigate and click **Go**.



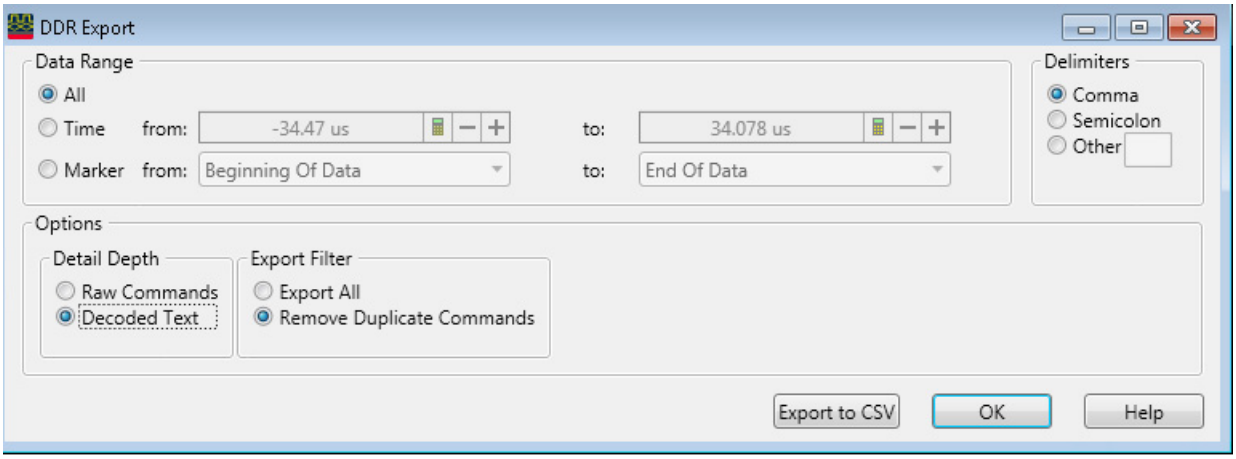
Exporting Mode Registers Overview Data

You can export the mode registers data displayed in the Mode Registers Overview tab to a specified .csv file.

To export mode registers overview data

1 Click the **Export Overview Data** button in the **Export** section of the **Mode Registers Overview** tab.

The **DDR Export** dialog box is displayed.



2 In the **Data Range** groupbox, specify the start and end points of the captured memory data for which you want to export mode registers data. The start and end points can be based on time or on the markers that you placed in the upper pane of the DDR/LPDDR Memory analysis window.

3 In the **Delimiters** groupbox, select the delimiter that you want to use to delimit the exported data in the csv file.

4 From the **Detail Depth** groupbox,

a Select **Raw Commands** if you want to export raw data for the mode register commands into the .csv file.

b Select **Decoded Text** if you want to export the decoded data of the mode register commands into the .csv file.

5 From the **Export Filter** groupbox,

a Select **Export All** to export all mode register commands including duplicate commands in the exported data.

b Select **Remove Duplicate Commands** to filter the duplicate mode register commands from the exported data.

6 Click **Export to CSV** to specify the CSV file name and start the export to this file.

7 Click **OK**.

A sample of the decoded mode registers data exported to a comma delimited .csv file is displayed.

```
Time,Rank,Mode Register,Precharge PD,Write Recovery,DLL Reset,TM,Read Burst Type,CAS Latency,BL,Mod
-34.470 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,???,???,???,???,???,???,???,MR2,
-34.469 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.468 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.467 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.466 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.465 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.464 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.462 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.461 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.460 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
-34.458 us,0,MR0,Fast exit (DLL on),5,No,Normal,Sequential,8,8,MR1,Output buffer disabled,Disable,D
```

15 Placing Markers

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Placing Markers in a Memory Analysis Chart / 104
To place a marker in a memory analysis chart / 104
To change the position of a marker / 104
To navigate to a particular marker placed in the chart / 104
Using the Center marker / 104

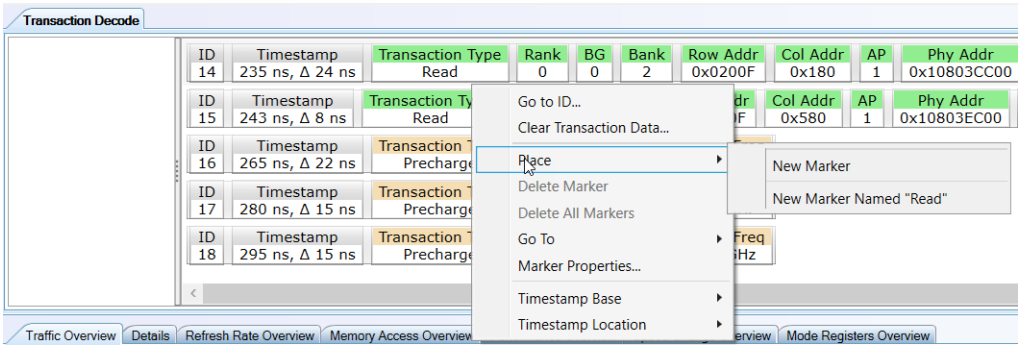
Placing Markers on Decoded Transactions

To place a marker on a decoded memory transaction displayed in the Transaction Decode pane

1 Right-click the memory transaction on which you want to place a marker.

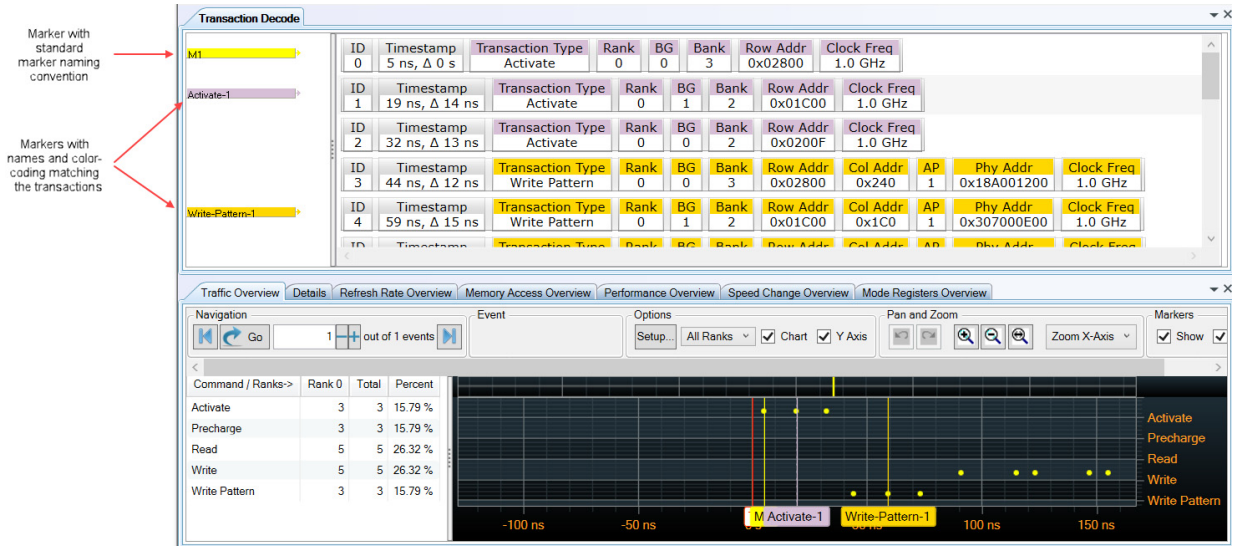
2 From the right-click menu, click **Place**.

- Either select **New Marker** to place a marker with the standard marker naming convention M1, M2....
- Or select **New Marker Named "<*transaction name*>"** to place a marker with the name and color-coding matching the transaction.



When you place a marker, it is also placed on the chart location that corresponds to the memory transaction on which the marker is placed.

The following screen shows markers placed on memory transactions.



To change the position of a marker

You can change the position of a marker by dragging/dropping markers.

1 Hover the mouse over the marker.

A double arrow appears indicating that the marker is selected.

2 Left-click to drag and release to drop.

To navigate to a particular marker placed on decoded transactions

Right-click anywhere in the decoded transactions list, select **Go To** and then select the marker to which you want to navigate.

On doing so, the decoded transactions list and the chart display moves to the point at which the selected marker is located.

Placing Markers in a Memory Analysis Chart

You can place markers in any of the charts displayed in different tabs of the Memory analysis window and use these markers to navigate to the memory transaction associated with the chart location at which you placed a marker. This helps you navigate to the exact trace position that corresponds to that chart location. Markers placed in the chart are correlated to markers displayed in the trace data in the upper pane of the Memory Analysis window.

To place a marker in a memory analysis chart

Double-click the location in the chart at which you want to place a marker. A new marker is added to that chart location as a yellow vertical line and at the corresponding trace location in the upper pane.

Alternatively, right-click the chart location where you want to place a marker. Then select **Place** > **New Marker** or select an existing marker to place that marker at the current location.

To change the position of a marker

You can change the position of a marker by dragging/dropping markers.

1 Hover the mouse over the marker vertical line.

A double arrow will appear indicating that the marker is selected.

2 Left-click to drag and release to drop.

To navigate to a particular marker placed in the chart

In situations when you have placed multiple markers in the chart, you may want to navigate to a particular marker and its associated trace position in the upper pane. To do so, right-click anywhere in the chart, select **Go To** and then select the marker to which you want to navigate.

On doing so, the chart display moves to the point at which the selected marker is located. Also, the trace position corresponding to the selected marker is highlighted in the upper pane.

Using the Center marker

When you use the list in the left pane of a tab to navigate to a particular occurrence of an event in the chart on the right, the chart display moves to the point of the occurrence's location. The location is centered in the chart. To clearly identify the location, you can use the Center checkbox from the top of the Chart pane. This marker is always displayed at the center of the charts display.

NOTE

If the markers are not displayed in a chart, click the **Show** checkbox in the **Markers** section at the top of the chart pane.

In the Memory Access Overview tab, markers are available in a chart only when you selected Time as the X-Axis of the chart. Markers can only represent Time and therefore when you select Col Addr as the X-axis, there are no Markers available in the chart.

16 Panning / Zooming a Memory Analysis Chart

Using the Pan Option to Navigate Through a Memory Analysis Chart / 106
Zooming a Memory Analysis Chart / 107

Using the Pan Option to Navigate Through a Memory Analysis Chart

To navigate through a chart horizontally, that is X-axis, select the **Pan X-axis** option from the Pan and Zoom section.

To navigate through a chart horizontally and vertically, that is both axes, select the **Pan Both Axes** option from the Pan and Zoom section.

Zooming a Memory Analysis Chart

You can zoom in or zoom out a defined area in the chart or the complete chart.

To zoom X-Axis for a defined area in the chart

1 Click the **Zoom X-Axis** option from the combo box displayed in the **Pan and Zoom** section of the charts pane to make it active.
2 Move the mouse pointer to the chart location from which you want to begin zooming.
3 Left-click at this location and while keeping the left mouse button pressed, drag the mouse to the chart location till which you want to zoom the display. As you move the mouse, the zooming extent is defined in chart and highlighted with grey.

When you release the left mouse button, the defined X-axis area is zoomed.

Similarly, you can zoom both X and Y axes of the defined area in the chart by selecting the **Zoom Both Axes** option from the combo box displayed in the **Pan and Zoom** section.

NOTE The X-axis zoom applies to all the displayed charts where as the Y-axis zoom (in both axis zoom) applies only to the chart in which you define the area to zoom.

You can also zoom in or zoom out complete charts. To do this, use the following buttons in the **Pan and Zoom** section of the charts pane.

-  - **Zoom In** magnifies the center 50% of the chart to the full width of the chart.
-  - **Zoom Out** doubles the time displayed in the full width of the chart.
-  - **Zoom Out Full** displays the entire range of Computed data across the full width of the chart.

NOTE You can undo and redo zooms by clicking the  and  buttons in the **Pan and Zoom** section of the charts pane.

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