TRACE
MB86R01 'JADE' & GREENHILLS TOOLCHAIN

APPLICATION NOTE
VERSION 0.01 16.9.2008
### Revision History

<table>
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<th>Date</th>
<th>Issue</th>
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<td>09/15/2008</td>
<td>0.1 tk</td>
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<td></td>
<td>First draft</td>
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1 Trace Overview

The MB86R01 has an integrated ETM9CS Single Macrocell for real-time tracing. With the ETM you can capture instructions and data executed by ARM926EJ-S core without influencing the execution. The trace data helps to find bugs more easily and allows stepping (both forwards and backwards) in the code.

1.1 Trace cell information

<table>
<thead>
<tr>
<th>ETM name</th>
<th>CoreSight ETM9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture version</td>
<td>ETMv3.2</td>
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<tr>
<td>Data width</td>
<td>4 Bit</td>
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<tr>
<td>FIFO size</td>
<td>60 bytes</td>
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</tbody>
</table>

1.2 Further information

Further information can be found on the ARM website
http://www.arm.com/documentation/Trace_Debug/index.html

The following documents are about the ETM cell:

- CoreSight ETM9 r0p0 Technical Reference Manual (DDI0315A)
- ETM9 Revision r2p2 Technical Reference Manual (DDI0157F)
- Embedded Trace Macrocell Architecture Specification (IHI0014N)
- CoreSight System Design Guide (DG10012A)
- CoreSight ETM9 Benchmarking (PR127-PRDC-006870 2.1, not publically available, requires an NDA with ARM)
2 MB86R01 Evaluation Board to GHS adapter

The Jade Evaluation Board is populated with a 20 pin JTAG and a separate 10 pin Trace connector. However, the GreenHills Super Trace Probe (STP) has a special connector. Therefore an adapter is needed to connect both devices. The adapter board can be ordered from Fujitsu. Furthermore, the schematic and layout are available on request.
3 Trace Connection

The following figure shows the connection between the Jade Evaluation Board, the adapter board and the GHS Super Trace probe. Pin 1 is marked on both boards. The GHS connector is protected against reverse polarity.

Figure 2 STP to GHS connection
4 Trace startup procedure

The following steps are necessary to configure and enable the trace functionality:

1. Power up Super Trace Probe (STP)
2. Power up the Jade Evaluation Board
3. Configure STP (must only be done when you start the STP for the first time)
   set etm_version 3
   *Note: clock <= 6 Mhz*
4. Start the Multi Debugger
5. Connect to the target
   *Note: The ETM clock is now running and the tracing LED is on*
6. Reset the target
7. Download the program to the target
5 Trace configuration

The trace data bit width directly effects the trace performance. Because of the limited number of (four) data bits, the required trace data volume can overflow. As a result, the user will lose some trace data. The user can avoid a FIFO overflow by disabling either the instruction or the data trace. This can be done in the GHS application.

The trace cell can be configured within the GHS Debugger. Select TimeMachine->TraceOptions from the top menu. Then select Target Specific Options to open the Trace options menu.

A detailed parameter description can be found in the GHS Debugging book in chapter 19 “Collecting and Using Trace data”. Here is a small summary:
Cycle Accurate
Enables ETM cycle accurate mode. The ETM normally outputs one trace packet every cycle when trace is enabled. Often many of these packets contain no useful information and can be discarded by the trace collection device. When this option is enabled, no packets will be discarded. This allows the trace tools to determine the number of cycles spent executing each instruction, but requires extra space in the trace buffer.

Use Timestamps
Enables timestamps. When timestamps are enabled, the trace collection device records a timestamp with each packet. Timestamps are displayed in the Trace List and are used by the Profile window, PathAnalyzer, and EventAnalyzer.

Prevent Overflow by Suppressing Data Trace
Enables the ETM FIFOFull mechanism. The amount of data output by the ETM varies depending on the code being executed and the trace configuration. Code with a large number of indirect branches and data accesses (if data trace is enabled) may generate so much data that the ETM FIFO overflows. Trace data is lost when this happens. If this option is enabled, the ETM attempts to prevent FIFO overflows by using the selected method:
• Suppressing Data Trace — Suppresses data trace when the FIFO is close to overflowing. This method is only available with ETMv3.x targets. Suppressing data trace is less effective at preventing the FIFO from overflowing than stalling the CPU, but has no impact.
6  Trace measurement

To evaluate the trace capability, FME made various measurements using different options. The test configuration and the results can be found in this chapter.

6.1  System configuration

<table>
<thead>
<tr>
<th>Multi</th>
<th>v5.0.5</th>
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<tbody>
<tr>
<td>STP</td>
<td>Green Hills Probe v3.3, Firmware built Apr 10 2008</td>
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<tr>
<td>Trace clock</td>
<td>82.69 Mhz</td>
</tr>
<tr>
<td>(JTAG) clock</td>
<td>5 Mhz</td>
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6.2  Test program

```
int main (void)
{
    /* temporary storage */
    int i;
    volatile unsigned long * ulpRegWrite1;
    volatile unsigned long * ulpRegWrite2;
    volatile unsigned long ulReg;

    printf("Trace Measurement running!\n");

    /* read and write DDR-RAM */
    ulpRegWrite1 = 0x47000000UL;

    for( i = 0x46000000; i < 0x46001000; i+=4 )
    {
        ulReg = *(volatile unsigned long*)i;
        *ulpRegWrite1 = ulReg;
        ulpRegWrite1++;
    }

    /* read and write SRAM */
    ulpRegWrite1 = 0x01000000UL;
    ulpRegWrite2 = 0x01000000UL;
    i = 0;

    for( ulpRegWrite1 = 0x01000000UL; ulpRegWrite1 < 0x01000000UL;
         ulpRegWrite1++,ulpRegWrite2++ )
    {
        *ulpRegWrite1 = i++;
        *ulpRegWrite2 = *ulpRegWrite1;
    }

    return 0;
}
```
6.3 Measurement

FME ran the same program several times with different trace options. The results of this are shown in the table below.

<table>
<thead>
<tr>
<th>Data Capture</th>
<th>Cycle Accurate</th>
<th>Use Timestamps</th>
<th>Prevent Overflow</th>
<th>Error*</th>
<th>Unknown opcode*</th>
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* These are some example trace messages

** Error:**

Error: Trace is not byte aligned. Trace data is corrupt.
Error: Trace is no longer synchronized. Resynchronizing.
Error: Unexpected Out of Order data.

** Unknown:**

Unknown opcode at address 0x40001c18

** |x|x|x| are different trace capture passes

6.4 Interpretation

As already mentioned, the trace performance depends heavily on the trace data width. With 4 bit only the PC (program counter) can be traced reliably. Otherwise the internal FIFO overflows and data is lost. Due to this, the trace output is corrupted and it is not possible to reproduce the complete program flow. However if the error is isolated and filters are used, it is possible to trace all data of interest.
7 Appendix

7.1 Figures

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