

*****DRAFT*****
SDRAM
10/02/18
*****DRAFT*****

Trying to add sdram support to the catzip. Steps

The command “python main_sdramdev.py”

creates sdramdev.v & Sdcntl.v Verilog files and the testbench main_sdramdev_tb.vcd.

Steps to obtain the Values Change Dump VCD. This creates the files sdramdev.v & Sdcntl.v

Modified the /testbuilds/catzip_simulated/catzip/sim/verilated/Makefile to add the sdramsim.cpp to /testbuilds/catzip_simulated/catzip/sim/verilated/arm-main_tb.

The disassemble is found at

Appendix D: Disassemble of testbuilds/catzip_simulation/catzip/sim/verilated/arm-main_tb where the SDRAMSIM

Note: Only one sdramdev_inst.convert(name = 'sdramdev') or SdCntl_inst.convert(name = 'Sdcntl')

can be uncommeted at the same time

not both or the following error will occur

Signal has multiple drivers: host_intf_rst_i

In the directory /home/pi/testbuilds/learning_hdl/MyHDL/sdram

“rm -f *.vcd”

“python main_sdramdev.py”

“gtkwave main_sdramdev_tb.vcd”

Create sdramdev.txt this is currently a draft version for use with

/home/pi/testbuilds/catzip_simulated/catzip/auto-data for the catzip.

/home/pi/testbuilds/catzip_simulated/catzip/auto-data for the catzip.

/home/pi/testbuilds/catzip_simulated/catzip/make autodata

Copying auto-data/toplevel.v to rtl/catzip/toplevel.v

Copying auto-data/main.v to rtl/catzip/main.v

Copying auto-data/regdefs.h to sw/host/regdefs.h

Copying auto-data/regdefs.cpp to sw/host/regdefs.cpp

Copying auto-data/board.h to sw/board/board.h

Copying auto-data/board.ld to sw/board/board.ld

Copying auto-data/rtl.make.inc to rtl/catzip/auto.mk

Copying auto-data/main_tb.cpp to sim/verilated/main_tb.cpp

Copying auto-data/testb.h to sim/verilated/testb.h

Steps to obtain the Values Change Dump VCD. This creates the file sdramdev.v.

Add the sdramsim.cpp & sdramsim.h to /testbuilds/catzip_simulated/catzip/sim/verilated.

Steps used to get a working catzip

“cd catzip”

“./myenv.sh”

“make datestamp”

“make autodata”

“cd rtl/catzip”

“make” This command creates catzip.bin that can be downloaded to FPGA. The Yosys Tools were used.

“cd ../../sim/verilated”

“make” This command creates arm-main_tb used to simulate the HX8K FPGA

“cd ../../sw/host” This creates

”make” This command creates arm-netpport & arm-wbregs

The script restores “config_catzip_simulation.sh” located in the learning_hdl/MyHDL/sdram folder.

Starts with a working catzip

1st shell

```
. /home/pi/testbuilds/catzip_simulation/catzip/myenv.sh
/home/pi/testbuilds/catzip_simulation/catzip/
make autodata
```

2nd shell

```
. /home/pi/testbuilds/catzip_simulation/catzip/myenv.sh
/home/pi/testbuilds/catzip_simulation/catzip/rtl/catzip
make clean
make cpudefs.h
make design.h
make verilated
make bin
/home/pi/testbuilds/catzip_simulation/catzip/sim/verilated/
make clean
make
```

3rd shell

```
. /home/pi/testbuilds/catzip_simulation/catzip/myenv.sh
cd testbuilds/catzip_simulation/catzip/sim/verilated/
make clean
make
./arm-main_tb
```

The script used to execute the arm-wbregs command is found at Appendix A: Script that executes the arm-wbregs commands sim_hw_test.sh

The output of the arm-main_tb is found at Appendix B: CATZIP testing the verilator simulation.

Listening on port 8363

Listening on port 8364

> T

In 4th shell

```
. /home/pi/testbuilds/catzip_simulation/catzip/myenv.sh
cd testbuilds/catzip_simulation/catzip/sw/host/
./sim_hw_test.sh
```

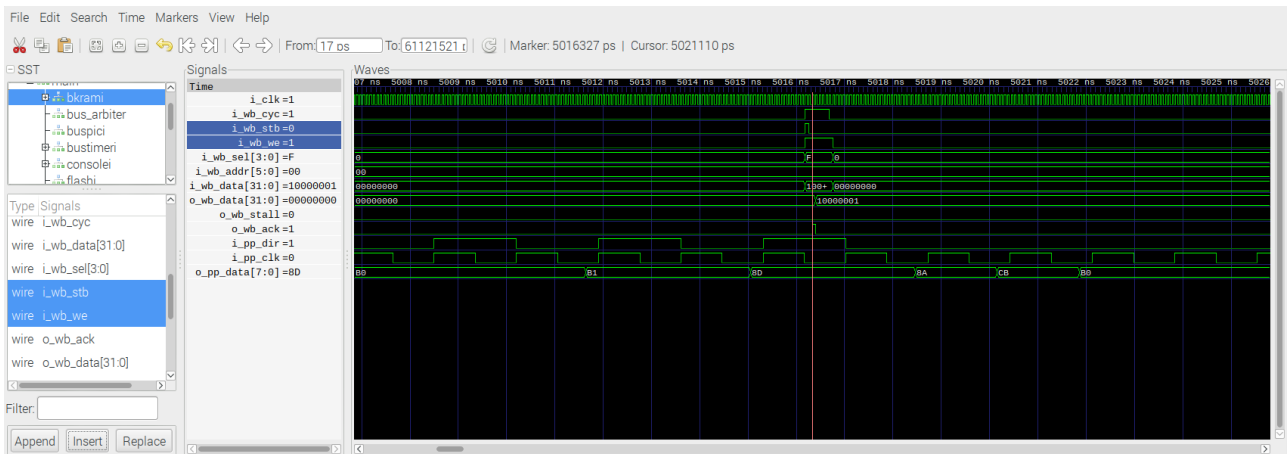
The output of the sim_hw_test.sh is found at Appendix C: CATZIP testing the verilator simulation running wbregs command from the script

sim_hw_test.sh .

```
cp testbuilds/learning_hdl/MyHDL/sdram/ topsdcnt.v & SdramCntl.v
~/testbuilds/catzip_simulation/catzip/rtl/catzip/
cp ~/testbuilds/learning_hdl/MyHDL/sdram/sdramdev.txt
~/testbuilds/catzip_simulation/catzip/auto-data/
cp ~/testbuilds/learning_hdl/MyHDL/sdram/Makefile_autodata
~/testbuilds/catzip_simulation/catzip/auto-data/Makefile
Note This provides a verilator sim of both sram & blkram
. ~/testbuilds/catzip_simulation/catzip/myenv.sh
cd ~/testbuilds/catzip_simulation/catzip/autodata
```

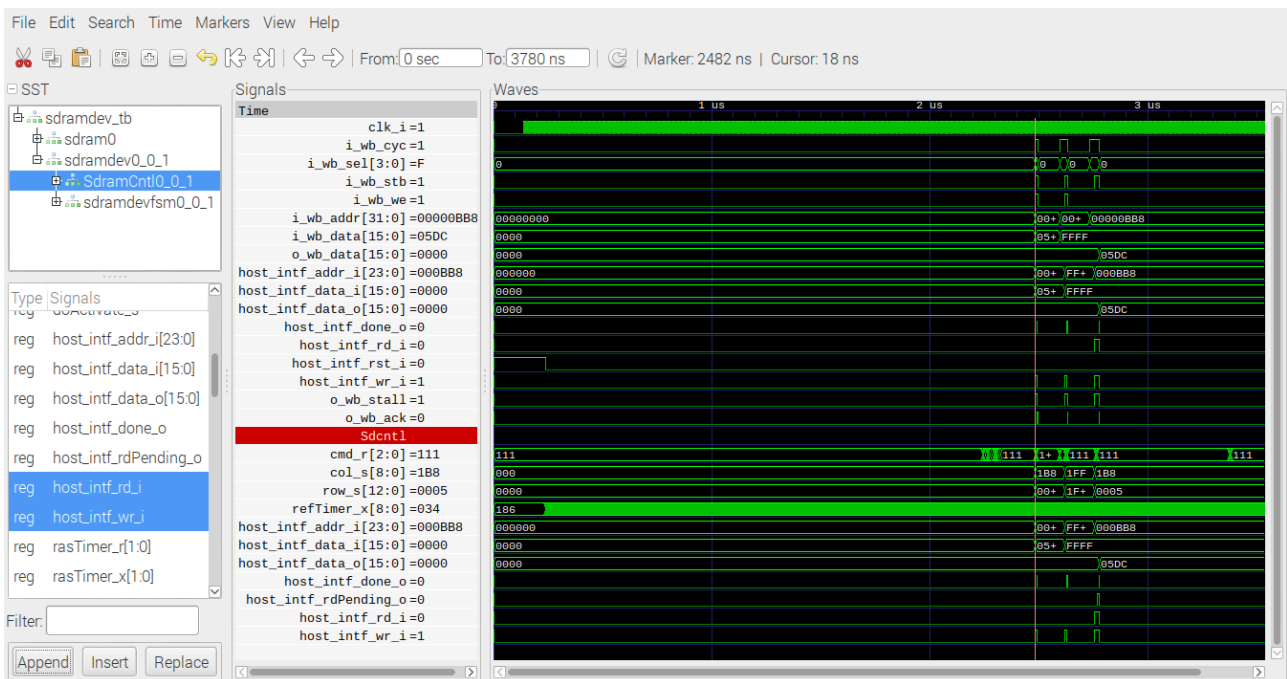
Create sdctl.txt

Modified Makefile in ~/testbuilds/catzip_simulation/catzip/autodata → Makefile_autodata



The Catboard has HX8K FPGA with a SDRAM that provides 0x000000 to 0xFFFFF 16 bit locations.

The SDCONTROLLER takes care of refreshing the SDRAM and interface between the FPGA and the SDRAM. The data 0x05DC 1500 is being wrote to address 0x000BB8 3000, the data 0xFFFF 65535 is being wrote to address 0xFFFFF 16777215. Then the data is read from address 0x000BB8 3000.



This test writes two SDRAM address and reads the value wrote to first location.
The data 0x05DC 1500 is being wrote to address 0x00000BB8 3000, 0xFFFF 65535 is being wrote to address 0x00FFFFFF 16777215. This is followed by reading the value at address 0x00000BB8 3000 which was 0x05DC 1500.

BANK 0 STATE : [CHANGE] Uninitialized -> Initialized @ 2138
BANK 1 STATE : [CHANGE] Uninitialized -> Initialized @ 2138
BANK 2 STATE : [CHANGE] Uninitialized -> Initialized @ 2138
BANK 3 STATE : [CHANGE] Uninitialized -> Initialized @ 2138

```
-----  
Mode | CAS | Burst  
-----|-----|-----  
Burst | 3   | 1  
-----
```

SDRAM : Bank 0 has active row 0005
BANK 0 STATE : WRITING @ 2514
DATA : [WRITE] Addr: 440 Data: 1500
The data 0x05DC 1500 is being wrote to address 0x000BB8 3000 Row 0005 col Addr: 440 0x1B8 is where the 1500 0x05DC is written.

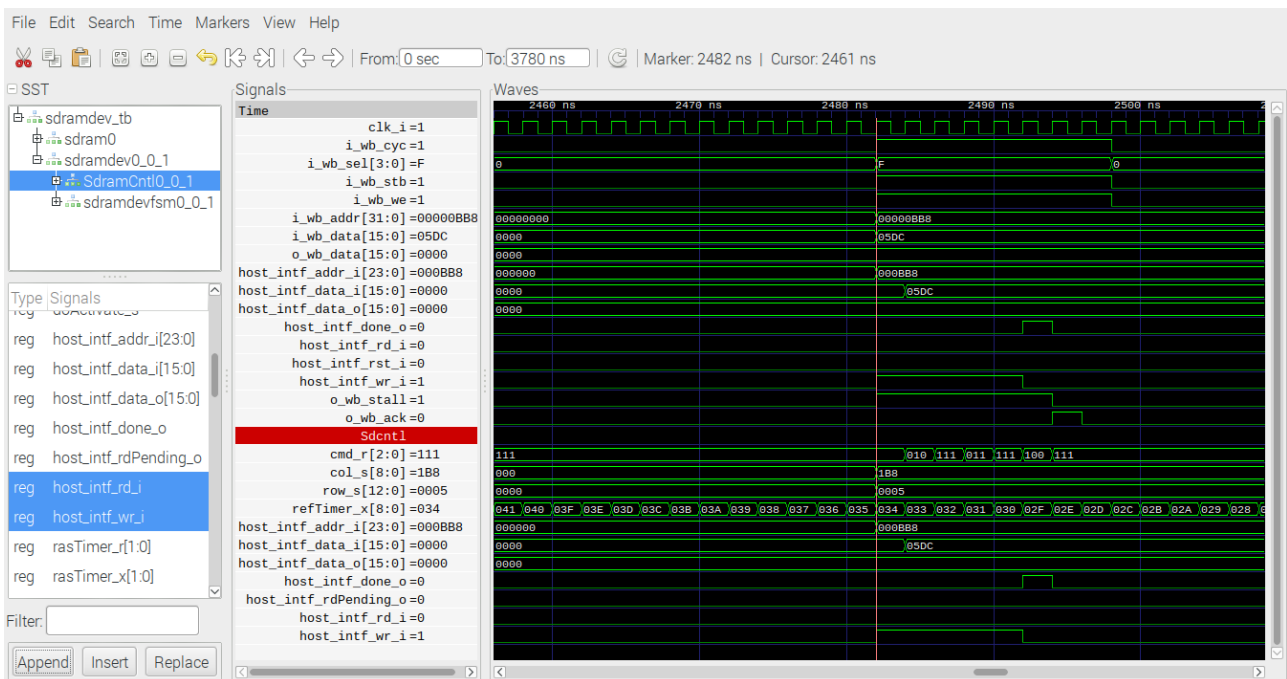
SDRAM : Bank 3 has active row 1fff
BANK 3 STATE : WRITING @ 2652
DATA : [WRITE] Addr: 511 Data: 65535
BANK 3 STATE : WRITING TO 01ff:511

The data 0xFFFF 65535 is being wrote to address 0xFFFFFFFF 16777215 (this is the last location in the sdram) Row 1FFF col Addr: 511 0x1FF is where the 65535 0xFFFF is written.

SDRAM : Bank 0 has active row 0005
BANK 0 STATE : READING @ 2790
SDRAM : [READ] Commnad registered
BANK 0 STATE : READING FROM 01b8:440
STATE : [READ] Data Ready @ 2794 value : 1500

BANK 0 STATE : WRITING TO 01b8:440
 4400440: 1500
 SDRAM : Bank 3 has active row 1fff
 BANK 3 STATE : WRITING @ 2652
 DATA : [WRITE] Addr: 511 Data: 65535
 BANK 3 STATE : WRITING TO 01ff:511
 4400440: 1500
 5110511: 65535
 SDRAM : Bank 0 has active row 0005
 BANK 0 STATE : READING @ 2790
 SDRAM : [READ] Commnad registered
 BANK 0 STATE : READING FROM 01b8:440
 STATE : [READ] Data Ready @ 2794 value : 1500

In the image below the data 0x05DC 1500 is being wrote to address 0x00000BB8 3000, 0xFFFF 65535 is being wrote to address 0x00FFFFFF 16777215. This is followed by reading the value at address 0x00000BB8 3000 which was 0x05DC 1500.
 BANK 3 STATE : WRITING @ 2652



DATA : [WRITE] Addr: 511 Data: 65535

BANK 3 STATE : WRITING TO 01ff:511

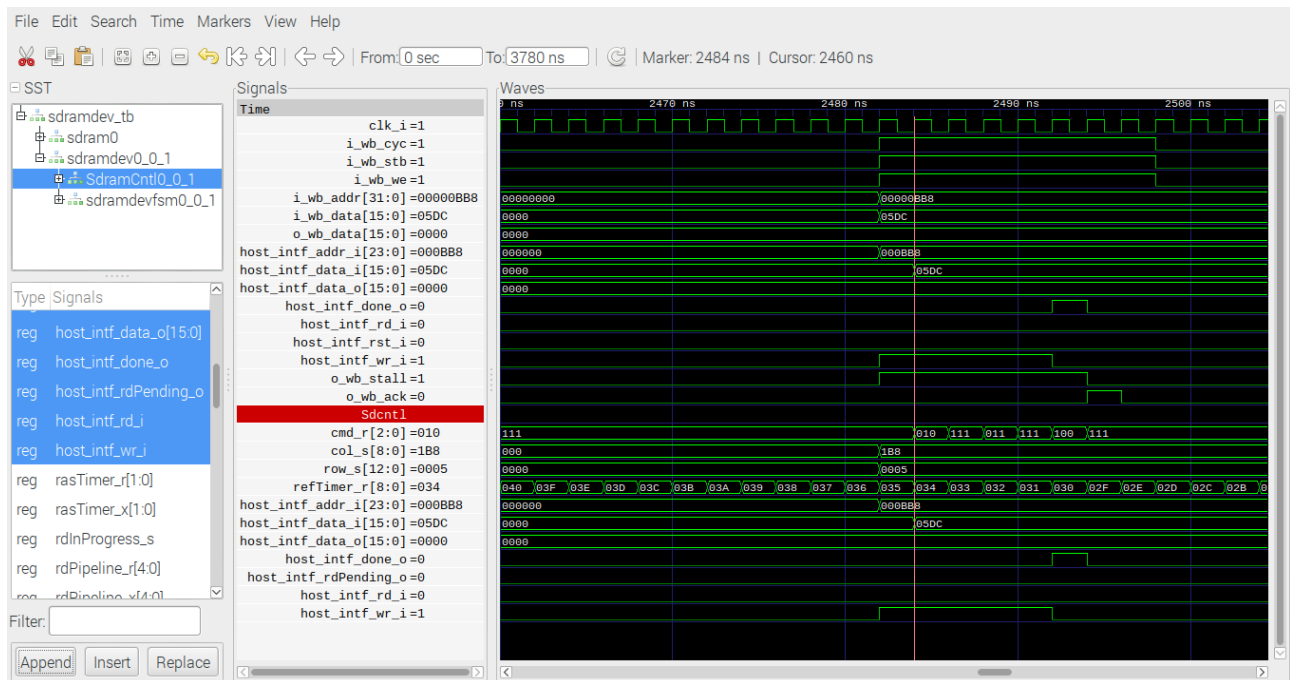
SDRAM : Bank 0 has active row 0005

BANK 0 STATE : WRITING @ 2514

DATA : [WRITE] Addr: 440 Data: 1500

BANK 0 STATE : WRITING TO 01b8:440

In the image below the data 0x05DC 1500 is being wrote to address 0x000BB8 3000



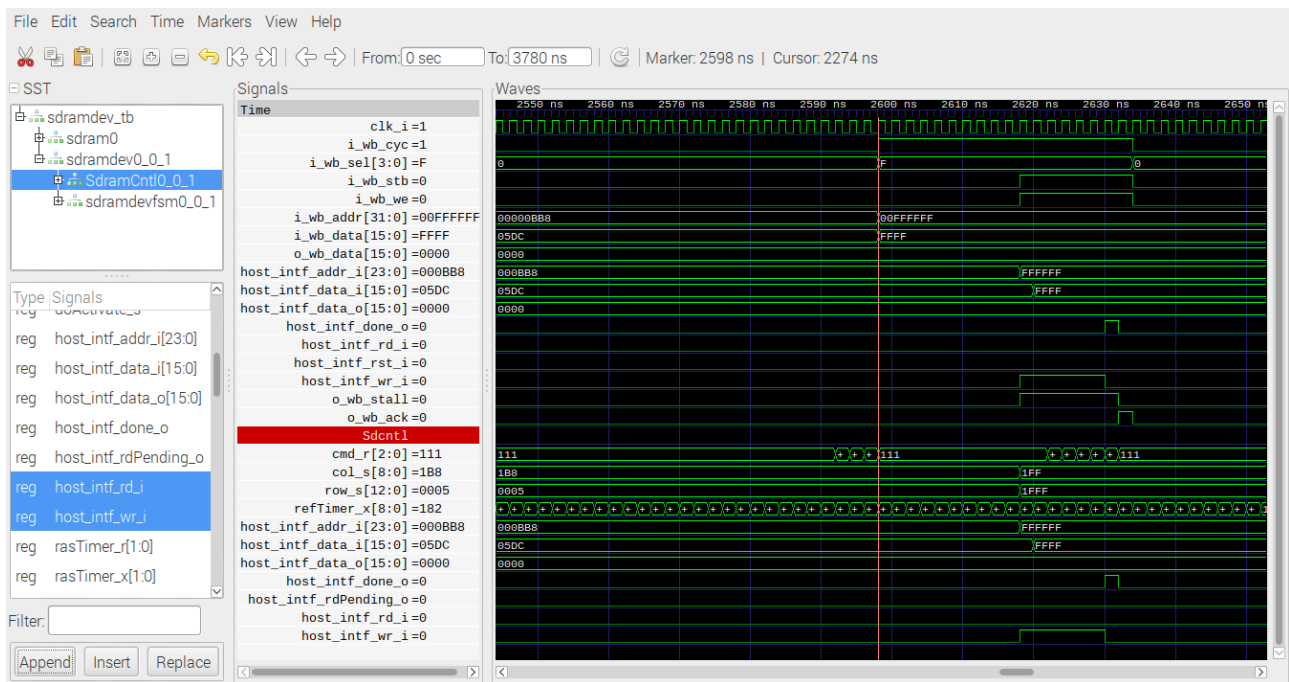
SDRAM : Bank 3 has active row 1fff

BANK 3 STATE : WRITING @ 2652

DATA : [WRITE] Addr: 511 Data: 65535

BANK 3 STATE : WRITING TO 01ff:511

In the image below the data 0xFFFF 65535 is being wrote to address 0xFFFFF 16777215.



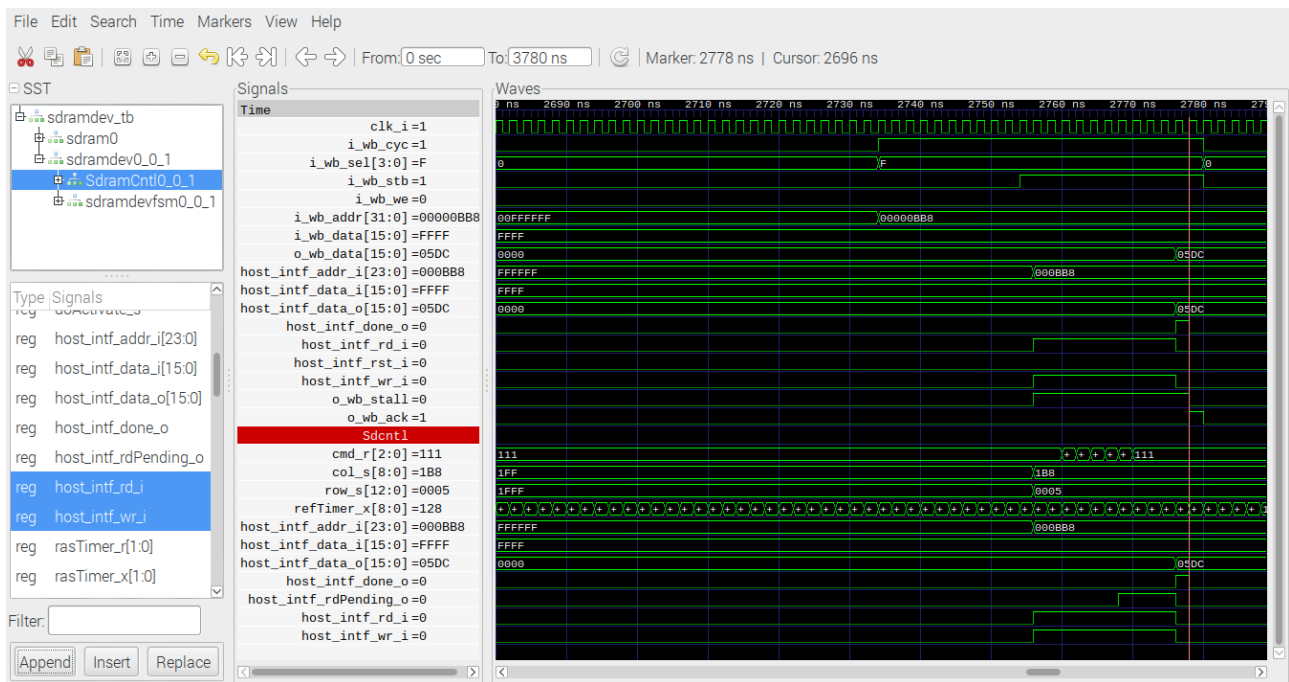
BANK 0 STATE : READING @ 2790

SDRAM : [READ] Command registered

BANK 0 STATE : READING FROM 01b8:440

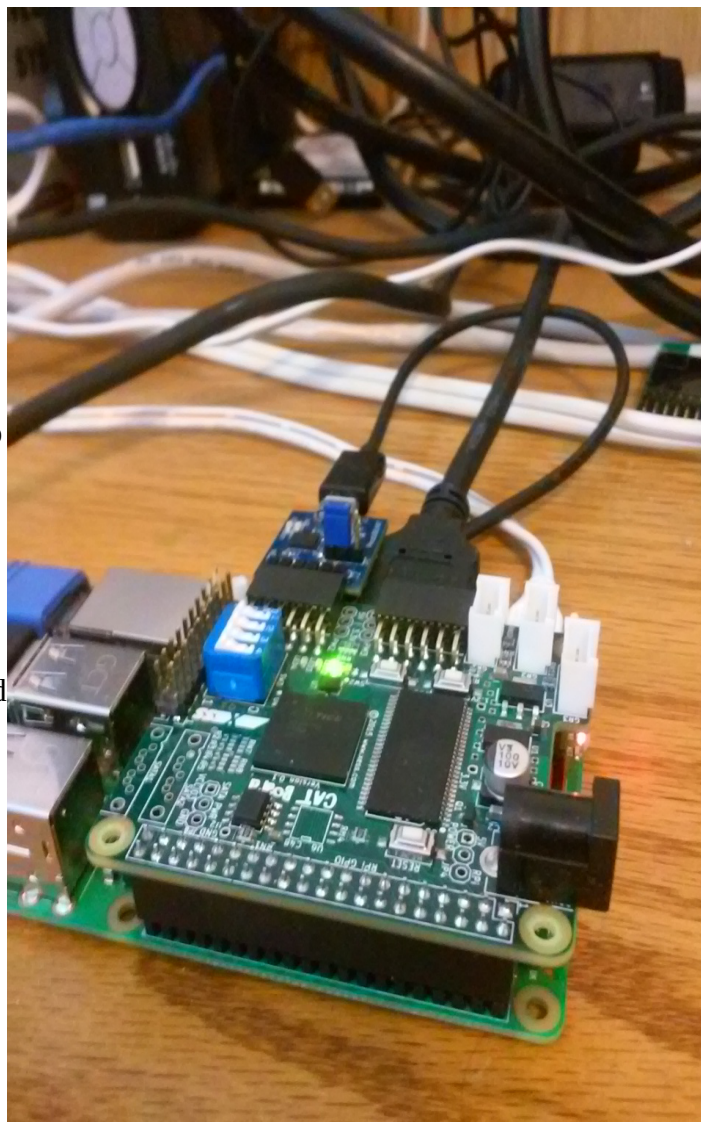
STATE : [READ] Data Ready @ 2794 value : 1500

In the image below reading the value at address 0x0000BB8 3000 which was 0x05DC 1500.



The `memory_test` takes approximately 3.5 sec or 175×10^6 clocks to complete at 50MHz. The `memory_test` writes to 16777215 locations and reads the data written.

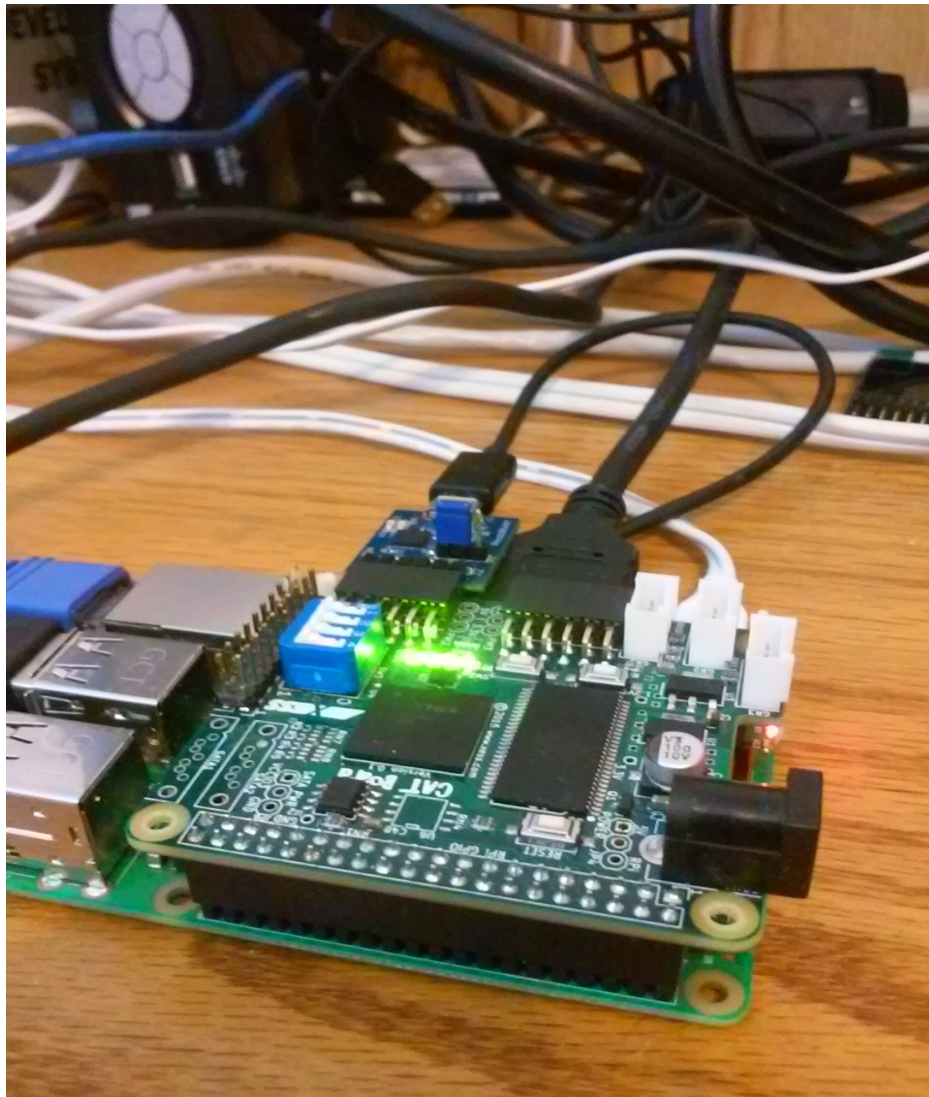
Catboard running `top.bin` after the program has been loaded starting to write to memory during the `memory_test`



Catboard running top.bin after the program has been load starting to read from memory during the memory_test



Catboard running top.bin after the program has been load and the end memory memory_test. Note all 4 leds are on.



Now the sdram_test is memdev

```
module top (
    clk100MHz,
    sdram_clk,
    sdram_return_clk,
    led_status,
    pb,
    memdev0_SdramCntl0_sd_intf_cke,
    memdev0_SdramCntl0_sd_intf_we,
    memdev0_SdramCntl0_sd_intf_addr,
    memdev0_SdramCntl0_sd_intf_dqml,
    memdev0_SdramCntl0_sd_intf_cas,
    memdev0_SdramCntl0_sd_intf_dqmh,
    memdev0_SdramCntl0_sd_intf_ras,
    memdev0_SdramCntl0_sd_intf_bs,
    memdev0_SdramCntl0_sd_intf_cs,
    memdev0_SdramCntl0_sd_intf_dq
);
=== top ===
```

Number of wires: 441

Number of wire bits:	968
Number of public wires:	84
Number of public wire bits:	537
Number of memories:	0
Number of memory bits:	0
Number of processes:	0
Number of cells:	719
\$_TBUF_	16
SB_CARRY	68
SB_DFF	4
SB_DFFE	4
SB_DFFER	98
SB_DFFES	1
SB_DFFESR	45
SB_DFFESS	4
SB_DFFR	52
SB_DFFS	8
SB_DFFSR	3
SB_DFFSS	4
SB_LUT4	412

Host interface signals

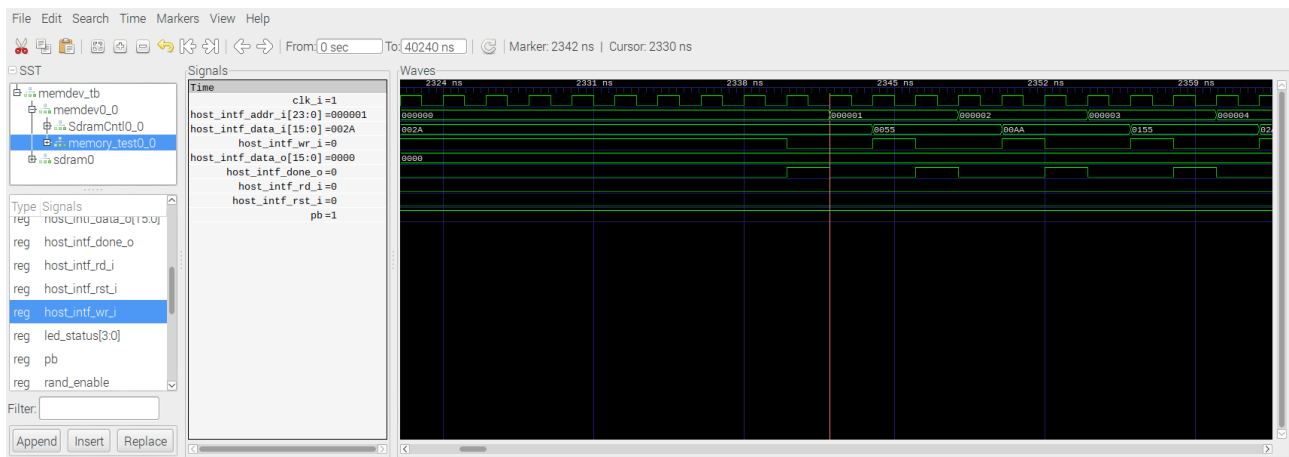
```
wire [23:0] memdev0_SdramCntl0_host_intf_addr_i;
wire [15:0] memdev0_SdramCntl0_host_intf_data_i;
wire [15:0] memdev0_SdramCntl0_host_intf_data_i;
wire [15:0] memdev0_SdramCntl0_host_intf_data_o;
wire memdev0_SdramCntl0_host_intf_done_o;
wire memdev0_SdramCntl0_host_intf_wr_i;
wire memdev0_memory_test0_host_intf_rst_i;
```

Write function

- during a write
- 4 clks in between address chg
- 4 clks in between data chg
- 80 nsec

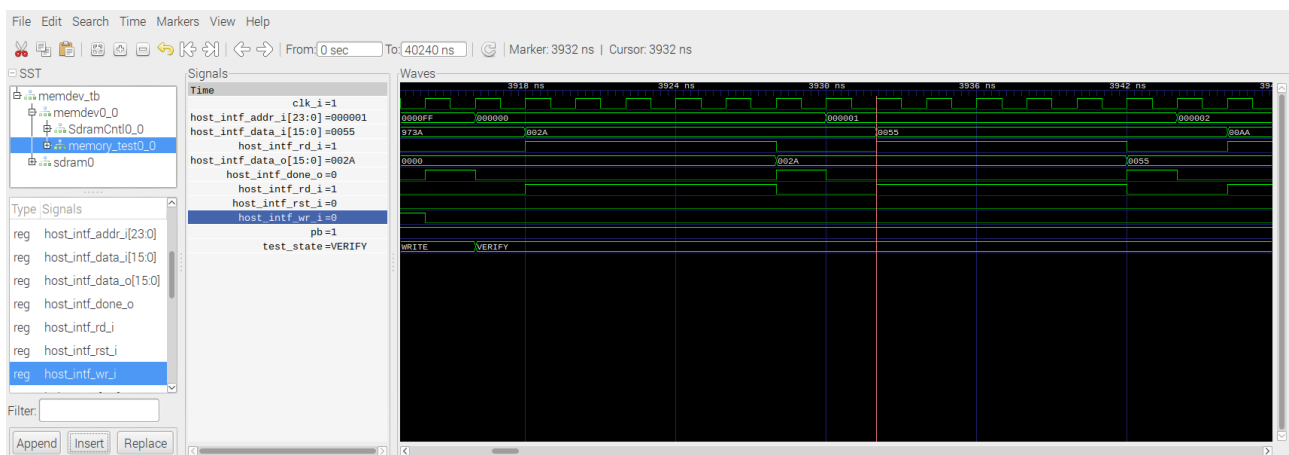
The 24 bit memdev0_SdramCntl0_host_intf_addr_i is set on the raising edge of clk. One clk later the 16 bit

memdev0_SdramCntl0_host_intf_data_i and memdev0_SdramCntl0_host_intf_wr_i goes hi. A clk later the memdev0_SdramCntl0_host_intf_done_o goes hi and the memdev0_SdramCntl0_host_intf_wr_i goes lo.



Read function

The 24 bit memdev0_Sdr0Cntl0_host_intf_addr_i is set on the raising edge of clk. One clk later the 16 bit memdev0_Sdr0Cntl0_host_intf_rd_i goes hi. Five clk later the memdev0_Sdr0Cntl0_host_intf_done_o goes hi, memdev0_Sdr0Cntl0_host_intf_data_o is valid and the memdev0_Sdr0Cntl0_host_intf_rd_i goes lo.



During the first part of the memory_test Write takes place.

python memdev.py

make

sudo config_cat top.bin

```
2^24      16777216    0x000000    0xFFFFFFFF    16Bits
@PREFIX=sdr0
@DEVID=SDRAM
@$LGMEMSZ=24
@$LGMEMSZ.FORMAT=%d
@$NADDR=(1<<(@$THIS.LGMEMSZ-2))
@$NBYTES=(1<<(@$THIS.LGMEMSZ))
@$NBYTES.FORMAT=0x%08x
@ACCESS=@$(DEVID)_ACCESS
```

```
@SLAVE.TYPE=MEMORY
@SLAVE.BUS=wb
@LD.PERM=wx
#!/bin/bash
```

Appendix A: Script that executes the arm-wbregs commands sim_hw_test.sh

```
#!/bin/bash

echo "The date built"
./arm-wbregs version
sleep 2
./arm-wbregs 0x700 0x10000001
sleep 2
./arm-wbregs 0x704 0x10000002
sleep 2
./arm-wbregs 0x708 0x10000003
sleep 2
./arm-wbregs 0x70c 0x10000004
sleep 2
./arm-wbregs 0x700
sleep 2
./arm-wbregs 0x704
sleep 2
./arm-wbregs 0x708
sleep 2
./arm-wbregs 0x70c
sleep 2
echo "Turning on the 4th led "
./arm-wbregs gpio 0x00010001
sleep 2
echo "Turning on the 1st led "
./arm-wbregs gpio 0x00020002
sleep 2
echo "Turning on the 2nd led "
./arm-wbregs gpio 0x00040004
sleep 5
echo "Turning off the leds "
./arm-wbregs gpio 0x00070000
```

Appendix B: CATZIP testing the verilator simulation.

```
./arm-main_tb
Listening on port 8363
Listening on port 8364
Accepted CMD connection
POLL = 1
RCVD: 6 bytes
< A611R
> A00000611R20180812
POLL = 1
RCVD: 0 bytes
```

< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 14 bytes
< A701W10000001
> A00000701
> K00000000
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 14 bytes
< A705W10000002
> A00000705
> K00000000
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 14 bytes
< A709W10000003
> A00000709
> K00000000
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 14 bytes
< A70dW10000004
> A0000070d
> K00000000
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 6 bytes
< A701R
> A00000701R10000001
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 6 bytes
< A705R
> A00000705R10000002
POLL = 1
RCVD: 0 bytes

< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 6 bytes
< A709R
> A00000709R10000003
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 6 bytes
< A70dR
> A0000070dR10000004
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 11 bytes
< A609W10001
> A00000609K00000000
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 11 bytes
< A609W20002
> A00000609K00000000
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 11 bytes
< A609W40004
> A00000609K00000000
POLL = 1
RCVD: 0 bytes
< [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 11 bytes
< A609W70000
> A00000609K00000000
POLL = 1
RCVD: 0 bytes
< [CLOSED]
> Z
CMD: Only sent 0 bytes of 3
^C

Appendix C: CATZIP testing the verilator simulation running wbreps command from the script
sim_hw_test.sh .

The date built

00000610 (VERSION) : [...] 20180812

00000700 (RAM)-> 10000001

00000704 ()-> 10000002

00000708 ()-> 10000003

0000070c ()-> 10000004

00000700 (RAM) : [...] 10000001

00000704 () : [...] 10000002

00000708 () : [...] 10000003

0000070c () : [...] 10000004

Turning on the 4th led

00000608 (GPIO)-> 00010001

Turning on the 1st led

00000608 (GPIO)-> 00020002

Turning on the 2nd led

00000608 (GPIO)-> 00040004

Turning off the leds

00000608 (GPIO)-> 00070000

Chgs after adding sdcntl.txt & sdramdev.txt blkram move from 0x700 to 0x00800000

The date built

00600010 (VERSION) : [...] 20180812

00800000 (RAM)-> 10000001

00800004 ()-> 10000002

00800008 ()-> 10000003

0080000c ()-> 10000004

00800000 (RAM) : [...] 10000001

00800004 () : [...] 10000002

00800008 () : [...] 10000003

0080000c () : [...] 10000004

Turning on the 4th led

00600008 (GPIO)-> 00010001

Turning on the 1st led

00600008 (GPIO)-> 00020002

Turning on the 2nd led

00600008 (GPIO)-> 00040004

Turning off the leds

00600008 (GPIO)-> 00070000

Appendix D: Disassemble of testbuilds/catzip_simulation/catzip/sim/verilated/arm-main_tb where
the SDRAMSIM

00024654 <_ZN8SDRAMSIMcLEiiiiijiss>:

2466c:	1a000004	bne	24684 <_ZN8SDRAMSIMcLEiiiiijiss+0x30>
24678:	1a000002	bne	24688 <_ZN8SDRAMSIMcLEiiiiijiss+0x34>
24680:	ea00001e	b	24700 <_ZN8SDRAMSIMcLEiiiiijiss+0xac>
24698:	0a00001a	beq	24708 <_ZN8SDRAMSIMcLEiiiiijiss+0xb4>
246a4:	ca0000c3	bgt	249b8 <_ZN8SDRAMSIMcLEiiiiijiss+0x364>
246ac:	1a000034	bne	24784 <_ZN8SDRAMSIMcLEiiiiijiss+0x130>
246c4:	1a000038	bne	247ac <_ZN8SDRAMSIMcLEiiiiijiss+0x158>
246cc:	0a000031	beq	24798 <_ZN8SDRAMSIMcLEiiiiijiss+0x144>
246d8:	0a00002e	beq	24798 <_ZN8SDRAMSIMcLEiiiiijiss+0x144>

```

246e4: 0a00002b    beq    24798 <_ZN8SDRAMSIMclEiiiiijiss+0x144>
24708: e59f496c    ldr     r4, [pc, #2412]          ; 2507c
<_ZN8SDRAMSIMclEiiiiijiss+0xa28>
24718: e59f0960    ldr     r0, [pc, #2400]          ; 25080
<_ZN8SDRAMSIMclEiiiiijiss+0xa2c>
24724: e59f1958    ldr     r1, [pc, #2392]          ; 25084
<_ZN8SDRAMSIMclEiiiiijiss+0xa30>
24734: e59f194c    ldr     r1, [pc, #2380]          ; 25088
<_ZN8SDRAMSIMclEiiiiijiss+0xa34>
24744: e59f1940    ldr     r1, [pc, #2368]          ; 2508c
<_ZN8SDRAMSIMclEiiiiijiss+0xa38>
24754: e59f1934    ldr     r1, [pc, #2356]          ; 25090
<_ZN8SDRAMSIMclEiiiiijiss+0xa3c>
24764: e59f1928    ldr     r1, [pc, #2344]          ; 25094
<_ZN8SDRAMSIMclEiiiiijiss+0xa40>
24770: e59f3920    ldr     r3, [pc, #2336]          ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24778: e59f191c    ldr     r1, [pc, #2332]          ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
2477c: e59f091c    ldr     r0, [pc, #2332]          ; 250a0
<_ZN8SDRAMSIMclEiiiiijiss+0xa4c>
24784: e59f390c    ldr     r3, [pc, #2316]          ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
2478c: e59f1908    ldr     r1, [pc, #2312]          ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24790: e59f090c    ldr     r0, [pc, #2316]          ; 250a4
<_ZN8SDRAMSIMclEiiiiijiss+0xa50>
24798: e59f38f8    ldr     r3, [pc, #2296]          ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
247a0: e59f18f4    ldr     r1, [pc, #2292]          ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
247a4: e59f08fc    ldr     r0, [pc, #2300]          ; 250a8
<_ZN8SDRAMSIMclEiiiiijiss+0xa54>
247b0: 0a000019    beq    2481c <_ZN8SDRAMSIMclEiiiiijiss+0x1c8>
247b8: 0a000028    beq    24860 <_ZN8SDRAMSIMclEiiiiijiss+0x20c>
247c0: 0a000042    beq    248d0 <_ZN8SDRAMSIMclEiiiiijiss+0x27c>
247c8: 0a000057    beq    2492c <_ZN8SDRAMSIMclEiiiiijiss+0x2d8>
247d0: 1affffc8    bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
247d8: 1a000071    bne    249a4 <_ZN8SDRAMSIMclEiiiiijiss+0x350>
247e0: 1a00006f    bne    249a4 <_ZN8SDRAMSIMclEiiiiijiss+0x350>
247ec: 1a00006c    bne    249a4 <_ZN8SDRAMSIMclEiiiiijiss+0x350>
247f8: 0a000069    beq    249a4 <_ZN8SDRAMSIMclEiiiiijiss+0x350>
24804: 1affffb2    bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24818: ea00005d    b      24994 <_ZN8SDRAMSIMclEiiiiijiss+0x340>
24820: 1afffb4     bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24828: 1afffb2     bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24834: 0afffaf     beq    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24840: 1afffac     bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
2485c: eaafffa5    b      246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24868: 1a000009    bne    24894 <_ZN8SDRAMSIMclEiiiiijiss+0x240>
2487c: aaffff9d    bge    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>

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24884:    e59f1820    ldr    r1, [pc, #2080]        ; 250ac
<_ZN8SDRAMSIMclEiiiiijiss+0xa58>
24890:    eafffff7    b      24874 <_ZN8SDRAMSIMclEiiiiijiss+0x220>
24898:    1a000007    bne    248bc <_ZN8SDRAMSIMclEiiiiijiss+0x268>
248a0:    1a000005    bne    248bc <_ZN8SDRAMSIMclEiiiiijiss+0x268>
248ac:    1a000002    bne    248bc <_ZN8SDRAMSIMclEiiiiijiss+0x268>
248b8:    1affff8e    bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
248bc:    e59f37d4    ldr    r3, [pc, #2004]        ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
248c4:    e59f17d0    ldr    r1, [pc, #2000]        ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
248c8:    e59f07e0    ldr    r0, [pc, #2016]        ; 250b0
<_ZN8SDRAMSIMclEiiiiijiss+0xa5c>
248d4:    1affff87    bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
248dc:    1affff85    bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
248e8:    1affff82    bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
248f4:    1affff7f    bne    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24900:    1a000004    bne    24918 <_ZN8SDRAMSIMclEiiiiijiss+0x2c4>
24914:    eaffff77    b      246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24918:    e59f3778    ldr    r3, [pc, #1912]        ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24920:    e59f1774    ldr    r1, [pc, #1908]        ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24924:    e59f0788    ldr    r0, [pc, #1928]        ; 250b4
<_ZN8SDRAMSIMclEiiiiijiss+0xa60>
24930:    0a000007    beq    24954 <_ZN8SDRAMSIMclEiiiiijiss+0x300>
2493c:    1a000009    bne    24968 <_ZN8SDRAMSIMclEiiiiijiss+0x314>
24950:    eaffff68    b      246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24954:    e59f373c    ldr    r3, [pc, #1852]        ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
2495c:    e59f1738    ldr    r1, [pc, #1848]        ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24960:    e59f0750    ldr    r0, [pc, #1872]        ; 250b8
<_ZN8SDRAMSIMclEiiiiijiss+0xa64>
2496c:    0affff61    beq    246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
24970:    e59f3720    ldr    r3, [pc, #1824]        ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24978:    e59f171c    ldr    r1, [pc, #1820]        ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
2497c:    e59f0738    ldr    r0, [pc, #1848]        ; 250bc
<_ZN8SDRAMSIMclEiiiiijiss+0xa68>
24988:    e59f171c    ldr    r1, [pc, #1820]        ; 250ac
<_ZN8SDRAMSIMclEiiiiijiss+0xa58>
2499c:    bafffff8    blt    24984 <_ZN8SDRAMSIMclEiiiiijiss+0x330>
249a0:    eaffff54    b      246f8 <_ZN8SDRAMSIMclEiiiiijiss+0xa4>
249a4:    e59f36ec    ldr    r3, [pc, #1772]        ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
249ac:    e59f16e8    ldr    r1, [pc, #1768]        ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
249b0:    e59f0708    ldr    r0, [pc, #1800]        ; 250c0
<_ZN8SDRAMSIMclEiiiiijiss+0xa6c>
249c4:    aa000005    bge    249e0 <_ZN8SDRAMSIMclEiiiiijiss+0x38c>

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249dc:	eafffff6	b	249bc <_ZN8SDRAMSIMclEiiiiijiss+0x368>
249e4:	ea000000	b	249ec <_ZN8SDRAMSIMclEiiiiijiss+0x398>
249f0:	ca00001a	bgt	24a60 <_ZN8SDRAMSIMclEiiiiijiss+0x40c>
24a2c:	0affffed	beq	249e8 <_ZN8SDRAMSIMclEiiiiijiss+0x394>
24a48:	aaffffe6	bge	249e8 <_ZN8SDRAMSIMclEiiiiijiss+0x394>
24a4c:	e59f3644	ldr	r3, [pc, #1604] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>			
24a54:	e59f1640	ldr	r1, [pc, #1600] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>			
24a58:	e59f0664	ldr	r0, [pc, #1636] ; 250c4
<_ZN8SDRAMSIMclEiiiiijiss+0xa70>			
24a78:	0a000003	beq	24a8c <_ZN8SDRAMSIMclEiiiiijiss+0x438>
24a88:	0a000048	beq	24bb0 <_ZN8SDRAMSIMclEiiiiijiss+0x55c>
24a94:	da000010	ble	24adc <_ZN8SDRAMSIMclEiiiiijiss+0x488>
24aa0:	0a00000d	beq	24adc <_ZN8SDRAMSIMclEiiiiijiss+0x488>
24ac8:	1a000040	bne	24bd0 <_ZN8SDRAMSIMclEiiiiijiss+0x57c>
24af4:	1a000040	bne	24bfc <_ZN8SDRAMSIMclEiiiiijiss+0x5a8>
24b20:	1a000046	bne	24c40 <_ZN8SDRAMSIMclEiiiiijiss+0x5ec>
24b28:	1a000044	bne	24c40 <_ZN8SDRAMSIMclEiiiiijiss+0x5ec>
24b34:	1a000041	bne	24c40 <_ZN8SDRAMSIMclEiiiiijiss+0x5ec>
24b40:	0a00003e	beq	24c40 <_ZN8SDRAMSIMclEiiiiijiss+0x5ec>
24b4c:	e59f1558	ldr	r1, [pc, #1368] ; 250ac
<_ZN8SDRAMSIMclEiiiiijiss+0xa58>			
24b74:	1a000022	bne	24c04 <_ZN8SDRAMSIMclEiiiiijiss+0x5b0>
24b80:	1a000024	bne	24c18 <_ZN8SDRAMSIMclEiiiiijiss+0x5c4>
24b8c:	1a000026	bne	24c2c <_ZN8SDRAMSIMclEiiiiijiss+0x5d8>
24b98:	0afffed8	beq	24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24b9c:	e59f34f4	ldr	r3, [pc, #1268] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>			
24ba4:	e59f14f0	ldr	r1, [pc, #1264] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>			
24ba8:	e59f0518	ldr	r0, [pc, #1304] ; 250c8
<_ZN8SDRAMSIMclEiiiiijiss+0xa74>			
24bb0:	e59f34c4	ldr	r3, [pc, #1220] ; 2507c
<_ZN8SDRAMSIMclEiiiiijiss+0xa28>			
24bc0:	e59f0504	ldr	r0, [pc, #1284] ; 250cc
<_ZN8SDRAMSIMclEiiiiijiss+0xa78>			
24bd4:	0affffbd	beq	24ad0 <_ZN8SDRAMSIMclEiiiiijiss+0x47c>
24be8:	0affffb8	beq	24ad0 <_ZN8SDRAMSIMclEiiiiijiss+0x47c>
24bf8:	eaffffb4	b	24ad0 <_ZN8SDRAMSIMclEiiiiijiss+0x47c>
24c00:	eaffffc0	b	24b08 <_ZN8SDRAMSIMclEiiiiijiss+0x4b4>
24c04:	e59f348c	ldr	r3, [pc, #1164] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>			
24c0c:	e59f1488	ldr	r1, [pc, #1160] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>			
24c10:	e59f04b8	ldr	r0, [pc, #1208] ; 250d0
<_ZN8SDRAMSIMclEiiiiijiss+0xa7c>			
24c18:	e59f3478	ldr	r3, [pc, #1144] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>			
24c20:	e59f1474	ldr	r1, [pc, #1140] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>			

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24c24:    e59f04a8    ldr    r0, [pc, #1192]        ; 250d4
<_ZN8SDRAMSIMclEiiiiijiss+0xa80>
24c2c:    e59f3464    ldr    r3, [pc, #1124]        ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24c34:    e59f1460    ldr    r1, [pc, #1120]        ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24c38:    e59f0498    ldr    r0, [pc, #1176]        ; 250d8
<_ZN8SDRAMSIMclEiiiiijiss+0xa84>
24c44:    1a000025    bne    24ce0 <_ZN8SDRAMSIMclEiiiiijiss+0x68c>
24c4c:    1a000023    bne    24ce0 <_ZN8SDRAMSIMclEiiiiijiss+0x68c>
24c58:    0a000020    beq    24ce0 <_ZN8SDRAMSIMclEiiiiijiss+0x68c>
24c64:    1a00001d    bne    24ce0 <_ZN8SDRAMSIMclEiiiiijiss+0x68c>
24c70:    0a00000b    beq    24ca4 <_ZN8SDRAMSIMclEiiiiijiss+0x650>
24c7c:    caffff9f    bgt    24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24ca0:    eafffff3    b      24c74 <_ZN8SDRAMSIMclEiiiiijiss+0x620>
24cac:    1a000006    bne    24ccc <_ZN8SDRAMSIMclEiiiiijiss+0x678>
24cc8:    eaffff8c    b      24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24ccc:    e59f33c4    ldr    r3, [pc, #964] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24cd4:    e59f13c0    ldr    r1, [pc, #960] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24cd8:    e59f03fc    ldr    r0, [pc, #1020]        ; 250dc
<_ZN8SDRAMSIMclEiiiiijiss+0xa88>
24ce4:    1a000032    bne    24db4 <_ZN8SDRAMSIMclEiiiiijiss+0x760>
24cec:    1a000030    bne    24db4 <_ZN8SDRAMSIMclEiiiiijiss+0x760>
24cf8:    0a00002d    beq    24db4 <_ZN8SDRAMSIMclEiiiiijiss+0x760>
24d04:    0a00002a    beq    24db4 <_ZN8SDRAMSIMclEiiiiijiss+0x760>
24d10:    1a000016    bne    24d70 <_ZN8SDRAMSIMclEiiiiijiss+0x71c>
24d28:    1a000019    bne    24d94 <_ZN8SDRAMSIMclEiiiiijiss+0x740>
24d50:    e59f2388    ldr    r2, [pc, #904] ; 250e0
<_ZN8SDRAMSIMclEiiiiijiss+0xa8c>
24d6c:    eaffff63    b      24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24d78:    e59f32fc    ldr    r3, [pc, #764] ; 2507c
<_ZN8SDRAMSIMclEiiiiijiss+0xa28>
24d88:    e59f0354    ldr    r0, [pc, #852] ; 250e4
<_ZN8SDRAMSIMclEiiiiijiss+0xa90>
24d90:    eaffffe5    b      24d2c <_ZN8SDRAMSIMclEiiiiijiss+0x6d8>
24d98:    e59f1348    ldr    r1, [pc, #840] ; 250e8
<_ZN8SDRAMSIMclEiiiiijiss+0xa94>
24d9c:    e59f02d8    ldr    r0, [pc, #728] ; 2507c
<_ZN8SDRAMSIMclEiiiiijiss+0xa28>
24db0:    eaffffdd    b      24d2c <_ZN8SDRAMSIMclEiiiiijiss+0x6d8>
24db8:    1a00008a    bne    24fe8 <_ZN8SDRAMSIMclEiiiiijiss+0x994>
24dc0:    0a000088    beq    24fe8 <_ZN8SDRAMSIMclEiiiiijiss+0x994>
24dcc:    1a000085    bne    24fe8 <_ZN8SDRAMSIMclEiiiiijiss+0x994>
24dd8:    1a00003c    bne    24ed0 <_ZN8SDRAMSIMclEiiiiijiss+0x87c>
24de4:    1a00002a    bne    24e94 <_ZN8SDRAMSIMclEiiiiijiss+0x840>
24dfc:    0a000029    beq    24ea8 <_ZN8SDRAMSIMclEiiiiijiss+0x854>
24e30:    0a000021    beq    24ebc <_ZN8SDRAMSIMclEiiiiijiss+0x868>
24e60:    0affff26    beq    24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24e88:    e59f3250    ldr    r3, [pc, #592] ; 250e0
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24e90:    eafffe1a    b    24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24e94:    e59f31fc    ldr    r3, [pc, #508] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24e9c:    e59f11f8    ldr    r1, [pc, #504] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24ea0:    e59f0234    ldr    r0, [pc, #564] ; 250dc
<_ZN8SDRAMSIMclEiiiiijiss+0xa88>
24ea8:    e59f31e8    ldr    r3, [pc, #488] ; 25098
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24eb0:    e59f11e4    ldr    r1, [pc, #484] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24eb4:    e59f0230    ldr    r0, [pc, #560] ; 250ec
<_ZN8SDRAMSIMclEiiiiijiss+0xa98>
24ebc:    e59f31d4    ldr    r3, [pc, #468] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24ec4:    e59f11d0    ldr    r1, [pc, #464] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24ec8:    e59f0220    ldr    r0, [pc, #544] ; 250f0 <_ZN8SDRAMSIMclEiiiiijiss+0xa9c>
24ed8:    1a000033    bne    24fac <_ZN8SDRAMSIMclEiiiiijiss+0x958>
24ef0:    0a000032    beq    24fc0 <_ZN8SDRAMSIMclEiiiiijiss+0x96c>
24f04:    e59f21e8    ldr    r2, [pc, #488] ; 250f4 <_ZN8SDRAMSIMclEiiiiijiss+0xaa0>
24f28:    1a000029    bne    24fd4 <_ZN8SDRAMSIMclEiiiiijiss+0x980>
24f7c:    0afffddf    beq    24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24fa0:    e59f3138    ldr    r3, [pc, #312] ; 250e0
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24fa8:    eafffdd4    b    24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24fac:    e59f30e4    ldr    r3, [pc, #228] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24fb4:    e59f10e0    ldr    r1, [pc, #224] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24fb8:    e59f011c    ldr    r0, [pc, #284] ; 250dc
<_ZN8SDRAMSIMclEiiiiijiss+0xa88>
24fc0:    e59f30d0    ldr    r3, [pc, #208] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24fc8:    e59f10cc    ldr    r1, [pc, #204] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24fcc:    e59f0118    ldr    r0, [pc, #280] ; 250ec
<_ZN8SDRAMSIMclEiiiiijiss+0xa98>
24fd4:    e59f30bc    ldr    r3, [pc, #188] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
24fdc:    e59f10b8    ldr    r1, [pc, #184] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
24fe0:    e59f0110    ldr    r0, [pc, #272] ; 250f8 <_ZN8SDRAMSIMclEiiiiijiss+0xaa4>
24fec:    1afffdc3    bne    24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
24ff4:    0a000005    beq    25010 <_ZN8SDRAMSIMclEiiiiijiss+0x9bc>
25000:    0a000002    beq    25010 <_ZN8SDRAMSIMclEiiiiijiss+0x9bc>
2500c:    1afffdbb    bne    24700 <_ZN8SDRAMSIMclEiiiiijiss+0xac>
25010:    e59f4064    ldr    r4, [pc, #100] ; 2507c
<_ZN8SDRAMSIMclEiiiiijiss+0xa28>
25020:    e59f00d4    ldr    r0, [pc, #212] ; 250fc <_ZN8SDRAMSIMclEiiiiijiss+0xaa8>
2502c:    e59f1054    ldr    r1, [pc, #84] ; 25088
<_ZN8SDRAMSIMclEiiiiijiss+0xa34>

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2503c:    e59f1048    ldr    r1, [pc, #72] ; 2508c
<_ZN8SDRAMSIMclEiiiiijiss+0xa38>
2504c:    e59f103c    ldr    r1, [pc, #60] ; 25090
<_ZN8SDRAMSIMclEiiiiijiss+0xa3c>
2505c:    e59f1030    ldr    r1, [pc, #48] ; 25094
<_ZN8SDRAMSIMclEiiiiijiss+0xa40>
25068:    e59f3028    ldr    r3, [pc, #40] ; 25098
<_ZN8SDRAMSIMclEiiiiijiss+0xa44>
25070:    e59f1024    ldr    r1, [pc, #36] ; 2509c
<_ZN8SDRAMSIMclEiiiiijiss+0xa48>
25074:    e59f0084    ldr    r0, [pc, #132] ; 25100
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