
# Linux for DesignWare® ARC® Release Notes 3.2

Version 5976-013 October 2012

## DesignWare® ARC Linux Release Notes

Synopsys, Inc.



Synopsys, Inc.
700 E. Middlefield Road
Mountain View, CA 94043
www.synopsys.com

# Contents

*Customer support is available through SolvNet online customer support and through contacting the Synopsys Technical Support Center for ARC Processor licensees with active/valid Core Support*

# Accessing SolvNet

SolvNet includes an electronic knowledge base of technical articles and answers to frequently asked questions about Synopsys tools. SolvNet also gives you access to a wide range of Synopsys online services, which include downloading software, viewing Documentation on the Web, and entering a call to the Support Center.

To access SolvNet:

1. Go to the SolvNet Web page at http://solvnet.synopsys.com/.
2. If prompted, enter your user name and password. (If you do not have a Synopsys user name and password, follow the instructions to register with SolvNet.)

If you need help using SolvNet, click SolvNet Help in the Support Resources section.

# Contacting the Synopsys Technical Support Center

If you have problems, questions, or suggestions, you can contact the Synopsys Technical Support Center in the following ways:

- Open a call to your local support center from the Web by going to http://solvnet.synopsys.com/ (Synopsys user name and password required), then clicking “Enter a Call to the Support Center.”

Send an e-mail message to your local support center.

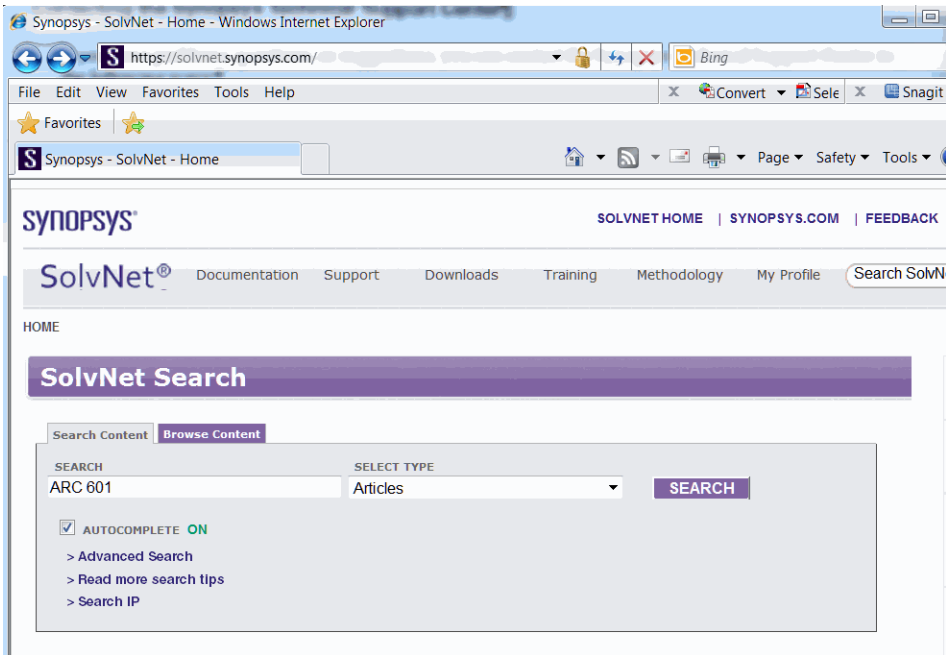
- E-mail support_center@synopsys.com from within North America.
- Find other local support center e-mail addresses at http://www.synopsys.com/Support/GlobalSupportCenters

- Telephone your local support center.
  - Call (800) 245-8005 from within the continental United States.
  - Call (650) 584-4200 from Canada.
  - Find other local support center telephone numbers at http://www.synopsys.com/support/support_ctr.

# Accessing ARC Application Notes

SolvNet articles include useful application notes to help you do your job using DesignWare ARC products. To find application notes for your DesignWare ARC product, do the following:

1. Go to the SolvNet Web page at http://solvnet.synopsys.com/.

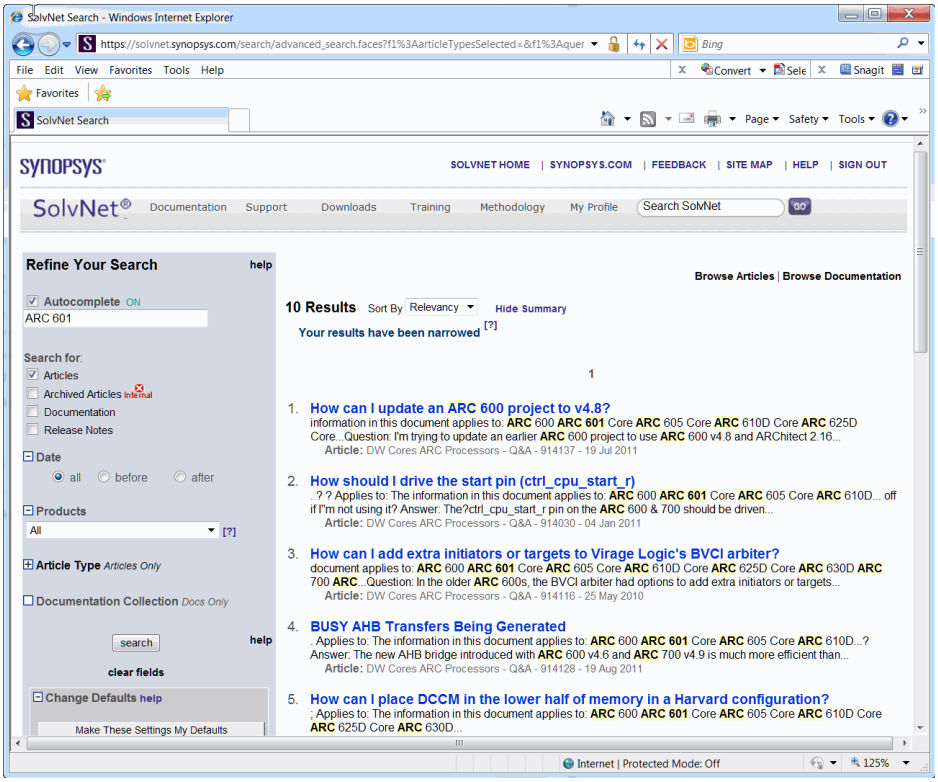



2. Enter the name of your product in the **Search** field.
3. Select **Articles** from the **Select Type** drop-down list.
4. Click **Search**

The figure below shows example results.

**Note**

Application notes are updated frequently, so results can vary.



# 1 Introduction

*Welcome to Linux for DesignWare ARC Processors, also referred to as ARC Linux. ARC Linux is a port of the Linux kernel to the ARC 700 CPU architecture, supporting both the ARC 750D and ARC 770D processors*

## Typographical Conventions

This document uses the following typographical conventions:

| Convention | Meaning | Examples |
|---|---|---|
| **bold** | • functions<br>• predefined classes<br>• values to be entered literally<br>• GUI elements | • **get_callback()**<br>• the **simple_initiator_socket** class<br>• **template**<int *init*, int *target*><br>• Select **Save All**. |
| *italics* | • text to be replaced with your own values<br>• titles of manuals | • *InstallationDir*/MetaWare<br>• **sc_time** *p* //period<br>• *DesignWare ARC Linux Getting Started* |
| monospace | code in general | ls.push_back("SHMEM"); |

## Module Version Numbers

ARC Linux consists of the following module version numbers:

| | |
|---|---|
| Linux kernel | 3.2 |
| ARC InitRAMfs | - |
| U-Boot | 2012.07 |

# Features

- ARC Linux is port of the Linux kernel to the ARC 700 architecture, including among other features support for MMU, on-chip timers, precise exceptions, interrupt handling, and VIPT caches).
- Linux feature support includes all features expected any modern Linux port, such as kernel preemption (`CONFIG_PREEMPT`), high-resolution timers, OProfile, `perf`, etc.

# Deliverables List

| Product | Components | Description |
|---|---|---|
| ARC Linux | ARC Linux | The Linux kernel source code. (https://github.com/foss-for-synopsys-dwc-arc-processors/linux) |
| | ARC InitRAMfs | An easy-to-configure container for a Linux initial RAM disk (https://github.com/foss-for-synopsys-dwc-arc-processors/arc_initramfs_archives) |
| | U-Boot | Denx Universal Boot Loader. (https://github.com/foss-for-synopsys-dwc-arc-processors/u-boot/) |

# Documentation

ARC Linux is supplied with all the standard Linux and U-Boot documentation in their customary locations.

```
arc_linux_3.2/Documentation
u-boot-2012.07/doc
```

# 2
# Release Change Information

*This chapter describes the major changes from previous releases of ARC Linux.*

## ARC Linux Release 3.2

The following top-level components are included in this release:

- Linux 3.2 kernel
- Custom initramfs with pre-built ARC GNU libraries, BusyBox, and `strace`
- U-Boot 2012.07

The newly supported features in the Linux kernel are described in the following subsections.

### Hardware Support

- Synopsys HAPS51 FPGA Prototyping System support
- Explicit platform support for SoCs and development boards: ARC Linux kernel distinctively compartmentalized into ARC common and ARC platform(s) code to allow for easy integration of new ARC based platforms.
- Legacy ARC FPGA Board ARCAngle4 no longer officially supported.

### Features

- Better alignment with open-source philosophy: Source code is now hosted on github for easy collaborative development.
- Closer upstream alignment: generic headers, generic IRQ,
- `CONFIG_PERF_EVENTS`: Basic support for `perf`
- `CONFIG_CPU_BIG_ENDIAN`: Support for a big-endian orientation on ARC 700
- `CONFIG_SMP`: This feature includes platform-independent ARC common code to support any SMP platform and as reference SMP-enabled platform code (MetaWare ISS simulation).
- `CONFIG_ARC_USE_HW_MPY`: Supports kernel builds with hardware multiplier.
- Support for GNU toolchain for DesignWare ARC v4.4 (gcc 4.4.7)

## Debugging

- CONFIG_KGDB: In-kernel debugger KGDB support to debug the Linux kernel from an external host

  For more information on KGDB, see *Linux for DesignWare ARC Getting Started*.

- Support for enabling DWARF stack unwinding out of loadable kernel modules.
- strace 4.7

## Optimizations

- Core checksum routines **csum_fold()** and **ip_fast_checksum()** optimized by loop unrolling and modulo scheduling.
- USER ABI v2: New syscall ABI to optimize some of the frequently used system calls (e.g., stat family).
- ioremap optimization: For addresses in ARC 700 uncached address space, V-P mappings are not needed, reducing overall pressure on MMU TLB.

## Robustness

- CONFIG_DEBUG_KMEMLEAK: kmemleak support

## Enhancements

- CONFIG_CMDLINE_UBOOT: Support for bootloader-provided standard command line. Older tag parsing removed.
- CONFIG_DEVTMPFS: This feature removes the need for creating static device nodes in initramfs prior to kernel build, which in turn requires root or sudo permissions on the build machine.

## Fixed Issues

- 9000487933 debug_frame section allocation after vmlinux is already built
- 9000519842 Usability Issues in Linux kernel built with gcc 4.4.7
- 9000553036 CONFIG_CONSOLE_POLL causes Linux 3.2 build to fail
- 9000558321 Inconsistent kprobe behavior for modules
- 9000575139 DW PGU2 driver lacks mandatory functionality, causing crashes

# ARC Linux Release 1.4

The following top-level components are included in this release:

- Linux 2.6.35.12
- Custom initramfs with pre-built ARC GNU libraries, BusyBox, strace
- U-Boot 2009.06

**Note**

BusyBox sources are no longer part of the release. Any recent upstream BusyBox version is expected to work with this kernel and toolchain combination (see the *Getting Started* guide for more details). The initramfs does have a verified, pre-built BusyBox 1.18.4.

The newly supported features in the Linux kernel are described in the following subsections.

## Hardware Support: Updated ARC700 core (Rel. 4.10)

- Support for ISA enhancements: `CONFIG_ARCH_HAS_LLSC` for atomic read-modify-write `LLOCK`/`SCOND` instruction; `CONFIG_ARCH_HAS_SWAPE` for single-cycle endian swap instruction
- `CONFIG_ARC_MMU_V3`: Support for Bigger J-TLB (128 x 4) and new CDU programming model
- Support for variable MMU page sizes: `CONFIG_ARC_PAGE_SIZE_4K`, `CONFIG_ARC_PAGE_SIZE_8k`, `CONFIG_ARC_PAGE_SIZE_16k`

**Note**

The default page size is 8 K. A system with different page size not only requires a kernel rebuild but also uClibc, the system shared libraries (libc, libm, etc.) and also user applications: BusyBox. For details, see the file `arch/arc/Documentation/arc-enabling-non-default-mmu-page-sz.txt` in your release.

In addition, due to a possible software cache-aliasing issue, Linux cannot be run on a 4-K page configuration with Caches greater than 16 K.

- Support for a patent-pending MMU enhancement for optimized shared libraries: `CONFIG_ARC_MMU_SASID`
- Support for variable cache-line size (32, 64, or 128 bytes). This is not a configuration option—select it by changing a single dial `L1_CACHE_SHIFT` in `kernel header arch/arc/include/asm/cache.h`

## Features

- `CONFIG_ARCH_ARC_FPU` for supporting floating point in the user space by saving FPU registers across context switches

- CONFIG_ARC_MISAILGNED_ACCESS to support emulation of unaligned memory access (user space only) for ease of application porting
- Correct restarting of timer related system calls: Supporting internal flag ERESTART_RESTARTBLOCK
- CONFIG_FUTEX to support futex for fast user-space synchronization primitives.

## Debugging

- CONFIG_KPROBES to dynamically debug/instrument kernel without recompile or reboot
- Ported upstream strace to assist user programs in debugging (tracing system calls)
- Dmalloc library support

## Optimizations

- Optimized Cache Flush API called by core kernel. Multiple full-cache flush/invalidates on fork/execve/exit are now removed.
- Major improvements of fork/execve timings due to shared address space ID feature of the ARC 700 4.10 MMU
- Optimized string and memory routines: **memcmp()**, **strchr()**, **strcpy()**, **strcmp()**, **strlen()**
- Page-table traversal split changed from 8:11:13 to 11:8:13
- Kernel built without `-mlong-calls`, reducing the generated code size in binary by approximately 10%
- optimised **ffs( )**, **fls( )**, **ffz( )**, **local_irq_save( )**

## Robustness

- Bug fixes: See Fixed Issues for details.
- More robust early **printk()** support - detecting and reporting a lot more mismatches between hardware (which is much more configurable now) and software (kernel)
- Completely rewritten UART driver fixes numerous user-space TTY-related bugs.
- Single toggle CONFIG_LINUX_LINK_BASE to enable Linux linkage at non-default 0x8000_0000

**Note**

This release of ARC Linux requires the ARC GNU v2.4 Toolchain. If you are upgrading to ARC Linux v1.4, you must also upgrade the ARC GNU Toolchain to v2.4.

## Enhancements

- 9000469866 Add username/password options to mount
- 9000470323 Add ML50x ARC 700 support to U-Boot Boot Loader
- ARS0090743 Add efficient `find_first_bit` and `find_next_bit` macros in ARC Linux
- ARS0092109 Serial-driver cleanup
- ARS0096414 Make a simulator-friendly version of BusyBox config
- ARS0097746 make **memcmp()**, **memcpy()** faster in ARC Linux kernel
- ARS0098477 STrace port for ARC Linux
- ARS0099483 Add software patch to support unaligned memory access
- ARS0099531 Add documentation on NFS cross-development
- ARS0102482 Add ARC Linux/uClibc support for **mmap()** with 4 k size

## Fixed Issues

- 9000464222 `CONFIG_EARLY_PRINTK` non-functional
- 9000470340 FUSE configuration failed
- 9000471224 LTP tripping a `BUG_ON` in kernel in cmn-vaddr-alloc subsystem
- 9000471721 `gcc`-hostlink for MetaWare build failed on Linux
- 9000473698 Make Qt demos work with 2.6.35 kernel and ARC 700 4.10
- 9000473699 Duplicate Pd issue (was: IDE disk won't work on 2.6.35 kernel with 4-K page size)
- 9000473700 userland built for 16-K pgsz not coming up in 2.6.35 kernel with 16-K pgsz
- 9000473994 LMbench crashes with 4.10 64-byte line length
- 9000477999 Linux kernel gets wrong IP from DHCP when configured with NFS as root file system
- 9000485549 **pthread_create()** call causes segmentation fault
- 9000488757 Linux 1.4 build breakage when built with caches disabled (RC1)
- 9000491107 `CONFIG_SWAP` broken in Linux pre-1,4, 1.3, 1.2
- ARS0095396 Setting baud rate of ARC UART from user space using `tcsetattr` doesn't work
- ARS0096195 `ifconfig up - down - up` causes error
- ARS0098447 Occasional Kernel panic in `gdb` debug (v2.6.26)

- ARS0098807 TFTP download is failing sometimes
- ARS0098822 Merge changes from U-Boot branch `ml50x_arc600_bootrom` into trunk
- ARS0098885 I_CACHE_BUILD register changed in the hardware
- ARS0098956 OProfile doesn't work with Linux 1.3 release kernel (patch needed)
- ARS0099056 BusyBox `top` seems to be occasionally stuck in a loop
- ARS0099181 Unable to load application with U-Boot
- ARS0099193 Disable EMAC LV2 if timer is not configured on LV2
- ARS0099511 Peripheral base in `/proc/cpuinfo` is incorrect
- ARS0099524 Reboot has some issues
- ARS0099527 *Getting Started* needs minor edits
- ARS0099649 `stty` returns 9600 even though baud is actually 57600
- ARS0099658 `/etc/hosts` in ramfs contains incorrect information
- ARS0099767 `ifconfig` command results in `get stats called` message on console
- ARS0099784 Linux 2.6.30 and 128-byte cache-line length
- ARS0099796 ENET simulation configuration option unclear
- ARS0100000 Document memory map restrictions for kernel
- ARS0100013 No `Documentation/arc` in ARC Linux distro
- ARS0100027 Default configuration for ISS should point to MMU v2
- ARS0100264 New UART driver hangs in ISS
- ARS0100656 `arch/arc/kernel/arcksyms.c` could add `__divsf3` and `__floatunsisf`
- ARS0101127 ARC Linux build failure with `CONFIG_IP_MULTICAST` enabled
- ARS0101512 Kernel-thread crash: unable to handle kernel paging request
- ARS0102285 Kernel crash when accessing files in `cramfs/squashfs`
- ARS0102425 Running a program with `gdbserver/gdb` causes segfault
- ARS0102758 LTP `sigaction/16-1.test` failing with `CONFIG_MMAP_CODE_SPACE`
- ARS0102864 Kernel boot stops early with ISS

# ARC Linux Release 1.3

The following top-level components are included in this release:

- Linux 2.6.30
- BusyBox 1.15.3
- U-Boot 2009.06
- Custom Initramfs with pre-built ARC GNU libraries and Busybox

The newly supported features in the Linux kernel are described in the following subsections.

## Hardware Support: New Features and Changes

- CONFIG_ARCH_ARC_ICCM and CONFIG_ARCH_ARC_DCCM : Support for closely coupled memory (ability to use DCCM and ICCM to optimize data and code performance)
- CONFIG_ARCH_ARC_MMU_V2 : MMU V2, which performs significantly better then V1, is the default.

**Note**
The kernel fails to boot if you attempt to run it on MMU-V1. If your ARC 700 processor does not have MMU-V2, disable this option in the `.config` file of your kernel.

- HAPS515 (Xilinx ML509) support—early version
- Support for single-cycle byte-swap instruction in kernel if implemented as extension instruction in hardware

## Features

- CIFS support
- CONFIG_ARCH_ARC_HLINK: User-space file system for host access via the MetaWare debugger's hostlink interface. This allows file I/O on the host from ARC Linux running on the ISS or hardware without a working Ethernet support.
- CONFIG_ARCH_ARC_SPACE_RND: Address-space randomization
- CONFIG_ARC_STACK_NONEXEC: Non-execute stack-mode option
- CONFIG_VFB_SIM: Virtual Framebuffer support for use with simulators
- CONFIG_ROOT_NFS : NFS-based root-filesystem now works out of the box.
- CONFIG_STACKTRACE kernel option to help trace sleeping tasks
- CONFIG_LATENCYTOP to find the latency of tasks in kernel mode

## Kernel Debugging

- CONFIG_EARLY_PRINTK to provide early serial-port support to help debug kernel bring-up on custom hardware

- CONFIG_ARC_USER_FAULTS_DEBUG is now replaced with a run-time toggle /proc/sys/kernel/print-fatal-signals to dump task state after a task is killed by a signal.
- Same kernel binary can now run on both hardware (AA4) and simulator to quickly debug field issues.

### Optimizations

- Signal-handling code no longer flushes TLB and caches for returning to kernel mode.
- Fast-Path I/D-TLB Refill handlers rewritten to reduce number of instructions (40/129) as opposed to (117/396).
- Five-cycle **htonl()** as opposed to nine cycles (and provision for one-cycle hardware-assisted bswap as described above)
- Reduced code size for **copy_to_user()** and **copy_from_user()** heavily used in networking and system calls.
- ARC EMAC Ethernet driver now works in NAPI mode by default. CONFIG_EMAC_NAPI provides dynamic switching between polling and interrupt modes for optimal system performance.
- Numerous other optimizations such as ext2-bitops/mutexes

### Robustness

- Bug fixes
- Expanded LTP testing up from 690 kernel syscall tests to 819 kernel tests and an additional 1965 OpenPosix tests

**Note**
This release of ARC Linux requires the ARC GNU v2.3 Toolchain. If you are upgrading to ARC Linux v1.3, you must also upgrade the ARC GNU Toolchain to v2.3.

## ARC Linux Release 1.2

This release supports the Linux 2.6.26 kernel and updated BusyBox and U-Boot components.

The key new features of this release are as follows:

- Linux 2.6.26
- High-resolution timers

- Tickless idle (for lower power)
- Real-time signals support
- Two levels of interrupt support
- NAPI support on the ARC EMAC for greatly improved networking performance
- Finely tuned **copy_from()** and **copy_to()** user code
- Re-worked DMA mapping API, optimized to flush only cache lines used
- Support for XFS, JFS, and EXT2
- Support for building with both **-**`O3` and **-**`Os`
- Support for `/proc/interrupts`
- BusyBox 1.13.2 support
- U-Boot 2009.01
- Numerous architecture-level code bug fixes and performance enhancements

# ARC Linux Release 1.1

This release supports the Linux 2.6.19 maintenance release.

The key features of this release are:

- Linux 2.6.19 maintenance release
- OProfile support
- Numerous new system calls supported
- U-boot command line support
- IPv6 support
- Busybox 1.12.1 support
- First ARC release of u-boot
- Updated debugging features, including
  - Kernel Stack Trace in Exceptions
  - Low Level Event Logging (similar to LTT)
  - Diagnostics to debug User Task Crashes (SegV)
- Updated performance:
  - r25 Register dedicated to current task pointer

  - ARC-optimized page copy and **memcpy()** functions
  - Cache-flush and TLB flush functions optimized
- New hardware support:
  - ARC 700 MMU v2 supported
  - ARC 700 hardware performance counters supported
  - ARC PGU and AC'97 support

# ARC Linux Release 1.0

This is the first release of ARC Linux from ARC. The release is based on the release found at www.arc-linux.org and has many major bug fixes and enhancements over that release.

The key features of this release follow:

- Linux 2.6.19 release
- Serial-driver changes to support multiple serial ports
- Ethernet driver pre-allocates SKBs for performance increase
  - A kernel thread runs and pre-allocates SKBs ready for use by the driver ISR
- Super-fast **copy_from_user() a**nd **copy_to_user()** functions heavily optimized for ARC
  - Instead of a byte copy, the function tries first to use an ARC-optimized read-read-read-read-write-write-write algorithm
- Re-write of the low-level TLB handling fixes multiple bugs exhibited as segmentation faults
- MMU ASID allocation fixed: Upon ASID rollover, if long-running task's ASID was acquired by a new task, TLBs were not being flushed
- MMU ASID allocation optimized: For a simple shell command such as `ls`, ASID now optimally increments by 4 instead of 13. This delays the ASID rollovers and hence TLB flushes
- Diagnostic code added in slow-path and fast TLB-miss handlers to catch any potential ASID-allocation issue.

  This has a minimal impact on performance, but if it needs to be disabled, change `#if 1` to `#if 0` to disable the check in the following files:
  - `arch/arc/mm/tlb.c:252`
  - `arch/arc/mm/tlbex.S:307`.
- The following issues have been addressed:

- Setting the system date with `date` (architecture-specific code implemented). Previously generated a segmentation fault
- Threading issue where child threads became unresponsive (missing **copy_to_user()** in the signal handling code, plus an array out of bounds access)
- Idle loop goes into sleep mode rather than a `while` loop
- Re-schedule was called twice for each clock tick
- Support for running on ARC xISS and ARC ISS simulators.