

Snap-Master Support of Keithley I/O Hardware

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This document provides an overview of the Keithley I/O hardware support by Snap-Master. It is intended to bridge the Snap-Master User's Guide and Keithley documentation. Please refer to each of those documents as well.

1. CONFIGURATION

The Keithley hardware handler for Snap-Master relies upon DriverLINX drivers for your Keithley hardware. This includes configuration settings. Before you attempt to use Snap-Master to control your Keithley hardware, you must:

- 1) Install the appropriate DriverLINX Driver software in your PC from the Keithley CD shipped with your I/O hardware, or from the Snap-Master CD if it has Keithley drivers for your hardware, or from the Keithley website download center at www.keithley.com. For example with a KPCI-3107 or 3108, first install the driver using the file kp08a4dl.exe, then run the update to this driver 3108-850a04[1].0.0.1.exe.

- 2) Install the hardware in your PC, and

- 3) Use the DriverLINX Configuration utility (from Start, All Program, DriverLYNX) to set hardware configuration options such as clock frequency and channel configuration (Single-Ended or Differential). Make a note of the Logical Device #, clock frequency and channel configuration for your hardware. Also, make a note of the Driver Name (found in the Properties dialog for your board).

1.1 BOARD TYPE

When you first install a Keithley element in an instrument and no KTH16.CNF (configuration store) exists yet, the first board type is a DAS-8. You will need to select your board model in the A/D element's Hardware Configuration dialog.

1.2 BASE ADDRESS

Because there is no actual selection of your hardware's base address from Snap-Master, this field instead selects the Logical Device # of your board. This will be set to 0 most times. However, if you have multiple boards installed for a given driver, each board for that driver will have a unique logical device #, starting at 0 and incrementing. You can determine the logical device # for a board by opening the DriverLINX Configuration utility (Windows Control Panel) and observing the tree view of driver types and logical devices within each driver type.

For example, if you have installed two KPCI-3108 boards and one KPCI-3116 board, you will see one KPCI-3100 series driver with a single KPCI-3116 board (Device 0) and one KPCI-3108 driver with two KPCI-3108 boards (Devices 0 and 1). Setting the Board Type and Base Address settings

for each board in Snap-Master will refer to each unique DriverLINX configuration and the associated hardware.

1.3 CLOCK FREQUENCY

In the "Time Base" dialog reached from Snap-Master's Device Configuration dialog, you can select either an internal or external (on some hardware) pacer clock, and the corresponding frequency. This setting must match exactly the configuration in your device's DriverLINX Configuration dialog. If not, you could experience incorrect sample rates when acquiring analog data.

1.4 CHANNEL CONFIGURATION

There is no direct configuration for Single-Ended or Differential channels from within Snap-Master's Device Configuration for Keithley hardware. This is done from the DriverLINX Configuration utility. Snap-Master will allow you to select all channels on the hardware, but you will get an error when actually trying to sample data if channels are selected which are not available for the current configuration.

For example, if you have set the DriverLINX configuration for analog input channels to Differential on your KPCI-3108 board, you may only select channels A0 thru A7 in Snap-Master. If you select a channel between A8 and A15, you will see an error message appear when you attempt to sample analog input data.

2. ANALOG IN

2.1 PACING TYPES

There are five pacing types used on Keithley devices. Your hardware may or may not support all of these. In addition, internal and external pacing are supported on most hardware.

i. SOFTWARE

Software pacing uses Snap-Master and the PC's internal timer to determine when to sample A/D channels or output D/A channels. This method of sampling is fairly accurate for very low sample rates, but loses accuracy for sample rates of 100 Hz and above. This pacing type is recommended when you will sample at rates slower than 2 Hz. This pacing type is not as accurate as hardware pacing types.

All channels are sampled as quickly as possible in software at the given sample time. For example, if a 1Hz rate is selected using this pacing type for A/D, Snap-Master will sample all selected A/D channels when 1 second has elapsed, and the time between channels will be the minimum possible for software-driven sampling.

This pacing type corresponds to the Polled mode in DriverLINX.

ii. HARDWARE

This pacing type uses the INTERRUPT mode for the sampling process on your board. Typically, an interrupt is generated by the board's timer according to the sample rate set. When the interrupt occurs, software responds and samples selected channels as quickly as possible using a software method. Check with your hardware manual to see exactly how the INTERRUPT mode operates.

This pacing type corresponds to the Interrupt mode and uses the Rate Generator in DriverLINX.

iii. HARDWARE 2

This pacing type uses a Direct Memory Access (DMA) process to transfer data to or from your computer's memory without software intervention. This pacing type typically uses equally-spaced timing between channels. For example, if an A/D process is sampling 4 channels at 100 Hz, each channel is sampled every 10mS, but each of the 4 channels is sampled 2.5mS from the next. Check with your hardware manual to see exactly how the DMA mode operates.

This pacing type corresponds to the DMA mode and uses the Rate Generator in DriverLINX.

iv. HARDWARE (BURST IRQ)

This pacing type uses the INTERRUPT mode to acquire a burst of samples as fast as possible at the beginning of each pacer clock period. On some hardware, a FIFO is used to buffer A/D samples which could cause an apparent delay.

This pacing type corresponds to the Interrupt mode and uses the Burst Generator in DriverLINX. The Burst timing is set to the maximum hardware sample rate.

v. HARDWARE (BURST SCAN)

This pacing type uses Direct Memory Access (DMA), but along with a channel scan list on your hardware. All sampled channels are referenced by the board's channel scan list and sampled as a group at the maximum sample rate. However, the group scan is initiated at the sample rate programmed in Snap-Master. For example, an A/D process samples 4 channels at 100Hz on a KPCI-3108 with a gain of 1. These 4 channels are sampled within a group in a single "burst" of only 10uS apart (100KHz), but the group is sampled only every 10mS (100Hz). This minimizes channel-to-channel time skew which could be a factor in trying to cross-correlate channel data.

This pacing type corresponds to the DMA and uses the Burst Generator in DriverLINX. The Burst timing is set to the maximum hardware sample rate.

Note: the burst mode on the KPCI-3110 and KCPI-3116 is not supported.

vi. EXTERNAL PACING

If External Pacing is selected in the A/D Settings dialog, Snap-Master expects that you will provide an external pacing signal to the appropriate digital input on your hardware. Check your hardware documentation to see which input is used as an XPCLK input. For example, the KPCI-3116 has a dedicated A/D Pacing Clock input, whereas the KPCI-3108 uses input IP0.

2.2 SAMPLE RATE

Snap-Master will not allow you to sample faster than the maximum sample rate of your hardware. If you need to sample at a very slow rate (below 2 Hz per channel), you must select the Software pacing type.

2.3 CHANNEL RANGES

The Keithley hardware generally requires that all of the channels be bipolar (+ and – voltage) range, or unipolar (positive range only). Make sure that set the channels you are using consistently. For example if one channel is set to bipolar at $\pm 5v$ then only the other bipolar channels can be legitimately selected such as ± 10 or ± 2.5 , but not +10 or +2.5.

2.4 TRIGGERS

Snap-Master supports Software Analog and Software Digital trigger types. These trigger types use software scanning of analog or digital data and support pre-trigger data. The timing and amplitude accuracy of these trigger types is limited, yet they serve as very effective and flexible trigger methods.

Hardware dependant trigger types include Analog H/W and Digital H/W triggers. Also, the Digital H/W (Gated) trigger type is supported. Support varies among board types; Snap-Master makes these trigger types available according to the board type selected. Board features are stored in the KTH16.INI file. Note that Hardware Dependant trigger types are not supported with Software pacing. Some Keithley hardware only supports Hardware Dependent trigger types with Hardware 2 and Hardware (Burst Scan) pacing types.

Analog H/W triggering is supported with Above-threshold, Below-Threshold, +Slope, and -Slope triggers. All of these are based on a single analog threshold.

Digital H/W triggering uses the TGIN input, a dedicated digital input on your hardware. Usually this is digital input IP0. Check your hardware manual to find out which input is used for the external TTL trigger input.

Digital H/W (Gated) triggers also use the TGIN input to enable or disable sampling. Check your hardware's documentation for capabilities to see if gated samples are supported and what input is used.

3. ANALOG OUT (D/A)

Slow speed analog out is supported. High speed waveform generation is not currently supported. Note that you may not see the correct D/A waveform on the first frame but should work correctly after that.

Some D/A cards support different resolutions such as 12, 16 or 24 bits. Use the Keithley configuration utilities to define the resolution. For example the KPCI-3130 D/a card is supported only as a 16 bit D/A in Snap-Master even though it supports other resolutions. If you need another resolution, contact HEM Data for assistance.

4. DIGITAL INPUTS AND OUTPUTS (Digital I/O)

Most Keithley boards have a few dedicated digital multipurpose inputs (e.g. IP0-IP5) and dedicated digital multipurpose outputs (e.g. OP0-OP4). Some boards also have programmable digital input/output ports; these may be configured as input or output ports. Snap-Master numbers the digital channels as programmable port channels followed by dedicated multipurpose channels.

For example, the KPCI-3108 has 4 programmable 8-bit ports, 6 dedicated digital inputs (IP0-5), and 5 dedicated digital outputs (OP0-4). Digital channels on the KPCI-3108 are referred to in Snap-Master as inputs A0-A36 and outputs B0-B35 (assuming that the digital input element is element A, and the digital output element is element B). Inputs IP0-5 are referenced as A32-36 and outputs OP0-4 are referenced as B32-35 by Snap-Master. Programmable ports 0 and 1 are configured as inputs, and ports 2 and 3 are configured outputs.

Snap-Master Bit Assignment Example: KPCI-3108

	I/O port 0	I/O port 1	I/O port 2	I/O port 3	Multipurpose Bits (IP/OP)
Bit	01234567	01234567	01234567	01234567	012345
DIGIN Chans: A0-A37, A16-A31 are unavailable	AAAAAAAA 01234567	AAAAAA AA111111 89012345			AAAAAA 333333 234567
DIGOUT Chans: B0-B36, B0-B15 are unavailable			BBBBBBBB 11112222 67890123	BBBBBBBB 22222233 45678901	BBBBB 33333 23456

To configure a digital port as an input or output port, you must edit the KTH16.INI file. Locate the section in this file for your board, and set the element's "Bits" line accordingly. In the above example for the KPCI-3108 board, the settings would be:

[KPCI-3108.DIN]

Channels=38

; multipurpose inputs (IP0-6) are in last (MSB) bit group for all boards

Bits=11111111 11111111 00000000 00000000 111111

[KPCI-3108.DOUT]

Channels=37

; multipurpose channels (OP0-6) are in last (MSB) bit group for all boards

Bits=00000000 00000000 11111111 11111111 11111

Note: Digital I/O on the KPCI-3100 and KPCI-3116 are currently not supported

5. COUNTER/TIMER (C/T)

Currently there is no support for counter/timers.