FW-1000 Filterwheel

(for Tiger)

Instruction Manual

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Electrical Characteristics

AC Input: 90-264 VAC, 3.3 A (peak), 50/60 Hz

AC In-rush Current (Cold Start): 7 A (maximum), at 240 VAC

Fuse Replacement: 2.0 A Fast Blow 250 VAC for 110VAC operation

(Spare fuse located in Power Jack on Back Panel)

Mains supply voltage fluctuations not to exceed 10% of the nominal voltage

Indoor use only

WARNINGS

1. Ensure power switch is in the OFF position before plugging in the power cord.

2. Do not unplug or plug-in devices / cables when power is on.

3. Do not remove the front or back panels; no user serviceable parts are inside.

4. Do not insert hand or non-isolated tools into Control Box even with power off. Stored charge on capacitors could result in personal electrical shock or damaging of electrical components if contact is made to internal circuit boards.

5. For indoor use only.

6. Do not position controller so that there is no access to the back mains supply input.

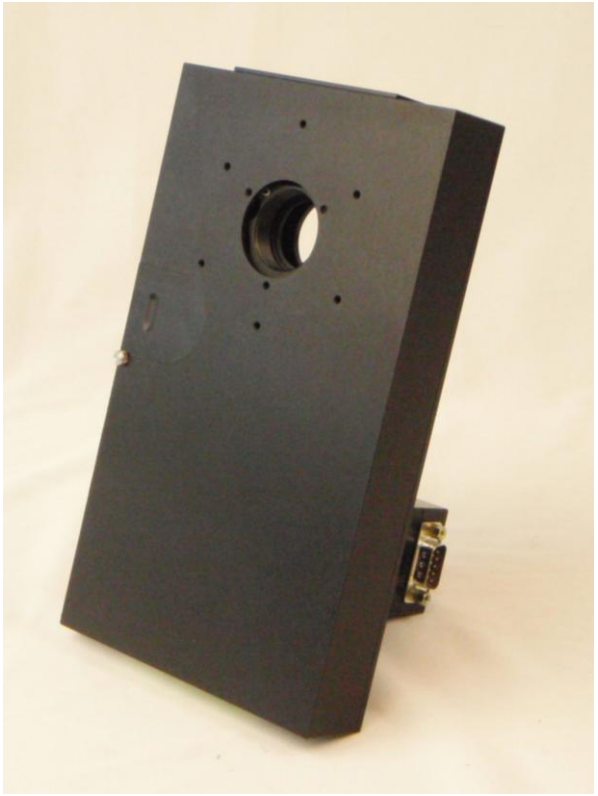
7. Protection provided by the equipment bay be impaired if the equipment is used in a manner not specified by ASI.

8. In the event of device failure, contact ASI: (541) 461-8181

   (800) 706-2284

   International: 011-541-461-8181

Description



FW-1000 Filterwheel

The FW-1000 uses a unique drive mechanism to give the lowest vibration possible when rotating to different filter positions. The ASI system is designed to work smoothly with the wheel loaded with filters. If filter positions are not used, the positions may be filled with the blank-off slugs provided for shuttering. For best results, attempt to maintain a balanced wheel. The filters and slugs should be distributed evenly about the wheel axis to keep second-order vibration minimized. The current FW-1000 design provides a side load door for easier access. Each slot has a 5 degree tilt to help avoid back reflection.

Tiger Control Box

The Tiger control box provides a unit that houses multiple control panel cards and allows for future expansion. Tiger Control Boxes are available in Six, Eight, or 16 slot configurations. The Com card provides communication to all cards installed into the controller system via an internal serial communication which is controlled by a PC via a USB connection. The COM card also has a reset button which resets all the Cards installed as well as an input for the ASI Joypod that can be set up to allow manual control for many control cards. A Tiger system can be supplied with just a Filter Wheel Control Card, with the optional Shutter Control Card, or with multiple control cards for various systems as seen in the photo above.

A FW-1000 Filterwheel Control Card Panel can handle two filterwheels and simultaneously move both wheels to the next set of filter positions. It may be controlled by the button or Trigger input on the panel. A Shutter Control Panel can handle two shutters, including the optional built-in shutters available with FW-1000 filterwheels. Both filterwheels and shutters may be controlled by computer commands via the RS-232 connector on the Filterwheel Control Panel. The shutters may also be controlled via the switches or TTL Trigger inputs on the Shutter Control panel.

Filterwheel Control Panel

The FW-1000 Filterwheel Control Panel provides control for two filterwheels, W0 and W1. The filterwheels are connected to the controller via the *W0 and W1 DB-9 Male Connectors* on the front panel. Upon power-up, any connected wheel will attempt to locate its HOME position and, if successful, its corresponding *LED numeric display* will indicate the wheel position. If no wheel is detected, the display digit will remain off. In the event of an unrecoverable error, the display will show the letter "E."

NEXT Button

Each press of the *NEXT* button advances the filterwheel(s) to the next pre-programmed filter position(s). In the event of an error, i.e., when an "E" is displayed on the LED display, holding the NEXT button down for 3 seconds will initiate a system reset. Holding the NEXT button down for more than 6 seconds will initiate a programmed sequence – equivalent to the serial **ST** command.

TRIG IN / SYNC OUT

A TTL input may be connected to the *TRIG IN BNC Connector* for triggered sequencing of the filterwheel(s). The *SYNC OUT BNC Connector* provides a TTL pulse as soon as the wheel(s) reach the commanded position(s). The *SYNC OUT* also provides flexible synchronization pulses when using the filter wheel in the *Spin/SYNC* mode of operation.

RS-232

The *RS-232 DB-9 Female Connector* is not connected to anything for the Tiger System. The connector is simply there to plug the hole on the plate.

Shutter Control Panel

The FW-1000 Shutter Control Panel provides for control for two shutters, 0 and 1. The shutters are connected to the controller with the *0 and 1 6-Pin Mini-Din Female Connectors* on the front panel. Upon power up, any connected shutter will go to its default position of *OPEN* or *CLOSED* depending on the position of the shutter's toggle switch and the type of shutter (normally-open or normally-closed). It should be noted that the panel/card will be set for either a normally-open or a normally-closed shutter at the factory. This setting can be changed using the *Shutter Setup* command (see page 34). The Shutter Control Panel is controlled internally through the Filterwheel Control Panel's RS-232 computer control serial port.

TOGGLE Switches

The two toggle switches for shutter 0 and 1 at the top of the panel allow manual override control of the shutter. When the toggle switch is placed in the left position, the shutter control is in the RS-232 controlled state that defaults to the de-energized position of the shutter at power up. When the toggle switch is moved to the right position, the control panel will energize the shutter for that switch. It should be noted that the switch must be in the LEFT position to be able to control the shutter through the Filterwheel Control Panel's RS-232 computer control port.

LEDS

If the shutter has a built-in internal position sensor, the corresponding *LED* will indicate the shutter is in its OPEN position if lit. If no internal position sensor is detected, the LED will always remain unlit.

TRG

A TTL input may be connected to the *TRIG IN BNC Connector* for external control of each shutter. A +5vdc signal applied to the internal pin of the *TRG IN BNC connector* (the outer connector is ground) will override any computer controls and energize the shutter.

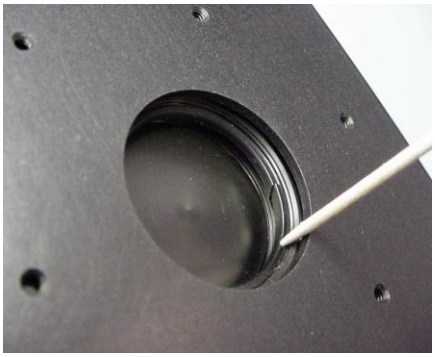
Order of Precedence

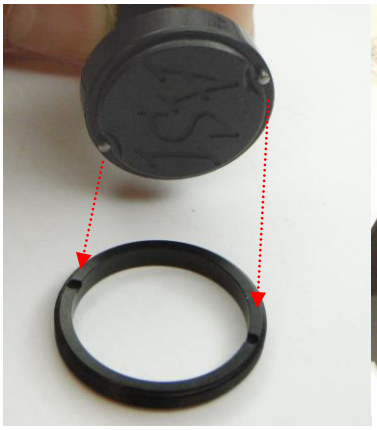
Whether it be computer serial control, toggle switch control, or TRG TTL control of a shutter, an energize signal from any one of them will dominate, and that shutter will remain energized until all control sources return to their de-energized state.

Installation

Installation of Filters

As outlined below in figures 1 and 2, the filters should be loaded into the wheel prior to installation on the microscope. Change the filters through the port on the side opposite the motor. Depending on the microscope, it may be necessary to remove the coupling adapter to the microscope to have better access to the filter holders.





ASI FW-1000 filter wheel rings.

On older obsolete units: Older units use a split retaining ring to hold filters, as shown upper left.

When correctly tightened, the threads and split-ring lock the filter securely in place. When removing, you can use a toothpick to "pop" the ring out of the threads and then spin the ring out.

Current units: utilize a bayonet style slot system. A special tool is used to twist rings into place on the filter wheel (upper center photo). Current filter wheels have a side loading door that can be removed to allow easier access to load filters and filter retainer rings using a clockwise rotation.

Please note the correct orientation / direction of the filter when installing it in place; most filter manufacturers inscribe an arrow that points in the direction the photons are expected to travel.

Installation of Adapters

Attach the filterwheel to the microscope using the mounting adapters supplied for your installation. The motor side on the filterwheel is located away from the microscope body for most installations. Attach the camera, detector, or lamp housing to the adapter on the motor side of the filterwheel.

Figure 3: Camera orientation adjustment on C-Mount

Emission Installations

In emission applications, the filterwheel is mounted between the photoport of the microscope and the camera. If you ordered your filterwheel for this application, an adapter specific to your microscope will be installed on one side of the filterwheel case. This adapter would mate with a photoport on your microscope. A male C-mount adapter shown in figure 3 will be installed on other side of the filterwheel case to mount a camera. The stainless steel portion of the C-mount adapter can be rotated to correctly position the camera. To rotate the C-mount adapter, use the 0.05" Allen wrench to loosen two of the three setscrews as shown in figure 3. After correctly positioning the camera, re-tighten these setscrews.

Excitation Installations

As shown in figure 4, the filterwheel may be mounted between the lamp housing and the microscope

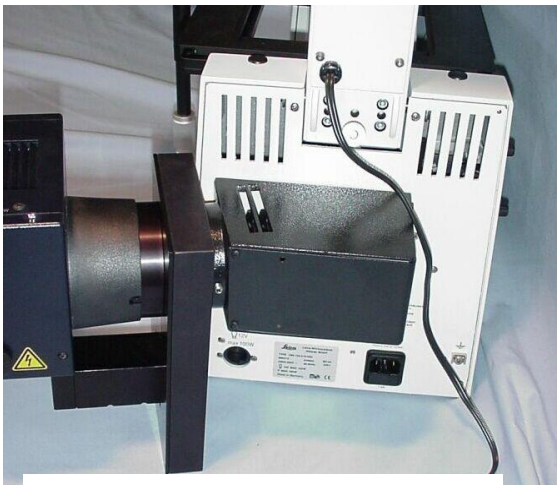


Figure 4: Excitation Installation

lamp housing port to control the excitation wavelength.

WARNING: When using the filterwheel in this manner, a heat filter must be installed between the lamp housing and the filterwheel or damage to the wheel will occur. If your lamp housing does not have a heat filter built into it, a heat filter must be ordered from ASI. This filter will be installed between the lamp housing adapter and the wheel.

Installation of Cables

Plug the AC power cord into the rear of the controller. Attach the cable between the filterwheel and the controller. Connect the serial cable between the computer and controller. *WARNING: Ensure that the power switch is in the "OFF" position while connecting or disconnecting connectors including the mains power plug. Connecting and disconnecting with the power on can result in permanent damage to the controller electronics.*

Figure 5: Power cord connection to rear of controller

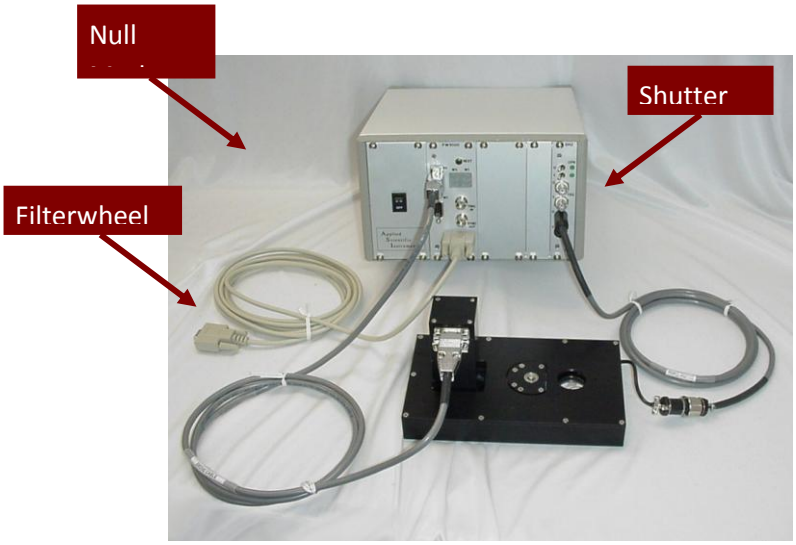
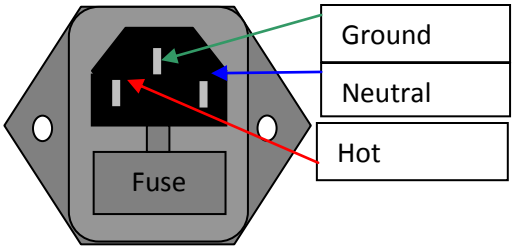


Figure 6: Cable connections on front of controller



The controller relies on proper orientation of the terminals on the mains input plug. The ground terminal must be properly earth grounded to provide safe protective grounding. Where possible, correct connection of Neutral and Hot convention should be followed.

Warning: Failure to follow Hot / Neutral conventions can result in failure of fuse shorting protection.

Danger: Failure to ground the ground terminal can result in failure of protection against electrical shock.

When setting up the controller several things should be taken into consideration. One the controller should not be setup in a location where access to the power cord is blocked. Although heat build up is generally not an issue, the controller should be placed where it can get adequate ventilation to the bottom air vents. The on/off power switch on the front of the controller should be easily accessible. The controller should be close enough to the filter wheel / shutters that there is no strain on the attachment cables.

FW-1000 Operation and Programming

Quick Start Procedure

Before installation on the microscope – check out the basic operation of the filterwheel and load your desired filters. The following Quick Start Procedure will walk you through these steps.

Plug the controller into an AC outlet and connect the filterwheel to the "W0" connector on the controller with the cable provided. Power up the filterwheel. Upon initialization, the wheel(s) will rotate to HOME.

The COM Card's USB link allows you to easily set up the filterwheel for your stand-alone or programmed operation. Upon plugging the USB cable from the PC to the COM card – a virtual serial port link is created automatically. The serial link direct control of the filterwheel(s) as well as diagnostic information.

Note: Since the Tiger system is designed to handle multiple cards with different communication protocols, you must first issue a Filter Wheel command before you see the Filterwheel command prompt.

0> (Command Prompt)

The "W0" digit of the numeric display on the controller should read "0", corresponding to the HOME position of the filterwheel. The "W1" digit should remain off if only one wheel is attached.

Try a few of the following commands; what you send is shown in **RED**:

0>MP *n* *n* Move wheel "0" to filter position *n,* where *n* is any valid filter position.

0>HO Cause the wheel(s) to seek HOME

0>P1 1 Read the value of P1 (the second programmed filter position)

Control indicates P1 for wheel "0" is set to 1

0>P1 3 3 Set the P1 value for wheel "0" to position 3

Control indicates P1 for wheel "0" is set to 3

0>ST Start a pre-programmed, timed move sequence.

0>HA Halt the move sequence

Press the "Next" button on the controller. The wheel(s) will advance to the next position of pre-programmed sequence each time the button is pressed.

If you have more than one filterwheel attached to the controller, change the active wheel with:

0>FW 1 1 Now all input will refer to wheel "1" where appropriate

1> The prompt indicates your commands are directed to wheel "1"

See the command list at the end of this manual for a complete description of the FW-1000 command set.

Programmed Sequences

The FW-1000 control card allows you to set up a series of filter positions that can be repeatedly sequenced in the order you desire. The sequence may be run with pre-set delays, with the front panel button, or with a TTL pulse connected to the front panel BNC connector. Alternatively, you may move both wheels to a pre-programmed position with the serial command, **Gn**, where *n* is the desired protocol position number.

Presently you may program up to 8 filterwheel positions for each wheel. You may also program a delay value for each step. The delay is used only when executing a time sequence using the **ST** (Start) serial command, and does not affect TTL-commanded sequencing. The wheel(s) will move to each programmed position in turn. The sequence will restart at the P0 position following the last position command (Pn) whose position for both wheels was not "-1". Initially, all programmed wheel positions are set to -1 except for P0 and P1 which are set to HOME (0) and to Position 1, respectively, for each wheel. The delay values are initialized with a value of 500 milliseconds for all positions.

The table below illustrates an example program sequence of five positions:

Command	Delay	Command	Wheel 0	Wheel 1
D0	500	P0	0	0
D1	500	P1	1	1
D2	500	P2	2	1
D3	500	P3	2	4
D4	500	P4	3	0
D5	500	P5	-1	-1
D6	500	P6	-1	-1
D7	500	P7	-1	-1

In this example, the P2, P3, and P4 positions for wheel 0 are changed to positions 2, 2, and 3 respectively. The P2, P3, and P4 positions for wheel 1 are changed to positions 1, 4, and 0 respectively. For successive TTL pulses (or button pushes) the wheels will advance as follows:

Pulse #	Wheel 0 Position	Wheel 1 Position
	0	0
1	1	1
2	2	1
3	2	4
4	3	0
5	0	0
6	1	1
7	2	1
Etc.	Etc.	Etc.

If you were to issue the serial command "**G4**" with the set-up above, the controller will move the wheels to the "P4" protocol position (i.e. Wheel 0, position 3 and Wheel 1, position 0). A subsequent TTL trigger would advance to P0 (i.e. Wheel 0, position 0 and Wheel 1, position 0).

If the serial command "**ST**" is issued, the wheels will advance from position to position with 500 ms delays between moves, moving continuously until the "**HA**" command.

Note: There is a HOME index on the encoder wheel located between the HOME (0) and the first (1) filter position. Each time the wheel passes this point, the position encoders are readjusted if necessary. This ensures that the wheel does not drift off its indexed position after many successive filter changes. The user should implement protocols that move the wheel across the index position (between positions 0 and 1) at least once in the course of the protocol cycle to ensure that the wheel does not drift from the indexed positions. The wheel will move the minimum distance between positions, so filter changes between the following positions will re-index the wheel: 0&1, 0&2, 0&3, 0&4, 7&1, 7&2, 6&1. Hence, it is recommended that you place your most commonly used filters in the HOME (0), 1, 2, 3, 6, and 7 positions.

Adjusting the Wheel Switching Speed

The FW-1000 controller is shipped with default speed settings that yield modest switching speeds and fairly smooth operation. Typical adjacent-filter switching time is about 70 milliseconds as shipped. The user has full control of the motion control parameters to affect faster switching speeds if desired, or slower speeds for even less vibration if that is necessary.

Establish communication with a host computer so you can program the controller. Issue the command "**VB 2**." This sets the verbose mode so that switching time, total move time, and maximum errors during move and settling are displayed following a move. Now if you issue a move command, following its completion, you will see the status line telling how long the move took.

0>HO HOME the wheel – should be at position 0

0>VB 2 Set controller to Verbose mode 2.

0>MP 1 Move to position 1

```
0>t:68 T:129 Em:10 Ef:-11
```

The line above shows that is took 68 milliseconds to get to position, and 129 milliseconds before all motors were completely turned off. **Em** and **Ef** show the maximum trajectory errors (in encoder counts) during the move into position, and during the settling period respectively.

You can change the run velocity **VR**, the up and down acceleration, **AU** and **AD**, or the servo motion parameters to affect the speed changes you desire (see page 30). You can see how your changes affect the switching speed and move errors when you make test moves. Once you are satisfied with your changes, you can save the settings to non-volatile (flash) memory with the serial command "**RS**." Afterwards, each time you power up the controller, your settings will be used.

If you try to use settings that are beyond the capability of the motor and the controller to follow, you will get errors when a move is initiated. Under these circumstances, change the offending

parameter to a more reasonable value, HOme the wheel to clear the error condition, and try again.

Adjusting the Filter Offset

The controller leaves the factory with the correct offset programmed into the controller for the wheel purchased. If, for some reason, you are using a different wheel or the correct offset is no longer programmed into the controller, you can use the following steps to reset it correctly.

1. Set up the wheel so that the filters can be observed in the aperture in the housing.
2. Set up serial communications to the controller and verify operation.
3. Issue the **OF** command (without a number) to see the present setting.
4. Issue the **HO** command to Home the wheel.
5. Note whether the filter at position zero is centered in the housing aperature. If so, you are done. Save the setting (Step 8) if you have changed the setting.
6. Otherwise, make a guess at the correct value for the offset between 1 and 128 for 8-position wheel and 1-170 for 6-position wheel. Adjust your guess based upon your last try. Issue the offset command with your guess; e.g., **OF 65**.
7. Issue the **HO** command to Home the wheel and go to Step 5.
8. Issue the **RS** (Ram Save) command to save your setting to flash memory.
9. Turn the controller off – Wait a few seconds and turn the controller back on. The wheel should "Home" upon power–up and filter "0" should be centered in the housing aperture.

Spin/Sync Operation

In some applications the user may wish to continuously spin the filter wheels to obtain relatively rapid switching of filter sets. For instance, with an 8 position filter wheel, filled with alternating 340nm and 380nm filters, switching speeds of about 10ms between filters is possible for calcium ratio experiments. The filter wheel has flexible sync pulse output that can be used to trigger data acquisitions synchronized with the filters reaching alignment. This provides a relatively inexpensive and simple way of achieving fast switching times for applications such as ratio imaging or photometry. The following serial commands are applicable to spin/sync operation:

VR Sets rotation speed in encoder counts/sec. (One turn is 1024 counts)

SP Starts or stops the wheel spinning.

NP Specifies the number of sync pulses per revolution of the wheel.

PH Specifies the relative phase of the sync pulses.

PL Specifies the duration of the sync pulses.

See the programming manual section for details of these commands.

A simple way to verify operation of the spin/sync mode of operation is to use the SYNC output to power a LED light source. Properly adjusted, the LED should appear illuminated when viewed through the rotating wheel. The phase and pulse length of the sync pulse can be changed while the wheel is spinning so optimal timing can be verified. Observing the LED near the edges of the aperture can check for bleed-through from adjacent positions. Once the LED is observed cleanly in the aperture without any bleed through around the edges, the phase and pulse length parameters can be saved and the sync pulse will serve as the sampling gate for the detector.

Firmware Upgrades

The FW1000 controller can be remotely upgraded to the most recent firmware available. Please check the ASI website http://www.asiimaging.com/ for details.

Error Conditions

Servo or encoder error conditions are reported on the RS-232 port. Usually intermittent errors can be ignored. When unrecoverable motion errors occur, the motors will be turned off and the error condition will be indicated by an "**E**" on the LED display. This condition can be cleared by pressing the NEXT button to reset the controller, or by sending a HOME command to the offending motor.

The temperature of the driver transistors is monitored as well. If overheating occurs, the motors will be turned off and an "**H**" will be displayed on the LED display.

FW-1000 ASCII Command Set

The FW-1000 controller card responds to serial commands. The <*DEL*> and <*BS*> characters are not interpreted, so mistyping will result in erroneous commands. The FW-1000 control card uses the following serial communication settings:

115200 Baud; 8 data bits; No Parity; 1 stop bit; No Flow Control

Commands that accept an input parameter return the current value of that parameter. If a new value is given in the command, the new value will be returned; if no value is given in the command, the current value will be returned. For example consider the velocity run command.

When **[addr#]** appears in the format, then the intended card address must be prepended to the serial command, as the command is Card-Addressed.

0>VR 3195	Sending only the command returns the current value.
0>VR 2000 1995	Sending the command with a new value, the program returns the working value (in this case there was a rounding difference from what was specified).
0> VR 1995	

The command response is terminated with a <LF><CR> followed by the prompt characters "*0>*" or "*1>*" depending on which wheel is actively taking commands.

The only exception to this standard are the commands : ?, RW, RR, and RD. See command descriptions for differences from the standard.

The following commands apply to *both* or *neither* wheel, and do not depend on the currently selected wheel:

? *Busy Query*

The "*?*" command is immediately processed (no <CR> or <LF> required)

and a single digit Busy Status is returned. The returned digit has the following meaning:

0 Neither wheel moving (not busy).

12 One or both wheels moving

16 The wheels have stopped off position

Example:

```
0>?<CR>                    Note: <CR> not required
0
```

Note: The reply has no <CR> or <LF>, nor does it give the 0> prompt - just the numeric response. This is to allow a quick response without ASCII character overhead in the communication stream.

FW n *Filterwheel Number*

Sets the current Filterwheel for subsequent commands. Prompt shows currently selected wheel, e.g., **0>** is result of *FW 0* command. If the selected wheel is HOMED and ready to go, the FW command returns the selected wheel as normal. If the wheel is not ready for any reason, the response *ERR* is returned. Example:

0>FW 1 1 Normal – switch to FW 1

1>FW 0 ERR FW 0 not ready

0> Although FW 0 not ready – can still change FW 0 parameters.

HA *Halt*

Stops all motor movement; Halts protocol execution.

NF n *Number of Filters*

Sets the number of slots in the wheel, e.g., 6 or 8.

(Normally set at the factory.)

NP n *Number of Pulses/Revolution (Spin/SYNC mode only)*

Sets the number of synchronization pulses/revolution of the filter wheel. The pulses will be uniformly spaced and are synchronized with wheel's position encoder. Default setting is 1.

RD *RAM Defaults*

Restore factory default parameters.

In verbose mode 6 the <LF> & <CR> are omitted.

RW *RAM Save*

Save current parameters to non-volatile (flash) memory. In FW-1000 this operation was performed by **RS** command. **RS** Command can still be used, however now the card address has to be appended to it.

Example:

0>FW 0

0>RW Saves RAM to no-volatile memory

0>1RS Saves FW Card with address #1 to memory

Note: In verbose mode 6 in addition to the 0>, the <LF> & <CR> are omitted.

RR *RAM Restore*

Recall last saved parameters.

Note: In verbose mode 6 in addition to the 0>, the <LF> & <CR> are omitted.

DR *Dump RAM*

Dumps the working variables stored in RAM to the RS-232 port.

DF *Dump Flash*

Dumps the variables stored in the non-volatile (flash) memory to the RS-232 port.

PL n *Pulse Length*

Sets the pulse length of the Sync Out signal to *n* milliseconds.

PH n *Pulse Phase (Spin/SYNC mode only)*

Sets the relative phase of the Sync Out pulses when in the Spin/Sync mode of operation. The phase is expressed in encoder counts. There are 1024 counts in a full revolution.

ST *Start*

Starts timed protocol. The protocol will start at the current protocol position. After a reset, this is the position P0. Use the **Gn** command to set the initial position before starting the protocol.

Gn *Go to protocol n*

Causes the wheel(s) to move to settings for Protocol Setting *n,* where *n* is a number in the range [0-7].

[addr#]VB n *Verbose Mode*

Selects information stream from processor to RS-232. **[addr#]** indicates that the command has to be appended with the FW card address.

n=0 normal mode – prompt and error messages only.

n=1 encoder position information.

n=2 show move times and motion-error maximums.

n=3 debug mode shows process steps.

n=4 other verbose debug info.

n=5 no serial output in response to some commands.

Supported in version 2.0f and later.

n=6 no prompt characters (e.g., **0>**) output in response to any commands.

Supported in version 2.0g and later.

VN *Version Number*

Returns the Version Number of the firmware.

The following commands set parameters that apply only to the currently selected wheel:

HO *Home*

Causes current wheel to seek its home position.

MP n *Move Position*

Move to filter position *n*, where *n* is a valid filter position.

OF n *Offset*

Sets the home index offset for the wheel to *n*. The value n should be in the range [0-128] such that a HO command returns the wheel centered on the optical axis. Once determined, this value should be saved to flash.

P[m] n *Protocol Position*

Sets protocol entry *m* to filter position *n* where *m* is a number in the range [0-7] and *n* is a valid filter position.

D[m] n *Protocol Delay*

Sets the delay time prior to execution of move to protocol entry *m* to the value *n* where *m* is a number in the range [0-7] and *n* is the delay time in milliseconds.

AU n *Acceleration Up*

Sets the acceleration value in encoder counts/sec/msec. Default is 250. Increase up to 400 for faster acceleration but more vibration.

AD n *Acceleration Down*

Sets the de-acceleration value in encoder counts/sec/msec.

SF n *Spin*

Initiates the Spin/SYNC mode.

n=0 Stops the spinning Wheel.

n=1 Starts the current wheel spinning.

n=2 Starts both wheels spinning together (version 1.3+)

n=3 Same as mode #1, except spins it in reverse direction

SV n *Speed Variables*

Selects a consistent set of preset acceleration and speed parameters.

n=0 Default - directly set and saved AU, AD, and VR parameters are used.

n=1 Slowest and smoothest switching speed.

n=2 to 8 Intermediate switching speeds.

n=9 Fastest and but least reliable switching speed.

VR n *Velocity Run*

Sets the maximum run velocity in encoder counts/sec. Default is 2000. Increase up to 4000 for faster top speed but more vibration. For spinning the filter wheel, can be increased up to a maximum of 12500. Expect some servo errors at high speeds.

GO n *Go*

Moves to absolute encoder position *n.* The range of *n* is +/-32768. The motor will move the commanded distance, but the final position will reflect the current location between 0 and 1023 of the wheel's rotation.

The following commands are used to control shutters with an SH-2 controller in the same cabinet as the FW-1000 controller. The parameter *n* may have any value from zero to (2N-1), where N is the number of shutter controller cards in use.

SO n *Shutter Open*

Opens shutter number *n.*

SC n *Shutter Close*

Closes shutter number *n.*

SQ [n] *Shutter Query*

Returns a decimal status byte from a shutter control register. The *n* parameter is optional in the *Shutter Query* command. If no *n* is specified, then the command returns the status byte from the most recently used shutter controller. If no shutter commands have been issued since the last system startup, then the command returns the status byte from the controller of shutters 0 and 1. If no SH-2 Card is present, 0 is returned.

The binary equivalent can be decoded as follows:

Bit 0 1 = Shutter 0 is open;

0 = Shutter 0 is closed.

Bit 1 1 = Shutter 1 is open;

0 = Shutter 1 is closed.

Bit 2 1 = Shutter 0 is closed or has no sensor;

0 = Shutter 0 is open and has a sensor.

Bit 3 1 = Shutter 1 is closed or has no sensor;

0 = Shutter 1 is open and has a sensor.

Bit 4 SH2 Card is present.

SS x *Shutter Setup*

Supports shutter control. Normally, the *SC* command causes the controller to energize a shutter, and *SO* causes the controller to de-energize it. Most shutters are normally-open; i.e., open, unless energized by the controller via the *SC* command. The *SS* parameter *x* is a binary number representing eight bit positions, i.e., an integer in the range 0…255. Within *x,* if some bit_k is set, then shutter *k* is normally-closed. With this setting in effect, the effects of *SO* and *SC* are reversed. Instead of *SC* causing the controller to energize the shutter, *SO* energizes it, and vice-versa. Once determined, this value may be saved to non-volatile (flash) memory using the *RS* command.

The default value of *x* is zero, denoting that all shutters are normally-open.

Examples: **SS 2** is correct if Shutter 1 is normally-open, because *x* has only bit 1 set.

SS 3 is correct if shutters 0 and 1 are normally-open, because *x* has only bits 0 and 1 set.

The following parameters affect the motor positioning algorithm. Change these at your own risk.

[addr#]KA n *Acceleration constant* - Default 1200

[addr#]KV n *Velocity constant* – Default 70

[addr#]KP n *Error proportional constant* – Default 350

[addr#]KI n *Error integral constant* – Default 0

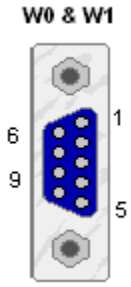
[addr#]KD n *Error derivative constant* – Default 500

[addr#]KR n *Current feedback constant* – Default 0

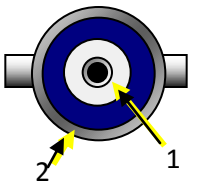
[addr#] indicates that the command has to be prepended with the FW card address.

Appendix

Filterwheel Control Panel Pin-Outs



W0 & W1 Filterwheel Connectors		
PIN	**Signal**	**INFORMATION**
1	Motor +	0-24 VDC, 6 Amps Max
2	Motor -	0-24 VDC, 6 Amps Max
3	Ground	Ground
4	ENC A	Input: Std TTL
5	ENC B	Input: Std TTL
6	Motor +	0-24 VDC, 6 Amps Max
7	Motor-	0-24 VDC, 6 Amps Max
8	Index	Input: Std TTL
9	+5 Vdc	6 Amps Max

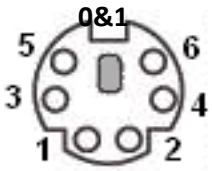


TRIG IN		
PIN	**SIGNAL**	**INFORMATION**
1	TTL Next Pulse	Input: Std TTL
2	GND	Ground

SYNC OUT		
PIN	**SIGNAL**	**INFORMATION**
1	SYNC OUT	Output: Std TTL
2	GND	Ground

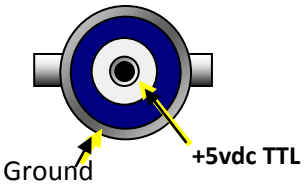
Shutter Control Panel Pin-Outs

Shutter Control



Shutter Control 0 & 1 Connectors		
PIN	**SIGNAL**	**INFORMATION**
1	Shutter +	~5msec 60vdc peek at start, 5vdc Holding Voltage when energized
2	Shutter -	Controlled Ground
3	Position Sensor LED +	+5 vdc
4	Position Sensor GND	Ground
5	Position Sensor Return	+5vdc TTL Signal
6	Position Sensor +5vdc	+5 vdc

TRG BNC



TRG 0 & 1 BNC Connectors		
PIN	**SIGNAL**	**INFORMATION**
1	Energize Shutter	Input: Std TTL Pulse
2	GND	Ground

Shutter Specifications

Methods of Control	Serial Interface, TTL Signal and Front Panel Toggle Switch
Number of Shutter Channels per Card	Two
0%-to-100% Opening Time from Trigger (N.C. shutter)	8 ms
100%-to-0% Closing Time from Trigger (N.O. shutter)	7 ms
Minimum 50%-to-50% Open Time (N.C. shutter)	5 ms
Minimum 50%-to-50% Closed Time (N.O. shutter)	13 ms
Minimum Total Window 0%-to-0%	14 ms
Minimum Trigger Width	7 ms
Peak Unsustained Repetition Rate	40 Hz
Maximum Sustained Repetition Rate	5 Hz

CLEANING & Maintenance:

Cleaning should be done with a 70% isopropyl alcohol solution. Bottom air vents should be checked to ensure that the vents do not become clogged with dust.

Maintenance should only be done by ASI, or an ASI approved technician.

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Changelog

4/4/2014	Edited commands RS/RW, VB,KI, KP, KD,KA	Vik