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MSCF2V04 (rev2)
User Configurable Frequency to Voltage Converter

Operator's Manual

Manual revision 11 (for U.I. software 4.6)
August 15, 2007

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Table of Contents

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Introduction:

The Michigan Scientific MSCF2V04 is an extremely versatile frequency to voltage converter. Using the supplied User Interface software, the user can configure the MSCF2V04 to produce Voltages proportional to the frequency (or the count) of incoming pulses. This allows for a simple measurement of rotational velocity, speed, position, and pulse count.

Typical Applications:

Measurement of rotational speed variation of engines and motors
Engine / motor startup and shutdown characteristics
Wheel speed measurement (such as ABS and traction control system testing)

Flexible Inputs:

The MSCF2V04 can accept both *Individual* (single-phase) and *Quadrature* signals, plus an *OPR-Index* (“once-per-rev.” positioning pulse) for each quadrature pair. The pulse inputs (4 *Channels* + 2 *OPR-Index*es) are fully differential, accept up to ±120V amplitude pulses, and provide up to 1500V of isolation.

Configure each *Channel* input for either *TTL*-threshold (digital square-wave), or *Mag Pickup* (magnetic reluctance type sensor) signals. *Mag Pickup* signals switch with at least 350mV peak amplitude. Adjust *Input Offset* of each *Channel* up to ±10V.

A 16-bit *Analog Input* is available to calibrate the pulse-*Channel*(s) to an external reference, such as an “analog fifth wheel” vehicle-speed sensor.

Configurable Outputs:

The 16-bit outputs are scalable to almost any range within the available ±10V, and the full-scale input frequency is adjustable to almost any value as well.

The *Minimum Measurable Frequency* can be adjusted to anywhere from about 0.15 Hz to 610 Hz. The maximum aggregate frequency is 124 kHz for *High Speed* mode, 68 kHz for *Quadrature* mode, 72 kHz for *Normal Speed* mode, and 180 kHz for *Pulse Count* mode. Different configurations over the four channels may reduce these maximum aggregate requirements. In order to maximize performance, disable all inactive channels and setup unit in high-speed mode.

Additional Features:

For wheel speed applications, an *ABS Algorithm* can be used to quickly detect wheel lock-up.

The digital display can be configured to display the output voltage (1mV minimum resolution) for each channel, the trigger status of each channel, or rotational velocity and position (*Quadrature* mode).

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Connections and Controls:

Figure 1 – Front and Rear Panel

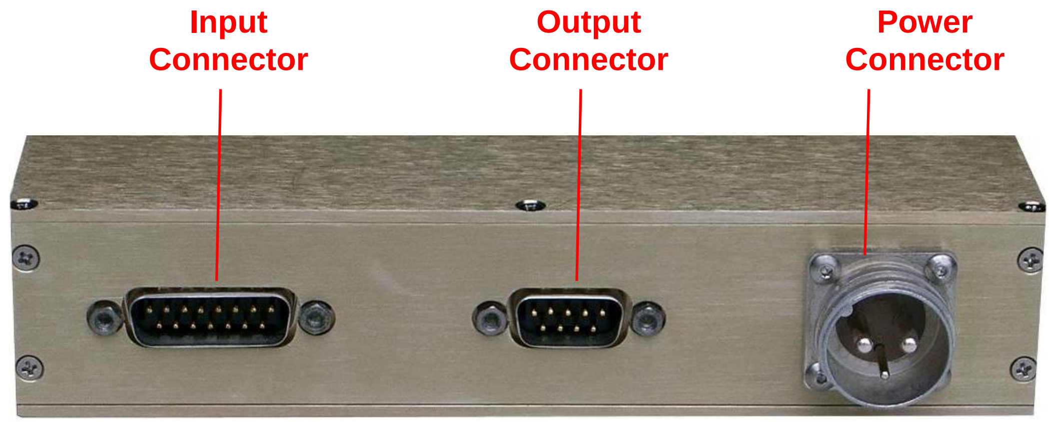

TABLE 1 – Front Panel Item Descriptions

Item	*Description*
Fuse	Holds a standard 3A fuse
Power Switch	Shuttered push-button is green when power is on
Configurable Display	Can be configured to display: 1) Output Voltage for selected Channel 2) Threshold Indicator (input's logic-level, above- or below-threshold) 3) Velocity (RPM) and Position (Degrees)
Display Selector	Knob to select which Channel (1—4) to show in Display
USB Port	Connect to computer for configuration, using provided USB cable
Analog Input	For calibration to an external Reference Voltage

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TABLE 2 – Rear Panel Connectors' pin-assignments

Pin#	*Signal*	*Type*
		Input Connector (DSUB-15)
1	(no-connect)	-
2	isolated GROUND	Encoder Power OUT
3	OPR-Index, ch3+4 (-)	pulse INPUT
4	OPR-Index, ch1+2 (-)	pulse INPUT
5	Channel 1 (-)	pulse INPUT
6	Channel 2 (-)	pulse INPUT
7	Channel 3 (-)	pulse INPUT
8	Channel 4 (-)	pulse INPUT
9	isolated +12V	Encoder Power OUT
10	OPR-Index, ch3+4 (+)	pulse INPUT
11	OPR-Index, ch1+2 (+)	pulse INPUT
12	Channel 1 (+)	pulse INPUT
13	Channel 2 (+)	pulse INPUT
14	Channel 3 (+)	pulse INPUT
15	Channel 4 (+)	pulse INPUT
		Output Connector (DSUB-9)
1	Channel 1 (+)	Voltage OUTPUT
2	Channel 2 (+)	Voltage OUTPUT
3	Channel 3 (+)	Voltage OUTPUT
4	Channel 4 (+)	Voltage OUTPUT
5	(no-connect)	-
6	Channel 1 (-)	Voltage OUTPUT
7	Channel 2 (-)	Voltage OUTPUT
8	Channel 3 (-)	Voltage OUTPUT
9	Channel 4 (-)	Voltage OUTPUT
		Power Connector (3-pin Cannon)
1	GROUND	Power Input
2	+10 to +19 V_{DC}	Power Input
3	(no-connect)	-

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Frequency to Voltage Conversion:

Frequency to voltage (F2V) converters are used for a broad range of testing applications and are designed to provide voltages proportional to the frequency or count of incoming pulses. This allows for a simple measurement of rotational speed, velocity, angular position and pulse count.

The incoming pulses can be generated through a number of methods. A common method is to utilize magnetic pickups or Hall Effect sensors that detect one or more magnetic "targets" that move past the sensor as the object rotates. A magnetic pickup usually generates a pulse, or sinusoid that increases in amplitude and frequency as the angular velocity of the "target" increases. A magnetic pickup generally requires no external excitation. A Hall Effect sensor requires an excitation voltage and usually generates a simple square wave with amplitudes equal to the excitation voltage. This signal will increase in frequency as the angular velocity of the "target" increases.

Another method is to utilize an encoder to generate pulses. Encoders typically output a square wave signal that has TTL or CMOS thresholds and amplitudes, although sometimes the amplitude can be as large as the supply voltage to the encoder. They are assigned a *Resolution (PPR)* rating, in pulses per revolution, which corresponds to the number of equally spaced pulses that are generated in the span of one complete revolution. Some encoders have a single-phase signal output while others have two phases, with one output ninety degrees out of phase with respect to the other signal. These are called quadrature encoders, and this type must be used when accurately tracking angular position and velocity. The direction of rotation is easily determined through observation of the two phases: In one direction, the first phase leads the second. In the opposite direction, the second phase leads the first. These quadrature encoders also sometimes have a third output, an *OPR-Index* pulse, used to provide a known zero for the angular position.

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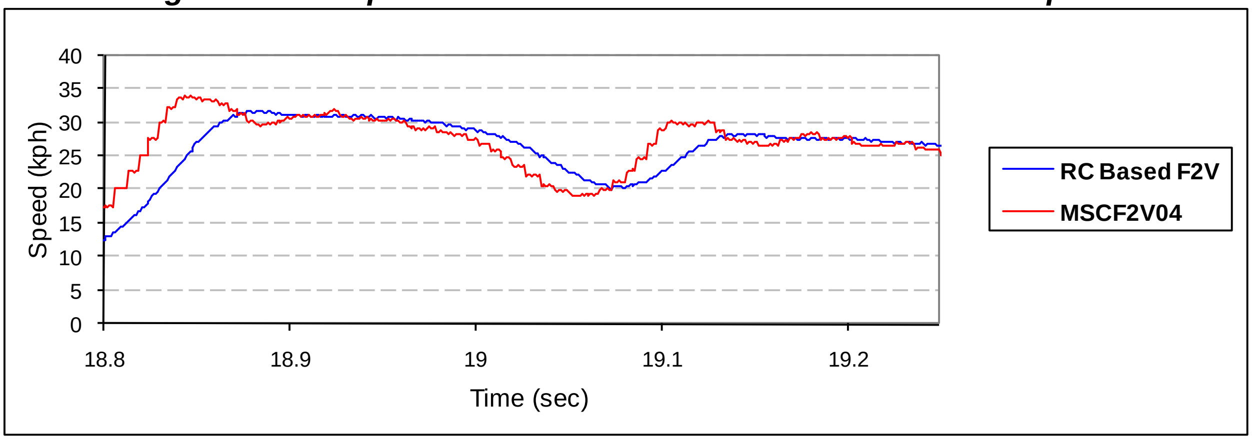
Digital vs. Analog Conversion

There are both digital and analog methods for frequency to voltage conversion. A typical method for analog conversion uses a Resistor-Capacitor network, which adds phase delay to the output and does not track frequency changes as quickly as a digital system can. The MSCF2V04 uses a digital method, which measures each period of the input signal and updates its output based upon the measured period. This output can be considered instantaneous because there is no averaging of the incoming measured periods. Every time a rising edge is received, a new period measurement is calculated, and the output is updated. Figure 2 illustrates the difference between the MSCF2V04 output and a typical RC-based F2V output.

Figure 2 – Comparison of MSCF2V04 and RC-based F2V outputs



There are two things worth noting about this data plot. First, the RC-based F2V output is phase delayed. Second, that the RC-based system obviously "smoothes" the signal, reducing the amount of useful information that can be derived from it.

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Application: Anti-lock Brake Systems

In the past, the method used by the MSCF2V04 [updating only whenever input-pulses are detected] has suffered from "signal hang" in situations where the input frequency drops to zero very quickly. An example of this occurs when measuring wheel speeds during anti-lock brake testing. The wheel will momentarily lock-up and the input signal pulses will immediately stop. With the *ABS Algorithm* that is incorporated into the MSCF2V04, signal dropout can be detected quickly as a lock-up and the output is updated accordingly. Figures 3 and 4 illustrate the effect of using the *ABS Algorithm* in these situations.

Figure 3 – Signal Hang during wheel Lock-Up (without ABS Algorithm)

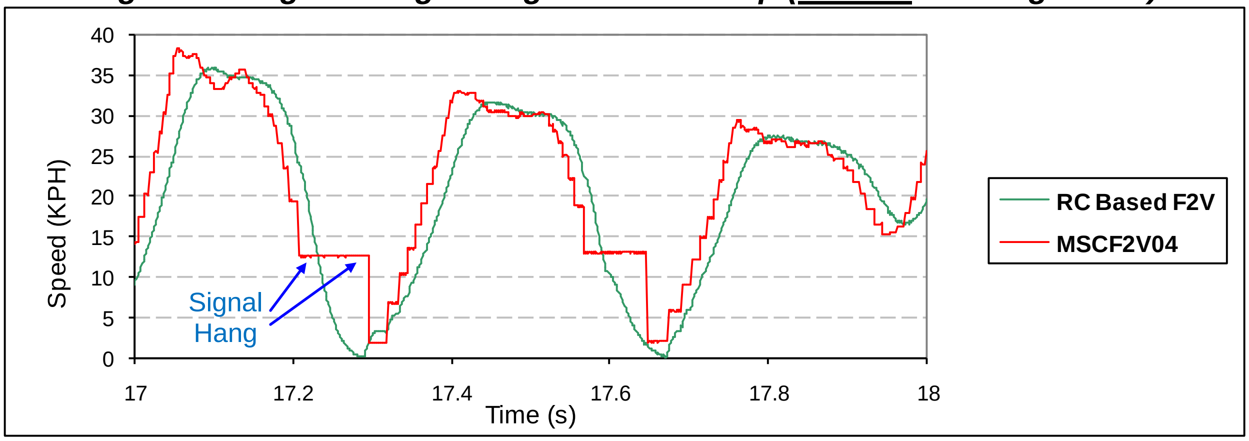
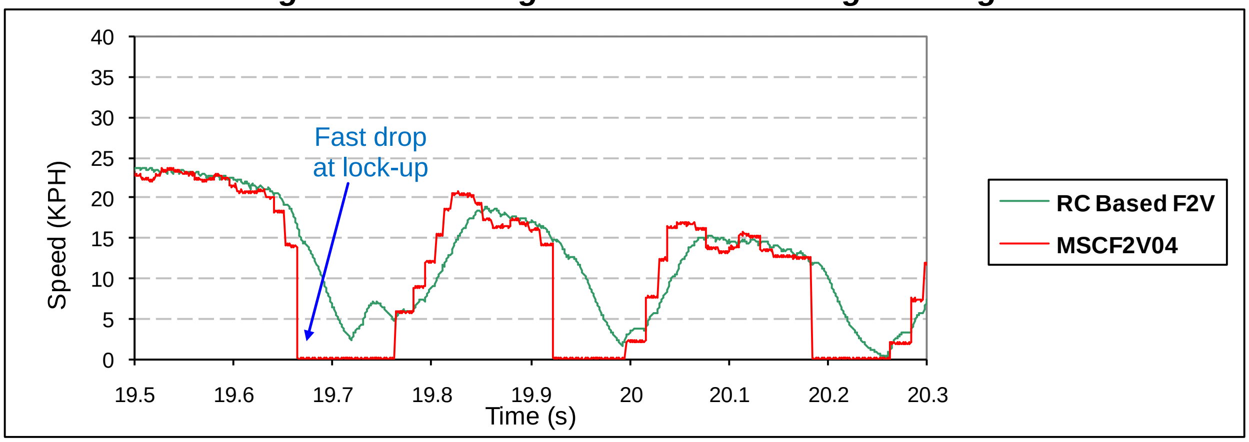


Figure 4 – ABS Algorithm eliminates Signal Hang



The "signal hang" in Figure 3 is eliminated in Figure 4, when the *ABS Algorithm* was enabled. Also note that the RC based F2V does not accurately display the data either, due to the fact that its output cannot drop to zero quickly. This gives the MSCF2V04 a clear advantage over analog F2V systems and most other digital F2V systems.

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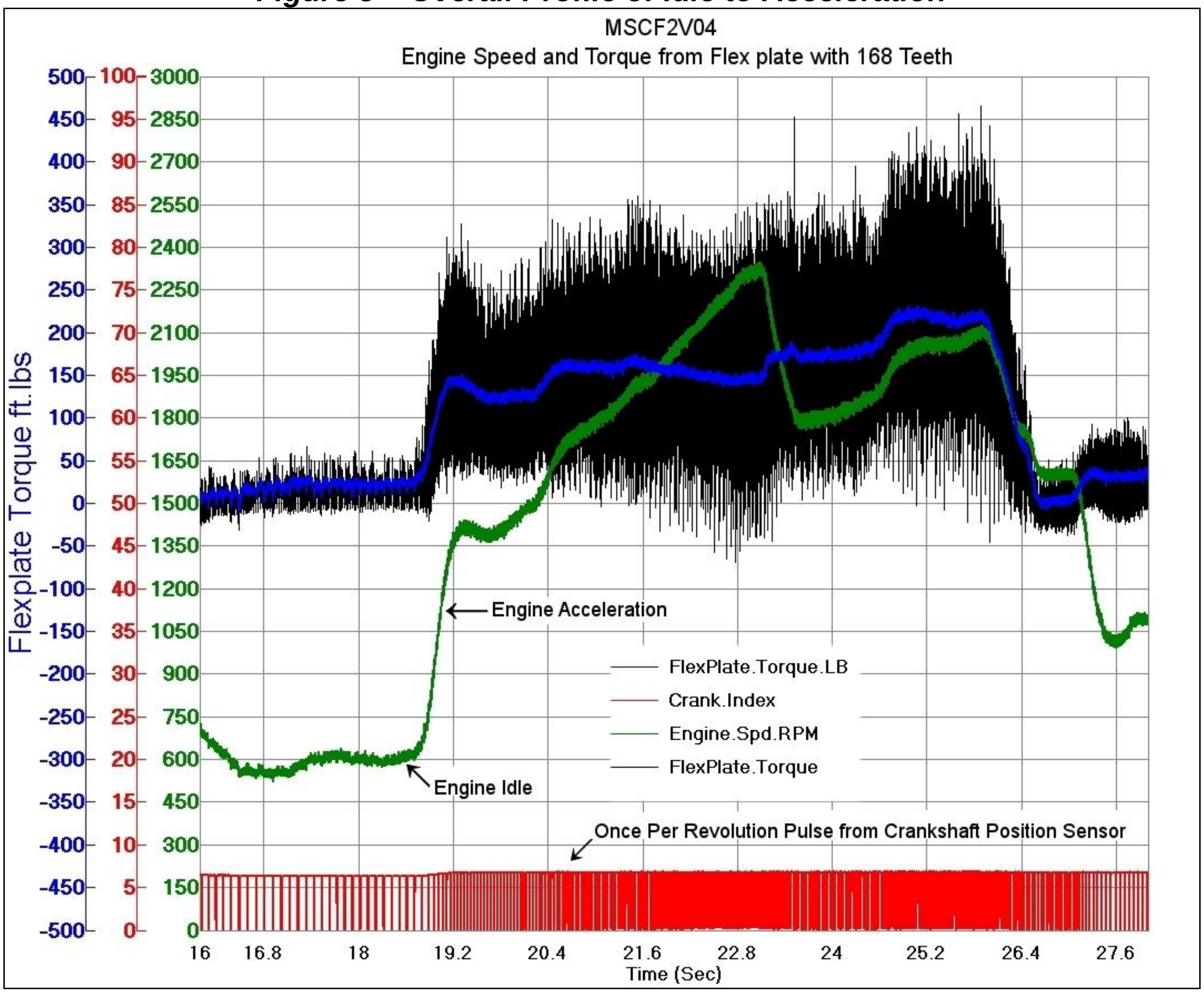
Application: Engine Speed Variations

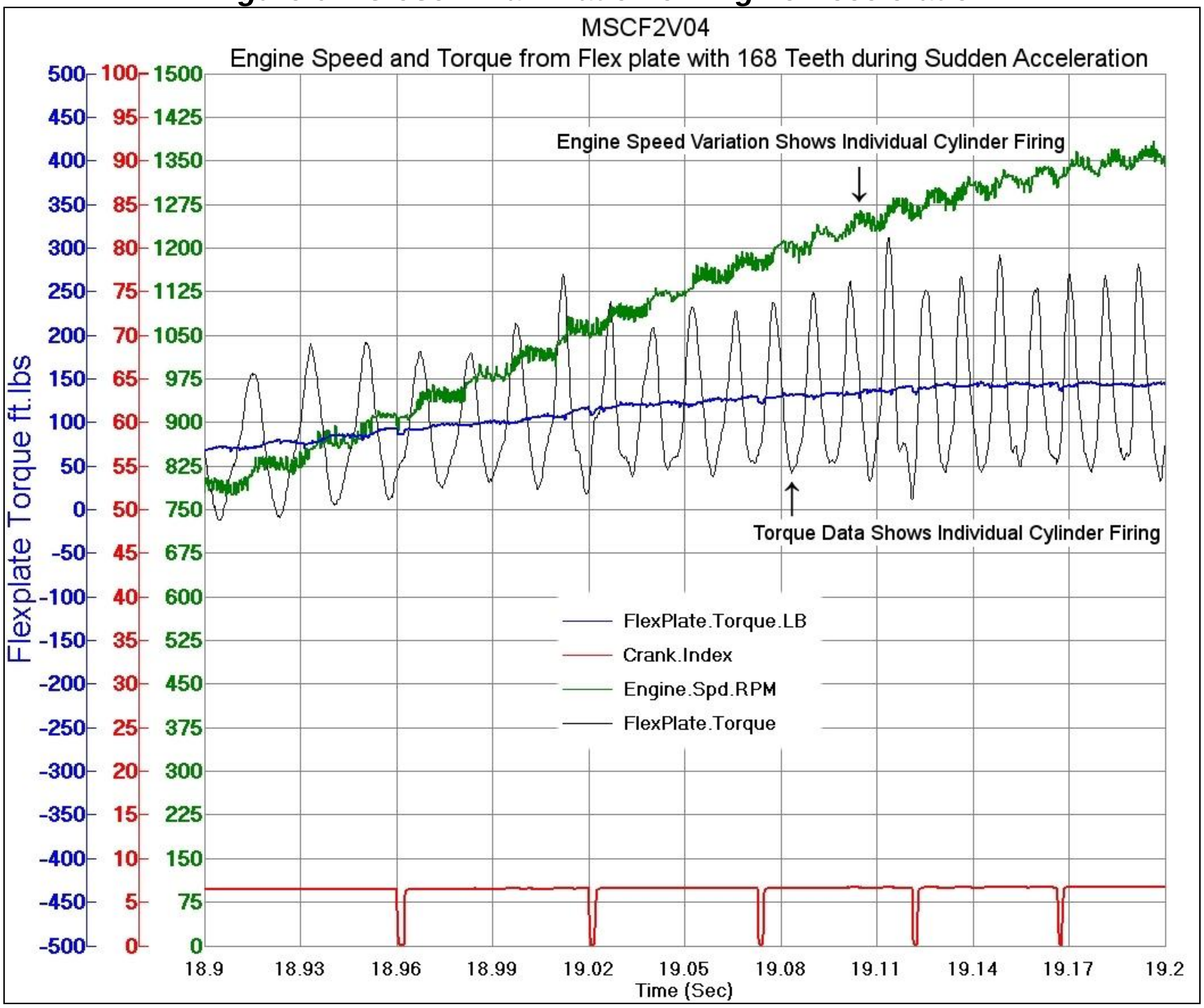
Another application in which the F2V can be used is for measuring rotational variation in engine speed. An example of this was accomplished by utilizing a *mag pickup* on the flex plate of an 8-cylinder engine. The flex plate contains 168 teeth. The engine speed is therefore updated 168 times per revolution of the engine. Figure 5 below shows the engine speed and also dynamic and average torque output from the engine. An *OPR-Index* crankshaft signal is also shown for reference. This data shows the profile from the engine at idle to a sudden acceleration.

Figure 5 – Overall Profile of Idle to Acceleration



Zooming in to an area of acceleration, Figure 6 shows the engine speed variation due to the individual cylinders firing. In an 8-cylinder engine, there are four main pulses per revolution of the engine, which is shown in both the dynamic torque and also the variation in engine speed. The conclusion that can be drawn from this data is that the engine speed variation corresponds to the torsional vibration of the engine.

Figure 6 – Closer Examination of Engine Acceleration

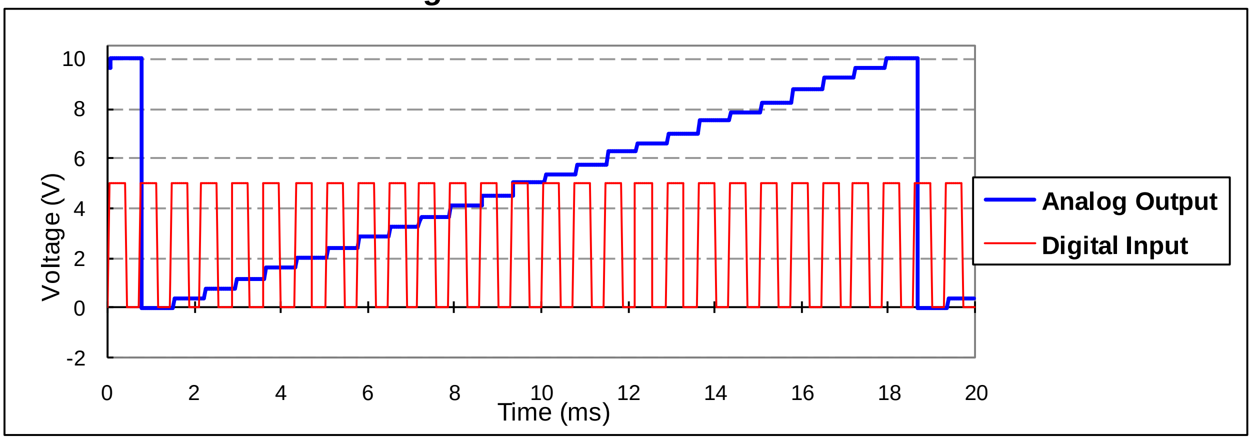


<u>Application: Count Pulses (encoder position)</u>

The final *Individual Channels* configuration available is the *Count Pulses* mode. This produces a "stair step" type output as each pulse is received. This configuration is useful for a multitude of applications such as angular position measurement (without quadrature inputs) or event counting.

For example, Figure 7 shows an output configured to reach full-scale (10V) at *FS Pulse Count* = 25.

Figure 7 – Count Pulses mode



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Application: Quadrature Encoders

The previous figures have all shown *Individual Channels* configurations. The MSCF2V04 is also capable of interfacing with *Quadrature* encoders. In *Quadrature* mode, both angular *Velocity* (F-to-V) and *Position* (pulse count) are calculated for the output.

Figure 8 below shows the velocity and position from a 360 PPR encoder. In this case the velocity is positive, and the position output is ramping upward. In Figure 9, reversing the direction of rotation caused the velocity output to become negative, and the position output to ramp downward.

Figure 8 – Angular Velocity and Position Outputs, clockwise rotation

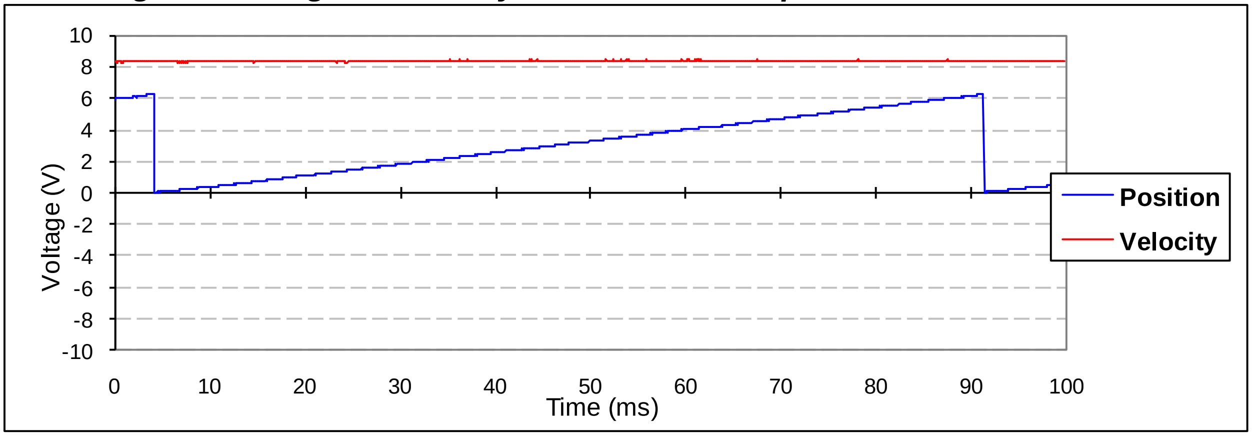
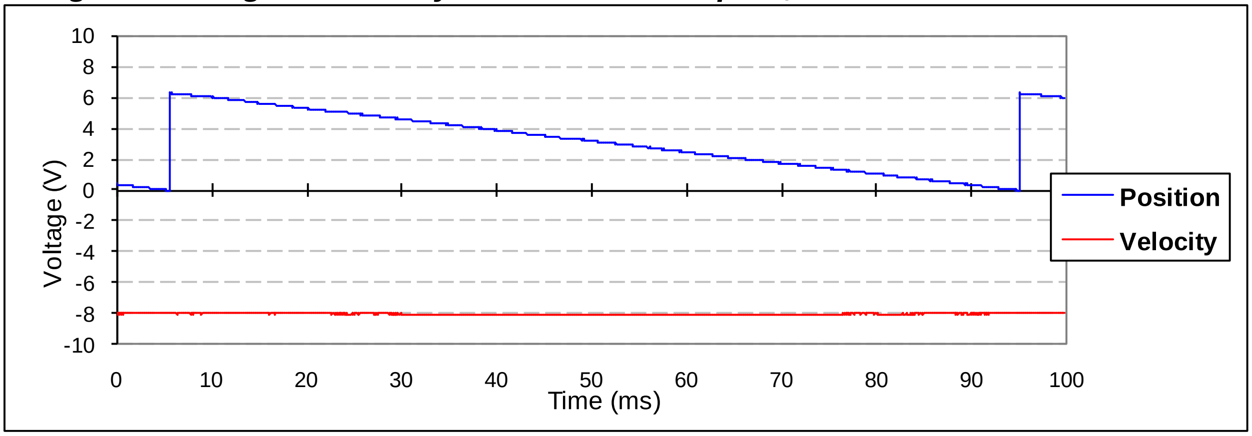


Figure 9 – Angular Velocity and Position Outputs, counter-clockwise rotation

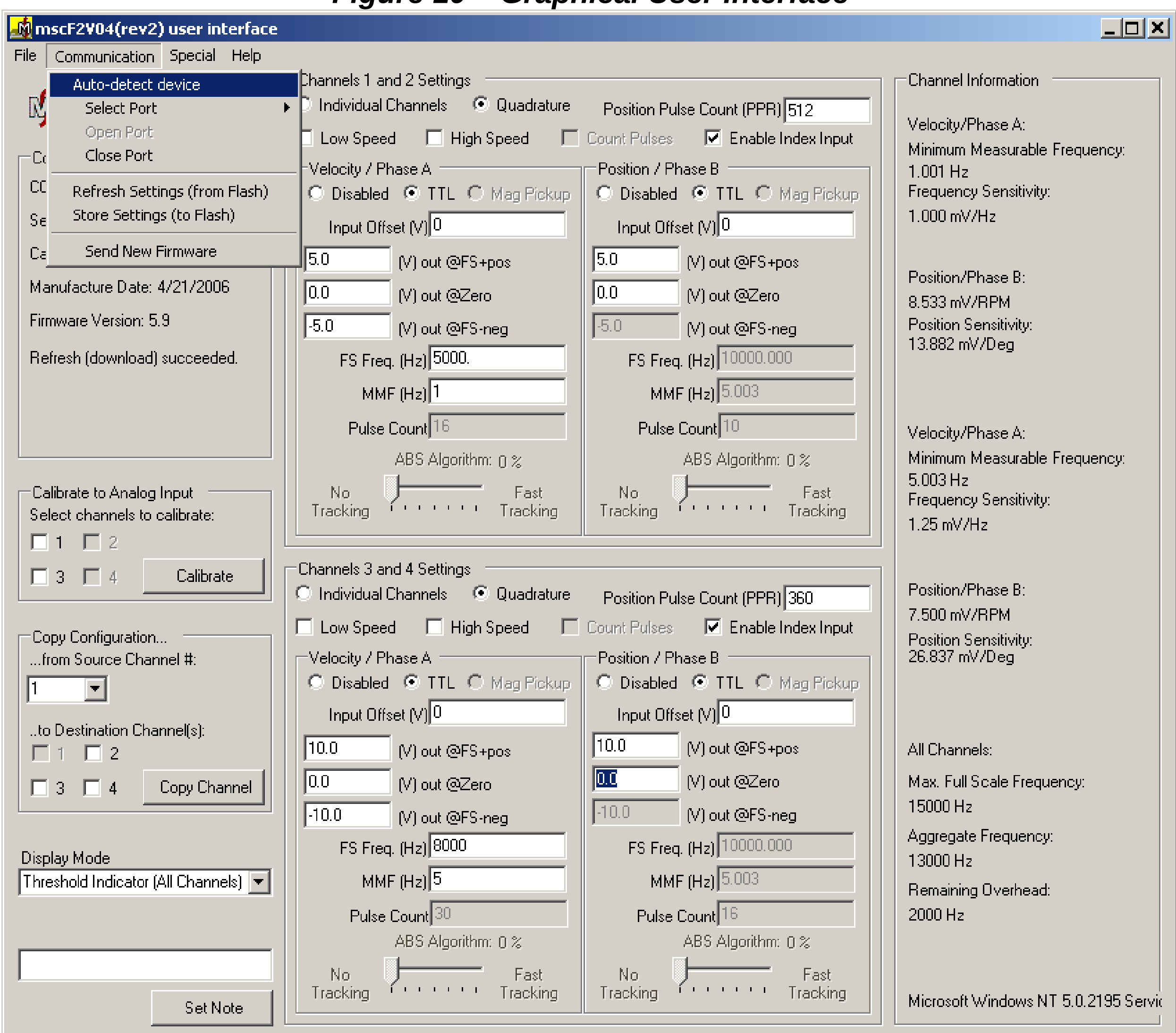


MSCF2V04 User Interface – configuration software:

**Note: The following section assumes that the user interface is installed. To install the U.I. and related USB drivers, use the provided install CD and follow the instructions in the “ReadMe.txt” file.*

The User Interface (U.I.) software runs on a Windows 98, 2000, or XP computer with a USB port. To begin, click on “**mscF2V04(rev2) user interface 4.6**” under “Start” > “Programs” > “MichSci”. The user window (Figure 10) should appear:

Figure 10 – Graphical User Interface

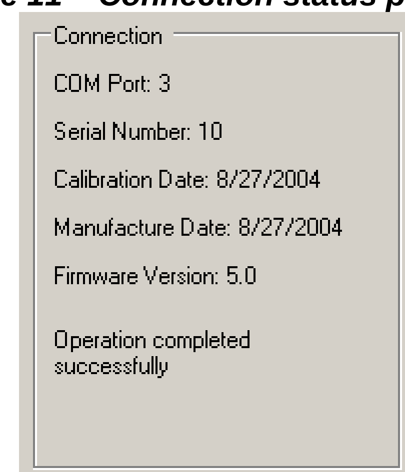


With the MSCF2V04 unit powered up, plug the square connector end of the supplied cable into the USB port. Plug the rectangular end of the cable into the PC that is running the U.I. Under the *Communication* menu, select "*Auto-detect device*". A window should appear stating that the MSCF2V04 has been found. If the device is not found, make sure that:

1. The MSCF2V04 is connected to power and switched on,
2. Both ends of the USB cable are plugged in,
3. The correct USB (to virtual COM Port) drivers are installed on the PC.

When the MSCF2V04 is detected, the current settings and unit-specific information are loaded and displayed in the interface. In the upper left corner of the window, the "*Connection*" status pane provides information such as the firmware version and the serial number of the connected unit.

Figure 11 – Connection status pane



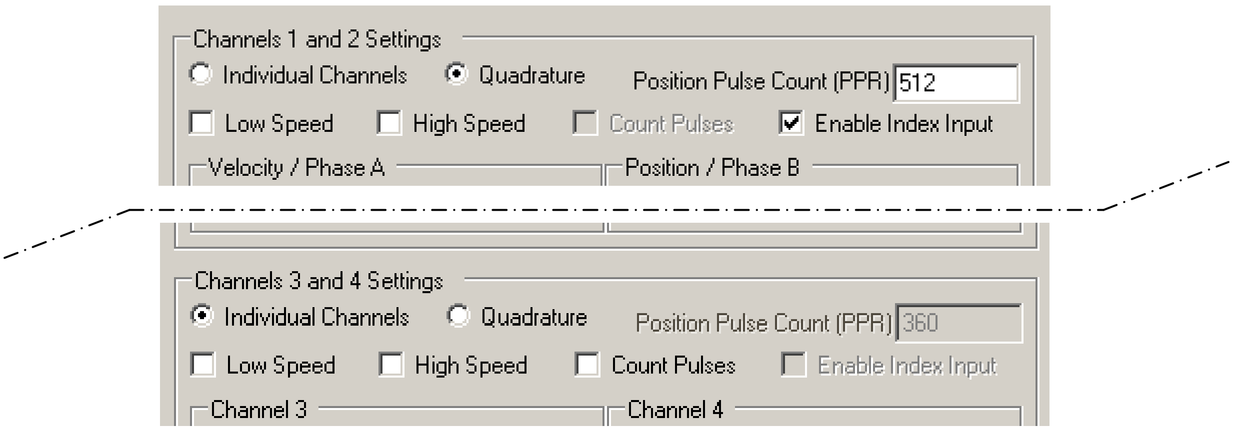
<u>Licensing:</u>

If the MSCF2V04 has been configured for only two channels, then any functions associated with channels three and four will not be available in the interface. An additional license fee is required to activate these channels and upgrade the unit.

<u>Channel Group configurations:</u>

There are configuration settings that apply to pairs of channels. These settings are the *Individual Channels* or *Quadrature* modes, and the *Low Speed*, *High Speed* and *Pulse Count* modes (Figure 12). These settings are not stored to the MSCF2V04 until the "*Store Settings (to Flash)*" menu item is selected.

Figure 12 – Two different Channel Group configurations



- *Individual Channels* – With this setting enabled, each channel in the channel group is a separate F2V channel.

  The *Velocity and Position* display mode is not available in *Individual* mode.

- *Quadrature* – This mode requires quadrature input signals, with or without an *OPR-Index* signal. Input channel 1 (or 3 for the second Channel Group) is "Phase A"; input channel 2 (or 4) is "Phase B"; and the channels' corresponding *OPR-Index* input is used. Output channel 1 (or 3) is the *Velocity*, which becomes negative for reverse-direction rotation (when Phase B leads Phase A). Output channel 2 (or 4) is used for the *Position* output, which is scaled by the *PPR* and *OPR-Index* settings described below.

  The *Velocity* and *Position* display mode is only available in this *Quadrature* configuration, but the *ABS Algorithm* is disabled.

- *Enable Index Input* – If an OPR-Index signal is available, then the "*Enable Index Input*" check box will enable this signal on *Digital Input 1* (or 2). Each index input pulse resets the position output to zero. When the index input is not enabled or connected, the zero position corresponds to the position of the encoder at power-up.

- "*Position Pulse Count (PPR)*" – The number of pulses per revolution of each phase of the encoder, which sets the full-scale position. This setting only applies to *quadrature* input mode.

- *Low Speed* and *High Speed* check-boxes – The *Low Speed* mode allows the user to set a full-scale frequency of less than 650 Hz. The *High Speed* mode disables the display, allowing the maximum aggregate full-scale frequency to be as large as 120 kHz. (Note: The default *Normal Speed* mode is selected by clearing both the *High Speed* and the *Low Speed* check-boxes.)

  The *ABS Algorithm* is disabled in both *Low* and *High Speed* modes.

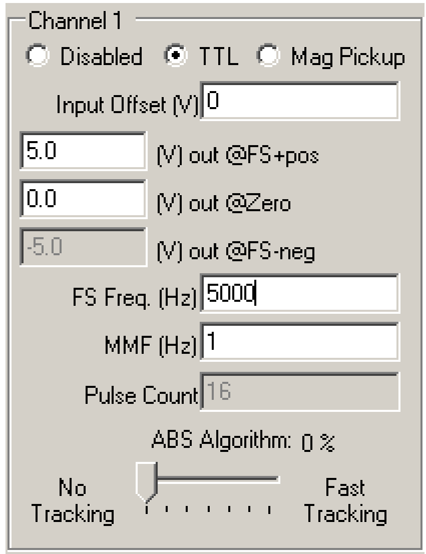
- *Pulse Count* – This output produces a "stair step" type output based on the number of pulses received and the sensitivity of each pulse. This output is only available when the *Individual Channels* radio button is selected.

  The *Enable Index Input* is also available in this mode, which allows an OPR-Index pulse to reset the *Pulse Count* output to zero. If no index pulse is used, the first pulse received after power-up will zero the pulse count output.

  Note: If the first group's index input is enabled, it will zero the pulse counts of both Channels 1 and 2 at the same time. The same goes for pulse counts of Channels 3 and 4 when the second group's index input used.

<u>Each Channel's settings:</u>

Figure 13 – Each Channel's settings



Each channel has its own configuration settings, as shown in Figure 13. These settings are not stored to the MSCF2V04 until the "*Store Settings (to Flash)*" menu item is selected. Depending on the Channel Group's mode, these may include:

- *Disabled*, *TTL*, or *Mag Pickup* input-type – Select from the two types of input signal conditioning available, or disable the channel.

  - *Disabling* unused channels allows the MSCF2V04 to handle larger full-scale and aggregate frequencies.

  - The standard "*TTL*" input is designed to accept a square-wave signal and has a switching threshold of 1.4V with a fixed 100mV of hysteresis (adjustable using the *Input Offset* described below).

  - The "*Mag Pickup*" input-type uses a special signal detection circuit that will generate one-shot pulses for each detected signal period. To generate a one-shot pulse, the signal must first exceed +350mV and then cross back down below zero (adjustable using the *Input Offset* described below). The maximum input frequency for the *Mag Pickup* input-type is 5 kHz.

- *Input Offset (V)* – This corresponds to the offset voltage added to the input signal before it is fed in to the signal conditioning electronics. For example, if an input signal has an actual range of [–3V to +2V] and you enter a value of "3" in to the "*Input Offset*" text box for that channel, the signal conditioning electronics will receive the input signal as having a range of [0V to +5V].

  Another way to describe this is as adjusting the (pre-offset input) Voltages that are recognized as a logic-level switch:

Input-type	Switching thresholds (Volts)	
	↑ (low-to-high)	↓ (high-to-low)
TTL	(1.45 – *Input Offset*)	(1.35 – *Input Offset*)
Mag Pickup	(0.35 – *Input Offset*)	(0.00 – *Input Offset*)

- Output Voltage range – These may be adjusted within the [-10 to +10V] range:

  - *"(V) out @ FS+pos*" = Full-Scale Positive output Voltage, which represents the maximum output voltage for that channel. This level is produced when the input signals reach *FS Freq.* (or *Pulse Count*). For example, entering a "5.0" in this box will limit the channel's output to no greater than +5V.

  - "*(V) out @ Zero*" = the value of the output when there is a zero input frequency signal (or position/ pulse-count).

  - *"(V) out @ FS-neg*" = Full-Scale Negative output Voltage, which is used only in *Quadrature* mode. This is the most negative *Velocity* output that will be produced (also at *FS Freq.* but in the reverse direction).

- *FS Freq. (Hz)* – The Full-Scale Frequency is the input frequency value that will produce the Full Scale Output value. For example, setting "*FS Freq. (Hz)*" = "10000" and "*(V) out @ FS+pos*" = "10", configures the MSCF2V04 to output 10V when the input signal reaches 10 kHz.

- *MMF* – The Minimum Measurable Frequency is the lowest frequency value that can be resolved by the MSCF2V04. An input signal frequency slower than this *MMF* will cause the channel's output to "time out" and drop to zero. Note that the nearest possible value (due to timing quantization) is calculated and displayed in the *Channel Information* pane (in Figure 10 on the right).

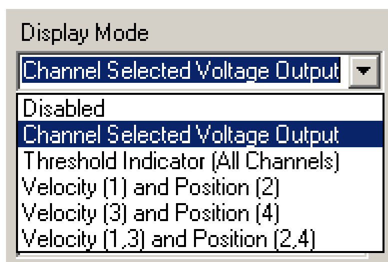
- *Pulse Count* – This is the (full-scale) number of expected pulses, used for calculating the *Pulse Count Sensitivity*. This is only used for *Individual Channels* in *Count Pulses* output mode; in the same way as the *Quadrature* mode's *(PPR)*.

- *ABS Algorithm* – Active only when the “Normal Speed” configuration is selected, this algorithm quickly detects signal dropout to reset the speed/velocity output to zero. Setting this slide bar to 100% (most aggressive) causes the algorithm to interpret even a slow decrease in frequency as a dropout. A less aggressive setting allows faster decreases in frequency without resetting. A setting of 0% disables the *ABS Algorithm* altogether.

  For example, a vehicle with very high performance braking might be able to decelerate fast enough that the MSCF2V04 would decide the wheel had locked-up if the *ABS Algorithm* were set at 100%. Reducing the setting will reduce the chance of false lock-up detection in high performance vehicles.

<u>Display Modes:</u>
There are six display modes, plus a “disabled” mode. The settings are not stored to the MSCF2V04 until the “*Store Settings (to Flash)*” menu item is selected. The display modes are:

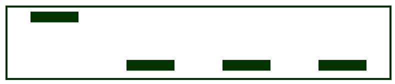
Figure 14 – Display Mode Drop Box



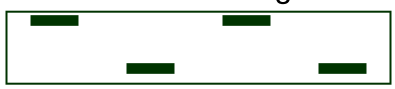
- *Disabled* – The display is dimmed and displays “OFF.” The display is also automatically disabled when either high-speed check box is selected.

- *Channel Selected Voltage Output* – Displays the output voltage for the channel selected by the Display Selector knob.

- *Threshold Indicator (All Channels)* – Indicates if the input signal is above or below that channel's switching threshold Voltage. This setting is only useful for "Standard *TTL*" input signal conditioning. For example, if Channel 1 is above the threshold setting for that channel and the rest of the channels are below their respective thresholds, the display will look like:



If Channel 3 then rises above its switching threshold, the display will update to:



- *Velocity (1) and Position (2)* – This mode is available only when using a *quadrature* configuration in channel group 1 and 2. The velocity in RPM for the quadrature device will be displayed for Display Selector knob setting 1, and the angular position in degrees will be displayed for Display Selector knob setting 2. Display Selector knob settings 3 and 4 will display the voltage outputs for channels 3 and 4. A colon preceding the RPM value denotes negative velocity.

- *Velocity (3) and Position (4)* – This mode is available only when using a quadrature configuration in channel group 3 and 4. The velocity in RPM will be displayed for Display Selector knob setting 3, and the angular position in degrees will be displayed for Display Selector knob setting 4. Display Selector knob settings 1 and 2 will display the voltage outputs for channels 1 and 2.

- *Velocity (1, 3) and Position (2, 4)* – This mode is available only when using a quadrature configuration in both channel groups. The velocity in RPM for the quadrature device on channels 1 and 2 will be displayed for Display Selector knob setting 1, and the velocity in RPM for the quadrature device on channels 3 and 4 will be displayed for Display Selector knob setting 3. The angular position in degrees will be displayed for Display Selector knob setting 2 (channels 1 and 2) and 4 (channels 3 and 4).

Channel Information pane:

The *Channel Information* pane, on the right side of the software screen, shows summary information about each channel, including:

(While in *Individual Channels* mode):

- *Minimum Measurable Frequency,* in (Hz), and
- *Frequency Sensitivity,* in (mV/Hz).
  Note that the minimum measurable frequency displayed here may be different from that entered in to the *MMF* box due to digital quantization; the value shown in the *Channel Information* box is the true value.

(In *Quadrature* mode):

- *Velocity Sensitivity,* in (mV/RPM), and
- *Position Sensitivity,* in (mV/Degree).

(In *Count Pulses* mode):

- The full-scale *Pulse Count*, and
- *Pulse Count Sensitivity,* in (mV/Pulse).

At the bottom of the *Channel Information* pane are three additional “bandwidth” values, in (Hz):

- “*Max. Full Scale Frequency*” is the largest full-scale frequency for any single channel.
- *“Aggregate Frequency”* is the sum of all of the active channels’ *FS Freq.*’s. This is important because the system has a maximum aggregate bandwidth.
- *“Remaining Overhead”* is the remaining portion of the system’s aggregate bandwidth. This is the total amount that any of the channels’ *FS Freq.*’s can be increased by.

These three values will vary depending on the current channel settings--including which channels are active, the speed modes and the output types. In order to accommodate the largest full-scale frequencies, *disable* any unused channels and select the MSCF2V04 device’s *High Speed* mode.

Figure 15 – Channel Information pane examples

Individual Channels Mode | Quadrature Mode | Pulse Count Mode

8500 Ance Rd.
Charlevoix, MI 49720
(231) 547-5511
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MICHIGAN SCIENTIFIC corporation

321 E. Huron Street
Milford, MI 48381
(248) 685-3939
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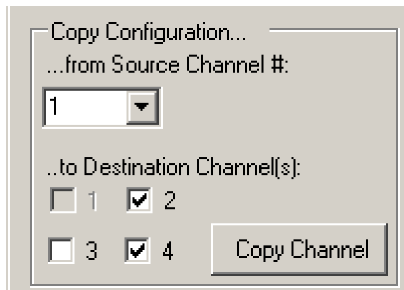
Copy Configuration from one channel to another:

To use the *Copy Configuration* function, select the *Source Channel #*, and check the *Destination Channel(s)* that you would like configured the same as the source. Then click the *[Copy Channel]* button. The copied settings are not stored to the MSCF2V04 device until the "*Store Settings (to Flash)*" menu item is selected.

Figure 16 – Copy Configuration (from Ch.1 to Ch's 2 & 4):

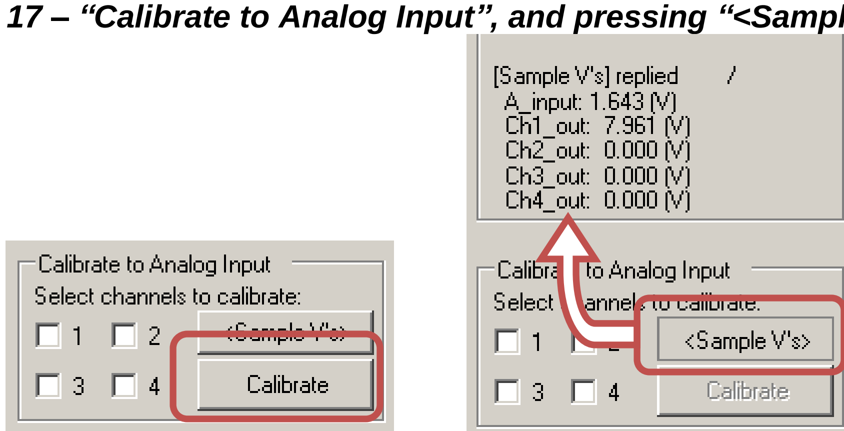


Calibrating to an Analog Input:

The "*Calibrate to Analog Input*" function adjusts the selected channels' outputs to match an external voltage input, for example from an analog "fifth wheel" speed sensor. To use this function, use the check-boxes to select which channels you wish to calibrate. Connect a voltage signal (within the [0 to +10 V] maximum range) to the *Analog Input* connector. There must be an active signal for this function to work; in the case of a vehicle with a fifth wheel, the selected channels must be connected to wheel speed sensors and the vehicle must be moving at a constant speed. After reaching a steady speed, click the [*Calibrate*] button, and the *FS Freq.* values will update. The settings are not stored to the MSCF2V04 until the "*Store Settings (to Flash)*" menu item is selected.

Note: In order for calibration to work correctly, the input frequency must be less than the current full-scale frequency (stored to Flash prior to calibration).

Figure 17 – "Calibrate to Analog Input", and pressing "<Sample V's>"

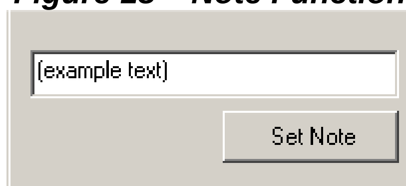


The "<*Sample V's*>" button will continuously poll the USB-connected MSCF2V04, as long as it is depressed. Click it a second time to stop sampling the Voltages.

Setting the Note:

Each MSCF2V04 has a 32 character note associated with it. This note is user configurable and can be any string of up to 32 ASCII characters. To set the note, simply type into the note box, and then click [*Set Note*] to store it. You do not need to select the "*Store Settings (to Flash)*" menu item for this operation.

Figure 18 – Note Function



File Menu Items:

The "*File*" menu is used for saving and reopening user configurations. Every setting, except the "*Note*", is saved in these (*.f2v) configuration files. The three menu items are:

1. *Open* – Brings up a dialog box that allows you to open previously saved configurations
2. *Save As* – Opens a dialog box that allows you to save the current configuration.
3. *Exit Program* – Closes the U.I. window

Communication Menu Items:

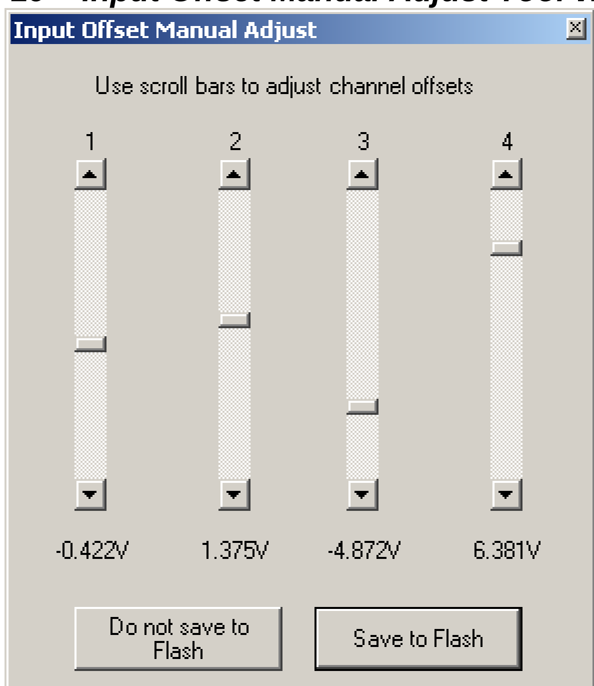
These items apply to the USB connection and operations performed over that connection.

1. *Auto-detect device* – This should be used whenever an MSCF2V04 is first connected to your PC. This function scans the PC's COM Ports for an attached MSCF2V04 device, then automatically connects (select & open port) and retrieves the device's current settings to the U.I. (refresh).
2. *Select Port* – Allows you to manually select a COM Port to try to communicate with the MSCF2V04. It is recommended that "Auto-detect" is used instead.
3. *Open Port* – Opens the selected COM Port.
4. *Close Port* – Closes the current COM Port.
5. *Refresh Settings (from Flash)* – Refreshes the information in the user interface with the settings stored in the MSCF2V04.
6. *Store Settings (to Flash)* – This item must be used when new settings have been entered into the U.I. and are ready to be loaded in to the MSCF2V04. Settings that are entered into the U.I. will not be applied to the MSCF2V04 until this item is selected.
7. *Send New Firmware* – This will load new firmware in to the MSCF2V04 from a binary file.

<u>Special Menu Items:</u>

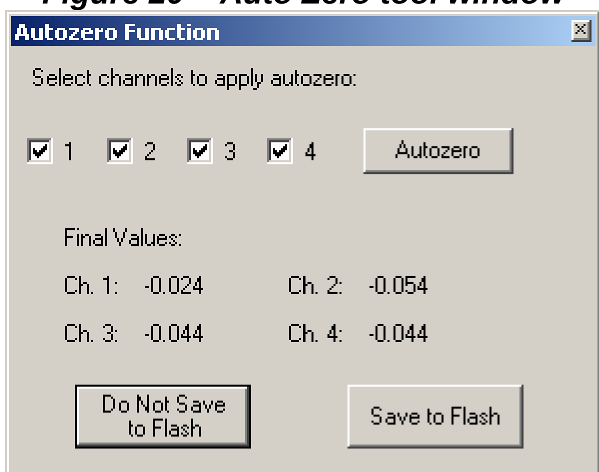
1. *Input Offset Manual Adjust* – This function brings up a tool window, which allows the user to adjust the input offset for each channel using scroll bars. Used in conjunction with the "*Input Thresholds*" display mode, an input signal can be adjusted to a value above or below the switching threshold very easily without knowing the voltage of the input signal. If the [*Do Not Save to Flash*] button is used to exit the tool window, the new offset settings will remain in effect only until the MSCF2V04 is powered off. The [*Save to Flash*] button will store the settings in nonvolatile memory and they will apply the next time the unit is powered up.

Figure 19 – Input Offset Manual Adjust Tool Window



2. *Auto Zero* – This function will automatically determine the best setting for the *Input Offset* of all selected channels. A tool window will appear as in Figure 20; simply select the channels to apply the auto-zero to then click the [*Autozero*] button. To properly auto-zero, there must be no active signal applied to the channel. For digital pulse type signals, the output must be at zero (V_{OL}); a high value (V_{OH}) would cause an incorrect zero value to be calculated. If the value that results for a channel does not seem right, try running the [*Autozero*] function again. As with the "*Input Offset Manual Adjust*" function above, clicking the [*Do Not Save to Flash*] button will retain the new offset settings only until the device's power is cycled. The [*Save to Flash*] button will store the values in nonvolatile memory, so they will be applied the next time the device is powered on.

Figure 20 – Auto Zero tool window



<u>Help Menu Items:</u>

1. *Enable Tooltips* – This enables the tooltips that will appear when the mouse cursor is hovering over a function in the U.I..
2. *Disable Tooltips* – This disables the tooltips.
3. *About* – Displays the U.I. software's version information.

Electrical Characteristics:

TABLE 3 – Electrical Spec's

PARAMETER		SPECIFICATION
OUTPUT		
Voltage Range		-10V to +10 V (Bipolar)
Short Circuit Current		-30mA to +30mA
Resolution		16 Bit
Output Error	(0 - 20kHz)	0.05% max of full scale
	(20 - 80kHz)	0.1% max of full scale
	(80-120kHz)	0.2% max of full scale
Response time		6 to 36 usec
Encoder Excitation		+12Vdc, 410mA
INPUT		
TTL signals		1.5 V threshold, 100 mV hysteresis
Zero Crossing signals		0.7 Vp-p Min, 0 V threshold, 350 mV hysteresis
Max. aggregate Freq. Normal mode		72kHz
Max. aggregate Freq. High speed mode		124kHz
Max. aggregate Freq. Pulse Count mode		180kHz
Max. aggregate Freq. Quadrature mode		68kHz
Frequency Voltage Range		-120V to +120V
Frequency Offset Range		-10V to +10V
Analog input Range		0 to 10 V
Analog input Resolution		16 Bit
USB communication port		USB 2.0 compatible
POWER REQUIREMENTS		
Voltage	@ 25°C	+10 to +19 VDC
Current		1A Max
ENVIRONMENT		
Operation		-40 to +85 °C (-40 to +185 °F)
Storage		-55 to +125 °C (-67 to +257 °F)
MECHANICAL		
Weight		1 lb 12 oz.
Size (H x W x L)		1.625 x 6.5 x 5.75 in (4.13 x 16.5 x 14.6 cm)