NuVinci® CVP
Developer Kit
User Manual

Developer Kit User Manual – July 31, 2009

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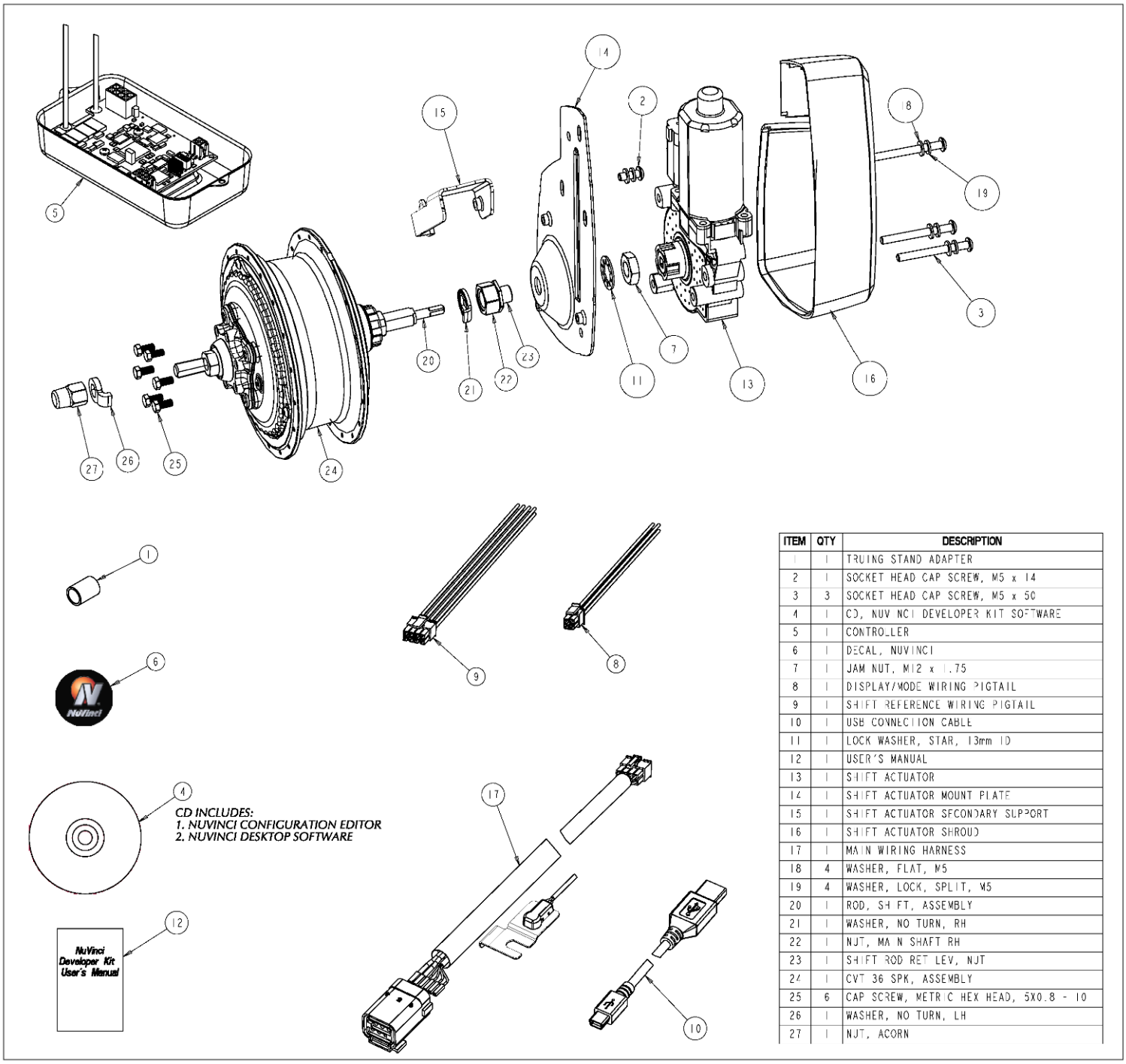
1 Product Overview

1.1 Included in the Box

The following components should be included in the NuVinci® CVP Developer Kit as shipped from Fallbrook Technologies.



ITEM	QTY	DESCRIPTION
1	1	TRUING STAND ADAPTER
2	1	SOCKET HEAD CAP SCREW, M5 x 14
3	3	SOCKET HEAD CAP SCREW, M5 x 50
4	1	CD, NUVINCI DEVELOPER KIT SOFTWARE
5	1	CONTROLLER
6	1	DECAL, NUVINCI
7	1	JAM NUT, M12 x 1.75
8	1	DISPLAY/MODE WIRING PIGTAIL
9	1	SHIFT REFERENCE WIRING PIGTAIL
10	1	USB CONNECTION CABLE
11	1	LOCK WASHER, STAR, 13mm ID
12	1	USER'S MANUAL
13	1	SHIFT ACTUATOR
14	1	SHIFT ACTUATOR MOUNT PLATE
15	1	SHIFT ACTUATOR SECONDARY SUPPORT
16	1	SHIFT ACTUATOR SHROUD
17	1	MAIN WIRING HARNESS
18	4	WASHER, FLAT, M5
19	4	WASHER, LOCK, SPLIT, M5
20	1	ROD, SHIFT, ASSEMBLY
21	1	WASHER, NO TURN, RH
22	1	NUT, MAIN SHAFT RH
23	1	SHIFT ROD RETAINER NUT
24	1	CVT 36 SPK, ASSEMBLY
25	6	CAP SCREW, METRIC HEX HEAD, 5X0.8 - 10
26	1	WASHER, NO TURN, LH
27	1	NUT, ACORN

Figure 1: Contents of *NuVinci* CVP Developer Kit

1.2 CVP Developer Kit Operation

The *NuVinci* CVP Developer Kit is a flexible and adaptable electronically-controlled continuously variable transmission system. The *NuVinci* bicycle CVP continues to win prestigious awards since its introduction in 2006, and the *NuVinci* system is now available in an automatic shifting version for bicycles, light-electric vehicles, small internal combustion engine vehicles, as well as many other applications.

The CVP Developer Kit consists of a *NuVinci* Continuously Variable Planetary (CVP) transmission, an electronic Shift Actuator, a Controller, and all primary wiring and mounting hardware to install the system. In addition, software is provided to configure the system with a Windows PC.

The CVP Developer Kit functions by automatically controlling the transmission speed ratio based upon vehicle speed (manual shift modes are also supported). The *NuVinci* Controller monitors vehicle speed via a Speed Sensor, and determines the appropriate Shift Position value based upon user-derived, uploaded Shift Maps. The Controller then commands the Shift Actuator to arrive at the correct speed ratio for the *NuVinci* CVP.

Significant benefits can be realized with the CVP Developer Kit, including increased acceleration, top speed, hill climb capability, range, and overall drivetrain efficiency. Additional information and results can be reviewed at the *NuVinci* website, www.fallbrooktech.com. Some recent applications of the CVP Developer Kit by Fallbrook Technologies are shown below.

Figures 2 & 3: *NuVinci* CVP Developer Kit Bicycle (Batavus) and Light Electric Vehicle (Currie) Applications

Figure 4: *NuVinci* CVP Developer Kit and *NuVinci* Display Interface Integrated Into a Light Electric Vehicle (eGo)

1.3 System Flowchart

The *NuVinci* CVP Developer Kit contains three separate sub-systems that allow the user to customize the transmission and control system to a particular vehicle or application:

- *Hardware* – All mechanical and electrical components of the system (Reference Figure 1)
- *NuVinci Configuration Editor* – Microsoft Excel spreadsheet template that allows the system configuration to be established and Configuration Table and Shift Table to be exported for the Controller
- *NuVinci* Desktop™ *Application* – Software application that enables communication between a PC and the *NuVinci* Controller to transfer Configuration and Shift Table files

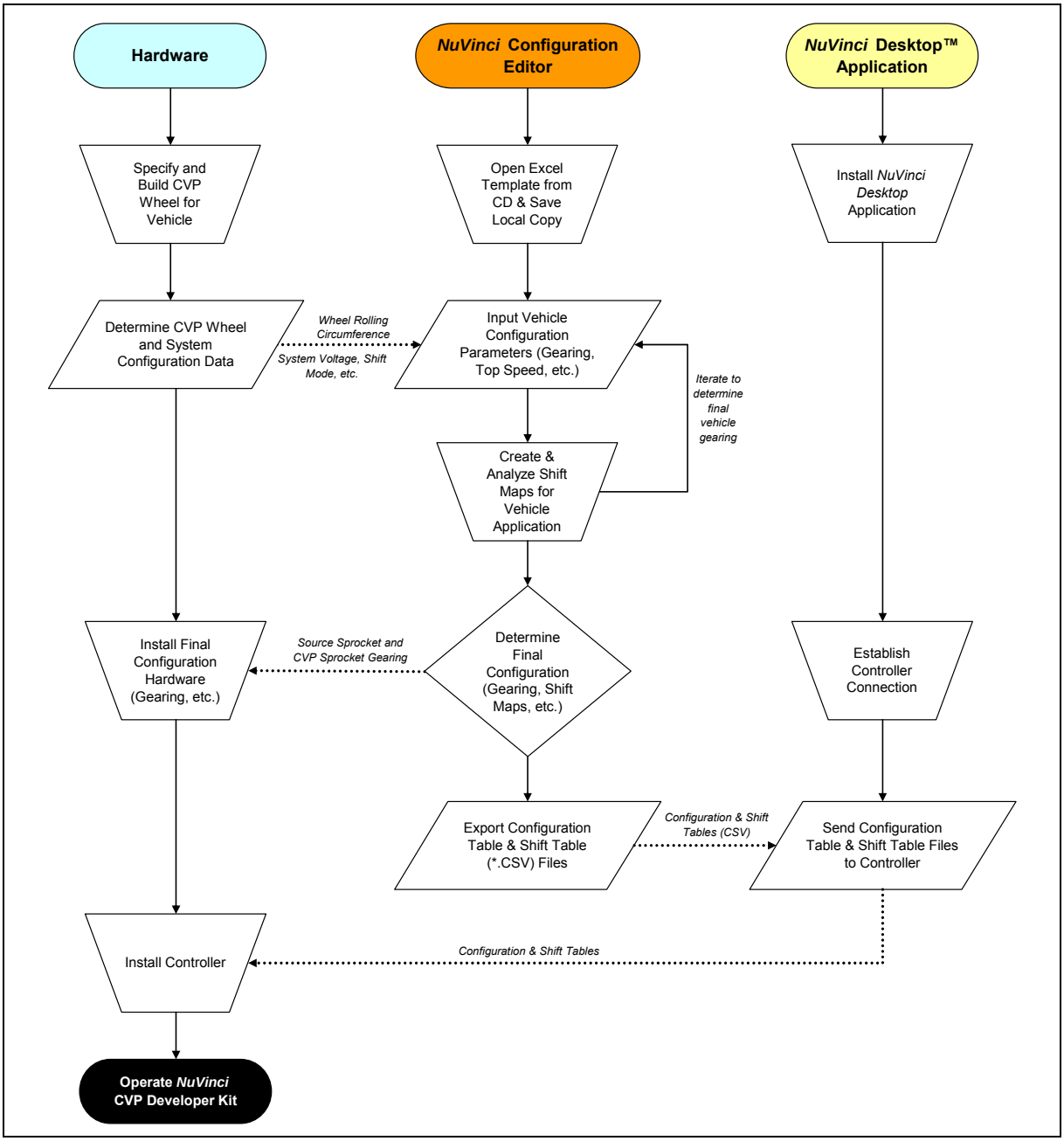


Figure 5: *NuVinci* CVP Developer Kit System Flowchart

1.4 System Capabilities

The electronic components of the *NuVinci* CVP Developer Kit are compatible with a power supply of 12 to 48 Volts, direct current (VDC). The *NuVinci* CVP transmission included with the CVP Developer Kit offers a nominal 350% ratio range, from a speed ratio of 0.5 (underdrive) to 1.75 (overdrive).

As with any transmission device, there are limits to torque, power, and speed. The *NuVinci* CVP is a production bicycle drivetrain that has proven to be extremely robust in bicycle and light-electric vehicle applications. Firm performance limits for vehicles other than bicycles are being developed, but Fallbrook Technologies recommends the following limits:

- Maximum Sustained (pulse-free) Input Torque: **65 Nm (48 lb-ft)**
- Maximum Instantaneous (spike) Input Torque: **130 Nm (96 lb-ft)**
- Maximum Sustained Input Power: **5 kW (7 hp)**
- Maximum Input Speed: **1000 RPM**
- Maximum Output Speed: **1000 RPM**
- CVP Orientation **Main Shaft Horizontal to Ground**

Operation at these torque and power conditions is not recommended for extended durations, and durability is heavily dependent on duty cycle. Use discretion and contact Fallbrook Technologies Customer Support for production application needs or customized configurations.

1.5 Product Development Options

Fallbrook Technologies is capable of configuring custom transmission designs specifically for production vehicles or applications. For drivetrain configurations outside of the *NuVinci* CVP Developer Kit performance envelope, please contact Fallbrook Technologies for other product possibilities.

1.6 Warranty

The *NuVinci* CVP Developer Kit is a development tool for applications that benefit from an electronically controlled continuously variable transmission. Fallbrook Technologies has no control over the type or quality of installation for the kit application, nor the performance characteristics of the electrical system that is powering the kit. Because of the possible varied nature of the application and installation for this system, the purchaser hereby acknowledges that the kit is a developmental unit provided for experimentation and is provided “AS IS.” FALLBROOK TECHNOLOGIES MAKES NO REPRESENTATION OR WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THE KIT OR THE USE THEREOF. FALLBROOK TECHNOLOGIES DISCLAIMS ALL IMPLIED WARRANTIES, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. FALLBROOK TECHNOLOGIES CUMULATIVE LIABILITY TO THE PURCHASER OR ANY OTHER PARTY FOR ANY LOSS OR DAMAGES RESULTING FROM ANY CLAIMS, DEMANDS, OR ACTIONS ARISING OUT OF OR RELATING TO THIS AGREEMENT SHALL NOT EXCEED THE AMOUNTS PAID TO FALLBROOK TECHNOLOGIES BY THE PURCHASER UNDER THIS AGREEMENT. IN NO EVENT SHALL FALLBROOK TECHNOLOGIES BE LIABLE FOR ANY INDIRECT, INCIDENTAL, CONSEQUENTIAL, SPECIAL, OR EXEMPLARY DAMAGES OR LOST PROFITS, EVEN IF FALLBROOK TECHNOLOGIES HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Notwithstanding the foregoing, Fallbrook Technologies may, at its sole discretion, replace kits that it determines have manufacturing or material defects. If you believe your product has manufacturing or material defects, notify Fallbrook Technologies and do not install or use the kit.

2 Hardware Details & Installation

2.1 Wheel building / Lacing of the CVP

The *NuVinci* CVP is intended to be laced into a 36-spoke bicycle wheel. The N17X series *NuVinci* CVP has successfully been laced into 20, 24, 26 inch and 700c wheels (wheel diameters smaller than 26 inch sizes may require custom-length spokes). A Truing Stand Adapter is included to install over the left axle to provide equal diameter contact points for a wheel truing stand.

Wheel building and lacing tips can be found in the '*NuVinci Technical Manual'*, available in the '*Bike Tech Data*' section of the *NuVinci* website (www.fallbrooktech.com). Other wheel or jackshaft configurations for the *NuVinci* CVP are possible, which may require custom components (output sprocket assembly, special frame mounting, etc.) to be fabricated by the developer.

2.2 Sprockets / Gearing

The *NuVinci* N17X series CVP is designed to transfer torque in one direction. Facing the drive side of the *NuVinci* CVP, the input torque direction must cause clockwise rotation, as shown in Figure 6. Therefore, the sprocket must be on the right side of the vehicle, as in a typical bicycle design. The *NuVinci* CVP in this production configuration will not transmit torque in the opposite direction (it will freewheel).

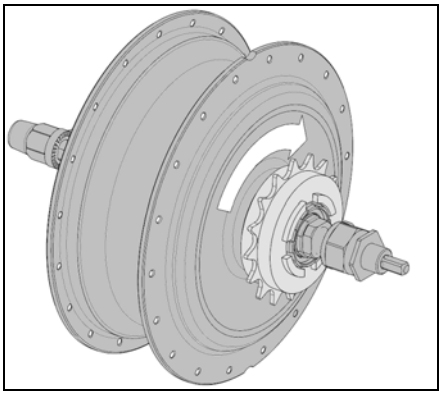


Figure 6: Clockwise Torque Input Direction
(Sprocket shown for illustration purposes only)

The CVP Developer Kit does not include a sprocket for the *NuVinci* CVP, as there are multitudes of gearing and drive chain/belt possibilities. The *NuVinci* Configuration Editor is a tool intended help the developer determine the correct gearing for their particular application. A standard ISO 24' x 1-3/8 TPI threaded freewheel adapter is included, which facilitates the use of many different freewheels and cogs. Compatible sprockets and freewheels can be found at bicycle retailers, electric scooter retailers (e.g. www.electricscooterparts.com), and several other hardware retailers.

If removal of a sprocket is required, a *NuVinci* sprocket removal tool is available for purchase through Fallbrook Technologies Customer Support. If regular use of multiple sprockets is desired, additional freewheel adapters can also be purchased for each sprocket option, allowing easy sprocket installation and removal.

2.3 Controller

The *NuVinci* CVP Developer Kit is delivered with an electronic shift Controller that can operate over a wide range of system voltages. The Controller has a powerful 32-bit microprocessor and advanced capabilities. There are six primary connections provided on the CVP Developer Kit Controller, as shown in Figure 7.

NOTE: ***The Controller printed circuit board and components are covered with a protective coating that will protect against some amount of contact, conduction, condensation, and corrosion. If harsh environments are expected, the Controller may require non-conductive potting.***

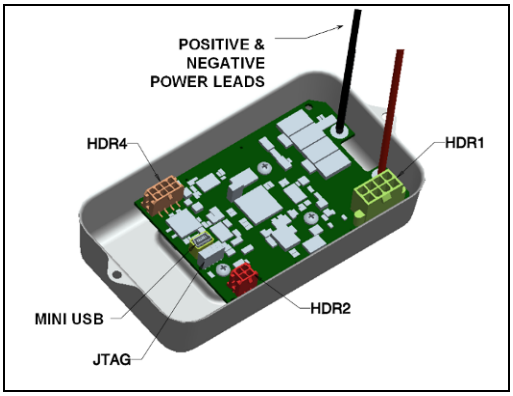


Figure 7: *NuVinci* Controller and Connector Locations

- *Positive & Negative Power Leads* – Provided bare for the developer to use their preferred connection. The system is designed to operate on 12 to 48 Volts DC. <u>While some protection is provided, please note that the Controller may be permanently damaged by reverse polarity</u>.

  NOTE: ***It is recommended to place a 5AMP fuse in line on the positive (red) wire. This will help to protect the vehicle/application electrical system from excessive current should any failures or surges occur.***

- *Mini USB connector* - Connector used for communicating between a PC and the Controller, including Shift Table and Configuration Table send and receive functions. Reference Appendix F for additional USB functionality.

  NOTE: ***If the USB connection to a PC is active, a CVP Developer Kit in the 'off' state will not be able to initialize and shift properly. If USB functionality is desired during CVP Developer Kit normal operation (shifting, measuring speed, etc.), the USB cable must be connected <u>after</u> the CVP Developer Kit is turned on and initialized. See Appendix F for further information and USB capabilities.***

- *HDR1 Main Wiring Harness connector* – Primary connection for operation of the CVP Developer Kit. This allows the Controller to receive Vehicle Speed and Shift Position information, as well as command and power the Shift Actuator.

- *HDR2 Display / Mode Wiring Pigtail connector* – Can accommodate a user-supplied Mode Switch, or a *NuVinci* Display Interface (reference Appendices E, F, and G).

- *HDR4 Shift Reference Wiring Pigtail connector* – Can accommodate a reference voltage signal for manual shifting, as well as other features (reference Appendices D and G).

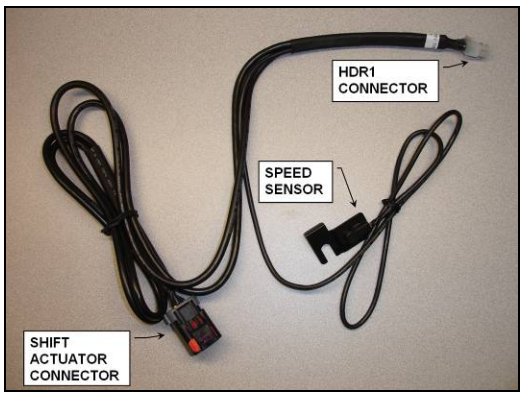
NOTE: ***The HDR1, HDR2, and HDR4 connections are not intended to be connected and disconnected repeatedly over the life of the product. Use care when installing or removing connectors from the Controller.***

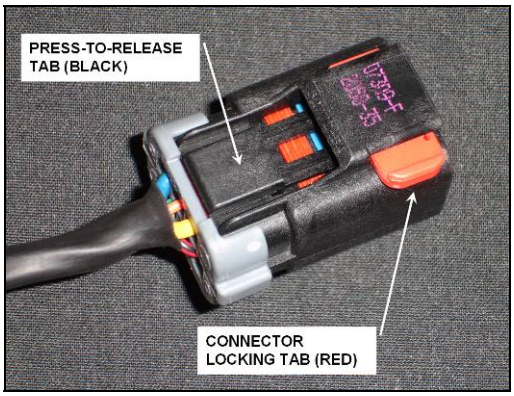
- *JTAG firmware programming connector* – If firmware changes are required or updates become available, this connector can be used by Fallbrook Technologies to flash new firmware to the Controller. Do not modify or attempt to utilize this connector.

2.4 Main Wiring Harness

The *NuVinci* Controller communicates with CVP Developer Kit components through the Main Wiring Harness. The Main Wiring Harness includes three components:

- *HDR1 Connector* – Attaches to the Controller
- *Speed Sensor* – Attaches at the *NuVinci* CVP left axle, and uses (6) ferrous bolts to register a speed signal for the Controller
- *Shift Actuator Connector* – Automotive-quality sealed connector that attaches to the Shift Actuator. There are two locking features on this connector, a red locking tab and a black press-to-release tab, as shown in Figure 9. When removing, ensure the red locking tab is extended (as shown) and press the black tab.





Figures 8 & 9: Main Wiring Harness and Components, Shift Actuator Connector

2.5 Installation of CVP and Speed Sensor

The *NuVinci* CVP was designed to be installed into a 135mm width dropout of a typical bicycle, as shown in Figure 10. Reference http://www.fallbrooktech.com/DevTech for CAD geometry and dimensions of select components of the *NuVinci* CVP Developer Kit.

The preferred mounting includes horizontal dropouts to allow for chain/belt tension adjustment, though vertical dropouts can be used with a chain/belt tensioner (not included). In addition to the CVP installation instructions here, bicycle installation instructions are available in the '*NuVinci Technical Manual*', within the '*Bike Tech Data*' section of the *NuVinci* website (www.fallbrooktech.com). The NuVinci CVP must be oriented in a position where the Main Shaft is approximately horizontal to the ground for distribution of internal lubrication.

Remove the protective clear cover on the Shift Rod threads, and apply all-purpose grease to the o-ring and adjacent shoulder on the Shift Rod (reference Figure 11). With the black Main Shaft plug oriented upward (to reduce the chance of spilling internal traction fluid), remove the rubber plug.

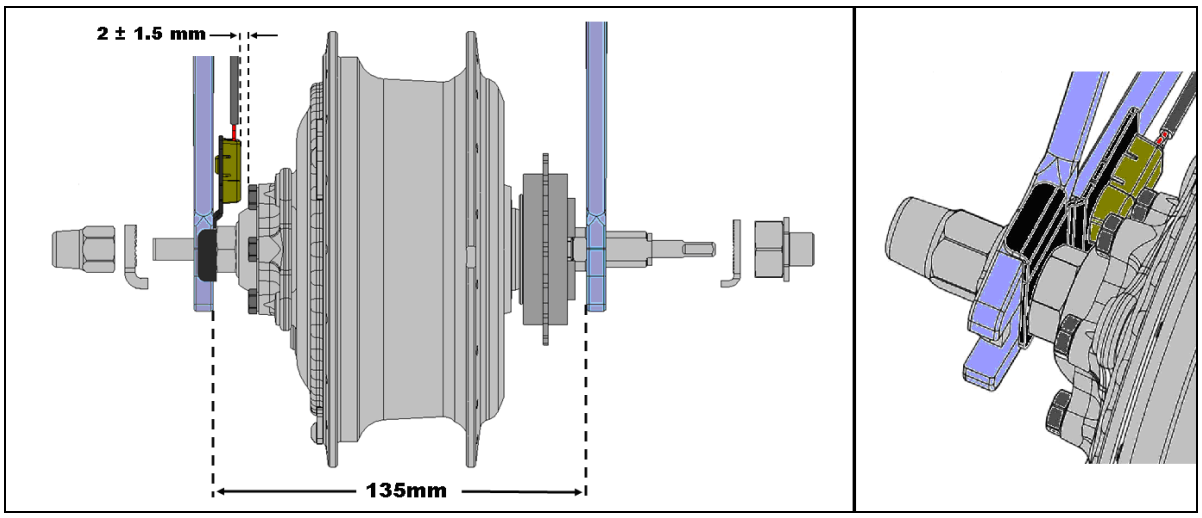


Figure 10: Standard Dropout Spacing of 135mm, Clearance between the Speed Sensor and Disk Brake Bolts, CVP Installation to Frame

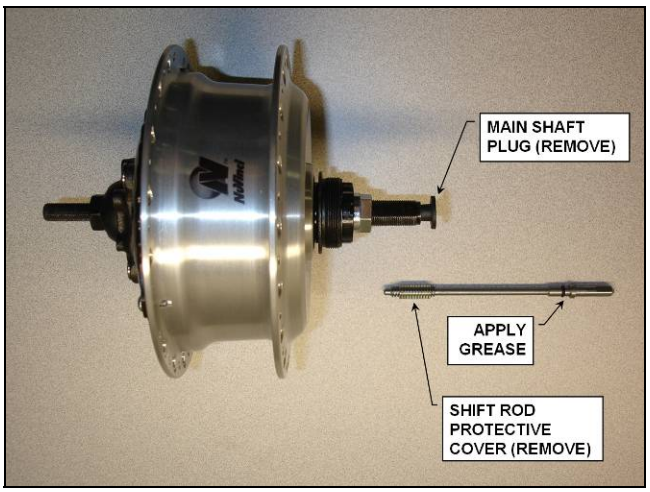
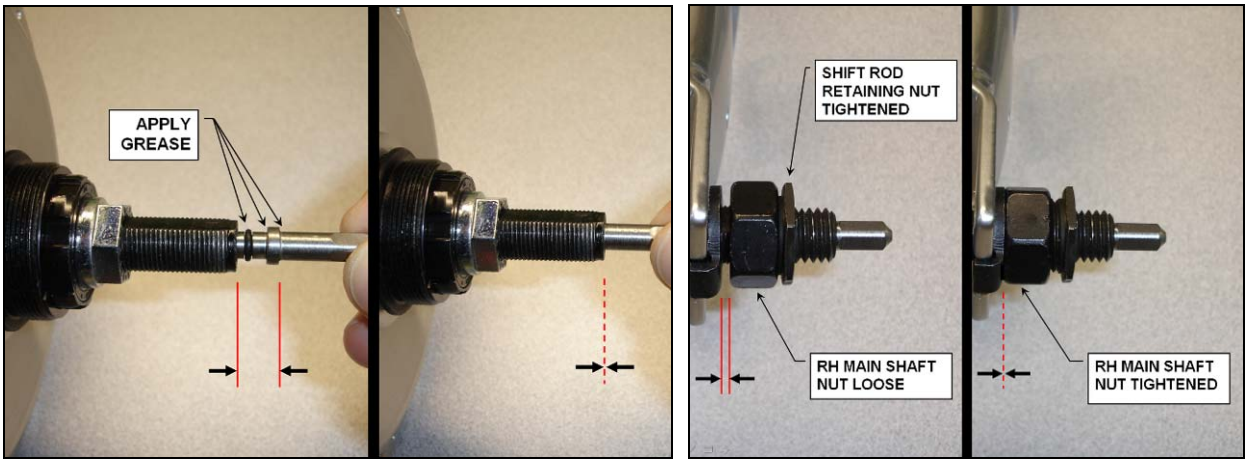


Figure 11: Shift Rod Cover and Main Shaft Plug (both to be removed)

Insert the threaded end of the Shift Rod and rotate clockwise until the Shift Rod shoulder seats fully inside the Main Shaft counterbore (see Figure 12). Next, slide the RH No-Turn Washer over the Main Shaft (the bent tab should point toward the CVP) and thread the Shift Rod Retaining Nut onto the Main Shaft (along with the RH Main Shaft Nut, reference Figure 13). Ensure that the RH Main Shaft Nut is not tightened against the No-Turn Washer at this time, and torque the Shift Rod Retaining Nut (with the thin hexagonal flange) to the value in Table 1.

With the RH No-Turn Washer outside of the dropout and the drive chain/belt loosely installed, slide the CVP into the frame/fixture. Locate the Speed Sensor on the non-drive side of the CVP, against the inside of the frame. The sheetmetal enclosure is intended to locate the Speed Sensor within a nominal distance of 2 mm (0.080 inch) to the (6) ferrous disk brake mounting bolts. These bolts function as the pick-ups for the Speed Sensor (reference Figure 10).

NOTE: ***The Speed Sensor in the CVP Developer Kit is not a standard Hall Effect sensor. The signal to the Controller varies between 0.7 and 1.4 volts to designate a ferrous bolt passing by the sensor. Fallbrook Technologies does not recommend using a different Speed Sensor (Speed Sensor voltages higher than 3.3 volts can cause permanent damage to the Controller).***



Figures 12 & 13: Seating the Shift Rod Fully Into the CVP, Shift Rod Retaining Nut and RH MainShaft Nut Tightening Order

Once the Speed Sensor is located, slide the LH No-Turn Washer over the protruding LH end of the Main Shaft. Set the chain/belt tension and tighten the RH Main Shaft Nut and Acorn Nut to the values shown in Table 1. If the application dropout thickness is less than 7mm (0.25 in), washers may be required to allow correct thread engagement on the Acorn Nut and RH Main Shaft Nut.

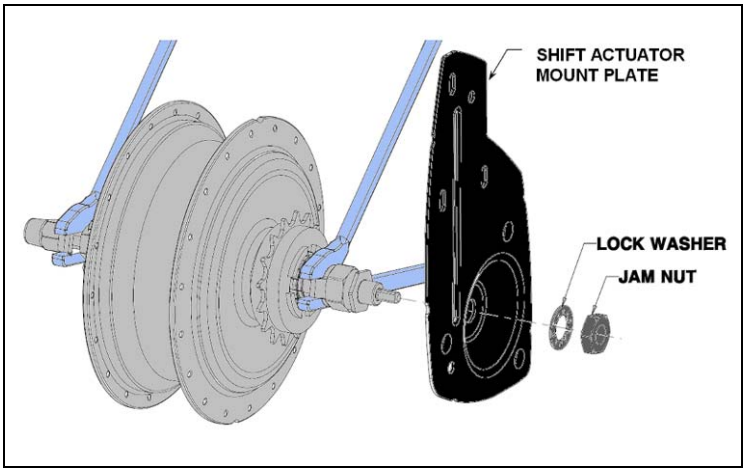
NOTE: ***It is important to note that the 'No-Turn' washers are required for this design, as there is significant torque reaction from the CVP main axle to the frame. The tabs on these washers can point either forward or backward, but must firmly engage the dropout slots of the frame/fixture.***

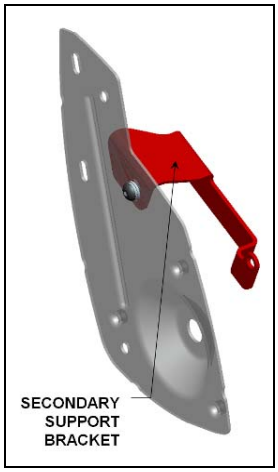
2.6 Shift Actuator Installation

Once the *NuVinci* CVP is installed in the vehicle/application, the Shift Actuator can be installed. Angular orientation of the Shift Actuator is not critical, though for this instruction manual it will be installed in a roughly vertical configuration. Once the orientation is chosen, the Shift Actuator Mount Plate can be installed over the Shift Rod Retaining Nut, and secured by the Lock Washer and Jam Nut. Torque values are provided in Table 1.

A Shift Actuator Secondary Support bracket is also included, though it may need to be modified for each particular application. Use of this secondary support bracket is encouraged if your vehicle will see bump or vibration loads at the CVP location (with the weight of the Shift Actuator, the assembly can rotate around the Main Shaft if not secured adequately). An example of the secondary support bracket is shown in Figure 15, for a light-electric vehicle application.

With the Shift Actuator Mount Plate installed, the Shift Actuator and Shift Actuator Shroud can be mounted. Manually rotate the Shift Rod approximately one turn clockwise from its counterclockwise 'stop' in order to have flexibility to mount the Shift Actuator to the Shift Rod. Install the Shift Actuator over the square end of the Shift Rod, aligning the male and female components. Once mated, rotate the Shift Actuator until the three mounting holes align with the extruded/tapped holes in the Shift Actuator Mount Plate. If resistance is felt when rotating the Shift Actuator, do not force the assembly; make sure that the Shift Rod is free to rotate fully.





Figures 14 & 15: Shift Actuator Mount Plate Installation, Secondary Support Bracket Example

Prior to mounting the Shift Actuator Shroud, it may be easier to attach the Main Wiring Harness connector to the Shift Actuator, and lock it in place with the red tab (See Section 2.4 Main Wiring Harness).

> ***NOTE: Ensure the power supply is disconnected and the CVP Developer Kit is powered OFF prior to attaching the wiring harness. Permanent damage can occur to the Controller and/or Shift Actuator if the system is energized when connecting components.***

Attach the Shift Actuator Shroud and secure the components with the three M5x50 fasteners and their associated washers and lock washers. Torque values are shown in Table 1. Once the installation orientation is finalized, it is recommended to use a thread locking compound that allows disassembly without extreme measures on the M12 Jam Nut and the M5 Button Head Cap Screw fasteners.

The Speed Sensor and Shift Actuator connector should now be installed, so the remainder of the Main Wiring Harness can be routed to the Controller location. If extensions are required for any of the wires, use similar gage wire and fully insulate and protect the wiring.

Table 1: Torque Specifications for Dry Threads

QTY	Fastener Description	Torque (in-lbs)	Torque (Nm)
1	*Shift-Rod Retaining Nut*	177 - 212	20 - 24
1	*Acorn Nut*	310 - 400	35 - 45
1	*RH Mainshaft Nut*	443 - 487	50 - 55
1	*Jam Nut, M12 x 1.75 (Mount plate)*	200-240	22 - 27
3	*M5x50 button-head cap screw (Actuator shroud)*	8 - 11	0.9 - 1.25
1	*M5x10 button-head cap screw (Secondary bracket)*	16 - 20	2.0 - 2.25

2.7 Wiring Pigtails

Two additional wiring assemblies are included with the *NuVinci* CVP Developer Kit. These connect to the Controller and provide colored leads for additional functionality. When connecting to these wire leads, use similar gage wire and fully insulate and protect the wiring.

The Display/Mode Wiring Pigtail and Shift Reference Wiring Pigtail are described further in Appendix G. These connection pigtails support future products from Fallbrook Technologies, as well as third party accessories.

3 *NuVinci Desktop* Application Installation & Operation

3.1 Introduction

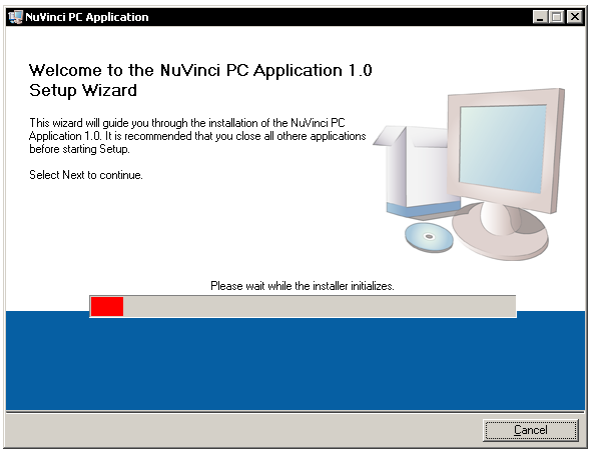
The *NuVinci* CVP Developer Kit is a powerful transmission and electronic control system that allows a developer to customize the *NuVinci* CVP to their particular application. The drivetrain can be custom-tuned, allowing maximum flexibility for the designer. In order to interface with the *NuVinci* Controller, the *NuVinci Desktop* application must be installed on a PC operating Microsoft Windows XP or Vista.

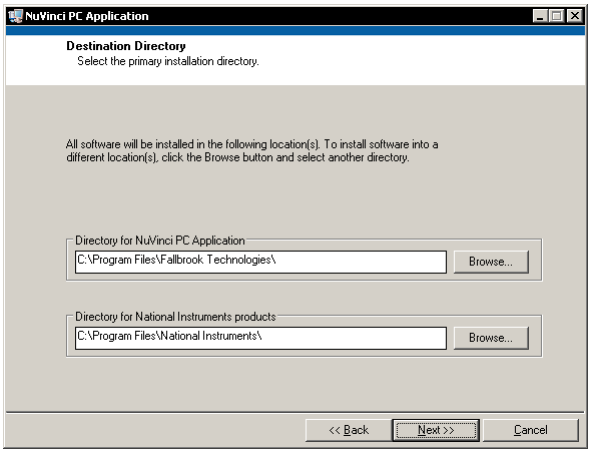
3.2 Installation and Configuration

The *NuVinci* CVP Developer Kit CD includes the *NuVinci Desktop* application and National Instruments (NI) LabVIEW Runtime Engine 8.2.1. If you already have LabVIEW or other NI software installed on your PC, the installer will not overwrite or otherwise interfere with normal operation of your currently installed software.

3.3 NuVinci Desktop Application Installation

Close all other open programs, and then run '*setup.exe*' (if the installation does not automatically begin) from the *NuVinci* CVP Developer Kit CD. Select the destination directories to which you wish to install the application components, and select '*Next*' to continue.





You must accept the end user license agreements from both Fallbrook Technologies and National Instruments to proceed with the installation. Updated terms and conditions governing the installation and use under the license purchased with the software are available at the NuVinci website (www.fallbrooktech.com). Review the summary of components the installer will add and select '*Next*' to begin the installation, which will take approximately 3 minutes to complete. Successful installation will display the '*Read Me*' file included with the documentation.

3.3.1 Connecting to the Controller via USB Cable

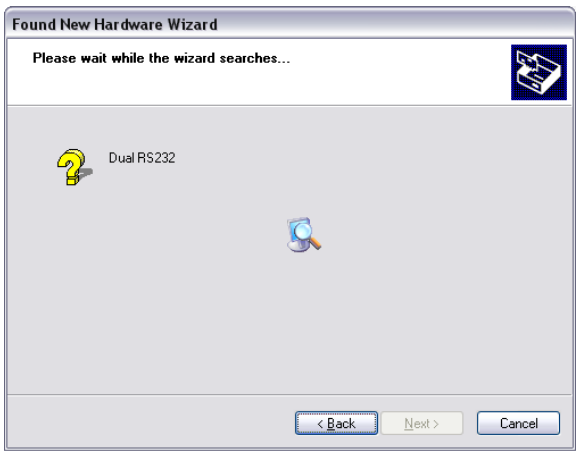
After successful installation of the *NuVinci Desktop* application, the correct USB device drivers must be installed in order to communicate between the PC and *NuVinci* Controller. Connect the mini-USB end of the connector cable to the Controller, and connect the other end to any functional USB port on the PC.

NOTE: ***To use the NuVinci Desktop application with the Controller, it is not necessary to supply external power to the Controller. The USB connection provides power to enable communication (but not for shift operation).***

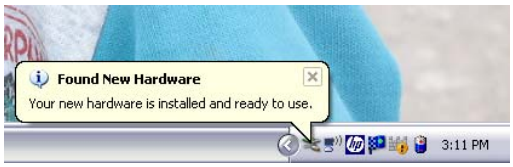
The first time the *NuVinci* Controller is connected to a Windows PC via the USB connector cable, Windows will recognize new hardware and attempt to load the appropriate drivers.

The '*Found New Hardware Wizard*' will guide the user to select appropriate drivers for the *NuVinci* Controller. If you have an active connection to the Internet, choose '*Yes, this time only*' when asked to connect to Windows Update to search for software (see note at the end of this section if there is no active connection to the Internet). Choose '*Install the software automatically (Recommended)*', as shown below:

The '*Found New Hardware Wizard*' will search the Internet for a period of time (sometimes 60 seconds or more) for the appropriate drivers from the manufacturer. When the appropriate driver has been found, a message will be displayed showing software has been installed for '*USB Serial Converter A*', as shown below:



Following the successful USB driver installation, a message will pop up stating '*Found New Hardware – Your new hardware is installed and ready to use*.' The same setup will repeat for '*USB Serial Converter B*', and should be executed in the same fashion as above.

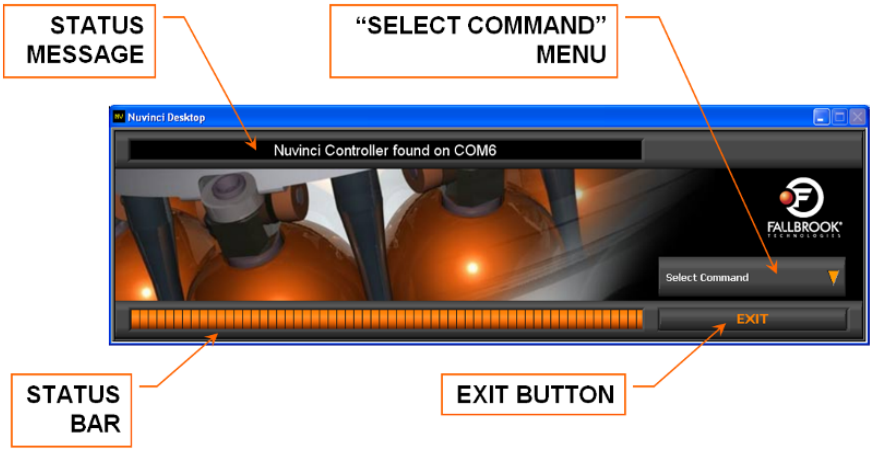


NOTE: ***If there is no active connection to the Internet, please reference Appendix I, section titled "Manually Installing USB Device Drivers". This will describe how to locate and install drivers that were installed on the local system drive during the NuVinci Desktop installation.***

3.3.2 *NuVinci Desktop* Application

Once the Controller is connected to your PC by the USB cable for approximately 5 seconds, start the *NuVinci Desktop* application *(Start >> All Programs >> Fallbrook Technologies >> NuVinci Desktop*). If a Hyperterminal application is running and communicating to the Controller, the *NuVinci Desktop* application will not locate the controller (reference Appendix F).

The *NuVinci Desktop* application will launch and immediately attempt to locate the Controller. The following status message should display when the Controller has established communication, though your COM port number will likely be different than the number (COM6) displayed below.



Notice that there are four main features to the *NuVinci Desktop* application:

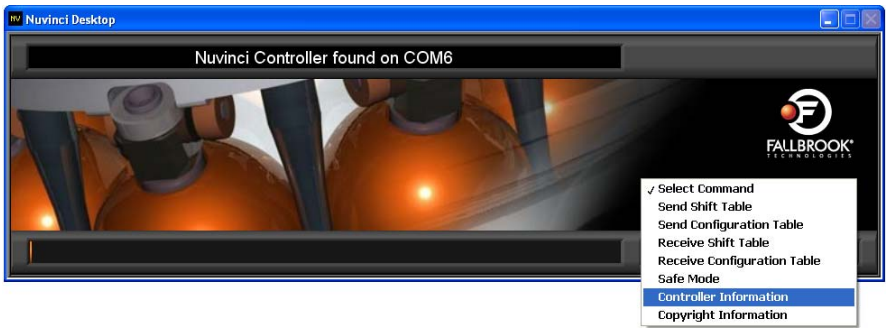
- *Status Message* – At the top of the window, there is a text status message that will remain until another action is performed
- *Status Bar* – At the bottom of the window, there is an orange graduated status bar that indicates the application is idle (black) or performing a task (some level of orange)
- *'Select Command' Menu* – At the right side of the window, this is a drop down menu with selections for communicating with the Controller
- *Exit Button* – At the lower right side of the window, this will exit the application

If the *NuVinci Desktop* application is not able to locate the Controller, the following status message will display, allowing you to re-scan for the Controller or to exit the application:

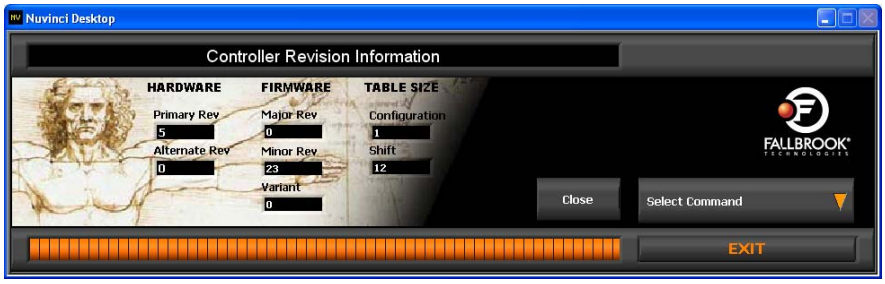
If you receive the '*No controllers found*' message, disconnect and reconnect the Controller to the PC with the supplied USB cable, and Rescan for the Controller after approximately 5 seconds. If the Controller is still not recognized, refer to Appendix I for troubleshooting tips. Visit http://www.fallbrooktech.com/DevTech for new releases of the *NuVinci* Desktop application.

3.3.3 Controller Information

When the *NuVinci Desktop* has successfully located the Controller, click on the '*Select Command*' drop-down menu, and choose '*Controller Information*':



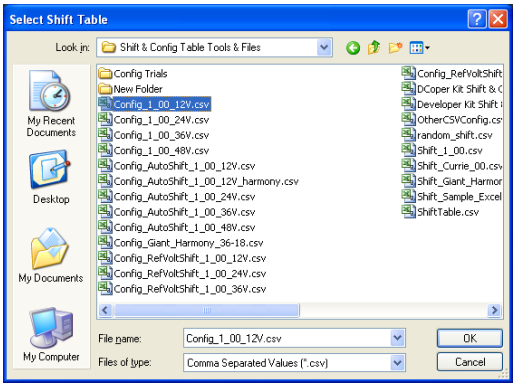
Controller revision information will be displayed that will reveal the hardware and firmware revisions for the particular Controller. This information can be useful for support from Fallbrook Technologies.



NOTE: ***If there is an error upon selecting 'Controller Information', the NuVinci Desktop application is likely mistaking another piece of hardware in your PC for the Controller. This is very common if a modem is installed on the PC. It is likely that this conflicting hardware will need to be disabled, as described in Appendix I.***

3.3.4 Sending Tables to the Controller

When the *NuVinci Desktop* application has successfully located the Controller, click on the '*Select Command*' drop-down menu, and choose either '*Send Shift Table*' or '*Send Configuration Table*' (reference the '*NuVinci Configuration Editor*' section of this User Manual for how to create Configuration Tables and Shift Tables). The program will ask you to locate the file you want to send on your PC, and will perform the communication between the PC and the Controller. The Controller can hold only one Shift Table and one Configuration Table at a time, so this procedure will overwrite the Shift Table or Configuration Table on the Controller with the one from your PC.



NOTE: ***If there is an an error when sending a Configuration Table or Shift Table to the controller, the data will not transfer to the controller and the system will not function as intended. After an error, communication will often be compromised. If this occurs, close the NuVinci Desktop application and unplug and reconnect the USB cable to the Controller before attempting again. Reference Appendices A and B to ensure the Configuration Table and Shift Table are in the correct format and entries are within limit values.***

3.3.5 Receiving Tables from the Controller

When the *NuVinci Desktop* application has established communication with the Controller, click on the '*Select Command*' drop-down menu, and choose either '*Receive Shift Table*' or '*Receive Configuration Table*'. The Controller can only hold one Shift Table and one Configuration Table at a time, so the *NuVinci Desktop* application will automatically read the appropriate information from the Controller, and ask you to locate and name the Configuration Table or Shift Table on your PC.

These files will be in the standard comma-delimited (*.csv) format and can be viewed by Microsoft Excel or any basic text editor.

3.3.6 Safe Mode

If you would like to reset the Controller to the default settings, click on the '*Select Command*' drop-down menu and choose '*Safe Mode*'. This will overwrite the Configuration Table and Shift Table with default values from within the Controller firmware. These tables will then need to again be modified for the current application, but will provide basic values for reference.

4 *NuVinci* Configuration Editor

4.1 Setting up your Application

The *NuVinci* CVP Developer Kit is designed to allow custom tuning of the *NuVinci* CVP drivetrain control for a variety of applications. This is accomplished by creating and sending two separate reference 'tables' to the *NuVinci* Controller; a Configuration Table and a Shift Table.

4.1.1 Configuration Table

The Configuration Table includes important information for the general setup and operation of the *NuVinci* CVP Developer Kit. The *NuVinci* Controller is a flexible tool with multiple functions and capabilities, most of which are enabled and configured through the Configuration Table.

The Configuration Table includes information such as system voltage, speed measurement parameters, shift control modes, and Shift Actuator performance parameters. The Configuration Table is a comma-delimited (*.csv, or *comma-separated values*) file, with all information in a simple text format, separated by commas. Reference Appendix A for further details and structure of the Configuration Table.

4.1.2 Shift Table

The Shift Table includes all shift information for automated shifting of the *NuVinci* CVP. Shift Maps are created for a range of vehicle speeds, which the Controller will reference to control the speed ratio of the CVP. Shift Positions are normalized from 0 to 1000, across the speed ratio of the *NuVinci* CVP. The values correspond to the rotational position of the Shift Rod, and not directly to speed ratio (reference Appendix H).

Up to 10 Shift Maps can be sent to the Controller in the existing Shift Table format (though the system can be configured to accommodate more). In addition to Shift Map information, the Shift Table includes other information such as software speed limiting, speed step size, and Shift Map table length. The Shift Table is also a comma-delimited (*.csv, or *comma-separated values*) file. Reference Appendix B for further details and structure of the Shift Table.

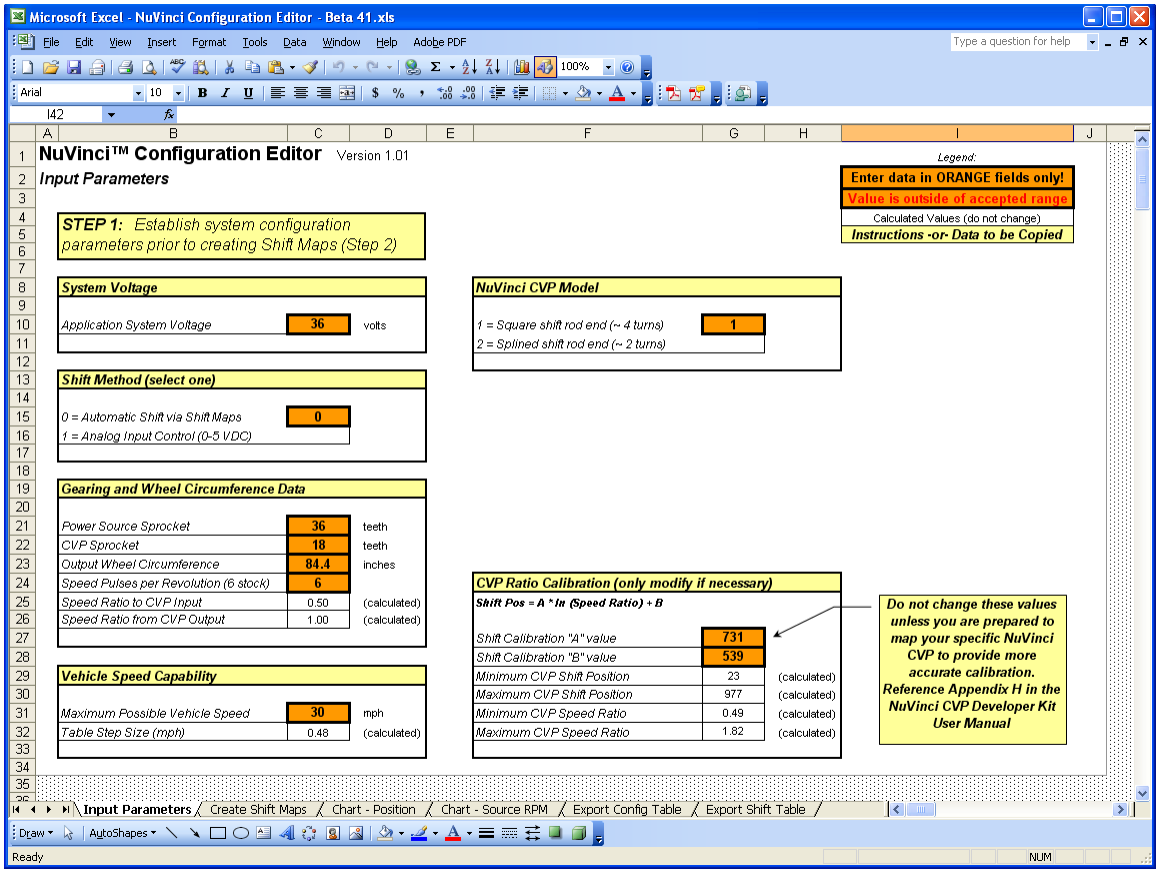
4.2 Define your Application Parameters

The best way to create and customize your Configuration Table and Shift Table is to use Microsoft Excel and the *NuVinci* Configuration Editor Template. This file is located in the '*Developer Tools*' directory on the *NuVinci* CVP Developer Kit CD. Visit http://www.fallbrooktech.com/DevTech for new releases of the *NuVinci* Configuration Editor.

If you do not have Microsoft Excel or a compatible spreadsheet tool, you can still modify the Configuration Table and Shift Table files using any simple text editor (such as Microsoft Notepad). The entries are separated by commas, and you must manually change the values and enter the appropriate data. There is also a free spreadsheet application available at www.openoffice.org, although Fallbrook does not recommend any particular application and is not responsible for any damage any other company's software may cause.

Configuration Table and Shift Table sample files are also provided on the *NuVinci* CVP Developer Kit CD. These are also located in the '*Developer Tools*' directory on the CD. For more information on Configuration Table and Shift Table format, reference Appendices A and B.

The *NuVinci* Configuration Editor is intended to simplify Configuration Table and Shift Table creation. This is how the document should appear when you first open it in the spreadsheet editor:



NOTE: ***Items in orange boxes are intended for information that the developer will enter for the intended vehicle/application. Items in white boxes are calculated values, and are not to be modified unless instructed by Fallbrook Technologies Customer Support. Items in light yellow boxes are instructions, or data that can be copied to a Shift Map.***

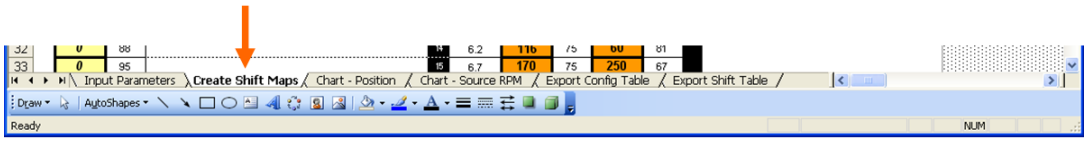
Legend:

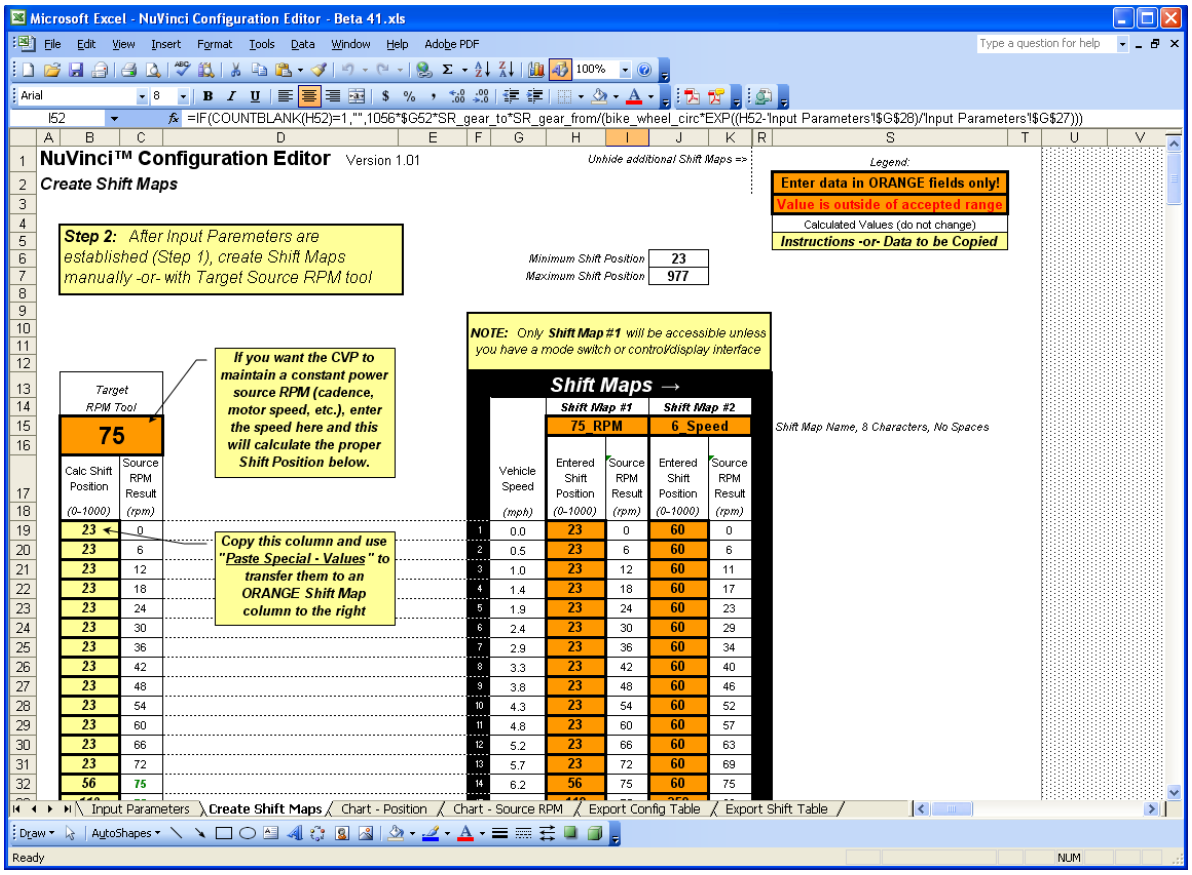
Enter data in ORANGE fields only!
Value is outside of accepted range
Calculated Values (do not change)
Instructions -or- Data to be Copied

There are multiple 'worksheets' in the *NuVinci* Configuration Editor, noted by the tabs at the bottom of the Excel document. <u>These worksheets are intended to be completed from left-to-right</u>. The first is the '*Input Parameters*' worksheet, where basic configuration information will be inserted by the developer (and is shown in the above screen shot).

NOTE: ***Shift Map information should only be entered after appropriate entries are made on the 'Input Parameters' worksheet.***

The second worksheet is titled '*Create Shift Maps*', which has tools to help create Shift Maps for the intended application:





The *NuVinci* Configuration Editor is intended to be a relatively simple interface for a feature-rich system, allowing the developer to customize the *NuVinci* CVP control to their application. By inserting configuration information into the orange fields and creating Shift Maps, the *NuVinci* Configuration Editor will allow the developer to export the Configuration Table and Shift Table that will be sent to the Controller via the *NuVinci Desktop* application.

Detailed instructions for exporting the Configuration Table and Shift Table files are included on the *NuVinci* Configuration Editor, on their respective worksheets ('*Export Config Table*' and '*Export Shift Table*'). These tables are required for operation of the *NuVinci* CVP Developer Kit.

If further details are required for the *NuVinci* Configuration Editor, please reference Appendix C, which details each step and worksheet involved with creating and exporting Configuration and Shift Tables.

4.3 Example Application

Suppose the target application is a pedal-assist bicycle with the motor in the front wheel hub. The goal for the *NuVinci* CVP Developer Kit application is to allow the rider to operate at a constant pedal cadence of 70 RPM (when within the speed ratio range of the transmission). The vehicle has the following attributes:

- 700c road wheels with a rolling circumference of 84.8 inches
- Front chain ring of 33 teeth
- Rear sprocket of 17 teeth
- Top speed of 40 mph
- 48 volt battery system
- Disk brakes, with speed sensor in standard location on 6 ferrous bolts

The *NuVinci* Configuration Editor process would follow these steps:

1. Open the *NuVinci* Configuration Editor template and save locally to your system.
2. Input the following values on the '*Input Parameter*' worksheet:

a.	*Application System Voltage:*	**48**	*(volts)*
b.	*Shift Method:*	**0**	*(automatic using Shift Table)*
c.	*Power Source Sprocket:*	**33**	*(pedal crank teeth)*
d.	*CVP Sprocket:*	**17**	*(sprocket teeth)*
e.	*Output Wheel Circumference:*	**84.8**	*(inches)*
f.	*Speed Pulses per Revolution:*	**6**	*(ferrous bolts)*
g.	*Maximum Possible Vehicle Speed:*	**40**	*(mph)*
h.	*NuVinci CVP Model:*	**1**	*(square shift rod end CVP)*
i.	*CVP Ratio Calibration:*		*(do not change)*

3. Click on the '*Create Shift Maps*' worksheet, and type '**70**' into the 'Target Source RPM Tool' orange entry box.
4. Copy the calculated Shift Map column (64 values highlighted in yellow boxes) to the "*Shift Map #1*" orange entry fields as the instructions state on the worksheet.
5. Name Shift Map #1 '**70 RPM**'.
6. *(optional)* View the Shift Map characteristics by clicking on the '*Chart – Position*' and '*Chart – Source RPM*' worksheets and graphs.
7. Click on the '*Export Config Table*' worksheet, and follow the instructions to export and create the Configuration Table CSV file.
8. Click on the '*Export Shift Table*' worksheet, and follow the instructions to export and create the Shift Table CSV file.
9. Use the *NuVinci Desktop* application to connect to the PC and then individually send the Configuration Table and Shift Table files to the Controller.

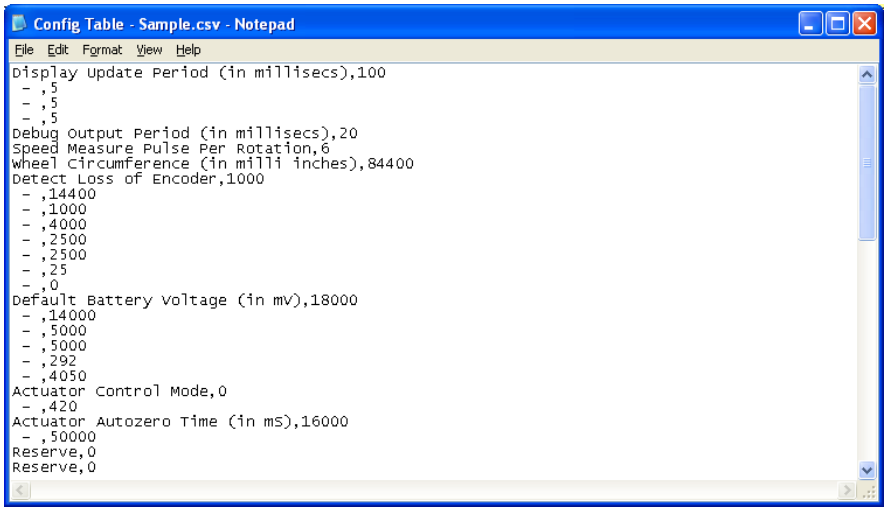
This concludes the basic User Manual for the *NuVinci* CVP Developer Kit. Please reference the Appendices for more detailed information and instructions. Fallbrook Technologies looks forward to the applications that will result from this product!

Appendix A – Configuration Table Format

The Configuration Table is a comma-delimited file, with entries separated by commas and line spacing. There are 64 lines in the Configuration Table, and 2 columns. The first column is a description, and the second column is the configuration value. There are limits to the values, some of which are displayed in the following representation (note that this is what the *NuVinci* Configuration Editor will create and format for the developer):

	Parameter	Value	Min	Max	Description
	Column A	*Column B*			
Line 1	Display Update Period (in mS)	100	10	10,000	Update period for display output, in milliseconds
2	--	5	1	100	*Do not modify*
3	--	5	4	10,000	*Do not modify*
4	--	5	1	1,000	*Do not modify*
5	Debug Update Period (in mS)	20	10	10,000	Update period for debug output stream to COM port, in milliseconds
6	Speed Measure Pulse Per Rotation	6	0	100	Number of speed sensor pulses per rotation of the CVP output wheel
7	Wheel Circumference (milli inches)	84,800	1,000	125,000	Wheel rolling circumference in milli inches (distance per rotation)
8	Detect Loss Of Encoder (in mS)	1	0	1,000,000	Deactivate system if actuator errors: "0" for inactive, "1" for active
9	--	10,000	10,000	53,000	*Unused*
10	--	1,000	50	5,500	*Unused*
11	--	4,000	50	5,500	*Unused*
12	--	2,500	2,400	60,000	*Unused*
13	--	2,500	2,400	60,000	*Do not modify*
14	--	25	0	1,000	*Unused*
15	--	0	0	1	*Unused*
16	Default Battery Voltage (in mV)	36,000	7,000	53,000	Default system battery voltage, in millivolts
17	--	18,000	0	42,000	*Do not modify*
18	--	5,000	100	10,000	*Unused*
19	--	5,000	100	10,000	*Unused*
20	--	292	2	10,000	*Do not modify*
21	Actuator Revolutions (in milli revs)	4,050	2	1,000,000	Revolutions of total mechanical travel for actuator, in milli revolutions
22	Actuator Control Mode	0	0	2	"0" for Automatic Shift, "1" for Analog (0-5VDC) Input Control, "2" for Command Interface
23	--	420	50	1,000	Do not modify
24	Actuator Autozero Time (in mS)	4,500	10	20,000	If autozero has not completed in this time, system will deactivate
25	--	50,000	100	50,000	*Unused*
26	Reserve	0			*Unused*
27	Reserve	0			*Unused*
28	Reserve	0			*Unused*
↓					
↓					
63	Reserve	0			*Unused*
Line 64	Reserve	0			*Unused*

A representation of how the Configuration Table appears in a normal text editor follows:



Sample Configuration Table files can be located on the *NuVinci* CVP Developer Kit CD, in the '*Developer Tools*' directory.

Appendix B – Shift Table Format

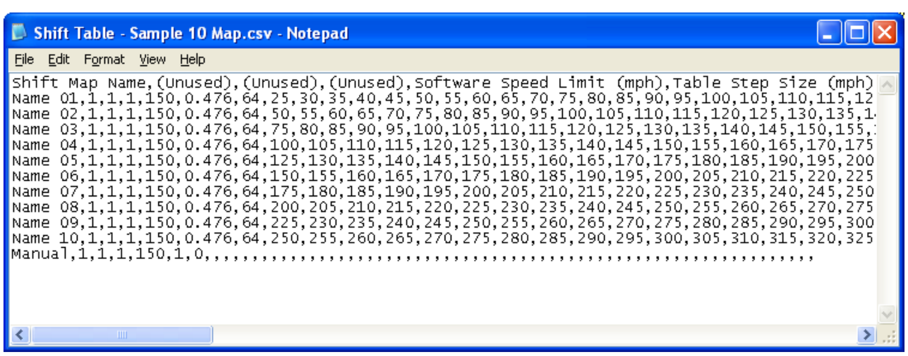
The Shift Table is a comma-delimited file, with entries separated by commas and line spacing. There are 7 lines in the Shift Table, and 71 columns. Line 1 is simply a header description. Shift Maps are aligned horizontally in rows starting at Row 2, with the name in the first column (note that this is what the *NuVinci* Configuration Editor will create and format for the developer):

	Column 1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	→ →	*69*	*70*	*71*
Line 1	Shift Map Name	(Unused)	(Unused)	(Unused)	Software Speed Limit (mph)	Table Step Size (mph)	Table Length (entries)	0.0	0.5	1.0	1.4	1.9	2.4		29.0	29.5	30.0
2	75_RPM	1	1	1	25	0.476	64	0	0	0	0	0	0		1000	1000	1000
3	6_Speed	1	1	1	75	0.476	64	60	60	60	60	60	60		1000	1000	1000
4	Name 03	1	1	1	75	0.476	64	0	0	0	0	0	0		0	0	0
5	Name 04	1	1	1	75	0.476	64	0	0	0	0	0	0		0	0	0
6	Name 05	1	1	1	75	0.476	64	0	0	0	0	0	0		0	0	0
7	Name 06	1	1	1	75	0.476	64	0	0	0	0	0	0		0	0	0
8	Name 07	1	1	1	75	0.476	64	0	0	0	0	0	0		0	0	0
9	Name 08	1	1	1	75	0.476	64	0	0	0	0	0	0		0	0	0
10	Name 09	1	1	1	75	0.476	64	0	0	0	0	0	0		0	0	0
11	Name 10	1	1	1	75	0.476	64	0	0	0	0	0	0		0	0	0
Line 12	Manual	1	1	1	75	1	0										

Additional information on Shift Table entries:

- *Software Speed Limit (mph)* – This is an imposed speed limit for a particular Shift Map. This value is set to 1.5 times the highest speed value on the Shift Map as a default, effectively disabling it. This feature has not been tested on a wide range of speeds or applications.
- *Table Step Size (mph)* – For this release of the *NuVinci* CVP Developer Kit, the maximum speed entered by the user on the *NuVinci* Configuration Editor is simply broken into 64 steps for each Shift Map (in this example, 64 evenly spaced steps from 0 to 30.0 mph is approximately 0.476 mph per step).
- *Table Entry Length* – This is how many steps the Shift Map is segmented into (64 in this example).
- *Speed Value Reference* – Line 1, starting in Column 8, is simply a reference value for the vehicle speed that the Shift Map relates to.

A representation of how the Shift Table appears in a normal text editor follows:




```
Shift Map Name,(Unused),(Unused),(Unused),Software Speed Limit (mph),Table Step Size (mph)
Name 01,1,1,1,150,0.476,64,25,30,35,40,45,50,55,60,65,70,75,80,85,90,95,100,105,110,115,12
Name 02,1,1,1,150,0.476,64,50,55,60,65,70,75,80,85,90,95,100,105,110,115,120,125,130,135,1
Name 03,1,1,1,150,0.476,64,75,80,85,90,95,100,105,110,115,120,125,130,135,140,145,150,155,
Name 04,1,1,1,150,0.476,64,100,105,110,115,120,125,130,135,140,145,150,155,160,165,170,175
Name 05,1,1,1,150,0.476,64,125,130,135,140,145,150,155,160,165,170,175,180,185,190,195,200
Name 06,1,1,1,150,0.476,64,150,155,160,165,170,175,180,185,190,195,200,205,210,215,220,225
Name 07,1,1,1,150,0.476,64,175,180,185,190,195,200,205,210,215,220,225,230,235,240,245,250
Name 08,1,1,1,150,0.476,64,200,205,210,215,220,225,230,235,240,245,250,255,260,265,270,275
Name 09,1,1,1,150,0.476,64,225,230,235,240,245,250,255,260,265,270,275,280,285,290,295,300
Name 10,1,1,1,150,0.476,64,250,255,260,265,270,275,280,285,290,295,300,305,310,315,320,325
Manual,1,1,1,150,1,0,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
```

Sample Shift Table files can be located on the *NuVinci* CVP Developer Kit CD, in the '*Developer Tools*' directory.

Appendix C – *NuVinci* Configuration Editor Template

The *NuVinci* Configuration Editor is intended to help determine the vehicle/application configuration parameters, as well as simplify the creation of accurate Shift Maps. Each aspect of the *NuVinci* Configuration Editor is covered in this Appendix. Visit http://www.fallbrooktech.com/DevTech for new releases of the *NuVinci* Configuration Editor.

'Input Parameters' Worksheet

System Voltage		
Application System Voltage	**36**	volts

The System Voltage section defines the nominal system voltage that will be used to operate the *NuVinci* CVP Developer Kit (the voltage applied to the positive and negative power leads from Figure 7 of the User Manual). The system is designed to operate on 12 to 48 Volts, direct current (VDC). If your system cannot provide voltage within this range, it is incompatible with the *NuVinci* CVP Developer Kit and Controller.

Shift Method (select one)	
0 = Automatic Shift via Shift Maps	**0**
1 = Analog Input Control (0-5 VDC)	

The Shift Method section includes three methods for shifting the *NuVinci* CVP Developer Kit:

- *Automatic Shifting (Shift Method '0')* – The default shift method that automatically controls Shift Position based on Shift Maps. Manual shifting in increments of ~50 Shift Positions (~5% of total range) is available through the Display Interface or PC/Terminal Display connection (reference Appendix F).
- *Analog Input Control (Shift Method '1')* – An alternative method of shifting by sending an analog reference voltage signal of 0-5 VDC (0 VDC is ~ 0 Shift Position, 5 VDC is ~ 1000 Shift Position, linear relationship). Reference Appendix D.
- *Command Interface (Shift Method '2')* – Currently unsupported. Reference Appendix D.

NOTE: ***If any Shift Method besides '0' is chosen, the Shift Maps are not used by the Controller. Red values will be displayed across the top of the Shift Map columns indicating this fact. See Appendix D for more information on alternative shift methods.***

Gearing and Wheel Circumference Data		
Power Source Sprocket	**36**	teeth
CVP Sprocket	**18**	teeth
Output Wheel Circumference	**84.4**	inches
Speed Pulses per Revolution (6 stock)	**6**	
Speed Ratio to CVP Input	0.50	(calculated)
Speed Ratio from CVP Output	1.00	(calculated)

The Gearing and Wheel Circumference Data section includes information for speed measurement for the Controller, as well as calculations within the *NuVinci* Configuration Editor.

- *Power Source Sprocket* – The number of teeth on the 'source' of input power. Examples include a front crank ring for bicycles, motor sprocket for electric vehicles, etc.
- *CVP Sprocket* – The number of teeth on the sprocket connected to the *NuVinci* CVP.
- *Output Wheel Circumference* – The circumference of the output wheel on the vehicle/application. This is used to calculate vehicle speed, and should be a 'rolling circumference' for the vehicle, such that it is accurate for a loaded rolling vehicle.
- *Speed Pulses per Revolution* – The number of encoder 'pulses' that the speed sensor will register for one revolution of the output wheel. The stock system uses (6) fasteners on the *NuVinci* Disk Brake Adapter to register with the speed sensor.

NOTE: ***The following two data entries are in grey boxes, meaning they are calculated values. Typical operation of the NuVinci CVP consists of only two sprockets, one for the 'source' and one for the 'CVP'. However, some applications will utilize multiple sets of sprockets prior to the CVP, and may even use additional gearing after the CVP. If your application is non-standard, you will need to replace the following data entries with your application speed ratios. Speed Ratio is defined as:***

$$Speed\ Ratio = \frac{Output\ Speed}{Input\ Speed} = \frac{1}{Gear\ Ratio}$$

- *Speed Ratio to CVP Input* – If you do not have the simple case of a source and CVP sprocket only, calculate your speed ratio from the source to the CVP. This is effectively how many times the CVP input sprocket rotates divided by the number of times the source rotates.
- *Speed Ratio from CVP Output* – If you are not using the *NuVinci* CVP as your output wheel, but are using it in some other configuration (jack shaft, for example), you will need to calculate your speed ratio from the CVP output to the output wheel. This is effectively how many times the output wheel rotates divided by the number of times the CVP output rotates.

Vehicle Speed Capability		
Maximum Possible Vehicle Speed	30	mph
Table Step Size (mph)	0.48	(calculated)

The Vehicle Speed Capability section includes the maximum possible speed for the vehicle, in miles per hour. This value will be used to determine the Shift Map speed increment size, in mph. The *NuVinci* Configuration Editor will provide 64 data entries equally spaced across the vehicle speed range. Thus, for each Shift Map, there will be 64 Shift Position values associated with 64 Vehicle Speeds.

NuVinci CVP Model	
1 = Square shift rod end (~ 4 turns) 2 = Splined shift rod end (~ 2 turns)	1

The *NuVinci* CVP Model section requires selection of the model CVP that is being used for the application. CVPs with a square shift rod end allow four (4) turns of the Shift Rod to span the ratio range of the CVP, while CVPs with a splined shift rod end allow two (2) turns of the Shift Rod to span the same ratio range.

CVP Ratio Calibration (only modify if necessary)		
Shift Pos = A * ln (Speed Ratio) + B		
Shift Calibration "A" value	731	
Shift Calibration "B" value	539	
Minimum CVP Shift Position	23	(calculated)
Maximum CVP Shift Position	977	(calculated)
Minimum CVP Speed Ratio	0.49	(calculated)
Maximum CVP Speed Ratio	1.82	(calculated)

The CVP Ratio Calibration section is only to be changed by experienced developers who are prepared to calibrate their particular *NuVinci* CVP. The CVP speed ratio is varied by rotating a shift rod on the input (right) side of the transmission. The speed ratio is dependent on the rotational position of the shift rod, which is controlled by the Shift Actuator and Controller.

These calibration values allow you to custom calibrate your CVP speed ratio. The factory settings should be accurate enough for most applications. If you need custom calibrations, reference Appendix H.

'Create Shift Maps' Worksheet

There are two distinct ways to create Shift Map values using the *NuVinci* Configuration Editor. One method is to simply enter Shift Map values manually, and the other method is to calculate constant 'Source RPM' Shift Maps.

> ***NOTE:*** ***The calculations to create Shift Maps depend on the data from the 'Input Parameters' worksheet, therefore accurate information should be entered prior to creation of any Shift Maps.***

Manual Entry

The Shift Maps are shown in the following basic configuration (columns truncated for display on this page). Up to ten separate Shift Maps are supported with the *NuVinci* Configuration Editor, though only the first Shift Map is accessible without a mode switch, Display Interface, or PC/Terminal connection (reference Appendices E and F). To view the Shift Maps in hidden columns L through Q, select the top column headers labled 'K' and 'AB', right-click, and select '*Unhide*' (as illustrated below).

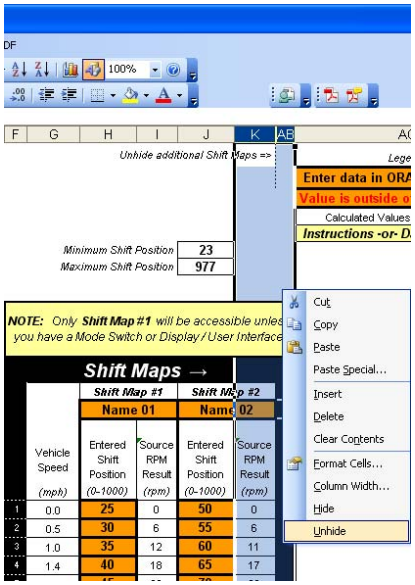
The Vehicle Speed column is automatically calculated using the previously input 'Maximum Possible Vehicle Speed'. For each Vehicle Speed value, there will be an associated transmission Shift Position entry. The transmission absolute range is normalized between '0' and '1000', respectively. A Shift Position of '0' is associated with the full underdrive 'stop' for the CVP (speed ratio ≈ 0.5), and '1000' is associated with the full overdrive 'stop' (speed ratio ≈ 1.75).

The full 0-1000 range cannot be safely utilized without the possibility of hitting the mechanical 'stops' inside the transmission, so there is a small 'buffer' at each end. The actual minimum and maximum Shift Position values will be displayed on the Configuration Editor above the Shift Maps, and will typically be the following (Shift Position values below or above these will not be attempted by the Controller, which will automatically stop at these limits):

DEVELOPER KIT	*SHIFT ROD NO. OF TURNS*	*SHIFT ROD END STYLE*	*MINIMUM SHIFT POSITION*	*MAXIMUM SHIFT POSITION*
N171B-DEV-36S-1	~4	SQUARE	23	977
N171B-DEV-36S-2	~2	SPLINED	46	954

Shift Maps →

	Vehicle Speed (mph)	Shift Map #1 55_RPM Entered Shift Position (0-1000)	Shift Map #1 55_RPM Source RPM Result (rpm)	Shift Map #2 6_Speed Entered Shift Position (0-1000)	Shift Map #2 6_Speed Source RPM Result (rpm)
1	0.0	23	0	60	0
2	0.5	23	7	60	6
3	1.0	23	13	60	12
4	1.4	23	20	60	19
5	1.9	23	26	60	25
6	2.4	23	33	60	31
7	2.9	23	39	60	37
8	3.3	23	46	60	44
9	3.8	23	52	60	50
10	4.3	23	59	60	56
11	4.8	23	66	60	62
12	5.2	23	72	60	69
13	5.7	57	75	60	75
14	6.2	116	75	60	81
15	6.7	170	75	250	67



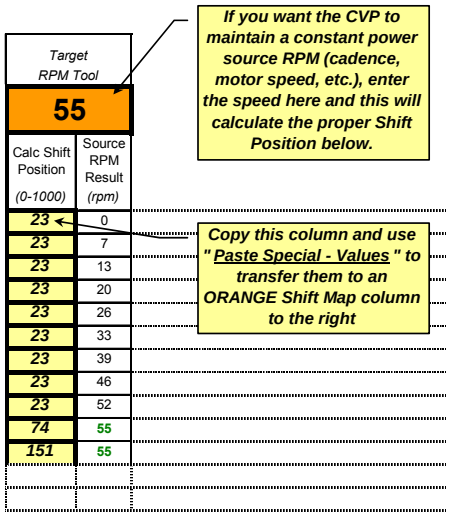
Notice that there is a calculated (white) field directly to the right of each (orange) Shift Map entry. These values estimate the 'Source RPM' (motor, engine, rider cadence, or other power source) for that Shift Position and Vehicle Speed. This column uses the information from the *NuVinci* Configuration Editor '*Input Parameters*' worksheet to estimate these values and provide the user an immediate reference.

To utilize Shift Maps #2 or higher, reference Appendices E and F. All ten Shift Maps are represented by the following screen shot (Shift Maps 3-10 are empty; Shift Maps are truncated for view on this page):

		Shift Maps →																			
		Shift Map #1		Shift Map #2		Shift Map #3		Shift Map #4		Shift Map #5		Shift Map #6		Shift Map #7		Shift Map #8		Shift Map #9		Shift Map #10	
		55 RPM		6 Speed		Name 03		Name 04		Name 05		Name 06		Name 07		Name 08		Name 09		Name 10	
	Vehicle Speed (mph)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)	Entered Shift Position (0-1000)	Source RPM Result (rpm)
1	0.0	23	0	60	0																
2	0.5	23	6	60	6																
3	1.0	23	12	60	11																
4	1.4	23	18	60	17																
5	1.9	23	24	60	23																
6	2.4	23	30	60	29																
7	2.9	23	36	60	34																
8	3.3	23	42	60	40																
9	3.8	23	48	60	46																
10	4.3	23	54	60	52																
11	4.8	23	60	60	57																
12	5.2	23	66	60	63																
13	5.7	57	69	60	69																
14	6.2	116	69	250	57																
15	6.7	170	69	250	62																

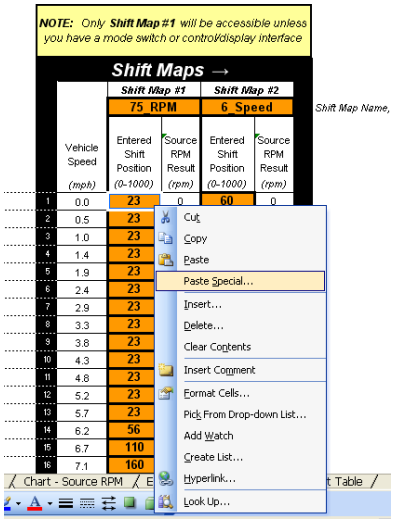
Constant Target Source RPM Calculator

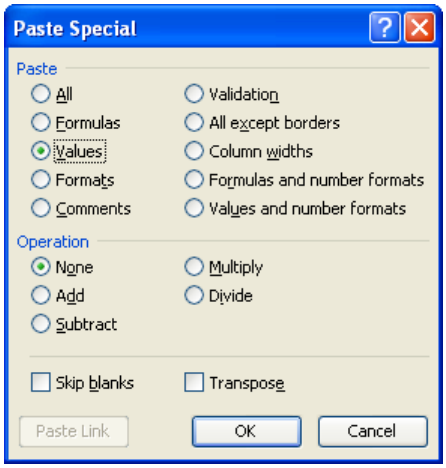
The 'Constant Target Source RPM' entry tool allows you to create Shift Maps that will maintain a constant source RPM (motor, engine, rider cadence, etc.) throughout the ratio range of the *NuVinci* CVP. This tool will create a Shift Map for a given target source RPM. This Shift Map will be in yellow boxes, and the calculated source RPM will be shown in white, directly to the right. The calculated values will be in a green font when it matches the target RPM (55 RPM in the following example). The only orange box is the target source RPM, which the developer enters:



NOTE: ***The Calculated Shift Position values from this tool will <u>not</u> be automatically transferred to the Shift Maps. The user must transfer them to the orange fields, as described below.***

In order to use the map that is calculated, the user must copy the Shift Position (yellow) values to one of the (orange) Shift Maps. The best way to do this, as shown in the yellow instructions above, is to select <u>all 64 Shift Position values</u> in the yellow column, right-click and select '*Copy*'. Then select the first entry on an orange Shift Map entry column, right-click, and select the '*Paste Special*' command, selecting '*Values*' from the option list (this will maintain the orange formatting for the Shift Map input fields; see spreadsheet for OpenOffice instructions):



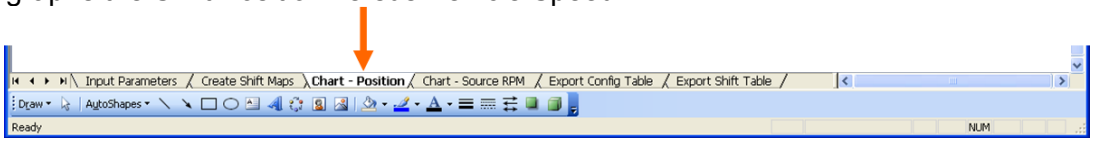


This will locate the values in the appropriate Shift Map column. You can then custom modify the Shift Map as you see fit. Always name the Shift Map at the top of the column, as shown above (55_RPM). The name should be 8 or fewer characters.

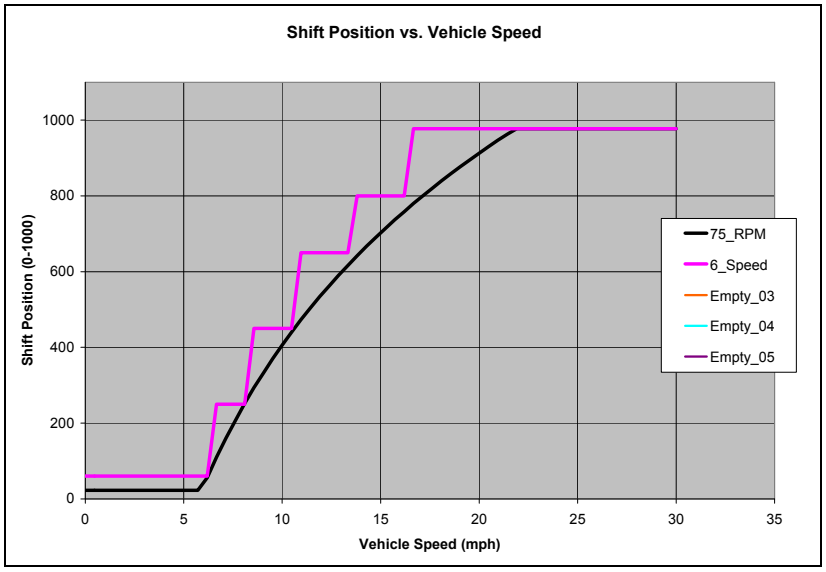
'Chart – Position' Worksheet

Once Shift Maps have been created, it can be helpful to view the maps in a graphical format. The *NuVinci* Configuration Editor allows you to automatically view the Shift Maps you have programmed in two fashions.

The '*Chart – Position*' worksheet is the third worksheet in the *NuVinci* Configuration Editor, which graphs the Shift Position versus Vehicle Speed.

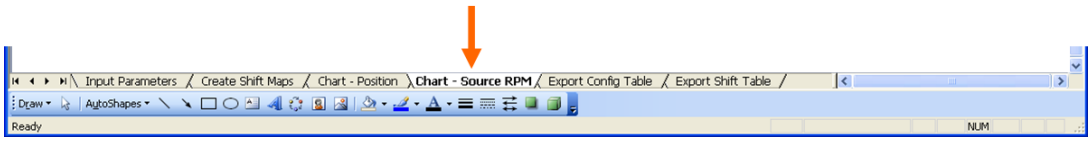


This shows what the Shift Position is for each Vehicle Speed, as was entered in the '*Create Shift Maps*' worksheet tab. It is good practice to view this prior to exporting your Shift Table, to ensure that your Shift Maps are correct.

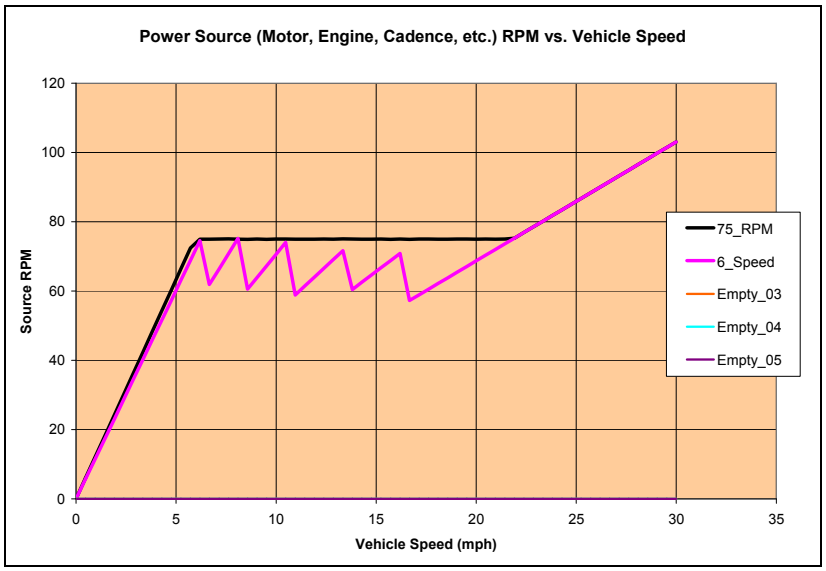


'Chart – Source RPM' Worksheet

The '*Chart – Source RPM*' worksheet is the fourth worksheet in the *NuVinci* Configuration Editor, which graphs the Source RPM versus Vehicle Speed.



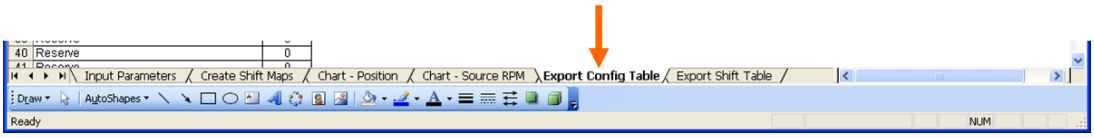
This shows what the source RPM (motor, engine, cadence, etc.) should be for all vehicle speed ranges. It is good practice to view this prior to exporting your Shift Table, to ensure that the source is within operation limits.



'Export Config Table' Worksheet

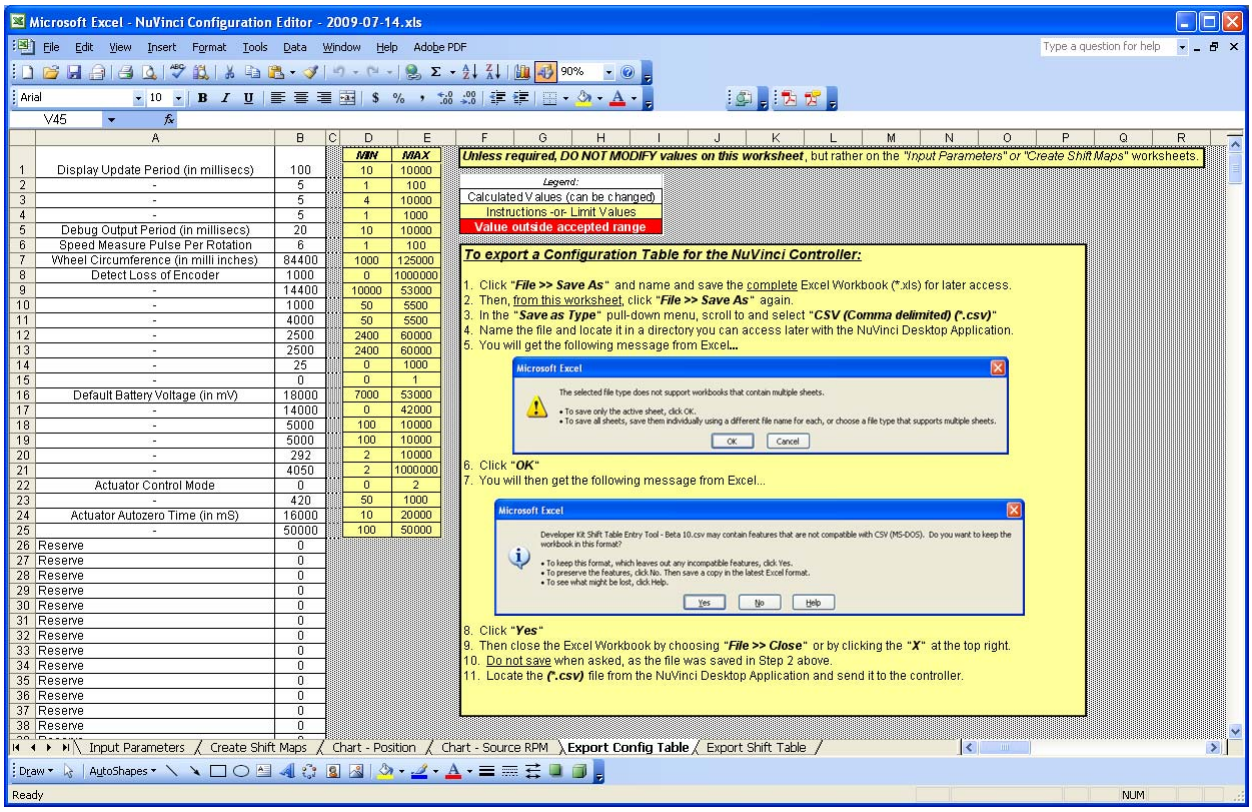
When you are sure that your '*Input Parameters*' worksheet is correct, you can export the Configuration Table to a comma-delimited (CSV) file that the *NuVinci Desktop* application can send to your Controller.

To export your Configuration Table, click on the worksheet titled '*Export Config Table*':



NOTE: ***Prior to exporting the Configuration Table, it is very important to save the Excel workbook in its entirety if you plan to access the spreadsheet and entry values again. Choose (File -> Save As) to rename the file and save it for future reference. After the Configuration Table is exported, you will close the NuVinci Configuration Editor without saving.***

After saving the Excel spreadsheet (see note above), the Config Table worksheet has instructions that walk through the process of creating a CSV file for the Configuration Table. Follow those instructions to save the active worksheet as a 'CSV (Comma delimited) (*.csv)' file, and name it descriptively and in a location you will remember so you can locate it with the *NuVinci Desktop* application and send it to the Controller.



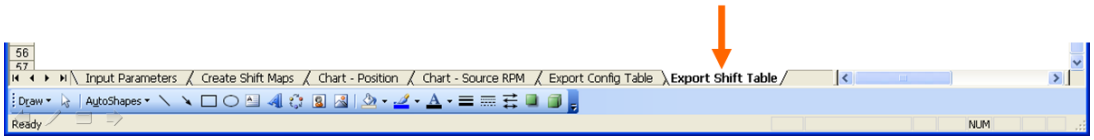
Legend:
Calculated Values (can be changed)
Instructions -or- Limit Values
Value outside accepted range

NOTE: ***There are a number of other parameters that are contained in the Configuration Table, but function and durability of the system may be compromised if they are modified. Therefore, it is critical that the user not modify any of the other values in the Configuration Table unless instructed by Fallbrook Technologies Customer Support.***

NOTE: ***If any cell in column B is highlighted in red, the value is outside of the accepted range for the Configuration Table and the table will not upload to the Controller. If there are values out of range, locate the cause and correct prior to exporting the Configuration Table.***

'Export Shift Table' Worksheet

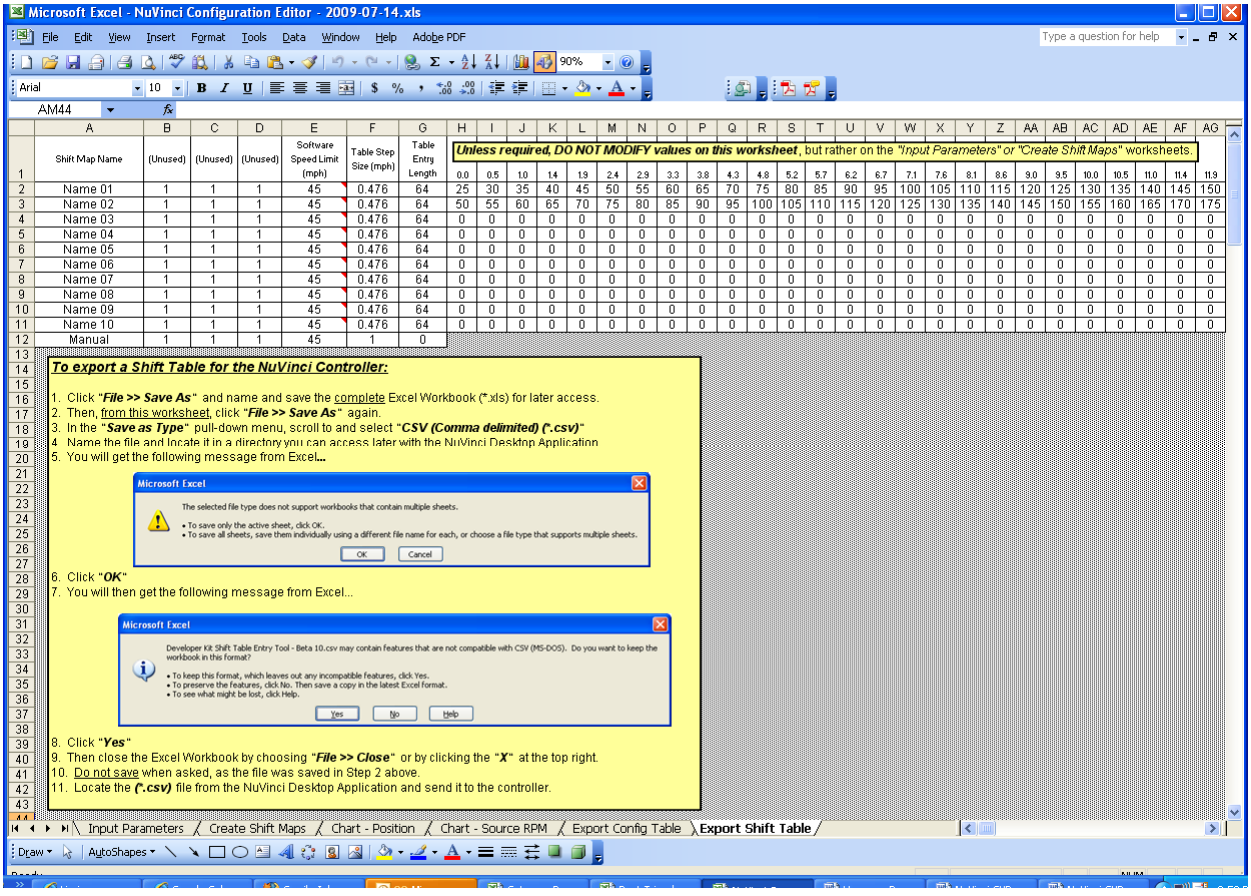
When you are sure that your '*Create Shift Maps*' worksheet is correct, you can export the Shift Table to a comma-delimited (CSV) file that the *NuVinci Desktop* can send to your Controller. To export your Shift Table, click on the worksheet titled '*Export Shift Table*':



NOTE: ***Prior to exporting the Shift Table, it is very important to save the Excel workbook in its entirety if you plan to access the spreadsheet and entry values again. Choose (File -> Save As) to rename the file and save it for future reference. After the Shift Table is exported, you will close the NuVinci Configuration Editor <u>without</u> saving.***

After saving the spreadsheet file, the Shift Table worksheet has instructions that walk through the process of creating a CSV file for the Shift Table. Follow those instructions to save the active worksheet as a '*CSV (Comma delimited) (*.csv)*' file, and name it descriptively and in a location you will remember so you can locate it with the *NuVinci Desktop* application.

After saving the Shift Table, the entire Excel spreadsheet (not just the active worksheet) will assume it has been renamed to the name you selected for the Shift Table only. To keep things organized, it is best to exit from the spreadsheet (which should have been saved prior to exporting the Shift Table) and not save it when prompted by the spreadsheet application.



NOTE: ***There are a number of other parameters that are contained in the Shift Table, but function and durability of the system may be compromised if they are modified. Therefore, it is critical that the user <u>not modify any of the other values in the Shift Table unless instructed by Fallbrook Technologies Customer Support</u>.***

Appendix D – Alternative Shift Methods

The default mode of operation for the CVP Developer Kit is automatic shift control based on speed measurement of the *NuVinci* CVP. Any Shift Maps that are programmed are used for this type of operation only (Reference section 4.2.1, Actuator Control Mode '0'). This default mode also supports manual shifting in ~50 Shift Position steps through the Display Interface and PC/Terminal Display connections, as detailed in Appendix F.

There are two other ways to control Shift Position for the *NuVinci* CVP Developer Kit:

Analog Input Control

This shift method forgoes Shift Maps and allows the developer to simply apply a reference voltage to the Controller to accurately control shifting. The resulting Shift Position will be determined by the direct current voltage applied, 0 to 5 VDC. To enable this shift method:

1. Set Shift Method to '1' in the *NuVinci* Configuration Editor, or manually set the *'Actuator Control Mode'* parameter to '1' in the Configuration Table.
2. Apply the 0 to 5 VDC reference voltage to the HDR4 connector via the Shift Reference Wiring Pigtail. Positive voltage is applied to the White pigtail wire, and the brown pigtail wire should be grounded (reference Appendix G).
3. The 0 to 5 VDC reference voltage is proportional to the normalized Shift Position values of 0 to 1000 (e.g. a value of 2.5 VDC correlates to a Shift Position of 500). Maximum and Minimum Shift Position values are still in effect, as noted in Appendix C.

NOTE: Speed Ratio is not directly proportional to voltage or Shift Position for the NuVinci CVP (reference Appendix H).

Command Interface Control (Unsupported)

This shift method forgoes Shift Maps and allows the developer to simply command the Shift Position (0-1000) directly to the Controller. Maximum and Minimum Shift Position values are still in effect, as noted in Appendix C.

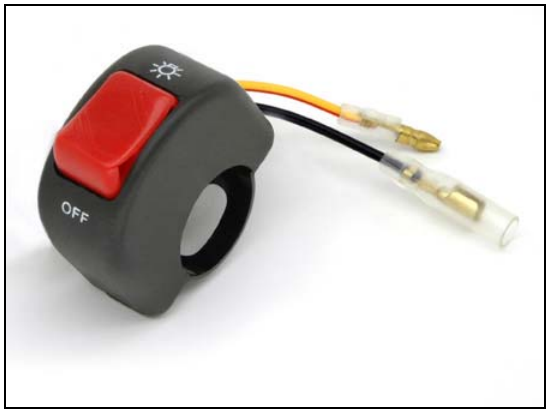
This shift method is currently under development and is unsupported by Fallbrook Technologies.

Appendix E – Mode Switch Capability

The *NuVinci* CVP Developer Kit supports a 'dual control' mode that is operated by a switch. Effectively, when the switch is 'open', the Controller will reference Shift Map #1. If the switch is 'closed', the Controller will reference Shift Map #2.

This provides immediate flexibility between two different Shift Maps for the target application. One possible use could be an easy way to switch between 'performance' and 'economy' modes for a vehicle.

Any basic switch will work for this application, and some examples from motorcycle electrical accessories can be found online at sites such as http://trailtech.net/switches.html, as a sample is shown below for a handlebar mounted switch:



The switch will utilize the Yellow (GND) and Black (Display/RXDO) wires on the HDR2 Display/Mode Wiring Pigtail. Simply connect the switch to these two wires, and the functionality will be as follows:

(Display/Mode Wiring Pigtail)

- Yellow pigtail wire isolated from Black pigtail wire (Switch Open): Shift Map #1 will be active
- Yellow pigtail wire connected to Black pigtail wire (Switch Closed): Shift Map #2 will be active

NOTE: ***The Mode Switch is not functional when a USB connection is made between a PC and the Controller.***

Reference Appendix G for HDR2 connector and Display/Mode Wiring Pigtail specifics.

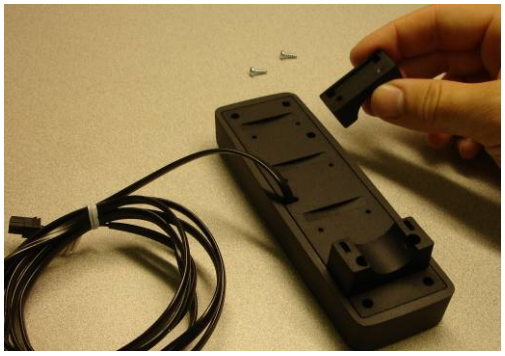
Appendix F – Display Interface Capabilities

NuVinci Display Interface

Fallbrook Technologies has made available a *NuVinci* Display Interface that allows system monitoring and interaction with the Controller. This can be mounted onto a flat back plane, or secured with included 'handlebar' style mounts.

The *NuVinci* Display Interface provides the following advantages:

- On-the-fly selection of Automatic shifting (referencing Shift Maps) or Manual shifting
- On-the-fly selection of up to 10 Shift Maps, displaying the current Shift Map name
- Display of the operating Shift Position, vehicle speed, and system operating conditions
- Any error messages or system function status



Information provided on the display is as follows:

- *VDC* – System measured voltage (Volts)
- *Spd* – Vehicle speed (mph)
- *ActuatorI* – Shift Actuator current (Amps)
- *T/A Pos* – Target Shift Position (0-1000) / Actual Shift Position (0-1000)
- *ShiftMap* – Name of the current Shift Map (see note below)

NOTE: ***<u>The default Shift Map with the NuVinci Display Interface is Shift Map #2</u> - This allows one map "below" the default Shift Map (without a NuVinci Display Interface, the default is Shift Map #1).***

When operating from a Shift Map (Default, ShiftMap ≠ Manual)

- '▲' – Will go to the next higher Shift Map (stopping at Shift Map #10)
- '▼' – Will go to the next lower Shift Map (stopping at Shift Map #1)
- '◄' – Will switch between Automatic shifting and Manual shifting

When operating in Manual shift mode (ShiftMap = Manual)

- '▲' – Will increase Shift Position by ~50
- '▼' – Will decrease Shift Position by ~50
- '◄' – Will switch between Automatic shifting and Manual shifting

If your application requires this display functionality and the ability to switch between multiple Shift Maps, contact Fallbrook Technologies Customer Support for further details, price, and availability of the *NuVinci* Display Interface.

USB to PC/Terminal Connection

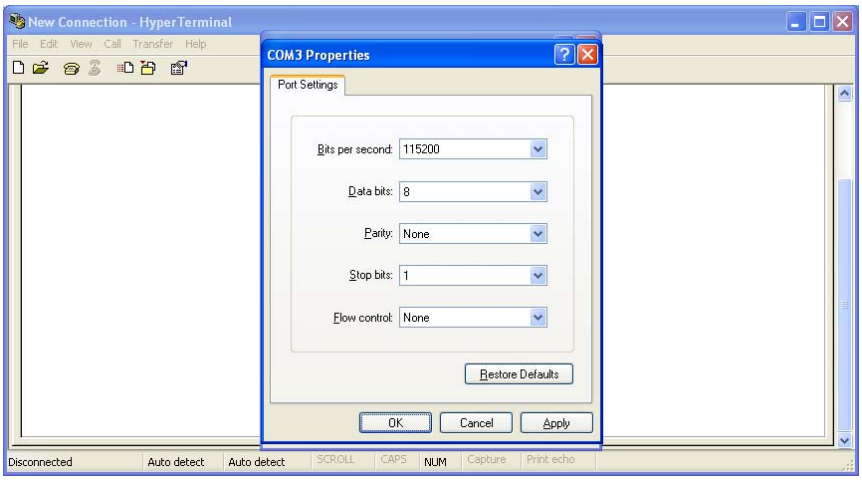
The *NuVinci* CVP Developer Kit Controller offers significant capabilities through the use of the USB connection protocol. Upon successful connection to a PC, two separate COM ports will be assigned. Both COM ports are accessible through a terminal application such as HyperTerminal *(Start >> All Programs >> Accessories >> Communication >> HyperTerminal)*.

NOTE: ***HyperTerminal was included with Windows operating systems prior to Windows Vista. HyperTerminal is available for Microsoft Vista from the original manufacturer (www.hilgraeve.com/hyperterminal.html), although there are free terminal emulators available elsewhere.***

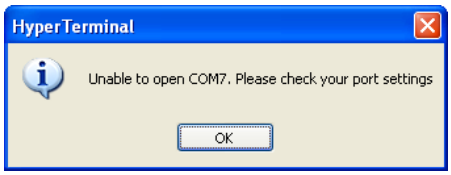
NOTE: ***The USB to PC/Terminal connection will not function while the NuVinci Desktop application is running. Conversely, the NuVinci Desktop application will not function while the PC/Terminal connection is active. This is due to the fact that both these programs attempt to use the same COM ports.***

NOTE: ***If using the optional NuVinci Display Interface, the USB to PC/Terminal connection will support only the PC/Terminal Debug connection (and not the redundant PC/Terminal Display connection).***

The following connection settings are required for both COM ports *(115200 Bits per second, 8 Data bits, No Parity, 1 Stop bits, No Flow control)*:



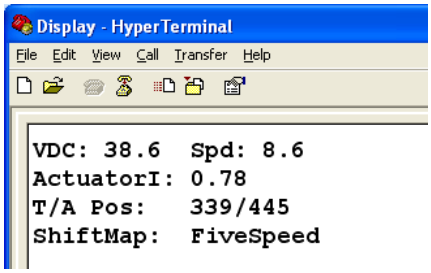
NOTE: ***Often on the first attempt to open the PC/Terminal connection to the Controller, an error may occur stating that the port was unable to be opened:***



If this happens, select 'OK' and then within HyperTerminal go to the 'Call' menu and select 'Call' (or click the telephone icon). Once the connection is established and saved, it should open immediately upon future sessions. Saved HyperTerminal session files can be saved to your desktop for easy execution.

PC/Terminal Display

Typically, the lower COM port value will be the PC/Terminal Display connection. Once connected, information should appear in HyperTerminal as:



This display is explained in the previous section for the optional *NuVinci* Display Interface. In addition to the display function, there is also a user interface to communicate with the Controller through the USB connection. When the terminal application is active, typing the following keys will have the following function:

When operating from a Shift Map (ShiftMap ≠ Manual)

- *'1' keystroke* – Will go to the next higher Shift Map (stopping at Shift Map #10)
- *'3' keystroke* – Will go to the next lower Shift Map (stopping at Shift Map #1)
- *'5' keystroke* – Will switch between Shift Map operation and Manual shift operation

When operating in Manual shift mode (ShiftMap = Manual)

- *'1' keystroke* – Will increase Shift Position by ~50
- *'3' keystroke* – Will decrease Shift Position by ~50
- *'5' keystroke* – Will switch between Shift Map operation and Manual shift operation

As with the optional *NuVinci* Display Interface, the user interface nature of the USB to PC/Terminal connection is quite powerful. The PC/Terminal connection allows full use of different Shift Maps, as well as manual shifting without having to supply a 0-5 V reference signal, as with Actuator Control Method '2' (see Appendix D).

> ***NOTE:*** ***The PC/Terminal Display connection is only functional if the USB connection is made after the CVP Developer Kit system is turned on and initialized. If the CVP Developer Kit is off and the USB cable is connected to a computer that is on, the CVP Developer Kit will not initialize and will remain in a 'Hardware Safe' mode.***

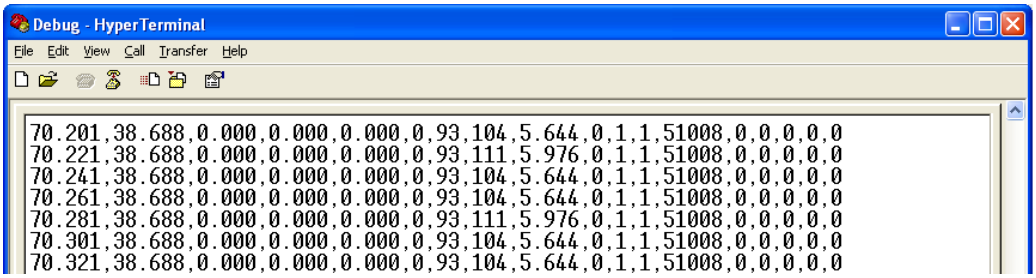
PC/Terminal Debug

For advanced developers, the second COM port (usually one higher than the PC/Terminal Display COM port) will be a running stream of 'debug' output, typically sent at a rate of 50 Hz. This will include the following information in comma-delimited format, with 18 entries on each line:

1. *System Clock* – System time count (seconds)
2. *System Voltage* – System voltage to the *NuVinci* Controller (volts)
3. *Drive Motor Current* – not utilized
4. *Shift Actuator Current* – Current supplied to Shift Actuator (Amps)
5. *Throttle Position In* – not utilized

6. *Throttle Position Out* – not utilized
7. *Shift Actuator Actual Position* – Actual Shift Position (0-1000)
8. *Shift Actuator Target Position* – Target Shift Position (0-1000)
9. *Vehicle Speed* – Measured from speed sensor (mph)
10. *Drive Motor RPM* – not utilized
11. *Shift Actuator PWM* – Pulse-width modulation of Shift Actuator
12. *Drive Motor PWM* – not utilized
13. *Main Loop Count* – not utilized
14. *Analog to Digital Loop* – not utilized
15. *Drive Motor Power* – not utilized
16. *Economy* – not utilized
17. *Shift Mode* – '0' is Shift Map #1, '1' is Shift Map #2, etc.
18. *Brake Interrupt* – not utilized

This data can be viewed in the HyperTerminal window in real-time, or can be saved to a data log. The data will look like this in the raw format:

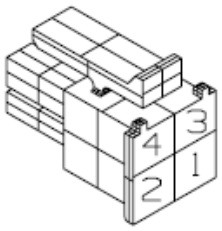


When imported into a spreadsheet, the data can be documented and used for analysis (grey columns are not applicable for the *NuVinci* CVP Developer Kit):

Time	*System Voltage*	*Drive Motor Current*	*Shift Actuator Current*	*Throttle Position In*	*Throttle Position Out*	*Shift Actuator Position - Actual*	*Shift Actuator Position - Target*	*Vehicle Speed*	*Source RPM*	*Actuator PWM*	*Drive Motor PWM*	*Main Loop Count*	*Analog to Digital Loop*	*Power*	*Economy*	*Shift Mode*	*Brake Interrupt*
(sec)	*(volts)*	*(amps)*	*(amps)*	*(0-1000)*	*(0-1000)*	*(0-1000)*	*(0-1000)*	*(mph)*	*(RPM)*					*(watts)*	*(Wh/m)*	*(+1 = Shift Map #)*	*(0 or 1)*
63.601	38.378	0	0.74	0	0	283	267	6.64	0	312	1	50432	8	0	0	2	0
63.621	38.316	0	0.84	0	0	280	257	6.64	0	376	1	50432	8	0	0	2	0
63.641	38.316	0	0.84	0	0	275	257	6.64	0	343	1	50432	8	0	0	2	0
63.661	38.378	0	0.32	0	0	272	257	6.64	0	280	1	50432	8	0	0	2	0
63.681	38.378	0	0.18	0	0	268	257	6.64	0	202	1	50432	8	0	0	2	0
63.701	38.502	0	0	0	0	265	257	6.64	0	1	1	50432	9	0	0	2	0

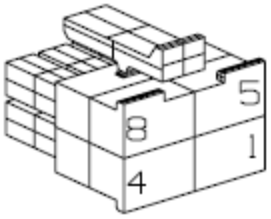
Appendix G – Controller Connections & Capability

HDR2: Display/Mode Wiring Pigtail – This connector is capable of performing two functions. A mode switch can be connected to the Yellow and Black wires to provide a quick method of switching between Shift Map #1 and Shift Map #2 (see Appendix E). Alternatively, all four wires can be used to interface with the optional *NuVinci* Display Interface (see Appendix F).



HDR2: Display/Mode Wiring Pigtail		
Cavity	**Wire Color**	**Function**
1	Red	5V supply
2	Blue	TXD0
3	Black	Display_RXD0
4	Yellow	GND

HDR4: Shift Reference Wiring Pigtail – This connector can perform multiple functions. Primarily, it will be used for reference voltage (0-5 VDC) analog shift control (see Appendix D). Additional capabilities can include current signal measurement, brake signal interrupt, throttle position measurement, and throttle position output.



HDR4: Shift Reference Wiring Pigtail		
Cavity	**Wire Color**	**Function**
1	Orange	Analog Input, 0-5VDC (Current In)
2	Grey	Brake Input
3	White	Analog Input, 0-5VDC (Shift Ref)
4	Purple	Throttle Out, 0-5VDC (Gov)
5	Brown	GND
6	Red/Black	Throttle_VCC, 5V
7	Yellow/Black	Throttle In
8	Green	Throttle GND

NOTE: Reference Figure 7 in the User Manual for mating connection points on the NuVinci Controller.

Appendix H – Speed Ratio & Shift Position Calibration

For automated shifting, the CVP Developer Kit relies on Shift Maps defined by the user. These Shift Maps relate a Shift Position to a corresponding CVP Speed Ratio. The *NuVinci* Configuration Editor uses this relationship to generate accurate Shift Maps.

The *NuVinci* CVP Developer Kit normalizes Shift Position from 0 to 1000. This calibration procedure requires the optional *NuVinci* Display Interface or the USB to PC/Terminal connection (reference Appendix F). These connections allow visual display of the actual Shift Position, as well as the ability to manually control the Shift Position in increments of ~50.

A general equation can be used for approximating the *NuVinci* CVP Speed Ratio to the Shift Position. The Speed Ratio is not directly proportional to the Shift Position, especially towards the ratio extremes at full underdrive and full overdrive. For the *NuVinci* CVP Developer Kit, the approximate relationship can be accurately estimated by:

$$\textbf{\textit{Shift Position} = A * ln (Speed Ratio) + B}$$

For initial operation, the following values can be used: ***A = 731***
B = 539

The above 'default' A and B values are used in the *NuVinci* Configuration Editor spreadsheet to calculate Shift Maps. If your specific hardware is determined to need more accurate control, the calibration procedure described below can be used to arrive at more specific A and B values for a particular CVP:

1. Interface with the Controller via the USB to PC/Terminal connection or the optional *NuVinci* Display Interface (reference Appendix F).
2. Switch to Manual shift mode by pressing '5' (PC/Terminal Display) or '◄' (*NuVinci* Display Interface) once.
3. In Manual mode, use the '1' and '3' keys (PC/Terminal Display) or '▲' and '▼' buttons (*NuVinci* Display Interface) to shift the CVP to different Shift Positions, noting the Actual Shift Position value (approximately 20 different Shift Positions are possible, due to the Manual mode Shift Position increments being approximately 5%).
4. When operating in Manual mode at multiple Shift Positions between 0 and 1000, accurately measure the input and output speeds (or number of relative rotations) of the *NuVinci* CVP in order to calculate the speed ratio at each condition. These values can then be used to estimate a new relationship using the equation above.

$$Speed\ Ratio = \frac{Output\ Speed}{Input\ Speed}$$

NOTE: ***For even higher accuracy and flexibility with this calibration, it is possible to use Analog Input Control (reference Appendix D) along with the NuVinci Display Interface or PC/Terminal Display connection to more finely control Shift Position with a 0-5 VDC reference signal.***

Appendix I – *NuVinci Desktop* Application Troubleshooting

FAQ

Does the *NuVinci Desktop* need to be running to detect my *NuVinci* Controller?
No. Your device will be detected and configured by the operating system when you have the appropriate drivers are installed.

What drivers do I need to communicate with the *NuVinci* Controller?
The drivers required for communication with your *NuVinci* Controller are provided by Future Devices International Ltd. The latest driver available at the time of this release is included with the installation and can be found in the ***…\Program Files\Fallbrook Technologies\NuVinci Developer Kit\Drivers*** directory; see "Manually Installing USB Device Drivers" below.

You may obtain the latest drivers from FTDI at http://www.ftdichip.com/Drivers/VCP.htm. Be sure to get the Virtual COM Port (VCP) and not Direct (D2XX) version (latest version as of this User Manual release is 2.04.16, released February 25, 2009).

What is the LabVIEW Run Time Engine?
The *NuVinci Desktop* application requires National Instruments LabVIEW Run Time Engine (LVRTE) version 8.2.1. If you already have this version of the LVRTE or the LabVIEW development environment, it will not be installed. If you have another version on your system (later or earlier), LVRTE 8.2.1 will be installed with it and will not interfere with the other version.

Errors

Unable to find required support libraries
When the application first starts, it self-checks the system for required components. If any components are missing or corrupted, it will return '*Unable to find required support binaries*' (CODE 25) and inform you that the application will exit. Your application will need to be uninstalled and reinstalled to recover them.

No serial ports found
After the application starts, it checks the system for available COM ports. If no COM ports are found, a dialog will inform you that the application will exit. Even if you do not have a *NuVinci* Controller installed, most PCs will have at least one COM Port that the application will detect. Check your system configuration for the existence of any COM ports. If you do have one or more COM ports and the application fails to detect them, contact Fallbrook Technologies for technical assistance. If you do not have any configured COM ports, particularly if none are assigned to your *NuVinci* Controller, refer to the Hardware Detection Troubleshooting section.

No Controllers found
After all of the available COM ports on your system are identified, each is scanned for the presence of the *NuVinci* Controller. If none are found, you will be prompted to rescan the ports or exit the application. Make sure the Controller is connected with the USB cable and rescan. If your Controller is not being detected, or is being detected and no COM ports are being assigned to it, refer to the Hardware Detection Troubleshooting section.

General communication errors
If you receive an error message that starts with '*The following error occurred during the last operation: …*' it is usually indicative of a break in communication with the Controller. You will be prompted to rescan the ports to check for the presence of a Controller. If your Controller is not detected, check the connection first by unplugging and reinstalling the USB cable. Wait for the

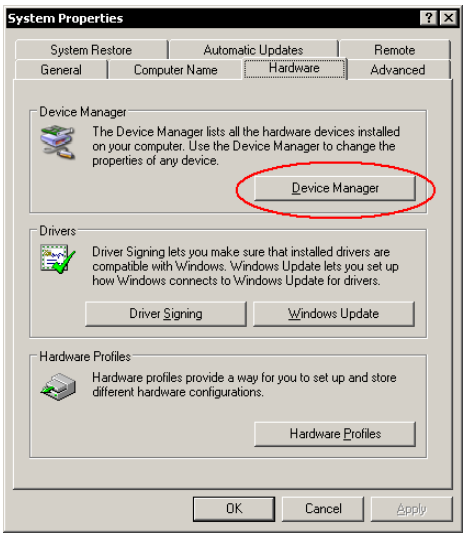
operating system to indicate it has detected and configured the new hardware, and then select rescan. If this does not work, verify that the Controller is redetected and has COM ports assigned to it. Refer to the Hardware Detection Troubleshooting section.

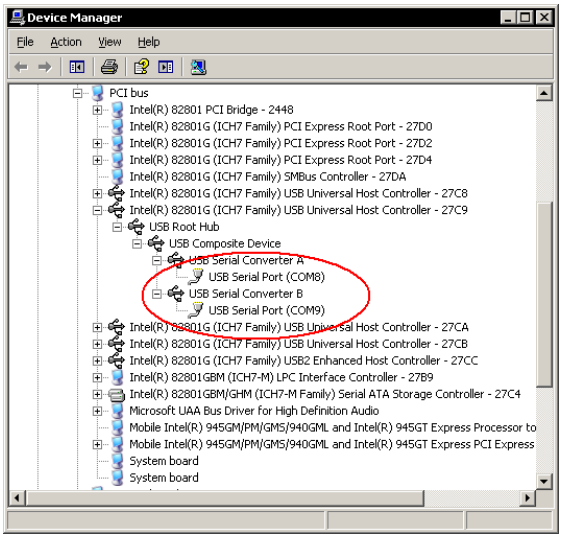
Hardware Detection

Normal detection

Device Manager is the primary tool to use for detecting and viewing the resources assigned to your *NuVinci* Controller. To open the Device Manager, go to *(Start Menu >>* right-click on *'My Computer',* select '*Properties',* select the '*Hardware*' tab, and select '*Device Manager*').

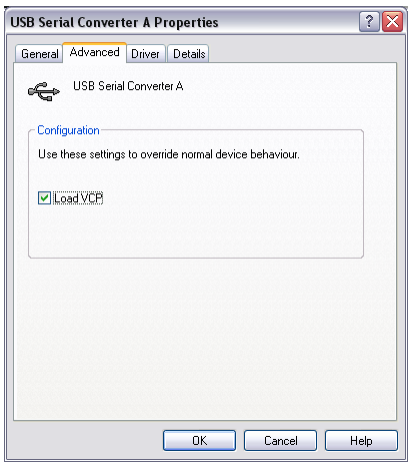
To see the COM Port assignments for your Controller, select *(View >> Devices by Connection).* Expand each USB Universal Host Controller entry until you find **USB Composite Device** with components **USB Serial Converter A** and **USB Serial Converter B**. Each entry should show the Serial port assigned to that device. If you see the resources assigned as below then your device is properly installed and ready to use.



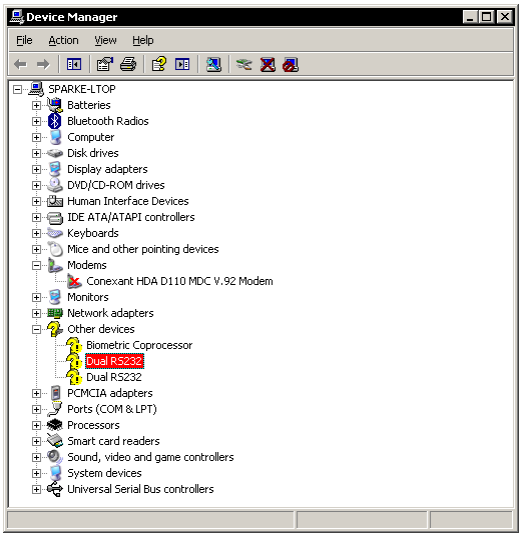


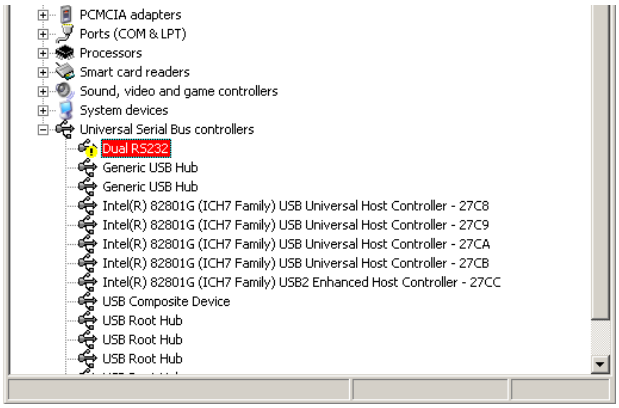
Controller not recognized as USB Serial Port

Your Controller may be recognized as a USB Serial Converter A and USB Serial Converter B, but may not have the Serial Ports assigned to it. First check to see that the '*Load VCP*' box is checked on the '*Advanced*' tab for both USB Serial Converter A and USB Serial Converter B. This is found by right-clicking the USB Serial Converter entries and selecting '*Properties*' and selecting the '*Advanced*' tab:



If you do not find your Controller as a USB Composite Device, look for unrecognized device types under '*Other devices*' as on the left, below. The Controller may be recognized as USB device, but as an unrecognized type, or possibly with no COM ports assigned, as on the right, below.

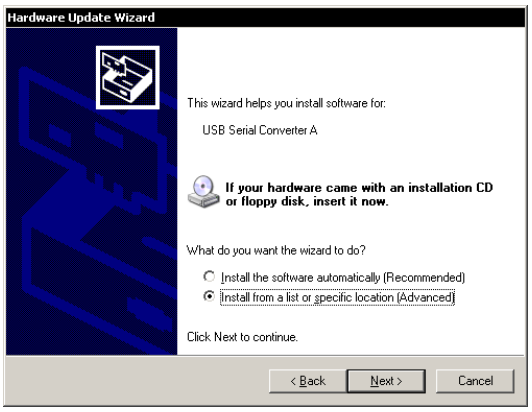




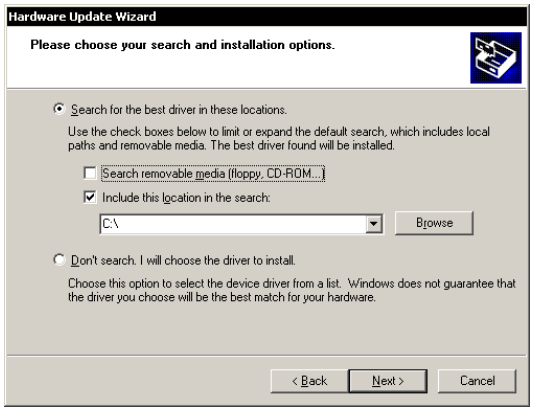
Manually Installing USB Device Drivers

In either circumstance above, the operating system was unable to associate a driver with Controller. You may choose to allow Windows to search for the driver itself, or get a specific driver from a location you specify. It is recommended that you choose the valid, tested driver that is included with each installation of the *NuVinci Desktop* application. To do so, Right-click the first **DualRS232** item and select '*Update Driver*'.

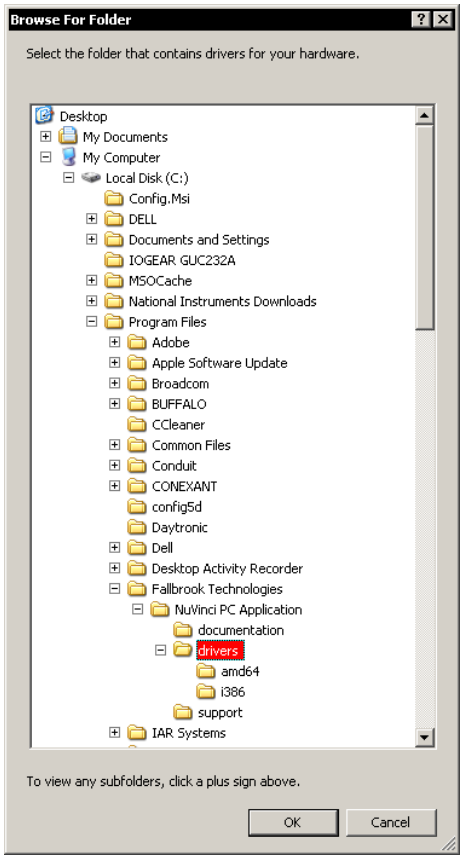
Select the following options at each prompt before selecting '*Next*':

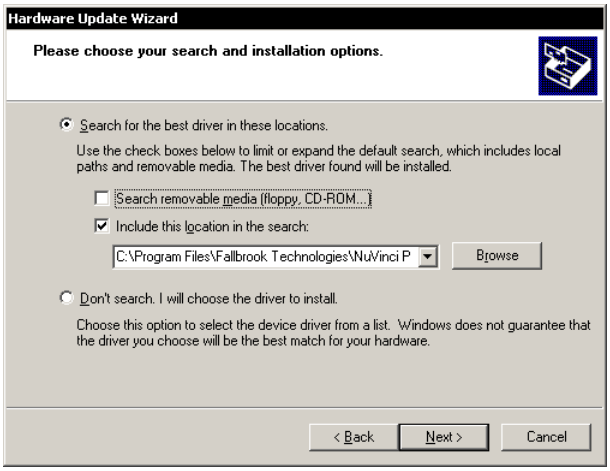


The operating system will then allow you to choose where to search the local system for the appropriate drivers. Select the following options before selecting *'Next'*:



Select '*Browse*' and navigate to the **…*drivers*** folder shown below (left). The search path is now the **…*drivers*** folder in the installation directory for the *NuVinci Desktop a*pplication.



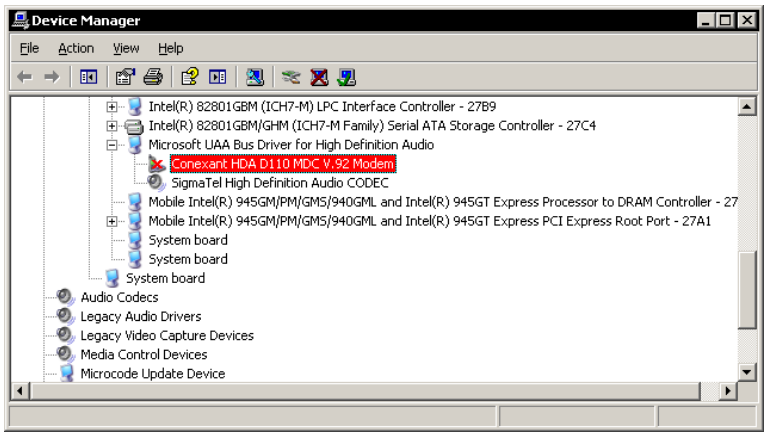


The Hardware Update Wizard will load the driver for the Controller. You will have to repeat this for the second USB Serial B. It may also be necessary to unplug and reinstall the USB cable to recognize the Controller.

Conflict with another Serial Device (such as a modem)

Another serial device in your system may erroneously be recognized as a Controller. This is not an installation issue with the Controller itself, as it may not even be connected. If your application is detecting a *NuVinci* Controller but it is not responding to commands, note the COM port that the application detected as your Controller.

Check this COM port against the COM port assignments in Device Manager. If they are different, another device is being detected as your Controller. Disconnect your Controller until the problem is resolved. Browse through the Device Manager and try to find the COM Port that is being falsely detected. If it is a device that is not in use, you may disable it from within Device Manager by right-clicking on it and selecting '*Disable*'. The disabled device will have a red '*X*' across its icon.



If possible, turn local echo for the device off. This may make it unnecessary to disable the device.

Another possible option is to reorder the devices in order to allow the *NuVinci Desktop* application to find the *NuVinci* Controller before the conflicting device. It is a function of the *NuVinci Desktop* application to scan each detected COM Port, in order detected, for a *NuVinci* Controller until it encounters one. The application will not scan beyond that point.

It is not necessarily true that the detected COM Ports are in sequence from lowest to highest, so reordering COM port assignments is not a foolproof method. Reorder the COM Port assignments by removing and reinstalling the devices in different order. Disable everything and then enable the *NuVinci* Controller first so that it 'moves up the list'. Enable the other devices after the *NuVinci* Controller gets its COM Port assigned.

Appendix J – Support and Services

Fallbrook Technologies Website

www.fallbrooktech.com
www.fallbrooktech.com/DevTech *(Developer Kit technical data & updates)*
www.fallbrooktech.com/08_bike_specs.asp *(Bicycle technical data)*

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