WOODWARD

Application Note 51442
(Revision NEW)
Original Instructions

MotoHawk® Control Solutions
Supplement to MotoHawk Recorded Training

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:

www.woodward.com/publications

The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Contents

Illustrations and Tables

Warnings and Notices

Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Chapter 1.
General Information

Introduction

Welcome to MotoHawk Recorded Training. The following application guide will help you purchase, assemble, and install the materials required to participate in the training exercises.

Participants in the training will use MotoHawk to develop a PI control and control the position of an Electronic Throttle Valve. Then, fault detection through the MotoHawk Fault blocks will be discussed and participants will add fault detection to their throttle control. Data storage and Memory will be explored through the addition of 'Freeze Frame' data storage of throttle position data. Participants will then learn how CAN communication is implemented in the application and modify the throttle model to control the throttle via CAN. Finally, angle based blocks for engine control (encoder, spark / injection sequence) blocks will be introduced.

DVD Contents

Day 1 Morning	Introduction to MotoHawk and Model Based Design
Day 1 Afternoon	Electronic Throttle Project (PI control of ETC)
Day 2 Morning	MotoHawk fault blocks and fault detection in ETC model
Day 2 Afternoon	Memory and Data Storage – freeze frame of throttle position Intro to CAN
Day 3 Morning	CAN continued, project – Control ETC via CAN
Day 3 Afternoon	Engine IO and angle synchronous blocks

Overview of MotoHawk and MotoTune Software

Woodward – MotoHawk Software

MotoHawk is a rapid controls system development tool that allows controls engineers to quickly create controls software within Simulink diagrams, which run on any MotoHawk-enabled electronic control modules. Successfully used in thousands of production applications, MotoHawk supports control feature development, vehicle calibration, and fleet testing. It allows a variety of applications using both single controller and distributed by-wire implementations.

Woodward – MotoTune ECU Calibration Tool

The MotoTune calibration development tool provides all of the functionality needed for typical day-to-day calibration tasks. MotoTune is also the flashing tool for control programs developed in MotoHawk. An intuitive, spreadsheet-like user interface provides easy access to all of the calibration-related RAM and ROM parameters contained in the Electronic Control Unit (ECU).

Chapter 2.
Required Materials

Hardware

In order to actively participate with the training exercises you will need:

- Qty 1: MotoHawk Development Kit, 8928-1267
- Qty 1: linear 0 - 1kΩ potentiometer
- Qty 1: one ETC (6945-5001, 40 mm Bosch ETC; 0 280 750 149) or other item with linear position feedback to control via PI control loop
- Qty 1: 12 V DC power supply (9 V to 16 V, 3 A minimum)
- Optional – connector for throttle (AMP connectors): connector female-6POS 1-967616-1, connector terminal-female 965906-1 (6), connector wire seal 967067-1

A floating point DEV (Calibratable) ECM with at least one H-bridge output is required. A 48-Pin ECM was used for the class, but 128 pin, 112-pin, GCM-48, or 80-pin ECM would be acceptable alternatives. See the MCS Product Guide, Woodward document number 36300, under Woodward.com publications for module, harness, and kit description and part numbers.

http://www.woodward.com/searchpublications.aspx

Figure 2-1. Example of Required Hardware

Software

In order to actively participate with the training exercises, the following software is required:

MATLAB, Simulink, Real Time Workshop, and Real Time Workshop Embedded Coder are required in order to run MotoHawk. This software is available from The MathWorks. Contact The MathWorks for purchase of this software.

- MATLAB
- Simulink
- RealTimeWorkshop
- Real Time Workshop Embedded Coder.

The following software is available for purchase through Woodward. Contact your Woodward sales representative if you need to purchase a license for the below software.

Register for an account on the MCS website (http://mcs.woodward.com) for access to the Woodward Software downloads.

- MotoTune
- MotoServerRuntime
- Compiler (GCC/GHS) GCC is available for free download under Optional Downloads
- KvaserCANKing (under optional downloads)
- MotoHawk

IMPORTANT

Older versions of MotoTune and MotoServer must be uninstalled using Windows Add/Remove programs prior to installing new versions. Versions of MotoHawk beginning with 2010a can be installed concurrently without uninstalling.

The following link provides details on MotoHawk/MATLAB version compatibility:

http://mcs.woodward.com/support/wiki/index.php?title=MotoHawk#MATLAB-version_independent

Chapter 3.
Assembling Your Kit

MotoHawk Development Kit

1. Insert your silver MotoTune/MotoHawk dongle.

2. Connect the USB-to-CAN adaptor and wait for windows to auto-detect it. When the New Hardware window appears select “No, not this time” and click next. Then, wait for Windows to automatically install the drivers.

3. If an isolated USB hub is included in your kit, install your isolated USB hub and apply power. Connect USB-to-CAN adaptor to the isolated USB hub.

4. Connect the development harness to the module (see datasheet for proper positioning).

5. Connect power branch to 12 V supply (9 V to 16 V DC, 3 A minimum).

6. Attach the SmartCraft connector on the development harness, USB-to-CAN adaptor, CAN termination resistor, and power (key) switch to the 6-position hub (junction box).

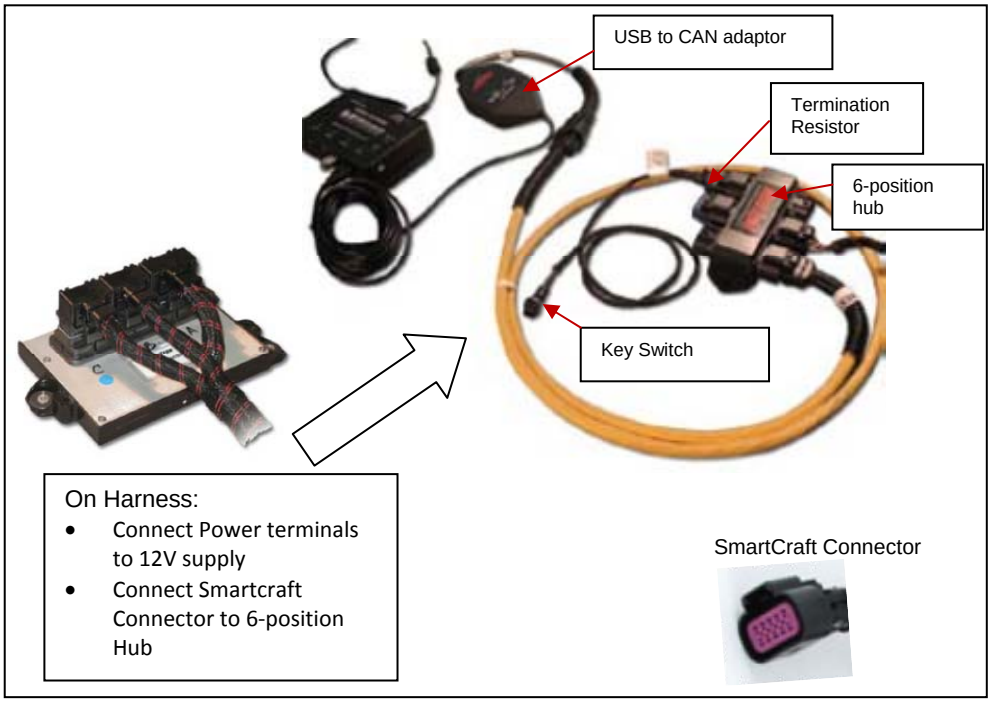


Figure 3-1. Development Kit Assembly

Desktop IO Simulator

1. Insert your silver MotoTune/MotoHawk dongle.

2. Connect the USB-to-CAN adaptor to a USB port of your PC and wait for windows to auto-detect it. When the New Hardware window appears select “No, not this time” and click next. Then, wait for Windows to automatically install the drivers.

3. If an isolated USB hub is included in your kit, install your isolated USB hub and apply power. Connect USB-to-CAN adaptor to the isolated USB hub.

4. Connect the simulator harness to the module (see datasheet for proper positioning) and connect the green connector to simulator.

5. Connect power branch from simulator to 12 V supply (9 V to 16 V DC, 3 A minimum).

6. Attach the SmartCraft connector on the simulator (SCF) to the 4-way hub on the front of the simulator and connect your USB-to-CAN cable to the 4-way hub. The simulator includes internal CAN termination resistance, so the CAN termination resistance does not need to be plugged into the hub.

   The SCM connector on the simulator provides for redundant connections but does not need to be connected.

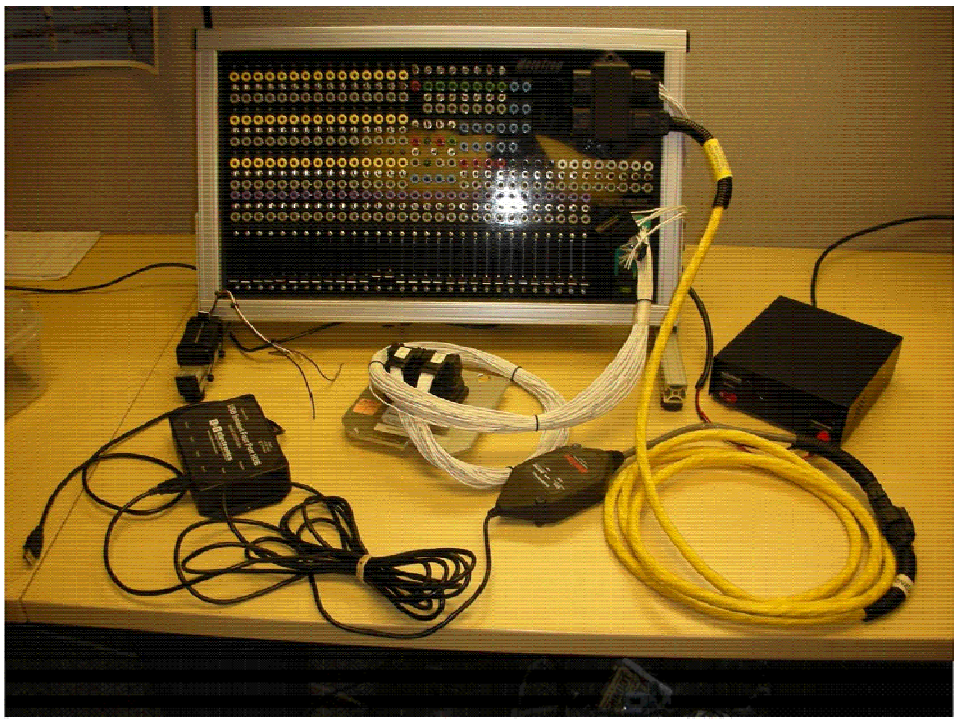


Figure 3-2. Example Desktop IO Simulator Setup

Chapter 4.
Starting a Project in MotoHawk

The MotoHawk_Project Script

Once you have completed the installation of your software, and assembled your hardware, create a basic model to verify operation and your toolchain installation.

1. Place your MotoHawk license dongle into the USB port of your PC.

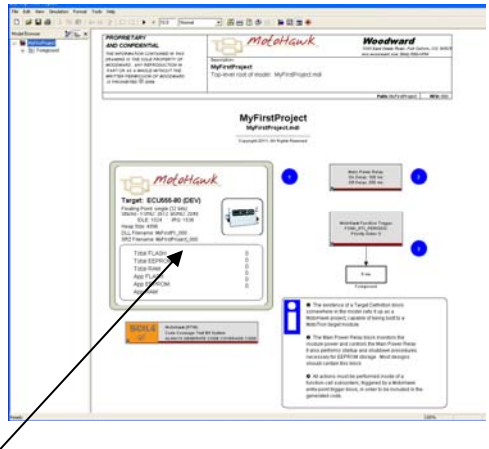
2. Start MATLAB: Double Click on the MATLAB icon on your desktop or select from the Start→ All Programs menu.

The following screen will appear.

Figure 4-1. Example Desktop IO Simulator Setup

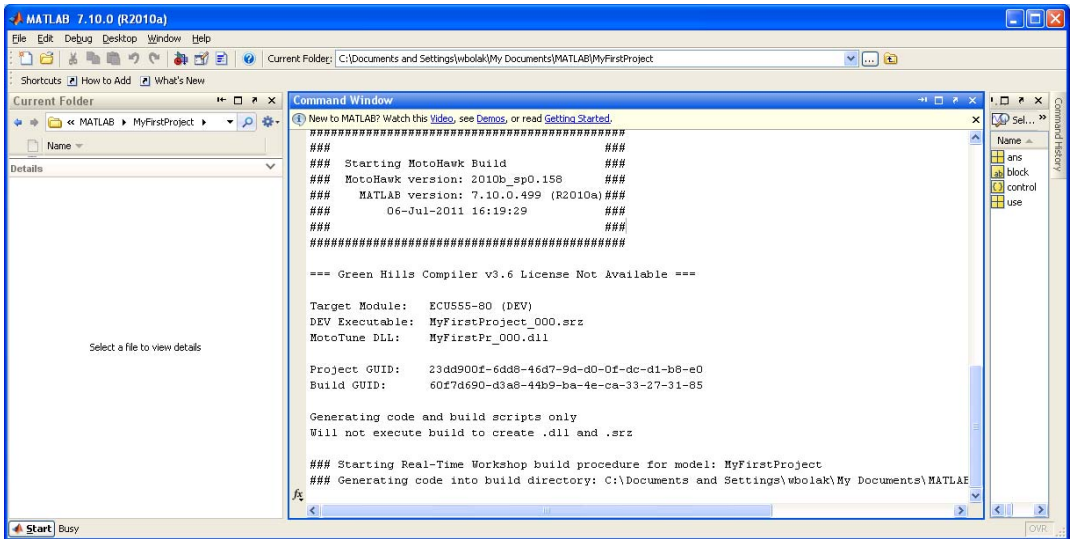
3. At the command line type:
   >> motohawk_project MyFirstProject

4. Press the Enter key. The following window will open (allow 1-2 minutes).



5. Double click on the Target Definition block and change the target to match your ECM module hardware.

6. Press Ctrl+B. The MATLAB window should look like this:



You can watch the build progress in the command window, or view the contents of the build in the .log file. At the end of the build you will get a successful MotoHawk build message.

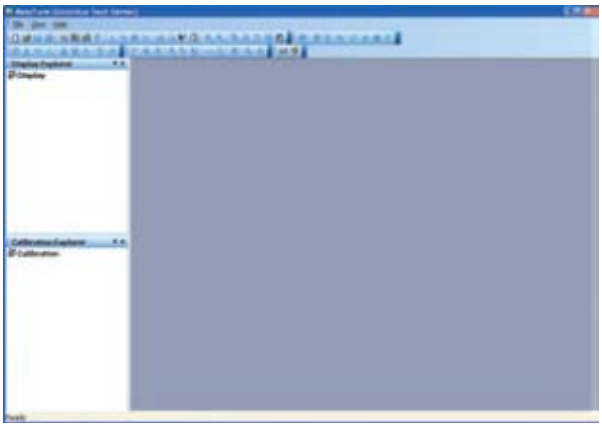
7. Once you have successfully built your default application, open Windows Explorer and navigate to the C:\ECUFiles directory. You will see a number of subdirectories including Programs and TDBDLL. These subdirectories contain, respectively, the .srz and .dll files which are used by MotoTune to program the ECU. You will learn more about the files in the training.

Chapter 5.
Programming Your ECU

Starting MotoTune

1. From the Start menu (or desktop shortcut) select All Programs/MotoTools/MotoTune.

2. The following window appears:



3. The name that was used to order your kit should appear at the top of the window. If it indicates [Unlicensed], you need to insert/reinsert the silver dongle and close, then restart, MotoTune.

Checking MotoServer

1. Right-click on the Satellite Dish MotoServer icon (located on the system tray). Select “Ports”.

2. If not already listed, add location PCM-1 as a CAN type port with Access Level 4; check the box on the list; and click on “Apply”.

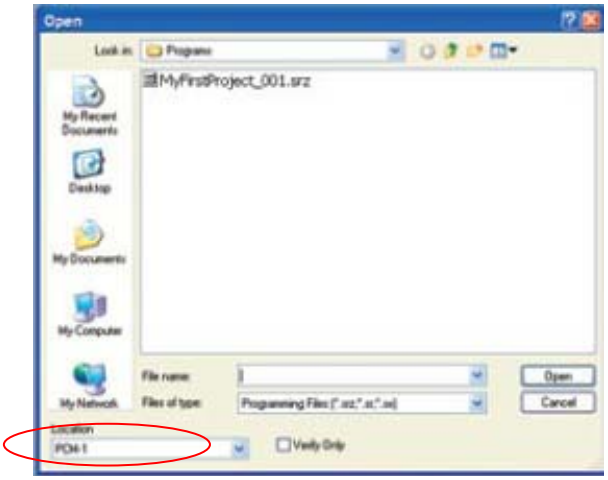
3. You are now ready to connect to the module.

Programming the Module

1. Turn power on and apply ECUP (Key) signal via power switch.

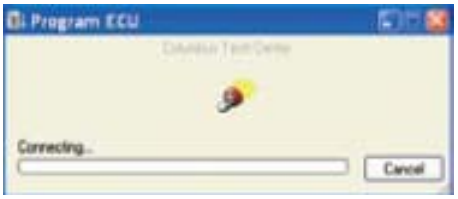
2. Select File/Program, in the MotoTune window. The file you created with CNTL-B should be displayed.

3. Chose your port location to be PCM-1.



4. Double-click on the .srz file in the window.

5. The Program ECU status pop up appears, and should show connecting to the module.



Congratulations! Your module is correctly connected to your PC and your software installation was successful.

Chapter 6.
Throttle Exercise Setup

Introduction

For the throttle exercises in the training, you will need to have the potentiometer and ETC connected to your module I/O. See the datasheet for your module for specific module pinout.

Note: A terminal strip (available from many electronics distributors) may be handy to make these temporary connections quickly.

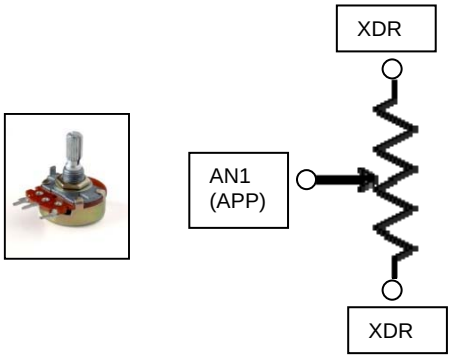
Potentiometer
(Accelerator Pedal, APP)

Connect the wiper pin of your potentiometer to AN1 (analog input 1) of your module.

Note: If your throttle model defines another resource (output pin) for APP, this pin should be connected to the wiper of the potentiometer.

Connect the remaining outside terminals of the potentiometer to XDRP (5 V) and XDRG (ground) respectively.

This will provide a 0 V to 5 V signal via the potentiometer voltage divider into Analog Input 1 of the ECM.

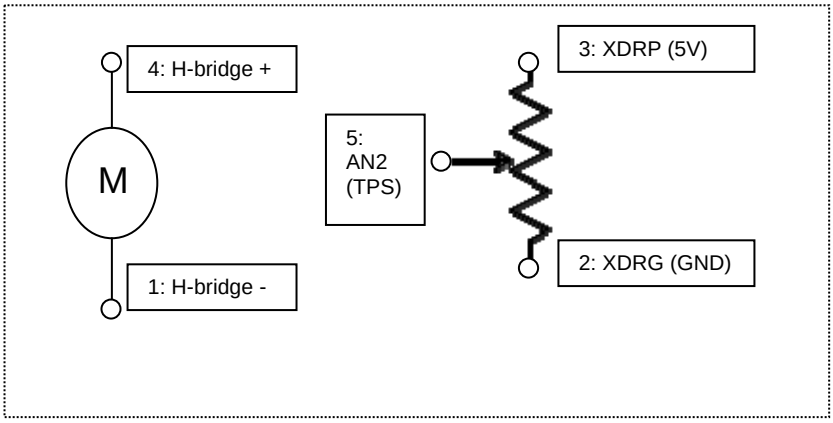


ETC Throttle

The ETC throttle contains a motor-controlled throttle valve along with potentiometer for position sensing.

Pinout of Bosch ETC

Motor –	Connect to H1– of your ECM H-bridge Output
Pot I –	Connect to XDRG
Pot I +	Connect to XDRP
Motor +	Connect to H1+ of your ECM H-bridge Output
Pot I1	Connect to AN2 (or your TPS resource) of your module
Pot I2	NC



WARNING **Do not put your fingers into the Electronic Throttle. If you need to move or adjust throttle plate, use a pen, pencil or similar tool.**

Chapter 7.
Useful Links

Our Wiki site contains numerous articles on a variety of MotoHawk topics. Log into the MCS.Woodward.com website to view the following links:
http://mcs.woodward.com/support/wiki/index.php?title=Main_Page

MotoTune Quick Guide:
http://mcs.woodward.com/support/wiki/index.php?title=MotoTune:Quick_Guide

MotoHawk Block Help: change version to your MotoHawk version
http://mcs.woodward.com/content/motohawk/Documentation/MotoHawk2011bSP0/HTML/motohawk_blocks.html

Troubleshooting Guide: MotoTune Communication Issues
http://mcs.woodward.com/user/download.php?filename=587

Debugging Communication Issues with CanKing:
http://mcs.woodward.com/support/wiki/index.php?title=Debugging_Using_CANking

Supported Compilers:
http://mcs.woodward.com/support/wiki/index.php?title=Compilers

Recovering a Module using the Boot Key (or Boot Harness)
http://mcs.woodward.com/support/wiki/index.php?title=Boot_key_recovery

ECM Datasheets on Woodward Publications
http://www.woodward.com/searchpublications.aspx

Additional MotoHawk Information on Woodward.com
http://www.woodward.com/InteriorTemplate.aspx?id=2147487101&terms=motohawk

Email Contacts

Sales: **MCSsales@woodward.com**

Technical Support**:** **MCSsupport@woodward.com**

Licensing**:** **MCSlicense@woodward.com**

Chapter 8.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in "like-new" condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:
- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used In Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used In Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used In Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 51442.

B51442:NEW

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Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

**Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.**

Complete address / phone / fax / email information for all locations is available on our website.

2012/11/Colorado