MotoHawk Control Solutions

ECM-0554-112-0904-C/F

Engine Control Modules
Calibratible / Flash

(0904-C: 1751-6455)
(0904-F: 1751-6454)

Description

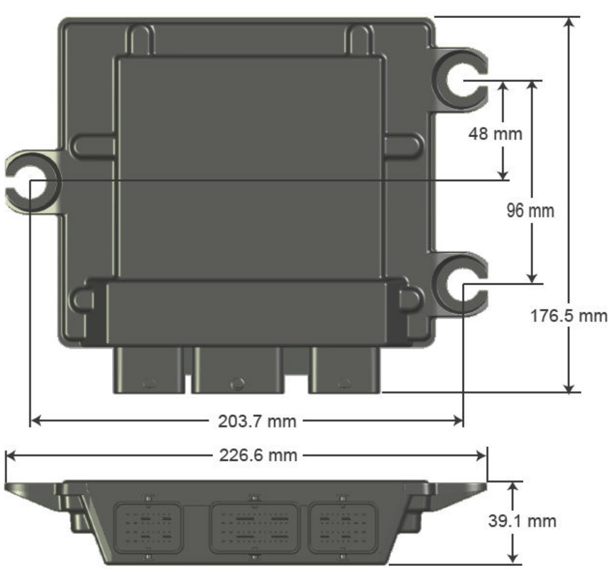
Presenting the ECM-5554-112-0904-C/F engine control modules from Woodward's MotoHawk Control Solutions product line. These rugged controllers are capable of operating in harsh automotive, marine, and off-highway applications. The module and its connector system are environmentally sealed and suitable for engine mounting in many applications.

This unit provides 112 connector pins with inputs, outputs, and communications interfaces that support a wide variety of applications.

The ECM-5554-112-0904 is part of the ControlCore® family of embedded control systems. The ControlCore operating system, MotoHawk® code generation product, and MotoHawk's suite of development tools enable rapid development of complex control systems.

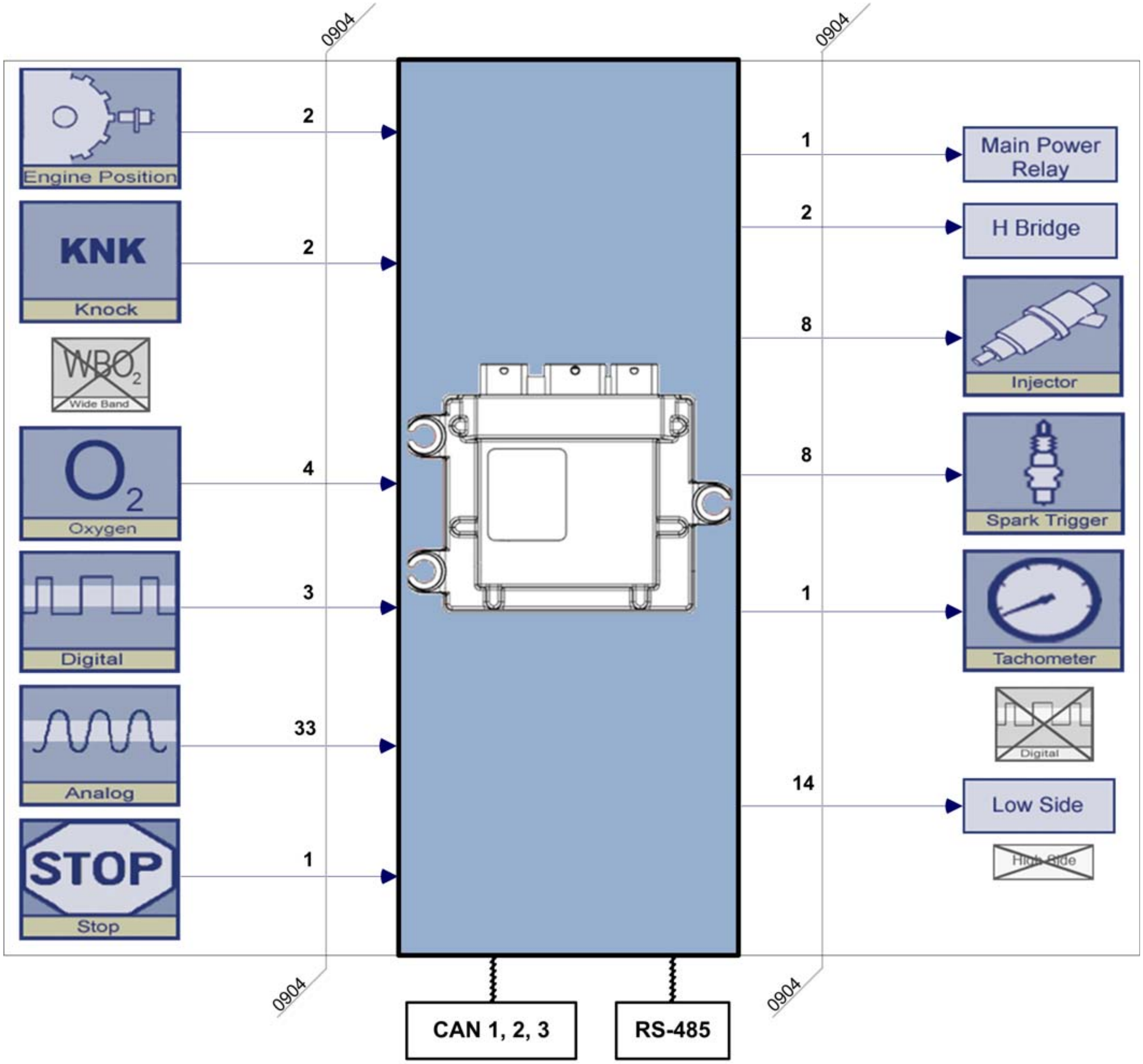
Each controller is available in 'F' (Flash) or 'C' (Calibratible) versions. Flash modules are typically used for production purposes. Calibratible modules are typically for prototyping/development only; they can be calibrated in real time using MotoTune®.

Physical Dimensions



- 112-pin platform
- **Microprocessor**: Freescale MPC5554, 80 MHz
- **Memory**: 2MB Flash, 64K RAM, + 32K Cache, 32K EEPROM
- **Calibratible Memory**: 512K (256K x2) RAM
- **Operating Voltage**: 9–16 Vdc, 24 V (jump start), 4.5 V (crank)
- **Operating Temperature**: –40 to +105 °C
- **Inputs:**
  VR and Digital Engine Position Sensor (crank and cam) Inputs
  33 Analog
  4 Oxygen Sensor
  3 Speed (digital)
  2 Knock Sensor
  1 Emergency Stop
- **Outputs:**
  8 Injector (high impedance)
  8 Electronic Spark Trigger (5 V)
  1 Tachometer or Link Interface
  14 Low Side Driver Outputs
  1 Digital Output
  1 Main Power Relay Driver Output
  2 H-Bridge Outputs
- **Communications:**
  3 CAN 2.0B Channels
  1 RS-485 Channel

Simple Block Diagram

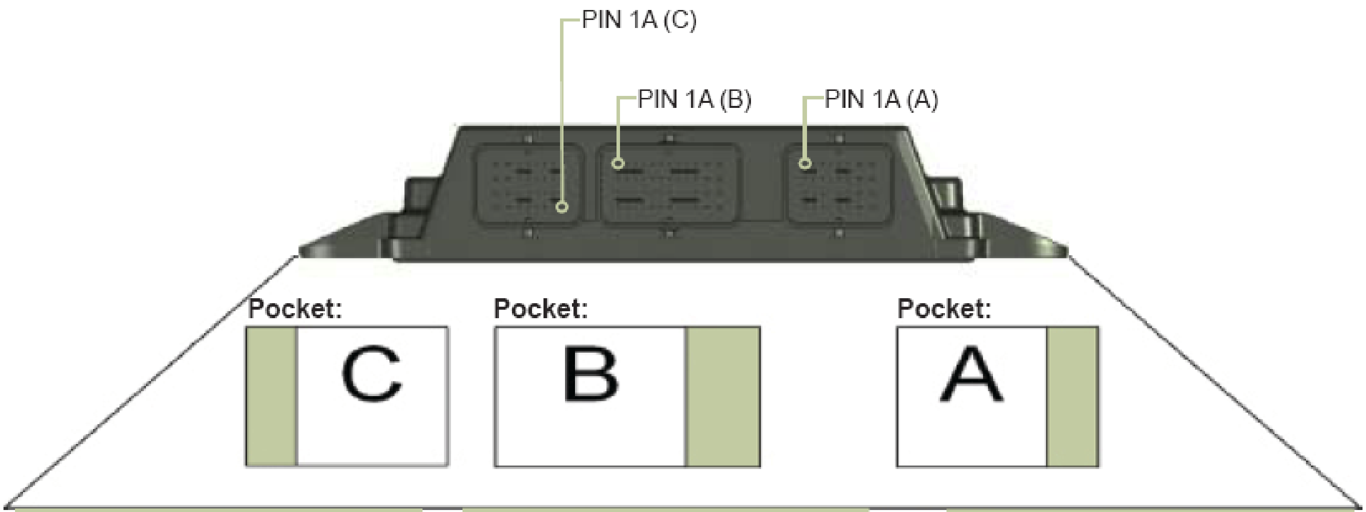


Ordering Information

Controller	Part No.	w/Mounting Hardware	Boot Key (P/N)	Boot Cable	Desktop Simulator Harness (P/N)
ECM555481120904CP0	1751-6455	8923-1629	1635-1800	N/A	5404-1205
ECM555481120904F00	1751-6454	8923-1628			
CP0 suffix indicates calibratible (development) version of a module.					

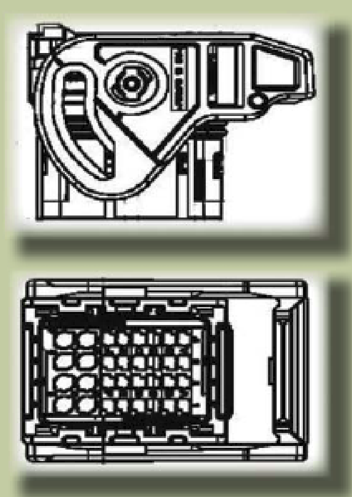
Harness	Part No.
Pigtail	5404-1215
Development Harness	5404-1216

Connector/Pocket Definitions



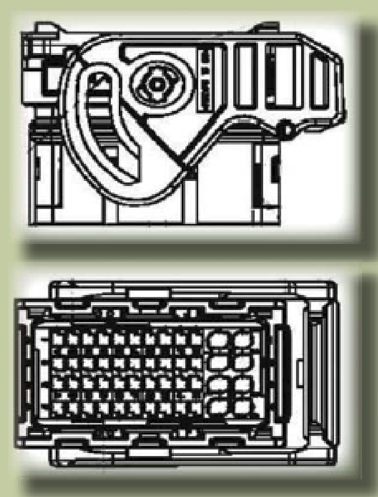
Connector: C
(Grey)

MotoTron P/N: CONFEML054
Molex P/N: 98944-3002-32
Woodward P/N: 1635-1771



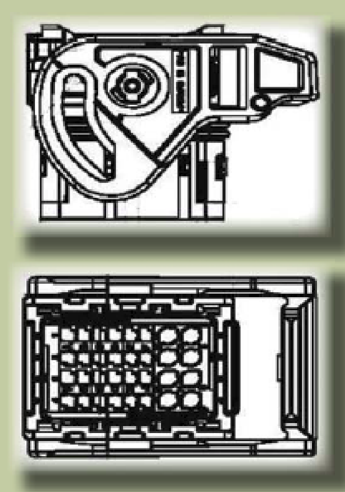
Connector: B
(Brown)

MotoTron P/N: CONFEML052
Molex P/N: 98950-2003-48
Woodward P/N: 1635-1769

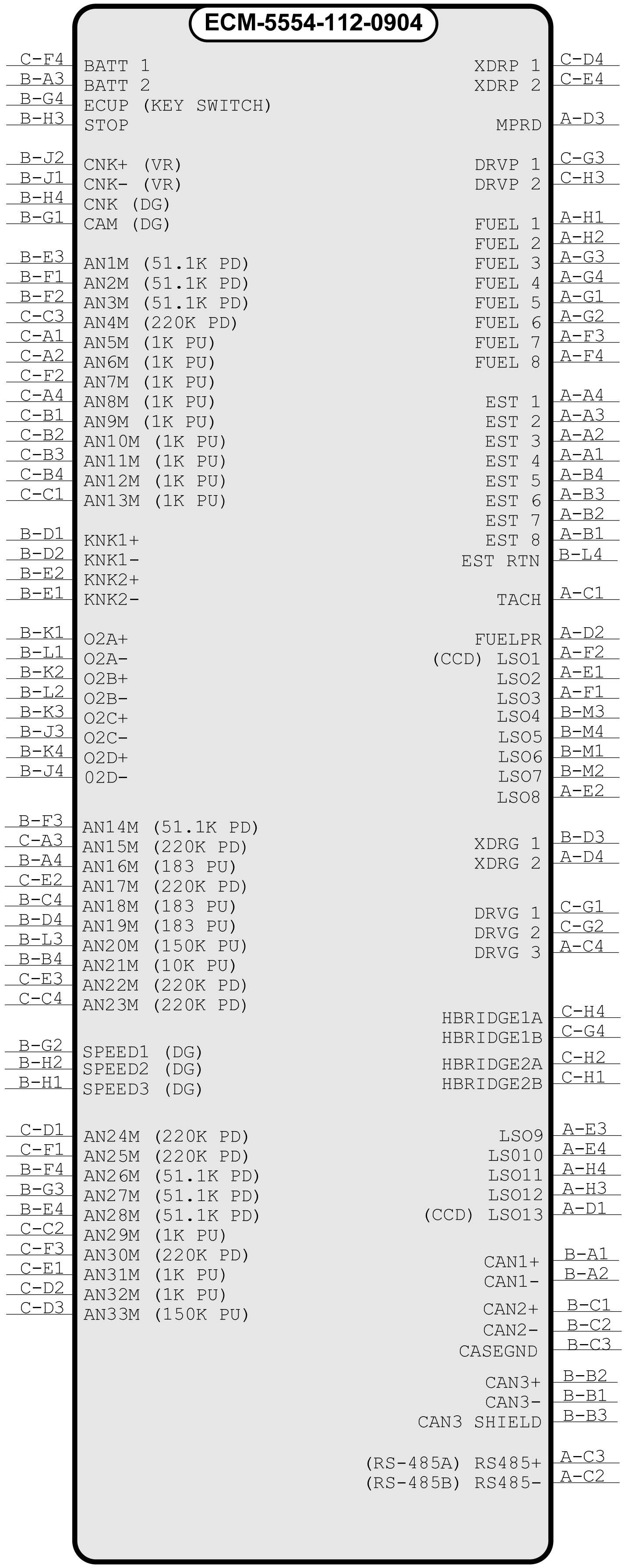


Connector: A
(Black)

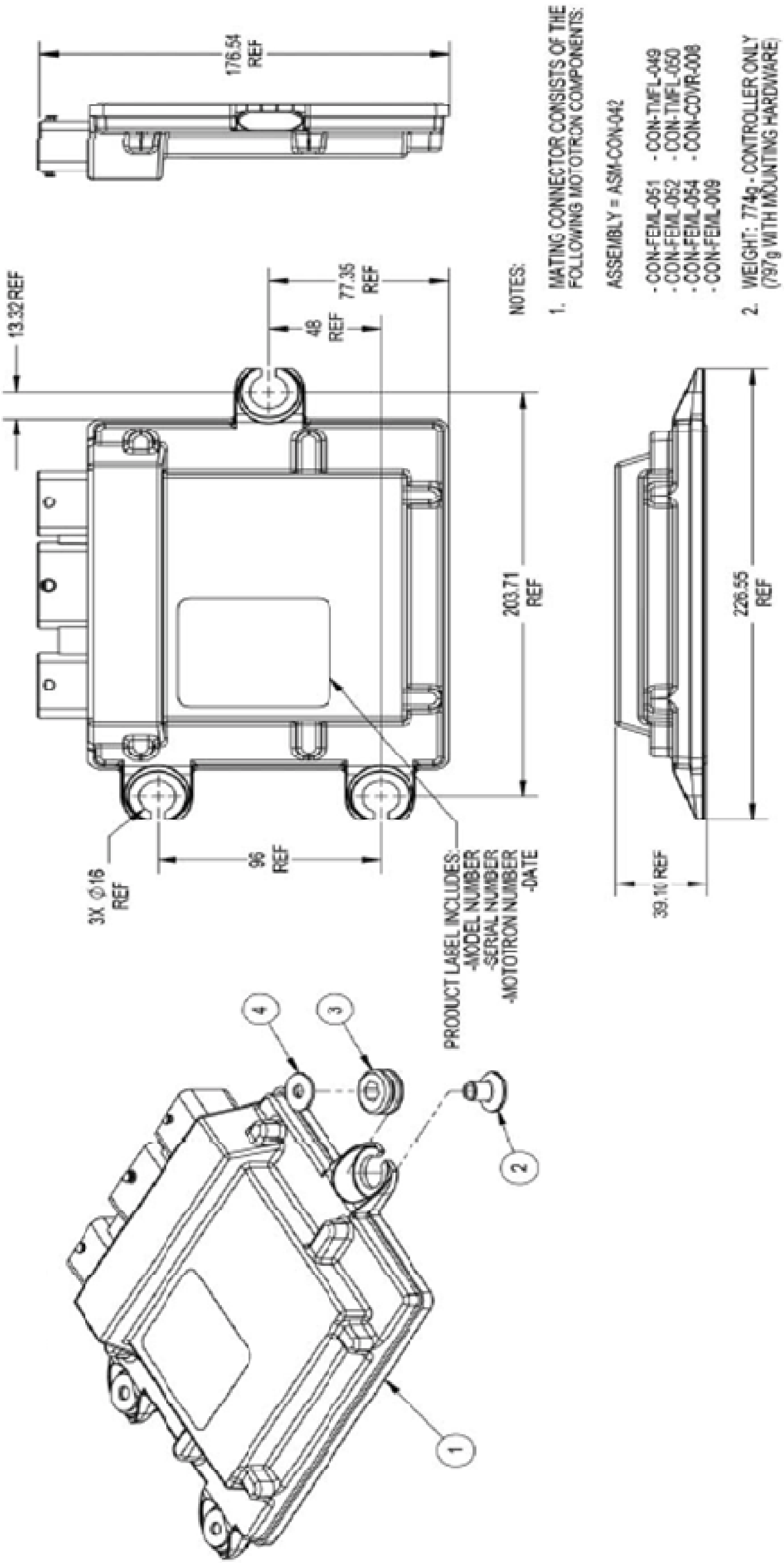
MotoTron P/N: CONFEML051
Molex P/N: 98944-2001-32
Woodward P/N: 1635-1768



Block Diagram



Outline Drawing



Signal Conditioning

Input Signal Conditioning	**Notes** (see Resource by Connector Pin table and/or block diagram for pull up/pull down resistor levels)
IMPORTANT **The ECM has been validated in an application using typical loads. Maximum loading is based on datasheet values. Actual capability is somewhere between typical (validated) and maximum (datasheet) and is dependent on ambient temperature, system voltage, and the state of all other inputs and outputs. In most cases, it will not be possible for an application to use the maximum values. Please contact Woodward sales for more information.**	
Power and Ground **BATT1, BATT2, ECUP (KEY SWITCH), DRVP 1, DRVP 2, DRVG 1, DRVG 2, DRVG 3**	**(Note: See Figure 1 in "Typical Circuit Schematics" section for Power and Ground Block Diagram)**
BATT1 (C-F4), BATT2 (B-A3) BATT and BATT2 are internally connected (one electrical node). BATT is normally connected to battery via a fuse. BATT2 provides for a single connector programming harness; it is not normally connected in the application wiring harness.	V_{BATT} (min) = 4.5 V (crank transient) and 6.3 V (continuous) V_{BATT} (nom) = 9-16 V I_{BATT} (key off, min) = 1 mA. (Battery drain when module is off)
ECUP (KEY SWITCH) (B-G4) This input is the user interface to turn the module on and off.	V_{IL}(max) = 2.7 V V_{IH} (min)= 6.8 V V_{ADC} = 0.181 x V_{KEYSW}(12-bit resolution) τ = 1.8 ms **Note:** The key switch provides the pull-up source for the STOP input. When the key is turned off STOP will be asserted (in hardware). See STOP.
DRVP 1 (C-G3), DRVP 2 (C-H3) These pins are normally connected to the output of the main power relay, Driver Power (battery voltage). They provide a current path back to the load (e.g. controlled current) as well as a power source to the internal H-bridges.	V_{IN} = 0 to 27.6 V V_{ADC} = 0.181 V_{DRVP} (12-bit resolution) τ = 1.8 ms **Note:** Unless otherwise specified, all low-side loads assume protection from reverse battery via the main power relay and DRVP.
DRVG 1 (C-G1), DRVG 2 (C-G2), DRVG 3 (A-C4) These pins are the single point ground for the module.	**Note:** All DRVG terminals are internally connected (one electrical node).
STOP (BH3)	V_{IL} (max) = 2.2 V V_{IH} (min) = 3.2 V V_{HYST} = 0.9 V V_{ADC} = 0.452 (V_{IN}) τ = 4.5 ms **Note:** The pull-up diode prevents voltage/current from corrupting V_{KEY}. V_{STOP} is a function of V_{KEY} and the resistance of the stop switch. Blocking diode to prevent ECM from sinking current.
CNK+ (VR) (B-J2), CNK- (VR) (B-J1)	V_{IN} (max) = 360 V peak-peak V_{IN} (min) = 500 mV peak-peak τ = 20 µs **Note:** Assertion of STOP will disable processing of this signal (in hardware).

Input Signal Conditioning	(continued)
CNK (DG) (B-H4) This is a digital position input, normally used for crankshaft position. It includes a software selectable pull-up resistor and is suitable for 5-volt or open-drain type sensors.	VIL (max) = 2 V VIH (min) = 3 V VHYST = 500 mV τ = 3.2 µs **Notes:** Hysteresis (and thresholds) are software configurable. Assertion of STOP will disable processing of this signal in hardware. This input may be used as a generic frequency input if the crank encoder is VR. Contact Woodward for more information on this feature.
CAM (DG) (B-G1) This is a digital position input, normally used for the camshaft. It includes a software selectable pull-up resistor and is suitable for 5 V or open-drain type sensors.	VIL (max) = 2 V VIH (min) = 3 V VHYST = 500 mV τ = 3.2 µs **Note:** Hysteresis (and thresholds) are software configurable.
SPEED1 (B-G2), SPEED2 (B-H2), SPEED3 (B-H1) Digital speed input (pulse/ frequency).	VIN = 0-5 V VIL (max) = 2 V VIH (min) = 3 V VHYST = 500 mV τ = 6.2 µs (except for SPEED1 where τ = 3.2 µs) **Note:** The actual logic thresholds and hysteresis are software configurable.
O2A+ (B-K1), O2A- (B-L1), O2B+ (B-K2), O2B- (B-L2), O2C+ (B-K3), O2C- (B-J3), O2D+ (B-K4), O2D- (B-J4) Analog- for switching type heated exhaust gas oxygen sensors (HEGOs).	VIN = -1 to +1.1 V from sensor τ = 165 µs **Notes:** The sensor MUST be isolated from ground and sensor's O2– must be connected to O2– input (not ground). Short-to-ground and short-to-battery protected.
KNK1+ (B-D1), KNK1- (B-D2), KNK2+ (B-E2), KNK2- (B-E1)	Broad-band (fl at response) sensors, able to provide independent cylinder knock sensors.
Analog Inputs **See Figure 2 in "Typical Circuit Schematics" section.**	VIN = 0-5 V VADC = VIN τ = 1 ms Resolution= 12-bits **Note:** Short-to-ground and short-to-battery protected.

Output Signal Conditioning	Notes
See Figure 4 in "Typical Circuit Schematics" section.	Outputs are protected from shorts to battery and ground. Outputs have open circuit and short circuit detection, excluding XDRG and H-Bridges (see H-bridges note for details).
XDRP1 (C-D4), XDRG1 (B-D3) 5 V supply for analog sensors.	VOUT = 4.9 to 5.1 V IOUT (max) = 100 mA **Notes:** XDRG is not isolated from PWRGND. Take care not to create ground loops by connecting XDRG to other system grounds. Excessive current on XDRG can create a common-mode voltage error on all sensors connected to XDRG. XDRG is not protected from shorts-to-battery; excessive current may cause permanent damage.

Output Signal Conditioning	(continued)
XDRP2 (C-E4), XDRG2 (A-D4) 5 V supply for analog sensors.	VOUT = 4.9 to 5.1 V IOUT (max) = 50 mA **Notes:** XDRG is not isolated from PWRGND. Take care not to create ground loops by connecting XDRG to other system grounds. Excessive current on XDRG can create a common-mode voltage error on all sensors connected to XDRG. XDRG is not protected from shorts-to-battery; excessive current may cause permanent damage.
MPRD (A-D3) Main power relay control output.	ISINK (max) = 700 mA **Notes:** The high-side of the main power relay is normally connected to battery (fused). Reverse battery-protected.
FUELPR (A-D2)	ISINK (typ) = 165 mA (85 Ω relay) ISINK (max) = 700 mA **Note:** FUELPR will be disabled (off) ~300 ms after STOP assertion.
FUEL 1 (A-H1), FUEL 2 (A-H2), FUEL 3 (A-G3), FUEL 4 (A-G4), FUEL 5 (A-G1), FUEL 6 (A-G2), FUEL 7 (A-F3), FUEL 8 (A-F4) These outputs control the low-side of high impedance fuel injectors.	ISINK(typ) = 1 A ISINK(max) = 2 A VCLAMP = 55 V
EST 1 (A-A4), EST 2 (A-A3), EST 3 (A-A2), EST 4 (A-A1), EST 5 (A-B4), EST 6 (A-B3), EST 7 (A-B2), EST 8 (A-B1) 5 V digital ignition outputs used to drive logic-level ignition coils.	VOL (max) = 1.3 V at ISINK = 1 mA VOH (min) = 4.1 V at ISOURCE = 500 µA
EST RTN (B-L4)	Low current ground reference for logic-level ignition coils.
TACH (A-C1) Tachometer output with Link Interface capabilities.	ISINK (max) = 100 mA **Notes:** The circuit is implemented as a low-side driver with 1.8 kΩ resistor pull-up to KEYSW. A blocking diode is also included to prevent back feeding into KEYSW.
LSO1 (A-F2), LSO13 (A-D1)	ISINK (typ) = 0 A to 1 A ISINK (max) = 1 A VCLAMP = 55 V **Notes:** Implementation uses low-side drive with flyback (recirculation) diode. Controlled current.
LSO2 (A-E1), LSO3 (A-F1), LSO8 (A-E2)	ISINK (typ) = 165 mA ISINK (max) = 700 mA VCLAMP = 55 V
LSO4 (B-M3), LSO5 (B-M4), LSO6 (B-M1), LSO7 (B-M2)	ISINK (typ) = 1 A ISINK (max) = 7 A VCLAMP = 55 V **Note:** Diagnostic includes current feedback.
LSO9 (A-E3), LSO10 (A-E4)	ISINK (typ) = 165 mA ISINK (max) = 700 mA VCLAMP = 55 V

Output Signal Conditioning	(continued)
LSO11 (A-H4), LSO12 (A-H3)	ISINK (typ) = 165 mA ISINK (max) = 350 mA VCLAMP = 55 V
HBRIDGE1A (C-G4), HBRIDGE1B (C-H4)	IO (max) = 10 A FO (max) = 10 kHz **Note:** Sign-magnitude (PWM) with diagnostic current sense feedback. H-Bridges only shutdown for over temperature. Repeatedly taking the chip to its thermal limit will reduce life.
HBRIDGE2A (C-H2), HBRIDGE2B (C-H1)	IO (max) = 10 A FO (max) = 10 kHz **Note:** Sign-magnitude (PWM) with diagnostic current sense feedback. H-Bridges only shutdown for over temperature. Repeatedly taking the chip to its thermal limit will reduce life.

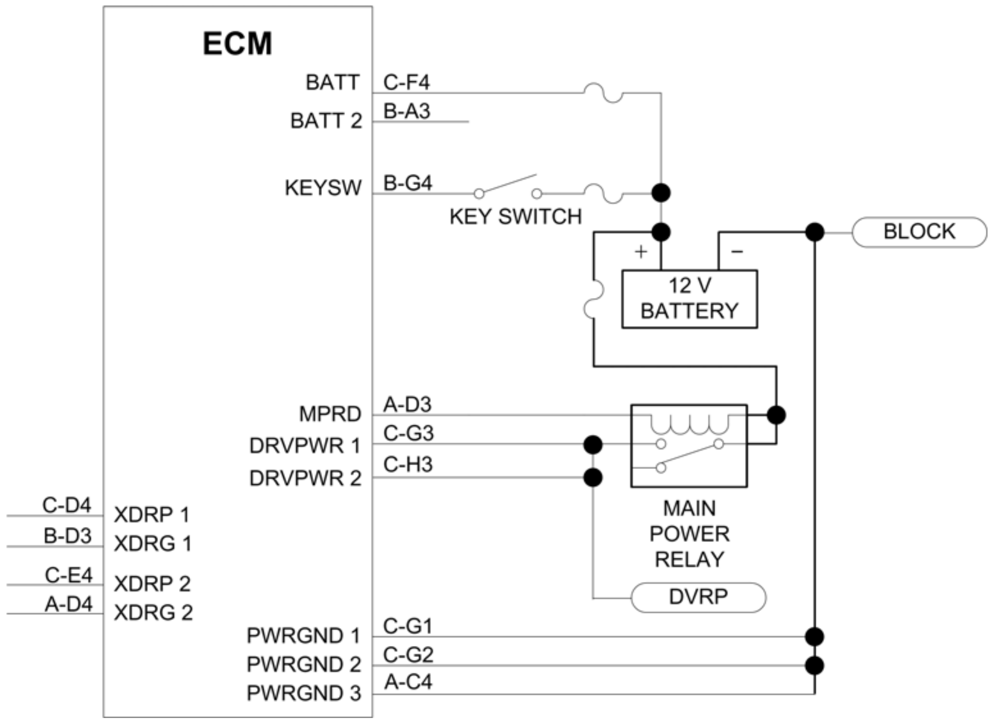
Communications	
CAN1+ (B-A1), CAN1– (B-A2), CAN2+ (B-C1), CAN2– (B-C2), CAN3+ (B-B2), CAN3– (B-B1)	High-speed CAN 2.0B buses. **Note:** Regarding termination: CAN1 and CAN2 buses require external termination. CAN3 is internally terminated with a 120 Ω Resistor. Regarding CANSHIELD: CAN3 SHIELD is available for shielded bus connections. The internal connection to PCM ground consists of a 1 Ω resister in series with a 1 micro-farad capacitor.
RS485+ (A-C3), RS485– (A-C2)	RS-485 serial lines

Memory	
FLASH	2 MB of FLASH memory, on chip.
RAM	64 K of RAM, on chip.
EEPROM	32 K EEPROM; serial.

Typical Circuit Schematics

Power and Ground

Figure 1:

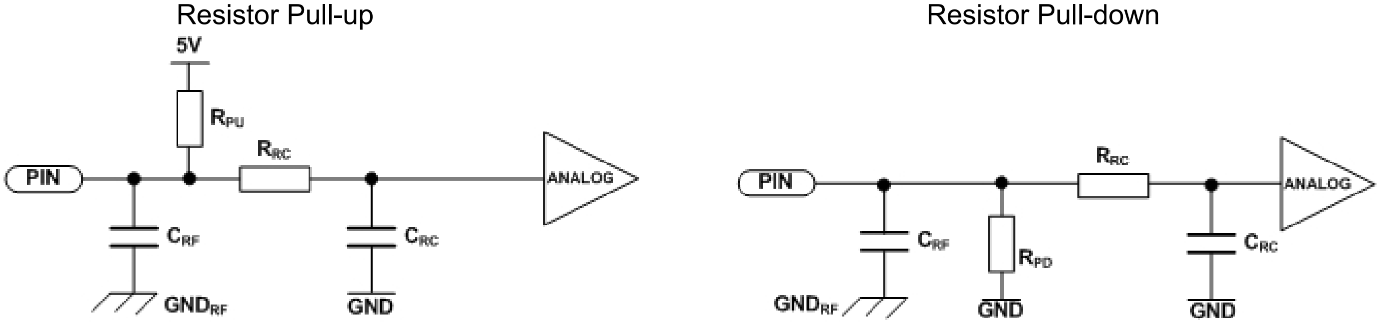


Analog Inputs

Figure 2:

Resistor Pull-up

Resistor Pull-down

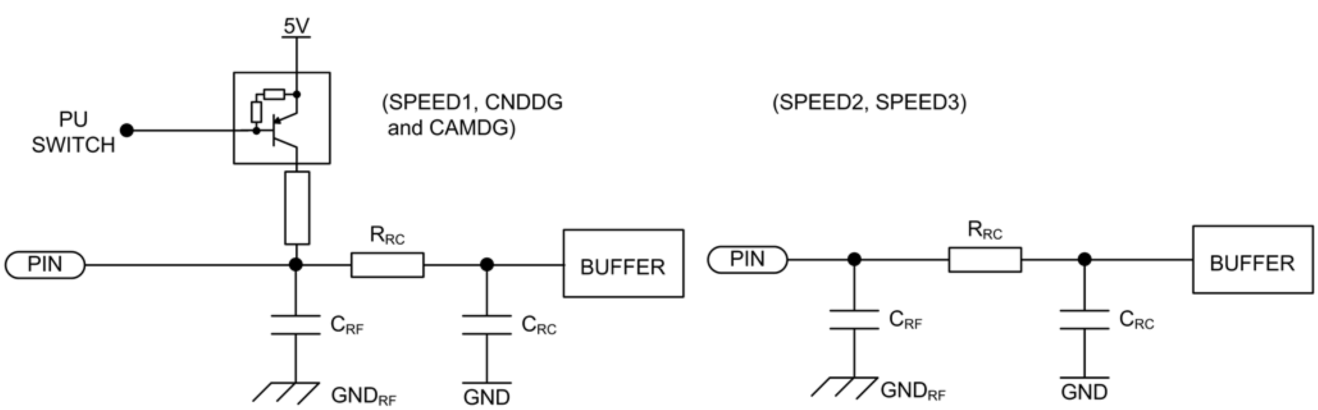


Digital Inputs

Figure 3:

Resistor Pull-up

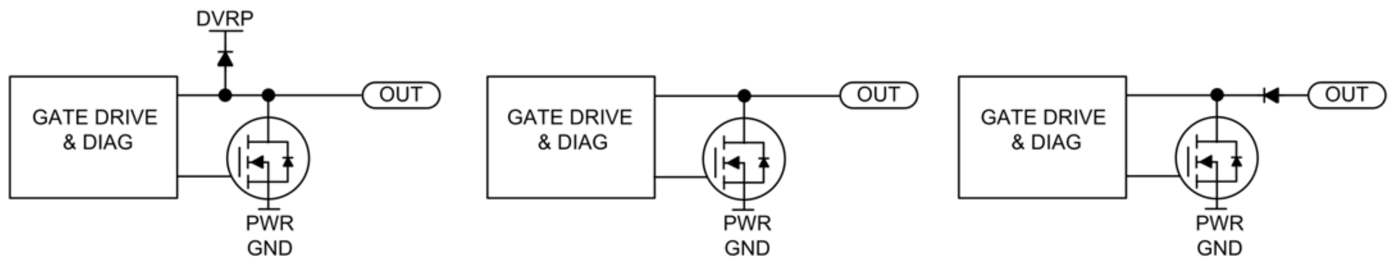
Resistor Pull-down



Typical Circuit Schematics (continued)

Typical Outputs **Figure 4:**

Recirculation Diode Without Diode Blocking Diode



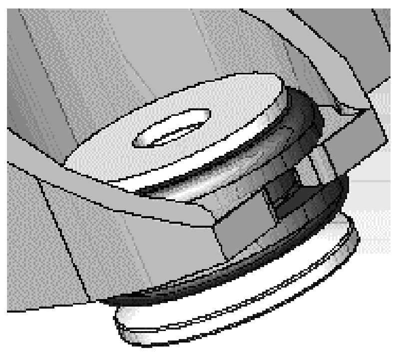
Connector Pinouts

Pin#		Pin#		Pin#		Pin#	
A-A1	**EST 4**	A-A2	**EST 3**	A-A3	**EST 2**	A-A4	**EST 1**
	Electronic Spark Timing 4		Electronic Spark Timing 3		Electronic Spark Timing 4		Electronic Spark Timing 1
	Drives logic level ignition coils		Drives logic level ignition coils		Drives logic level ignition coils		Drives logic level ignition coils
A-B1	**EST 8**	A-B2	**EST 7**	A-B3	**EST 6**	A-B4	**EST 5**
	Electronic Spark Timing 8		Electronic Spark Timing 7		Electronic Spark Timing 6		Electronic Spark Timing 5
	Drives logic level ignition coils		Drives logic level ignition coils		Drives logic level ignition coils		Drives logic level ignition coils
A-C1	**TACH**	A-C2	**RS485-**	A-C3	**RS485+**	A-C4	**DRVG 3**
	5 V Digital Output		Serial Communications		Serial Communications		Driver Ground
	Rpullup= 1.8K to KEY		RS-485B		RS-485A		
A-D1	**LSO13**	A-D2	**FUELPR**	A-D3	**MPRD**	A-D4	**XDRG 2**
	Low Side Output 13		Fuel Pump Relay		Main Power Relay Driver		Transducer Ground
	Controlled current				Reverse battery diode, 1 A		Analog ground reference
A-E1	**LSO2**	A-E2	**LSO8**	A-E3	**LSO9**	A-E4	**LSO10**
	Low Side Output 2		Low Side Output 8		Low Side Output 9		Low Side Output 10
					Reverse battery diode		Reverse battery diode
A-F1	**LSO3**	A-F2	**LSO1**	A-F3	**FUEL 7**	A-F4	**FUEL 8**
	Low Side Output 3		Low Side Output 1		Fuel Injector 7		Fuel Injector 8
			Controlled current		Low-side driver		Low-side driver

Pin#		Pin#		Pin#		Pin#	
A-G1	**FUEL 5**	A-G2	**FUEL 6**	A-G3	**FUEL 3**	A-G4	**FUEL 4**
	Fuel Injector 5		Fuel Injector 6		Fuel Injector 3		Fuel Injector 4
	Low-side driver		Low-side driver		Low-side driver		Low-side driver
A-H1	**FUEL 1**	A-H2	**FUEL 2**	A-H3	**LSO12**	A-H4	**LSO11**
	Fuel Injector 81		Fuel Injector 2		Low Side Output 12		Low Side Output 11
	Low-side driver		Low-side driver		Discrete		Discrete
B-A1	**CAN1+**	B-A2	**CAN1-**	B-A3	**BATT 2**	B-A4	**AN16M**
	CAN1 Hi signal		CAN1 Low signal		Battery		Analog Input 16
	CAN 2.0B		CAN 2.0B		Internal connect to BATT 1		Rpullup= 183
B-B1	**CAN3-**	B-B2	**CAN3+**	B-B3	**CANSHIELD3**	B-B4	**AN21M**
	CAN3 Low signal		CAN3 Hi signal		CAN Shield 3		Analog Input 21
	CAN 2.0B						Rpullup= 10K
B-C1	**CAN2+**	B-C2	**CAN2-**	B-C3	**CANSHIELD3**	B-C3	**AN18M**
	CAN2 Hi signal		CAN2 Low signal		CAN Shield 3		Analog Input 18
	CAN 2.0B		CAN 2.0B				Rpullup= 183
B-D1	**KNK1+**	B-D2	**KNK1-**	B-D3	**XDRG 1**	B-D4	**AN19M**
	Knock Sensor Hi		Knock Sensor Low		Transducer Ground		Analog Input 19
	Differential broad-band		Differential broad-band		Analog ground reference		Rpullup= 183
B-E1	**KNK2-**	B-E2	**KNK2+**	B-E3	**AN1M**	B-E4	**AN28M**
	Knock Sensor Low		Knock Sensor Hi		Analog Input 1		Analog Input 28
	Differential broad-band		Differential broad-band		Rpulldown= 51.1K		Rpulldown= 51.1K
B-F1	**AN2M**	B-F2	**AN3M**	B-F3	**AN14M**	B-F4	**AN26M**
	Analog Input 2		Analog Input 3		Analog Input 14		Analog Input 26
	Rpulldown= 51.1K		Rpulldown= 51.1K		Rpulldown= 51.1K		Rpulldown= 51.1K
B-G1	**CAM (DG)**	B-G2	**SPEED 1 (DG)**	B-G3	**AN27M**	B-G4	**ECUP**
	Camshaft Sensor		Speed Sensor 1		Analog Input 27		Key Switch Input
	Engine camshaft position		Resolves variable freq.		Rpulldown= 51.1K		Module “wake up” signal
B-H1	**SPEED 2 (DG)**	B-H2	**SPEED 3 (DG)**	B-H3	**STOP**	B-H4	**CNK (DG)**
	Speed Sensor 2		Speed Sensor 3		E-Stop Input		Crankshaft Sensor
	Resolves variable freq.		Resolves variable freq.		Shuts off engine, disables fuel		Digital only
B-J1	**CNK- (VR)**	B-J2	**CNK+ (VR)**	B-J3	**O2C–**	B-J4	**O2D–**
	Crankshaft Sensor Lo		Crankshaft Sensor Hi		Oxygen Sensor Lo		Oxygen Sensor Lo
	VR only		VR only		Switching type		Switching type

Pin#		Pin#		Pin#		Pin#	
B-K1	**O2A+** Oxygen Sensor Hi Switching type	B-K2	**O2B+** Oxygen Sensor Hi Switching type	B-K3	**O2C+** Oxygen Sensor Hi Switching type	B-K4	**O2D+** Oxygen Sensor Hi Switching type
B-L1	**O2A–** Oxygen Sensor Lo Switching type	B-L2	**O2B–** Oxygen Sensor Lo Switching type	B-L3	**AN20M** Analog Input 20 Rpullup= 150K	B-L4	**EST RTN** EST Return Digital Ground Reference
B-M1	**LSO6** Low Side Output 6	B-M2	**LSO7** Low Side Output 7	B-M3	**LSO4** Low Side Output 4	B-M4	**LSO5** Low Side Output 5
C-A1	**AN5M** Analog Input 5 Rpullup= 1K	C-A2	**AN6M** Analog Input 6 Rpullup= 1K	C-A3	**AN15M** Analog Input 15 Rpulldown= 220K	C-A4	**AN5M** Analog Input 8 Rpullup= 1K
C-B1	**AN9M** Analog Input 9 Rpullup= 1K	C-B2	**AN10M** Analog Input 10 Rpullup= 1K	C-B3	**AN11M** Analog Input 11 Rpullup= 1K	C-B4	**AN12M** Analog Input 12 Rpullup= 1K
C-C1	**AN13M** Analog Input 13 Rpullup= 1K	C-C2	**AN29M** Analog Input 29 Rpullup= 1K	C-C3	**AN4M** Analog Input 4 Rpulldown= 220K	C-C4	**AN23M** Analog Input 23 Rpulldown= 220K
C-D1	**AN24M** Analog Input 24 Rpulldown= 220K	C-D2	**AN32M** Analog Input 32 Rpullup= 1K	C-D3	**AN33M** Analog Input 33 Rpullup= 150K	C-D4	**XDRP 1** Transducer Power 5 V Sensor Power
C-E1	**AN31M** Analog Input 31 Rpullup= 1K	C-E2	**AN17M** Analog Input 17 Rpulldown= 220K	C-E3	**AN22M** Analog Input 22 Rpulldown= 220K	C-E4	**XDRP 2** Transducer Power 5 V Sensor Power
C-F1	**AN25M** Analog Input 25 Rpulldown= 220 K	C-F2	**AN7M** Analog Input 7 Rpullup= 1K	C-F3	**AN30M** Analog Input 30 Rpulldown= 220K	C-F4	**BATT 1** Battery Internal connect BATT 2
C-G1	**DRVG 1** Driver Ground	C-G2	**DRVG 2** Driver Ground	C-G3	**DRVP 1** Driver Power Recirculation path	C-G4	**HBRIDGE1A** H-Bridge Output 1 Sign-magnitude (PWM)
C-H1	**HBRIDGE2A** H-Bridge Output 2 Discrete mode	C-H2	**HBRIDGE2B** H-Bridge Output 2 Discrete mode	C-H3	**DRVP 2** Driver Power Recirculation path	C-H4	**HBRIDGE1A** H-Bridge Output 1 Sign-magnitude (PWM)

Environmental Ratings

Environmental Ratings	Notes
The ECM is designed for automotive, under hood and marine industry environmental requirements. Validation tests include extreme operating temperatures, thermal shock, humidity, salt spray, salt fog, immersion, fluid resistance, mechanical shock, vibration, and EMC. The customer must contact Woodward and provide the intended environmental conditions in the application for verification of performance capability.	
Storage Temperature	–40 °C to +125 °C
Operating Temperature	–40 °C to +105 °C
Thermal Shock	–40 °C to +125 °C
Fluid Resistance	Two-stroke motor oil, four-stroke motor oil, unleaded gasoline, ASTM Reference 'C' fuel
Humidity Resistance	90 % humidity at 85 °C for 1000 hours
Salt Fog Resistance	500 hours. 5 % salt fog, 35 °C
Immersion	4.34 psi test (simulated 3 m / 10 feet), salt water, 20 minutes
Mechanical Shock	50 G's, 11 ms, half-sine wave
Drop Test	Drop test on concrete from 1 m
Vibration This ECM family has been successfully deployed in engine mounted applications ranging from common small displacement engines to large racing engines with extreme vibrations. Electrical and mechanical isolation is achieved via Woodward mounting hardware (consisting of grommet, bushing, and washer) shown to the right. **IMPORTANT** **For prior verification of performance capability, contact Woodward and provide the vibration profile of the intended application.**	

Programming Information

Using a Boot Key/Cable

Errors in configuration, logic and/or other programming made during program development for this module (via .srz file), can cause a persistent loss of CAN communications with the module under development.

If this happens, apply the boot key (or cable, depending on the model) to force the module into reboot mode, reloading the module with functional program code (a known, valid .srz file) in order to allow resumption of module communication. Follow the steps listed in this section. Refer to diagram below for connections.

Refer to “Ordering Information” on p. 2 for related boot key/cable part numbers.

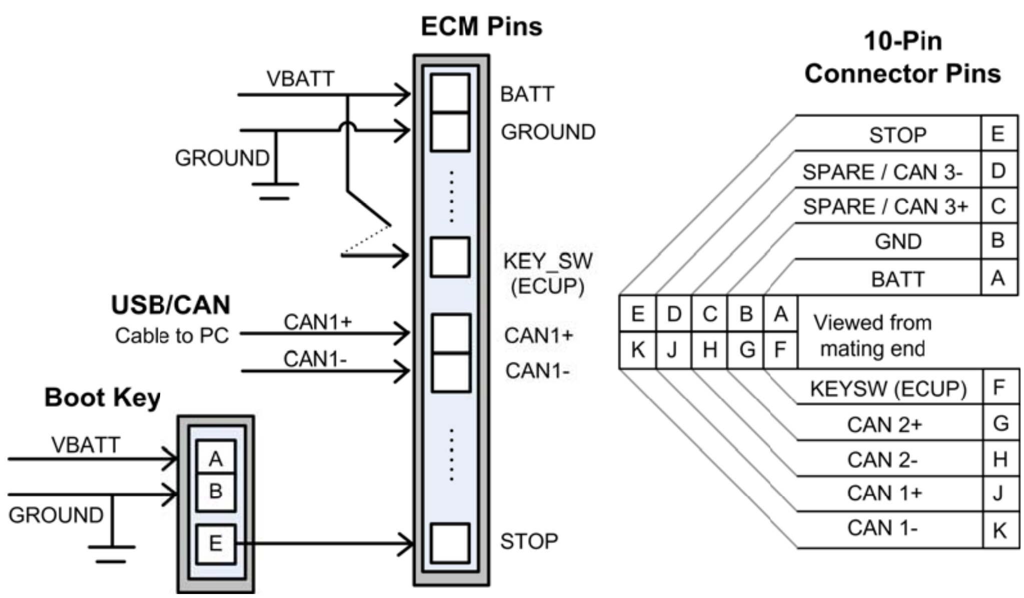
⚠WARNING **Remove ECU from control connections before performing the reboot procedure, as outputs are set to defaults or undefined states, with possibly unpredictable and hazardous results if applied.**

NOTICE **Remove other ECUs from CANbus for this procedure.**

1. Connect the module for programming via necessary cables, CAN converter, etc.
2. Select a known, valid .srz file for programming.
3. With key off, disconnect battery power from module. With module power off, initiate programming of the module using MotoTune.
4. When the “Looking for an ECU” prompt appears in the dialog, reconnect Battery, and then turn key on, to power up and “wake-up” ECU.

The module must “wake-up”—KEYSW (or ECUP) on—with the boot key or cable connections applied as described in order to initiate a reboot and to absorb the selected program.

IMPORTANT **A boot key provides a 555 Hz, 50 % duty cycle, V=Vbatt, square wave signal to the STOP pin, which may be duplicated by applying this signal from a signal generator to that pin.**



NOTES:

1) This pinout reflects the Mercury Marine SmartCraft pinout standard for CAN2 and CAN3:
   - CAN2 on pins G/H
   - CAN3 on pins C/D

2) Some MotoHawk Control Solutions products, including the dual-channel KVASER cable (Woodward P/N 5404-1324), use an alternate pinout standard:
   - CAN2 on pins C/D
   - CAN3 on pins G/H

WOODWARD

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