



MotoHawk Control Solutions  
**HCM-0563-048-0802-C/F**  
**Hydraulic Control Modules**  
 (Part Nos. 1751-6528 / 1751-6358)

### Description

Presenting the HCM-0563-048-0802-C/F hydraulic control modules from Woodward's new MotoHawk Control Solutions product line. These rugged embedded controllers are capable of operating in harsh automotive, marine, and off-highway applications. Over 300,000 successful marine applications prove the capability of this module. Based on a proven microprocessor, the HCM-0563-048-0802-C/F modules are capable of delivering complex control strategies. The onboard floating point unit and the high clock frequency allow software to be developed in shorter times. Dual CAN 2.0B datalinks ensure interoperability with other system components.

The HCM-0563-048-0802-C/F modules are part of the ControlCore® family of embedded control systems. MotoHawk Control Solutions' ControlCore operating system, MotoHawk® code-generation product, and MotoHawk's suite of development tools enable rapid development of complex control systems.

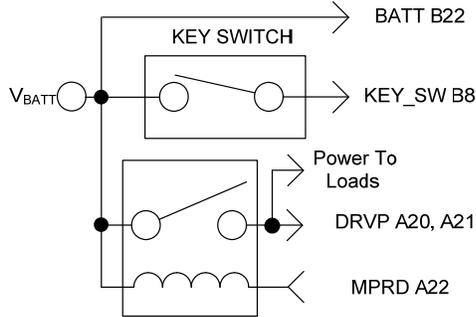
**IMPORTANT** Woodward does not warranty these ECMs based on information supplied in this datasheet, but only with an express and specific production supply agreement based on customer's operating mode. Information in this datasheet is subject to change without prior notice. Please contact MotoHawk Control Solutions sales for more information.

- **Microprocessor:**  
Freescale MPC563,  
40 MHz
- **Memory:** 512K Flash,  
32K RAM (4K  
overlayable), 128K  
parallel EEPROM  
(HCM-0563-048-0802-  
C)
- **Operating Voltage:**  
8–32 Vdc
- **Operating  
Temperature:** –40 to  
+105 °C
- Sealed connectors  
operable to 10 ft (3 m)  
submerged
- **Inputs:**  
Up to 16 Analog  
Up to 8 Discrete/  
Frequency  
Up to 2 VR/Hall  
Frequency  
1 Stop
- **Outputs:**  
3x 2.5 A Low Side  
Drivers w/ Current  
Feedback  
7x 3 A Low Side  
Drivers  
1x 1 A EasyLink/Low  
Side Driver  
1x Relay Driver (Main  
Power)  
1x 5 A Low Side Driver
- **Datalinks:**  
2 CAN 2.0B Channels

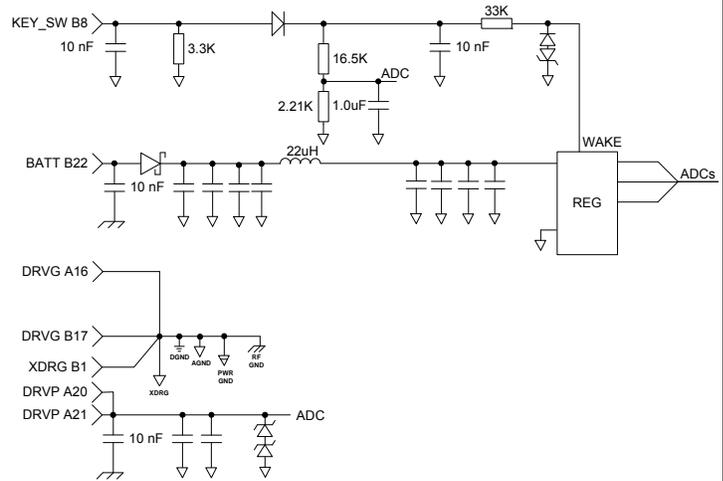
# 1-Input Signal Conditioning

## 1.1 KEY\_SW (B8), DRVP (A20, A21), DRVG (A16, A24, B17), XDRG (B1)

The **KEY\_SW** input wakes the module power supply regulator. The DRVP inputs are wired via the Main Power Relay which will supply the loads while the MPRD signal is asserted (see below). The processor will hold the module power on after the **KEY\_SW** signal is removed for controlled shutdowns. Inputs are monitored by the processor.

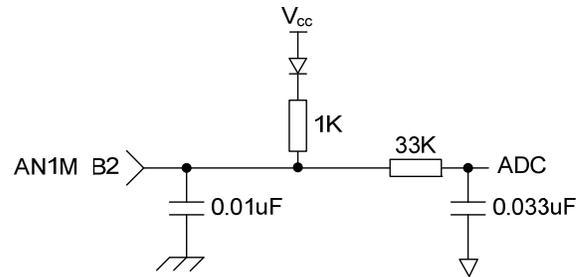


The DRVG inputs are the system (battery) ground connections.



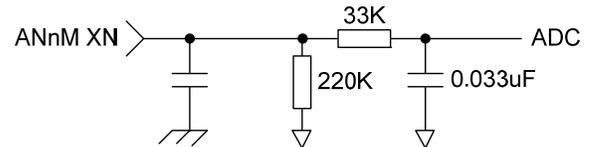
## 1.2 AN1M (B2)

This input is a 10-bit 0–5 V ADC,  $\tau = 1$  ms.



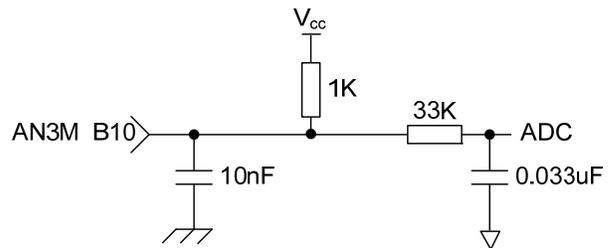
## 1.3 AN2M, AN4M, AN9M, AN10M (B3, B11, B9, B12)

These inputs are 10-bit 0–5 V ADC,  $\tau = 1$  ms.



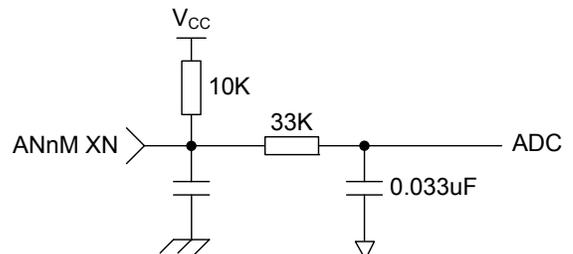
## 1.4 AN3M (B10)

This input is a 10-bit 0–5 V ADC,  $\tau = 1$  ms.

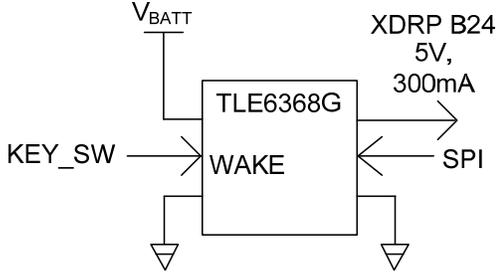
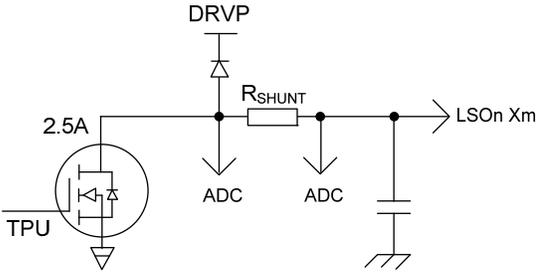
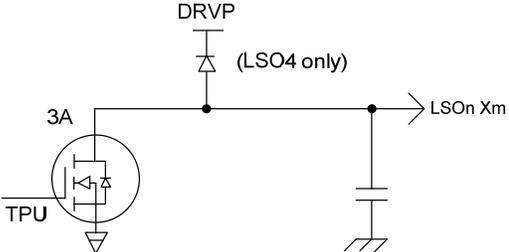
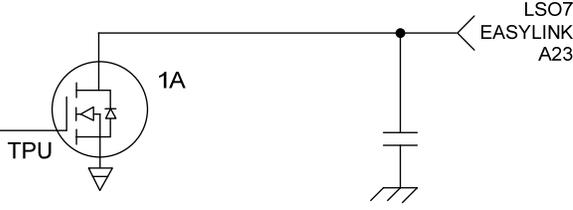
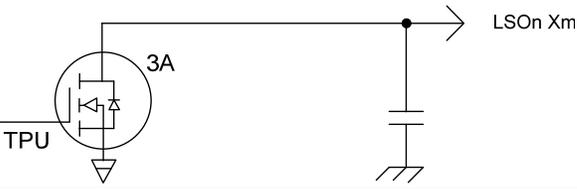
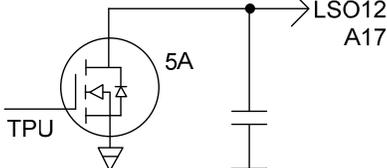
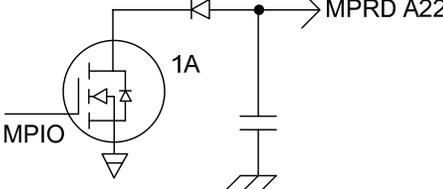


## 1.5 AN5M, AN6M, AN7M, AN8M (A10, A11, A9, A12)

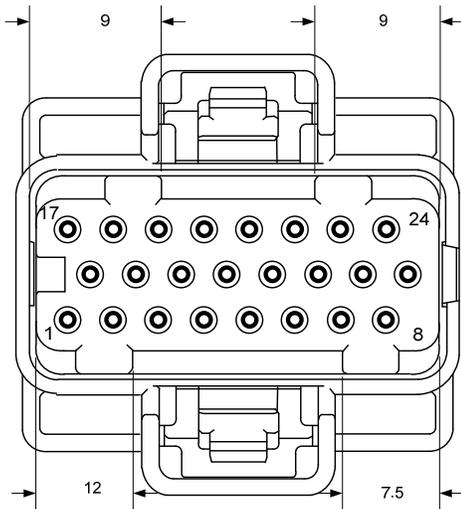
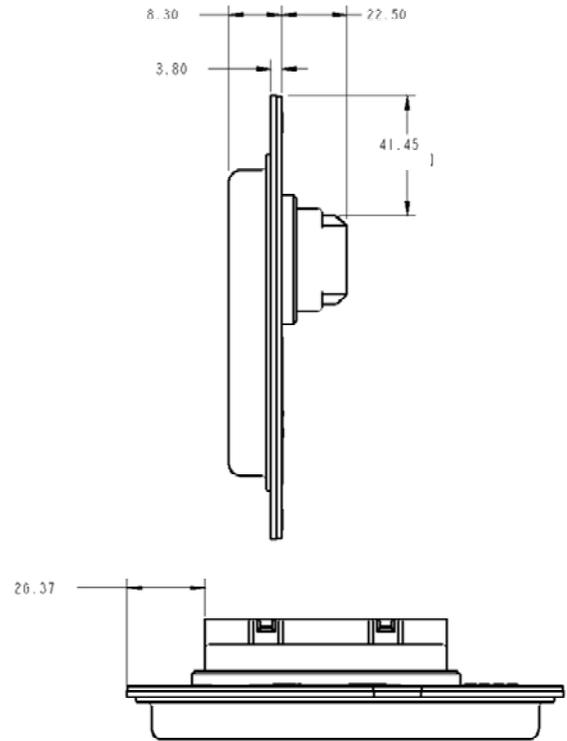
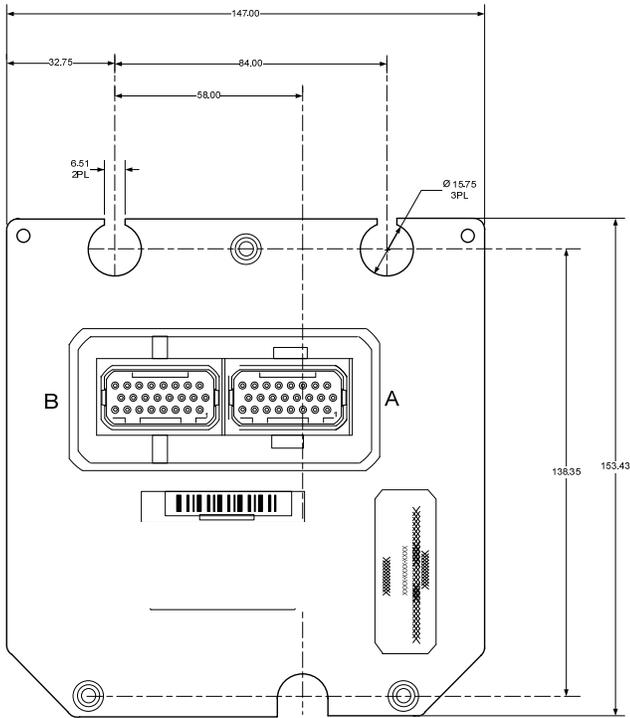
These inputs are 10-bit 0–5 V ADC,  $\tau = 1$  ms.



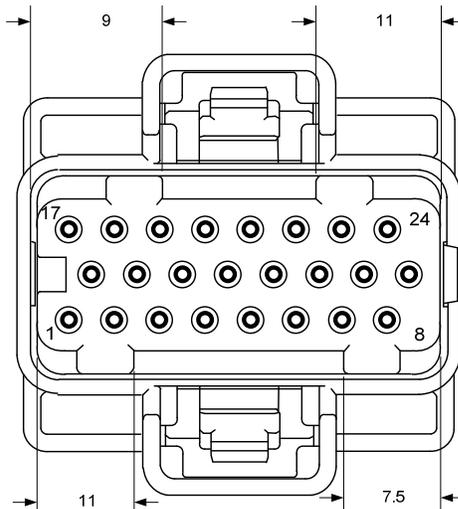
1-Input Signal Conditioning	(continued)
<p><b>1.6 AN11M_DG3M, AN13M_DG5M (B18, A15)</b></p> <p>These inputs are 10-bit 0–5 V ADCs, <math>\tau = 5.1 \mu\text{s}</math>.</p>	
<p><b>1.7 AN12M_DG4M, AN16M_DG8 (B19, A19)</b></p> <p>These inputs are 10-bit 0–5 V ADCs, <math>\tau = 5.1 \mu\text{s}</math>.</p>	
<p><b>1.8 AN14M_DG6M, AN15M_DG7M (A6, A3)</b></p> <p>These inputs are 10-bit 0–5 V ADCs, <math>\tau = 5.1 \mu\text{s}</math>.</p>	
<p><b>1.9 VR1+_DG1M, VR2+_DG2M, VR1-, VR2- (B5, B16, B4, B15)</b></p> <p>Variable Reluctance/Hall Effect/Discrete switch input.</p> <p><math>V_{IL}=2.0 \text{ Vmax}</math>. <math>V_{IH}=2.5 \text{ Vmin}</math>, <math>\tau = 100 \mu\text{s}</math>.</p>	
<p><b>1.10 STOP (B23)</b></p> <p>This is the emergency stop input. It is activated by switching to ground.</p>	

2-Output Signal Conditioning	
<p><b>2.1 XDRP (B24)</b></p> <p>This output is for powering sensor transducers and is monitored by the processor. 5 V, 300 mA</p>	
<p><b>2.2 LSO1, LSO2, LSO3 (A2, A13, A7)</b></p> <p>This output is a sink driver, 2.5 A max. with current feedback. Short circuit protection, open circuit and short circuit detection.</p>	
<p><b>2.3 LSO4, LSO5, LSO6 (A8, A14, A5)</b></p> <p>These outputs are sink drivers, 3 A typical. Short circuit protection, open circuit and short circuit detection.</p>	
<p><b>2.4 LSO7_EASYLINK (A23)</b></p> <p>This output is a sink driver, 1 A max., it may also be used to drive EasyLink gauges (with external pull-up resistor). Short circuit protection, open circuit and short circuit detection.</p>	
<p><b>2.5 LSO8, LSO9, LSO10, LSO11 (A4, A18, A1, A16)</b></p> <p>This output is a sink driver, 3 A typical. Short circuit protection, open circuit and short circuit detection.</p>	
<p><b>2.6 LSO12 (A17)</b></p> <p>This output is a high current sink driver, 5 A typical. Short circuit protection, open circuit and short circuit detection.</p>	
<p><b>2.7 MPRD (A22)</b></p> <p>This output energizes the Main Power Relay. Short circuit protection, open circuit and short circuit detection.</p>	

### 3-Connector Definitions



CON-FEML-001A  
A



CON-FEML-001B  
B

## 3.1 Block Diagram

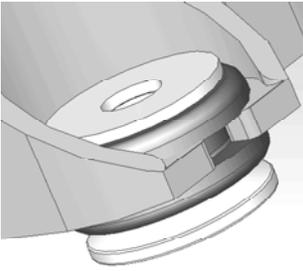
## HCM-0563-048-0802-C/F

HCM-0563-048-0802			
B22	BATT_IN	MPRD (1A)	A22
B08	KEY_SW (PD 3K)	DRVP-1	A20
		DRVP-2	A21
B23	STOP-DIG/AN IN (PD 18.7K, PU 100 w/Diode)		
B05	VR1+_DIG1	LSO1-W-CS AND RECIRC (2.5A)	A02
B04	VR1-	LSO2-W-CS AND RECIRC (2.5A)	A13
B16	VR2+_DIG2	LSO3-W-CS AND RECIRC (2.5A)	A07
B15	VR2-	LSO4-W RECIRC (3A)	A08
B24	XDRP-300mA	LSO5-W-RECIRC (3A)	A14
B02	AN1 (PU 1K W DIODE)		
B03	AN2 (PD 220K)	LSO6-W RECIRC (3A)	A05
B10	AN3 (PU 1K)	EASY LINK LSO7 (1A) PWM	A23
B11	AN4 (PD 220K)	LSO8 (3A)	A04
A10	AN5 (PU 10K)	LSO9 (3A)	A18
A11	AN6 (PU 10K)	LSO10 (3A)	A01
A09	AN7 (PU 10K)	LSO11 (3A)	A24
A12	AN8 (PU 10K)		
B09	AN9 (PD 220K)	LSO12 (5A)	A17
B12	AN10 (PD 220K)		
B18	AN11-DIG3 (PU 1K W DIODE)		
B19	AN12-DIG4 (PD 51.1K)		
A15	AN13-DIG5 (PU 1K W DIODE)		
A06	AN14-DIG6 (PD 10K)		
A03	AN15-DIG7 (PD 10K)		
A19	AN16-DIG8 (PD 51.1K)		
B13	NC		
B14	NC		
B01	XDRG		
B20	CAN1+		
B21	CAN1-	GND	A16
B07	CAN2+		
B06	CAN2-	GND	B17

3.2 Connector Pinouts			3.2.1 Resource by Connector Pin	
Pin # ECM	ControlCore Resource Name	Function Name	Notes	Wire Number Color Code
A1	LSO10	Low Side Out 10	3 A	1 Pink/Light Blue
A2	LSO1	Low Side Out 1	2.5 A, Current Sense, Diode	2 Pink/Orange
A3	AN15_DG7	Analog/Discrete In	10K to GND	3 Yellow/Black
A4	LSO8	Low Side Out 8	3	4 White
A5	LSO6	Low Side Out 6	3	5 White/ Dark Blue
A6	AN14_DG6	Analog/Discrete In	10K to GND	6 Black/Red
A7	LSO3	Low Side Out 3	2.5 A, Current Sense, Diode	7 Yellow/Orange
A8	LSO4	Low Side Out 4	3 A, Diode	8 Light Blue
A9	AN7	Analog In 7	10K to 5 V	9 Tan/Light Blue
A10	AN5	Analog In 5	10K to 5 V	10 Gray
A11	AN6	Analog In 6	10K to 5 V	11 Dark Blue
A12	AN8	Analog In 8	10K to 5 V	12 Dark Blue/White
A13	LSO2	Low Side Out 2	2.5 A, Current Sense, Diode	13 White/Light Blue
A14	LSO5	Low Side Out 5	3 A	14 White/Black
A15	AN13_DG5	Analog/Discrete In	1K to 5 V, $\tau = 5.1 \mu\text{s}$	15 Black/Yellow
A16	GND	System Ground	Battery Ground	16 Black/White
A17	LSO12	Low Side Out 12	5 A	17 Pink/Purple
A18	LSO9	Low Side Out 9	3 A	18 Pink/Brown
A19	AN16_DG8	Analog/Discrete In	51K to GND, $\tau = 5.1 \mu\text{s}$	19 Orange
A20	DRVP	Driver Power	Wire via MPR contacts	20 Orange/White
A21	DRVP	Driver Power	Wire via MPR contacts	21 Black/Blue
A22	MPRD	Main Power Relay Driver	1.0 A max.	22 Yellow/Purple
A23	LSO7/EasyLink	Low Side Out 7	1 A	23 Red/Blue
A24	LSO11	Low Side Out 11	3 A	24 Black/White

3.2 Connector Pinouts			3.2.1 Resource by Connector Pin (continued)	
Pin # ECM	ControlCore Resource Name	Function Name	Notes	Wire Number Color Code
B1	XDRG	Transducer Ground	Low Current Return	25 Black/Orange
B2	AN1	Analog In 1	1K to 5 V via Diode	26 Tan
B3	AN2	Analog In 2	220K Pull Down, $\tau = 1$ ms	27 Yellow
B4	VR1-	Return VR Input	Leave open for Hall	28 Dark Blue/Pink
B5	VR1+	VR Sensor Positive	VR, Hall, Discrete	29 Red/Pink
B6	CAN2-	CAN2 Negative		30 White
B7	CAN2+	CAN2 Positive		31 White/Green
B8	KEY_SW	Key Switch	Module Wake	32 Brown/White
B9	AN9	Analog In 9	220K Pull Down, $\tau = 1$ ms	33 Gray/Red
B10	AN3	Analog In 3	1K to 5 V, $\tau = 1$ ms	34 Orange/Black
B11	AN4	Analog In 4	220K Pull Down, $\tau = 1$ ms	35 Blue/Black
B12	AN10	Analog In 10	220K Pull Down, $\tau = 1$ ms	36 White/Orange
B13	NC	No Connection		
B14	NC	No Connection		
B15	VR2-	Return VR Input	Leave open for Hall	37 White/Yellow
B16	VR2+	VR Sensor Positive	VR, Hall, Discrete	38 Tan/Green
B17	GND	System Ground	Battery Ground	39 Green/Yellow
B18	AN11_DG3	Analog/Discrete In	1K to 5 V, $\tau = 5.1$ $\mu$ s	40 Green/Red
B19	AN12_DG4	Analog In 12	51.1K Pull Down, $\tau = 5.1$ $\mu$ s	41 Black/Green
B20	CAN1+	CAN1 Positive		42 Purple
B21	CAN1-	CAN1 Negative		43 Tan/Purple
B22	BATT_IN	Battery Connection	Module Power	44 Light Blue/White
B23	STOP_DIG_AN	E-STOP Input	100 W to 5 V via Diode, 16.5K to GND	45 Purple/Yellow
B24	XDRP	Transducer Power	300 mA	46 Black/ Orange

3.2 Connector Pinouts			3.2.2 Resource by Name	
Pin # ECM	ControlCore Resource Name	Function Name	Notes	Wire Number Color Code
B2	AN1	Analog In 1	1K to 5 V via Diode	26 Tan
B3	AN2	Analog In 2	220K Pull Down, $\tau = 1$ ms	27 Yellow
B10	AN3	Analog In 3	1K to 5 V, $\tau = 1$ ms	34 Orange/Black
B11	AN4	Analog In 4	220K Pull Down, $\tau = 1$ ms	35 Blue/Black
A10	AN5	Analog In 5	10K to 5 V, $\tau = 1$ ms	10 Gray
A11	AN6	Analog In 6	10K to 5 V, $\tau = 1$ ms	11 Dark Blue
A9	AN7	Analog In 7	10K to 5 V, $\tau = 1$ ms	9 Tan/Light Blue
A12	AN8	Analog In 8	10K to 5 V, $\tau = 1$ ms	12 Dark Blue/White
B9	AN9	Analog In 9	220K Pull Down, $\tau = 1$ ms	33 Gray/Red
B12	AN10	Analog In 10	220K Pull Down, $\tau = 1$ ms	36 White/Orange
B18	AN11_DG3	Analog/Discrete In	1K to 5 V via Diode, $\tau = 5.1$ $\mu$ s	40 Green/Red
B19	AN12_DG4	Analog/Discrete In	51.1K to GND, $\tau = 5.1$ $\mu$ s	41 Black/Green
A15	AN13_DG5	Analog/Discrete In	1K to 5 V via Diode, $\tau = 5.1$ $\mu$ s	15 Black/Yellow
A6	AN14_DG6	Analog/Discrete In	10K to GND, $\tau = 5.1$ $\mu$ s	6 Black/Red
A3	AN15_DG7	Analog/Discrete In	10K to GND, $\tau = 5.1$ $\mu$ s	3 Yellow/Black
A19	AN16_DG8	Analog/Discrete In	51.1K to GND, $\tau = 5.1$ $\mu$ s	19 Orange
B22	BATT_IN	Battery Connection	Module Power	44 Light Blue/White
B21	CAN1-	CAN1 Negative		43 Tan/Purple
B20	CAN1+	CAN1 Positive		42 Purple
B6	CAN2-	CAN2 Negative		30 White
B7	CAN2+	CAN2 Positive		31 White/Green
A20	DRVP	Driver Power	Wire via MPR contacts	20 Orange/White
A21	DRVP	Driver Power	Wire via MPR contacts	21 Black/Blue
A16	GND	System Ground	Battery Ground	16 Black/White
B17	GND	System Ground	Battery Ground	39 Green/Yellow
B8	KEY_SW	Key Switch	Module Wake	32 Brown/White
A2	LSO1	Low Side Out 1	2.5 A, Current Sense, Diode	2 Pink/Orange
A13	LSO2	Low Side Out 2	2.5 A, Current Sense, Diode	13 White/Light Blue
A7	LSO3	Low Side Out 3	2.5 A, Current Sense, Diode	7 Yellow/Orange
A8	LSO4	Low Side Out 4	3 A, Diode	8 Light Blue
A14	LSO5	Low Side Out 5	3 A	14 White/Black
A5	LSO6	Low Side Out 6	3 A	5 White/ Dark Blue
A23	LSO7/EasyLink	Low Side Out 7	1 A	23 Red/Blue
A4	LSO8	Low Side Out 8	3 A	4 White
A18	LSO9	Low Side Out 9	3 A	18 Pink/Brown
A1	LSO10	Low Side Out 10	3 A	1 Pink/Light Blue
A24	LSO11	Low Side Out 11	3 A	24 Black/White
A17	LSO12	Low Side Out 12	5 A	17 Pink/Purple
A22	MPRD	Main Power Relay Driver	1.0 A max.	22 Yellow/Purple
B23	STOP_DIG_AN	E-STOP Input	1K to 5 V via Diode, 27.6 V FS	45 Purple/Yellow
B4	VR1-	Return VR Input	Leave open for Hall	28 Dark Blue/Pink
B5	VR1+	VR Sensor Positive	VR, Hall, Discrete	29 Red/Pink
B15	VR2-	Return VR Input	Leave open for Hall	37 White/Yellow
B16	VR2+	VR Sensor Positive	VR, Hall, Discrete	38 Tan/Green
B1	XDRG	Transducer Ground	Low Current Return	25 Black/Orange
B24	XDRP	Transducer Power	300 mA	46 Black/Orange

4-Environmental																																		
<b>Environmental Ratings:</b>		<p>The ECM is designed to meet automotive industry standard under hood environmental requirements for 12/24 volt systems, and also meets marine industry environmental requirements. Validation tests include extreme operating temperatures (-40 to +85 °C), thermal shock, humidity, salt spray, salt fog, immersion, fluid resistance, mechanical shock, vibration, steam pressure wash, and EMC.</p> <p>It is the responsibility of the application engineer to ensure that the application does not exceed the demonstrated capabilities of the unit; vibration or thermal. It may be necessary to perform additional tests to validate the unit in the application.</p>																																
<b>4.1 Storage Temperature:</b>		-50 to +125 °C																																
<b>4.2 Operating Temperature:</b>		-40 to +85 °C																																
<b>4.3 Thermal Shock:</b>		-40 to +125 °C temperature stable for 6 seconds at each point for 500 cycles																																
<b>4.4 Fluid Resistance:</b>		An extensive list of solvents, caustics, etc.																																
<b>4.5 Humidity Resistance:</b>		85% humidity at 85 °C for 1000 hours																																
<b>4.6 Salt Fog Resistance:</b>		500 hours of operation, 5% salt fog, 35 °C																																
<b>4.7 Immersion:</b>		Submersible in 8% salt water solution to 10 ft (3 m)																																
<b>4.8 Mechanical Shock:</b>		50 g's, 11 ms, 1/2 sine wave, 4x each axis (+ & -)																																
<b>4.9 Drop:</b>		Drop tests on concrete from 1 meter, 6 surfaces																																
<b>4.10 Vibration:</b> Engine mountable and designed to high-performance levels, the ECM has been tested according to the schedule shown at right:  Electrical and mechanical isolation is via a bushing, grommet, and washer, as shown: <div style="text-align: center;">  </div>		<table border="1"> <thead> <tr> <th colspan="2">Chassis, 5.82 Grms</th> </tr> <tr> <th>Break-point Frequency</th> <th>PSD [G<sup>2</sup>/Hz]</th> </tr> </thead> <tbody> <tr><td>1</td><td>1.E-02</td></tr> <tr><td>1.6</td><td>1.E-02</td></tr> <tr><td>3</td><td>3.E-02</td></tr> <tr><td>4</td><td>3.E-01</td></tr> <tr><td>5</td><td>3.E-02</td></tr> <tr><td>10</td><td>3.E-01</td></tr> <tr><td>10</td><td>3.E-01</td></tr> <tr><td>30</td><td>3.E-01</td></tr> <tr><td>60</td><td>5.E-02</td></tr> <tr><td>100</td><td>5.E-02</td></tr> <tr><td>230</td><td>1.E-02</td></tr> <tr><td>330</td><td>1.E-01</td></tr> <tr><td>1300</td><td>1.E-03</td></tr> <tr><td>2000</td><td>1.E-03</td></tr> </tbody> </table>	Chassis, 5.82 Grms		Break-point Frequency	PSD [G <sup>2</sup> /Hz]	1	1.E-02	1.6	1.E-02	3	3.E-02	4	3.E-01	5	3.E-02	10	3.E-01	10	3.E-01	30	3.E-01	60	5.E-02	100	5.E-02	230	1.E-02	330	1.E-01	1300	1.E-03	2000	1.E-03
Chassis, 5.82 Grms																																		
Break-point Frequency	PSD [G <sup>2</sup> /Hz]																																	
1	1.E-02																																	
1.6	1.E-02																																	
3	3.E-02																																	
4	3.E-01																																	
5	3.E-02																																	
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30	3.E-01																																	
60	5.E-02																																	
100	5.E-02																																	
230	1.E-02																																	
330	1.E-01																																	
1300	1.E-03																																	
2000	1.E-03																																	
<b>4.11 Abnormal Supply Voltage Resistance:</b>																																		
<b>Condition</b>	<b>Supplied Voltage</b>	<b>Time</b>																																
Reverse Battery	-36 Vdc	5 minutes																																
Double Battery	36 Vdc	5 minutes																																
Minimum Battery	8 Vdc	Indefinitely																																
Low Battery Condition	6.3 Vdc	Indefinitely																																
<b>4.12 Power Dropout Susceptibility:</b>																																		
<b>Test</b>	<b>Vsupply</b>	<b>Time</b>	<b>Response</b>																															
1	Interrupt	< 100 μs	No resets																															
2	Slow Decal	> 10 min	No abnormal behaviors																															

## 5-Using a Boot Key/Cable

Errors made in programming a module (via .srz file), such as errors within the CAN software or model, can inadvertently prevent communication with the module. When this happens, module operation appears to be locked up when communicating with the module, as when using MotoTune®.

In such a case, use the Boot Key or Cable to force the module into reboot mode, in order to reprogram the module (with a known, valid .srz file) in order to allow resumption of module communication.

Use boot key part. no. HARNINTR00801 (part no. 1635-1800). See diagram below for boot connection scenario.

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

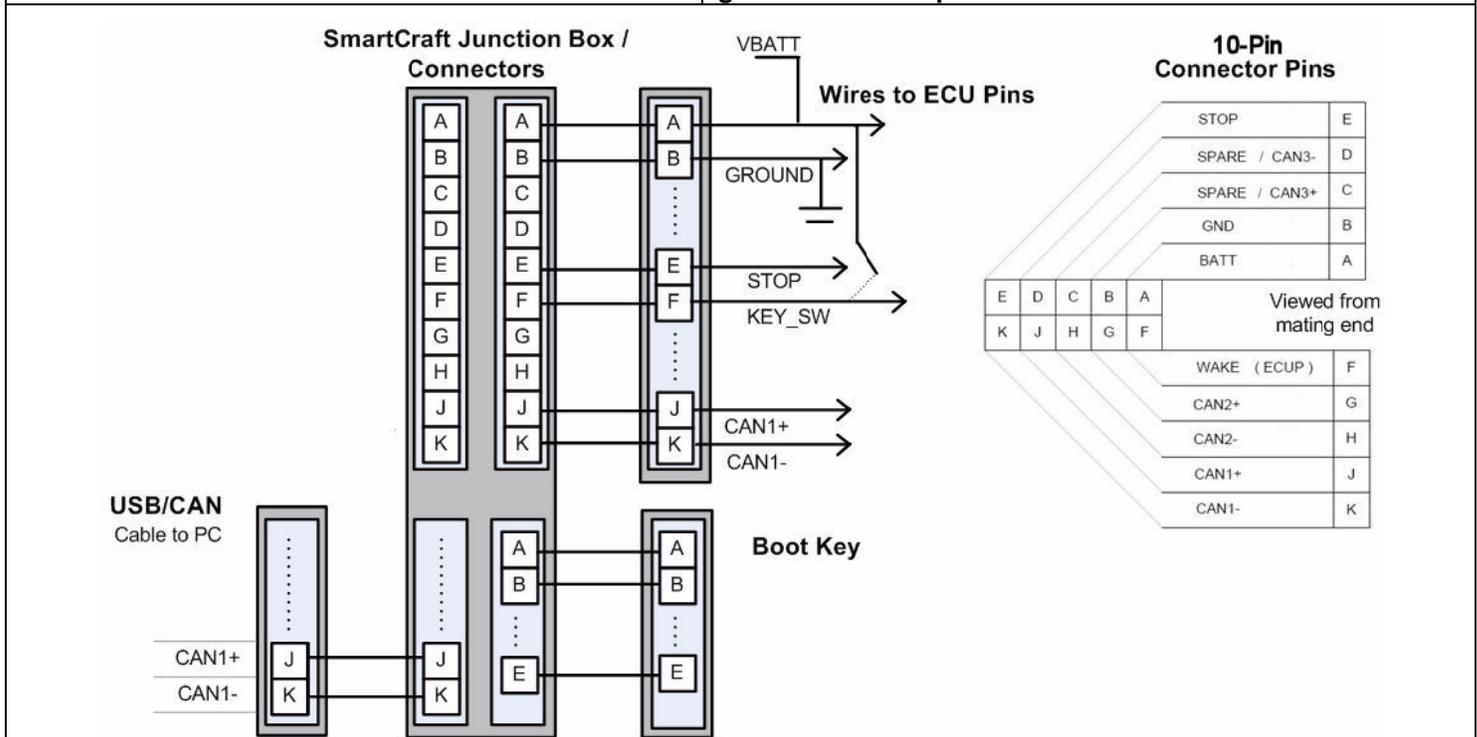
## Use Boot Key and Reprogram the Module

**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" (KEY\_SW on) with the boot key or cable applied 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 a signal from a signal generator to that pin.



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