Blue rectangles are links to other catalog pages.

Electronic Control Units — Technical Reference

Technical Reference Information for Controller Models ECU-ML and ECU-MM

PRODUCT OVERVIEW — INPUTS/OUTPUTS

User Liability and Safety — OEM Responsibility

Full responsibility for the safe and effective functioning of the equipment into which HydraForce electronic controls are installed is assumed by the OEM of the equipment. HydraForce assumes no responsibility for application performance, or for the consequences of improper application or equipment malfunction.

An emergency stop function should be included on all safety-critical systems to switch off the main power supply for the output signals of the machine's electronic control system. The main supply voltage should be designed to switch off immediately when unsafe conditions are encountered. A manual emergency stop switch should be clearly visible and easily accessed by the machine or vehicle operator.

Absolute Maximum Ratings

Operating Temperature: –40°C to 85°C
Storage Temperature: –50°C to 125°C
Supply Voltage: 9 to 32 VDC
Output Load Current per Channel: Up to 2 Amps
Total Output Current: Varies by specific model

CAN (Controller Area Networks) Ports

All HydraForce machine controllers have CAN ports that conform to CAN 2.0b specifications, including CAN shield.

Module Supply Voltage / Maximum Current Rating

HydraForce machine controllers are designed to operate with a 9 to 32 VDC power supply, and are protected against reverse polarity. The voltage is internally monitored for Low/High Voltage and Load Dump. See individual product pages for maximum current ratings for specific models.

Input/Output Types and Specifications

HydraForce machine controllers include input and output pins for multiple I/O functions that are software-configurable by the OEM or the machine user. See individual product pages for details about each model's features and functions.

Inputs — General

The controllers' input pins support one or more of the following input types:

- Digital in: Switch to Ground and Battery
- Analog in: Voltage and Resistive
- Frequency in: Speed and PWM

Communication — General

Model Dependent: CAN2.0

Key Switch Input

The key switch input allows the power to be turned On or Off manually. After the power is applied, the software will have control of all the inputs and outputs. The software can also disable the function of the key switch input.

- Provide a method of resetting the entire ECU.
- Provide software option for key switch override.
- Allows low battery drain (10 mA) when ECU is "asleep."
- Internal pull-down resistor is available for an external signal to turn off the key switch input.
- Input is protected from ESD and EMI.
- Key switch status is monitored by software.

Inputs — Digital

- Input voltage below minimum results in a non-damaging, non-latching reading saturated to the low limit.
- Input voltage above maximum results in a non-damaging, non-latching reading saturated to the high limit.

Switch-to-Ground Features

- Switch-to-ground inputs are normally pulled high to +13 VDC through 2KΩ resistor when they are floating.
- Inputs are protected from ESD, EMI and short to +Battery faults.
- Fast response times.

Specifications for Switch-to-Ground Inputs:
Short ckt current: 10 mA DC maximum
Maximum Resistance for On: 50Ω to Ground
Minimum Resistance for Off: 4KΩ to Ground
Non-Damaging Voltage Range: 0 to 32 VDC continuous

Switch to +Battery Features

- Switch to battery inputs will detect a signal of +Batt –2V through a series resistance of 50Ω.
- Inputs have an internal pull-down resistor
- All inputs are protected from ESD, EMI, transients and short-to-ground faults.

Specifications for Switch to +Battery Inputs:
Activation Resistance: 50Ω maximum to +Batt
De-Activation Resistance: 4KΩ minimum to +Batt
Non-Damaging Voltage Range: –32 to +32 VDC continuous

Note: for Controller Model ECU-MS, see pages 3.520.5–8

Technical Reference Information for Controller Models ECU-ML and ECU-MM

INPUTS/OUTPUTS (cont'd.)

Inputs — Analog Voltage

- Input can measure voltage of analog sensors and can also serve as a current source with an internal 22KΩ pull-up resistor to +13 VDC.
- Input-open reads as 13 VDC; input short reads as 0 VDC.
- Protection for Short to +Batt and ground as well as ESD and EMI, provided internally.

Specifications for Analog Inputs:

Input Voltage: 0 to 5 VDC

Input Accuracy: 2% Full Scale

Pull-Up Resistance: 22KΩ to +13 VDC

Analog to Digital Resolution: 5mV

Sampling Rate: 2 msec.

Inputs — Analog Resistive (Temperature)

- Resistive or analog sensor input.
- Internal protection for short-to-battery or ground.
- ESD and EMI protected.

Specifications for Resistive Sensor (Temperature) Inputs:

Working Range: 0 to 5 VDC

Pull-Up Resistance: 499Ω to +5 VDC

Analog to Digital Resolution: 5mV

Accuracy: ±50mV

Inputs — Frequency (Timing)

Frequency inputs can be logic-level pulse pickup units (Hall Effect), Variable Reluctance (VR), PWM duty-cycle or frequency-encoded sensors, or switch-to-ground.

Features for Variable Reluctance:

- Inputs are individually software-configurable as Passive (balanced) or Active (unbalanced) sensors.
- Adjacent input channels can be paired up as differential or single-ended to provide direction decoding.
- Diagnostic functions available through software configuration are maximum frequency and maximum period faults. Direction and fault counter diagnostics are also available.

Specifications for Variable Reluctance:

Input Impedence: 20KΩ ±10% input to input.

Input Measurable Limits: 0.5V to 120V p-p

Frequency Range: 0.1 to 10 KHz programmable

Frequency Accuracy: ±1% of actual

Non-Damaging Voltage Range: –0.7 to 32 VDC

Note: When using these inputs, best results will be obtained when a sensor is connected to the ECU with twisted shielded pair to reduce noise. The shield is then grounded to the –Battery pin on the ECU.

PWM Inputs:

These inputs allow an interface to active PWM and speed sensors. The inputs can be configured to measure both duty cycle and frequency.

Specifications for PWM Inputs:

Input Low Threshold: <1.0 VDC

Input High Threshold: >4.0 VDC

Input Pull Up Resistance: 2 kΩ to +5 VDC

Frequency Range: 0.6 Hz to 10 KHz

Frequency Accuracy: ±1% for 0.6 Hz to 4 KHz; ±2% for 4 KHz to 10 KHz

Timing Resolution: 1 µsec.

Duty Cycle Range: 3% to 97%

Duty Cycle Accuracy: ±1%

Non-Damaging Voltage Range: –0.7 to 32 VDC

Alternator Input:

This input monitors the alternator frequency and voltage for proper operation. This can also be used for measuring engine speed.

- Frequency Range: 3 Hz to 10 KHz
- Accuracy and Resolution: 2% of input
- Voltage Range: 0.5 to 100 Vpeak

Outputs — General

HydraForce machine controllers include factory-programmable output circuits configured via software. The controllers' output pins support one or more of the following output types:

- Digital out: 2 Amp Sourcing, 300 milliamp Sinking
- PWM: 1-Wire and 2-Wire 2 Amp Drivers

Outputs — Digital

2 Amp Sourcing Driver

- Protection Driver: Outputs will survive shorts to +Bat, –Bat through any impedance with no degradation in performance. If commanded ON, driver remains ON during 80V jump start and load dump unless current limit is exceeded during these events, in which case the driver is disabled and a short-to-ground diagnostic is reported. If driver protection feature disables driver during these events, the driver is allowed to retry within 10 ms.
- Protection Load: If commanded ON, driver remains ON during 80V jump start and load dump unless current limit is exceeded during these events. If commanded OFF, driver will not source more then 100 µA during 80V jump start and load dump.
- Diagnostics: Output fault detection reports short to battery or ground, as well as open circuits whether drivers are in ON or OFF state.

Note: for Controller Model ECU-MS, see pages 3.520.5–8

Electronic Control Units — Technical Reference

Technical Reference Information for Controller Models ECU-ML and ECU-MM

INPUTS/OUTPUTS (cont'd) / RATINGS

Specifications for 2 Amp Sourcing Driver:

Output Voltage: +Battery –2.0 VDC minimum at rated current.

Output Current: 2 Amps maximum.

Leakage Current: 350 µA maximum.

Idle Current: Less than 10 mA.

Turn-On Time: Less than 1 ms from command to 90% of maximum output or voltage into resistive load at rated current.

Maximum Switching Frequency for HydraForce Solenoids:

Timing Resolution and Latency: Less than 1.25 ms.

Return Connection: Separate return is NOT required for each driver. A total of two specific returns are assigned to all ON/OFF drivers. Spreading drivers evenly between the two return lines is recommended.

System Reset Status: Drivers turn off during a system Reset.

Specifications for 300 mA Sinking Outputs:

Load Supply Voltage: 32 VDC maximum.

Load Current: 300 mA (current limited at 400 mA).

Leakage Current: 0.5 mA with Driver Off.

Transition Time: 20 µsec. maximum.

Maximum Switching Frequency for Non-Inductive Loads:

Typical Loads: Lamps, LEDs > 0.50 mA, relays with maximum flyback energy of 12 mJ

Outputs — PWM

- Programmable control range of 50mA to 2A sourcing.
- Full-time diagnostics detect open or short to battery or ground; diagnostic limits for resistive, open circuit, leakage, or saturated driver faults.
- Software configurable for PWM, On/Off drivers, or Lamp drivers.
- One wire driver shares a common return with three other drivers.
- Two wire separate driver and return, both switch to avoid short to battery.

Specifications for PWM Outputs:

Output Current: Programmable from 0 to 2.0 AmpsDC.

Controllable Current Range: 50mA to Imax.

Output Current Resolution: 2mA.

Output Voltage: +Battery –2.0 VDC minimum at maximum load.

Leakage Current: 100 µA maximum at driver off.

Switching Frequency: 1 KHz.

Dither Period: Programmable 4 mS to 500 mS in 2 mS increments.

Dither Amplitude: Programmable, 0 to 250 mA.

Current Accuracy:
For 50 mA to 80 mA: ±9% > 0°C, ±11% < 0°C
For 80 mA to 150 mA: ±6% > 0°C, ±8% < 0°C
For 150 mA to 400 mA: ±4% > 0°C, ±5% < 0°C
For 400 mA to 2.0 A: ±2% > 0°C, ±3% < 0°C

Frequency Response: 30 Hz or better.

Sensor Power Supply Ratings

Models that support sensor inputs include dedicated, regulated sensor power supplies and ground pins. See individual product pages for sensor power supply ratings.

Diagnostics:

- Software controlled diagnostic functions executed every 15 mS.
- Short-to-Ground: Supply voltage is <95% of sensor voltage (5, 8 or 10 VDC) for two seconds minimum with ECU having been powered for three seconds minimum at fault detection.
- Short-to-Battery: Supply voltage is >105% of sensor voltage (5, 8 or 10 VDC) for two seconds minimum with ECU having been powered for three seconds minimum at fault detection.

Specifications:

Output Voltage: 5 VDC ±0.25 V

Output Current: 200 mA minimum

Output Short-Circuit Current: 250 mA maximum

Specifications:

Output Voltage: 8 VDC ±0.4 V

Output Current: 400 mA minimum

Output Short-Circuit Current: 450 mA maximum

Specifications:

Output Voltage: 10 VDC +1.0/–3.0 V

Output Current: 3 A minimum

Output Short-Circuit Current: 3.5 A maximum

General Ratings

Reverse Polarity Protection: Controller will withstand reverse polarity at supply voltage up to -16V for 12V nominal systems and up to -32V for 24V nominal systems.

Short-Circuit Protection: Inputs and outputs will withstand continuous short-circuit to all other leads including positive and negative terminals. When the short-circuit condition is ended, the controller will return to normal function.

Other Voltage Protection: Up to 30V for a 12V system and 80V for a 24V system for 2 minutes.

Automotive Electrical Transients —
Conformance to the Following Standards:
- ISO 7637; Road Vehicles: Electrical disturbance by conduction and Coupling.
- SAE J1113-11: Immunity to conducted transients on power leads.
- IEC 61000-4-4 2001-07: Immunity to electrical fast transient/burst
- IEC 61000-4-11: Voltage dips and interruptions

Note: for Controller Model ECU-MS, see pages 3.520.5–8

Technical Reference Information for Controller Models ECU-ML and ECU-MM

RATINGS (cont'd) / WIRING GUIDELINES / COMMUNICATIONS

EMC/EMI

Modules conform to 89/336/EEC Directive ISO 14982 for Agricultural and Forestry machinery

EMI Emission: Modules conform to the following standards:

Near Field Radiated Emissions: 150 KHz to 50 MHz; SAE J1113-41: Limits and methods of measurement of radio disturbance characteristics of components and modules for the protection of receivers used on board vehicles.

Near Field Radiated Emissions: 30 MHz to 1000 MHz: ISO 13766; Earth-Moving machinery; Electromagnetic compatibility.

Far Field Radiated Emissions: 30 MHz to 1000 MHz: CISPR 11:2003-03; Industrial, scientific and medical (ISM) radio frequency equipment; Electromagnetic disturbance characteristics; limits and methods of measurement.

Conducted Emissions: 150 KHz to 108 MHz: CISPR 25:2002-08; Radio disturbance characterisitcs for the protection of receivers used on board vehicles, boats, and on devices; limits and methods of measurement.

EMC Immunity: Conforms to the following standards:

SAE J1113-21: Electromagnetic compatibility measurement procedure for vehicle components; Part 21: Immunity to electromagnetic fields, 10 KHz to 18 GHz, absorber-lined chamber

IEC 61000-4-3 2002-03 Radiated Immunity 10V/M

IEC 61000-4-5 2001-04 Surge Immunity (Lightning 2KV)

IEC 61000-4-6 1996 Conducted RF Injection 150 KHz to 230 MHz

IEC61000-4-8 2001 Power Frequency Magnetic Field 30 Amps/Meter

SAE J1113-23 Electromagnetic compatibility measurement procedure for Vehicle Components; Part 23: Immunity to Electromagnetic Fields, 10 KHz to 200 MHz, Strip Line Method.

Electrostatic Discharge: Conforms to the following standards:

IEC 61000-4-2 Electromagnetic Compatibility (ECM); Part 4-2: Testing and Measurement Techniques; Electrostatic Discharge Immunity Test

SAE J1113-13 Electromagnetic Compatibility Measurement Procedure for Vehicle Components; Part 13: Immunity to Electrostatic Discharge

Machine Diagnostic Connector

HydraForce recommends that a diagnostic connector be installed on machines controlled by HydraForce electronic controllers. The connector should be located to be convenient and readily accessible by the machine operator.

Data communication between the controller and a personal computer is accomplished via the machine's CAN network. Teeing into the machine's CAN bus, the diagnostic connector should have the following connections: CAN+, CAN–, CAN-shield, Battery+, Battery.

Recommended Machine Wiring Guidelines

- Wherever possible, avoid running wires in hot areas. Where it is necessary to run wires in especially hot areas, use wire rated to 105°C. In general, wire rated to 85°C should always be used.
- Plastic or flexible metal conduit is recommended to help prevent mechanical damage to wires.
- To help shield wires from EMI/RFI radiation, where possible run the wires next to or inside of metal machine surfaces.
- 18 AWG wire is recommended.
- Keep wires supported along their length. Avoid wire harness anchors that hold the wires rigid. Allowing the wires to "float" is preferable.
- Use strain relief devices, and grommets for corner protection. Always protect wires from sharp metal parts and corners, and from moving or vibrating parts of the machine.
- Control wires and high-current-carrying wires should be separated from each other.
- Run sensor lines separately from digital and switching signals where possible. Twist sensor lines approximately one turn for every 10 mm (0.4 in.).
- For analog sensors, the ground wire should be connected to the sensor ground pin on the controller. Power to analog sensors should come from the controller's sensor power source.

USB/CAN Communicator

A USB/CAN connector allows the controller to exchange data with a PC. When connected to a PC, the controller functions as a USB slave; all electrical power is supplied by the PC; no other power source is required.

The USB/CAN connector has internal CAN bus terminating resistors which the user can control using the controller's Service and Diagnostic tool. Refer to the controller's software manual for setup information. Refer to the USB/CAN Connector product information sheet for specifications and connector pin details.

Note: for Controller Model ECU-MS, see pages 3.520.5–8

Blue rectangles are links to other catalog pages.

Electronic Control Units — Technical Reference

Technical Reference Information for Controller Model ECU-MS

PRODUCT OVERVIEW — INPUTS/OUTPUTS

User Liability and Safety — OEM Responsibility

Full responsibility for the safe and effective functioning of the equipment into which HydraForce electronic controls are installed is assumed by the OEM of the equipment. HydraForce assumes no responsibility for application performance, or for the consequences of improper application or equipment malfunction.

An emergency stop function should be included on all safety-critical systems to switch off the main power supply for the output signals of the machine's electronic control system. The main supply voltage should be designed to switch off immediately when unsafe conditions are encountered. A manual emergency stop switch should be clearly visible and easily accessed by the machine or vehicle operator.

Absolute Maximum Ratings

Operating Temperature: –40°C to 85°C
Storage Temperature: –50°C to 125°C
Supply Voltage: 9 to 32 VDC
Output Load Current per Channel: Up to 2 Amps
Total Output Current: 15 Amps

CAN (Controller Area Networks) Ports

All HydraForce machine controllers have CAN ports that conform to CAN 2.0b specifications, including CAN shield.

Module Supply Voltage / Maximum Current Rating

HydraForce machine controllers are designed to operate with a 9 to 32 VDC power supply, and are protected against reverse polarity. The voltage is internally monitored for Low/High Voltage and Load Dump. See individual product pages for maximum current ratings for specific models.

Input/Output Types and Specifications

HydraForce machine controllers include input and output pins for multiple I/O functions that are software-configurable by the OEM or the machine user. See individual product pages for details about each model's features and functions.

Inputs — General

The controllers' input pins support one or more of the following input types:

- Digital in: Switch to Ground and Battery
- Analog in: Voltage and Resistive
- Frequency in: Frequency and PWM

Communication — General

Model Dependent: CAN2.0

Key Switch Input

The key switch input allows the power to be turned On or Off manually. After the power is applied, the software will have control of all the inputs and outputs. The software can also disable the function of the key switch input.

- Provide a method of resetting the entire ECU.
- Provide software option for key switch override.
- Allows low battery drain (10 mA) when ECU is "asleep."
- Internal pull-down resistor is available for an external signal to turn off the key switch input.
- Input is protected from ESD and EMI.
- Key switch status is monitored by software.

Inputs — Digital

- Input voltage below minimum results in a non-damaging, non-latching reading saturated to the low limit.
- Input voltage above maximum results in a non-damaging, non-latching reading saturated to the high limit.

Switch-to-Ground Features

- Switch-to-ground inputs are normally pulled high to +10 VDC through 2KΩ resistor when they are floating.
- Inputs are protected from ESD, EMI and short to +Battery faults.
- Fast response times.

Specifications for Switch-to-Ground Inputs:
Short ckt current: 10 mA DC maximum
Maximum Resistance for On: 50Ω to Ground
Minimum Resistance for Off: 4KΩ to Ground
Non-Damaging Voltage Range: 0 to 32 VDC continuous

Switch to +Battery Features

- Switch to battery inputs will detect a signal of +Batt –2V through a series resistance of 50Ω.
- Inputs have an internal pull-down resistor
- All inputs are protected from ESD, EMI, transients and short-to-ground faults.

Specifications for Switch to +Battery Inputs:
Activation Resistance: 50Ω maximum to +Batt
De-Activation Resistance: 4KΩ minimum to +Batt
Non-Damaging Voltage Range: –32 to +32 VDC continuous

Note: for Controller Models ECU-ML and ECU-MM, see pages 3.520.1–4

Technical Reference Information for Controller Model ECU-MS

INPUTS/OUTPUTS (cont'd.)

Inputs — Analog Voltage

- Input can measure voltage of analog sensors and can also serve as a current source with an internal 16KΩ pull-up resistor to +10 VDC.
- Input-open reads as 10 VDC; input short reads as 0.2 VDC.
- Protection for Short to +Batt and ground as well as ESD and EMI, provided internally.

Specifications for Analog Inputs:

Input Voltage: 0.5 to 4.5 VDC
Input Accuracy: 2% Full Scale
Pull-Up Resistance: 16KΩ to +10 VDC
Analog to Digital Resolution: 5mV, 10 bits
Sampling Rate: 2 msec.

Inputs — Analog Resistive (Temperature)

- Resistive or analog sensor input.
- Internal protection for short-to-battery or ground.
- ESD and EMI protected.

Specifications for Resistive Sensor (Temperature) Inputs:

Working Range: 0 to 5 VDC
Pull-Up Resistance: 499Ω to +5 VDC
Analog to Digital Resolution: 5mV
Accuracy: 2.5%

Inputs — Frequency (Timing)

Frequency inputs can be logic-level pulse pickup units (Hall Effect), Variable Reluctance (VR), PWM duty-cycle or frequency-encoded sensors, or switch-to-ground.

Features for Variable Reluctance:

- Inputs are individually software-configurable as Passive (balanced) or Active (unbalanced) sensors.
- Adjacent input channels can be paired up as differential or single-ended to provide direction decoding.
- Diagnostic functions available through software configuration are maximum frequency and maximum period faults. Direction and fault counter diagnostics are also available.

Specifications for Variable Reluctance:

Input Impedence: 20KΩ ±10% input to input.
Input Measurable Limits: 0.55V to 120V p-p
Frequency Range: 0.1 to 10 KHz programmable
Frequency Accuracy: ±1% of actual
Non-Damaging Voltage Range: –0.7 to 32 VDC

Note: When using these inputs, best results will be obtained when a sensor is connected to the ECU with twisted shielded pair to reduce noise. The shield is then grounded to the –Battery pin on the ECU.

PWM Inputs:

These inputs allow an interface to active PWM and speed sensors. The inputs can be configured to measure both duty cycle and frequency.

Specifications for PWM Inputs:

Input Low Threshold: <1.0 VDC
Input High Threshold: >4.0 VDC
Input Pull Up Resistance: 2 kΩ to +5 VDC

Specifications for Frequency Inputs:

Frequency Range: 120 Hz to 1500 Hz
Frequency Accuracy: ±1%
Timing Resolution: 1 µsec.
Duty Cycle Range: 3% to 97%
Duty Cycle Accuracy: ±0.5%
Non-Damaging Voltage Range: –0.7 to 32 VDC

Outputs — General

HydraForce machine controllers include factory-programmable output circuits configured via software. The controllers' output pins support one or more of the following output types:

- Digital out: 2 Amp Hi/Lo Driver, Sinking
- PWM: 2-Wire, 2 Amp Drivers

Outputs — Digital

2 Amp Low Side Driver

- Protection Driver: Outputs will survive shorts to +Bat, –Bat through any impedance with no degradation in performance. If commanded ON, driver remains ON during 80V jump start and load dump unless current limit is exceeded during these events, in which case the driver is disabled and a short-to-battery diagnostic is reported. If driver protection feature disables driver during these events, the driver is allowed to retry within 10 ms.
- Diagnostics: Output fault detection reports short to battery or ground, as well as open circuits whether drivers are in ON or OFF state.

Specifications for 2 Amp Sinking Outputs:

Load Supply Voltage: 32 VDC maximum.
Load Current: 2 Amps
Leakage Current: 0.5 mA with Driver Off.
Transition Time: 100 µsec. maximum.

Note: for Controller Models ECU-ML and ECU-MM, see pages 3.520.1–4

Electronic Control Units — Technical Reference

Technical Reference Information for Controller Model ECU-MS

INPUTS/OUTPUTS (cont'd) / RATINGS

Outputs — PWM Hi/Lo Side

- Programmable control range of 50mA to 2A sourcing.
- Full-time diagnostics detect open or short to battery or ground; diagnostic limits for resistive, open circuit, leakage, or saturated driver faults.
- Software configurable for PWM, On/Off drivers, or Lamp drivers.
- One wire driver shares a common return with three other drivers.
- Two wire separate driver and return, both switch to avoid short to battery.

Specifications for PWM Outputs:

Output Current: Programmable from 0 to 2.0 Amps DC.

Controllable Current Range: 50mA to full scale.

Output Current Resolution: 1.5mA.

Output Voltage: +Battery –2.8 VDC minimum at maximum load.

Leakage Current: 100 µA maximum at driver off.

Switching Frequency: 1 KHz.

Dither Period: Programmable 4 mS to 500 mS in 2 mS increments.

Dither Amplitude: Programmable, 0 to 250 mA.

Current Accuracy: ±10%@25°C, ±15% Imax.

Frequency Response: 30 Hz or better.

Sensor Power Supply Ratings

Models that support sensor inputs include dedicated, regulated sensor power supplies and ground pins. See individual product pages for sensor power supply ratings.

Diagnostics:

- Software controlled diagnostic functions executed every 15 mS.
- Short-to-Ground: Supply voltage is <95% of sensor voltage (5, 8 or 10 VDC) for two seconds minimum with ECU having been powered for three seconds minimum at fault detection.
- Short-to-Battery: Supply voltage is >105% of sensor voltage (5, 8 or 10 VDC) for two seconds minimum with ECU having been powered for three seconds minimum at fault detection.

Specifications:

Output Voltage: 5 VDC ±0.25 V, or 8 VDC ±0.4 V

Output Current: 330 mA minimum

Output Short-Circuit Current: 360 mA maximum

General Ratings

Reverse Polarity Protection: Controller will withstand reverse polarity at supply voltage up to -16V for 12V nominal systems and up to -32V for 24V nominal systems.

Short-Circuit Protection: Inputs and outputs will withstand continuous short-circuit to all other leads including positive and negative terminals. When the short-circuit condition is ended, the controller will return to normal function.

Other Voltage Protection: Up to 30V for a 12V system and 80V for a 24V system for 2 minutes.

Automotive Electrical Transients — Conformance to the Following Standards:

- ISO 7637; Road Vehicles: Electrical disturbance by conduction and coupling.
- SAE J1113-11: Immunity to conducted transients on power leads.
- IEC 61000-4-4 2001-07: Immunity to electrical fast transient/burst
- IEC 61000-4-11: Voltage dips and interruptions

EMC/EMI

Modules conform to 89/336/EEC Directive ISO 14982 for Agricultural and Forestry machinery

EMI Emission: Modules conform to the following standards:

Near Field Radiated Emissions: 150 KHz to 50 MHz; SAE J1113-41: Limits and methods of measurement of radio disturbance characteristics of components and modules for the protection of receivers used on board vehicles.

Near Field Radiated Emissions: 30 MHz to 1000 MHz: ISO 13766; Earth-Moving machinery; Electromagnetic compatibility.

Far Field Radiated Emissions: 30 MHz to 1000 MHz: CISPR 11:2003-03; Industrial, scientific and medical (ISM) radio frequency equipment; Electromagnetic disturbance characteristics; limits and methods of measurement.

Conducted Emissions: 150 KHz to 108 MHz: CISPR 25:2002-08; Radio disturbance characterisitcs for the protection of receivers used on board vehicles, boats, and on devices; limits and methods of measurement.

EMC Immunity: Conforms to the following standards:

SAE J1113-21: Electromagnetic compatibility measurement procedure for vehicle components; Part 21: Immunity to electromagnetic fields, 10 KHz to 18 GHz, absorber-lined chamber

IEC 61000-4-3 2002-03 Radiated Immunity 10V/M

IEC 61000-4-5 2001-04 Surge Immunity (Lightning 2KV)

IEC 61000-4-6 1996 Conducted RF Injection 150 KHz to 230 MHz

IEC61000-4-8 2001 Power Frequency Magnetic Field 30 Amps/Meter

SAE J1113-23 Electromagnetic compatibility measurement procedure for Vehicle Components; Part 23: Immunity to Electromagnetic Fields, 10 KHz to 200 MHz, Strip Line Method.

Note: for Controller Models ECU-ML and ECU-MM, see pages 3.520.1–4

Technical Reference Information for Controller Model ECU-MS

RATINGS (cont'd) / WIRING GUIDELINES / COMMUNICATIONS

Electrostatic Discharge: Conforms to the following standards:

IEC 61000-4-2 Electromagnetic Compatibility (ECM); Part 4-2: Testing and Measurement Techniques; Electrostatic Discharge Immunity Test

SAE J1113-13 Electromagnetic Compatibility Measurement Procedure for Vehicle Components; Part 13: Immunity to Electrostatic Discharge

Machine Diagnostic Connector

HydraForce recommends that a diagnostic connector be installed on machines controlled by HydraForce electronic controllers. The connector should be located to be convenient and readily accessible by the machine operator.

Data communication between the controller and a personal computer is accomplished via the machine's CAN network. Teeing into the machine's CAN bus, the diagnostic connector should have the following connections: CAN+, CAN–, CAN-shield, Battery+, Battery.

Recommended Machine Wiring Guidelines

- Wherever possible, avoid running wires in hot areas. Where it is necessary to run wires in especially hot areas, use wire rated to 105°C. In general, wire rated to 85°C should always be used.
- Plastic or flexible metal conduit is recommended to help prevent mechanical damage to wires.
- To help shield wires from EMI/RFI radiation, where possible run the wires next to or inside of metal machine surfaces.
- 18 AWG wire is recommended.
- Keep wires supported along their length. Avoid wire harness anchors that hold the wires rigid. Allowing the wires to "float" is preferable.
- Use strain relief devices, and grommets for corner protection. Always protect wires from sharp metal parts and corners, and from moving or vibrating parts of the machine.
- Control wires and high-current-carrying wires should be separated from each other.
- Run sensor lines separately from digital and switching signals where possible. Twist sensor lines approximately one turn for every 10 mm (0.4 in.).
- For analog sensors, the ground wire should be connected to the sensor ground pin on the controller. Power to analog sensors should come from the controller's sensor power source.

USB/CAN Communicator

A USB/CAN connector allows the controller to exchange data with a PC. When connected to a PC, the controller functions as a USB slave; all electrical power is supplied by the PC; no other power source is required.

The USB/CAN connector has internal CAN bus terminating resistors which the user can control using the controller's Service and Diagnostic tool. Refer to the controller's software manual for setup information. Refer to the USB/CAN Connector product information sheet for specifications and connector pin details.

Note: for Controller Models ECU-ML and ECU-MM, see pages 3.520.1–4