



### MODEL 1236/1238



## DESCRIPTION

Curtis Models 1236 and 1238 provide advanced control of AC induction motors performing on-vehicle traction drive or hydraulic pump duties. They offer vehicle developers a highly cost-effective combination of power, performance and functionality.

## APPLICATION

Designed primarily for use on medium to large material handling vehicles such as counterbalance or warehouse trucks. The Model 1236 is equally suitable for Light-On-Road passenger vehicles and utility vehicles. The larger Model 1238 is also intended for use on all heavy-duty applications such as Tow Tractors and Airport Ground Support Equipment (GSE).

Patents Pending

### Only Curtis AC can offer:

- **Curtis VCL -Vehicle Control Language** is an easy to use programming language that allows vehicle developers to write powerful logic functions and create a 'virtual system controller'. Curtis offers customers VCL development tools and training. Curtis also provides a VCL service where Curtis engineers will work with the OEM to create any custom VCL code required.
- **Indirect Field Orientation (IFO) vector control** algorithm generates the maximum possible torque and efficiency across the entire speed range. Advanced Curtis IFO vector control provides superb drive 'feel', improved speed regulation and increased gradeability.
- **Curtis Auto-Tune** function enables quick and easy characterization of the AC motor without having to remove it from the vehicle. Curtis AC controllers are fully compatible with any brand of AC motor.
- **Dual-Drive functionality** is standard, allowing correct control of vehicles such as 3-wheel counterbalance trucks or other applications featuring twin traction motors. This function ensures smooth and safe operation, minimal tire wear and correct load sharing between the traction motors at all times.
- **Configurable CANbus** connection allows communication with other CANbus enabled devices. These models are CANopen compatible and can be further customized and configured using VCL.
- **Integrated System Controller** - More than just motor controllers, they are also powerful system controllers. They feature a comprehensive allocation of multi-function I/O pins for use as analog inputs, digital inputs, contactor coil drivers and proportional valve drivers. In addition to this local I/O, these controllers can use VCL to map and configure the remote I/O available on other CANbus devices, send messages to CAN displays and thus control and monitor the entire system.

## FEATURES

### Advanced functionality, compact power

- High frequency, silent operation across the 0-300Hz stator frequency range.
- Models available for 350-650A output at 24-80V system voltages. These are true 2 minute RMS ratings, not short duration 'boost' ratings.
- Powerful operating system allows parallel processing of vehicle control tasks, motor control tasks and user configurable programmable logic.
- Advanced Pulse Width Modulation techniques produce low motor harmonics, low torque ripple and minimized heating losses, resulting in high efficiency.

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## FEATURES continued

### Unmatched Flexibility

- Programmable for either traction or pump applications.
- Field upgradeable software.
- Integrated Battery state-of-charge algorithm and hour meter.
- Multi-Mode™ provides user-selectable vehicle operating profiles.
- Fully-featured generic software and VCL for typical Warehouse Truck applications is included.
- Comprehensive programming options and VCL allow other applications to be easily supported.
- Curtis hand-held or PC Windows programming tools provide easy programming and powerful system diagnostic tools.
- Integrated status LED provides instant diagnostic indication.

### Robust Safety and Reliability

- Insulated Metal Substrate power base provides superior heat transfer for increased reliability.
- Fail-Safe power component design.

- Redundant hardware watchdog timers.
- Reverse polarity protection on battery connections.
- Short circuit protection on all output drivers.
- Thermal cutback, warning, and automatic shutdown provide protection to motor and controller.
- Rugged sealed housing and connectors meet IP65 environmental sealing standards for use in harsh environments.

### Meets or complies with relevant US and International Regulations

EMC: Designed to the requirements of EN12895

Safety: Designed to the requirements of EN1175

IP65 Rated per IEC 529

UL recognized

Regulatory compliance of the complete vehicle system with the controller installed is the responsibility of the vehicle OEM.

## MODEL CHART

Model	Battery Voltage V	2 Min RMS Current Rating Arms (A)	2 Min RMS Power Rating (kVA)
1236-44XX	24-36	400	16.6
1236-45XX	24-36	500	20.9
1238-46XX	24-36	650	25.4
1236-53XX	36-48	350	19.7
1236-54XX	36-48	450	24.8
1238-54XX	36-48	450	25.5
1238-56XX	36-48	650	36.3
1236-63XX	48-80	300	28.1
1238-65XX	48-80	550	51.3

## SYSTEM ACCESSORIES



The Curtis Model 840 LCD Multifunction display contains 8 large, easy to read characters to provide display of battery discharge (BDI), hour meter and error messages. Built-in backlight is also available.



The Curtis model 1352 CANbus I/O expansion module features 9 I/O pins, including 6 proportional valve drivers. This module can be used to further expand the I/O capability of Curtis AC motor controllers using VCL.

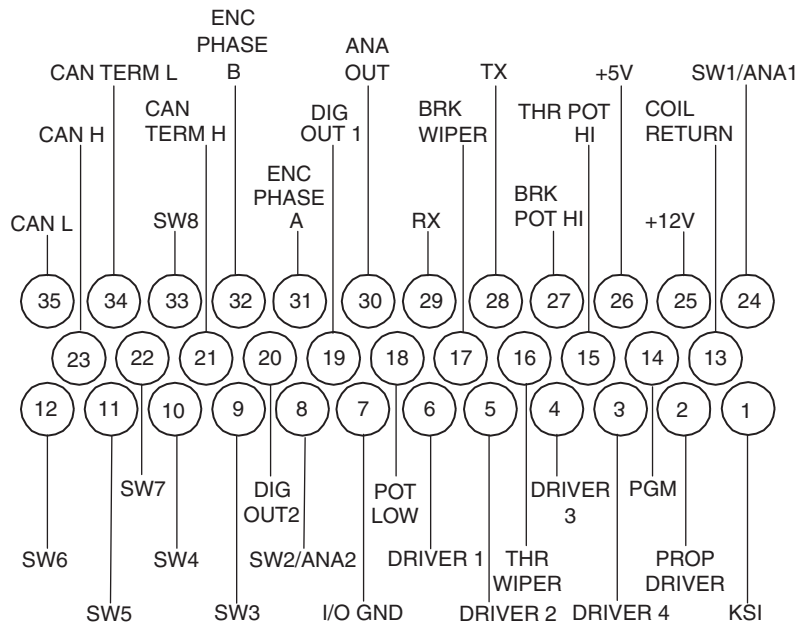


The Curtis Model 1311 Handheld Programmer is ideal for setting parameters and performing diagnostic functions.

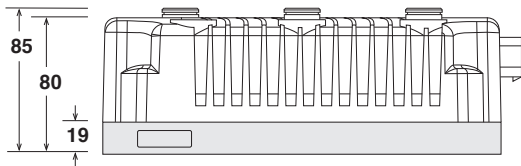
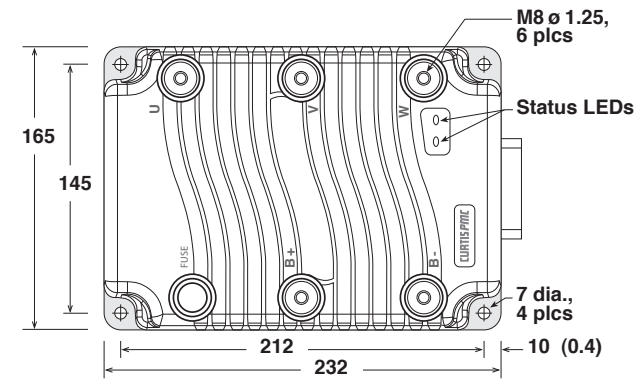
**Contact Curtis to obtain the VCL Vehicle Control Language compiler and development tools.**

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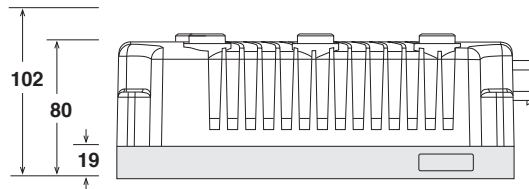
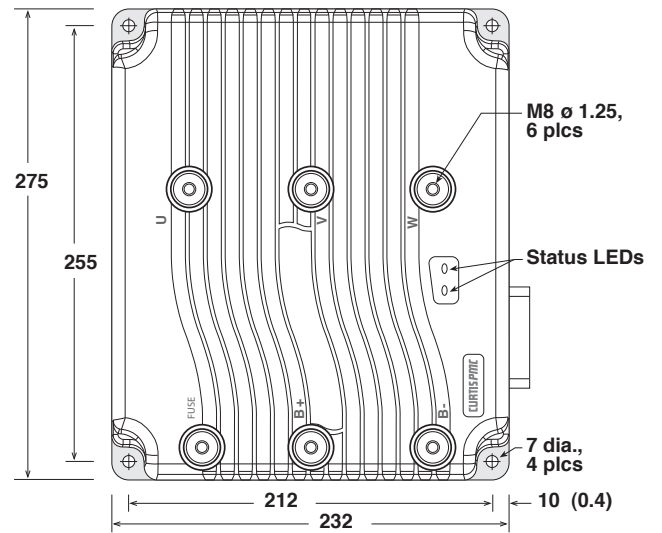
## CONNECTOR WIRING



## DIMENSIONS mm



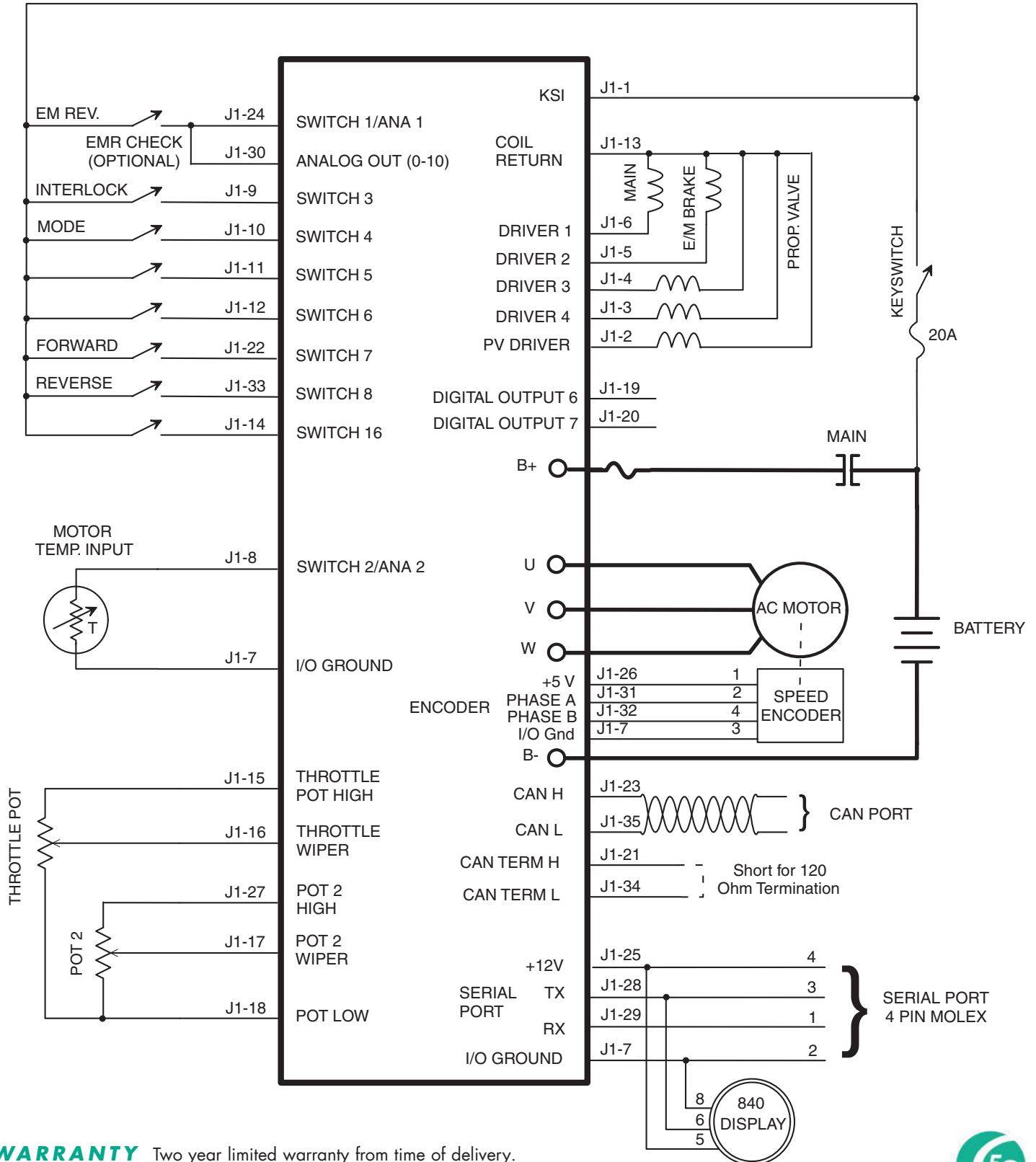
1236



1238

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## TYPICAL WIRING



**WARRANTY** Two year limited warranty from time of delivery.



Table 5 TROUBLESHOOTING CHART

CODE	PROGRAMMER LCD DISPLAY <i>EFFECT OF FAULT</i>	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
12	Controller Overcurrent <i>ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>External short of phase U,V, or W motor connections.</li> <li>Motor parameters are mis-tuned.</li> <li>Controller defective.</li> </ol>	<p><i>Set:</i> Phase current exceeded the current measurement limit.</p> <p><i>Clear:</i> Cycle KSI.</p>
13	Current Sensor Fault <i>ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>Leakage to vehicle frame from phase U, V, or W (short in motor stator).</li> <li>Controller defective.</li> </ol>	<p><i>Set:</i> Controller current sensors have invalid offset reading.</p> <p><i>Clear:</i> Cycle KSI.</p>
14	Precharge Failed <i>ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging.</li> <li>See 1311 menu Monitor » Battery: Capacitor Voltage.</li> </ol>	<p><i>Set:</i> Precharge failed to charge the capacitor bank to the KSI voltage.</p> <p><i>Clear:</i> Cycle Interlock input or use VCL function <i>Precharge()</i>.</p>
15	Controller Severe Undertemp <i>ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake; ShutdownThrottle; FullBrake.</i>	<ol style="list-style-type: none"> <li>Controller is operating in an extreme environment.</li> <li>See 1311 menu Monitor » Controller: Temperature.</li> </ol>	<p><i>Set:</i> Heatsink temperature below -40°C.</p> <p><i>Clear:</i> Bring heatsink temperature above -40°C, and cycle interlock or KSI.</p>
16	Controller Severe Overtemp <i>ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake; ShutdownThrottle; FullBrake.</i>	<ol style="list-style-type: none"> <li>Controller is operating in an extreme environment.</li> <li>Excessive load on vehicle.</li> <li>Improper mounting of controller.</li> <li>See 1311 menu Monitor » Controller: Temperature.</li> </ol>	<p><i>Set:</i> Heatsink temperature above +95°C.</p> <p><i>Clear:</i> Bring heatsink temperature below +95°C, and cycle interlock or KSI.</p>
17	Severe Undervoltage <i>Reduced drive torque.</i>	<ol style="list-style-type: none"> <li>Battery Menu parameters are misadjusted.</li> <li>Non-controller system drain on battery.</li> <li>Battery resistance too high.</li> <li>Battery disconnected while driving.</li> <li>See 1311 menu Monitor » Battery: Capacitor Voltage.</li> <li>Blown B+ fuse or main contactor did not close.</li> </ol>	<p><i>Set:</i> Capacitor bank voltage dropped below the Severe Undervoltage limit (see page 55) with FET bridge enabled.</p> <p><i>Clear:</i> Bring capacitor voltage above Severe Undervoltage limit.</p>
18	Severe Overvoltage <i>ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake; ShutdownThrottle; FullBrake.</i>	<ol style="list-style-type: none"> <li>Battery Menu parameters are misadjusted.</li> <li>Battery resistance too high for given regen current.</li> <li>Battery disconnected while regen braking.</li> <li>See 1311 menu Monitor » Battery: Capacitor Voltage.</li> </ol>	<p><i>Set:</i> Capacitor bank voltage exceeded the Severe Overvoltage limit (see page 55) with FET bridge enabled.</p> <p><i>Clear:</i> Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.</p>
21	Controller Undertemp Cutback <i>None, unless a fault action is programmed in VCL.</i>	<ol style="list-style-type: none"> <li>Controller is performance-limited at this temperature.</li> <li>Controller is operating in an extreme environment.</li> <li>See 1311 menu Monitor » Controller: Temperature.</li> </ol>	<p><i>Set:</i> Heatsink temperature dropped below -25°C.</p> <p><i>Clear:</i> Bring heatsink temperature above -25°C.</p>

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY <i>EFFECT OF FAULT</i>	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
22	Controller Overtemp Cutback <i>Reduced drive and brake torque.</i>	<ol style="list-style-type: none"> <li>1. Controller is performance-limited at this temperature.</li> <li>2. Controller is operating in an extreme environment.</li> <li>3. Excessive load on vehicle.</li> <li>4. Improper mounting of controller.</li> <li>5. See 1311 menu Monitor » Controller: Temperature.</li> </ol>	<p><i>Set:</i> Heatsink temperature exceeded 85°C. <i>Clear:</i> Bring heatsink temperature below 85°C.</p>
23	Undervoltage Cutback <i>Reduced drive torque.</i>	<ol style="list-style-type: none"> <li>1. Normal operation. Fault shows that the batteries need recharging. Controller is performance limited at this voltage.</li> <li>2. Battery parameters are misadjusted.</li> <li>3. Non-controller system drain on battery.</li> <li>4. Battery resistance too high.</li> <li>5. Battery disconnected while driving.</li> <li>6. See 1311 menu Monitor » Battery: Capacitor Voltage.</li> <li>7. Blown B+ fuse or main contactor did not close.</li> </ol>	<p><i>Set:</i> Capacitor bank voltage dropped below the Undervoltage limit (see page 55) with the FET bridge enabled. <i>Clear:</i> Bring capacitor voltage above the Undervoltage limit.</p>
24	Overvoltage Cutback <i>Reduced brake torque.</i>	<ol style="list-style-type: none"> <li>1. Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage.</li> <li>2. Battery parameters are misadjusted.</li> <li>3. Battery resistance too high for given regen current.</li> <li>4. Battery disconnected while regen braking.</li> <li>5. See 1311 menu Monitor » Battery: Capacitor Voltage.</li> </ol>	<p><i>Set:</i> Capacitor bank voltage exceeded the Overvoltage limit (see page 55) with the FET bridge enabled. <i>Clear:</i> Bring capacitor voltage below the Overvoltage limit.</p>
25	+5V Supply Failure <i>None, unless a fault action is programmed in VCL.</i>	<ol style="list-style-type: none"> <li>1. External load impedance on the +5V supply (pin 26) is too low.</li> <li>2. See 1311 menu Monitor » outputs: 5 Volts and Ext Supply Current.</li> </ol>	<p><i>Set:</i> +5V supply (pin 26) outside the +5V±10% range. <i>Clear:</i> Bring voltage within range.</p>
26	Digital Out 6 Overcurrent <i>Digital Output 6 driver will not turn on.</i>	<ol style="list-style-type: none"> <li>1. External load impedance on Digital Output 6 driver (pin 19) is too low.</li> </ol>	<p><i>Set:</i> Digital Output 6 (pin 19) current exceeded 15 mA. <i>Clear:</i> Remedy the overcurrent cause and use the VCL function <i>Set_DigOut()</i> to turn the driver on again.</p>
27	Digital Out 7 Overcurrent <i>Digital Output 7 driver will not turn on.</i>	<ol style="list-style-type: none"> <li>1. External load impedance on Digital Output 7 driver (pin 20) is too low.</li> </ol>	<p><i>Set:</i> Digital Output 7 (pin 20) current exceeded 15 mA. <i>Clear:</i> Remedy the overcurrent cause and use the VCL function <i>Set_DigOut()</i> to turn the driver on again.</p>



Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY <i>EFFECT OF FAULT</i>	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
28	Motor Temp Hot Cutback <i>Reduced drive torque.</i>	<ol style="list-style-type: none"> <li>1. Motor temperature is at or above the programmed Temperature Hot setting, and the requested current is being cut back.</li> <li>2. Motor Temperature Control Menu parameters are mis-tuned.</li> <li>3. See 1311 menus Monitor » Motor: Temperature and Monitor » Inputs: Analog2.</li> <li>4. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.</li> </ol>	<p><i>Set:</i> Motor temperature is at or above the Temperature Hot parameter setting.</p> <p><i>Clear:</i> Bring the motor temperature within range.</p>
29	Motor Temp Sensor Fault <i>MaxSpeed reduced (LOS, Limited Operating Strategy) and motor temperature cutback is disabled.</i>	<ol style="list-style-type: none"> <li>1. Motor thermistor is not connected properly.</li> <li>2. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.</li> <li>3. See 1311 menus Monitor » Motor: Temperature and Monitor » Inputs: Analog2.</li> </ol>	<p><i>Set:</i> Motor thermistor input (pin 8) is at the voltage rail (0 or 10V).</p> <p><i>Clear:</i> Bring the motor thermistor input voltage within range.</p>
31	Coil1 Driver Open/Short <i>ShutdownDriver1.</i>	<ol style="list-style-type: none"> <li>1. Open or short on driver load.</li> <li>2. Dirty connector pins.</li> <li>3. Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Driver 1 (pin 6) is either open or shorted.</p> <p><i>Clear:</i> Correct open or short, and cycle driver.</p>
31	Main Open/Short <i>ShutdownDriver1; ShutdownMotor; ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>1. Open or short on driver load.</li> <li>2. Dirty connector pins.</li> <li>3. Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Main contactor driver (pin 6) is either open or shorted.</p> <p><i>Clear:</i> Correct open or short, and cycle driver.</p>
32	Coil2 Driver Open/Short <i>ShutdownDriver2.</i>	<ol style="list-style-type: none"> <li>1. Open or short on driver load.</li> <li>2. Dirty connector pins.</li> <li>3. Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Driver 2 (pin 5) is either open or shorted.</p> <p><i>Clear:</i> Correct open or short, and cycle driver.</p>
32	EM Brake Open/Short <i>ShutdownDriver2; ShutdownThrottle; FullBrake.</i>	<ol style="list-style-type: none"> <li>1. Open or short on driver load.</li> <li>2. Dirty connector pins.</li> <li>3. Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Electromagnetic brake driver (pin 5) is either open or shorted.</p> <p><i>Clear:</i> Correct open or short, and cycle driver.</p>
33	Coil3 Driver Open/Short <i>ShutdownDriver3.</i>	<ol style="list-style-type: none"> <li>1. Open or short on driver load.</li> <li>2. Dirty connector pins.</li> <li>3. Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Driver 3 (pin 4) is either open or shorted.</p> <p><i>Clear:</i> Correct open or short, and cycle driver.</p>
34	Coil4 Driver Open/Short <i>ShutdownDriver4.</i>	<ol style="list-style-type: none"> <li>1. Open or short on driver load.</li> <li>2. Dirty connector pins.</li> <li>3. Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Driver 4 (pin 3) is either open or shorted.</p> <p><i>Clear:</i> Correct open or short, and cycle driver.</p>
35	PD Open/Short <i>ShutdownPD.</i>	<ol style="list-style-type: none"> <li>1. Open or short on driver load.</li> <li>2. Dirty connector pins.</li> <li>3. Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Proportional driver (pin 2) is either open or shorted.</p> <p><i>Clear:</i> Correct open or short, and cycle driver.</p>
36	Encoder Fault <i>Control Mode changed to LOS (Limited Operating Strategy).</i>	<ol style="list-style-type: none"> <li>1. Motor encoder failure.</li> <li>2. Bad crimps or faulty wiring.</li> <li>3. See 1311 menu Monitor » Motor: Motor RPM.</li> </ol>	<p><i>Set:</i> Motor encoder phase failure detected.</p> <p><i>Clear:</i> Cycle KSI.</p>

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY <i>EFFECT OF FAULT</i>	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
37	Motor Open <i>ShutdownMainContactor;</i> <i>ShutdownMotor;</i> <i>ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>1. Motor phase is open.</li> <li>2. Bad crimps or faulty wiring.</li> <li>3. Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Motor phase U, V, or W detected open.</p> <p><i>Clear:</i> Cycle KSI.</p>
38	Main Contactor Welded <i>ShutdownMainContactor;</i> <i>ShutdownMotor;</i> <i>ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>1. Main contactor tips are welded closed.</li> <li>2. Motor phase U is disconnected or open.</li> <li>3. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal).</li> </ol>	<p><i>Set:</i> Just prior to the main contactor closing, the capacitor bank voltage (B+ connection terminal) was loaded for a short time and the voltage did not discharge.</p> <p><i>Clear:</i> Cycle KSI</p>
39	Main Contactor Did Not Close <i>ShutdownMainContactor;</i> <i>ShutdownMotor;</i> <i>ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>1. Main contactor did not close.</li> <li>2. Main contactor tips are oxidized, burned, or not making good contact.</li> <li>3. External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging.</li> <li>4. Blown B+ fuse.</li> </ol>	<p><i>Set:</i> With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+.</p> <p><i>Clear:</i> Cycle KSI.</p>
41	Throttle Wiper High <i>ShutdownThrottle.</i>	<ol style="list-style-type: none"> <li>1. Throttle pot wiper voltage too high.</li> <li>2. See 1311 menu Monitor » Inputs: Throttle Pot.</li> </ol>	<p><i>Set:</i> Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function <i>Setup_Pot_Faults()</i>).</p> <p><i>Clear:</i> Bring throttle pot wiper voltage below the fault threshold.</p>
42	Throttle Wiper Low <i>ShutdownThrottle.</i>	<ol style="list-style-type: none"> <li>1. Throttle pot wiper voltage too low.</li> <li>2. See 1311 menu Monitor » Inputs: Throttle Pot.</li> </ol>	<p><i>Set:</i> Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function <i>Setup_Pot_Faults()</i>).</p> <p><i>Clear:</i> Bring throttle pot wiper voltage above the fault threshold.</p>
43	Brake Wiper High <i>FullBrake.</i>	<ol style="list-style-type: none"> <li>1. Brake pot wiper voltage too high.</li> <li>2. See 1311 menu Monitor » Inputs: Brake Pot.</li> </ol>	<p><i>Set:</i> Brake pot wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function <i>Setup_Pot_Faults()</i>).</p> <p><i>Clear:</i> Bring brake pot wiper voltage below the fault threshold.</p>
44	Brake Wiper Low <i>FullBrake.</i>	<ol style="list-style-type: none"> <li>1. Brake pot wiper voltage too low.</li> <li>2. See 1311 menu Monitor » Inputs: Brake Pot.</li> </ol>	<p><i>Set:</i> Brake pot wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function <i>Setup_Pot_Faults()</i>).</p> <p><i>Clear:</i> Bring brake pot wiper voltage above the fault threshold.</p>
45	Pot Low Overcurrent <i>ShutdownThrottle;</i> <i>FullBrake.</i>	<ol style="list-style-type: none"> <li>1. Combined pot resistance connected to pot low is too low.</li> <li>2. See 1311 menu Monitor » Outputs: Pot Low.</li> </ol>	<p><i>Set:</i> Pot low (pin 18) current exceeds 10mA.</p> <p><i>Clear:</i> Clear pot low overcurrent condition and cycle KSI.</p>



Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY <i>EFFECT OF FAULT</i>	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
46	EEPROM Failure <i>ShutdownMainContactor;</i> <i>ShutdownMotor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>ShutdownInterlock;</i> <i>ShutdownDriver1;</i> <i>ShutdownDriver2;</i> <i>ShutdownDriver3;</i> <i>ShutdownDriver4;</i> <i>ShutdownPD;</i> <i>FullBrake.</i>	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the 1311, or by loading new software into the controller.	<i>Set:</i> Controller operating system tried to write to EEPROM memory and failed. <i>Clear:</i> Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	HPD/Sequencing Fault <i>ShutdownThrottle.</i>	1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See 1311 menu Monitor » Inputs.	<i>Set:</i> HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. <i>Clear:</i> Reapply inputs in correct sequence.
47	Emer Rev HPD <i>ShutdownThrottle;</i> <i>ShutdownEMBrake.</i>	1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral.	<i>Set:</i> At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral. <i>Clear:</i> If EMR_Interlock = On, clear the interlock, throttle, and direction inputs. If EMR_Interlock = Off, clear the throttle and direction inputs.
49	Parameter Change Fault <i>ShutdownMainContactor;</i> <i>ShutdownMotor;</i> <i>ShutdownEMBrake.</i>	1. This is a safety fault caused by a change in certain 1311 parameter settings so that the vehicle will not operate until KSI is cycled. For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate.	<i>Set:</i> Adjustment of a parameter setting that requires cycling of KSI. <i>Clear:</i> Cycle KSI.
51–67	OEM Faults <i>(See OEM documentation.)</i>	1. These faults can be defined by the OEM and are implemented in the application-specific VCL code. See OEM documentation.	<i>Set:</i> See OEM documentation. <i>Clear:</i> See OEM documentation.
68	VCL Runtime Error <i>ShutdownMainContactor;</i> <i>ShutdownMotor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>ShutdownInterlock;</i> <i>ShutdownDriver1;</i> <i>ShutdownDriver2;</i> <i>ShutdownDriver3;</i> <i>ShutdownDriver4;</i> <i>ShutdownPD;</i> <i>FullBrake.</i>	1. VCL code encountered a runtime VCL error. 2. See 1311 menu Monitor » Controller: VCL Error Module and VCL Error. This error can then be compared to the runtime VCL module ID and error code definitions found in the specific OS system information file.	<i>Set:</i> Runtime VCL code error condition. <i>Clear:</i> Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY <i>EFFECT OF FAULT</i>	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
69	External Supply Out of Range <i>None, unless a fault action is programmed in VCL.</i>	<ol style="list-style-type: none"> <li>External load on the 5V and 12V supplies draws either too much or too little current.</li> <li>Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned.</li> <li>See 1311 menu Monitor » Outputs: Ext Supply Current.</li> </ol>	<p><i>Set:</i> The external supply current (combined current used by the 5V supply [pin 26] and 12V supply [pin 25]) is either greater than the upper current threshold or lower than the lower current threshold. The two thresholds are defined by the Ext Supply Max and Ext Supply Min parameter settings (page 52).</p> <p><i>Clear:</i> Bring the external supply current within range.</p>
71	OS General <i>ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake.</i>	<ol style="list-style-type: none"> <li>Internal controller fault.</li> </ol>	<p><i>Set:</i> Internal controller fault detected.</p> <p><i>Clear:</i> Cycle KSI.</p>
72	PDO Timeout <i>ShutdownInterlock; CAN NMT State set to Pre-operational.</i>	<ol style="list-style-type: none"> <li>Time between CAN PDO messages received exceeded the PDO Timeout Period.</li> </ol>	<p><i>Set:</i> Time between CAN PDO messages received exceeded the PDO Timeout Period.</p> <p><i>Clear:</i> Cycle KSI.</p>
73	Stall Detect <i>Control Mode changed to LOS (Limited Operating Strategy).</i>	<ol style="list-style-type: none"> <li>Stalled motor.</li> <li>Motor encoder failure.</li> <li>Bad crimps or faulty wiring.</li> <li>Problems with power supply for the motor encoder.</li> <li>See 1311 menu Monitor » Motor: Motor RPM.</li> </ol>	<p><i>Set:</i> No motor encoder movement detected.</p> <p><i>Clear:</i> Either cycle KSI, or detect valid motor encoder signals while operating in LOS mode and return Throttle Command = 0 and Motor RPM = 0.</p>
87	Motor Characterization Fault <i>ShutdownMainContactor; ShutdownThrottle; ShutdownEMBrake; ShutdownMotor.</i>	<ol style="list-style-type: none"> <li>Motor characterization failed because of an Overvoltage or Undervoltage fault, Motor Temperature Sensor fault, or Motor_Temperature &gt; 150°C during the characterization process.</li> </ol>	<p><i>Set:</i> Motor characterization failed during the motor characterization process.</p> <p><i>Clear:</i> Cycle KSI.</p>
88	Encoder Characterization Fault <i>ShutdownMainContactor; ShutdownThrottle; ShutdownEMBrake; ShutdownMotor Encoder_Steps set to value = 31.</i>	<ol style="list-style-type: none"> <li>Encoder characterization failed during the motor characterization process.</li> <li>Motor encoder pulse rate is not a standard value (32, 48, 64, 80 ppr).</li> </ol>	<p><i>Set:</i> During the motor characterization process, encoder pulses were detected but the Encoder_Steps were not detected as 32, 48, 64, or 80 ppr.</p> <p><i>Clear:</i> Manually set Encoder_Steps to the correct value for the motor encoder and cycle KSI.</p>

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY <i>EFFECT OF FAULT</i>	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
89	Motor Type Fault <i>ShutdownMainContactor;</i> <i>ShutdownThrottle;</i> <i>ShutdownEMBrake;</i> <i>ShutdownMotor.</i>	1. The Motor_Type parameter value is out of range.	<i>Set:</i> Motor_Type parameter is set to an illegal value. <i>Clear:</i> Set Motor_Type to correct value and cycle KSI.
92	EM Brake Failed to Set <i>Enter Position Hold.</i>	1. Vehicle movement sensed after the EM Brake has been commanded to set. 2. EM Brake will not hold the motor from rotating.	<i>Set:</i> After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. <i>Clear:</i> Activate the throttle.
93	Limited Operating Strategy (LOS) <i>Enter LOS control mode.</i>	1. Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detect Fault (Code 73). 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Vehicle is stalled.	<i>Set:</i> Encoder Fault (Code 36) or Stall Detect Fault (Code 73) was activated, and Brake or Interlock has been applied to activate LOS control mode, allowing limited motor control. <i>Clear:</i> Cycle KSI, <b>or</b> if the LOS mode was activated by the Stall Fault, clear LOS by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.
94	Emer Rev Timeout <i>ShutdownThrottle;</i> <i>ShutdownEMBrake.</i>	1. Emergency Reverse was activated and concluded because the EMR Timeout timer has expired. 2. The emergency reverse input is stuck On.	<i>Set:</i> Emergency Reverse was activated and ran until the EMR Timeout timer expired. <i>Clear:</i> Turn the emergency reverse input Off.