

## 2.2 *libToolController Error codes and exceptions*

The error codes detailed in below sections are generated by the firmware application and libToolController. Note: these error codes at libToolController level are slightly different from the error codes defined in TCU firmware. Here is the list of all errors:

0. BAD\_INPUT\_ARGUMENT
1. BAD\_LIBRARY\_USE
2. BAD\_CONFIGURATION\_FILE
3. BAD\_CHECKSUM\_CONFIGURATION\_FILE
4. UNEXPECTED\_LIBRARY\_ERROR
5. UNEXPECTED\_FIRMWARE\_ERROR
6. ILLEGAL\_CONTROLLER\_STATE\_TRANSITION
7. NETWORK\_TIMEOUT
8. BAD\_NETWORK\_CHECKSUM
9. BAD\_NETWORK\_SOCKET
10. BAD\_NETWORK\_FORMAT
11. BAD\_NETWORK\_SYNC
12. BOARD\_SUPPLY\_UNDERVOLTAGE
13. BOARD\_SUPPLY\_OVERVOLTAGE
14. DRILL\_DRIVER\_FAULT
15. EXPOSURE\_DRIVER\_FAULT
16. DRILL\_CURRENT\_SENSE\_ERROR
17. EXPOSURE\_CURRENT\_SENSE\_ERROR
18. DRILL\_COMMUNICATION\_DRIVER\_ERROR
19. MCU\_SYSTEM\_ERROR
20. DRILL\_DRIVER\_OVERHEAT
21. DRILL\_DRIVER\_OVERCURRENT
22. EXPOSURE\_DRIVER\_OVERHEAT
23. TOOL\_OVERHEAT
24. EXPOSURE\_MOTOR\_STALL
25. DRILL\_MOTOR\_STALL
26. TOOL\_DISCONNECTED
27. TOOL\_IDENTIFICATION\_FAILURE
28. TOOL\_NOT\_SUPPORTED
29. TOOL\_HOMING\_FAILURE
30. BAD\_EXPOSURE\_SENSOR\_SUPPLY
31. BAD\_EXPOSURE\_POSITION\_SENSOR
32. BAD\_EXPOSURE\_SENSOR\_COMBINATION
33. EXPOSURE\_POSITION\_OUT\_OF\_RANGE
34. EXPOSURE\_MOTOR\_INDEXING\_FAILURE
35. BAD\_TOOL\_TEMPERATURE\_SENSOR
36. TOOL\_PROGRAMMING\_FAILURE
37. BAD\_FOOT\_CONTROL\_SUPPLY
38. FOOT\_CONTROL\_DISCONNECTED
39. BAD\_SPEED\_CONTROL\_PEDAL
40. NETWORK\_WATCHDOG\_TIMEOUT
41. NO\_TOOL\_CONTROLLER\_ERROR

### Tool controller network exceptions

Error code	<code>errorRegisterBits_t::networkTimeout</code>
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<b>Exception</b>	<b>ToolControllerNetworkException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>For every communication to the Tool control Unit.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Ethernet cable disconnected.</li> <li>Lock up of the Tool Control Unit firmware.</li> <li>Tool Control Unit is down or reset</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>Tool Control Unit remains in current state.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Verify hardware connection to the Tool Control Unit.</li> </ul>

<b>Error code</b>	<b>errorRegisterBits_t::badNetworkChecksum</b>
<b>Exception</b>	<b>ToolControllerNetworkException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>For every communication to the Tool Control Unit.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>RAM data corruption in transmission / reception buffers.</li> <li>Data packet corrupted during the transfer</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>Communication received / transmitted is rejected.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Verify hardware connection to the Tool Control Unit.</li> </ul>

<b>Error code</b>	<b>errorRegisterBits_t::badNetworkFormat</b>
<b>Exception</b>	<b>ToolControllerNetworkException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>For every communication to the Tool Control Unit.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>RAM data corruption in transmission / reception buffers.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>Data packet corrupted during the preparation of the transmission / reception of the packet.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Verify hardware connection to the Tool Control Unit.</li> </ul>

<b>Error code</b>	<b>errorRegisterBits_t::badNetworkSync</b>
<b>Exception</b>	<b>ToolControllerNetworkException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Transmission/Reception pairing verification on every communication to the Tool Controller Unit. Transmissions and receptions are paired with a counter ID.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Communication packet lost in reception/transmission buffer.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>Exception thrown, communication retry.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Verify software memory stack of transmission / reception buffers.</li> </ul>

### 1.1.1 Tool controller usage exceptions

<b>Error code</b>	<b>errorRegisterBits_t::badInputArgument</b>
<b>Exception</b>	<b>ToolControllerUsageException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>On API calls using a function argument with boundary conditions.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Bug in host application / library.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>Return exception on call.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Check for boundary condition on variable.</li> </ul>

<b>Error code</b>	<b>errorRegisterBits_t::badLibraryUse</b>
<b>Exception</b>	<b>ToolControllerUsageException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>On API calls requiring subsequent API call (for instance OpenDevice need to be called first)</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Bug in host application / library</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>Return exception on function call</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Check host application workflow.</li> </ul>

<b>Error code</b>	<b>errorRegisterBits_t::badConfigurationFile</b>
<b>Exception</b>	<b>ToolControllerUsageException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>When opening the object dictionary.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>The format of the object dictionary file is corrupted.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>Return exception on function call.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Check object dictionary file.</li> </ul>

<b>Error code</b>	<code>errorRegisterBits_t::badChecksumConfigurationFile</code>
<b>Exception</b>	<code>ToolControllerUsageException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>When opening the object dictionary.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>The object dictionary file was modified after checksum generation. Checksum was not generated correctly.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>Return exception when opening object dictionary.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Check object dictionary checksum.</li> </ul>

## 1.1.2 Tool controller device exceptions

Table 1 Drill driver fault

<b>Error code</b>	<code>errorRegisterBits_t::drillDriverFault</code>
<b>Exception</b>	<code>ToolControllerDeviceException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Power-up and periodically</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Motor is not properly wired,</li> <li>Motor is damaged,</li> <li>Tool cable is damaged,</li> <li>MOSFETs or other driver components are damaged</li> <li>Incorrect PID controller settings</li> <li>See section related to drill driver failure for further diagnostic.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill driver: external FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure driver: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Consult drill driver register to know root cause.</li> <li>Repair board.</li> <li>Clear FAULT status.</li> </ul>

Table 2 Exposure driver fault

<b>Error code</b>	<code>errorRegisterBits_t::exposureDriverFault</code>
<b>Exception</b>	<code>ToolControllerDeviceException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Power up and periodically</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Motor is not properly wired</li> <li>Motor is damaged</li> <li>Tool cable is damaged</li> <li>MOSFETs or other driver components are damaged</li> <li>Incorrect PID controller settings</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Clear FAULT status.</li> </ul>

Table 3 Drill supply over-voltage

<b>Error code</b>	<code>errorRegisterBits_t::boardSupplyOvervoltage</code>
<b>Exception</b>	<code>ToolControllerDeviceException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Power-up, periodically,</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>The voltage supply of the drill is too high ( &gt; 105% of nominal voltage).</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Hardware repair / replacement.</li> </ul>

Table 4 Drill supply under-voltage

<b>Error code</b>	<code>errorRegisterBits_t::boardSupplyUndervoltage</code>
<b>Exception</b>	<code>ToolControllerDeviceException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Power-up, periodically,</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>The voltage supply of the drill is too low ( &lt; 95% of nominal</li> </ul>

Document for the CORI Tool control exceptions.

	voltage).
<b>Effect</b>	<ul style="list-style-type: none"><li>• MCU transits to FAULT state.</li><li>• Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li><li>• Exposure: driver FETs Hi-Z.</li></ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"><li>• Hardware repair / replacement.</li></ul>

Table 5 Tool communication failure

<b>Error code</b>	<b>errorRegisterBits_t::toolCommunicationFailure</b>
<b>Exception</b>	<b>ToolControllerToolException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>At tool connection and for every communication.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>See Section related to tool info.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Tool repair / replacement.</li> </ul>

Table 6 Drill current sensing circuitry failure

<b>Error code</b>	<b>errorRegisterBits_t::drillCurrentSenseFailure</b>
<b>Exception</b>	<b>ToolControllerDeviceException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>At tool homing during homing</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Current sensing circuitry is damaged.</li> <li>Tool is damaged.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Hardware repair / replacement.</li> </ul>

Table 7 Exposure current sensing circuitry failure

<b>Error code</b>	<b>errorRegisterBits_t::exposureCurrentSenseFailure</b>
<b>Exception</b>	<b>ToolControllerDeviceException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>At tool homing</li> <li>Trigger this error by shorting TP20 or TP21 to 3.3V during homing</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Current sensing circuitry is damaged.</li> <li>Tool is damaged.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Hardware repair / replacement.</li> </ul>

Table 8 Tool disconnected

<b>Error code</b>	<b>errorRegisterBits_t::toolDisconnected</b>
<b>Exception</b>	<b>ToolControllerToolException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>When tool is homed or powered</li> <li>Trigger this error by unplugging the handpiece during bur loading or calibration.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Tool connection assertion failed.</li> <li>Intermittent connection in handpiece cable</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Hardware repair / replacement.</li> </ul>

Table 9 Tool homing failure

<b>Error code</b>	<b>errorRegisterBits_t::toolHomingFailure</b>
<b>Exception</b>	<b>ToolControllerToolException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>In homing state</li> <li>Trigger this error by not allowing the bur to move to rear or front hard stop.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Tool damaged</li> <li>Anomalies with exposure system</li> <li>Error detected during homing</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>

<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Hardware repair / replacement.</li> </ul>
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Table 10 Illegal state machine transition

<b>Error code</b>	<code>errorRegisterBits_t::illegalStateMachineTransition</code>
<b>Exception</b>	<code>ToolControllerDeviceException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>On state transition, triggered by user Host computer</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Host computer do not follow state machine flow.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Recovery</b>	<ul style="list-style-type: none"> <li>Clear FAULT state.</li> </ul>

Table 11 Drill driver communication failure

<b>Error code</b>	<code>errorRegisterBits_t::drillDriverCommunicationFailure</code>
<b>Exception</b>	<code>ToolControllerDeviceException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Periodically, when tool powered</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Motor driver chip pins not soldered well or shorted by something</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Hardware repair / replacement</li> </ul>

Table 12 Unexpected firmware error

<b>Error code</b>	<code>errorRegister_t::unexpectedFirmwareError</code>
<b>Exception</b>	<code>ToolControllerDeviceException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Firmware execution failure</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Unexpected bug in firmware code.</li> <li>EEPROM reading errors</li> <li>Incorrect EEPROM motor settings</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Firmware debug</li> </ul>

Table 13 Microcontroller system failure

<b>Error code</b>	<code>errorRegister_t::mcuSystemFailure</code>
<b>Exception</b>	<code>ToolControllerDeviceException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>System error that can be triggered because of unexpected hardware failure.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Bad hardware</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Hardware repair / replacement</li> </ul>

### 1.1.3 Tool controller tool exceptions

Table 14 Drill motor stall

<b>Error code</b>	<code>errorRegisterBits_t::drillMotorStall</code>
<b>Exception</b>	<code>ToolControllerToolException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Periodically, when tool powered</li> <li>Drill motor needs restart over 12 times in 5 seconds to trigger this error</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>The motor stalls because the torque applied on the drill is too high for a prolonged time.</li> <li>The motor rotor is jammed.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> </ul>

	<ul style="list-style-type: none"> <li>• Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>• Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>• Check drill can spin freely</li> <li>• Clear FAULT status.</li> <li>• Release pedal.</li> </ul>

Table 15 Exposure motor stall

<b>Error code</b>	<b>errorRegisterBits_t::exposureMotorStall</b>
<b>Exception</b>	<b>ToolControllerToolException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>• Periodically, when tool powered</li> <li>• Trigger this error by commanding the bur move to position it cannot reach physically( -5mm, or 21mm or using a fixture to block the bur)</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>• The motor stalls because the torque applied on the drill is too high for a prolonged time.</li> <li>• The motor rotor is jammed.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>• MCU transits to FAULT state.</li> <li>• Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>• Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>• Check drill can spin freely</li> <li>• Clear FAULT state.</li> <li>• Hardware repair / replacement.</li> </ul>

Table 16 Tool Exposure Indexing failure

<b>Error code</b>	<b>errorRegisterBits_t::motorIndexingFailure</b>
<b>Exception</b>	<b>ToolControllerToolException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>• Power-up, periodically,</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>• The voltage supply of the drill is too high ( &gt; 105% of nominal voltage)</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>• MCU transits to FAULT state.</li> <li>• The motors are disabled.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>• Hardware repair / replacement.</li> </ul>

Table 17 Tool overheat

<b>Error code</b>	<b>errorRegisterBits_t::toolOverheat</b>
<b>Exception</b>	<b>ToolControllerToolException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>• Power-up, periodically when tool connected</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>• The tool motors produce too much heat.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>• MCU transits to FAULT state.</li> <li>• The motors are disabled.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>• Tool repair / replacement.</li> </ul>

Table 18 Tool temperature sensor failure

<b>Error code</b>	<b>errorRegisterBits_t::toolTempSensorFailure</b>
<b>Exception</b>	<b>ToolControllerToolException</b>
<b>Verification</b>	<ul style="list-style-type: none"> <li>• Power-up, periodically when tool connected.</li> <li>• Trigger this error by shorting pin #9 and #10 of connector J7 on TCU board</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>• The tool temperature sensor is damaged.</li> <li>• The tool cable is damaged</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>• MCU transits to FAULT state.</li> <li>• Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>• Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>• Hardware repair / replacement.</li> </ul>

Table 19 Quadrature encoder failure

<b>Error code</b>	<b>errorRegisterBits_t::exposureBadPositionSensor</b>
<b>Exception</b>	<b>ToolControllerToolException</b>

<b>Verification</b>	<ul style="list-style-type: none"> <li>Periodically, when tool connected</li> <li>Trigger this error by shorting TCU board TP68, or TP70 or TP73 to GND</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>The position sensor is damaged</li> <li>Tool cable is damaged.</li> <li>Quadrature encoder is not powered</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Tool repair.</li> </ul>

Table 20 Hall sensor failure

<b>Error code</b>	<code>errorRegisterBits_t::exposureBadSensorCombination</code>
<b>Exception</b>	<code>ToolControllerToolException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Periodically, when tool connected</li> <li>Feature not implemented</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>The position sensor is damaged</li> <li>Tool cable is damaged.</li> <li>Hall sensor is not powered.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>MCU transits to FAULT state.</li> <li>Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li> <li>Exposure: driver FETs Hi-Z.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Tool repair</li> </ul>

## 1.1.4 Tool controller pedal exceptions

Table 21

<b>Error code</b>	<code>errorRegisterBits_t::badFootControlSupply</code>
<b>Exception</b>	<code>ToolControllerPedalException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Periodically.</li> <li>Trigger this error by shorting TCU board the joint of R131 and R132 to isolated ground ISO_GND</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Short circuit on the foot control supply resulting in opening of the fuse.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>The foot control is not powered (the drill pedal is not functional)</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Replace foot control, check for PTC fuse on the 24V of the foot control.</li> </ul>

Table 22

<b>Error code</b>	<code>errorRegisterBits_t::footControlDisconnected</code>
<b>Exception</b>	<code>ToolControllerPedalException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Periodically.</li> <li>Not implemented in existing code.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>The foot control gets disconnected while in OPERATING state.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>The Tool Control Unit goes to the Safe State.</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Check foot control hardware connection.</li> </ul>

Table 23

<b>Error code</b>	<code>errorRegisterBits_t::badSpeedControlPedal</code>
<b>Exception</b>	<code>ToolControllerPedalException</code>
<b>Verification</b>	<ul style="list-style-type: none"> <li>Periodically.</li> <li>Trigger this error by applying 14VDC on TCU board test point TP55.</li> </ul>
<b>Possible causes</b>	<ul style="list-style-type: none"> <li>Foot drill control pedal voltage is outside of expected boundary range. Maybe due to short circuit condition on the foot control or foot control internal failure.</li> </ul>
<b>Effect</b>	<ul style="list-style-type: none"> <li>The Tool Control Unit goes to Safe State</li> </ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"> <li>Verify / replace hardware.</li> </ul>



## 1.1.5 Tool controller watchdog exceptions

Table 24 Communication watchdog timeout

<b>Error code</b>	<code>errorRegisterBits_t::commWatchdogTimeout</code>
<b>Exception</b>	<code>ToolControllerWatchdogException</code>
<b>Verification</b>	<ul style="list-style-type: none"><li>• When state machine is in OPERATE state.</li></ul>
<b>Possible causes</b>	<ul style="list-style-type: none"><li>• Host Computer is too slow or not responsive.</li></ul>
<b>Effect</b>	<ul style="list-style-type: none"><li>• MCU transits to FAULT state.</li><li>• Drill: External FETs Hi-Z; Weak pulldown of all gate driver output.</li><li>• Exposure: driver FETs Hi-Z.</li></ul>
<b>Troubleshooting</b>	<ul style="list-style-type: none"><li>• Hardware repair / replacement.</li></ul>