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## Chapter 6

### Diagnostics And Fault Finding

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## Chapter 6 Diagnostics And Fault Finding

### INTRODUCTION

The 620 Vector Drives provide comprehensive diagnostic, alarm and trip facilities. These facilities minimise the possibility of damage to the drive, motor and associated components under unusual or fault conditions. The diagnostics and alarm information, available at the MMI display, enable ready identification of conditions. In the event that a fault is traced to the drive, the drive should be returned to the manufacturer - no corrective maintenance should be attempted.

### DIAGNOSTICS

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.....DIAGNOSTICS
.....TOTAL SPD.DMD.    [6 ] =      0.00 %
h.....SPEED FB UNFIL   [7 ] =      0.00 %
.....SPEED FEEDBACK    [11 ] =      0.00 %
.....SPEED ERROR       [8 ] =      0.00 %
.....TORQUE DEMAND      [9 ] =      0.00 %
.....TORQUE FEEDBACK    [10 ] =      0.00 %
.....CURRENT FEEDBACK   [78 ] =      0.00 %
f.....TERMINAL VOLTS    [480] =        0 VOLTS
f.....DC LINK VOLTS     [613] =      597 VOLTS
f.....TERM V INTEGRAL   [623] =     100.00 %
.....ACTUAL POS I LIM    [13 ] =      0.00 %
.....ACTUAL NEG I LIM    [14 ] =      0.00 %
.....INVERSE TIME O/P   [15 ] =      0.00 %
.....AT CURRENT LIMIT   [16 ] = FALSE
.....AT ZERO SPEED      [17 ] = TRUE
.....AT ZERO SETPOINT    [18 ] = TRUE
.....AT STANDSTILL      [19 ] = TRUE
.....STALL TRIP         [20 ] = OK
.....RAMPING            [21 ] = FALSE
.....DRIVE START        [23 ] = FALSE
.....DRIVE ENABLE       [24 ] = FALSE
.....OPERATING MODE     [25 ] = STOPPED
.....HEALTHY            [27 ] = TRUE
.....HEALTH OUTPUT      [12 ] = TRUE
.....READY              [559] = FALSE
.....RUN                [28 ] = FALSE
f.....CO-PRO PRESENT    [150] = TRUE
.....ANIN 1 (C3)        [29 ] =      7.453 VOLTS
.....ANIN 3 (F2)        [31 ] =      0.002 VOLTS
.....ANIN 4 (F3)        [32 ] =      0.002 VOLTS
.....ANIN 5 (F4)        [33 ] =      0.003 VOLTS
.....ANOUT 1 (C5)       [34 ] =      0.000 VOLTS
.....ANOUT 2 (F5)       [35 ] =      0.000 VOLTS
.....COAST STOP         [26 ] = TRUE
.....PROGRAM STOP       [22 ] = TRUE
.....DIGIN B6 START     [37 ] = FALSE
.....DIGIN B7 JOG       [36 ] = FALSE
.....DIGIN B8 ENABLE    [38 ] = TRUE
.....DIGIN 1 (E2)       [39 ] = FALSE
.....DIGIN 2 (E3)       [40 ] = FALSE
.....DIGIN 3 (E4)       [41 ] = FALSE
.....DIGIN 4 (E5)       [521] = FALSE
.....DIGOUT 1 (E6)      [42 ] = TRUE
.....DIGOUT 2 (E7)      [43 ] = TRUE
.....DIGOUT 3 (E8)      [44 ] = FALSE
.....RAISE/LOWER O/P    [45 ] =      0.00 %
.....SPT SUM O/P 1      [46 ] =      74.61 %
.....SPT SUM O/P 2      [385] =      74.65 %
.....SPT SUM O/P 3      [386] =      0.00 %
.....RAMP OUTPUT        [47 ] =      74.65 %

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.....PRESET O/P      [110] =      0.00 %
.....SPEED SETPOINT   [48 ] =      74.66 %
f.....SEQ RUN INPUT   [49 ] =      74.63 %
f.....SEQ OUTPUT      [50 ] =      0.00 %
.....ENCODER          [51 ] =      0 RPM

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The Diagnostics menu allows the user to monitor the operation of the drive. Diagnostics that can be monitored are described in the following paragraphs. These diagnostics are read-only.

<b>TOTAL SPD.DMD.</b>	Speed loop total setpoint after the ramp-to-zero block.
<b>SPEED FB UNFIL</b>	Raw speed feedback, usually used for analog outputs.
<b>SPEED FEEDBACK</b>	Speed loop feedback.
<b>SPEED ERROR</b>	Speed loop error.
<b>TORQUE DEMAND</b>	Current loop demand (speed error PI output or external current demand clamped by all the current limits).
<b>TORQUE FEEDBACK</b>	Scaled and filtered torque.
<b>CURRENT FEEDBACK</b>	Scaled and filtered current.
<b>TERMINAL VOLTS</b>	Scaled motor output volts.
<b>DC LINK VOLTS</b>	DC link volts.
<b>TERM V INTEGRAL</b>	Output out motor volts compensation loop..
<b>ACTUAL POS I LIM</b>	Overall positive current limit value.
<b>ACTUAL NEG I LIM</b>	Overall negative current limit value.
<b>INVERSE TIME O/P</b>	Inverse time clamp output level.
<b>AT CURRENT LIMIT</b>	Current demand is being restrained by the overall current limit.
<b>AT ZERO SPEED</b>	At zero speed feedback.
<b>AT ZERO SETPOINT</b>	At zero speed demand.
<b>AT STANDSTILL</b>	"AT ZERO SPEED" and "AT ZERO SETPOINT".
<b>STALL TRIP</b>	Armature current is above "STALL THRESHOLD" and "AT ZERO SPEED" but not "AT ZERO SETPOINT".
<b>RAMPING</b>	If the difference between the ramp input and the ramp output is greater than the "RAMP THRESHOLD", then "RAMPING" is TRUE.
<b>DRIVE START</b>	Controller start / run command .
<b>DRIVE ENABLE</b>	Drive speed and current loop are enabled / quenched.
<b>OPERATING MODE</b>	Indicates whether the drive is in RUN, JOG 1....STOP etc.
<b>HEALTHY</b>	
<b>HEALTH OUTPUT</b>	
<b>READY</b>	

**RUN**

<b>CO-PRO PRESENT</b>	Indicates that there is a co-processor fitted and working normally, only applicable to the 620L and 620Adv.
<b>ANIN 1 (C3)</b>	Diagnostic displaying the current state of the analog input 1 (C3), by default this is connected to Speed setpoint no. 1.*
<b>ANIN 2 (C4)</b>	Diagnostic displaying the current state of the analog input 2 (C4), by default this is connected to Direct speed setpoint no. 2 / current demand.
<b>ANIN 3 (F2)</b>	Diagnostic displaying the current state of the analog input 3 (F2), by default this is connected to Speed setpoint no. 3 (ramped).*
<b>ANIN 4 (F3)</b>	Diagnostic displaying the current state of the analog input 4 (F3), by default this is unconnected.
<b>ANIN 5 (F4)</b>	Diagnostic displaying the current state of the analog input 5 (F4), by default this is unconnected.
<b>ANOUT 1 (C5)</b>	Diagnostic displaying the current state of the analog output 1 (C5), by default this is connected to Speed feedback.*
<b>ANOUT 2 (F5)</b>	Diagnostic displaying the current state of the analog output 2 (F5), by default this is connected to Torque demand. *
<b>COAST STOP</b>	
<b>PROGRAM STOP</b>	State of program stop (terminal B8). When B8 is at 24V then " <b>PROGRAM STOP</b> " is <b>FALSE</b>
<b>START (B7)</b>	Diagnostic displaying the current state of the start input 2 (B7), by default this is connected to Start terminal.
<b>JOG INPUT (B6)</b>	Diagnostic displaying the current state of the Jog input 2 (B6), by default this is connected to Jog Input terminal.
<b>ENABLE (B8)</b>	Diagnostic displaying the current state of the Enable input (B8), by default this is connected an Electronic Enable (ON = Enabled).
<b>DIGIN 1 (E2)</b>	Diagnostic displaying the current state of the digital input 1 (E2), by default this is connected to Ramp hold input (ON = Hold).*
<b>DIGIN 2 (E3)</b>	Diagnostic displaying the current state of the digital input 2 (E3), by default this is connected to Preset Select input 1. *
<b>DIGIN 3 (E4)</b>	Diagnostic displaying the current state of the digital input 3 (E4), by default this is connected to Preset Select input 2. *
<b>DIGIN 4 (E5)</b>	Diagnostic displaying the current state of the digital input 4 (E5), by default this is connected to Preset Select input 3. *
<b>DIGOUT 1 (E6)</b>	Diagnostic displaying the current state of the digital output 1 (E6), by default this is connected to At zero speed.
<b>DIGOUT 2 (E7)</b>	Diagnostic displaying the current state of the digital output 2 (E7), by default this is connected to Drive <u>HEALTH</u> , and is always ON when the start is low. This differs from Health as displayed on a front panel i.e.d. which remains of until health is reset by the drive being restarted.

<b>DIGOUT 3 (E8)</b>	Diagnostic displaying the current state of the digital output 3 (E8), by default this is connected to drive <u>READY</u>
<b>RAISE/LOWER O/P</b>	Value of the raise / lower ramp function.
<b>PRESET O/P</b>	Output of Preset function block.
<b>SPT SUM O/P 1</b>	Output of Setpoint Sum 1 function block.
<b>SPT SUM O/P 2</b>	Output of Setpoint Sum 2 function block.
<b>SPT SUM O/P 3</b>	Output of Setpoint Sum 3 function block.
<b>RAMP OUTPUT</b>	Output of Ramp function block.
<b>SPEED SETPOINT</b>	Speed loop total setpoint including the ramp output before the ramp-to-zero function. The ramp-to-zero function block is only used while during the stopping states, Normal Stop, Program Stop and Coast Stop.
<b>ENCODER</b>	Encoder speed feedback diagnostic in RPM.

## Speed Feedback

There are two speed feedback diagnostics available in the DIAGNOSTICS menu:

<b>ENCODER</b>	This displays the speed setpoint in RPM.
<b>SPEED FEEDBACK</b>	This displays the speed setpoint as a percentage.

## Alarm Status :: First Alarm, Alarm Status :: Health Store and Alarm Status :: Health Store.

First Alarm, Health Store and Health Word are displayed as 16bit hexadecimal status words where every bit has unique meaning described in the table below. These parameters are in the Alarms section of the MMI.

In Health Store and First Alarm only one bit is set at any one time, All active bits are set in Health Word immediately the alarm condition is detected.

HEALTH OVERSPEED	0x0001	Over Speed
HEALTH 2	0x0002	Reserved
HEALTH 4	0x0004	Reserved
HEALTH HEATSINK	0x0008	Fin Temp
HEALTH MOTOR TEMP	0x0010	Motor Temp
HEALTH OVER VOLTS	0x0020	Over Volts
HEALTH UNDER VOLTS	0x0040	Under Volts
HEALTH 80	0x0080	Reserved
HEALTH 100	0x0100	Reserved
HEALTH STACK TRIP	0x0200	Gate drive shut down due to Over Current or Over Volts.
HEALTH AUTOTUNE	0x0400	Autotune Error
HEALTH 5703 RECEIVE	0x0800	P3 in slave mode is not receiving valid messages
HEALTH STALL TRIP	0x1000	The motor has stalled
HEALTH OVER CURRENT	0x2000	Over Current Trip

HEALTH EXTERNAL TRIP	0x4000	External Trip
HEALTH OTHER	0x8000	Other Alarms

## Alarm Error Codes

### Calibration Error Messages

Error no.	Cause	Action
E000	Number of encoder lines too high.	Set the encoder lines to a sensible value.
E001	Number of encoder lines (or value of max speed) too small	Set encoder lines (or max speed) to a sensible value.
E002	Mag current greater than drive rating.	Set mag current to a sensible value.
E003	Mag current greater than motor current.	Set mag current to a sensible value.
E004	Current loop 'gain' parameter value too small value (i.e. actual gain is very large)	Set current loop 'gain' parameter to a sensible value.
E005	Motor rating is greater than 3 X Drive Rating.	Reduce motor rating.
E006	Max speed exceeds the allowable range, i.e. 5 times the nameplate rpm value.	Reduce max speed to less than or equal to 5 times the nameplate rpm value.
E007	Max speed X encoder lines exceeds the maximum encoder frequency of 250kHz (equivalent to 5000 lines, 3000 rpm)	Reduce max speed, or fit an encoder with fewer lines.
E009	Rotor time constant too small.	Set rotor time constant to a sensible value.
E010	Max speed is set to a value which is more than 30% higher than the value of 'max speed rpm' which existed when autotune was last carried out. Autotune gathers data on the motor up to 'max speed rpm' plus 30%, and no higher. Therefore any attempt to run the motor faster than this will degrade performance.	<p>Either:</p> <ol style="list-style-type: none"> <li>1. Reduce max speed to less than or equal to 'autocal max rpm' plus 30%. Note that 'autocal max rpm' is a parameter which may be found in the 'Autotune' menu under 'Setup Parameters'. It records the value of 'max speed rpm' which existed when autotune was last carried out.</li> <li>Or 2. Re-run autotune with 'max speed rpm' set to a higher value.</li> </ol>



## Autotune Errors

Error no.	Cause	Action
D100	Drive was stopped in the middle of the Autotune process.	If necessary, re-run Autotune.
D101	Motor was unable to reach the required speed - timeout occurred.	Ensure that motor is able to spin freely. Alternatively, ensure that the drive has been set up and is able to control the motor. See instructions for Autotune.
D102	Low mains. The mains voltage is not high enough to enable the autotune to be carried out.	Retry when the mains has recovered.
D103	Drive was not able to set up the magnetising current - timeout occurred.	Check motor data is correct, especially nameplate rpm and motor volts. Check also that the motor is correctly rated for the drive.
D104	Mag current greater than motor or drive rating.	As above.
D105	'Max Speed Rpm' is set to a value lower than the motor 'Nameplate Rpm'.	Set 'Max Speed Rpm' to a value greater than or equal to 'Nameplate Rpm'. This restriction will no longer apply after autotune has been completed.
D106	Mag current greater than drive rating.	The motor is too large for the drive.
D107	Mag current greater than motor current.	As error D103.
D108	Nameplate rpm set to a value greater than the base speed of the motor.	Set nameplate rpm to the correct value exactly as given on the nameplate.
D109	Calculated value of rotor time constant is too large. Probably due to an incorrect value of nameplate rpm.	As above.
D110	Calculated value of rotor time constant is too small. Probably due to an incorrect value of nameplate rpm.	As above.

Error no.	Cause	Action
F001	AUTOTUNE_ERROR	Autotune failed to complete.
F002	AUTOTUNE_ABORT	Autotune aborted by user.
F003	PRE_READY_FAULT	Fault in pre_ready state
F100	CAM_FULL_INIT	Internal software error
F200	CFG_INHIBIT	Config Enable high - Set to low and retry
F300	SEQ_STATE_MACHINE	Internal software error
F400	SYSTEM_TIME_FREEZE	Internal software error

## ALARMS

If the drive trips then the display immediately shows a message indicating the reason for the trip. Alarm conditions are reset by removing and re-applying RUN. The alarm message can be cleared from the display by pressing the "E" key. It can be retrieved by using the **FIRST ALARM** menu.

The possible alarm messages are:

**LINK UNDERVOLTS**

The DC link voltage is too low. Possible reasons for this alarm message are:

- (a) The mains voltage is too low;
- (b) The mains supply has been lost;
- (c) One of the three phases of the supply is missing.

**LINK OVERVOLTAGE**

The DC link voltage is too high. Possible reasons for this alarm message are:

- (a) The mains voltage is too high;
- (b) Trying to decelerate a large inertia load too quickly.

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<b>LINK OVERCURRENT</b>	<p>The DC link current is too high. Possible reasons for this alarm message are:</p> <ul style="list-style-type: none"><li>(a) Trying to accelerate a large inertia load too quickly;</li><li>(b) Trying to decelerate a large inertia load too quickly;</li><li>(c) Application of shock load;</li><li>(d) Short circuit between motor phases;</li><li>(e) Short circuit between motor phase and earth;</li><li>(f) Too long output cables or too many parallel motors;</li><li>(g) Voltage boost set too high.</li></ul>
<b>HEATSINK TEMP</b>	<p>The drive heatsink temperature is too high. Possible reasons for this alarm message are:</p> <ul style="list-style-type: none"><li>(a) The ambient air temperature is too high;</li><li>(b) A drive cooling fan has failed.;</li><li>(c) Poor ventilation.</li></ul>
<b>MOTOR TEMP</b>	<p>The motor temperature is too high. Possible reasons for this alarm message are:</p> <ul style="list-style-type: none"><li>(a) Prolonged operation of the motor at low speed without forced cooling;</li><li>(b) Excessive load;</li><li>(c) Motor voltage rating incorrect; / Mag Current set too high.</li></ul>
<b>MOTOR STALLED</b>	<p>The motor has stalled. Possible reasons for this alarm message are:</p> <ul style="list-style-type: none"><li>(a) Motor loading too great;</li><li>(b) <b>MOTOR I LIMIT</b> parameter set too low;</li><li>(c) <b>STALL TRIP TIME</b> parameter too low;</li></ul>
<b>EXTERNAL TRIP</b>	<p>A Tag that can optionally be connected to a digital input. The drive will trip if this is set high.</p>
<b>CONFIG ENABLE</b>	<p>The "Enable Configuration" flag has been left in the enable state. This needs to be disabled in order to run the drive.</p>
<b>CHECKSUM FAILED</b>	<p>Hardware error.</p>
<b>EE VERSION ERROR</b>	<p>Hardware error.</p>
<b>EEPROM ERROR</b>	<p>Hardware error. Or 620L or 620Adv has been reset to factory defaults.</p>