Trips and Fault Finding

Trips

What Happens when a Trip Occurs

When a trip occurs, the Drive's power stage is immediately disabled causing the motor and load to coast to a stop. The trip is latched until action is taken to reset it. This ensures that trips due to transient conditions are captured and the Drive is disabled, even when the original cause of the trip is no longer present.

Drive Indications

If a trip condition is detected the unit displays and performs the following actions.

1. The HEALTH LED goes out indicating a Trip condition has occurred. (Investigate, find and remove the cause of the trip.)
2. Terminal B6 (Healthy) goes low (0V).

Keypad Indications

If a trip condition is detected the MMI displays and performs the following actions.

1. The HEALTH LED goes out indicating a Trip condition has occurred. The MMI displays the activated alarm. (Investigate, find and remove the cause of the trip.)
2. The alarm message(s) can be acknowledged by pressing the **E** key, however, the unit will not restart at this point.

Resetting a Trip Condition

All trips must be reset before the Drive can be re-enabled. A trip can only be reset once the trip condition is no longer active, i.e. a trip due to a heatsink over-temperature will not reset until the temperature is below the trip level.

NOTE

More than one trip can be active at any time. For example, it is possible for both the HEATSINK TRIP and the OVERVOLTS (VA) trips to be active. Alternatively it is possible for the Drive to trip due to a FIELD OVER I error and then for the HEATSINK TRIP trip to become active after the Drive has stopped (this may occur due to the thermal time constant of the heatsink).

You can reset the trip(s) in one of two ways:

1. Power-up, or remove and re-apply the auxiliary power supply.
2. Stop and start the drive, i.e. remove and re-apply the Start/Run signal (terminal C3 or C4, or the STOP and RUN keys on the MMI).

Success is indicated by the HEALTH LED (on the unit or MMI) illuminating. The MMI will return to its original display.

Fault Finding

Problem	Possible Cause	Remedy
Drive will not power-up	Fuse blown	Check supply details, replace with correct fuse.
		Check Product Code against Model No.
	Faulty cabling	Check all connections are correct and secure.
		Check cable continuity
Drive fuse keeps blowing	Faulty cabling or connections wrong	Check for problem and rectify before replacing with correct fuse
	Faulty Drive	Contact Parker SSD Drives
Cannot obtain HEALTH state	Incorrect or no supply available	Check supply details
Motor will not run at switch on	Motor jammed	Stop the Drive and clear the jam
Motor runs and stops	Motor becomes jammed	Stop the Drive and clear the jam
Motor runs at full speed only	Reversed tachogenerator or open circuit tachogenerator	Check tachogenerator connections
	Open circuit speed reference potentiometer	Check terminal

Table 7-1 Fault Finding

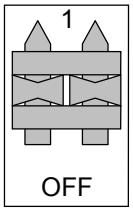
Calibration Checks

The drive leaves the factory with the following calibration switches correctly set. Inappropriate settings will prevent the drive from operating correctly. For your reference, the correct settings are given below.

IMPORTANT ***If you change the settings for any of these switches you MUST re-calibrate the Control Board. Refer to Chapter 4: "Operating the Drive" - Calibrating the Control Board.***

Control Board Calibration

The control board calibration scaling switch of previous DC590+ products (shown opposite) has been replaced by a software-controlled scaling function. There are no user settings required.



Power Board Current Calibration Switches (Frame 2)

NO POWER IS CONNECTED AT THIS STAGE

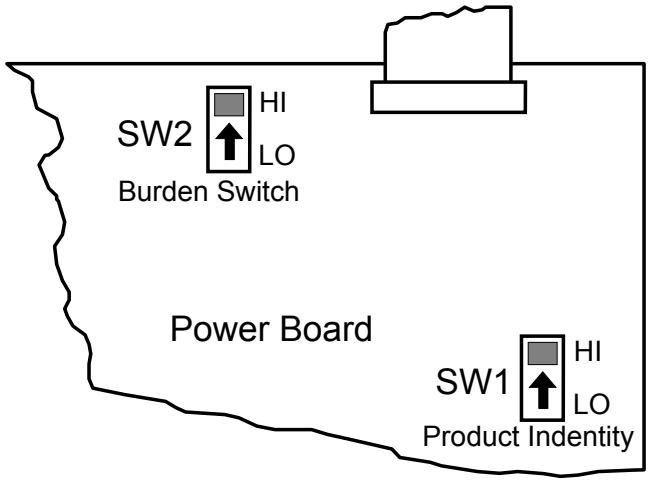
View the switches with the drive door open:

SW1 - Product Identity Switch

This switch is always set to HI.

SW2 - Burden Switch

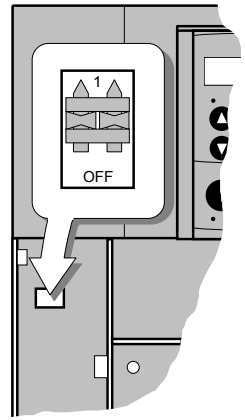
This switch is always set to HI.



Adaptor Board Current Calibration Switch (Frame 3)

NO POWER IS CONNECTED AT THIS STAGE

View the switch with the terminal cover removed:



IA CAL - Armature Current Calibration Switch

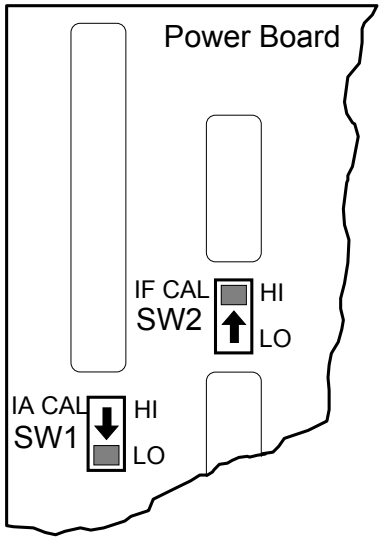
This switch should be set to "1" (ON) for armature current scaling greater than 128A.
Set to OFF for other values.

NOTE **This switch must only be operated with the drive powered-down.**

Power Board Current Calibration Switches (Frames 4 & 5)

NO POWER IS CONNECTED AT THIS STAGE

View the switches with the drive door open:



IA CAL – Armature Current Calibration Switch (SW1)

This switch is always set to LO on Frame 4 & 5 drives of 500A or less, and HI for drives greater than 500A.

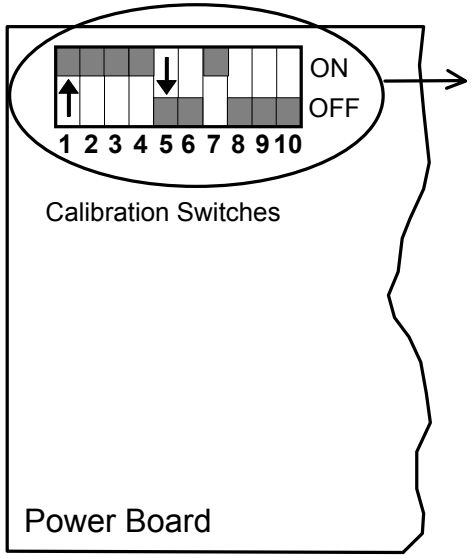
IF CAL – Field Current Calibration Switch (SW2)

This switch is always set to HI for Frame 4 & 5 drives. The maximum field current calibration is 30A.

Power Board Current Calibration Switches (Frames 6 & H)

NO POWER IS CONNECTED AT THIS STAGE

To access the power board remove the terminal cover, unscrew the two fixings on the right hand side of the control door. Open the door to reveal the power board.



SW1 - 6 **Armature Current Calibration**
500A stages (factory setting = 2000A)
thus switches 1 to 4 = ON

SW7 Reserved (factory setting = ON)

SW8 - 9 **Field Current Calibration**

0 = OFF
1 = ON

8	9	Field Current Range
0	0	up to 20A (factory setting)
0	1	up to 40A
1	0	up to 60A
1	1	up to 80A

(not used on standard build)

SW10 **Armature Voltage Calibration**
OFF = VA / 100 (for VA up to 875V) (factory setting)

Figure 7-1 Calibration Switches

IA CAL - Armature Current

Calibration switches 1 to 4 are always set to “ON”, and 5 to 6 are always set to “OFF”.

Armature Voltage

Calibration switch SW10 is always set to "OFF".

IF CAL - Field Current

For field currents greater than 20A, set the Field Current calibration switches 8 and 9 to give the required Field Current range. The drive’s Product Code includes the value for Field Current. If you change the Field Current from the 20A factory setting to another value, you must now select the correct Product Code rating:

AUXILIARY POWER ONLY IS CONNECTED AT THIS STAGE

Apply auxiliary power. Note the current Product Code which is displayed on the MMI's Welcome screen at the top of the menu, e.g. DC 4Q 1700A **20** D (**20** = 20A Field Current range)

Set the following parameters, but first select CONFIGURE ENABLE to be ENABLED.

Now, for instance, to set the Field Current range for 40A, you must select the appropriate Product Code for a Field Current range of 40A, e.g. DC 4Q 1700A **40** D

To do this, refer to Chapter 6: "The Keypad" – Changing the Stack Size (3-button reset).

Note the nominal field current from the motor rating plate and set this value in the FIELD CURRENT parameter.

MMI Menu Map

1 CONFIGURE DRIVE
FIELD CURRENT

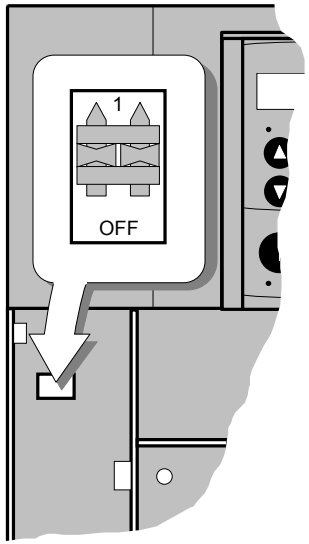
Now select CONFIGURE ENABLE to be DISABLED and perform a PARAMETER SAVE.

You MUST re-calibrate the Control Board.
Refer to Chapter 4: "Operating the Drive" - Calibrating the Control Board.

Adaptor Board Current Calibration Switch (Frames 6 & H)

NO POWER IS CONNECTED AT THIS STAGE

View the switch with the terminal cover removed:



IA CAL - Armature Current Calibration Switch

This switch is always set to "1" (ON).

Alarm Messages

When a trip occurs an alarm message is displayed on the MMI, and information about the trip is stored in the ALARM STATUS menu.

The alarm message and the LAST ALARM parameter are displayed in the selected language when viewed on the MMI.

The HEALTH STORE, HEALTH WORD and ALARM HISTORY parameters display information as hexadecimal values, or the sum of the hexadecimal values when more than one alarm is active. Thus the unique value can represent one or more alarms.

MMI Menu Map

1 ALARM STATUS
- LAST ALARM
- HEALTH WORD
- HEALTH STORE

NOTE **Hexadecimal refers to the common practice of counting to the base of 16 in computing rather than the base of 10. The sixteen `numbers' used being 0 to 9, A to F. Thus an 8 bit byte is represented by two characters in the range 00 to FF, while a 16 bit word is represented by four characters in the range 0000 to FFFF.**

LAST ALARM

(Tag 528). This display shows the last alarm message to have been displayed. To reset the parameter simply press the ▼ (DOWN) key to clear the alarm. Alternatively, you can switch the auxiliary supply off and on, causing NO ACTIVE ALARMS to be displayed.

NOTE **The LAST ALARM value is presented in hexadecimal format when viewed in CELite or when used in the Block Diagram.**

HEALTH WORD

(Tag 115).This parameter is used to continuously monitor the status of the Drive. As alarms are added or removed, the display will immediately update to show the hexadecimal sum of these alarms.

The value reverts to 0x0000 when the Start (C3) input is raised (+24V), and when no trip condition is present.

HEALTH STORE

(Tag 116).This displays the hexadecimal value of the first (or only) alarm to occur causing the trip condition.

The display reverts to 0x0000 when the Start (C3) input is raised (+24V).

ALARM HISTORY

The most recent 10 alarm events are stored in the ALARM HISTORY funtion block, with the oldest in parameter ALARM 10 (OLDEST), and most recent in ALARM 1 (NEWEST). As with the HEALTH STORE and HEALTH WORD parameters, the alarm history is stored as four character hexadecimal numbers.

MMI Menu Map

1 FUNCTION BLOCKS

2 ALARMS

3 ALARM HISTORY
- ALARM 1 NEWEST
- ALARM 2
- ALARM 3
- ALARM 4
- ALARM 5
- ALARM 6
- ALARM 7
- ALARM 8
- ALARM 9
- ALARM 10 OLDEST

Hexadecimal Representation of Trips

The LAST ALARM, HEALTH WORD, HEALTH STORE and ALARM HISTORY parameters use a four digit hexadecimal number to identify individual trips. Each trip has a unique corresponding number as shown below.

LAST ALARM, HEALTH WORD and HEALTH STORE					
Trip		Trip Code			
		First Digit	Digit	Digit	Last Digit
	NO ACTIVE ALARMS				
0	OVERSPEED				1
1	MISSING PULSE				2
2	FIELD OVER I				4
3	HEATSINK TRIP *				8
4	THERMISTOR			1	
5	OVER VOLTS (VA)			2	
6	SPD FEEDBACK			4	
7	ENCODER FAILED			8	
8	FIELD FAILED		1		
9	3 PHASE FAILED *		2		
10	PHASE LOCK		4		
11	5703 RCV ERROR		8		
12	STALL TRIP	1			
13	OVER I TRIP	2			
14	OTHER •	4			
15	ACCTS FAILED *	8			

* Refer to "Power Board LED Trip Information (Frame 4, 5, 6 & H)" below

• *For the LAST ALARM parameter, replace OTHER with trip codes opposite.*

Trip Codes : LAST ALARM only					
14	AUTOTUNE ERROR	F	0	0	1
14	AUTOTUNE ABORTED	F	0	0	2
14	SEQ PRE READY	F	0	0	3
14	CONTACTOR DELAY	F	0	0	4
14	EXTERNAL TRIP	F	0	0	5
14	REMOTE TRIP	F	0	0	6
14	ENABLE LOW	F	0	0	7
14	SEQUENCING	F	0	0	9
14	COMMS TIMEOUT	F	0	1	0
14	CONFIG ENABLED	F	2	0	0
14	CALIBRATION TRIP	F	3	0	0
14	NO OP-STATION	F	4	0	0
14	AUX SUPPLY	F	F	0	3

When more than one trip is to be represented at the same time then the trip codes are simply added together to form the value displayed. Within each digit, values between 10 and 15 are displayed as letters A to F

For example, if the HEALTH WORD parameter is **01A8** then this represents a “1” in digit 3, an “8” and a “2” in digit 2, (8+2 = 10, displayed as A) and an 8 in digit 1. This in turn represents the active trips FIELD FAILED, ENCODER FAILED, OVER VOLTS (VA) and HEATSINK TRIP (an unlikely situation).

Decimal number	Display
10	A
11	B
12	C
13	D
14	E
15	F

Power Board LED Trip Information (Frame 4, 5, 6 & H)

The HEATSINK TRIP, 3 PHASE FAILED and ACCTS FAILED trips are associated with the following LED indications:

Frame 4

Check the LEDs on the power board for more HEATSINK TRIP information.

The LEDs light to indicate a problem.

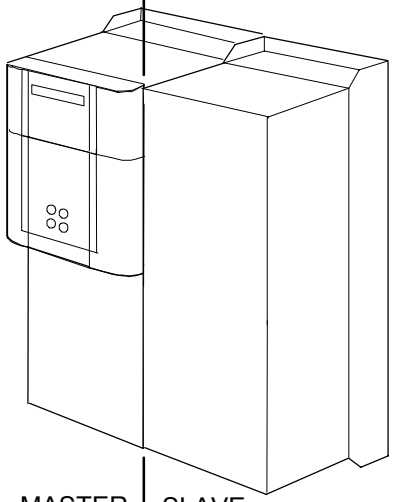
Trips		
HEATSINK TRIP	field heatsink overtemperature	FLD HS OT
	armature heatsink overtemperature	ARM HS OT
3 PHASE FAILED	phase loss	PHASE LOSS

Frame 5

The master power board (on the left hand side of the unit) is fitted with a Parallel Expansion Board. This board has four additional LEDs providing information about the slave power board (on the right hand side of the unit), and about the general status of the unit.

The LEDs light to indicate a problem.

Trips		***Master Power Board***	***Slave Power Board*** *(indicated by the Parallel Expansion Board)*
HEATSINK TRIP	field heatsink overtemperature	FLD HS OT	
	armature heatsink overtemperature	ARM HS OT	ARM HS OT
3 PHASE FAILED	phase loss	PHASE LOSS	PHASE LOSS
	phase rotation fault		PH ROT FLT
ACCTS FAILED	current imbalance		CUR IMBALANCE



It is essential that the phase sequence applied to the two stacks are identical otherwise the converter will trip on 3 PHASE FAILED.

If there is a current imbalance between the stacks which exceeds 10% the converter will trip on ACCTS FAILED.

Frame 6

Eight diagnostic LEDs indicate further trip information, and general status of the unit. The LEDs go out to indicate a problem (note that LED1 may also flash as the SMPS attempts to power-up repeatedly, indicating a fault).

Trips		Power Board	
	switched mode power supply on	SMPS OK	O LED1
ACCTS FAILED	trigger board connection status	TRIGGER BOARD PRESENT	O LED9
	ac current transformer connection status	ACCTS PRESENT	O LED10
3 PHASE FAILED	thyristor fuses status	THYRISTOR FUSES	O LED11
HEATSINK TRIP	field heatsink temperature normal	FIELD THERMOSTAT	O LED12
	L1 Phase Assembly heatsink temperature normal	L1 STACK THERMOSTAT	O LED13
	L2 Phase Assembly heatsink temperature normal	L2 STACK THERMOSTAT	O LED14
	L3 Phase Assembly heatsink temperature normal	L3 STACK THERMOSTAT	O LED15
	Fans stalled	L* FAN	O Fan LEDS

* In the event of a trip due to a stalled fan, an unlit fan LED will indicate the failed fan. With the drive stopped, operate the fan fail override switch and restart the drive. Diagnose the failed fan from the fan LEDs status.

Frame H

The power board has six LEDs indicating further trip information, and general status of the unit.

The LEDs go out to indicate a problem (note that LED1 may also flash as the SMPS attempts to power-up repeatedly, indicating a fault).

Trips		***Power Board***	
	switched mode power supply on	SMPS OK	LED1
ACCTS FAILED	trigger board connection status	TRIGGER BOARD PRESENT	LED4
	ac current transformer connection status	ACCTS PRESENT	LED3
3 PHASE FAILED	thyristor fuses status	THYRISTOR FUSES	LED6
HEATSINK TRIP	field heatsink temperature normal	FIELD HEATSINK	LED2
	armature heatsink temperature normal	STACK THERMOSTATS	LED5

Using the MMI to Manage Trips

Trip Messages

Most of the alarms have a delay timer so that the Drive only trips if the condition persists for the whole of the delay period.

If the Drive trips, then the display immediately shows a message indicating the reason for the trip. The possible trip messages are given in the table below.

Trip Message and Meaning	Possible Reason for Trip
OVERSPEED Motor overspeed - the speed feedback signal has exceeded 125% of rated speed.	Badly adjusted speed loop (alarm only operates with encoder or armature volts feedback selected) Alarm time delay : 50 milliseconds
MISSING PULSE A missing pulse from the 6-pulse armature current waveform. This trip is only enabled when the motor loading exceeds 1.5 times the DISCONTINUOUS parameter value. **Note that the MISSING PULSE trip is not intended or able to protect the drive if a thyristor fails to function during regenerative operation. This can result in damage to the drive.** We recommend fusing the armature circuit if regenerative operation is intended. The MISSING PULSE trip is intended to detect firing circuit connector problems during motoring operation of the drive.	Firing plug failure Connection failure Alarm time delay : 60 seconds
FIELD OVER I The motor field current has exceeded 120% of the calibrated value	External field has incorrect supply phases applied (Alarm only operates with field current control mode selected) Alarm time delay : 10 seconds

Trip Message and Meaning	Possible Reason for Trip
HEATSINK TRIP The Drive heatsink temperature is too high	The ambient air temperature is too high Poor ventilation or spacing between Drives Fan failure, check fuse on power board, wrong rotation (models above 70A bridge rating) Blocked ventilation slots Clogged air filters Excessive armature current - nominal armature current on motor nameplate should be checked against the current calibration for the Drive. ***Note:*** **The stack must be allowed to cool in order to re-start the Drive.** Alarm time delay : 0.5 seconds
THERMISTOR The motor temperature is too high	Inadequate ventilation Blower failure -check for direction, clogged air filters (models above 70A bridge rating) Excessive armature current - check nominal armature current on nameplate against current calibration) ***Note:*** **The motor must be allowed to cool in order to re-start the Drive.** Alarm time delay : 5 seconds
OVER VOLTS (VA) Motor armature voltage has exceeded 120% of rated volts	Loose armature connection Badly adjusted field voltage setting Badly adjusted field current loop Badly adjusted field-weakening bemf loop Badly adjusted speed loop Alarm time delay : 1 second
SPEED FEEDBACK The difference between speed feedback and armature voltage feedback is greater than the SPDFBK ALM LEVEL parameter value If FLD WEAK ENABLE parameter is enabled, speed feedback is less than 10% when in the field weakening region	Analog tacho feedback polarity incorrect (terminals G3 and G4) The ENCODER SIGN parameter's polarity is incorrect Disconnection of wiring, including fibre optics Armature voltage calibration has not been suitably reduced when running at reduced field currents Tachogenerator failure Tachogenerator coupling failure Alarm time delay : 0.125 seconds

Trip Message and Meaning	Possible Reason for Trip
ENCODER FAILED No speed feedback signal	The SPEED FBK SELECT parameter is set to ENCODER but an optional Encoder board is not fitted Where applicable, check fibre optic cable for damage, bend radius, operating length - refer to the Microtach handbook. Check cable and connections on wire-ended encoder
FIELD FAIL Field current is less than 6% of rated current when in Current Control mode Field current is less than 50mA when in Voltage Control mode (with default current burden of 15K)	Open circuit motor field - check connection and measure field resistance Faulty operation of field controller Where an ac supply feeds the onboard field regulator, check connections FL1 & FL2 for line-to-line voltage (rather than line-to-neutral) - L1 into FL1, L2 into FL2. Note that the 3-phase supply must be present for mains synchronisation purposes. For loads where no field supply is required, e.g. a permanent magnet motor, set the FIELD ENABLE parameter to DISABLED to suspend this alarm. Alarm time delay : 1 second
3-PHASE FAILED 3-phase supply failure	Total failure of supply, or missing phase of 3-phase supply (detected under most circumstances) - check supply to the controller, check high-speed thyristor stack protection fuses, check power chassis coding fuses. Check the mains voltage of the Drive (refer to the Product Code). This alarm may not operate properly with controller if the voltage is incorrect, i.e. wrong unit or controller.
PHASE LOCK Supply frequency is outside the frequency band limits 45 - 65Hz	Check supply frequency Synchronisation errors caused by distorted supply
5703 RCV ERROR Invalid data received via P3 port from another Drive	(Alarm only operates when MODE parameter is set to 5703 SLAVE)
STALL TRIP With motor stationary (AT ZERO SPEED parameter shows TRUE), current has exceeded the STALL THRESHOLD parameter value for longer than the STALL TRIP DELAY parameter value	(Alarm only operates when the STALL TRIP parameter is enabled).
OVER I TRIP Current feedback value has exceeded 280% of rated current	(300% loading not exceeding 15ms or 325% not exceeding 6.6ms is acceptable) Motor armature windings failure - check insulation resistance. Badly tuned current loop Faulty Drive - refer to Parker SSD Drives

Trip Message and Meaning	Possible Reason for Trip
ACCTS FAILED AC current transformer plug connection to Drive power board missing	Check armature current transformer plug for correct installation. Frame 5 only : Load imbalance between the two parallel power stacks ***Note:*** **The trip prevents the contactor closing and the current loop activating without armature current feedback - important in the case of external stack controllers where the thyristor stack is remote from the control board.**
AUTOTUNE ERROR Error has been encountered during the Autotune process to include: Speed feedback has exceeded 20% of rated speed Field current feedback has exceeded 6% of rated field current	The motor shaft was rotating, or was caused to rotate. The field current was seen to exceed 6%, when a field-off Autotune had been selected, or the field current stopped during a field-on Autotune. The drive to armature wiring was open-circuit. The discontinuous current boundary was found to exceed 200% of either the stack rating or the nominated motor armature current rating (refer to Chapter 5: "Control Loops" - Manual Tuning) Large imbalance in the three-phase voltages of the supply (refer to Chapter 5: "Control Loops" - Manual Tuning) A hardware fault relating to current feedback was detected on the control board.
AUTOTUNE ABORT The Autotune sequence has been aborted.	Coast Stop, Program Stop, Enable or Start Run terminal(s) disabled during Autotune sequence The AUTOTUNE parameter reset during the Autotune sequence Autotune sequence has timed-out (approximately 2 minutes).
SEQ PRE READY Coding not present.	Replace power board or chassis.
CONTACTOR DELAY The internal auxiliary 3-phase contactor failed to close.	Check the position of the Calibration Scaling Switch - refer to Calibration Checks, page 7-3.
EXTERNAL TRIP	Customer alarm! Trip operates if input open or high impedance. Alarm time delay : 0.2 seconds Device not wired to drive or device open circuited : check C1 to C2 connections to drive - connect C1 to C2 if customer device not fitted.
REMOTE TRIP	REM. SEQUENCE parameter Remote Trip flag set to zero.
ENABLE LOW	Local Mode run with Enable input low

Trip Message and Meaning	Possible Reason for Trip
SEQUENCING Internal sequencing error	Contact Parker SSD Drives
COMMS TIMEOUT Remote comms timeout	See COMMS TIMEOUT parameter in the SEQUENCING function block
CONFIG ENABLED	The drive was requested to start whilst in Configuration mode
CALIBRATION FAIL	Signal calibration fault If powering the unit off and on does not remove the problem, a hardware failure is suspected. Refer to Parker SSD Drives.
NO OP STATION	Keypad has been disconnected from Drive whilst Drive is running in local control.
AUX SUPPLY	Check auxilliary supply and/or mains input
COMMS FAULT CODE x	Keypad faulty Remote cable to keypad faulty Drive firmware not running
CRITICAL ERROR xxxx::xxxxxxxx	Contact Parker SSD Drives

Table 7-2 Trip Messages

Self Test Alarms

Self Test Alarm and Meaning	Possible Reason for Alarm
(EEPROM) CHECKSUM FAIL Parameters not saved, or are corrupted.	(The alarm appears at power-up or at the end of "Upload" UDP Transfer) Corrupted UDP file loaded - press the **E** key and perform a PARAMETER SAVE. The Drive will be returned to its factory default values.
LANGUAGE CHECKSUM FAIL Incorrect language selected, or corrupted	(The alarm appears at power-up or at the end of "Upload" UDP Transfer) Corrupted UDP file loaded - press the **E** key and reload the correct language or de-select the second language.

Setting Trip Conditions

The following parameters in the CALIBRATION and ALARMS menus are used to set trip conditions:

CALIBRATION :: OVER SPEED LEVEL
ALARMS :: SPDFBK ALM LEVEL
ALARMS :: STALL THRESHOLD
ALARMS :: STALL TRIP DELAY
ALARMS :: REMOTE TRIP DELAY

Viewing Trip Conditions

The following parameters in the ALARMS menu can be viewed to investigate trip conditions:

LAST ALARM
HEALTH WORD
HEALTH STORE
THERMISTOR STATE
SPEED FBK STATE
STALL TRIP
REMOTE TRIP

There are ten parameters in the ALARMS HISTORY function block that store the most recent alarm events.

Inhibiting Alarms

The following alarms can be inhibited in the ALARMS menu.

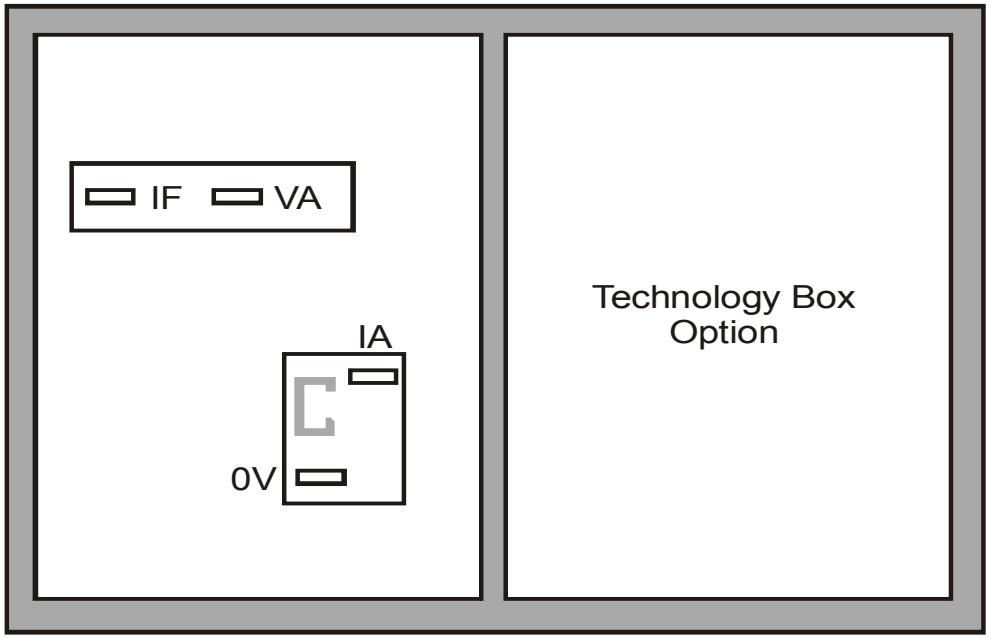
SPEED FBK ALARM
ENCODER ALARM
FIELD FAIL
5703 RCV ERROR
STALL TRIP
TRIP RESET
REM TRIP INHIBIT

The block diagram can be wired to reset a trip condition by using the TRIP RESET parameter in the ALARMS function block. A FALSE to TRUE transition of this parameter will cause the trip to reset.

NOTE **The STALL TRIP parameter in the DIAGNOSTICS menu is set regardless of the state of STALL TRIP inhibit. The flag is set after the stall time-out expires. The relevant bit (bit 12) in the HEALTH WORD and HEALTH STORE parameters is only set when STALL TRIP is enabled.**

Test Points

The following test points are located on the control board and can be accessed through the Technology Option housing. When used with a meter, they will provide valuable information in the event of a fault. Refer to Parker SSD Drives for further information.



Test Points viewed through the front of the drive.

Test Point	Description
IF	Field current feedback 0.0V = 0% 4.0V =100% (mean voltage), *value of FIELD I FBK diagnostic, Tag No. 300*
IA	Armature current feedback ± 1.1V ≡ ±100% (mean current), *value of CURRENT FEEDBACK diagnostic, Tag No. 298*
VA	Armature volts feedback +5V ≡ +100%, +2.5V ≡ 0%, 0V ≡ -100% calculated VA (mean voltage), *value of TERMINAL VOLTS diagnostic, Tag No. 57*
0V	Control board 0V reference